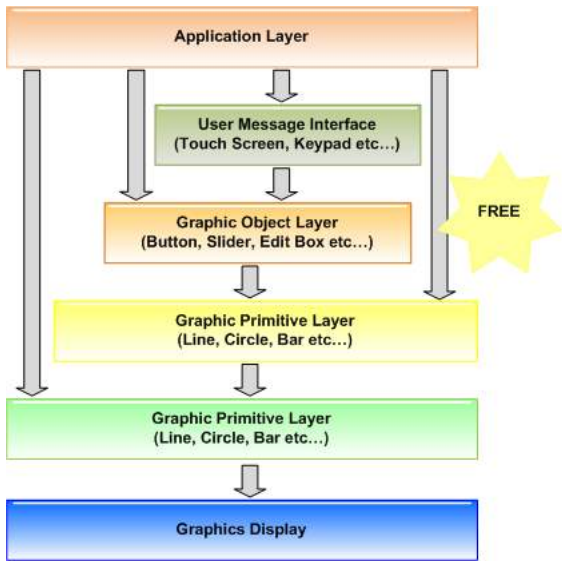
Microchip Graphics Library

Manual for Microchip Graphics Library

Table of Contents

1 Introduction

This document explains how to get started with Microchip Graphics Library solution. It presents the available resources and where to obtain these resources. It also includes the Application Programming Interface (API) of the Microchip Graphics Library.


Application Layer
User Message Interface (Touch Screen, Keypad etc...)
Graphic Object Layer (Button, Slider, Edit Box etc...)
FREE
Graphic Primitive Layer (Line, Circle, Bar etc...)
Graphic Primitive Layer (Line, Circle, Bar etc...)
Graphics Display

The Microchip Graphics Library is highly modular and is optimized for Microchip's 16-bit microcontrollers. Additionally, the library is free for Microchip customers, easy to use, and has an open documented interface for new driver support, which requires creation of only one C file.

The Microchip Graphics Library Software Version 3.01 supports the following features:

- Configurable graphic resolution
- Up to 16-bit or 65K colors
- 2D objects such as line, circle, text, rectangle, polygon, bar
- 3D objects such as buttons, meter, dial, list box, edit box, check box, radio buttons, window, group box, slider.
- Image, animation
- Variety of user input device such as touch screen, keypad etc...
- Multiple fonts
- Unicode fonts
- PIC24 support, PIC32 support

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3 Release Notes

Microchip Graphics Library Release Notes

v3.01 (v3.00)

July-2011

This library provides support for the display modules with built in graphics controller and displays connected to external graphics controller. Documentation for the Microchip Graphics Library can be found in this file:

- **Graphics Library Help.chm**

Version Log

New:

- Graphics External Memory Programmer ported to java version.
- Two options to program boards:
- UART option if the board supports UART interface
- USB option if the board support USB device interface
- when installing the USB drivers for the programmer utility Use the drivers located in "<install directory>\Microchip\Utilities\USB Drivers\MPLABComm"
- For detailed usage, please refer to the External Programmer help file
- Added Analog Clock (see page 70) widget.
- Added new driver Epson S1D13517 display driver with additional driver features:
- Gradient
- Alpha Blending
- 16/24 bits per pixel (bpp)
- Added new Graphics PICtail Plus Epson S1D13517 Board (AC164127-7)
- Added new Graphics Display Truly 5.7" 640x480 Board (AC164127-8)
- Added new Graphics Display Truly 7" 800x480 Board (AC164127-9)
- Added 24bpp support.
- Added a specific PIC24FJ256DA210 demo, PIC24F_DA
- Graphics Resource Converter - refer to the Graphics Resource Converter help file for release note information.
- New PIC32MX Low-Cost Controllerless Graphics PICTail Board (AC164144)
- Added Run Length Encoding (RLE) compression for bitmap images.
- RLE4 - compression for 4-bit palette (16 color) images
- RLE8 - compression for 8-bit palette (256 color) images
- Added Transparency feature for PutImage (see page 383)() functions in Primitive Layer. For Driver Layer, this feature is enabled in the following drivers:
- mchpGfxDrv - Microchip Graphics Controller Driver
- SSD1926 - Solomon Systech Display Controller Driver
- Added new demo for Graphics PICtail Plus Epson S1D13517 Board (S1D13517 Demo)
- Added AR1020 Resistive Touch Screen Controller beta support.
- Added support for MikroElektronika "mikroMMB for PIC24" board.
- Added DisplayBrightness (see page 404)() function for display drivers that have an option to control the display back

light.

- MPLAB X demo project support (BETA)
- Tested with MPLAB X Beta 6
- Each demo project contains multiple configuration schemes
- The graphics object layer uses a default scheme structure. If the application wishes to use a different default scheme, the application will need to define GFX_SCHEMEDEFAULT in GraphicsConfig header file.

Changes:

- Relocated all Graphics Demo projects under Graphics directory (<install directory>/Graphics).
- Works with Graphics Display Designer version 2.1
- Works with Graphics Resource Converter version 3.3
- Removed IPU decoding from the Primitive demo
- Removed ImageFileConverter application from Image Decoder demo
- Use Graphics Resource Converter to generate output for the demo.
- Shorten file name by using abbreviated names
- Refer to abbreviations.htm in the Microchip help directory for details
- Change the "Alternative Configurations" directory in the demos to "Configs"
- Changed the "Precompiled Demos (see page 28)" directory in the demos to "Precompiled Hex"
- Combined all application note demos (AN1136, AN1182, AN1227 and AN1246) into one demo project (AppNotes).
- Modified External Memory and JPEG demos to include USB device mode to program external flash memory.
- Moved the location of the COLOR_DEPTH (see page 48) setting from the HardwareProfile.h to the GraphicsConfig.h (see page 945)
- Removed USE_DRV_FUNCTIONNAME (example USE_DRV_LINE to implement the Line() function in the driver) option to implement Primitive Layer functions in the Driver Layer. The Primitive Layer functions are now modified to have weak attributes, so when the driver layer implements the same function, the one in the driver will be used at build time.
- Modified HardwareProfile.h for Graphics demo boards and development Platforms.
- When using Resistive Touch Screen: add macro USE_TOUCHSCREEN_RESISTIVE
- When using AR1020 as the touch screen controller: add macro USE_TOUCHSCREEN_AR1020
- When using SPI Flash Memory (SST25VF016) in Graphics Development Boards: add macro USE_SST25VF016
- When using Parallel Flash Memory (SST39LF400) in PIC24FJ256DA210 Development Board: add macro USE_SST39LF400
- When using Parallel Flash Memory (SST39LF400) in PIC24FJ256DA210 Development Board: add macro USE_SST39LF400
- Added function pointers for Non-Volatile Memories when used in the Demos (see page 28).
- NVM_SECTORERASE_FUNC - function pointer to sector erase function.
- NVM_WRITE_FUNC - function pointer to write function.
- NVM_READ_FUNC - function pointer to read function.
- Display Driver Layer architecture is changed. Refer to Adding New Device Driver (see page 417) for new requirements.
- Modified Resistive Touch Driver calibration
- In the PIC24FJ256DA210 driver, CopyWindow (see page 407)() is modified to CopyBlock (see page 439)().

Fixes:

- Fixed issue on vertical Progress Bar (see page 371) rendering.
- Updated demos Google map and JPEG to use the proper GFX_RESOURCE (see page 388) identifiers for JPEG resources
- HX8347 driver now compiles and works with 'mikroMMB for PIC24'
- Bug fixes in the digital meet and cross hair widgets

- Removed references to the PIC24 configuration bit COE_OFF.
- Fixed issue on PutImage (see page 383)() when using PIC24FJ256DA210 and look up table is used on images located at internal or external SPI flash with color depth less than 8bpp.
- Fixed issue on Line() in the SSD1926 and mchpGfxDrv driver files. The stored coordinates after a successful rendering of a line will be at the end point (x2,y2).

Deprecated Items:

- TYPE_MEMORY - replaced by GFX_RESOURCE (see page 388)
- EXTDATA - replaced by GFX_EXTDATA (see page 391)
- BITMAP_FLASH - replaced by IMAGE_FLASH (see page 390)
- BITMAP_RAM - replaced by IMAGE_RAM (see page 390)
- BITMAP_EXTERNAL - replaced by GFX_EXTDATA (see page 391)

Migration Changes:

- DisplayDriver.c is not used to select the display driver (the file is not a part of the graphics library release package).
- The application should include the driver(s) in the project. Multiple driver files can be included in one project because the hardware profile will define the driver and only that driver's source code will be used.
- For example, a project may be designed to use the Microchip's PIC24FJ256DA210 graphics controller and the SSD1926 depending on the hardware profile used. The project will include the following source files, SSD1926.c (see page 1144) and mchpGfxDrv.c, among the graphics source files. The hardware profile will contain the following macros, GFX_USE_DISPLAY_CONTROLLER_SSD1926 (see page 57) and GFX_USE_DISPLAY_CONTROLLER_MCHP_DA210 (see page 56), to select the SSD1926 and Microchip's PIC24FJ256DA210 graphics controller, respectively.
- When using PIC24FJ256DA210, the driver files are now changed to:
- mchpGfxDrv.c - source code
- mchpGfxDrv.h - header file
- mchpGfxDrvBuffer.c - source code that declares display buffer, work areas and cache areas for IPU operations in EDS.
- The touch screen drivers in the "Board Support Package" directory are renamed to:
- TouchScreenResistive.c - internal resistive touch source code
- TouchScreenResistive.h - internal resistive touch header file
- TouchScreenAR1020.c - external AR1020 touch source code
- TouchScreenAR1020.h - external AR1020 touch header file
- The two original files (TouchScreen.c and TouchScreen.h) are still needed since they are defining common interfaces to resistive touch drivers.
- When using the internal resistive touch module, the project will contain TouchScreenResistive.c and TouchScreen.c. All modules that reference touch screen APIs will include TouchScreen.h header file.
- When using the external AR1020 touch module, the project will contain TouchScreenAR1020.c and TouchScreen.c. All modules that reference touch screen APIs will include TouchScreen.h header file.
- The touch screen initialization routine API has changed. The new TouchInit API has four parameters passed. Please refer to the API definition for more details.
- When using the Potentiometer on the graphics development boards, include in your project the following files found in the "Board Support Package" directory :
- TouchScreenResistive.c - source code
- TouchScreenResistive.h - header file
- Potentiometer.h - contains the APIs for the A/D interface.
- EEPROM.h and EEPROM.c are going to be deprecated. Use the two new files:
- MCHP25LC256.c - source code
- MCHP25LC256.h - header file
- in the HardwareProfile.h add #define USE_MCHP25LC256 to use the new driver.

- A SPI driver has been created to support projects with multiple devices on one SPI channel.
- Projects will need to include the source file drv_spi.c in projects that use devices on a SPI channel.
- SPI Flash initialization routines will need to pass a DRV_SPI_INIT_DATA structure. This structure defines the SPI control and bit rate used by the SPI Flash module.
- The COLOR_DEPTH (see page 48) macro has been moved from the hardware profile header file to the GraphicsConfig.h (see page 945) header file.
- For project migration please refer the graphics demos for examples.

Known Issues:

- PutImage (see page 383)() does not work when using PIC24FJ256DA210 and look up table is used on images located at EDS memory with color depth less than 8bpp.
- PutImage (see page 383)() of when using PIC24FJ256DA210 for 8bpp images is missing the last row and last column of the bitmap when the image is from external memory, look up table is used and the screen is rotated 90 degrees.
- When compiling the Analog Clock source code with C30 v3.24 the optimization setting must be set to 0 (none).
- External Memory Programmer utility does not work with Graphics PICTail v2 (AC164127)
- When using PIC24FJ256GB210 PIM with Explorer 15 board with a 5v Lumex LCD display, the S1D13517 demo does not run correctly.
- Font tables are limited to 256 pixel character height. For fonts generated for external memory, the maximum height limitation is 128 pixels.

Application Notes

- AN1136 How to Use Widgets in Microchip Graphics Library
- AN1182 Fonts in the Microchip Graphics Library
- AN1227 Using a Keyboard with the Microchip Graphics Library
- AN1246 How to Create Widgets in Microchip Graphics Library
- AN1368 Developing Graphics Applications using PIC MCU with Integrated Graphics Controller

Technical Briefs

- TB3012 Conversion of Graphics PICtail™ Plus Board 2 for Compatibility with USB PICtail Plus

PIC Family

This version of the library supports PIC24, dsPIC and PIC32 Family.

Development Tools

This graphics library release (v3.01) was tested with IDEs MPLAB v8.70 and MPLAB X beta 6; compilers C30 v3.24 and C32 v1.12a.

There is a known compatibility issue between the graphics library and C30 v3.25. using C30 3.25 is not recommended for graphics library development.

There is a known compiler issue with C30 v3.30 ELF libraries, which is the only library format supported by MPLAB X beta 6.

Work around:

1. Use C30 v3.30 COFF libraries in MPLAB 8.xx
2. Use C30 v3.30b

Display Modules

The display driver layer of the library is organized to easily switch from one display driver to another. Use of customized display driver is allowed and in the Display Device Driver Layer (see page 393) section. Following graphics controllers are supported in this version:

Display Module	Interface	File Names
Microchip Display Driver MCHP_DA210 (for the future product PIC24FJ256DA210 Development Board)	8/16 bit EPMP	MicrochipGraphicsModule.c, MicrochipGraphicsModule.h
Samsung S6D0129/S6D0139	8/16 bit PMP	drvTFT001.c (see page 1051), drvTFT001.h (see page 1077)

LG LGDP4531	8/16 bit PMP	drvTFT001.c (see page 1051), drvTFT001.h (see page 1077)
Renesas R61505U/R61580	8/16 bit PMP	drvTFT001.c (see page 1051), drvTFT001.h (see page 1077)
Orise Technology SPDF5408	8/16 bit PMP	drvTFT001.c (see page 1051), drvTFT001.h (see page 1077)
Epson S1D13517	8/16 bit PMP	S1D13517.c, S1D13517.h
Solomon Systech SSD1926	8/16 bit PMP	SSD1926.c (see page 1144), SSD1926.h (see page 1188)
Solomon Systech SSD1289	8/16 bit PMP	drvTFT002.c, drvTFT002.h
Solomon Systech SSD1339 for OLED displays	8 bit PMP	SSD1339.c (see page 1126), SSD1339.h (see page 1142)
Solomon Systech SSD1303 for OLED displays	8 bit PMP	SH1101A_SSD1303.c (see page 1116), SH1101A_SSD1303.h (see page 1124)
Solomon Systech SSD2119	8/16 bit PMP	drvTFT002.c, drvTFT002.h
Sino Wealth SH1101A for OLED displays	8 bit PMP	SH1101A_SSD1303.c (see page 1116), SH1101A_SSD1303.h (see page 1124)
Sitronix ST7529	8 bit PMP	ST7529.c, ST7529.h
Hitech Electronics HIT1270	8 bit PMP	HIT1270.c (see page 1080), HIT1270.h (see page 1095)
Ilitek ILI9320	8/16 bit PMP	drvTFT001.c (see page 1051), drvTFT001.h (see page 1077)
Himax HX8347	8/16 bit PMP	HX8347.c (see page 1097), HX8347.h (see page 1115)
UltraChip UC1610	8 bit PMP	UC1610.c (see page 1224), UC1610.h (see page 1236)

Please refer to Adding New Device Driver (see page 417) section to get more information on adding support for another LCD controller.

Widgets

In this version the following widgets are implemented:

- Analog Clock (see page 70)
- Button (see page 78)
- Chart (see page 92)
- Checkbox (see page 130)
- Dial (see page 138)
- Digital Meter (see page 149)
- Edit Box (see page 157)
- Grid (see page 167)
- Group Box (see page 184)
- List Box (see page 191)
- Meter (see page 210)
- Picture Control (see page 224)
- Progress Bar (see page 232)
- Radio Button (see page 240)
- Slider (see page 251) / Scroll Bar (see page 251)

- Static Text (see page 266)
- Text Entry (see page 274)
- Window (see page 292)

This version of the library supports touch screen, side buttons and a variety of key pad configurations as a user input device.

Required Resources

The library utilizes the following estimated MCU resources (in # of bytes):

Module	Heap for PIC24F	Heap for PIC32	RAM for PIC24F	RAM for PIC32	ROM for PIC24F	ROM for PIC32
Primitives Layer (see page 353)	0	0	68	53	3375	8868
GOL (see page 64)	20 (per style scheme)	24 (per style scheme)	32	28	2076	5400
Button (see page 78)	28 (per instance)	44 (per instance)	8	12	1002	2748
Chart (see page 92)	48 (per instance)	76 (per instance)	94	104	11427	26364
Check Box (see page 130)	22 (per instance)	36 (per instance)	2	4	894	2320
Dial (see page 138)	30 (per instance)	40 (per instance)	8	12	1065	3228
Digital Meter (see page 149)	28 (per instance)	56 (per instance)	2	4	1125	2202
Edit Box (see page 157)	26 (per instance)	40 (per instance)	2	4	822	2332
Group Box (see page 184)	24 (per instance)	36 (per instance)	8	12	903	2164
List Box (see page 191)	28 (per instance), 12 (per item)	44 (per instance)	6	12	1809	2580
Meter (see page 210)	52 (per instance)	68 (per instance)	36	40	2778	6788
Picture Control (see page 224)	22 (per instance)	36 (per instance)	10	12	645	1512
Progress Bar (see page 232)	24 (per instance)	36 (per instance)	12	16	1050	2452
Radio Button (see page 240)	26 (per instance)	44 (per instance)	14	20	993	2632
Slider (see page 251) / Scroll Bar (see page 251)	32 (per instance)	44 (per instance)	20	24	2094	5720
Static Text (see page 266)	22 (per instance)	36 (per instance)	8	12	747	1884
Text Entry (see page 274)	34 (per instance), (24 per key)	52 (per instance)	22	28	2484	6376
Window (see page 292)	24 (per instance)	40 (per instance)	2	4	804	1996

The heap is a dynamic memory requirement. It is released when screen is destroyed. Please consider screen with maximum number of objects to calculate worse case RAM requirement. If for worse case you have 6 buttons, 2 sliders and 2 edit box on screen that utilizes three style schemes then worse case dynamic memory requirement will be 6*28 + 2*32 + 2*26 + 3*20; 344 bytes. The RAM requirement in column 4 doesn't change based on number of instances. If object is included in code then it will take fix amount of RAM irrespective of its usage.

Each font may require 7 – 10KB of program memory. This is for English fonts. This requirement may change for other languages with additional characters.

Images require additional memory. The memory requirement for images depends on color depth and size.

The fonts and images can be stored in internal memory or external memory. The external memory can be anything serial EEPROM, parallel Flash, SD card etc. The application provides physical interface code for these devices.

Previous Versions Log

v2.11

New:

- Graphics Resource Converter (GRC) ported to java version.
- Added support for Inflate Processing Unit (IPU) and Character Processing Unit (CHRGPU)of the Microchip Graphics Module implemented in PIC24FJ256DA210.
- Added new "Google Map Demo" for PIC32MX795F512L and PIC24FJ256DA210 device.
- Added SST39LF400 Parallel Flash Memory driver in "Board Support Package". This is the driver for the parallel flash on the "PIC24FJ256DA210 Development Board".
- Added demo support for PIC32 MultiMedia Expansion Board (DM320005).
- Added GFX_IMAGE_HEADER (see page 389) structure. This structure defines how the image(s) are accessed and processed by the Graphics Library.
- Added a third option (#define XCHAR (see page 361) unsigned char) on the XCHAR (see page 361) usage. This is provided as an option to use characters with IDs above 127 and below 256. With this option, European fonts that uses characters with character IDs above 127 and below 256 can now be generated and used in the library.
- Added a scheme to replace the default font GOLFontDefault (see page 346) in the library with any user defined fonts. Refer to "Changing the default Font (see page 541)" for details.

Changes:

- Added compile switches to all drivers in "Board Support Package" for options to compile out when not used in specific projects.
- Replaced TYPE_MEMORY with GFX_RESOURCE (see page 388) type enumeration and expanded the enumeration for graphics resources (such as images and fonts). GFX_RESOURCE (see page 388) type will determine the source and the data format of the resource (compressed or uncompressed).
- Changes on the macros used on the "Graphics JPEG Demo":

```
// Valid values of the first field for JPEG_FLASH and JPEG_EXTERNAL structures
#define FILE_JPEG_FLASH     2   // the JPEG file is located in internal flash
#define FILE_JPEG_EXTERNAL  3   // the JPEG file is located in external memory
```

to

```
// Valid values of the first field for JPEG_FLASH and JPEG_EXTERNAL structures
#define FILE_JPEG_FLASH     0   // the JPEG file is located in internal flash
#define FILE_JPEG_EXTERNAL  1   // the JPEG file is located in external memory
```

- Added function pointers to GOL (see page 64) structure OBJ_HEADER (see page 68). These function pointers makes it easier to add user created objects in the Graphics Library.
- DRAW_FUNC (see page 69) - function pointer to object drawing function.
- FREE_FUNC (see page 69) - function pointer to object free function. Only for objects that needs free routines to effectively free up memory used by the object create function.
- MSG_FUNC (see page 70) - function pointer to object message function.
- MSG_DEFAULT_FUNC (see page 69) - function pointer to object default message function.
- Merged "Graphics External Memory Demo" and "Graphics External Memory Programmer" into one demo "Graphics External Memory Programmer and Demo".

Fixes:

- TouchScreen driver now checks display orientation and adjusts the touch to be aligned to the display orientation.
- Fixed GOLFocusNext() issue on list that does not contain an object that can be focused.
- Removed redundant code in GOLRedrawRec (see page 309)().
- Added an option in XCHAR (see page 361) to use unsigned char.

Deprecated Items:

- TYPE_MEMORY - replaced by GFX_RESOURCE (see page 388)

- EXTDATA - replaced by GFX_EXTDATA (see page 391)
- BITMAP_FLASH - replaced by IMAGE_FLASH (see page 390)
- BITMAP_RAM - replaced by IMAGE_RAM (see page 390)
- BITMAP_EXTERNAL - replaced by GFX_EXTDATA (see page 391)

Migration Changes:

- To use drivers located in "Board Support Package" directory, add the USE_DRIVERNAME macro in application code (in the demos these are added in the HardwareProfile.h) to include the drivers. Refer to the specific driver code for the correct USE_DRIVERNAME macro name.
- The new version of the Graphics Resource Converter generates graphics application resources (fonts and images) using the new GFX_IMAGE_HEADER (see page 389) structure for images and new GFX_RESOURCE (see page 388) type defines to specify location of the resources. Because of this, some structures are deprecated and replaced with more appropriate structures. To remove the deprecation warnings, regenerate the fonts and images files using the new Graphics Resource Converter.

Known Issues:

- Graphics SSD1926 JPEG and SD Card Demo does not support Graphics Display Powertip 4.3" 480x272 Board (PH480272T_005_I11Q). As is, there's not enough spare memory space to carry out the hardware JPEG decoding operation by the SSD1926. A potential work around is to reduce the active display area size to reserve more memory space for the JPEG decoding operation.
- SSD1926 hardware acceleration for eclipse is disabled due to missing pixels at Angle 0.
- PIC32MX460 PIM (not Starter Kit) does not support 16-bit PMP mode with Graphics PICtail™ Plus Board Version 3 (SSD1926) Board. It only supports 8-bit PMP mode. This is due to pin mapping conflicts on the boards.
- This version of Graphics Library is not compatible with Graphics Display Designer v2.0.0.9c

v2.10

New:

- Added new demo "Graphics Object Layer Palette Demo" for PIC24FJ256DA210 device.
- Added support for PIC32MX795F512L device.
- Added documentation for the Grid (see page 167) object.
- Added Vertical Mode to Progress Bar (see page 371).
- Added MicrochipGraphicsModule display driver.
- Added "Board Support Package" directory. This contains common hardware drivers for Microchip demo boards.
- Added OBJ_MSG_PASSIVE as a translated message on the slider to detect a touch screen release message. This has no effect on the state of the slider. Applications that does not qualify for touch press and touch move event must now qualify the messages for the slider object to avoid processing messages for touch release.

Changes:

- To improve speed modified gfxpmp.c and gfxepmp.c to be inline functions in gfxpmp.h and gfxepmp.h respectively.
- Changed HX8347A.c to HX8347.c (see page 1097) (both the D and A driver version is implemented in the new file). To select set the DISPLAY_CONTROLLER to be HX8347A or HX8347D in the hardware profile.
- Modified malloc() and free() to be defined by macros in GraphicsConfig.h (see page 945) file. For applications using Operating System, the macros can be redefined to match the OS malloc and free functions. The default settings are:
- #define GFX_malloc (see page 48)(size) malloc(size)
- #define GFX_free (see page 48)(ptr) free(ptr)
- Merged GOL (see page 64) Demo English and Chinese demo into one demo.
- Removed the macro "GRAPHICS_HARDWARE_PLATFORM". This is specific to Microchip demo boards.
- Abstracted the timer from the touch screen driver.
- Moved the following hardware drivers to the "Board Support Package" directory
- Touch screen driver: TouchScreen.c and TouchScreen.h files.
- SPI Flash driver: SST25VF016.c and SST25VF016.h files.

- Graphics PICtail Version 2 Parallel Flash driver: SST39VF040.c and SST39VF040.h files.
- Explorer 16 SPI EEPROM Flash driver: EEPROM.c and EEPROM.h files.
- Graphics PICtail Version 2 Beeper driver: Beep.c and Beep.h files.
- Revised the Seiko 3.5" 320x240 display panel schematic to revision B. Corrected the pin numbering on the hirose connector. See "Schematic for Graphics Display Seiko 3.5in 320x240 Board Rev B.pdf" file on the \Microchip Solutions\Microchip\Graphics\Documents\Schematics directory.

Fixes:

- Fixed TextEntry object issue on output string maximum length.
- Fixed Slider (see page 251) increment/decrement issue on Keyboard messages.
- Fixed GOLGetFocusNext (see page 321)() bug when none of the objects in the list can be focused.

Migration Changes:

- pmp interface files are converted to header files and functions are now inline functions to speed up pmp operations. Projects must be modified to:
- include gfxpmp.h and gfxepmp.h source files in the project.
- gfxepmp.c file is retained but will only contain the definition of the EPMP pmp_data.
- Converted the macro: #define GRAPHICS_HARDWARE_PLATFORM HARDWARE_PLATFORM where HARDWARE_PLATFORM is one of the supported hardware platforms defined in the section Graphics Hardware Platform to just simply #define HARDWARE_PLATFORM.
- Since the timer module is abstracted from the touch screen driver in the "Board Support Package", the timer or the module that calls for the sampling of the touch screen must be implemented in the application code. Call the function TouchProcessTouch() to sample the touch screen driver if the user has touched the touch screen or not.

Example:

```
// to indicate the hardware platform used is the
// Graphics PICtail™ Plus Board Version 3
#define GFX_PICTAIL_V3
```

- Projects which uses the following hardware drivers will need to use the latest version of the drivers located in the "Board Support Package" directory.
- Touch screen driver: TouchScreen.c and TouchScreen.h files.
- SPI Flash driver: SST25VF016.c and SST25VF016.h files.
- Graphics PICtail Version 2 Parallel Flash driver: SST39VF040.c and SST39VF040.h files.
- Explorer 16 SPI EEPROM Flash driver: EEPROM.c and EEPROM.h files.
- Graphics PICtail Version 2 Beeper driver: Beep.c and Beep.h files.
- In the TouchScreen driver, the timer initialization and timer interrupt sub-routine (ISR) are abstracted out of the driver. The initialization and the ISR should be defined in the application code. the TouchProcessTouch() function in the driver should be called in the ISR to process the touch.

Known Issues:

- Graphics SSD1926 JPEG and SD Card Demo does not support Graphics Display Powertip 4.3" 480x272 Board (PH480272T_005_I11Q). As is, there's not enough spare memory space to carry out the hardware JPEG decoding operation by the SSD1926. A potential work around is to reduce the active display area size to reserve more memory space for the JPEG decoding operation.
- SSD1926 hardware acceleration for eclipse is disabled due to missing pixels at Angle 0.
- PIC32MX460 PIM (not Starter Kit) does not support 16-bit PMP mode with Graphics PICtail™ Plus Board Version 3 (SSD1926) Board. It only supports 8-bit PMP mode. This is due to pin mapping conflicts on the boards.
- This version of Graphics Library is not compatible with Graphics Display Designer v2.0.0.9c

v2.01

Changes:

- Modified drivers for abstraction of pmp and epmp interfaces. they have a common header file DisplayDriverInterface.h.
- DisplayDriverInterface.h is added to the Graphics.h (see page 639) file.

- DelayMs() API is abstracted from the driver files. TimeDelay.c and TimeDelay.h is added.

Fixes:

- Fixed background color bug in StaticText and Digital Meter (see page 210) object.
- Fixed ListBox LbSetFocusedItem (see page 203)() bug on empty lists.
- Graphics SSD1926 JPEG and SD Card Demo is fixed to support SD card of size 2GB or bigger

Migration Changes:

- pmp interface is abstracted from the driver. Projects must be modified to:
- include gfxpmp.c and gfxepmp.c source files in the project.
- DelayMs() is abstracted from the drivers.
- Add TimeDelay.c source file in the project.
- Add TimeDelay.h header file in the project.

v2.00

Changes:

- "Graphics PICtail Board Memory Programmer" has been renamed to "Graphics External Memory Programmer".
- "Bitmap & Font Converter" utility has been renamed to "Graphics Resource Converter".
- Font format has changed. The bit order has been reversed. Necessary for cross compatibility.
- Added 2 new directories in each demo
- Precompiled Demos (see page 28) - this directory contains all pre-compiled demos for all hardware and PIC devices supported by the demo.
- Alternative Configurations - this directory contains all the Hardware Profiles for all hardware and PIC devices supported by the demo.
- Moved all hardware and display parameters from GraphicsConfig.h (see page 945) to HardwareProfile.h.HardwareProfile.h references a hardware profile file in "Alternative Configurations" directory based on the PIC device selected.

Fixes:

- Fixed BtnSetText (see page 87)() bug when using Multi-Line Text in Buttons.
- Fixed SDSectorWrite() function in SSD1926_SDCard.c in the "Graphics SSD1926 JPEG and SD Card Demo".

Migration Changes:

- Move all hardware and display parameters from GraphicsConfig.h (see page 945) to HardwareProfile.h
- panel type, display controller, vertical and horizontal resolution, front and back porches, synchronization signal timing and polarity settings etc.
- GRAPHICS_PICTAIL_VERSION,1,2,250,3 options are now deprecated, new usages are:
- #define GRAPHICS_HARDWARE_PLATFORM GFX_PICTAIL_V1
- #define GRAPHICS_HARDWARE_PLATFORM GFX_PICTAIL_V2
- #define GRAPHICS_HARDWARE_PLATFORM GFX_PICTAIL_V3 (see page 54)
- The font format has changed, run Graphics Resource Converter to regenerate font files, the bit order is reversed. No legacy support is provided. Primitive/Driver layers now expects the new format.
- The initialization sequence of GOLInit (see page 320)() relative to the flash memory initialization is sensitive due to the sharing of hardware resources, i.e. SPI or PMP. Care should be taken to make sure the peripheral and I/O port settings are correct when accessing different devices.
- A number of configuration options have been moved from GraphicsConfig.h (see page 945) to HardwareProfile.h, this is required to maintain a more logical flow.
- HardwareProfile.h now points to one of many Alternative Configuration files, each one specific to a certain hardware board setup.
- DelayMs routine in SH1101A-SSD1303.c/h is now a private function, no public API is exposed. In future releases, DelayMS will be removed from all drivers and be replaced by an independent module.

- GenericTypeDefs.h has been updated with new definitions, this should not impact any legacy codes.

v1.75b

Changes:

- None.

Fixes:

- Fixed Line2D() bug in SSD1926.c (see page 1144).
- Fixed remainder error in JPEG decoding in JpegDecoder.c (see page 506).
- Fixed pinout labels for reference design schematic "Schematic for Graphics Display Powertip 4.3in 480x272 Board Rev 2.pdf".

Migration Changes:

- None.

v1.75 Release (July 10, 2009)

Changes:

- Added 2D acceleration support for controllers with accelerated primitive drawing functions.
- Added Digital Meter (see page 149) Widget for fast display refresh using fixed width fonts.
- Added support for selected PIC24H Family of devices.
- Added support for selected dsPIC33 Family of devices.
- Updated all primitive functions to return success or fail status when executed. This is used to evaluate if the primitive function has finished rendering.
- Updated Solomon Systech SSD1926 driver to use 2D accelerated functions.
- New Display Controller Driver supported:
- Ilitek ILI9320
- Solomon Systech SSD1289
- Himax HX8347
- Renesas R61580
- New demos are added:
- PIC24F Starter Kit Demo
- PIC24H Starter Kit Demo 1
- Graphics JPEG Demo using internal and external flash memory for image storage
- Graphics SSD1926 JPEG and SD Card Demo using SD Card for image storage
- Added JPEG support to "Font and Bitmap Converter Utility".
- Modified Button (see page 78) Widget for new options:
- Use multi-line text (set USE_BUTTON_MULTI_LINE (see page 33))
- Detect continuous touch screen press event using messaging
- Added Touch Screen event EVENT_STILLPRESS to support continuous press detection.
- New reference design schematics added:
- Schematic for Graphics Display DisplayTech 3.2in 240x320 Board.pdf
- Schematic for Graphics Display Newhaven 2.2in 240x320 with HX8347.pdf
- Schematic for Graphics Display Seiko 3.5in 320x240 Board.pdf
- Schematic for Graphics Displays DisplayTech and Truly 3.2in 240x320 with SSD1289.pdf
- Schematic for ILI9320.pdf

Fixes:

- Fixed dimension calculation for quarter sized meter.

Migration Changes:

- When using accelerated primitive functions while USE_NONBLOCKING_CONFIG (see page 45) is enabled, the accelerated primitive must be checked if it succesfully rendered. Refer to the coding example (see page 542) for details.
- Replaced LGDP4531_R61505_S6D0129_S6D0139_SPFD5408.c and LGDP4531_R61505_S6D0129_S6D0139_SPFD5408.h files with drvTFT001.c (see page 1051) and drvTFT001.h (see page 1077) respectively.

v1.65 Release (March 13, 2009)

Changes:

- Added support for the new Graphics PICtail™ Plus Daughter Board (AC164127-3). This new board comes in two components: the controller board and the display board. The display board uses RGB type displays driven by the controller board. This configuration allows easy replacement of the display glass.
- Added application note AN1246 "How to Create Widgets".
- New Display Controller Driver supported
- UltraChip UC1610
- New demos are added
- Graphics AN1246 Demo showing the TextEntry Widget.
- Graphics Multi-App Demo showing USB HID, USB MSD and SD MSD demos using the Microchip Graphics Library.
- Modified Meter (see page 210) Widget for new options:
- Set Title and Value Font at creation time
- Added GOLGetFocusPrev (see page 322)() for focus control on GOL (see page 64) Objects.
- Added work spaces to demo releases.
- Graphics PICtail™ Plus Board 1 is obsolete. All references to this board is removed from documentation.
- New reference design schematics added:
- Schematic for Graphics Display Ampire 5.7in 320x240 Board Rev A.pdf
- Schematic for Graphics Display Powertip 3.5in 320x240 Board Rev B.pdf
- Schematic for Graphics Display Powertip 4.3in 480x272 Board Rev B.pdf
- Schematic for Graphics Display Truly 3.5in 320x240 Board Rev A.pdf
- Schematic for Truly TOD9M0043.pdf

Fixes:

- Fixed drawing bug on TextEntry Widget
- Added missing documentation on Chart (see page 92) and Text Entry (see page 274) Widgets

Migration Changes:

- none

v1.60 Release (December 3, 2008)

Changes:

- Added TextEntry Widget.
- Modified Meter (see page 210) Widget for new options:
- Define different fonts for value and title displayed.
- Add option for resolution of one decimal point when displaying values.
- Add color options to all six arcs of the Meter (see page 210).
- Meter (see page 210) range is not defined by a minimum value and a maximum value.
- Added feature to a the Button (see page 78) Widget to allow cancelling of press by moving away the touch and releasing from the Button (see page 78)'s face.
- Added font sizes options of 3,4,5,6 & 7 in Font & Bitmap Converter Utility when converting fonts from TTF files.

- Enhanced the architecture of the Display Device Driver Layer.

Fixes:

- Fixed Font & Bitmap Converter Utility generation of reference strings to be set to const section.
- Fixed panel rendering to always draw the panel face color even if bitmaps are present.

Migration Changes:

- Added the following files in the Display Device Driver Layer to easily switch from one display driver to another.
- DisplayDriver.h
- DisplayDriver.c
- Modified implementation of GraphicsConfig.h (see page 945) file to support new Display Device Driver Layer architecture.
- Moved the definitions of pins used in device drivers implemented in all the demos to HardwareProfile.h file.
- EEPROM Driver
- Touch Screen Driver
- Beeper Driver
- Flash Memory Driver
- Display Drivers
- Modified GOL.c (see page 550) and GOL.h (see page 571) to include processing of TextEntry object when enabled by application.

v1.52 Release (August 29, 2008)

Changes:

- Added Chart (see page 92) Widget.
- Added Property State for Window (see page 292) Widget. Text in Title Area can now be centered.
- Added Supplementary Library for Image Decoders.
- Added documentation of Default Actions on widgets.
- Replaced USE_MONOCHROME compile switch with COLOR_DEPTH (see page 48) to define color depth of the display.
- Added GOL_EMBOSS_SIZE (see page 347) to be user defined in GraphicsConfig.h (see page 945).
- Simplified initialization code for SSD1906 driver.

Fixes:

- Fixed touch screen algorithm.
- Fixed file path error in Font & Bitmap Converter Utility.

Migration Changes:

- USE_GOL (see page 36) must be defined when using any Widgets.
- New include directory paths are added to demo projects:
- ..\..\..\Your Project Directory Name
- ..\..\Include
- Moved all driver files to new directory
- C files from ..\Microchip\Graphics to ..\Microchip\Graphics\Drivers
- GOL_EMBOSS_SIZE (see page 347) can now be defined by the user in GraphicsConfig.h (see page 945). If user does not define this in GraphicsConfig.h (see page 945) the default value in GOL.h (see page 571) is used.

v1.4 Release (April 18, 2008)

Changes:

- Added full support for PIC32 families.
- Added Application Note demo on fonts.

- Added images for end designs using PIC devices.

Fixes:

- Fixed GetPixel (see page 394) error in SSD1906 Driver.
- Fixed SST39VF040 parallel flash driver reading instability.
- Fixed error in 64Kbytes rollover in utility conversion of bitmaps and SST39VF040 parallel flash driver.
- Fixed milli-second delay on PIC32.
- Fixed compile time option errors for PIC32.
- Fixed Graphics Object Layer Demo error in PIC32 when time and date are set.
- Fixed Picture (see page 224) widget bug in detecting touchscreen in translating messages.

v1.3 Release (March 07, 2008)

Changes:

- none

Fixes:

- Fixed an inaccurate ADC reading problem with some Explorer 16 Development Boards that uses 5V LCD display.
- Editbox allocation of memory for text is corrected.
- Fix slider SetRange() bug.
- Set PIC32 configuration bits related to PLL to correct values.
- Touch screen portrait mode bug is fixed.

v1.2 Release (February 15, 2008)

Changes:

- Added support for Graphics PICtail Plus Board Version 2
- Added support for foreign language fonts
- Version 1.2 of the font and bitmap utility
- Support for multi-language scripts
- Support for generating font table from installed fonts
- Support to reduce font table size by removing unused characters
- Support to select between C30 and C32 compiler when generating bitmaps and font tables.
- Added Chinese version of Graphics Object Layer Demo.
- New Display Controller Drivers supported
- Solomon Systech SSD1906
- Orise Technology SPDF5408
- Replaced USE_UNICODE compile switch to USE_MULTIBYTECHAR (see page 37) compile switch to define XCHAR (see page 361) as 2-byte character.
- Added compile switches
- GRAPHICS_PICTAIL_VERSION - sets the PICtail board version being used.
- USE_MONOCHROME – to enable monochrome mode.
- USE_PORTRAIT - to enable the portrait mode of the display without changing the display driver files.
- Added beta support for PIC32 device

Fixes:

- Specification changes to List Box widget. Bitmap is added to List Box items.
- Fixed List Box LbDelItemsList (see page 207)() error in not resetting item pointer to NULL when items are removed.
- Editbox allocation of memory for text is corrected.
- Static Text multi-byte character failure is fixed.

- Bar (see page 371)() function erroneous call to MoveTo (see page 382)() is removed since it causes the drawing cursor to be displaced.
- Removed SCREEN_HOR_SIZE and SCREEN_VER_SIZE macros from documentation. Maximum X and Y sizes are to be obtained by GetMaxX (see page 397)( ) and GetMaxY (see page 397)( ) macros.

v1.0 Release (November 1, 2007)

Changes:

- Edit Box, List Box, Meter (see page 210), Dial (see page 138) widgets are added.
- Button (see page 78) is modified. New options for the object are added.
- Modified OBJ_REMOVE definition to OBJ_HIDE (example BTN_REMOVE to BTN_HIDE (see page 82)).
- Modified GOLPanelDraw (see page 322)() function to include rounded panels.
- External memory support for the fonts and bitmaps is implemented.
- SSD1339 and LGDP4531 controllers support is added.
- Bevel (see page 377)(), FillBevel (see page 378)() and Arc (see page 375)() functions are added.
- Modified Graphics Object Layer Demo.
- Added Graphics External Memory Demo & Graphics PICtail^{TM} Board Memory Programmer Demo.
- Added Graphics Application Note (AN1136- How to use widgets.) Demo.

Fixes: none

v0.93 Beta release (August 29, 2007)

Changes: none

Fixes:

- In demo code the bitmap images couldn’t be compiled without optimization. bmp2c.exe utility output is changed to fix this bug.
- In demo code “volatile” is added for global variables used in ISRs.

v0.92 Beta release (July 25, 2007)

Changes:

- Keyboard and side buttons support is added.
- Keyboard focus support is added.
- PutImage (see page 383)() parameters are changed. Instead of pointer to the bitmap image the pointer to BITMAP_FLASH structure must be passed.
- GOLSuspend() and GOLResume() are removed.
- GOLMsg (see page 328)() doesn’t check object drawing status. It should be called if GOL (see page 64) drawing is completed.
- GOLStartNewList() is replaced with GOLNewList (see page 316)().
- Line() function calls are replaced with Bar (see page 371)() function calls for vertical and horizontal lines.
- Parameter “change” is removed for SldIncVal() and SldDecVal() .
- Some optimization and cleanup.
- Slider (see page 251) API is changed:
- SldSetVal() is changed to SldSetPos (see page 259)()
- SldGetVal() is changed to SldGetPos (see page 260)()
- SldIncVal() is changed to SldIncPos (see page 262)()
- SldDecVal() is changed to SldDecPos (see page 263)()
- SldCreate (see page 255)() input parameter are changed:
- “delta” changed to “res”

Fixes:

- PutImage (see page 383)().
- Line().
- FillCircle (see page 374)().
- For vertical slider the relation between thumb location and slider position is changed. For position = 0 thumb will be located at the bottom. For position = range it will be at the top.

v0.9 Beta release (July 06, 2007)

Changes:

- Background color support is removed.
- Non-blocking configuration for graphics primitives is added.
- GetImageWidth (see page 384)(), GetImageHeight (see page 383)() are added.
- OutText (see page 358)(), OutTextXY (see page 359)() and GetTextWidth (see page 360)() functions are terminated by control characters (< 32).
- Graphics Objects Layer (GOL (see page 64)) is added.
- Button (see page 78), Slider (see page 251), Checkbox (see page 130), Radio Button (see page 78), Static Text, Picture (see page 224) control, Progress Bar (see page 371), Window (see page 292), Group Box are implemented.
- Touch screen support is added.

Fixes:

- ReadFlashByte().
- GetTextWidth (see page 360)().

v0.1 (June 05, 2007)

Changes:

- Initial release includes driver and graphic primitive layers only.
- Only driver for Samsung S6D0129 controller is available.

Fixes:

- None.

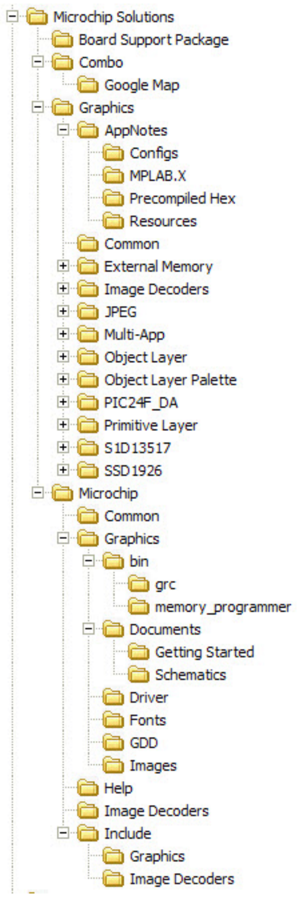
Known Issues

None

4 Getting Started

Directory Structure

The Microchip Graphics Library installation follows the standard directory structure for all Microchip library solutions. Installing the library will give the following structure:



One of the demo subdirectories (example: Graphics or Combo) may become "*Your Applications Directory"* that will contain your application source code. You can add code and modules here that will use and interact with the library. The library specific folders are the following:

- The **Microchip** folder will contain the library components.
- The **Help** sub-folder under **Microchip** folder will contain this document (**Graphics Library Help.chm** file).
- The **Graphics** sub-folder under the **Microchip** folder is where the C files, documentation and utilities are located.
- Inside this **Graphics** sub-folder are the directories for the **Drivers**, **Documents**, **GDD**, **Images** and **bin** directories. It will also contain the directory for the **Image Decoders** source files.
- The **GDD** (Graphics Display Designer) directory contains the GDD project template. Use this to start projects using the Graphics Display Designer.
- The **bin** directory contains the Graphics Resource Converter utility and External Memory Programmer both implemented in java.
- The **Include** sub-folder under the **Microchip** folder will contain common header files to all Microchip library solutions.
- Another **Graphics** directory is included in the **Include** sub folder. This will hold the Graphics Library header files as well as the header files for the **Image Decoders**.
- The **Board Support Package** folder will contain hardware specific drivers that are common to the Microchip Demo

Boards (such as Explorer 16, display panels or PICtail™ Plus Daughter Boards).

All subdirectories and files under the **Microchip** directory should not be modified. In case your project will use more than one Microchip library solution, this directory will contain all the library files you install. Thus, it is important to maintain the files in this directory. The **Microchip Solutions** directory may become your "*MyProjects*" directory that will contain all your projects using the different Microchip solutions.

How to Get Started

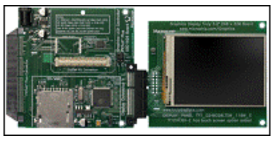
There are various ways to get started with Microchip Graphics Library:

1. Obtain Development Boards from the "Getting Started" section of the Microchip graphics website (www.microchip.com/graphics):

1. Explorer 16 Starter Kit (DV164003) with any of the Graphics PICtail™ Plus Daughter Boards.
2. PIC24FJ256DA210 Development Board (DV164039) with any of the individual Graphics Display Boards.
3. A PIC32 Starter Kit and Graphics LCD Controller PICtail™ Plus SSD1926 Board (AC164127-5) with any of the individual Graphics Display Boards.
4. A PIC32 Starter Kit and Graphics PICtail Plus Epson S1D13517 Board (AC164127-7) with any of the individual Graphics Display Boards.
5. A PIC32 Starter Kit and Multi-Media Expansion Board (DM320005).

2. Graphics PICtail™ Plus Daughter Board available:

1. AC164127-3 - Graphics PICtail Plus Daughter Board with Truly 3.2" Display Kit

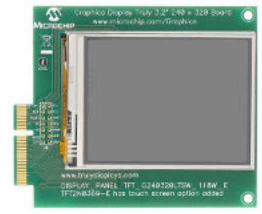


2. AC164127-5 - Graphics LCD Controller PICtail Plus SSD1926 Board. This board is the same board used in AC164127-3 PIctail Plus and Display Panel combo shown above.

3. AC164127-7 - Graphics PICtail Plus Epson S1D13517 Board

3. Graphics Display Boards available:

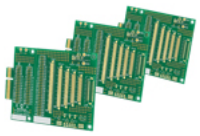
1. AC164127-4 - Graphics Display Truly 3.2" 240x320 Board



2. AC164127-6 - Graphics Display Powertip 4.3" 480x272 Board

3. AC164127-8 - Graphics Display Truly 5.7" 640x480 Board
4. AC164127-9 - Graphics Display Truly 7" 800x480 Board

5. AC164139 - Graphics Display Prototype Board



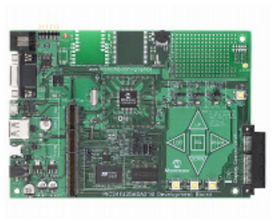
4. Refer to Web Seminar 4 on “Microchip Graphics Library Architecture” from the "Training and Support" section for an overview of the structure and the different layers of the library. It also gives a brief information on how to use the library.
5. Refer to Microchip's Regional Training Center class on Graphics Library:

- HIF 2131 – Designing with Microchip Graphics Library

6. For a much detailed look on the usage, you can refer to the following application notes from the "Training and Support" section.

- AN1136 How to Use Widgets in Microchip Graphics Library. This application note introduces the basic functions needed to create and manage Widgets.
- AN1182 Fonts in the Microchip Graphics Library. This application note describes the format of the Microchip Graphics Library's font image. It also tells how to reduce the number of characters in a font and automate the creation of the character arrays referring to an application's strings.
- AN1227 Using a Keyboard with the Microchip Graphics Library. This application note describes how to implement a keyboard-based GUI.
- AN1246 How to Create Widgets in Microchip Graphics Library. This application note serves as a useful guide in creating customized Widgets. The essential components of a Widget are enumerated and described in this document. This application note also outlines the process of integrating the new Widget into the Graphics Library in order to utilize the already implemented routines for processing messages and rendering Widgets.
- AN1368 Developing Graphics Applications using PIC MCUs with Integrated Graphics Controller. This application note is intended for engineers who are designing their first graphic application. It describes the basic definitions and jargons of graphics applications and it helps the engineer to understand the theory, necessary decision factors, hardware considerations, available microcontrollers and development tools.

7. Finally, you can obtain the free licensed Microchip Graphics library also from the "Getting Started" section.



How to Build Projects for the PIC24FJ256DA210 Development Board

1. In the application specific HardwareProfile.h file of your project set the hardware platform to PIC24FJ256DA210 Development Board:

```
#define PIC24FJ256DA210_DEV_BOARD
```

2. In the the same application specific HardwareProfile.h file of your project, set the correct display controller and the display panel combination. Selecting the correct display panel will choose the correct parameter settings for the display. Examples (see page 99) of these parameters are horizontal and vertical resolution, display orientation, vertical and horizontal pulse width, and front and back porch settings.

- When using the Truly 3.2" display on AC164127-4 board

```
// set the display controller
#define GFX_USE_DISPLAY_CONTROLLER_MCHP_DA210
// set the display panel
#define GFX_USE_DISPLAY_PANEL_TFT_G240320LTSW_118W_E
```

- When using the Powertip 4.3" display on AC164127-6 board

```
// set the display controller
#define GFX_USE_DISPLAY_CONTROLLER_MCHP_DA210
// set the display panel
#define GFX_USE_DISPLAY_PANEL_PH480272T_005_I11Q
```

3. In the the same application specific HardwareProfile.h file of your project, set following (Refer to each demo hardware profiles for examples):

```
// set the display controller
#define GFX_USE_DISPLAY_CONTROLLER_MCHP_DA210
// set the display panel
#define GFX_USE_SIPLAY_PANEL_TFT_G240320LTSW_118W_E
// set the PMP interface
#define USE_16BIT_PMP
// set the Graphics Clock Divider that generates the Pixel clock.
// Refer to display data sheet for pixel clock frequency requirement
// and Family Reference Manual - Oscillator for details on GCLK divider (GCLKDIV).
#define GFX_GCLK_DIVIDER 38
// set the display buffer start address.
#define GFX_DISPLAY_BUFFER_START_ADDRESS 0x00020000ul
// set the EPMP CS1 base address if using external memory on EPMP CS 1 space and its size
#define GFX_EPMP_CS1_BASE_ADDRESS 0x00020000ul
#define GFX_EPMP_CS1_MEMORY_SIZE  0x40000ul
// set the EPMP CS2 base address if using external memory on EPMP CS 1 space and its size
#define GFX_EPMP_CS2_BASE_ADDRESS 0x00080000ul
#define GFX_EPMP_CS2_MEMORY_SIZE  0x80000ul
```

4. In the the project's GraphicsConfig.h (see page 945) set the color depth to the desired bpp value (Refer to each demo hardware profiles for examples):

```
// set the color depth used
#define COLOR_DEPTH 16
```

How to Build Projects for Graphics PICtail™ Plus Board Version 3:

1. In the application specific HardwareProfile.h file of your project set the hardware platform to Graphics PICtail™ Plus Board Version 3:

```
#define GFX_PICTAIL_V3
```

2. In the the same application specific HardwareProfile.h file of your project, set the correct display controller and the display panel combination. Selecting the correct display panel will choose the correct parameter settings for the display. Examples (see page 99) of these parameters are horizontal and vertical resolution, display orientation, vertical and horizontal pulse width, and front and back porch settings.

- When using the Truly 3.2" display on AC164127-4 board

```
// set the display controller
#define GFX_USE_DISPLAY_CONTROLLER_SSD1926
```

```
// set the display panel
#define GFX_USE_DISPLAY_PANEL_TFT_G240320LTSW_118W_E
```

- When using the Powertip 4.3" display on AC164127-6 board

```
// set the display controller
#define GFX_USE_DISPLAY_CONTROLLER_SSD1926
// set the display panel
#define GFX_USE_DISPLAY_PANEL_PH480272T_005_I11Q
```

3. In the the same application specific HardwareProfile.h file of your project, set following (Refer to each demo hardware profiles for examples):

```
// set the hardware platform
#define EXPLORER_16// set the display panel
// set the PMP interface
#define USE_8BIT_PMP
```

4. In the the project's GraphicsConfig.h (see page 945) set the color depth to the desired bpp value (Refer to each demo hardware profiles for examples):

```
// set the color depth used
#define COLOR_DEPTH 16
```

How to Build Projects for Graphics PICtail™ Plus Epson S1D13517 Board

1. In the application specific HardwareProfile.h file of your project set the hardware platform to Graphics PICtail™ Plus Epson S1D13517 Board:

```
#define GFX_PICTAIL_V3E
```

2. In the application specific HardwareProfile.h file of your project, set the correct display controller.

```
#define GFX_USE_DISPLAY_CONTROLLER_S1D13517
```

3. In the the same application specific HardwareProfile.h file of your project, set following (Refer to each demo hardware profiles for examples):

```
// set the hardware platform
#define EXPLORER_16// set the display panel
// set the PMP interface
#define USE_8BIT_PMP
```

4. In the the project's GraphicsConfig.h (see page 945) set the color depth to the desired bpp value (Refer to each demo hardware profiles for examples):

```
// set the color depth used
#define COLOR_DEPTH 16
```

How to Build Projects for the Multimedia Expansion Board

1. In the application specific HardwareProfile.h file of your project set the hardware platform to Graphics PICtail™ Plus Epson S1D13517 Board:

```
#define MEB_BOARD
```

2. In the application specific HardwareProfile.h file of your project, set the correct display controller.

```
#define GFX_USE_DISPLAY_CONTROLLER_SSD1926
```

3. In the the same application specific HardwareProfile.h file of your project, set following (Refer to each demo hardware

profiles for examples):

```
// set the PMP interface
#define USE_8BIT_PMP
// set the Starter Kit used
#define PIC32_GP_SK // use generic PIC32 Starter Kit
 or
#define PIC32_USB_SK // use PIC32 USB Starter Kit
or
#define PIC32_ETH_SK // use PIC32 Ethernet Starter Kit
```

4. In the the project's GraphicsConfig.h (see page 945) set the color depth to the desired bpp value (Refer to each demo hardware profiles for examples):

```
// set the color depth used
#define COLOR_DEPTH 16
```

Demo Projects

The Microchip Graphics Library documentation has several components that covers installation, customization and usage of the library. Several demo projects are included in the installation to help you get started. Detailed information on each demo project is available from the "Getting Started" help file located in each of the demo folders.

Schematics

The library installation also includes schematics of currently supported controllers and glass. These can be found in the *../<install directory>/Microchip/Graphics/Documents/Schematics* directory.

- Schematic for Graphics Display Ampire 5.7in 320x240 Board Rev A.pdf
- Schematic for Graphics Display Powertip 3.5in 320x240 Board Rev B.pdf
- Schematic for Graphics Display Powertip 4.3in 480x272 Board Rev B.pdf
- Schematic for Graphics Display Truly 3.2in 240x320 Board Rev 4.pdf
- Schematic for Graphics Display Truly 3.5in 320x240 Board Rev A.pdf
- Schematic for Graphics LCD Controller PICtail SSD1926 Board Rev 2.pdf
- Schematic for Solomon Systech SSD1906.pdf
- Schematic for Truly GG1N1291UTSW-W-TP-E.pdf
- Schematic for Truly TFT-G240320UTSW-92W-TP.pdf
- Schematic for Truly TOD9M0043.pdf
- Schematic for Microtips MTF-T022BHNLP.pdf
- Schematic for Densitron TSR67802.pdf
- Schematic for Graphics Display DisplayTech 3.2in 240x320 Board.pdf
- Schematic for Graphics Display Newhaven 2.2in 240x320 with HX8347.pdf
- Schematic for Graphics Display Seiko 3.5in 320x240 Board.pdf
- Schematic for Graphics Displays DisplayTech and Truly 3.2in 240x320 with SSD1289.pdf
- Schematic for ILI9320.pdf
- Schematic for Graphics Display Prototype Board Rev 1.pdf
- Schematic for Graphics Display Truly 5.7in 640x480 Board Rev 2.pdf
- Schematic for Graphics Display Truly 7in 800x480 Board Rev 2.pdf
- Schematic for Graphics LCD Controller PICTail Plus S1D13517 Rev 1.1.pdf
- Schematic for Low-Cost Controllerless (LCC) Graphics Board Rev 1.pdf

- Schematic for PIC24FJ256DA210 Development Board Rev 1.1.pdf

Images

The library allows displaying 1bpp, 4bpp, 8bpp, 16bpp and 24bpp images. They can be located in program flash space or external memory. To convert the bitmap format file (BMP extension) or JPEG format file into source C file containing data array for internal memory or Intel hex file for external memory the **“Graphics Resource Converter”** included in the library installation can be used. Refer to the utility help file for details on usage.

Fonts

The library operates with 8-bit character encoded strings. It covers languages defined in IS0 8859 standards. East Asian and any other languages support is available for UNICODE encoded fonts. Font can be stored in internal flash as an array in const section (this limits font image size by 32Kbytes) or can be located in external memory. To convert the font file into source C file containing data array for internal memory or Intel hex file for external memory the **“Graphics Resource Converter”** utility can be used. The utility allows importing raster font files (FNT extension) or true font files (TTF extension). Refer to the help built in the utility for details. Raster font files can be extracted from MS Windows bitmap font package file (FNT extension) or converted from true type font file (TTF extension) with a third party font editor. One such freeware editor Fony is available at http://hukka.furtopia.org/. Another example is http://fontforge.sourceforge.net.

The utility also allows reducing the generated fonts to include only the characters that the application will use. This can be done by using font filtering. Please refer to application note "AN1182: Fonts in the Microchip Graphics Library" from the "Training and Support" section of the Microchip graphics website for details of implementing reduced fonts.

How to use the API Documentation

This help file includes the API description of the library. The way the API is structured is similar to the library layers.

1. The Device Driver Layer presents all the API included to initialize and use the display controller and the glass. This section also contains information on how to add new Device Driver.
2. The Graphics Primitive Layer is a hardware independent layer that contains the API for basic rendering functions. Use this section to render basic shapes like lines, rectangles, filled circle etc.
3. The Graphics Object Layer contains the API specific to each Widget type. Use this section to create and manage Widgets (see page 64) as well as pages or screens of different Widgets (see page 64). Messaging and rendering of Widgets (see page 64) are also included in this section.

Updates and News

Refer to the Microchip graphics website www.microchip.com/graphics for the latest version of the Microchip Graphics Library, webinars, application notes, FAQs and latest news and updates.

5 Demo Projects

Summary of demo projects that comes with the installation of the Microchip Graphics Library.

5.1 Demo Summary

This is the current list of demo projects released with the Graphics Library.

Description

Demo Name	Description
Primitive Layer	Shows how primitive functions are used.
Object Layer	Shows how objects are used with user messages interacting with objects.
Object Layer Palette	The same as the Object Layer demo but uses the Color Look Up Table of the Microchip Graphics Module.
External Memory	A simple demo showing how images and fonts from external memory are used in a graphics application.
Multi-App	A demo showing USB Framework, Memory Disk Drive, Image Decoders and Graphics libraries and stacks are integrated into one application.
SSD1926	A demo showing the Solomon Systech Controller JPEG decoder module on the Graphics LCD Controller PICtail™ Plus SSD1926 Board (AC164127-5) and Multi-Media Expansion Board (DM320005) displaying JPEG images from an SD Card.
S1D13517	A demo showing the different features of the Epson S1D13517 Controller in the Graphics PICtail Plus Epson S1D13517 Board (AC164127-7)
PIC24F_DA	A demo showing the graphics module in PIC24FJ256DA210.
JPEG	A demo showing Image Decoders and Graphics libraries are integrated into one application.
AppNotes	A collection of application notes demo - Demo for Application Note AN1136 - Demo for Application Note AN1182 - Demo for Application Note AN1227 - Demo for Application Note AN1246
Image Decoders	A demo showing the Image Decoder library rendering bitmaps and jpeg images.
PIC24F Starter Kit	Demo for the PIC24F Starter Kit.
PIC24H Starter Kit	Demo for the PIC24H Starter Kit.
Google Map	A demo showing the TCPIP Stack and Graphics Library combined in an application.

5.2 Microchip Application Library Abbreviations

Summary of Microchip Applications Library Abbreviations used.

Description

Microchip Application Library Configuration File and Project Name Abbreviations. A summary of the abbreviations used can be found at <Install Directory>/Microchip/Help/Abbreviations.htm

5.3 Demo Compatibility Matrix

Refer to the Demo Compatibility matrix located in the <install directory>/Microchip/Graphics/Documents/Getting Started/Getting Started - Demo Compatibility Matrix.htm for details.

Description

Refer to the Demo Compatibility matrix located in the <install directory>/Microchip/Graphics/Documents/Getting Started/Getting Started - Demo Compatibility Matrix.htm for details.

6 Graphics Library Configuration

The library can be customized by adding or specifying the compile time options located in the application code named GraphicsConfig.h (see page 49) or the HardwareProfile.h files. The following compile time options are supported by the library.

6.1 Graphics Object Layer Configuration

Module

Graphics Library Configuration (see page 30)

Description

The following compile time options configures the Graphics Library's Object Layer.

6.1.1 Input Device Selection

Macros

Name	Description
USE_KEYBOARD (see page 30)	Input devices used defines the messages that Objects will process. The following definitions indicate the usage of the different input device: • USE_TOUCHSCREEN - enables the touch screen support. • USE_KEYBOARD (see page 30) - enables the key board support. Define in GraphicsConfig.h (see page 945)
USE_TOUCHSCREEN (see page 31)	Input devices used defines the messages that Objects will process. The following definitions indicate the usage of the different input device: • USE_TOUCHSCREEN - enables the touch screen support. • USE_KEYBOARD (see page 30) - enables the key board support. Define in GraphicsConfig.h (see page 945)

Description

These compile options selects input devices used by GOL (see page 64) widgets. Remove definitions for unused input devices to reduce code size.

The USE_INPUTDEVICE options are located in the GraphicsConfig.h (see page 945) header file.

6.1.1.1 USE_KEYBOARD Macro

File

GraphicsConfig.h (see page 945)

C

```
#define USE_KEYBOARD
```

Overview

Input devices used defines the messages that Objects will process. The following definitions indicate the usage of the different input device:

- USE_TOUCHSCREEN - enables the touch screen support.
- USE_KEYBOARD - enables the key board support.

Define in GraphicsConfig.h (see page 945)

6.1.1.2 USE_TOUCHSCREEN Macro

File

GraphicsConfig.h (see page 945)

C

```
#define USE_TOUCHSCREEN
```

Overview

Input devices used defines the messages that Objects will process. The following definitions indicate the usage of the different input device:

- USE_TOUCHSCREEN - enables the touch screen support.
- USE_KEYBOARD (see page 30) - enables the key board support.

Define in GraphicsConfig.h (see page 945)

6.1.2 Focus Support Selection

Macros

Name	Description
USE_FOCUS (see page 31)	Keyboard control on some objects can be used by enabling the GOL (see page 64) Focus (USE_FOCUS)support. Define this in GraphicsConfig.h (see page 945)

Description

This compile option allows keyboard input focus. GOLSetFocus (see page 318)(), GOLGetFocus (see page 320)(), GOLCanBeFocused (see page 321)(), GOLGetFocusNext (see page 321)() functions will be available. Focus is also changed by touch screen.

The USE_FOCUS (see page 31) option is located in the GraphicsConfig.h (see page 945) header file.

6.1.2.1 USE_FOCUS Macro

File

GraphicsConfig.h (see page 945)

C

```
#define USE_FOCUS
```

Overview

Keyboard control on some objects can be used by enabling the GOL (see page 64) Focus (USE_FOCUS)support. Define this in GraphicsConfig.h (see page 945)

6.1.3 Graphics Object Selection

Macros

Name	Description
USE_ANALOGCLOCK (see page 32)	Enable Analog Clock Object.
USE_BUTTON (see page 32)	Enable Button (see page 78) Object.
USE_BUTTON_MULTI_LINE (see page 33)	Enable Multi-Line (see page 366) Button (see page 78) Object
USE_CHECKBOX (see page 33)	Enable Checkbox (see page 130) Object.
USE_DIGITALMETER (see page 33)	Enable DigitalMeter Object.
USE_EDITBOX (see page 33)	Enable Edit Box Object.
USE_GROUPBOX (see page 34)	Enable Group Box Object.
USE_LISTBOX (see page 34)	Enable List Box Object.
USE_METER (see page 34)	Enable Meter (see page 210) Object.
USE_PICTURE (see page 34)	Enable Picture (see page 224) Object.
USE_PROGRESSBAR (see page 34)	Enable Progress Bar (see page 371) Object.
USE_RADIOBUTTON (see page 35)	Enable Radio Button (see page 78) Object.
USE_ROUNDDIAL (see page 35)	Enable Dial (see page 138) Object.
USE_SLIDER (see page 35)	Enable Slider (see page 251) or Scroll (see page 439) Bar (see page 371) Object.
USE_STATICTEXT (see page 35)	Enable Static Text Object.
USE_WINDOW (see page 36)	Enable Window (see page 292) Object.
USE_CUSTOM (see page 36)	Enable Custom Control Object (an example to create customized Object).
USE_GOL (see page 36)	Enable Graphics Object Layer.
USE_TEXTENTRY (see page 36)	Enable TextEntry Object.

Description

These compile options selects objects used. Remove definitions for unused objects to reduce code size.

The USE_GOL (see page 36) and USE_OBJECT options are located in the GraphicsConfig.h (see page 945) header file. USE_GOL (see page 36) should be included if any of the objects are to be used.

6.1.3.1 USE_ANALOGCLOCK Macro

File

GraphicsConfig.h (see page 945)

C

```
#define USE_ANALOGCLOCK
```

Description

Enable Analog Clock Object.

6.1.3.2 USE_BUTTON Macro

File

GraphicsConfig.h (see page 945)

C

```
#define USE_BUTTON
```

Description

Enable Button (see page 78) Object.

6.1.3.3 USE_BUTTON_MULTI_LINE Macro

File

GraphicsConfig.h (see page 945)

C

```
#define USE_BUTTON_MULTI_LINE
```

Description

Enable Multi-Line (see page 366) Button (see page 78) Object

6.1.3.4 USE_CHECKBOX Macro

File

GraphicsConfig.h (see page 945)

C

```
#define USE_CHECKBOX
```

Description

Enable Checkbox (see page 130) Object.

6.1.3.5 USE_DIGITALMETER Macro

File

GraphicsConfig.h (see page 945)

C

```
#define USE_DIGITALMETER
```

Description

Enable DigitalMeter Object.

6.1.3.6 USE_EDITBOX Macro

File

GraphicsConfig.h (see page 945)

C

```
#define USE_EDITBOX
```

Description

Enable Edit Box Object.

6.1.3.7 USE_GROUPBOX Macro

File

GraphicsConfig.h (see page 945)

C

```
#define USE_GROUPBOX
```

Description

Enable Group Box Object.

6.1.3.8 USE_LISTBOX Macro

File

GraphicsConfig.h (see page 945)

C

```
#define USE_LISTBOX
```

Description

Enable List Box Object.

6.1.3.9 USE_METER Macro

File

GraphicsConfig.h (see page 945)

C

```
#define USE_METER
```

Description

Enable Meter (see page 210) Object.

6.1.3.10 USE_PICTURE Macro

File

GraphicsConfig.h (see page 945)

C

```
#define USE_PICTURE
```

Description

Enable Picture (see page 224) Object.

6.1.3.11 USE_PROGRESSBAR Macro

File

GraphicsConfig.h (see page 945)

C

```
#define USE_PROGRESSBAR
```

Description

Enable Progress Bar (see page 371) Object.

6.1.3.12 USE_RADIOBUTTON Macro

File

GraphicsConfig.h (see page 945)

C

```
#define USE_RADIOBUTTON
```

Description

Enable Radio Button (see page 78) Object.

6.1.3.13 USE_ROUNDDIAL Macro

File

GraphicsConfig.h (see page 945)

C

```
#define USE_ROUNDDIAL
```

Description

Enable Dial (see page 138) Object.

6.1.3.14 USE_SLIDER Macro

File

GraphicsConfig.h (see page 945)

C

```
#define USE_SLIDER
```

Description

Enable Slider (see page 251) or Scroll (see page 439) Bar (see page 371) Object.

6.1.3.15 USE_STATICTEXT Macro

File

GraphicsConfig.h (see page 945)

C

```
#define USE_STATICTEXT
```

Description

Enable Static Text Object.

6.1.3.16 USE_WINDOW Macro

File

GraphicsConfig.h (see page 945)

C

```
#define USE_WINDOW
```

Description

Enable Window (see page 292) Object.

6.1.3.17 USE_CUSTOM Macro

File

GraphicsConfig.h (see page 945)

C

```
#define USE_CUSTOM
```

Description

Enable Custom Control Object (an example to create customized Object).

6.1.3.18 USE_GOL Macro

File

GraphicsConfig.h (see page 945)

C

```
#define USE_GOL
```

Description

Enable Graphics Object Layer.

6.1.3.19 USE_TEXTENTRY Macro

File

GraphicsConfig.h (see page 945)

C

```
#define USE_TEXTENTRY
```

Description

Enable TextEntry Object.

6.1.4 Image Compression Option

6.2 Graphics Primitive Layer Configuration

Module

Graphics Library Configuration (see page 30)

Description

The following compile time options configures the Graphics Library's Primitive Layer.

6.2.1 Font Type Selection

Macros

Name	Description
USE_MULTIBYTECHAR (see page 37)	To enable support for unicode fonts, USE_MULTIBYTECHAR must be defined. This sets the XCHAR (see page 361) definition (0-2^16 range). See XCHAR (see page 361) for details. Define this in GraphicsConfig.h (see page 945)
USE_UNSIGNED_XCHAR (see page 38)	To enable support for unsigned characters data type for fonts, USE_UNSIGNED_XCHAR must be defined. This sets the XCHAR (see page 361) definition (0-255 range). See XCHAR (see page 361) for details. Define this in GraphicsConfig.h (see page 945)

Description

This compile option selects if the support for unicode fonts, unsigned char or the default signed char type fonts.

There are three types of font (characters) that can be used in the Graphics Library. This gives the user the option to implement multi-language application or use the default signed char type.

- #define USE_MULTIBYTECHAR (see page 37) - To enable support for unicode fonts, USE_MULTIBYTECHAR (see page 37) must be defined. This sets the XCHAR (see page 361) definition to use unsigned short.
- #define USE_UNSIGNED_XCHAR (see page 38) - To enable support for character range of 0-255, this must be defined. This sets the XCHAR (see page 361) definition to use unsigned char.
- to use the default signed char, do not define any of the two.

See XCHAR (see page 361) for details.

The font type selection (USE_MULTIBYTECHAR (see page 37) USE_UNSIGNED_CHAR) should be defined in the GraphicsConfig.h (see page 945) header file.

6.2.1.1 USE_MULTIBYTECHAR Macro

File

GraphicsConfig.h (see page 945)

C

```
#define USE_MULTIBYTECHAR
```

Overview

To enable support for unicode fonts, USE_MULTIBYTECHAR must be defined. This sets the XCHAR (see page 361) definition (0-2^16 range). See XCHAR (see page 361) for details. Define this in GraphicsConfig.h (see page 945)

6.2.1.2 USE_UNSIGNED_XCHAR Macro

File

GraphicsConfig.h (see page 945)

C

```
#define USE_UNSIGNED_XCHAR
```

Overview

To enable support for unsigned characters data type for fonts, USE_UNSIGNED_XCHAR must be defined. This sets the XCHAR (see page 361) definition (0-255 range). See XCHAR (see page 361) for details. Define this in GraphicsConfig.h (see page 945)

6.2.2 Gradient Bar Rendering

Macros

Name	Description
USE_GRADIENT (see page 38)	To enable support for Gradient bars and bevel primitives. Define this in GraphicsConfig.h (see page 945).

Description

This compile option enables the usage of the Gradient Bar (see page 371) and Bevel (see page 377) function in the Primitive Layer.

6.2.2.1 USE_GRADIENT Macro

File

GraphicsConfig.h (see page 945)

C

```
#define USE_GRADIENT
```

Overview

To enable support for Gradient bars and bevel primitives. Define this in GraphicsConfig.h (see page 945).

6.2.3 Transparent Color Feature in PutImage()

Macros

Name	Description
USE_TRANSPARENT_COLOR (see page 39)	To enable support for transparent color in PutImage (see page 383)(). Enabling this macro enables the use of a transparent color (set by TransparentColorEnable (see page 401)()) in rendering images by PutImage (see page 383)(). When a pixel in the image matches the transparent color set, the pixel is not rendered to the screen. This is useful in rendering rounded icons or images to the screen with a complex background. Define this in GraphicsConfig.h (see page 945)

Description

This compile option enables the transparent color feature in PutImage (see page 383)().

6.2.3.1 USE_TRANSPARENT_COLOR Macro

File

GraphicsConfig.h (see page 945)

C

```
#define USE_TRANSPARENT_COLOR
```

Overview

To enable support for transparent color in PutImage (see page 383)(). Enabling this macro enables the use of a transparent color (set by TransparentColorEnable (see page 401)()) in rendering images by PutImage (see page 383)(). When a pixel in the image matches the transparent color set, the pixel is not rendered to the screen. This is useful in rendering rounded icons or images to the screen with a complex background. Define this in GraphicsConfig.h (see page 945)

6.3 Display Device Driver Layer Configuration

Macros

Name	Description
USE_ALPHABLEND (see page 40)	To enable support for Alpha Blending. Use this feature only if the display driver used can support alpha blending. Define this in GraphicsConfig.h (see page 945)
USE_DOUBLE_BUFFERING (see page 41)	To enable support for double buffering. Use this feature only if the display driver used can support double buffering. Define this in GraphicsConfig.h (see page 945)
USE_COMP_IPU (see page 41)	To enable support for DEFLATE compressed images for PutImage (see page 383)(). When this macro is enabled, the PutImage (see page 383)() function will be able to process images generated by the Graphics Resource Converter (GRC) that are compressed using the DEFLATE algorithm. PutImage (see page 383)() will need the IPU module of the Microchip Graphics Module to decompress. Enable this feature only when the driver features the IPU module (example: PIC24FJ2456DA210). Define this in GraphicsConfig.h (see page 945)
USE_COMP_RLE (see page 41)	To enable support for RLE compressed images for PutImage (see page 383)(). When this macro is enabled, the PutImage (see page 383)() function will be able to process images generated by the Graphics Resource Converter (GRC) that are RLE compressed. Define this in GraphicsConfig.h (see page 945)
GFX_LCD_TYPE (see page 42)	Sets the type of display glass used. Define this in the Hardware Profile. • #define GFX_LCD_TYPE GFX_LCD_TFT (see page 43) - sets type TFT display • #define GFX_LCD_TYPE GFX_LCD_CSTN (see page 42) - sets type color STN display • #define GFX_LCD_TYPE GFX_LCD_MSTN (see page 42) - sets type mon STN display • #define GFX_LCD_TYPE GFX_LCD_OFF (see page 42) - display is turned off

STN_DISPLAY_WIDTH (see page 43)	Sets the STN glass data width. Define this in the Hardware Profile. • #define STN_DISPLAY_WIDTH STN_DISPLAY_WIDTH_4 (see page 44) - use 4-bit wide interface • #define STN_DISPLAY_WIDTH STN_DISPLAY_WIDTH_8 (see page 44) - Use 8-bit wide interface • #define STN_DISPLAY_WIDTH STN_DISPLAY_WIDTH_16 (see page 43) - Use 16-bit wide interface

Module

Graphics Library Configuration (see page 30)

Description

The following compile time options configures the Graphics Library's Display Device Driver Layer. The choices are based on the specific hardware used.

The options Graphics Hardware Platform, DISPLAY_CONTROLLER and DISPLAY_PANEL are specific to the hardware used. The Graphics Hardware Platform selects the Graphics PICtail™ Plus Board version, PIC24FJ256DA210 Development Board or any other Microchip demo boards for the Graphics Library. Currently there are two Graphics PICtail™ Plus Board versions supported as shown in the Getting Started (see page 21) section.

The rest of the settings are used to specify the the display parameters when using an RGB type display controller such as SSD1906 and SSD1926 from Solomon Systech. The table below summarizes the generic parameters found in RGB type display controllers and when each type is used.

Options	Color STN	Mono STN	TFT
COLOR_DEPTH (see page 48)	YES	YES	YES
DISP_DATA_WIDTH	YES	YES	YES
DISP_ORIENTATION	YES	YES	YES
DISP_HOR_FRONT_PORCH	NO	NO	YES
DISP_HOR_RESOLUTION	YES	YES	YES
DISP_VER_RESOLUTION	YES	YES	YES
DISP_HOR_BACK_PORCH	NO	NO	YES
DISP_VER_FRONT_PORCH	NO	NO	YES
DISP_VER_BACK_PORCH	NO	NO	YES
DISP_HOR_PULSE_WIDTH	YES	YES	YES
DISP_VER_PULSE_WIDTH	YES	YES	YES
DISP_INV_LSHIFT	YES	YES	YES

All the options listed here are set in the HardwareProfile.h header file implemented in the application layer. An example of this file is shown in HardwareProfile.h Example section.

6.3.1 USE_ALPHABLEND Macro

File

GraphicsConfig.h (see page 945)

C

```
#define USE_ALPHABLEND
```

Overview

To enable support for Alpha Blending. Use this feature only if the display driver used can support alpha blending. Define this in GraphicsConfig.h (see page 945)

6.3.2 USE_DOUBLE_BUFFERING Macro

File

GraphicsConfig.h (see page 945)

C

```
#define USE_DOUBLE_BUFFERING
```

Overview

To enable support for double buffering. Use this feature only if the display driver used can support double buffering. Define this in GraphicsConfig.h (see page 945)

6.3.3 USE_COMP_IPU Macro

File

GraphicsConfig.h (see page 945)

C

```
#define USE_COMP_IPU
```

Overview

To enable support for DEFLATE compressed images for PutImage (see page 383)(). When this macro is enabled, the PutImage (see page 383)() function will be able to process images generated by the Graphics Resource Converter (GRC) that are compressed using the DEFLATE algorithm. PutImage (see page 383)() will need the IPU module of the Microchip Graphics Module to decompress. Enable this feature only when the driver features the IPU module (example: PIC24FJ2456DA210). Define this in GraphicsConfig.h (see page 945)

6.3.4 USE_COMP_RLE Macro

File

GraphicsConfig.h (see page 945)

C

```
#define USE_COMP_RLE
```

Overview

To enable support for RLE compressed images for PutImage (see page 383)(). When this macro is enabled, the PutImage (see page 383)() function will be able to process images generated by the Graphics Resource Converter (GRC) that are RLE compressed. Define this in GraphicsConfig.h (see page 945)

6.3.5 GFX_LCD_TYPE Macro

File

mchpGfxDrv.h

C

```
#define GFX_LCD_TYPE
```

Macros

Name	Description
GFX_LCD_CSTN (see page 42)	Type Color STN Display
GFX_LCD_MSTN (see page 42)	Type Mono STN Display
GFX_LCD_OFF (see page 42)	display is turned off
GFX_LCD_TFT (see page 43)	Type TFT Display

Overview

Sets the type of display glass used. Define this in the Hardware Profile.

- #define GFX_LCD_TYPE GFX_LCD_TFT (see page 43) - sets type TFT display
- #define GFX_LCD_TYPE GFX_LCD_CSTN (see page 42) - sets type color STN display
- #define GFX_LCD_TYPE GFX_LCD_MSTN (see page 42) - sets type mon STN display
- #define GFX_LCD_TYPE GFX_LCD_OFF (see page 42) - display is turned off

6.3.5.1 GFX_LCD_CSTN Macro

File

SSD1926.h (see page 1188)

C

```
#define GFX_LCD_CSTN 0x03               // Type Color STN Display
```

Description

Type Color STN Display

6.3.5.2 GFX_LCD_MSTN Macro

File

SSD1926.h (see page 1188)

C

```
#define GFX_LCD_MSTN 0x02               // Type Mono STN Display
```

Description

Type Mono STN Display

6.3.5.3 GFX_LCD_OFF Macro

File

mchpGfxDrv.h

C

```
#define GFX_LCD_OFF 0x00            // display is turned off
```

Description

display is turned off

6.3.5.4 GFX_LCD_TFT Macro

File

SSD1926.h (see page 1188)

C

```
#define GFX_LCD_TFT 0x01            // Type TFT Display
```

Description

Type TFT Display

6.3.6 STN_DISPLAY_WIDTH Macro

File

mchpGfxDrv.h

C

```
#define STN_DISPLAY_WIDTH
```

Macros

Name	Description
STN_DISPLAY_WIDTH_16 (see page 43)	display interface is 16 bits wide
STN_DISPLAY_WIDTH_4 (see page 44)	display interface is 4 bits wide
STN_DISPLAY_WIDTH_8 (see page 44)	display interface is 8 bits wide

Overview

Sets the STN glass data width. Define this in the Hardware Profile.

- #define STN_DISPLAY_WIDTH STN_DISPLAY_WIDTH_4 (see page 44) - use 4-bit wide interface
- #define STN_DISPLAY_WIDTH STN_DISPLAY_WIDTH_8 (see page 44) - Use 8-bit wide interface
- #define STN_DISPLAY_WIDTH STN_DISPLAY_WIDTH_16 (see page 43) - Use 16-bit wide interface

6.3.6.1 STN_DISPLAY_WIDTH_16 Macro

File

mchpGfxDrv.h

C

```
#define STN_DISPLAY_WIDTH_16 0x02    // display interface is 16 bits wide
```

Description

display interface is 16 bits wide

6.3.6.2 STN_DISPLAY_WIDTH_4 Macro

File

mchpGfxDrv.h

C

```
#define STN_DISPLAY_WIDTH_4 0x00    // display interface is 4 bits wide
```

Description

display interface is 4 bits wide

6.3.6.3 STN_DISPLAY_WIDTH_8 Macro

File

mchpGfxDrv.h

C

```
#define STN_DISPLAY_WIDTH_8 0x01    // display interface is 8 bits wide
```

Description

display interface is 8 bits wide

6.4 Application Configuration

Module

Graphics Library Configuration (see page 30)

Description

6.4.1 Configuration Setting

Macros

Name	Description
USE_NONBLOCKING_CONFIG (see page 45)	Blocking and Non-Blocking configuration selection. To enable non-blocking configuration USE_NONBLOCKING_CONFIG must be defined. If this is not defined, blocking configuration is assumed. Define this in GraphicsConfig.h (see page 945)

Description

This selects the configuration of the library. When Non-blocking configuration is selected, state machine based rendering is used to perform object rendering.

When blocking configuration is used, this line MUST be commented. In this case object rendering will not exit until the object is fully rendered.

The USE_NONBLOCKING_CONFIG (see page 45) option is located in the GraphicsConfig.h (see page 945) header file.

6.4.1.1 USE_NONBLOCKING_CONFIG Macro

File

GraphicsConfig.h (see page 945)

C

```
#define USE_NONBLOCKING_CONFIG
```

Overview

Blocking and Non-Blocking configuration selection. To enable non-blocking configuration USE_NONBLOCKING_CONFIG must be defined. If this is not defined, blocking configuration is assumed. Define this in GraphicsConfig.h (see page 945)

6.4.2 Font Source Selection

Macros

Name	Description
USE_FONT_FLASH (see page 45)	Font data can be placed in two locations. One is in FLASH memory and the other is from external memory. Definining one or both enables the support for fonts located in internal flash and external memory. Define this in GraphicsConfig.h (see page 945) • USE_FONT_FLASH - Font in internal flash memory support. • USE_FONT_EXTERNAL (see page 46) - Font in external memory support (including external memory mapped to EDS).
USE_FONT_EXTERNAL (see page 46)	Font data can be placed in two locations. One is in FLASH memory and the other is from external memory. Definining one or both enables the support for fonts located in internal flash and external memory. Define this in GraphicsConfig.h (see page 945) • USE_FONT_FLASH - Font in internal flash memory support. • USE_FONT_EXTERNAL (see page 46) - Font in external memory support (including external memory mapped to EDS).

Description

Font data can be placed in multiple locations. Set these options in the GraphicsConfig.h (see page 945) header file.

- USE_FONT_FLASH (see page 45) - Font in internal flash memory support.

- USE_FONT_EXTERNAL (see page 46) - Font in external memory support. Use this for fonts located in external memory like SPI Flash or external memory mapped to Extended Data Space.

6.4.2.1 USE_FONT_FLASH Macro

File

GraphicsConfig.h (see page 945)

C

```
#define USE_FONT_FLASH
```

Overview

Font data can be placed in two locations. One is in FLASH memory and the other is from external memory. Definining one or both enables the support for fonts located in internal flash and external memory. Define this in GraphicsConfig.h (see page 945)

- USE_FONT_FLASH - Font in internal flash memory support.
- USE_FONT_EXTERNAL (see page 46) - Font in external memory support (including external memory mapped to EDS).

6.4.2.2 USE_FONT_EXTERNAL Macro

File

GraphicsConfig.h (see page 945)

C

```
#define USE_FONT_EXTERNAL
```

Overview

Font data can be placed in two locations. One is in FLASH memory and the other is from external memory. Definining one or both enables the support for fonts located in internal flash and external memory. Define this in GraphicsConfig.h (see page 945)

- USE_FONT_FLASH - Font in internal flash memory support.
- USE_FONT_EXTERNAL - Font in external memory support (including external memory mapped to EDS).

6.4.3 Image Source Selection

Macros

Name	Description
USE_BITMAP_FLASH (see page 46)	Similar to Font data bitmaps can also be placed in two locations. One is in FLASH memory and the other is from external memory. Definining one or both enables the support for bitmaps located in internal flash and external memory. Define this in GraphicsConfig.h (see page 945) • USE_BITMAP_FLASH - Images located in internal flash memory. • USE_BITMAP_EXTERNAL (see page 47) - Images located in external memory (including external memory mapped to EDS)..
USE_BITMAP_EXTERNAL (see page 47)	Similar to Font data bitmaps can also be placed in two locations. One is in FLASH memory and the other is from external memory. Definining one or both enables the support for bitmaps located in internal flash and external memory. Define this in GraphicsConfig.h (see page 945) • USE_BITMAP_FLASH - Images located in internal flash memory. • USE_BITMAP_EXTERNAL (see page 47) - Images located in external memory (including external memory mapped to EDS)..

Description

Similar to Font data bitmaps can also be placed in two locations. One is in FLASH memory and the other is from external memory. Definining one or both enables the support for bitmaps located in internal flash and external memory.

The USE_BITMAP_FLASH (see page 46) and USE_BITMAP_EXTERNAL (see page 47) options are located in the GraphicsConfig.h (see page 945) header file.

6.4.3.1 USE_BITMAP_FLASH Macro

File

GraphicsConfig.h (see page 945)

C

```
#define USE_BITMAP_FLASH
```

Overview

Similar to Font data bitmaps can also be placed in two locations. One is in FLASH memory and the other is from external memory. Definining one or both enables the support for bitmaps located in internal flash and external memory. Define this in GraphicsConfig.h (see page 945)

- USE_BITMAP_FLASH - Images located in internal flash memory.
- USE_BITMAP_EXTERNAL (see page 47) - Images located in external memory (including external memory mapped to EDS)..

6.4.3.2 USE_BITMAP_EXTERNAL Macro

File

GraphicsConfig.h (see page 945)

C

```
#define USE_BITMAP_EXTERNAL
```

Overview

Similar to Font data bitmaps can also be placed in two locations. One is in FLASH memory and the other is from external memory. Definining one or both enables the support for bitmaps located in internal flash and external memory. Define this in GraphicsConfig.h (see page 945)

- USE_BITMAP_FLASH - Images located in internal flash memory.
- USE_BITMAP_EXTERNAL - Images located in external memory (including external memory mapped to EDS)..

6.4.4 Miscellaneous

Macros

Name	Description
USE_PALETTE_EXTERNAL (see page 48)	Palettes can also be specified to reside in external memory similar to fonts and images. Use this when the palette is located in external memory. Define this in GraphicsConfig.h (see page 945)
USE_PALETTE (see page 48)	Using Palettes, different colors can be used with the same bit depth. Define this in GraphicsConfig.h (see page 945)
COLOR_DEPTH (see page 48)	Specifies the color depth used in the application defined in GraphicsConfig.h (see page 945).
GFX_free (see page 48)	When using Operating Systems (OS), define the OS specific malloc() and free() functions for compatibility with the OS based systems. Define these in GraphicsConfig.h (see page 945)
GFX_malloc (see page 48)	When using Operating Systems (OS), define the OS specific malloc() and free() functions for compatibility with the OS based systems. Define these in GraphicsConfig.h (see page 945)

Description

This contains miscellaneous macros and functions that can be redefined for various system support such as Operating System defined functions.

6.4.4.1 USE_PALETTE_EXTERNAL Macro

File

GraphicsConfig.h (see page 945)

C

```
#define USE_PALETTE_EXTERNAL
```

Overview

Palettes can also be specified to reside in external memory similar to fonts and images. Use this when the palette is located in external memory. Define this in GraphicsConfig.h (see page 945)

6.4.4.2 USE_PALETTE Macro

File

GraphicsConfig.h (see page 945)

C

```
#define USE_PALETTE
```

Overview

Using Palettes, different colors can be used with the same bit depth. Define this in GraphicsConfig.h (see page 945)

6.4.4.3 COLOR_DEPTH Macro

File

GraphicsConfig.h (see page 945)

C

```
#define COLOR_DEPTH 16
```

Overview

Specifies the color depth used in the application defined in GraphicsConfig.h (see page 945).

6.4.4.4 GFX_free Macro

File

GraphicsConfig.h (see page 945)

C

```
#define GFX_free(pObj) free(pObj)          // <COPY GFX_malloc>
```

Overview

When using Operating Systems (OS), define the OS specific malloc() and free() functions for compatibility with the OS based systems. Define these in GraphicsConfig.h (see page 945)

6.4.4.5 GFX_malloc Macro

File

GraphicsConfig.h (see page 945)

C

```
#define GFX_malloc(size) malloc(size)
```

Overview

When using Operating Systems (OS), define the OS specific malloc() and free() functions for compatibility with the OS based systems. Define these in GraphicsConfig.h (see page 945)

6.4.5 GraphicsConfig.h Example

This is an example of the GraphicsConfig.h (see page 945) file implementation:

```
//////////////////// COMPILE OPTIONS AND DEFAULTS ////////////////////

#define     USE_NONBLOCKING_CONFIG     // Comment this line to use blocking configuration
#define     USE_FOCUS                  // Comment this line when not using FOCUS
#define     USE_TOUCHSCREEN            // Enable touch screen support.
#define     USE_KEYBOARD               // Enable key board support.

#define     USE_GOL                    // Enable Graphics Object Layer.
#define     USE_BUTTON                 // Enable Button Object.
#define     USE_CHART                  // Enable Chart Object.
#define     USE_WINDOW                 // Enable Window Object.
#define     USE_CHECKBOX               // Enable Checkbox Object.
#define     USE_RADIOBUTTON            // Enable Radio Button Object.
#define     USE_EDITBOX                // Enable Edit Box Object.
#define     USE_LISTBOX                // Enable List Box Object.
#define     USE_SLIDER                 // Enable Slider or Scroll Bar Object.
#define     USE_PROGRESSBAR            // Enable Progress Bar Object.
#define     USE_STATICTEXT             // Enable Static Text Object.
#define     USE_PICTURE                // Enable Picture Object.
#define     USE_GROUPBOX               // Enable Group Box Object.
#define     USE_ROUNDDIAL              // Enable Dial Object.
#define     USE_METER                  // Enable Meter Object.
#define     USE_TEXTENTRY              // Enable Text Entry Object.
#define     USE_CUSTOM                 // Enable Custom Control Object (an example to
create customized Object).

#define     USE_MULTIBYTECHAR          // Enable unicode derived characters
#define     USE_FONT_FLASH             // Support for fonts located in internal flash
#define     USE_BITMAP_FLASH           // Support for bitmaps located in internal flash

#define     GOL_EMBOSS_SIZE            2

#define     COLOR_DEPTH                16  // The color depth used
```

6.5 Hardware Profile

Module

Graphics Library Configuration (see page 30)

Description

These functions and macros are used to determine hardware profile settings on the chosen PIC microcontroller and hardware such as demo boards used.

6.5.1 PMP Interface

Macros

Name	Description
USE_8BIT_PMP (see page 50)	Specifies the interface type to the Parallel Master Port (PMP) or Enhanced Parallel Master Port (EPMP). • USE_8BIT_PMP - Use 8-bit interface to PMP or EPMP • USE_16BIT_PMP (see page 50) - Use 16-bit interface to PMP or EPMP
USE_16BIT_PMP (see page 50)	Specifies the interface type to the Parallel Master Port (PMP) or Enhanced Parallel Master Port (EPMP). • USE_8BIT_PMP - Use 8-bit interface to PMP or EPMP • USE_16BIT_PMP (see page 50) - Use 16-bit interface to PMP or EPMP

Description

Specifies the interface type to the Parallel Master Port (PMP) or Enhanced Parallel Master Port (EPMP).

6.5.1.1 USE_8BIT_PMP Macro

File

HardwareProfile.h

C

```
#define USE_8BIT_PMP
```

Overview

Specifies the interface type to the Parallel Master Port (PMP) or Enhanced Parallel Master Port (EPMP).

- USE_8BIT_PMP - Use 8-bit interface to PMP or EPMP
- USE_16BIT_PMP (see page 50) - Use 16-bit interface to PMP or EPMP

6.5.1.2 USE_16BIT_PMP Macro

File

HardwareProfile.h

C

```
#define USE_16BIT_PMP
```

Overview

Specifies the interface type to the Parallel Master Port (PMP) or Enhanced Parallel Master Port (EPMP).

- USE_8BIT_PMP - Use 8-bit interface to PMP or EPMP
- USE_16BIT_PMP - Use 16-bit interface to PMP or EPMP

6.5.2 Development Platform Used

Macros

Name	Description
EXPLORER_16 (↗ see page 52)	Specifies the Development Platform used for the Microchip Graphics Library demos. • EXPLORER_16 - Using the Explorer 16 Development Board (DM240001). • PIC24FJ256DA210_DEV_BOARD (↗ see page 52) - Using the PIC24FJ256DA210 Development Board (DM240312). • MEB_BOARD (↗ see page 52) - Using the Multi-Media Expansion Board (DM320005). • PIC_SK (↗ see page 53) - Using PIC32 or dsPIC Starter Kit (examples: PIC32 Starter Kit (DM320001), PIC32 USB Starter Kit II (DM320003-2), PIC32 Ethernet Starter Kit (DM320004)).
PIC24FJ256DA210_DEV_BOARD (↗ see page 52)	Specifies the Development Platform used for the Microchip Graphics Library demos. • EXPLORER_16 - Using the Explorer 16 Development Board (DM240001). • PIC24FJ256DA210_DEV_BOARD (↗ see page 52) - Using the PIC24FJ256DA210 Development Board (DM240312). • MEB_BOARD (↗ see page 52) - Using the Multi-Media Expansion Board (DM320005). • PIC_SK (↗ see page 53) - Using PIC32 or dsPIC Starter Kit (examples: PIC32 Starter Kit (DM320001), PIC32 USB Starter Kit II (DM320003-2), PIC32 Ethernet Starter Kit (DM320004)).
MEB_BOARD (↗ see page 52)	Specifies the Development Platform used for the Microchip Graphics Library demos. • EXPLORER_16 - Using the Explorer 16 Development Board (DM240001). • PIC24FJ256DA210_DEV_BOARD (↗ see page 52) - Using the PIC24FJ256DA210 Development Board (DM240312). • MEB_BOARD (↗ see page 52) - Using the Multi-Media Expansion Board (DM320005). • PIC_SK (↗ see page 53) - Using PIC32 or dsPIC Starter Kit (examples: PIC32 Starter Kit (DM320001), PIC32 USB Starter Kit II (DM320003-2), PIC32 Ethernet Starter Kit (DM320004)).
PIC_SK (↗ see page 53)	Specifies the Development Platform used for the Microchip Graphics Library demos. • EXPLORER_16 - Using the Explorer 16 Development Board (DM240001). • PIC24FJ256DA210_DEV_BOARD (↗ see page 52) - Using the PIC24FJ256DA210 Development Board (DM240312). • MEB_BOARD (↗ see page 52) - Using the Multi-Media Expansion Board (DM320005). • PIC_SK (↗ see page 53) - Using PIC32 or dsPIC Starter Kit (examples: PIC32 Starter Kit (DM320001), PIC32 USB Starter Kit II (DM320003-2), PIC32 Ethernet Starter Kit (DM320004)).

Description

Specifies the Development Platform used for the Microchip Graphics Library demos.

6.5.2.1 EXPLORER_16 Macro

File

HardwareProfile.h

C

```
#define EXPLORER_16
```

Overview

Specifies the Development Platform used for the Microchip Graphics Library demos.

- EXPLORER_16 - Using the Explorer 16 Development Board (DM240001).
- PIC24FJ256DA210_DEV_BOARD (see page 52) - Using the PIC24FJ256DA210 Development Board (DM240312).
- MEB_BOARD (see page 52) - Using the Multi-Media Expansion Board (DM320005).
- PIC_SK (see page 53) - Using PIC32 or dsPIC Starter Kit (examples: PIC32 Starter Kit (DM320001), PIC32 USB Starter Kit II (DM320003-2), PIC32 Ethernet Starter Kit (DM320004)).

6.5.2.2 PIC24FJ256DA210_DEV_BOARD Macro

File

HardwareProfile.h

C

```
#define PIC24FJ256DA210_DEV_BOARD
```

Overview

Specifies the Development Platform used for the Microchip Graphics Library demos.

- EXPLORER_16 - Using the Explorer 16 Development Board (DM240001).
- PIC24FJ256DA210_DEV_BOARD - Using the PIC24FJ256DA210 Development Board (DM240312).
- MEB_BOARD (see page 52) - Using the Multi-Media Expansion Board (DM320005).
- PIC_SK (see page 53) - Using PIC32 or dsPIC Starter Kit (examples: PIC32 Starter Kit (DM320001), PIC32 USB Starter Kit II (DM320003-2), PIC32 Ethernet Starter Kit (DM320004)).

6.5.2.3 MEB_BOARD Macro

File

HardwareProfile.h

C

```
#define MEB_BOARD
```

Overview

Specifies the Development Platform used for the Microchip Graphics Library demos.

- EXPLORER_16 - Using the Explorer 16 Development Board (DM240001).
- PIC24FJ256DA210_DEV_BOARD (see page 52) - Using the PIC24FJ256DA210 Development Board (DM240312).
- MEB_BOARD - Using the Multi-Media Expansion Board (DM320005).
- PIC_SK (see page 53) - Using PIC32 or dsPIC Starter Kit (examples: PIC32 Starter Kit (DM320001), PIC32 USB Starter Kit II (DM320003-2), PIC32 Ethernet Starter Kit (DM320004)).

6.5.2.4 PIC_SK Macro

File

HardwareProfile.h

C

```
#define PIC_SK
```

Overview

Specifies the Development Platform used for the Microchip Graphics Library demos.

- EXPLORER_16 - Using the Explorer 16 Development Board (DM240001).
- PIC24FJ256DA210_DEV_BOARD (see page 52) - Using the PIC24FJ256DA210 Development Board (DM240312).
- MEB_BOARD (see page 52) - Using the Multi-Media Expansion Board (DM320005).
- PIC_SK - Using PIC32 or dsPIC Starter Kit (examples: PIC32 Starter Kit (DM320001), PIC32 USB Starter Kit II (DM320003-2), PIC32 Ethernet Starter Kit (DM320004)).

6.5.3 Graphics PICtail Used

Macros

Name	Description
GFX_PICTAIL_LCC (see page 54)	Specifies the Graphics PICtail Display Panel used. • GFX_PICTAIL_V3 - Graphics LCD Controller PICtail Plus SSD1926 Board (AC164127-5) • GFX_PICTAIL_V3E (see page 54) - Graphics LCD Controller PICtail Plus S1D13517 Board (AC164127-7) • GFX_PICTAIL_LCC (see page 54) - Low Cost Controllerless (LCC) Graphics PICtailâ„¢ Plus Board (AC164144)
GFX_PICTAIL_V3 (see page 54)	Specifies the Graphics PICtail Display Panel used. • GFX_PICTAIL_V3 - Graphics LCD Controller PICtail Plus SSD1926 Board (AC164127-5) • GFX_PICTAIL_V3E (see page 54) - Graphics LCD Controller PICtail Plus S1D13517 Board (AC164127-7) • GFX_PICTAIL_LCC (see page 54) - Low Cost Controllerless (LCC) Graphics PICtailâ„¢ Plus Board (AC164144)
GFX_PICTAIL_V3E (see page 54)	Specifies the Graphics PICtail Display Panel used. • GFX_PICTAIL_V3 - Graphics LCD Controller PICtail Plus SSD1926 Board (AC164127-5) • GFX_PICTAIL_V3E (see page 54) - Graphics LCD Controller PICtail Plus S1D13517 Board (AC164127-7) • GFX_PICTAIL_LCC (see page 54) - Low Cost Controllerless (LCC) Graphics PICtailâ„¢ Plus Board (AC164144)

Description

Specifies the Graphics PICtail Display Panel used.

6.5.3.1 GFX_PICTAIL_LCC Macro

File

HardwareProfile.h

C

```
#define GFX_PICTAIL_LCC
```

Overview

Specifies the Graphics PICtail Display Panel used.

- GFX_PICTAIL_V3 - Graphics LCD Controller PICtail Plus SSD1926 Board (AC164127-5)
- GFX_PICTAIL_V3E (see page 54) - Graphics LCD Controller PICtail Plus S1D13517 Board (AC164127-7)
- GFX_PICTAIL_LCC - Low Cost Controllerless (LCC) Graphics PICtailâ„¢ Plus Board (AC164144)

6.5.3.2 GFX_PICTAIL_V3 Macro

File

HardwareProfile.h

C

```
#define GFX_PICTAIL_V3
```

Overview

Specifies the Graphics PICtail Display Panel used.

- GFX_PICTAIL_V3 - Graphics LCD Controller PICtail Plus SSD1926 Board (AC164127-5)
- GFX_PICTAIL_V3E (see page 54) - Graphics LCD Controller PICtail Plus S1D13517 Board (AC164127-7)
- GFX_PICTAIL_LCC (see page 54) - Low Cost Controllerless (LCC) Graphics PICtailâ„¢ Plus Board (AC164144)

6.5.3.3 GFX_PICTAIL_V3E Macro

File

HardwareProfile.h

C

```
#define GFX_PICTAIL_V3E
```

Overview

Specifies the Graphics PICtail Display Panel used.

- GFX_PICTAIL_V3 - Graphics LCD Controller PICtail Plus SSD1926 Board (AC164127-5)
- GFX_PICTAIL_V3E - Graphics LCD Controller PICtail Plus S1D13517 Board (AC164127-7)
- GFX_PICTAIL_LCC (see page 54) - Low Cost Controllerless (LCC) Graphics PICtailâ„¢ Plus Board (AC164144)

6.5.4 Display Controller Used

Macros

Name	Description
GFX_USE_DISPLAY_CONTROLLER_DMA (see page 56)	Specifies the controller used in the Graphics Library supplied demo. • GFX_USE_DISPLAY_CONTROLLER_DMA - Using the PIC32 Low Cost Controllerless (LCC) solution. • GFX_USE_DISPLAY_CONTROLLER_MCHP_DA210 (see page 56) - Use the Microchip Graphics Module that comes with the PIC Microcontroller (PIC24FJ256DA210 Device Family) • GFX_USE_DISPLAY_CONTROLLER_SSD1926 (see page 57) - Using the Solomon Systech SSD1926 Display Controller. • GFX_USE_DISPLAY_CONTROLLER_S1D13517 (see page 56) - Using the Epson S1D13517 Display Controller.
GFX_USE_DISPLAY_CONTROLLER_MCHP_DA210 (see page 56)	Specifies the controller used in the Graphics Library supplied demo. • GFX_USE_DISPLAY_CONTROLLER_DMA - Using the PIC32 Low Cost Controllerless (LCC) solution. • GFX_USE_DISPLAY_CONTROLLER_MCHP_DA210 (see page 56) - Use the Microchip Graphics Module that comes with the PIC Microcontroller (PIC24FJ256DA210 Device Family) • GFX_USE_DISPLAY_CONTROLLER_SSD1926 (see page 57) - Using the Solomon Systech SSD1926 Display Controller. • GFX_USE_DISPLAY_CONTROLLER_S1D13517 (see page 56) - Using the Epson S1D13517 Display Controller.
GFX_USE_DISPLAY_CONTROLLER_S1D13517 (see page 56)	Specifies the controller used in the Graphics Library supplied demo. • GFX_USE_DISPLAY_CONTROLLER_DMA - Using the PIC32 Low Cost Controllerless (LCC) solution. • GFX_USE_DISPLAY_CONTROLLER_MCHP_DA210 (see page 56) - Use the Microchip Graphics Module that comes with the PIC Microcontroller (PIC24FJ256DA210 Device Family) • GFX_USE_DISPLAY_CONTROLLER_SSD1926 (see page 57) - Using the Solomon Systech SSD1926 Display Controller. • GFX_USE_DISPLAY_CONTROLLER_S1D13517 (see page 56) - Using the Epson S1D13517 Display Controller.
GFX_USE_DISPLAY_CONTROLLER_SSD1926 (see page 57)	Specifies the controller used in the Graphics Library supplied demo. • GFX_USE_DISPLAY_CONTROLLER_DMA - Using the PIC32 Low Cost Controllerless (LCC) solution. • GFX_USE_DISPLAY_CONTROLLER_MCHP_DA210 (see page 56) - Use the Microchip Graphics Module that comes with the PIC Microcontroller (PIC24FJ256DA210 Device Family) • GFX_USE_DISPLAY_CONTROLLER_SSD1926 (see page 57) - Using the Solomon Systech SSD1926 Display Controller. • GFX_USE_DISPLAY_CONTROLLER_S1D13517 (see page 56) - Using the Epson S1D13517 Display Controller.

Description

Specifies the controller used in the Graphics Library supplied demo.

6.5.4.1 GFX_USE_DISPLAY_CONTROLLER_DMA Macro

File

HardwareProfile.h

C

```
#define GFX_USE_DISPLAY_CONTROLLER_DMA
```

Overview

Specifies the controller used in the Graphics Library supplied demo.

- GFX_USE_DISPLAY_CONTROLLER_DMA - Using the PIC32 Low Cost Controllerless (LCC) solution.
- GFX_USE_DISPLAY_CONTROLLER_MCHP_DA210 (see page 56) - Use the Microchip Graphics Module that comes with the PIC Microcontroller (PIC24FJ256DA210 Device Family)
- GFX_USE_DISPLAY_CONTROLLER_SSD1926 (see page 57) - Using the Solomon Systech SSD1926 Display Controller.
- GFX_USE_DISPLAY_CONTROLLER_S1D13517 (see page 56) - Using the Epson S1D13517 Display Controller.

6.5.4.2 GFX_USE_DISPLAY_CONTROLLER_MCHP_DA210 Macro

File

HardwareProfile.h

C

```
#define GFX_USE_DISPLAY_CONTROLLER_MCHP_DA210
```

Overview

Specifies the controller used in the Graphics Library supplied demo.

- GFX_USE_DISPLAY_CONTROLLER_DMA - Using the PIC32 Low Cost Controllerless (LCC) solution.
- GFX_USE_DISPLAY_CONTROLLER_MCHP_DA210 - Use the Microchip Graphics Module that comes with the PIC Microcontroller (PIC24FJ256DA210 Device Family)
- GFX_USE_DISPLAY_CONTROLLER_SSD1926 (see page 57) - Using the Solomon Systech SSD1926 Display Controller.
- GFX_USE_DISPLAY_CONTROLLER_S1D13517 (see page 56) - Using the Epson S1D13517 Display Controller.

6.5.4.3 GFX_USE_DISPLAY_CONTROLLER_S1D13517 Macro

File

HardwareProfile.h

C

```
#define GFX_USE_DISPLAY_CONTROLLER_S1D13517
```

Overview

Specifies the controller used in the Graphics Library supplied demo.

- GFX_USE_DISPLAY_CONTROLLER_DMA - Using the PIC32 Low Cost Controllerless (LCC) solution.
- GFX_USE_DISPLAY_CONTROLLER_MCHP_DA210 (see page 56) - Use the Microchip Graphics Module that comes with the PIC Microcontroller (PIC24FJ256DA210 Device Family)
- GFX_USE_DISPLAY_CONTROLLER_SSD1926 (see page 57) - Using the Solomon Systech SSD1926 Display Controller.

- GFX_USE_DISPLAY_CONTROLLER_S1D13517 - Using the Epson S1D13517 Display Controller.

6.5.4.4 GFX_USE_DISPLAY_CONTROLLER_SSD1926 Macro

File

HardwareProfile.h

C

```
#define GFX_USE_DISPLAY_CONTROLLER_SSD1926
```

Overview

Specifies the controller used in the Graphics Library supplied demo.

- GFX_USE_DISPLAY_CONTROLLER_DMA - Using the PIC32 Low Cost Controllerless (LCC) solution.
- GFX_USE_DISPLAY_CONTROLLER_MCHP_DA210 (see page 56) - Use the Microchip Graphics Module that comes with the PIC Microcontroller (PIC24FJ256DA210 Device Family)
- GFX_USE_DISPLAY_CONTROLLER_SSD1926 - Using the Solomon Systech SSD1926 Display Controller.
- GFX_USE_DISPLAY_CONTROLLER_S1D13517 (see page 56) - Using the Epson S1D13517 Display Controller.

6.5.5 Display Panel Used

Macros

Name	Description
GFX_USE_DISPLAY_PANEL_PH480272T_005_I11Q (see page 58)	Specifies the Graphics Display Panel used. • GFX_USE_DISPLAY_PANEL_TFT_G240320LTSW_118W_E - 3.2 inch QVGA Truly TFT Display Board (AC164127-4) • GFX_USE_DISPLAY_PANEL_PH480272T_005_I11Q (see page 58) - 4.3 inch WQVGA Powertip TFT Display Board (AC164127-6) • GFX_USE_DISPLAY_PANEL_TFT_640480_8_E (see page 59) - 5.7 inch VGA Truly TFT Display Board (AC164127-8) • GFX_USE_DISPLAY_PANEL_TFT_800480_33_E (see page 59) - 7 inch WVGA Truly TFT Display Board (AC164127-8)

GFX_USE_DISPLAY_PANEL_TFT_640480_8_E (see page 59)	Specifies the Graphics Display Panel used. • GFX_USE_DISPLAY_PANEL_TFT_G240320LTSW_118W_E - 3.2 inch QVGA Truly TFT Display Board (AC164127-4) • GFX_USE_DISPLAY_PANEL_PH480272T_005_I11Q (see page 58) - 4.3 inch WQVGA Powertip TFT Display Board (AC164127-6) • GFX_USE_DISPLAY_PANEL_TFT_640480_8_E (see page 59) - 5.7 inch VGA Truly TFT Display Board (AC164127-8) • GFX_USE_DISPLAY_PANEL_TFT_800480_33_E (see page 59) - 7 inch WVGA Truly TFT Display Board (AC164127-8)
GFX_USE_DISPLAY_PANEL_TFT_800480_33_E (see page 59)	Specifies the Graphics Display Panel used. • GFX_USE_DISPLAY_PANEL_TFT_G240320LTSW_118W_E - 3.2 inch QVGA Truly TFT Display Board (AC164127-4) • GFX_USE_DISPLAY_PANEL_PH480272T_005_I11Q (see page 58) - 4.3 inch WQVGA Powertip TFT Display Board (AC164127-6) • GFX_USE_DISPLAY_PANEL_TFT_640480_8_E (see page 59) - 5.7 inch VGA Truly TFT Display Board (AC164127-8) • GFX_USE_DISPLAY_PANEL_TFT_800480_33_E (see page 59) - 7 inch WVGA Truly TFT Display Board (AC164127-8)
GFX_USE_DISPLAY_PANEL_TFT_G240320LTSW_118W_E (see page 60)	Specifies the Graphics Display Panel used. • GFX_USE_DISPLAY_PANEL_TFT_G240320LTSW_118W_E - 3.2 inch QVGA Truly TFT Display Board (AC164127-4) • GFX_USE_DISPLAY_PANEL_PH480272T_005_I11Q (see page 58) - 4.3 inch WQVGA Powertip TFT Display Board (AC164127-6) • GFX_USE_DISPLAY_PANEL_TFT_640480_8_E (see page 59) - 5.7 inch VGA Truly TFT Display Board (AC164127-8) • GFX_USE_DISPLAY_PANEL_TFT_800480_33_E (see page 59) - 7 inch WVGA Truly TFT Display Board (AC164127-8)

Description

Specifies the Graphics Display Panel used.

6.5.5.1 GFX_USE_DISPLAY_PANEL_PH480272T_005_I11Q Macro

File

HardwareProfile.h

C

```
#define GFX_USE_DISPLAY_PANEL_PH480272T_005_I11Q
```

Overview

Specifies the Graphics Display Panel used.

- GFX_USE_DISPLAY_PANEL_TFT_G240320LTSW_118W_E - 3.2 inch QVGA Truly TFT Display Board (AC164127-4)
- GFX_USE_DISPLAY_PANEL_PH480272T_005_I11Q - 4.3 inch WQVGA Powertip TFT Display Board (AC164127-6)
- GFX_USE_DISPLAY_PANEL_TFT_640480_8_E (see page 59) - 5.7 inch VGA Truly TFT Display Board (AC164127-8)
- GFX_USE_DISPLAY_PANEL_TFT_800480_33_E (see page 59) - 7 inch WVGA Truly TFT Display Board (AC164127-8)

6.5.5.2 GFX_USE_DISPLAY_PANEL_TFT_640480_8_E Macro

File

HardwareProfile.h

C

```
#define GFX_USE_DISPLAY_PANEL_TFT_640480_8_E
```

Overview

Specifies the Graphics Display Panel used.

- GFX_USE_DISPLAY_PANEL_TFT_G240320LTSW_118W_E - 3.2 inch QVGA Truly TFT Display Board (AC164127-4)
- GFX_USE_DISPLAY_PANEL_PH480272T_005_I11Q (see page 58) - 4.3 inch WQVGA Powertip TFT Display Board (AC164127-6)
- GFX_USE_DISPLAY_PANEL_TFT_640480_8_E - 5.7 inch VGA Truly TFT Display Board (AC164127-8)
- GFX_USE_DISPLAY_PANEL_TFT_800480_33_E (see page 59) - 7 inch WVGA Truly TFT Display Board (AC164127-8)

6.5.5.3 GFX_USE_DISPLAY_PANEL_TFT_800480_33_E Macro

File

HardwareProfile.h

C

```
#define GFX_USE_DISPLAY_PANEL_TFT_800480_33_E
```

Overview

Specifies the Graphics Display Panel used.

- GFX_USE_DISPLAY_PANEL_TFT_G240320LTSW_118W_E - 3.2 inch QVGA Truly TFT Display Board (AC164127-4)
- GFX_USE_DISPLAY_PANEL_PH480272T_005_I11Q (see page 58) - 4.3 inch WQVGA Powertip TFT Display Board (AC164127-6)
- GFX_USE_DISPLAY_PANEL_TFT_640480_8_E (see page 59) - 5.7 inch VGA Truly TFT Display Board (AC164127-8)
- GFX_USE_DISPLAY_PANEL_TFT_800480_33_E - 7 inch WVGA Truly TFT Display Board (AC164127-8)

6.5.5.4 GFX_USE_DISPLAY_PANEL_TFT_G240320LTSW_118W_E Macro

File

HardwareProfile.h

C

```
#define GFX_USE_DISPLAY_PANEL_TFT_G240320LTSW_118W_E
```

Overview

Specifies the Graphics Display Panel used.

- GFX_USE_DISPLAY_PANEL_TFT_G240320LTSW_118W_E - 3.2 inch QVGA Truly TFT Display Board (AC164127-4)
- GFX_USE_DISPLAY_PANEL_PH480272T_005_I11Q (see page 58) - 4.3 inch WQVGA Powertip TFT Display Board (AC164127-6)
- GFX_USE_DISPLAY_PANEL_TFT_640480_8_E (see page 59) - 5.7 inch VGA Truly TFT Display Board (AC164127-8)
- GFX_USE_DISPLAY_PANEL_TFT_800480_33_E (see page 59) - 7 inch WVGA Truly TFT Display Board (AC164127-8)

6.5.6 Device Driver Options

The options Graphics Hardware Platform, DISPLAY_CONTROLLER and DISPLAY_PANEL are specific to the hardware used. The Graphics Hardware Platform selects the Graphics PICtail™ Plus Board version, PIC24FJ256DA210 Development Board or any other Microchip demo boards for the Graphics Library. Currently there are two Graphics PICtail™ Plus Board versions supported as shown in the Getting Started (see page 21) section.

The rest of the settings are used to specify the the display parameters when using an RGB type display controller such as SSD1906 and SSD1926 from Solomon Systech. The table below summarizes the generic parameters found in RGB type display controllers and when each type is used.

Options	Color STN	Mono STN	TFT
DISP_DATA_WIDTH	YES	YES	YES
DISP_ORIENTATION	YES	YES	YES
DISP_HOR_FRONT_PORCH	NO	NO	YES
DISP_HOR_RESOLUTION	YES	YES	YES
DISP_VER_RESOLUTION	YES	YES	YES
DISP_HOR_BACK_PORCH	NO	NO	YES
DISP_VER_FRONT_PORCH	NO	NO	YES
DISP_VER_BACK_PORCH	NO	NO	YES
DISP_HOR_PULSE_WIDTH	YES	YES	YES
DISP_VER_PULSE_WIDTH	YES	YES	YES
DISP_INV_LSHIFT	YES	YES	YES

All the options listed here are set in the HardwareProfile.h header file implemented in the application layer. An example of this file is shown in HardwareProfile.h Example section.

6.5.7 HardwareProfile.h Example

This is an example of the HardwareProfile.h file implementation:

```
/*********************************************************************
* GetSystemClock() returns system clock frequency.
* GetPeripheralClock() returns peripheral clock frequency.
* GetInstructionClock() returns instruction clock frequency.
********************************************************************/

/*********************************************************************
* Macro: #define    GetSystemClock()
* Overview: This macro returns the system clock frequency in Hertz.
*             * value is 8 MHz x 4 PLL for PIC24
*             * value is 8 MHz/2 x 18 PLL for PIC32
********************************************************************/
    #if defined(__PIC24F__)
        #define GetSystemClock()    (32000000ul)
    #elif defined(__PIC32MX__)
        #define GetSystemClock()    (72000000ul)
    #elif defined(__dsPIC33F__) || defined(__PIC24H__)
        #define GetSystemClock()    (80000000ul)
    #endif

/*********************************************************************
* Macro: #define    GetPeripheralClock()
* Overview: This macro returns the peripheral clock frequency
*             used in Hertz.
*             * value for PIC24 is <PRE>(GetSystemClock()/2) </PRE>
*             * value for PIC32 is <PRE>(GetSystemClock()/(1<<OSCCONbits.PBDIV)) </PRE>
********************************************************************/
    #if defined(__PIC24F__) || defined(__PIC24H__) || defined(__dsPIC33F__)
        #define GetPeripheralClock()    (GetSystemClock() / 2)
    #elif defined(__PIC32MX__)
        #define GetPeripheralClock()    (GetSystemClock() / (1 << OSCCONbits.PBDIV))
    #endif

/*********************************************************************
* Macro: #define    GetInstructionClock()
* Overview: This macro returns instruction clock frequency
*             used in Hertz.
*             * value for PIC24 is <PRE>(GetSystemClock()/2) </PRE>
*             * value for PIC32 is (GetSystemClock()/PFMWSbits.CHECON) </PRE>
********************************************************************/
    #if defined(__PIC24F__) || defined(__PIC24H__) || defined(__dsPIC33F__)
        #define GetInstructionClock()   (GetSystemClock() / 2)
    #elif defined(__PIC32MX__)
        #define GetInstructionClock()   (GetSystemClock() / PFMWSbits.CHECON)
    #endif


//Auto Generated Code
#define PIC24FJ256DA210_DEV_BOARD
#define USE_16BIT_PMP
#define GFX_USE_DISPLAY_CONTROLLER_MCHP_DA210
#define GFX_USE_DISPLAY_PANEL_TFT_G240320LTSW_118W_E
#define GFX_GCLK_DIVIDER 61
#define GFX_DISPLAY_BUFFER_START_ADDRESS 0x00020000ul
#define GFX_DISPLAY_BUFFER_LENGTH 0x00025800ul
#define GFX_EPMP_CS1_BASE_ADDRESS 0x00020000ul
#define GFX_EPMP_CS1_MEMORY_SIZE 0x40000ul
//End Auto Generated Code

/*********************************************************************
* External Memory Programmer Settings
*********************************************************************/
#if defined (EXPLORER_16)
```

```
        #define USE_COMM_PKT_MEDIA_SERIAL_PORT
        #define BAUDRATE2               115200UL
        #define BRG_DIV2                4
        #define BRGH2                   1
    #else
        #define USE_COMM_PKT_MEDIA_USB

        //#define USE_SELF_POWER_SENSE_IO
        #define tris_self_power     TRISAbits.TRISA2    // Input
        #define self_power          1

        //#define USE_USB_BUS_SENSE_IO
        #define tris_usb_bus_sense  TRISBbits.TRISB5    // Input
        #define USB_BUS_SENSE       U1OTGSTATbits.SESVD // Special considerations required if
    using SESVD for this purpose.  See documentation.

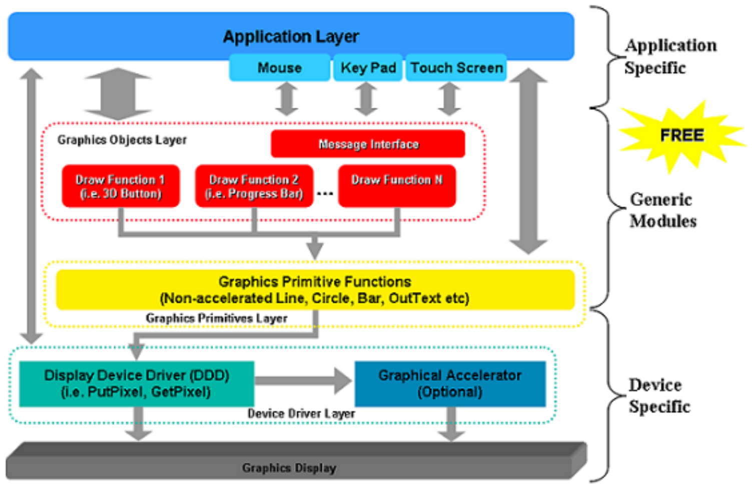
    #endif

    #define COMM_PKT_RX_MAX_SIZE    (1024)

    .....
```

7 Library Structure

The Microchip Graphics Library structure is shown in the following figure.


Application Layer
Mouse
Key Pad
Touch Screen
Application Specific
FREE
Graphics Objects Layer
Message Interface
Draw Function 1 (i.e. 3D Button)
Draw Function 2 (i.e. Progress Bar)
Draw Function N
Generic Modules
Graphics Primitive Functions (Non-accelerated Line, Circle, Bar, OutText etc)
Graphics Primitives Layer
Display Device Driver (DDD) (i.e. PutPixel, GetPixel)
Graphical Accelerator (Optional)
Device Driver Layer
Device Specific
Graphics Display

Microchip Graphics Library Architecture

1. Application Layer – This is the program that utilizes the Graphics Library.
2. User Message Interface- This layer should be implemented by user to provide messages for the library.
3. Graphics Object Layer – This layer renders the widgets controls such as button, slider, window and so on.
4. Graphics Primitives Layer – This layer implements the primitive drawing functions.
5. Device Display Driver – This layer is dependent on the display device being used.
6. Graphics Display Module – This is the display device being used.

The library provides two configurations (Blocking and Non-Blocking).

For Blocking configuration, draw functions delay the execution of program until drawing is done. For Non-Blocking configuration, draw functions do not wait for the drawing completion and release control to the program. Draw functions should be called repeatedly to complete the rendering. This allows efficient use of microcontroller time.

8 Graphics Object Layer

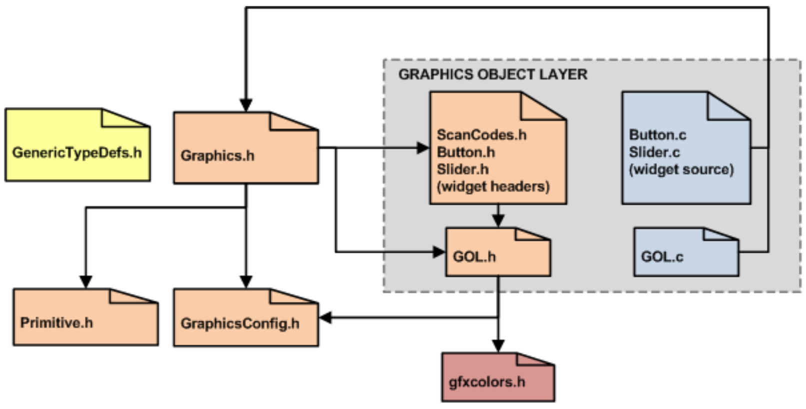
Types

Name	Description
GFX_COLOR (see page 351)	Data type that defines the color data. This type is dependent on the COLOR_DEPTH (see page 48) setting. See COLOR_DEPTH (see page 48). • GFX_COLOR is type BYTE if COLOR_DEPTH (see page 48) <= 8 • GFX_COLOR is type WORD if COLOR_DEPTH (see page 48) = 16 • GFX_COLOR is type DWORD if COLOR_DEPTH (see page 48) = 24

Description

The Graphics Object Layer (GOL) implements the Widgets and the Graphics Library managed messaging and rendering. All Widget drawing are based on the Primitive Layer rendering functions.

The Graphics Object Layer organization is shown on the figure below:



8.1 GOL Objects

The Graphics Object Layer (GOL (see page 64)) contains the Advanced Graphics Objects or commonly known as widgets.

Enumerations

Name	Description
GOL_OBJ_TYPE (see page 67)	This structure defines the Object types used in the library.

Module

Graphics Object Layer (see page 64)

Modules

Name	Description
Analog Clock (see page 70)	Analog Clock is an Object that emulates an analog clock with moving hands. It can be used with or without a bitmap image as the background source.
Button (see page 78)	Button is an Object that emulates a press and release effect when operated upon.

Chart (see page 92)	Chart is an Object that draws a bar chart or a pie chart representation of a single data or series of data.
Checkbox (see page 130)	Check Box is an Object that simulates a check box on paper. Usually it is used as an option setting where the checked or filled state means the option is enabled and the unfilled or unchecked state means the option is disabled.
Round Dial (see page 138)	Dial is an Object that can be used to display emulate a turn dial that can both go in clockwise or counterclockwise.
Digital Meter (see page 149)	DigitalMeter is an Object that can be used to display a value of a sampled variable. This Object is ideal when fast refresh of the value is needed. The Object refreshes only the digits that needs to change. A limitation of this Object is that the font used should have equal character widths.
Edit Box (see page 157)	Edit Box is is an Object that emulates a cell or a text area that can be edited dynamically.
Grid (see page 167)	Grid is an Object that draws a grid on the screen with each cell capable of displaying an image or a string.
Group Box (see page 184)	Group Box is an Object that can be used to group Objects together in the screen.
List Box (see page 191)	List Box is an Object that defines a scrollable area where items are listed. User can select a single item or set of items.
Meter (see page 210)	Meter is an Object that can be used to graphically display a sampled input.
Picture Control (see page 224)	Picture is an Object that can be used to transform a bitmap to be an Object in the screen and have control on the bitmap rendering. This object can be used to create animation using a series of bitmaps.
Progress Bar (see page 232)	Progress Bar (see page 371) is an Object that can be used to display the progress of a task such as a file download or transfer.
Radio Button (see page 240)	Radio Button (see page 78) is an Object that can be used to offer set of choices to the user. Only one of the choices is selectable. Changing selection automatically removes the selection on the previous option.
Slider/Scroll Bar (see page 251)	Slider or Scrollbar is an Object that can be used to display a value or scrolling location in a predefined area.
Static Text (see page 266)	Static Text is an Object that can be used to display a single or multi-line string of text in a predefined location.
Text Entry (see page 274)	Text Entry is an Object that can be used to emulate a key pad entry with a display area for the entered characters. The Object has a feature where you can define a key to reply with a translated message that signifies a command key was pressed. A command key example can be your enter or carriage return key or an escape key. Multiple keys can be assigned command keys. Application can utilize the command key to define the behavior of the program based on a command key press.
Window (see page 292)	Window is an Object that can be used to encapsulate objects into a group. Unlike the Group Box Object, the Window Object has additional features such as displaying an icon or a small bitmap on its Title Bar (see page 371). It also has additional controls for both Title Bar (see page 371) and Client Area.

Structures

Name	Description
OBJ_HEADER (see page 68)	This structure defines the first nine fields of the Objects structure. This allows generic operations on library Objects.

Types

Name	Description
DRAW_FUNC (see page 69)	object draw function pointer typedef
FREE_FUNC (see page 69)	object free function pointer typedef
MSG_DEFAULT_FUNC (see page 69)	object default message function pointer typedef
MSG_FUNC (see page 70)	object message function pointer typedef

Description

All the GOL (see page 64) objects that will be shown in the display have a corresponding data structure that keeps and maintains its parameters.

Each object type has a set of functions that enables the user to change the state of the object. The Microchip graphics library supports the following set of GOL (see page 64) objects.

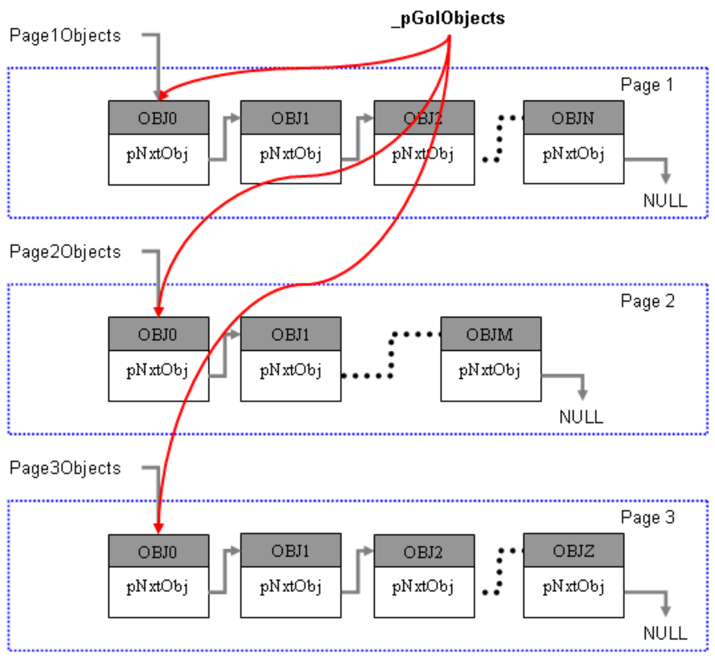
Object	Type Definition
Button (see page 78)	OBJ_BUTTON
Chart (see page 92)	OBJ_CHART
Checkbox (see page 130)	OBJ_CHECKBOX
Dial (see page 138)	OBJ_ROUNDDIAL
Digital Meter (see page 149)	OBJ_DIGITALMETER
Edit Box (see page 157)	OBJ_EDITBOX
Grid (see page 167)	OBJ_GRID
Group Box (see page 184)	OBJ_GROUPBOX
List Box (see page 191)	OBJ_LISTBOX
Meter (see page 210)	OBJ_METER
Picture (see page 224)	OBJ_PICTURE
Progress Bar (see page 232)	OBJ_PROGRESSBAR
Radio Button (see page 240)	OBJ_RADIOBUTTON
Slider (see page 251)	OBJ_SLIDER
Static Text (see page 266)	OBJ_STATICTEXT
Text Entry (see page 274)	OBJ_TEXTENTRY
Window (see page 292)	OBJ_WINDOW

Each GOL (see page 64) object type uses a style scheme. The style scheme defines the font and color settings. User can create new style schemes and assign it to objects. Multiple style schemes can be used for different objects.

To efficiently manage the different objects the first 9 fields of the structure for each object are defined the same. Collectively they are referred to as the object header structure (OBJ_HEADER (see page 68)). Defining the OBJ_HEADER (see page 68) enables the common APIs to manage the objects of different types in the same manner.

The GOL (see page 64) operation is centered on two major processes. First is the rendering process and second is the messaging process. These processes make use of linked list objects. The field pNxtObj in OBJ_HEADER (see page 68) makes this possible. To manage the list a global pointer _pGolObjects (see page 349) is utilized. It defines the current active linked list. Newly created objects are automatically added to the end of this list. The active linked list is the list that the messaging and rendering operation parses to evaluate if the messages received affect the objects and if objects need to be redrawn.

The use of the _pGolObjects (see page 349) pointer also provides a way to easily manage objects. In applications where multiple pages are displayed on the screen, objects can be grouped according to pages. The pointer can be manipulated to switch from one page to another depending on the page currently shown on the screen.



Implementation of Multi-Page Objects

User can remove an object from a list by pointer manipulation. Objects that are removed from the list are not accessible by the rendering and messaging processes.

8.1.1 GOL_OBJ_TYPE Enumeration

File

GOL.h (see page 571)

C

```
typedef enum {
  OBJ_BUTTON,
  OBJ_WINDOW,
  OBJ_CHECKBOX,
  OBJ_RADIOBUTTON,
  OBJ_EDITBOX,
  OBJ_LISTBOX,
  OBJ_SLIDER,
  OBJ_PROGRESSBAR,
  OBJ_STATICTEXT,
  OBJ_PICTURE,
  OBJ_GROUPBOX,
  OBJ_CUSTOM,
  OBJ_ROUNDDIAL,
  OBJ_METER,
  OBJ_GRID,
  OBJ_CHART,
  OBJ_TEXTENTRY,
  OBJ_DIGITALMETER,
  OBJ_ANALOGCLOCK,
  OBJ_UNKNOWN
} GOL_OBJ_TYPE;
```

Members

Members	Description
OBJ_BUTTON	Type defined for Button (see page 78) Object.
OBJ_WINDOW	Type defined for Window (see page 292) Object.
OBJ_CHECKBOX	Type defined for Check Box Object.
OBJ_RADIOBUTTON	Type defined for Radio Button (see page 78) Object.
OBJ_EDITBOX	Type defined for Edit Box Object.
OBJ_LISTBOX	Type defined for List Box Object.
OBJ_SLIDER	Type defined for Slider (see page 251) and/or Scroll (see page 439) Bar (see page 371) Object.
OBJ_PROGRESSBAR	Type defined for Progress Object.
OBJ_STATICTEXT	Type defined for Static Text Object.
OBJ_PICTURE	Type defined for Picture (see page 224) or Bitmap Object.
OBJ_GROUPBOX	Type defined for Group Box Object.
OBJ_CUSTOM	Type defined for Custom Object.
OBJ_ROUNDDIAL	Type defined for Dial (see page 138) Object.
OBJ_METER	Type defined for Meter (see page 210) Object.
OBJ_GRID	Type defined for Grid (see page 167) Object.
OBJ_CHART	Type defined for Chart (see page 92) Object.
OBJ_TEXTENTRY	Type defined for Text-Entry Object.
OBJ_DIGITALMETER	Type defined for DIGITALMETER (see page 157) Object.
OBJ_ANALOGCLOCK	Type defined for ANALOGCLOCK (see page 78) Object.
OBJ_UNKNOWN	Type is undefined and not supported by the library.

Overview

This structure defines the Object types used in the library.

8.1.2 OBJ_HEADER Structure

File

GOL.h (see page 571)

C

```
typedef struct {
  WORD ID;
  void * pNxtObj;
  GOL_OBJ_TYPE type;
  WORD state;
  SHORT left;
  SHORT top;
  SHORT right;
  SHORT bottom;
  GOL_SCHEME * pGolScheme;
  DRAW_FUNC DrawObj;
  FREE_FUNC FreeObj;
  MSG_FUNC MsgObj;
  MSG_DEFAULT_FUNC MsgDefaultObj;
} OBJ_HEADER;
```

Members

Members	Description
WORD ID;	Unique id assigned for referencing.
void * pNxtObj;	A pointer to the next object.

GOL_OBJ_TYPE type;	Identifies the type of GOL (see page 64) object.
WORD state;	State of object.
SHORT left;	Left position of the Object.
SHORT top;	Top position of the Object.
SHORT right;	Right position of the Object.
SHORT bottom;	Bottom position of the Object.
GOL_SCHEME * pGolScheme;	Pointer to the scheme used.
DRAW_FUNC DrawObj;	function pointer to the object draw function
FREE_FUNC FreeObj;	function pointer to the object free function
MSG_FUNC MsgObj;	function pointer to the object message function
MSG_DEFAULT_FUNC MsgDefaultObj;	function pointer to the object default message function

Overview

This structure defines the first nine fields of the Objects structure. This allows generic operations on library Objects.

8.1.3 DRAW_FUNC Type

File

GOL.h (see page 571)

C

```
typedef WORD (* DRAW_FUNC)(void *);
```

Description

object draw function pointer typedef

8.1.4 FREE_FUNC Type

File

GOL.h (see page 571)

C

```
typedef void (* FREE_FUNC)(void *);
```

Description

object free function pointer typedef

8.1.5 MSG_DEFAULT_FUNC Type

File

GOL.h (see page 571)

C

```
typedef void (* MSG_DEFAULT_FUNC)(WORD, void *, GOL_MSG *);
```

Description

object default message function pointer typedef

8.1.6 MSG_FUNC Type

File

GOL.h (see page 571)

C

```
typedef WORD (* MSG_FUNC)(void *, GOL_MSG *);
```

Description

object message function pointer typedef

8.1.7 Analog Clock

Analog Clock is an Object that emulates an analog clock with moving hands. It can be used with or without a bitmap image as the background source.

Functions

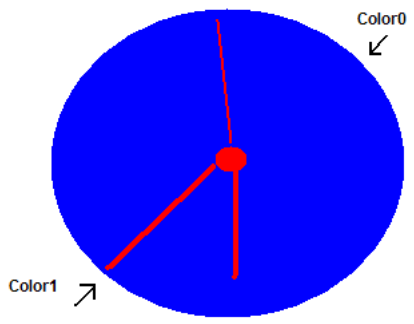
	Name	Description
	AcCreate (see page 73)	This function creates an Analog Clock object with the parameters given. It automatically attaches the new object into a global linked list of objects and returns the address of the object.
	AcDraw (see page 74)	This function renders the object on the screen using the current parameter settings. Location of the object is determined by the left, top, right and bottom parameters. The colors used are dependent on the state of the object. The font used is determined by the style scheme set.
	AcHandsDraw (see page 75)	Draws the current position of the clock hands with the given thickness and color.
	AcSetHour (see page 76)	Sets the hour of the analog clock.
	AcSetMinute (see page 77)	Sets the minute of the analog clock.
	AcSetSecond (see page 77)	Sets the second of the analog clock.

Structures

Name	Description
ANALOGCLOCK (see page 78)	Defines the parameters required for a clock Object. The following relationships of the parameters determines the general shape of the button: 1. Width is determined by right - left. 2. Height is determined by top - bottom. 3. Radius - specifies if the button will have a rounded edge. If zero then the button will have sharp (cornered) edge. 4. If 2*radius = height = width, the button is a circular button.

Description

The Analog Clock object is rendered using the assigned style scheme. The following figure illustrates the color assignments for the clock.



8.1.7.1 Analog Clock States

Macros

Name	Description
AC_DRAW (see page 71)	Bit to indicate button must be redrawn.
AC_DISABLED (see page 71)	Bit for disabled state.
AC_HIDE (see page 72)	Bit to indicate button must be removed from screen.
AC_PRESSED (see page 72)	Bit for press state.
AC_TICK (see page 72)	Bit to tick second hand
UPDATE_HOUR (see page 72)	Bit to indicate hour hand must be redrawn
UPDATE_MINUTE (see page 72)	Bit to indicate minute hand must be redrawn
UPDATE_SECOND (see page 73)	Bit to indicate minute hand must be redrawn

Module

Analog Clock (see page 70)

Description

List of Analog Clock bit states.

8.1.7.1.1 AC_DRAW Macro

File

AnalogClock.h (see page 655)

C

```
#define AC_DRAW 0x4000   // Bit to indicate button must be redrawn.
```

Description

Bit to indicate button must be redrawn.

8.1.7.1.2 AC_DISABLED Macro

File

AnalogClock.h (see page 655)

C

```
#define AC_DISABLED 0x0002   // Bit for disabled state.
```

Description

Bit for disabled state.

8.1.7.1.3 AC_HIDE Macro

File

AnalogClock.h (see page 655)

C

```
#define AC_HIDE 0x8000   // Bit to indicate button must be removed from screen.
```

Description

Bit to indicate button must be removed from screen.

8.1.7.1.4 AC_PRESSED Macro

File

AnalogClock.h (see page 655)

C

```
#define AC_PRESSED 0x0004   // Bit for press state.
```

Description

Bit for press state.

8.1.7.1.5 AC_TICK Macro

File

AnalogClock.h (see page 655)

C

```
#define AC_TICK 0x1000   // Bit to tick second hand
```

Description

Bit to tick second hand

8.1.7.1.6 UPDATE_HOUR Macro

File

AnalogClock.h (see page 655)

C

```
#define UPDATE_HOUR 0x2000   // Bit to indicate hour hand must be redrawn
```

Description

Bit to indicate hour hand must be redrawn

8.1.7.1.7 UPDATE_MINUTE Macro

File

AnalogClock.h (see page 655)

C

```
#define UPDATE_MINUTE 0x0100   // Bit to indicate minute hand must be redrawn
```

Description

Bit to indicate minute hand must be redrawn

8.1.7.1.8 UPDATE_SECOND Macro

File

AnalogClock.h (see page 655)

C

```
#define UPDATE_SECOND 0x0200   // Bit to indicate minute hand must be redrawn
```

Description

Bit to indicate minute hand must be redrawn

8.1.7.2 AcCreate Function

File

AnalogClock.h (see page 655)

C

```
ANALOGCLOCK * AcCreate(
    WORD ID,
    SHORT left,
    SHORT top,
    SHORT right,
    SHORT bottom,
    SHORT hour,
    SHORT minute,
    SHORT radius,
    BOOL sechand,
    WORD state,
    void * pBitmap,
    GOL_SCHEME * pScheme
);
```

Module

Analog Clock (see page 70)

Input Parameters

Input Parameters	Description
WORD ID	Unique user defined ID for the object instance.
SHORT left	Left most position of the object.
SHORT top	Top most position of the object.
SHORT right	Right most position of the object.
SHORT bottom	Bottom most position of the object.
SHORT hour	set the current hour.
SHORT minute	set the current minute.
SHORT radius	radius of the clock.
BOOL sechand	Flag to draw cecond hand or not.
WORD state	Sets the initial state of the object.
void * pBitmap	Pointer to the bitmap used on the face of the button dimension of the bitmap must match the dimension of the button.
GOL_SCHEME * pScheme	Pointer to the style scheme used.
pText	Pointer to the text of the button.

Returns

Returns the pointer to the object created.

Preconditions

none

Example

```
GOL_SCHEME *pScheme;
WORD state;

    pScheme = GOLCreateScheme();
    state = AC_DRAW;

    AnalogClock = AcCreate(1,20,64,50,118,0, state, NULL, "ON", pScheme);
Side Effects:none
```

Overview

This function creates an Analog Clock object with the parameters given. It automatically attaches the new object into a global linked list of objects and returns the address of the object.

Syntax

ANALOGCLOCK (see page 78) *AcCreate(WORD ID, SHORT left, SHORT top, SHORT right, SHORT bottom, SHORT radius, void *pBitmap, XCHAR (see page 361) *pText, GOL_SCHEME (see page 345) *pScheme)

8.1.7.3 AcDraw Function

File

AnalogClock.h (see page 655)

C

```
WORD AcDraw(
    void * pObj
);
```

Module

Analog Clock (see page 70)

Input Parameters

Input Parameters	Description
pAc	Pointer to the object to be rendered.

Side Effects

none

Returns

Returns the status of the drawing

- 1 - If the rendering was completed and
- 0 - If the rendering is not yet finished.

Next call to the function will resume the rendering on the pending drawing state.

Preconditions

Object must be created before this function is called.

Example

```
void MyGOLDraw(){
    static OBJ_HEADER *pCurrentObj = NULL;
    int done;

    // There are no objects
    if(GOLGetList() == NULL)
        return;
    // If it's last object jump to head
    if(pCurrentObj == NULL)
        pCurrentObj = GOLGetList();

    done = 0;

    // this only process Button and Window
    while(pCurrentObj != NULL){
        // check if object state indicates redrawing
        if(pCurrentObj->state&0xFC00) {
            switch(pCurrentObj->type){
                case OBJ_ANALOGCLOCK:
                    done = AcDraw((ANALOGCLOCK*)pCurrentObj);
                    break;
                case OBJ_WINDOW:
                    done = WndDraw((WINDOW*)pCurrentObj);
                    break;
                default:
                    done = 1;
                    break;
            }
            if(done){
                // reset only the state if drawing was finished
                pCurrentObj->state = 0;
            }else{
                // done processing the list
                return;
            }
        }
        // go to next object
        pCurrentObj = pCurrentObj->pNxtObj;
    }
}
```

Overview

This function renders the object on the screen using the current parameter settings. Location of the object is determined by the left, top, right and bottom parameters. The colors used are dependent on the state of the object. The font used is determined by the style scheme set.

Syntax

WORD AcDraw(ANALOGCLOCK (see page 78) *pB)

8.1.7.4 AcHandsDraw Function

File

AnalogClock.h (see page 655)

C

```
WORD AcHandsDraw(
    ANALOGCLOCK * pAc,
    SHORT hand,
    SHORT thickness,
    WORD color,
    void * pBitmap
);
```

Module

Analog Clock (see page 70)

Input Parameters

Input Parameters	Description
ANALOGCLOCK * pAc	The pointer to the object whose hands will be modified.
SHORT hand	which hand to be drawn (second, minute, hour)

SHORT thickness	thickness to draw the hand
WORD color	color to draw the hand *pBitmap - bitmap background to be redrawn

Side Effects

none

Returns

none

Preconditions

none

Overview

Draws the current position of the clock hands with the given thickness and color.

Syntax

AcHandsDraw(ANALOGCLOCK (see page 78) *pAc, SHORT hand, SHORT thickness, WORD color, void *pBitmap);

8.1.7.5 AcSetHour Function

File

AnalogClock.h (see page 655)

C

```
void AcSetHour(
    ANALOGCLOCK * pAc,
    SHORT hour
);
```

Module

Analog Clock (see page 70)

Input Parameters

Input Parameters	Description
ANALOGCLOCK * pAc	The pointer to the object whose hands will be modified.
SHORT hour	current hour of the analog clock

Side Effects

none

Returns

none

Preconditions

none

Overview

Sets the hour of the analog clock.

Syntax

AcSetHour(ANALOGCLOCK (see page 78) *pAc, SHORT hour)

8.1.7.6 AcSetMinute Function

File

AnalogClock.h (see page 655)

C

```
void AcSetMinute(
    ANALOGCLOCK * pAc,
    SHORT minute
);
```

Module

Analog Clock (see page 70)

Input Parameters

Input Parameters	Description
ANALOGCLOCK * pAc	The pointer to the object whose hands will be modified.
SHORT minute	current minute of the analog clock

Side Effects

none

Returns

none

Preconditions

none

Overview

Sets the minute of the analog clock.

Syntax

AcSetMinute(ANALOGCLOCK (see page 78) *pAc, SHORT minute)

8.1.7.7 AcSetSecond Function

File

AnalogClock.h (see page 655)

C

```
void AcSetSecond(
    ANALOGCLOCK * pAc,
    SHORT second
);
```

Module

Analog Clock (see page 70)

Input Parameters

Input Parameters	Description
ANALOGCLOCK * pAc	The pointer to the object whose hands will be modified.
SHORT second	current minute of the analog clock

Side Effects

none

Returns

none

Preconditions

none

Overview

Sets the second of the analog clock.

Syntax

AcSetMinute (see page 77)(ANALOGCLCOK *pAc, SHORT second)

8.1.7.8 ANALOGCLOCK Structure

File

AnalogClock.h (see page 655)

C

```
typedef struct {
  OBJ_HEADER hdr;
  SHORT radius;
  SHORT centerx;
  SHORT centery;
  SHORT valueS;
  SHORT prev_valueS;
  SHORT valueM;
  SHORT prev_valueM;
  SHORT valueH;
  SHORT prev_valueH;
  void * pBitmap;
} ANALOGCLOCK;
```

Members

Members	Description
OBJ_HEADER hdr;	Generic header for all Objects (see OBJ_HEADER (see page 68)).
SHORT radius;	Radius of the clock.
void * pBitmap;	Pointer to bitmap used.

Module

Analog Clock (see page 70)

Overview

Defines the parameters required for a clock Object. The following relationships of the parameters determines the general shape of the button:

1. Width is determined by right - left.
2. Height is determined by top - bottom.
3. Radius - specifies if the button will have a rounded edge. If zero then the button will have sharp (cornered) edge.
4. If 2*radius = height = width, the button is a circular button.

8.1.8 Button

Button is an Object that emulates a press and release effect when operated upon.

Functions

	Name	Description
	BtnCreate (see page 83)	This function creates a BUTTON (see page 91) object with the parameters given. It automatically attaches the new object into a global linked list of objects and returns the address of the object.
	BtnDraw (see page 85)	This function renders the object on the screen using the current parameter settings. Location of the object is determined by the left, top, right and bottom parameters. The colors used are dependent on the state of the object. The font used is determined by the style scheme set. The text on the face of the button is drawn on top of the bitmap. Text is always rendered centered on the face of the button. When rendering objects of the same type, each object must be rendered completely before the rendering of the next object is started. This is to avoid... more (see page 85)
	BtnSetText (see page 87)	This function sets the string used for the object.
	BtnMsgDefault (see page 89)	This function performs the actual state change based on the translated message given. The following state changes are supported:
	BtnTranslateMsg (see page 90)	This function evaluates the message from a user if the message will affect the object or not. The table below enumerates the translated messages for each event of the touch screen and keyboard inputs.

Macros

Name	Description
BtnGetText (see page 86)	This macro returns the address of the current text string used for the object.
BtnGetBitmap (see page 87)	This macro returns the location of the currently used bitmap for the object.
BtnSetBitmap (see page 88)	This macro sets the bitmap used in the object. The size of the bitmap must match the face of the button.

Structures

Name	Description
BUTTON (see page 91)	Defines the parameters required for a button Object. The following relationships of the parameters determines the general shape of the button: 1. Width is determined by right - left. 2. Height is determined by top - bottom. 3. Radius - specifies if the button will have a rounded edge. If zero then the button will have sharp (cornered) edge. 4. If 2*radius = height = width, the button is a circular button.

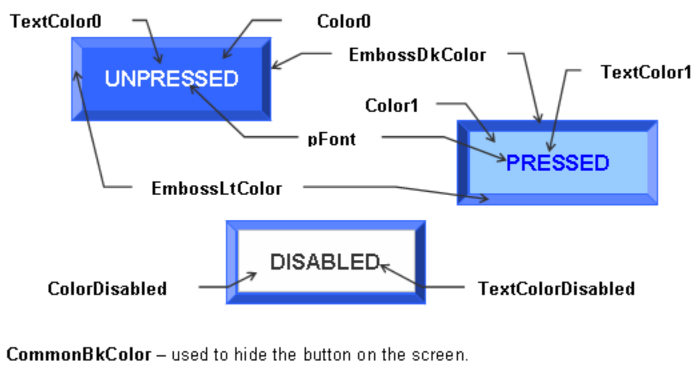
Description

Button supports Keyboard and Touchscreen inputs, replying to their events with the following messages:

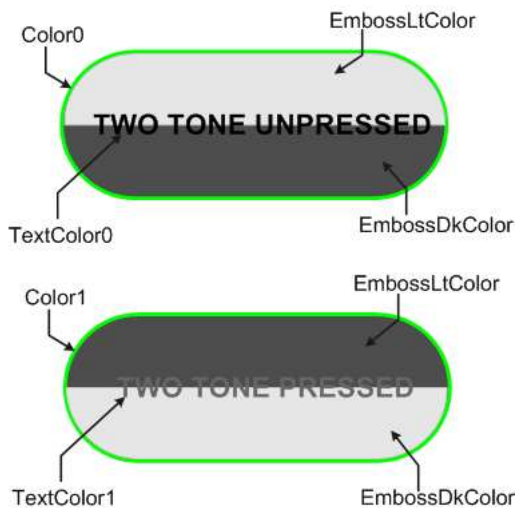
1. BTN_MSG_PRESSED

2. BTN_MSG_RELEASED

The button object is rendered using the assigned style scheme. The following figure illustrates the color assignments for the button.



A variant of the button widget, is to implement it as a two tone button. The button object is rendered using the modified color assignments in the style scheme.



Two Tone Button

8.1.8.1 Button States

Macros

Name	Description
BTN_DISABLED (↗ see page 81)	Bit for disabled state.
BTN_DRAW (↗ see page 81)	Bit to indicate button must be redrawn.
BTN_DRAW_FOCUS (↗ see page 81)	Bit to indicate focus must be redrawn.
BTN_FOCUSED (↗ see page 81)	Bit for focus state.
BTN_HIDE (↗ see page 82)	Bit to indicate button must be removed from screen.
BTN_PRESSED (↗ see page 82)	Bit for press state.
BTN_TEXTBOTTOM (↗ see page 82)	Bit to indicate text is top aligned.
BTN_TEXTLEFT (↗ see page 82)	Bit to indicate text is left aligned.
BTN_TEXTRIGHT (↗ see page 82)	Bit to indicate text is right aligned.
BTN_TEXTTOP (↗ see page 83)	Bit to indicate text is bottom aligned.
BTN_TOGGLE (↗ see page 83)	Bit to indicate button will have a toggle behavior.
BTN_TWOTONE (↗ see page 83)	Bit to indicate the button is a two tone type.

BTN_NOPANEL (see page 83)	Bit to indicate the button will be drawn without a panel (for faster drawing when the button image used is larger than the button panel).

Module

Button (see page 78)

Description

List of Button (see page 78) bit states.

8.1.8.1.1 BTN_DISABLED Macro

File

Button.h (see page 672)

C

```
#define BTN_DISABLED 0x0002  // Bit for disabled state.
```

Description

Bit for disabled state.

8.1.8.1.2 BTN_DRAW Macro

File

Button.h (see page 672)

C

```
#define BTN_DRAW 0x4000  // Bit to indicate button must be redrawn.
```

Description

Bit to indicate button must be redrawn.

8.1.8.1.3 BTN_DRAW_FOCUS Macro

File

Button.h (see page 672)

C

```
#define BTN_DRAW_FOCUS 0x2000  // Bit to indicate focus must be redrawn.
```

Description

Bit to indicate focus must be redrawn.

8.1.8.1.4 BTN_FOCUSED Macro

File

Button.h (see page 672)

C

```
#define BTN_FOCUSED 0x0001  // Bit for focus state.
```

Description

Bit for focus state.

8.1.8.1.5 BTN_HIDE Macro

File

Button.h (see page 672)

C

```
#define BTN_HIDE 0x8000  // Bit to indicate button must be removed from screen.
```

Description

Bit to indicate button must be removed from screen.

8.1.8.1.6 BTN_PRESSED Macro

File

Button.h (see page 672)

C

```
#define BTN_PRESSED 0x0004  // Bit for press state.
```

Description

Bit for press state.

8.1.8.1.7 BTN_TEXTBOTTOM Macro

File

Button.h (see page 672)

C

```
#define BTN_TEXTBOTTOM 0x0040  // Bit to indicate text is top aligned.
```

Description

Bit to indicate text is top aligned.

8.1.8.1.8 BTN_TEXTLEFT Macro

File

Button.h (see page 672)

C

```
#define BTN_TEXTLEFT 0x0020  // Bit to indicate text is left aligned.
```

Description

Bit to indicate text is left aligned.

8.1.8.1.9 BTN_TEXTRIGHT Macro

File

Button.h (see page 672)

C

```
#define BTN_TEXTRIGHT 0x0010  // Bit to indicate text is right aligned.
```

Description

Bit to indicate text is right aligned.

8.1.8.1.10 BTN_TEXTTOP Macro

File

Button.h (see page 672)

C

```
#define BTN_TEXTTOP 0x0080  // Bit to indicate text is bottom aligned.
```

Description

Bit to indicate text is bottom aligned.

8.1.8.1.11 BTN_TOGGLE Macro

File

Button.h (see page 672)

C

```
#define BTN_TOGGLE 0x0008  // Bit to indicate button will have a toggle behavior.
```

Description

Bit to indicate button will have a toggle behavior.

8.1.8.1.12 BTN_TWOTONE Macro

File

Button.h (see page 672)

C

```
#define BTN_TWOTONE 0x0100  // Bit to indicate the button is a two tone type.
```

Description

Bit to indicate the button is a two tone type.

8.1.8.1.13 BTN_NOPANEL Macro

File

Button.h (see page 672)

C

```
#define BTN_NOPANEL 0x0200  // Bit to indicate the button will be drawn without a panel
(for faster drawing when the button image used is larger than the button panel).
```

Description

Bit to indicate the button will be drawn without a panel (for faster drawing when the button image used is larger than the button panel).

8.1.8.2 BtnCreate Function

File

Button.h (see page 672)

C

```
BUTTON * BtnCreate(
    WORD ID,
    SHORT left,
    SHORT top,
    SHORT right,
    SHORT bottom,
    SHORT radius,
    WORD state,
    void * pBitmap,
    XCHAR * pText,
    GOL_SCHEME * pScheme
);
```

Module

Button (see page 78)

Input Parameters

Input Parameters	Description
WORD ID	Unique user defined ID for the object instance.
SHORT left	Left most position of the object.
SHORT top	Top most position of the object.
SHORT right	Right most position of the object.
SHORT bottom	Bottom most position of the object.
SHORT radius	Radius of the rounded edge.
WORD state	Sets the initial state of the object.
void * pBitmap	Pointer to the bitmap used on the face of the button dimension of the bitmap must match the dimension of the button.
XCHAR * pText	Pointer to the text of the button.
GOL_SCHEME * pScheme	Pointer to the style scheme used.

Side Effects

none

Returns

Returns the pointer to the object created.

Preconditions

none

Example

```
GOL_SCHEME *pScheme;
BUTTON *buttons[3];
WORD state;

    pScheme = GOLCreateScheme();
    state = BTN_DRAW;

    buttons[0] = BtnCreate(1,20,64,50,118,0, state, NULL, "ON", pScheme);
    // check if button 0 is created
    if (buttons[0] == NULL)
       return 0;

    buttons[1] = BtnCreate(2,52,64,82,118,0, state, NULL, "OFF", pScheme);
    // check if button 1 is created
    if (buttons[1] == NULL)
       return 0;

    buttons[2] = BtnCreate(3,84,64,114,118,0, state, NULL, "HI", pScheme);
    // check if button 2 is created
    if (buttons[2] == NULL)
       return 0;

    return 1;
```

Overview

This function creates a BUTTON (see page 91) object with the parameters given. It automatically attaches the new object into a global linked list of objects and returns the address of the object.

Syntax

BUTTON (see page 91) *BtnCreate(WORD ID, SHORT left, SHORT top, SHORT right, SHORT bottom, SHORT radius, void *pBitmap, XCHAR (see page 361) *pText, GOL_SCHEME (see page 345) *pScheme)

8.1.8.3 BtnDraw Function

File

Button.h (see page 672)

C

```
WORD BtnDraw(
    void * pObj
);
```

Module

Button (see page 78)

Input Parameters

Input Parameters	Description
pB	Pointer to the object to be rendered.

Side Effects

none

Returns

Returns the status of the drawing

- 1 - If the rendering was completed and
- 0 - If the rendering is not yet finished.

Next call to the function will resume the rendering on the pending drawing state.

Preconditions

Object must be created before this function is called.

Example

```
void MyGOLDraw(){
    static OBJ_HEADER *pCurrentObj = NULL;
    int done;

    // There are no objects
    if(GOLGetList() == NULL)
        return;

    // If it's last object jump to head
    if(pCurrentObj == NULL)
        pCurrentObj = GOLGetList();

    done = 0;

    // this only process Button and Window
    while(pCurrentObj != NULL){
        // check if object state indicates redrawing
        done = pCurrentObj->draw(pCurrentObj);

            if(done){
                // reset only the state if drawing was finished
```

```
                    pCurrentObj->state = 0;
                }else{
                    // done processing the list
                    return;
                }
            }
            // go to next object
            pCurrentObj = pCurrentObj->pNxtObj;
        }
    }
```

Overview

This function renders the object on the screen using the current parameter settings. Location of the object is determined by the left, top, right and bottom parameters. The colors used are dependent on the state of the object. The font used is determined by the style scheme set.

The text on the face of the button is drawn on top of the bitmap. Text is always rendered centered on the face of the button.

When rendering objects of the same type, each object must be rendered completely before the rendering of the next object is started. This is to avoid incomplete object rendering.

Syntax

WORD BtnDraw(void *pObj)

8.1.8.4 BtnGetText Macro

File

Button.h (see page 672)

C

```
#define BtnGetText(pB) ((BUTTON *)pB)->pText
```

Module

Button (see page 78)

Input Parameters

Input Parameters	Description
pB	Pointer to the object.

Side Effects

none

Returns

Returns pointer to the text string being used.

Preconditions

none

Example

```
XCHAR *pChar;
BUTTON Button[2];

pChar = BtnGetText(Button[0]);
```

Overview

This macro returns the address of the current text string used for the object.

Syntax

BtnGetText(pB)

8.1.8.5 BtnSetText Function

File

Button.h (see page 672)

C

```
void BtnSetText(
    BUTTON * pB,
    XCHAR * pText
);
```

Module

Button (see page 78)

Input Parameters

Input Parameters	Description
BUTTON * pB	The pointer to the object whose text will be modified.
XCHAR * pText	Pointer to the text that will be used.

Side Effects

none

Returns

none

Preconditions

none

Example

```
XCHAR Label0[] = “ON”;
XCHAR Label1[] = “OFF”;
BUTTON Button[2];

    BtnSetText(Button[0], Label0);
    BtnSetText(Button[1], Label1);
```

Overview

This function sets the string used for the object.

Syntax

BtnSetText(BUTTON (see page 91) *pB, XCHAR (see page 361) *pText)

8.1.8.6 BtnGetBitmap Macro

File

Button.h (see page 672)

C

```
#define BtnGetBitmap(pB) ((BUTTON *)pB)->pBitmap
```

Module

Button (see page 78)

Input Parameters

Input Parameters	Description
pB	Pointer to the object.

Side Effects

none

Returns

Returns the pointer to the current bitmap used.

Preconditions

none

Example

```
BUTTON *pButton;
BITMAP_FLASH *pUsedBitmap;

    pUsedbitmap = BtnGetBitmap(pButton);
```

Overview

This macro returns the location of the currently used bitmap for the object.

Syntax

BtnGetBitmap(pB)

8.1.8.7 BtnSetBitmap Macro

File

Button.h (see page 672)

C

```
#define BtnSetBitmap(pB, pBtmap) ((BUTTON *)pB)->pBitmap = pBtmap
```

Module

Button (see page 78)

Input Parameters

Input Parameters	Description
pB	Pointer to the object.
pBitmap	Pointer to the bitmap to be used.

Side Effects

none

Returns

none

Preconditions

none

Example

```
extern BITMAP_FLASH myIcon;
BUTTON *pButton;

    BtnSetBitmap(pButton , &myIcon);
```

Overview

This macro sets the bitmap used in the object. The size of the bitmap must match the face of the button.

Syntax

BtnSetBitmap(pB, pBitmap)

8.1.8.8 BtnMsgDefault Function

File

Button.h (see page 672)

C

```
void BtnMsgDefault(
    WORD translatedMsg,
    void * pObj,
    GOL_MSG * pMsg
);
```

Module

Button (see page 78)

Input Parameters

Input Parameters	Description
WORD translatedMsg	The translated message.
void * pObj	The pointer to the object whose state will be modified.
GOL_MSG * pMsg	The pointer to the GOL (see page 64) message.

Side Effects

none

Returns

none

Preconditions

none

Example

See BtnTranslateMsg (see page 90)() example.

Overview

This function performs the actual state change based on the translated message given. The following state changes are supported:

Translated Message	Input Source	Set/Clear State Bit	Description
BTN_MSG_PRESSED	Touch Screen, Keyboard	Set BTN_PRESSED (see page 82)	Button (see page 78) will be redrawn in the pressed state.
BTN_MSG_RELEASED	Touch Screen, Keyboard	Clear BTN_PRESSED (see page 82)	Button (see page 78) will be redrawn in the unpressed state.
BTN_MSG_CANCELPRESS	Touch Screen,	Clear BTN_PRESSED (see page 82)	Button (see page 78) will be redrawn in the unpressed state.

Syntax

BtnMsgDefault(WORD translatedMsg, void *pObj, GOL_MSG (see page 330)* pMsg)

8.1.8.9 BtnTranslateMsg Function

File

Button.h (see page 672)

C

```
WORD BtnTranslateMsg(
    void * pObj,
    GOL_MSG * pMsg
);
```

Module

Button (see page 78)

Input Parameters

Input Parameters	Description
void * pObj	The pointer to the object where the message will be evaluated to check if the message will affect the object.
GOL_MSG * pMsg	Pointer to the message struct containing the message from the user interface.

Side Effects

none

Returns

Returns the translated message depending on the received GOL (see page 64) message:

- BTN_MSG_PRESSED – Button (see page 78) is pressed
- BTN_MSG_RELEASED – Button (see page 78) is released
- BTN_MSG_CANCELPRESS – Button (see page 78) will be released, user cancels press action on the button
- OBJ_MSG_INVALID – Button (see page 78) is not affected

Preconditions

none

Example

```
void MyGOLMsg(GOL_MSG *pMsg){

    OBJ_HEADER *pCurrentObj;
    WORD objMsg;

    if(pMsg->uiEvent == EVENT_INVALID)
        return;
    pCurrentObj = GOLGetList();

    while(pCurrentObj != NULL){
        // If the object must be redrawn
        // It cannot accept message
        if(!IsObjUpdated(pCurrentObj)){
            translatedMsg = pCurrentObj->MsgObj(pCurrentObj, pMsg);

             if(translatedMsg != OBJ_MSG_INVALID)
             {
                 if(GOLMsgCallback(translatedMsg, pCurrentObj, pMsg))
                     if(pCurrentObj->MsgDefaultObj)
                         pCurrentObj->MsgDefaultObj(translatedMsg, pCurrentObj, pMsg);
             }

        }
    }
    pCurrentObj = pCurrentObj->pNxtObj;
}
```

Overview

This function evaluates the message from a user if the message will affect the object or not. The table below enumerates the translated messages for each event of the touch screen and keyboard inputs.

Translated Message	Input Source	Set/Clear State Bit	Description
BTN_MSG_PRESSED	Touch Screen	EVENT_PRESS, EVENT_MOVE	If events occurs and the x,y position falls in the face of the button while the button is not pressed.
	Keyboard	EVENT_KEYSCAN	If event occurs and parameter1 passed matches the object's ID and parameter 2 passed matches SCAN_CR_PRESSED (see page 335) or SCAN_SPACE_PRESSED (see page 339) while the button is not pressed.
BTN_MSG_STILLPRESSED	Touch Screen	EVENT_STILLPRESS	If event occurs and the x,y position does not change from the previous press position in the face of the button.
BTN_MSG_RELEASED	Touch Screen	EVENT_RELEASE	If the event occurs and the x,y position falls in the face of the button while the button is pressed.
	Keyboard	EVENT_KEYSCAN	If event occurs and parameter1 passed matches the object's ID and parameter 2 passed matches SCAN_CR_RELEASED (see page 335) or SCAN_SPACE_RELEASED (see page 339) while the button is pressed.
BTN_MSG_CANCELPRESS	Touch Screen	EVENT_MOVE	If the event occurs outside the face of the button and the button is currently pressed.
OBJ_MSG_INVALID	Any	Any	If the message did not affect the object.

Syntax

BtnTranslateMsg(void *pObj, GOL_MSG (see page 330) *pMsg)

8.1.8.10 BUTTON Structure

File

Button.h (see page 672)

C

```
typedef struct {
  OBJ_HEADER hdr;
  SHORT radius;
  SHORT textWidth;
  SHORT textHeight;
  XCHAR * pText;
  void * pBitmap;
} BUTTON;
```

Members

Members	Description
OBJ_HEADER hdr;	Generic header for all Objects (see OBJ_HEADER (see page 68)).
SHORT radius;	Radius for rounded buttons.
SHORT textWidth;	Computed text width, done at creation.
SHORT textHeight;	Computed text height, done at creation.
XCHAR * pText;	Pointer to the text used.
void * pBitmap;	Pointer to bitmap used.

Module

Button (see page 78)

Overview

Defines the parameters required for a button Object. The following relationships of the parameters determines the general shape of the button:

1. Width is determined by right - left.
2. Height is determined by top - bottom.
3. Radius - specifies if the button will have a rounded edge. If zero then the button will have sharp (cornered) edge.
4. If 2*radius = height = width, the button is a circular button.

8.1.9 Chart

Chart is an Object that draws a bar chart or a pie chart representation of a single data or series of data.

Functions

	Name	Description
	ChCreate (see page 100)	This function creates a CHART (see page 124) object with the parameters given. It automatically attaches the new object into a global linked list of objects and returns the address of the object.
	ChDraw (see page 102)	This function renders the object on the screen using the current parameter settings. Location of the object is determined by the left, top, right and bottom parameters. The colors used are dependent on the state of the object. The font used is determined by the style scheme set. The colors of the bars of the bar chart or sectors of the pie chart can be the default color table or user defined color table set by ChSetColorTable (see page 117)() function. When rendering objects of the same type, each object must be rendered completely before the rendering of the next object is... more (see page 102)
	ChAddDataSeries (see page 103)	This function creates a DATASERIES (see page 124) object and populates the structure with the given parameters.
	ChRemoveDataSeries (see page 103)	This function removes DATASERIES (see page 124) object from the list of DATASERIES (see page 124) objects and frees the memory used of that removed object. The position of the object to be removed is specified by the number parameter. If the list has only one member, it removes the member regardless of the number given.
	ChSetValueRange (see page 109)	This function sets the minimum and maximum range of values that the bar chart will show. The criteria is that min <= max.
	ChSetPercentRange (see page 113)	This function sets the minimum and maximum range of percentage that the bar chart will show. The criteria is that min <= max. This affects bar charts only and CH_PERCENTAGE bit state is set.
	ChSetSampleRange (see page 114)	This function sets the sample start and sample end when drawing the chart. Together with the data series' SHOW_DATA (see page 98) flags the different way of displaying the chart data is achieved.
	ChFreeDataSeries (see page 122)	This function removes DATASERIES (see page 124) object from the list of DATASERIES (see page 124) objects and frees the memory used of that removed object.
	ChTranslateMsg (see page 123)	This function evaluates the message from a user if the message will affect the object or not. The table below enumerates the translated messages for each event of the touch screen and keyboard inputs.

Macros

Name	Description
ChShowSeries (see page 104)	This macro sets the specified data series number show flag to be set to SHOW_DATA (see page 98).
ChHideSeries (see page 105)	This macro sets the specified data series number show flag to be set to HIDE_DATA (see page 98).
ChGetShowSeriesCount (see page 106)	This macro shows the number of data series that has its show flag set to SHOW_DATA (see page 98)
ChGetShowSeriesStatus (see page 106)	This macro returns the show ID status of the DATASERIES (see page 124).
ChSetValueLabel (see page 107)	This macro sets the address of the current text string used for the value axis label of the bar chart.
ChGetValueLabel (see page 107)	This macro returns the address of the current text string used for the value axis label of the bar chart.
ChGetValueMax (see page 108)	This macro returns the current maximum value that will be drawn for bar charts.
ChGetValueMin (see page 108)	This macro returns the current minimum value that will be drawn for bar charts.
ChGetValueRange (see page 110)	This macro gets the current range for bar charts. The value returned is calculated from the current (valMax - valMin) set. To get the minimum use ChGetValueMin (see page 108)() and to get the maximum use ChGetValueMax (see page 108)().
ChSetSampleLabel (see page 110)	This macro sets the address of the current text string used for the sample axis label of the bar chart.
ChGetSampleLabel (see page 111)	This macro returns the address of the current text string used for the sample axis label of the bar chart.
ChGetSampleStart (see page 111)	This macro returns the sampling start value.
ChGetSampleEnd (see page 112)	This macro returns the sampling end value.
ChGetPercentRange (see page 113)	This macro gets the percentage range for bar charts. The value returned is calculated from percentage max - min. To get the minimum use ChGetPercentMin (see page 116)() and to get the maximum use ChGetPercentMax (see page 115)().
ChGetSampleRange (see page 115)	This macro gets the sample range for pie or bar charts. The value returned is calculated from smplEnd - smplStart.
ChGetPercentMax (see page 115)	This macro returns the current maximum value of the percentage range that will be drawn for bar charts when CH_PERCENTAGE bit state is set.
ChGetPercentMin (see page 116)	This macro returns the current minimum value of the percentage range that will be drawn for bar charts when CH_PERCENTAGE bit state is set.
ChSetColorTable (see page 117)	This macro sets the color table used to draw the data in pie and bar charts.
ChGetColorTable (see page 117)	This macro returns the current color table used for the pie and bar charts.
ChSetTitle (see page 118)	This macro sets the address of the current text string used for the title of the chart.
ChGetTitle (see page 118)	This macro returns the address of the current text string used for the title of the chart.
ChSetTitleFont (see page 119)	This macro sets the location of the font used for the title of the chart.
ChGetTitleFont (see page 119)	This macro returns the location of the font used for the title of the chart.
ChGetAxisLabelFont (see page 120)	This macro returns the location of the font used for the X and Y axis labels of the chart.
ChSetAxisLabelFont (see page 121)	This macro sets the location of the font used for the X and Y axis labels of the chart.
ChGetGridLabelFont (see page 121)	This macro returns the location of the font used for the X and Y axis grid labels of the chart.
ChSetGridLabelFont (see page 122)	This macro sets the location of the font used for the X and Y axis grid labels of the chart.

Structures

Name	Description
CHART (see page 124)	Defines the parameters required for a chart Object.
DATASERIES (see page 124)	Defines a variable for the CHART (see page 124) object. It specifies the number of samples, pointer to the array of samples for the data series and pointer to the next data series. A member of this structure (show) is used as a flag to determine if the series is to be drawn or not. Together with the smplStart and smplEnd it will determine what kind of chart will be drawn.
CHARTPARAM (see page 125)	Defines the parameters for the CHART (see page 124) object.

Description

It supports only Keyboard inputs, replying to any touch screen events with the message: CH_MSG_SELECTED.

The Chart Object is rendered using the assigned style scheme. The following figure illustrates the color assignments.

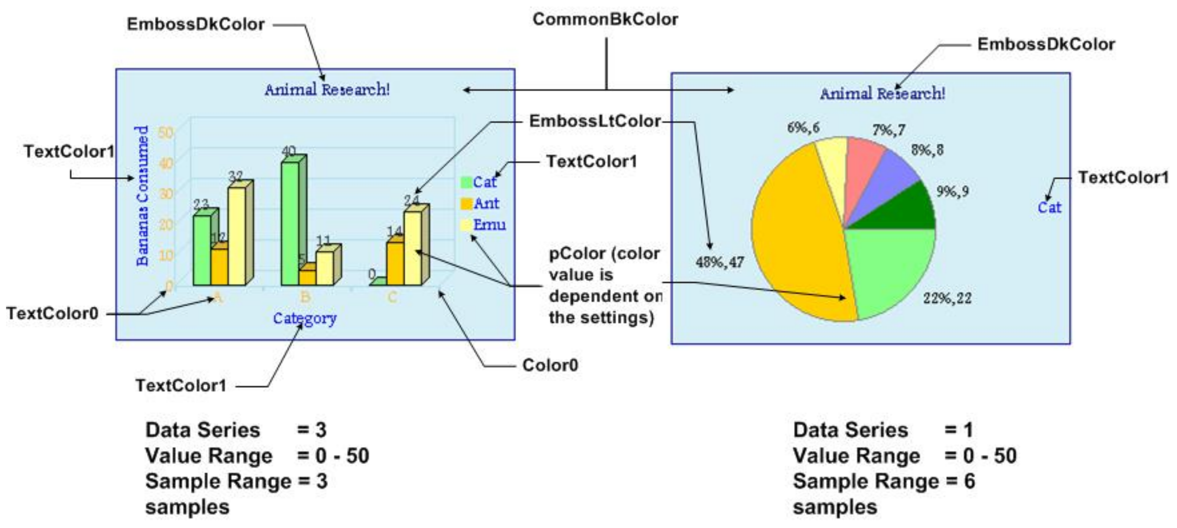


Chart Terminologies

1. Value Axis - This is the vertical range of a chart for normal bar charts and horizontal range of the chart for horizontally drawn bar charts. In most cases this axis will represent values ($ amounts), temperatures, or other numeric data.
2. Sample Axis - This is the horizontal range of a chart for normal bar charts and vertical range of the chart for horizontally drawn bar charts. In most cases this axis will represent categories, such as months, sample segments, or other non-numeric data.
3. Title - The text used to define the Title of the chart.
4. Data Points (or the sample points) These are the individual points where a value is graphed, as a point on a line, a bar, or a pie slice.
5. Data Series - A complete series of data, distinguished by the same color and type of sample point.
6. Legend - Labels that indicate how each data series is displayed on the chart. Each color represents a different data series. For pie charts with only one data series shown, each color represents one sector or one sample point.
7. Data Sample Range - The scale for the data sample axis. Example: months from January to December. Internally, this range is represented by:

- Numeric Sequence 1, 2, 3, ... and so on
- Alphabet Sequence A, B, C, .. and so on.

8. Value Range - The scale for the value axis. Example: range of numbers from the lowest to the highest to be charted.

8.1.9.1 Chart States

Macros

Name	Description
CH_DISABLED (↗ see page 95)	Bit for disabled state.
CH_DRAW (↗ see page 95)	Bit to indicate chart must be redrawn.
CH_DRAW_DATA (↗ see page 95)	Bit to indicate data portion of the chart must be redrawn.
CH_3D_ENABLE (↗ see page 96)	Bit to indicate that bar charts are to be drawn with 3-D effect
CH_BAR (↗ see page 96)	Bit to indicate the chart is type bar. If both PIE and BAR types
CH_BAR_HOR (↗ see page 96)	These bits (with CH_BAR (↗ see page 96) bit set), sets the bar chart to
CH_DONUT (↗ see page 96)	These bits (with CH_PIE (↗ see page 97) bit set), sets the pie chart to
CH_LEGEND (↗ see page 97)	Bit to indicate that legend is to be shown. Usable only when seriesCount > 1.
CH_NUMERIC (↗ see page 97)	This bit is used only for bar charts. If this bit is set, it indicates that the
CH_PERCENT (↗ see page 97)	Bit to indicate that the pie chart will be drawn with percentage
CH_PIE (↗ see page 97)	Bit to indicate the chart is type pie. If both PIE and BAR types
CH_VALUE (↗ see page 97)	Bit to indicate that the values of the bar chart data or pie chart
CH_HIDE (↗ see page 98)	Bit to indicate chart must be removed from screen.

Module

Chart (↗ see page 92)

Description

List of Chart (↗ see page 92) bit states.

8.1.9.1.1 CH_DISABLED Macro

File

Chart.h (↗ see page 724)

C

```
#define CH_DISABLED 0x0002          // Bit for disabled state.
```

Description

Bit for disabled state.

8.1.9.1.2 CH_DRAW Macro

File

Chart.h (↗ see page 724)

C

```
#define CH_DRAW 0x4000      // Bit to indicate chart must be redrawn.
```

Description

Bit to indicate chart must be redrawn.

8.1.9.1.3 CH_DRAW_DATA Macro

File

Chart.h (↗ see page 724)

C

```
#define CH_DRAW_DATA 0x2000      // Bit to indicate data portion of the chart must be
redrawn.
```

Description

Bit to indicate data portion of the chart must be redrawn.

8.1.9.1.4 CH_3D_ENABLE Macro

File

Chart.h (see page 724)

C

```
#define CH_3D_ENABLE 0x0008      // Bit to indicate that bar charts are to be drawn with
3-D effect
```

Description

Bit to indicate that bar charts are to be drawn with 3-D effect

8.1.9.1.5 CH_BAR Macro

File

Chart.h (see page 724)

C

```
#define CH_BAR 0x0200              // Bit to indicate the chart is type bar. If both PIE
and BAR types
```

Description

Bit to indicate the chart is type bar. If both PIE and BAR types

8.1.9.1.6 CH_BAR_HOR Macro

File

Chart.h (see page 724)

C

```
#define CH_BAR_HOR 0x0240          // These bits (with CH_BAR bit set), sets the bar chart
to
```

Description

These bits (with CH_BAR (see page 96) bit set), sets the bar chart to

8.1.9.1.7 CH_DONUT Macro

File

Chart.h (see page 724)

C

```
#define CH_DONUT 0x0140          // These bits (with CH_PIE bit set), sets the pie chart to
```

Description

These bits (with CH_PIE (see page 97) bit set), sets the pie chart to

8.1.9.1.8 CH_LEGEND Macro

File

Chart.h (see page 724)

C

```
#define CH_LEGEND 0x0001          // Bit to indicate that legend is to be shown. Usable
only when seriesCount > 1.
```

Description

Bit to indicate that legend is to be shown. Usable only when seriesCount > 1.

8.1.9.1.9 CH_NUMERIC Macro

File

Chart.h (see page 724)

C

```
#define CH_NUMERIC 0x0080          // This bit is used only for bar charts. If this bit is
set, it indicates that the
```

Description

This bit is used only for bar charts. If this bit is set, it indicates that the

8.1.9.1.10 CH_PERCENT Macro

File

Chart.h (see page 724)

C

```
#define CH_PERCENT 0x0010          // Bit to indicate that the pie chart will be drawn with
percentage
```

Description

Bit to indicate that the pie chart will be drawn with percentage

8.1.9.1.11 CH_PIE Macro

File

Chart.h (see page 724)

C

```
#define CH_PIE 0x0100      // Bit to indicate the chart is type pie. If both PIE and BAR
types
```

Description

Bit to indicate the chart is type pie. If both PIE and BAR types

8.1.9.1.12 CH_VALUE Macro

File

Chart.h (see page 724)

C

```
#define CH_VALUE 0x0004          // Bit to indicate that the values of the bar chart data
```

```
or pie chart
```

Description

Bit to indicate that the values of the bar chart data or pie chart

8.1.9.1.13 CH_HIDE Macro

File

Chart.h (⧉ see page 724)

C

```
#define CH_HIDE 0x8000      // Bit to indicate chart must be removed from screen.
```

Description

Bit to indicate chart must be removed from screen.

8.1.9.2 Data Series Status Settings

Macros

Name	Description
HIDE_DATA (⧉ see page 98)	Macro used to reset the data series show flag or indicate that the data series will be not be shown when the chart is drawn.
SHOW_DATA (⧉ see page 98)	Macro used to set the data series show flag or indicate that the data series will be shown when the chart is drawn.

Module

Chart (⧉ see page 92)

Description

Data Series show status flag settings.

8.1.9.2.1 HIDE_DATA Macro

File

Chart.h (⧉ see page 724)

C

```
#define HIDE_DATA 0               // Macro used to reset the data series show flag or
indicate that the data series will be not be shown when the chart is drawn.
```

Description

Macro used to reset the data series show flag or indicate that the data series will be not be shown when the chart is drawn.

8.1.9.2.2 SHOW_DATA Macro

File

Chart.h (⧉ see page 724)

C

```
#define SHOW_DATA 1               // Macro used to set the data series show flag or
indicate that the data series will be shown when the chart is drawn.
```

Description

Macro used to set the data series show flag or indicate that the data series will be shown when the chart is drawn.

8.1.9.3 Chart Examples

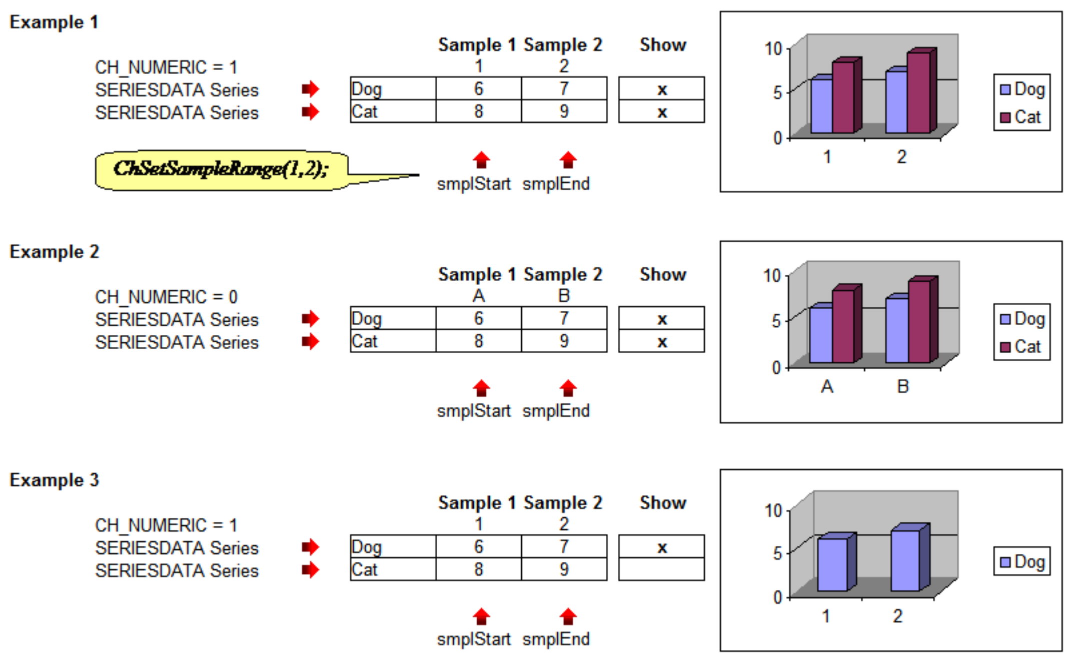
Examples of generated bar charts based on settings.

Module

Chart (see page 92)

Description

The following are some examples of settings and output chart that will be generated.



Example 1

CH_NUMERIC = 1
SERIESDATA Series
SERIESDATA Series

	Sample 1	Sample 2	Show
	1	2	
Dog	6	7	x
Cat	8	9	x

Example 2

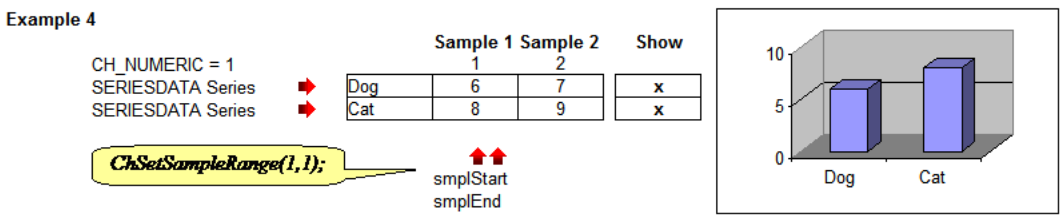
CH_NUMERIC = 0
SERIESDATA Series
SERIESDATA Series

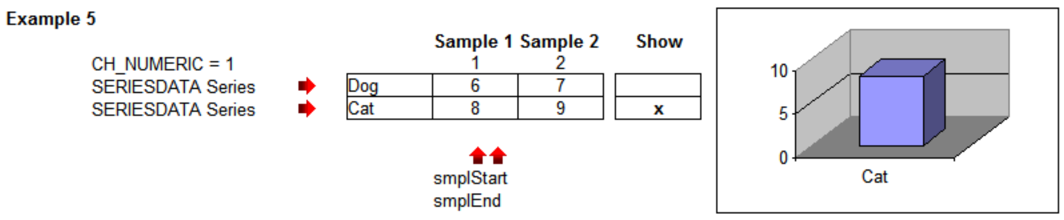
	Sample 1	Sample 2	Show
	A	B	
Dog	6	7	x
Cat	8	9	x

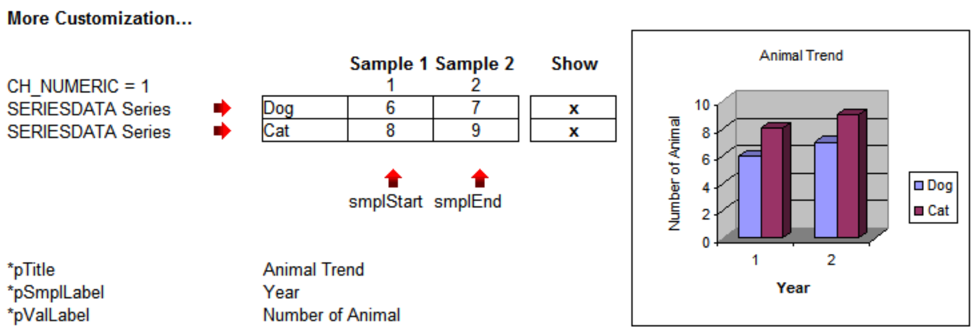
Example 3

CH_NUMERIC = 1
SERIESDATA Series
SERIESDATA Series

	Sample 1	Sample 2	Show
	1	2	
Dog	6	7	x
Cat	8	9	







8.1.9.4 ChCreate Function

File

Chart.h (see page 724)

C

```
CHART * ChCreate(
    WORD ID,
    SHORT left,
    SHORT top,
    SHORT right,
    SHORT bottom,
    WORD state,
    DATASERIES * pData,
    CHARTPARAM * pParam,
    GOL_SCHEME * pScheme
);
```

Module

Chart (see page 92)

Input Parameters

Input Parameters	Description
WORD ID	Unique user defined ID for the object instance.
SHORT left	Left most position of the object.
SHORT top	Top most position of the object.
SHORT right	Right most position of the object.
SHORT bottom	Bottom most position of the object.

WORD state	Sets the initial state of the object.
DATASERIES * pData	Pointer to the data for the contents of the chart. NULL can be assigned initially when creating the object.
CHARTPARAM * pParam	Pointer to the chart parameters. NULL can be assigned initially when creating the object and the chart parameters can be populated using the API provided.
GOL_SCHEME * pScheme	Pointer to the style scheme used. When set to NULL, the default style scheme will be used.

Side Effects

none

Returns

Returns the pointer to the object created.

Preconditions

none

Example

```
extern const FONT_FLASH GOLSmallFont;
extern const FONT_FLASH GOLMediumFont;

// Note that strings are declared as such to cover cases
// where XCHAR type is declared as short (2 bytes).
XCHAR ChTitle[]     = {'E','x','a','m','p','l','e',0};
XCHAR SampleName[]  = {'C','a','t','e','g','o','r','y',0};
XCHAR ValueName[]   = {'#','H','i','t','s',0};
XCHAR SeriesName[2] = {
                       {'V','1',0},
                       {'V','2',0},
                      };
V1Data[2] = { 50, 100};
V2Data[2] = { 5,  10};

GOL_SCHEME  *pScheme;
CHART       *pChart;
CHARTPARAM   Contents;
WORD         state;

    pScheme = GOLCreateScheme();
    state = CH_BAR|CH_DRAW|CH_BAR_HOR;  // Bar Chart to be drawn with horizontal orientation


    pChart = ChCreate(0x01,                            // ID
                      0, 0,                            // dimensions
                      GetMaxX(),
                      GetMaxY(),
                      state,                           // state of the chart
                      NULL,                            // data not initialized yet
                      NULL,                            // no parameters yet
                      pScheme);                        // style scheme used

    if (pMyChart == NULL)                              // check if chart was allocated memory
        return 0;

    ChSetTitleFont(pChart, (void*)&GOLMediumFont);
    ChSetTitle(pChart, ChTitle);                       // set the title

    // set the grid labels and axis labels font
    ChSetGridLabelFont(pChart, (void*)&GOLSmallFont);
    ChSetAxisLabelFont(pChart, (void*)&GOLSmallFont);

    // set the labels for the X and Y axis
    ChSetSampleLabel(pChart, (XCHAR*)SampleName);
    ChSetValueLabel(pChart, (XCHAR*)ValueName);

    ChAddDataSeries(pChart, 2, V1Data, (XCHAR*)SeriesName[0]);
    ChAddDataSeries(pChart, 2, V2Data, (XCHAR*)SeriesName[1]);
```

```
        // set the range of the sample values
        ChSetValueRange(pChart, 0, 100);

        // show all two samples to be displayed (start = 1, end = 2)
        ChSetSampleRange(pChart, 1, 2);

        GOLDraw();                                      // draw the chart
```

Overview

This function creates a CHART (see page 124) object with the parameters given. It automatically attaches the new object into a global linked list of objects and returns the address of the object.

Syntax

CHART (see page 124) *ChCreate(WORD ID, SHORT left, SHORT top, SHORT right, SHORT bottom, WORD state, DATASERIES (see page 124) *pData, CHARTPARAM (see page 125) *pParam, GOL_SCHEME (see page 345) *pScheme)

8.1.9.5 ChDraw Function

File

Chart.h (see page 724)

C

```
WORD ChDraw(
    void * pObj
);
```

Module

Chart (see page 92)

Input Parameters

Input Parameters	Description
pCh	Pointer to the object to be rendered.

Side Effects

none.

Returns

Returns the status of the drawing

- 1 - If the rendering was completed and
- 0 - If the rendering is not yet finished.

Next call to the function will resume the rendering on the pending drawing state.

Preconditions

Object must be created before this function is called.

Overview

This function renders the object on the screen using the current parameter settings. Location of the object is determined by the left, top, right and bottom parameters. The colors used are dependent on the state of the object. The font used is determined by the style scheme set.

The colors of the bars of the bar chart or sectors of the pie chart can be the default color table or user defined color table set by ChSetColorTable (see page 117)() function.

When rendering objects of the same type, each object must be rendered completely before the rendering of the next object is started. This is to avoid incomplete object rendering.

Syntax

WORD ChDraw(void *pObj)

8.1.9.6 ChAddDataSeries Function

File

Chart.h (see page 724)

C

```
DATASERIES * ChAddDataSeries(
    CHART * pCh,
    WORD nSamples,
    WORD * pData,
    XCHAR * pName
);
```

Module

Chart (see page 92)

Input Parameters

Input Parameters	Description
CHART * pCh	Pointer to the chart object.
WORD nSamples	The number of samples or data points.
WORD * pData	Pointer to the array of samples or data points.
XCHAR * pName	Pointer to the string used to label the data series.

Side Effects

Appends to the list of DATASERIES (see page 124) that the chart is operating on. By default, the show flag of the newly added data series is set to SHOW_DATA (see page 98) or enabled.

Returns

Returns the pointer to the data variable (DATASERIES (see page 124)) object created. If NULL is returned, the addition of the new object failed due to not enough memory for the object.

Preconditions

none

Example

See ChCreate (see page 100)() example.

Overview

This function creates a DATASERIES (see page 124) object and populates the structure with the given parameters.

Syntax

ChAddDataSeries(CHART (see page 124) *pCh, WORD nSamples, WORD *pData, XCHAR (see page 361) *pName)

8.1.9.7 ChRemoveDataSeries Function

File

Chart.h (see page 724)

C

```
void ChRemoveDataSeries(
    CHART * pCh,
    WORD number
);
```

Module

Chart (see page 92)

Input Parameters

Input Parameters	Description
CHART * pCh	Pointer to the chart object.
WORD number	The position of the object to be removed in the list where the first object in the list is assigned a value of 1. If this parameter is set to zero, the whole list of DATA_SERIES is removed.

Side Effects

none.

Returns

none.

Preconditions

none

Example

```
void ClearChartData(CHART *pCh) {
    if(pCh->pChData != NULL)
        // remove the all data series
        ChRemoveDataSeries(pCh, 0);
}
```

Overview

This function removes DATASERIES (see page 124) object from the list of DATASERIES (see page 124) objects and frees the memory used of that removed object. The position of the object to be removed is specified by the number parameter. If the list has only one member, it removes the member regardless of the number given.

Syntax

ChRemoveDataSeries(CHART (see page 124) *pCh, WORD number)

8.1.9.8 ChShowSeries Macro

File

Chart.h (see page 724)

C

```
#define ChShowSeries(pCh, seriesNum) (ChSetDataSeries(pCh, seriesNum, SHOW_DATA))
```

Module

Chart (see page 92)

Input Parameters

Input Parameters	Description
pCh	Pointer to the chart object.
seriesNum	The data series number that will be modified. If this number is zero, all the entries' flag in the list will be set to SHOW_DATA (see page 98).

Side Effects

none

Returns

Returns the same passed number if successful otherwise -1 if unsuccesful.

Preconditions

none

Example

```
// from the example in  ChCreate() we change the items to be shown when
// GOLDraw() is called.

// reset all data series to be HIDE_DATA
ChHideSeries(pMyChart, 0);
// set data series 1 (V1Data) to be shown
ChShowSeries(pMyChart, 1);
// draw the chart
GOLDraw();
.....

*
```

Overview

This macro sets the specified data series number show flag to be set to SHOW_DATA (see page 98).

Syntax

SHORT ChShowSeries(CHART (see page 124) *pCh, WORD seriesNum)

8.1.9.9 ChHideSeries Macro

File

Chart.h (see page 724)

C

```
#define ChHideSeries(pCh, seriesNum) (ChSetDataSeries(pCh, seriesNum, HIDE_DATA))
```

Module

Chart (see page 92)

Input Parameters

Input Parameters	Description
pCh	Pointer to the chart object.
seriesNum	The data series number that will be modified. If this number is zero, all the entries' flag in the list will be set to HIDE_DATA (see page 98).

Side Effects

none

Returns

Returns the same passed number if successful otherwise -1 if unsuccesful.

Preconditions

none

Example

See ChShowSeries (see page 104)() example.

Overview

This macro sets the specified data series number show flag to be set to HIDE_DATA (see page 98).

Syntax

SHORT ChHideSeries(CHART (see page 124) *pCh, WORD seriesNum)

8.1.9.10 ChGetShowSeriesCount Macro

File

Chart.h (see page 724)

C

```
#define ChGetShowSeriesCount(pCh) (pCh->prm.seriesCount)
```

Module

Chart (see page 92)

Input Parameters

Input Parameters	Description
pCh	Pointer to the object.

Side Effects

none

Returns

Returns the number of data series with its show flag set to SHOW_DATA (see page 98).

Preconditions

none

Overview

This macro shows the number of data series that has its show flag set to SHOW_DATA (see page 98)

Syntax

ChGetShowSeriesCount(pCh)

8.1.9.11 ChGetShowSeriesStatus Macro

File

Chart.h (see page 724)

C

```
#define ChGetShowSeriesStatus(pDSeries) (pDSeries->show)
```

Module

Chart (see page 92)

Input Parameters

Input Parameters	Description
pDSeries	Pointer to the data series(DATASERIES (see page 124)) that is being checked.

Side Effects

none

Returns

Returns the status of the show flag. 1 - (SHOW_DATA (see page 98)) means that the show status flag is set. 0 - (HIDE_DATA (see page 98)) means that the show status flag is not set.

Preconditions

none

Overview

This macro returns the show ID status of the DATASERIES (see page 124).

Syntax

ChGetShowSeriesStatus(pDSeries)

8.1.9.12 ChSetValueLabel Macro

File

Chart.h (see page 724)

C

```
#define ChSetValueLabel(pCh, pNewValueLabel) (((CHART *)pCh)->prm.pValLabel =
pNewValueLabel)
```

Module

Chart (see page 92)

Input Parameters

Input Parameters	Description
pCh	Pointer to the object.
pNewYLabel	pointer to the string to be used as an value axis label of the bar chart.

Side Effects

none

Returns

none.

Preconditions

none

Example

See ChCreate (see page 100)() example.

Overview

This macro sets the address of the current text string used for the value axis label of the bar chart.

Syntax

ChSetValueLabel(pCh, pNewYLabel)

8.1.9.13 ChGetValueLabel Macro

File

Chart.h (see page 724)

C

```
#define ChGetValueLabel(pCh) (((CHART *)pCh)->prm.pValLabel)
```

Module

Chart (see page 92)

Input Parameters

Input Parameters	Description
pCh	Pointer to the object.

Side Effects

none

Returns

Returns the pointer to the current value axis label text of the bar chart.

Preconditions

none

Overview

This macro returns the address of the current text string used for the value axis label of the bar chart.

Syntax

ChGetValueLabel(pCh)

8.1.9.14 ChGetValueMax Macro

File

Chart.h (see page 724)

C

```
#define ChGetValueMax(pCh) (pCh->prm.valMax)
```

Module

Chart (see page 92)

Input Parameters

Input Parameters	Description
pCh	Pointer to the object.

Side Effects

none

Returns

Returns the maximum value set when bar charts are drawn.

Preconditions

none

Overview

This macro returns the current maximum value that will be drawn for bar charts.

Syntax

ChGetValueMax(pCh)

8.1.9.15 ChGetValueMin Macro

File

Chart.h (see page 724)

C

```
#define ChGetValueMin(pCh) (pCh->prm.valMin)
```

Module

Chart (see page 92)

Input Parameters

Input Parameters	Description
pCh	Pointer to the object.

Side Effects

none

Returns

Returns the minimum value set when bar charts are drawn.

Preconditions

none

Overview

This macro returns the current minimum value that will be drawn for bar charts.

Syntax

ChGetValueMin(pCh)

8.1.9.16 ChSetValueRange Function

File

Chart.h (see page 724)

C

```
void ChSetValueRange(
    CHART * pCh,
    WORD min,
    WORD max
);
```

Module

Chart (see page 92)

Input Parameters

Input Parameters	Description
CHART * pCh	Pointer to the chart object.
WORD min	Minimum value that will be displayed in the bar chart.
WORD max	Maximum value that will be displayed in the bar chart.

Side Effects

none.

Returns

none.

Preconditions

none

Overview

This function sets the minimum and maximum range of values that the bar chart will show. The criteria is that min <= max.

Syntax

ChSetValueRange(CHART (see page 124) *pCh, WORD min, WORD max)

8.1.9.17 ChGetValueRange Macro

File

Chart.h (see page 724)

C

```
#define ChGetValueRange(pCh) (pCh->prm.valMax - pCh->prm.valMin)
```

Module

Chart (see page 92)

Input Parameters

Input Parameters	Description
pCh	Pointer to the chart object.

Side Effects

none.

Returns

Value range computed from valMax-valMin.

Preconditions

none

Overview

This macro gets the current range for bar charts. The value returned is calculated from the current (valMax - valMin) set. To get the minimum use ChGetValueMin (see page 108)() and to get the maximum use ChGetValueMax (see page 108)().

Syntax

ChGetValueRange(pCh)

8.1.9.18 ChSetSampleLabel Macro

File

Chart.h (see page 724)

C

```
#define ChSetSampleLabel(pCh, pNewXLabel) (((CHART *)pCh)->prm.pSmplLabel = pNewXLabel)
```

Module

Chart (see page 92)

Input Parameters

Input Parameters	Description
pCh	Pointer to the object.
pNewXLabel	pointer to the string to be used as an sample axis label of the bar chart.

Side Effects

none

Returns

none.

Preconditions

none

Example

See ChCreate (see page 100)() example.

Overview

This macro sets the address of the current text string used for the sample axis label of the bar chart.

Syntax

ChSetSampleLabel(pCh, pNewXLabel)

8.1.9.19 ChGetSampleLabel Macro

File

Chart.h (see page 724)

C

```
#define ChGetSampleLabel(pCh) (((CHART *)pCh)->prm.pSmplLabel)
```

Module

Chart (see page 92)

Input Parameters

Input Parameters	Description
pCh	Pointer to the object.

Side Effects

none

Returns

Returns the pointer to the current sample axis label text of the bar chart.

Preconditions

none

Overview

This macro returns the address of the current text string used for the sample axis label of the bar chart.

Syntax

ChGetSampleLabel(pCh)

8.1.9.20 ChGetSampleStart Macro

File

Chart.h (see page 724)

C

```
#define ChGetSampleStart(pCh) (((CHART *)pCh)->prm.smplStart)
```

Module

Chart (see page 92)

Input Parameters

Input Parameters	Description
pCh	Pointer to the object.

Side Effects

none

Returns

Returns the sample start point.

Preconditions

none

Overview

This macro returns the sampling start value.

Syntax

ChGetSampleStart(pCh)

8.1.9.21 ChGetSampleEnd Macro

File

Chart.h (see page 724)

C

```
#define ChGetSampleEnd(pCh) ((CHART *)pCh)->prm.smplEnd
```

Module

Chart (see page 92)

Input Parameters

Input Parameters	Description
pCh	Pointer to the object.

Side Effects

none

Returns

Returns the sample end point.

Preconditions

none

Overview

This macro returns the sampling end value.

Syntax

ChGetSampleEnd(pCh)

8.1.9.22 ChSetPercentRange Function

File

Chart.h (see page 724)

C

```
void ChSetPercentRange(
    CHART * pCh,
    WORD min,
    WORD max
);
```

Module

Chart (see page 92)

Input Parameters

Input Parameters	Description
CHART * pCh	Pointer to the chart object.
WORD min	Minimum percentage value that will be displayed in the bar chart.
WORD max	Maximum percentage value that will be displayed in the bar chart.

Side Effects

none.

Returns

none.

Preconditions

none

Overview

This function sets the minimum and maximum range of percentage that the bar chart will show. The criteria is that min <= max. This affects bar charts only and CH_PERCENTAGE bit state is set.

Syntax

ChSetPercentRange(CHART (see page 124) *pCh, WORD min, WORD max)

8.1.9.23 ChGetPercentRange Macro

File

Chart.h (see page 724)

C

```
#define ChGetPercentRange(pCh) (pCh->prm.perMax - pCh->prm.perMin)
```

Module

Chart (see page 92)

Input Parameters

Input Parameters	Description
pCh	Pointer to the chart object.

Side Effects

none.

Returns

Percentage range computed from max-min.

Preconditions

none

Overview

This macro gets the percentage range for bar charts. The value returned is calculated from percentage max - min. To get the minimum use ChGetPercentMin (see page 116)() and to get the maximum use ChGetPercentMax (see page 115)().

Syntax

ChGetPercentRange(pCh)

8.1.9.24 ChSetSampleRange Function

File

Chart.h (see page 724)

C

```
void ChSetSampleRange(
    CHART * pCh,
    WORD start,
    WORD end
);
```

Module

Chart (see page 92)

Input Parameters

Input Parameters	Description
CHART * pCh	Pointer to the chart object.
WORD start	Start point of the data samples to be displayed.
WORD end	End point of the data samples to be displayed.

Side Effects

none.

Returns

none.

Preconditions

none

Example

See ChCreate (see page 100)() example.

Overview

This function sets the sample start and sample end when drawing the chart. Together with the data series' SHOW_DATA (see page 98) flags the different way of displaying the chart data is achieved.

Start & End Value	The # of Data Series Flag Set	Chart (see page 92) Description
Start <= End	1	Show the data indicated by Start and End points of the DATASERIES (see page 124) with the flag set
Start = End	1	Show the data indicated by Start or End points of the DATASERIES (see page 124) with the flag set
Start, End = don't care	> 1	Show the data indicated by Start point of the DATASERIES (see page 124) with the flag set. Each samples of all checked data series are grouped together according to sample number.

Syntax

ChSetSampleRange(CHART (see page 124) *pCh, WORD start, WORD end)

8.1.9.25 ChGetSampleRange Macro

File

Chart.h (see page 724)

C

```
#define ChGetSampleRange(pCh) (ChGetSampleEnd(pCh) - ChGetSampleStart(pCh))
```

Module

Chart (see page 92)

Input Parameters

Input Parameters	Description
pCh	Pointer to the chart object.

Side Effects

none.

Returns

Sample range computed from smplEnd - smplStart.

Preconditions

none

Overview

This macro gets the sample range for pie or bar charts. The value returned is calculated from smplEnd - smplStart.

Syntax

ChGetSampleRange(pCh)

8.1.9.26 ChGetPercentMax Macro

File

Chart.h (see page 724)

C

```
#define ChGetPercentMax(pCh) (pCh->prm.perMax)
```

Module

Chart (see page 92)

Input Parameters

Input Parameters	Description
pCh	Pointer to the object.

Side Effects

none

Returns

Returns the maximum percentage value set when bar charts are drawn.

Preconditions

none

Overview

This macro returns the current maximum value of the percentage range that will be drawn for bar charts when CH_PERCENTAGE bit state is set.

Syntax

ChGetPercentMax(pCh)

8.1.9.27 ChGetPercentMin Macro

File

Chart.h (see page 724)

C

```
#define ChGetPercentMin(pCh) (pCh->prm.perMin)
```

Module

Chart (see page 92)

Input Parameters

Input Parameters	Description
pCh	Pointer to the object.

Side Effects

none

Returns

Returns the minimum percentage value when bar charts are drawn.

Preconditions

none

Overview

This macro returns the current minimum value of the percentage range that will be drawn for bar charts when CH_PERCENTAGE bit state is set.

Syntax

ChGetPercentMin(pCh)

8.1.9.28 ChSetColorTable Macro

File

Chart.h (see page 724)

C

```
#define ChSetColorTable(pCh, pNewTable) ((((CHART *)pCh)->prm.pColor) = pNewTable)
```

Module

Chart (see page 92)

Input Parameters

Input Parameters	Description
pCh	Pointer to the object.
pNewTable	Pointer to the color table that will be used.

Side Effects

none

Returns

none.

Preconditions

none

Overview

This macro sets the color table used to draw the data in pie and bar charts.

Syntax

ChSetColorTable(pCh, pNewTable)

8.1.9.29 ChGetColorTable Macro

File

Chart.h (see page 724)

C

```
#define ChGetColorTable(pCh) (((CHART *)pCh)->prm.pColor)
```

Module

Chart (see page 92)

Input Parameters

Input Parameters	Description
pCh	Pointer to the object.

Side Effects

none

Returns

Returns the address of the color table used.

Preconditions

none

Overview

This macro returns the current color table used for the pie and bar charts.

Syntax

ChGetColorTable(pCh)

8.1.9.30 ChSetTitle Macro

File

Chart.h (see page 724)

C

```
#define ChSetTitle(pCh, pNewTitle) (((CHART *)pCh)->prm.pTitle = pNewTitle)
```

Module

Chart (see page 92)

Input Parameters

Input Parameters	Description
pCh	Pointer to the object.
pNewTitle	pointer to the string to be used as a title of the chart.

Side Effects

none

Returns

none.

Preconditions

none

Example

See ChCreate (see page 100)() example.

Overview

This macro sets the address of the current text string used for the title of the chart.

Syntax

ChSetTitle(pCh, pNewTitle)

8.1.9.31 ChGetTitle Macro

File

Chart.h (see page 724)

C

```
#define ChGetTitle(pCh) (((CHART *)pCh)->prm.pTitle)
```

Module

Chart (see page 92)

Input Parameters

Input Parameters	Description
pCh	Pointer to the object.

Side Effects

none

Returns

Returns the pointer to the current title text used.

Preconditions

none

Overview

This macro returns the address of the current text string used for the title of the chart.

Syntax

ChGetTitle(pCh)

8.1.9.32 ChSetTitleFont Macro

File

Chart.h (see page 724)

C

```
#define ChSetTitleFont(pCh, pNewFont) (((CHART *)pCh)->prm.pTitleFont = pNewFont)
```

Module

Chart (see page 92)

Input Parameters

Input Parameters	Description
pCh	Pointer to the object.
pNewFont	Pointer to the font used.

Side Effects

none

Returns

none.

Preconditions

none

Example

See ChCreate (see page 100)() example.

Overview

This macro sets the location of the font used for the title of the chart.

Syntax

ChSetTitleFont(pCh, pNewFont)

8.1.9.33 ChGetTitleFont Macro

File

Chart.h (see page 724)

C

```
#define ChGetTitleFont(pCh) (((CHART *)pCh)->prm.pTitleFont)
```

Module

Chart (see page 92)

Input Parameters

Input Parameters	Description
pCh	Pointer to the object.

Side Effects

none

Returns

Returns the address of the current font used for the title text.

Preconditions

none

Overview

This macro returns the location of the font used for the title of the chart.

Syntax

ChGetTitleFont(pCh)

8.1.9.34 ChGetAxisLabelFont Macro

File

Chart.h (see page 724)

C

```
#define ChGetAxisLabelFont(pCh) (((CHART *)pCh)->prm.pAxisLabelsFont)
```

Module

Chart (see page 92)

Input Parameters

Input Parameters	Description
pCh	Pointer to the object.

Side Effects

none

Returns

Returns the address of the current font used for the title text.

Preconditions

none

Overview

This macro returns the location of the font used for the X and Y axis labels of the chart.

Syntax

ChGetAxisLabelFont(pCh)

8.1.9.35 ChSetAxisLabelFont Macro

File

Chart.h (see page 724)

C

```
#define ChSetAxisLabelFont(pCh, pNewFont) (((CHART *)pCh)->prm.pAxisLabelsFont = pNewFont)
```

Module

Chart (see page 92)

Input Parameters

Input Parameters	Description
pCh	Pointer to the object.
pNewFont	Pointer to the font used.

Side Effects

none

Returns

none.

Preconditions

none

Example

See ChCreate (see page 100)() example.

Overview

This macro sets the location of the font used for the X and Y axis labels of the chart.

Syntax

ChSetAxisLabelFont(pCh, pNewFont)

8.1.9.36 ChGetGridLabelFont Macro

File

Chart.h (see page 724)

C

```
#define ChGetGridLabelFont(pCh) (((CHART *)pCh)->prm.pGridLabelsFont)
```

Module

Chart (see page 92)

Input Parameters

Input Parameters	Description
pCh	Pointer to the object.

Side Effects

none

Returns

Returns the address of the current font used for the title text.

Preconditions

none

Overview

This macro returns the location of the font used for the X and Y axis grid labels of the chart.

Syntax

ChGetGridLabelFont(pCh)

8.1.9.37 ChSetGridLabelFont Macro

File

Chart.h (see page 724)

C

```
#define ChSetGridLabelFont(pCh, pNewFont) (((CHART *)pCh)->prm.pGridLabelsFont = pNewFont)
```

Module

Chart (see page 92)

Input Parameters

Input Parameters	Description
pCh	Pointer to the object.
pNewFont	Pointer to the font used.

Side Effects

none

Returns

none.

Preconditions

none

Example

See ChCreate (see page 100)() example.

Overview

This macro sets the location of the font used for the X and Y axis grid labels of the chart.

Syntax

ChSetGridLabelFont(pCh, pNewFont)

8.1.9.38 ChFreeDataSeries Function

File

Chart.h (see page 724)

C

```
void ChFreeDataSeries(
    void * pObj
);
```

Module

Chart (see page 92)

Input Parameters

Input Parameters	Description
pCh	Pointer to the chart object.

Side Effects

none.

Returns

none.

Preconditions

none

Example

```
void ClearChartData(CHART *pCh) {
    if(pCh->pChData != NULL)
        // remove the all data series
        ChFreeDataSeries(pCh;
}
```

Overview

This function removes DATASERIES (see page 124) object from the list of DATASERIES (see page 124) objects and frees the memory used of that removed object.

Syntax

void ChFreeDataSeries(void *pObj)

8.1.9.39 ChTranslateMsg Function

File

Chart.h (see page 724)

C

```
WORD ChTranslateMsg(
    void * pObj,
    GOL_MSG * pMsg
);
```

Module

Chart (see page 92)

Input Parameters

Input Parameters	Description
GOL_MSG * pMsg	Pointer to the message struct containing the message from the user interface.
pCh	The pointer to the object where the message will be evaluated to check if the message will affect the object.

Side Effects

none

Returns

Returns the translated message depending on the received GOL (see page 64) message:

- CH_MSG_SELECTED – Chart (see page 92) area is selected
- OBJ_MSG_INVALID – Chart (see page 92) is not affected

none.

Preconditions

none

Overview

This function evaluates the message from a user if the message will affect the object or not. The table below enumerates the translated messages for each event of the touch screen and keyboard inputs.

Translated Message	Input Source	Events	Description
CH_MSG_SELECTED	Touch Screen	EVENT_PRESS, EVENT_RELEASE, EVENT_MOVE	If events occurs and the x,y position falls in the area of the chart.
OBJ_MSG_INVALID	Any	Any	If the message did not affect the object.

Syntax

ChTranslateMsg(void *pObj, GOL_MSG (see page 330) *pMsg)

8.1.9.40 CHART Structure

File

Chart.h (see page 724)

C

```
typedef struct {
  OBJ_HEADER hdr;
  CHARTPARAM prm;
  DATASERIES * pChData;
} CHART;
```

Members

Members	Description
OBJ_HEADER hdr;	Generic header for all Objects (see OBJ_HEADER (see page 68)).
CHARTPARAM prm;	Structure for the parameters of the chart.
DATASERIES * pChData;	Pointer to the first chart data series in the link list of data series.

Module

Chart (see page 92)

Overview

Defines the parameters required for a chart Object.

8.1.9.41 DATASERIES Structure

File

Chart.h (see page 724)

C

```
typedef struct {
  XCHAR * pSData;
  WORD samples;
  BYTE show;
  WORD * pData;
  void * pNextData;
} DATASERIES;
```

Members

Members	Description
XCHAR * pSData;	Pointer to the data series name.
WORD samples;	Indicates the number of data samples (or data points) contained in the array specified by pData.
BYTE show;	The flag to indicate if the data series will be shown or not. If this flag is set to SHOW_DATA (see page 98), the data series will be shown. If HIDE_DATA (see page 98), the data series will not be shown.
WORD * pData;	Pointer to the array of data samples.
void * pNextData;	Pointer to the next data series. NULL if no other data series follows.

Module

Chart (see page 92)

Overview

Defines a variable for the CHART (see page 124) object. It specifies the number of samples, pointer to the array of samples for the data series and pointer to the next data series. A member of this structure (show) is used as a flag to determine if the series is to be drawn or not. Together with the smplStart and smplEnd it will determine what kind of chart will be drawn.

8.1.9.42 CHARTPARAM Structure

File

Chart.h (see page 724)

C

```
typedef struct {
  XCHAR * pTitle;
  XCHAR * pSmplLabel;
  XCHAR * pValLabel;
  SHORT seriesCount;
  WORD smplStart;
  WORD smplEnd;
  WORD valMax;
  WORD valMin;
  WORD perMax;
  WORD perMin;
  WORD * pColor;
  void * pTitleFont;
  void * pAxisLabelsFont;
  void * pGridLabelsFont;
} CHARTPARAM;
```

Members

Members	Description
XCHAR * pTitle;	Pointer to the Title of the chart.
XCHAR * pSmplLabel;	Pointer to the bar chart sample axis label. Depending
XCHAR * pValLabel;	Pointer to the bar chart value axis label. Depending
SHORT seriesCount;	Number of data series that will be displayed when chart is drawn.
WORD smplStart;	Start point of data sample range to be displayed (minimum/default value = 1)
WORD smplEnd;	End point of data sample range to be displayed.
WORD valMax;	Maximum value of a sample that can be displayed.
WORD valMin;	Minimum value of a sample that can be displayed.
WORD perMax;	Maximum value of the percentage range that can be displayed.
WORD perMin;	Minimum value of the percentage range that can be displayed.

WORD * pColor;	Pointer to the color table used to draw the chart data.
void * pTitleFont;	Pointer to the font used for the title label of the chart.
void * pAxisLabelsFont;	Pointer to the font used for X and Y axis labels.
void * pGridLabelsFont;	Pointer to the font used for X and Y axis grid labels.

Module

Chart (see page 92)

Overview

Defines the parameters for the CHART (see page 124) object.

8.1.9.43 Color Table

Macros

Name	Description
CH_CLR0 (see page 126)	Bright Blue
CH_CLR1 (see page 127)	Bright Red
CH_CLR2 (see page 127)	Bright Green
CH_CLR3 (see page 127)	Bright Yellow
CH_CLR4 (see page 127)	Orange
CH_CLR5 (see page 127)	Blue
CH_CLR6 (see page 128)	Red
CH_CLR7 (see page 128)	Green
CH_CLR8 (see page 128)	Yellow
CH_CLR9 (see page 128)	Dark Orange
CH_CLR10 (see page 128)	Light Orange
CH_CLR11 (see page 129)	Light Red
CH_CLR12 (see page 129)	Light Green
CH_CLR13 (see page 129)	Light Yellow
CH_CLR14 (see page 129)	Light Orange
CH_CLR15 (see page 129)	Gold

Module

Chart (see page 92)

Description

Default color table used to draw data points in a chart.

8.1.9.43.1 CH_CLR0 Macro

File

Chart.h (see page 724)

C

```
#define CH_CLR0 BRIGHTBLUE      // Bright Blue
```

Description

Bright Blue

8.1.9.43.2 CH_CLR1 Macro

File

Chart.h (see page 724)

C

```
#define CH_CLR1 BRIGHTRED       // Bright Red
```

Description

Bright Red

8.1.9.43.3 CH_CLR2 Macro

File

Chart.h (see page 724)

C

```
#define CH_CLR2 BRIGHTGREEN     // Bright Green
```

Description

Bright Green

8.1.9.43.4 CH_CLR3 Macro

File

Chart.h (see page 724)

C

```
#define CH_CLR3 BRIGHTYELLOW    // Bright Yellow
```

Description

Bright Yellow

8.1.9.43.5 CH_CLR4 Macro

File

Chart.h (see page 724)

C

```
#define CH_CLR4 RGBConvert(0xFF, 0xBB, 0x4C) // Orange
```

Description

Orange

8.1.9.43.6 CH_CLR5 Macro

File

Chart.h (see page 724)

C

```
#define CH_CLR5 BLUE                            // Blue
```

Description

Blue

8.1.9.43.7 CH_CLR6 Macro

File

Chart.h (see page 724)

C

```
#define CH_CLR6 RED                           // Red
```

Description

Red

8.1.9.43.8 CH_CLR7 Macro

File

Chart.h (see page 724)

C

```
#define CH_CLR7 GREEN                         // Green
```

Description

Green

8.1.9.43.9 CH_CLR8 Macro

File

Chart.h (see page 724)

C

```
#define CH_CLR8 YELLOW                        // Yellow
```

Description

Yellow

8.1.9.43.10 CH_CLR9 Macro

File

Chart.h (see page 724)

C

```
#define CH_CLR9 RGBConvert(255, 140, 0)     // Dark Orange
```

Description

Dark Orange

8.1.9.43.11 CH_CLR10 Macro

File

Chart.h (see page 724)

C

```
#define CH_CLR10 LIGHTBLUE                     // Light Orange
```

Description

Light Orange

8.1.9.43.12 CH_CLR11 Macro

File

Chart.h (see page 724)

C

```
#define CH_CLR11 LIGHTRED                         // Light Red
```

Description

Light Red

8.1.9.43.13 CH_CLR12 Macro

File

Chart.h (see page 724)

C

```
#define CH_CLR12 LIGHTGREEN                       // Light Green
```

Description

Light Green

8.1.9.43.14 CH_CLR13 Macro

File

Chart.h (see page 724)

C

```
#define CH_CLR13 RGBConvert(255, 255, 150)    // Light Yellow
```

Description

Light Yellow

8.1.9.43.15 CH_CLR14 Macro

File

Chart.h (see page 724)

C

```
#define CH_CLR14 RGBConvert(255, 200, 0)      // Light Orange
```

Description

Light Orange

8.1.9.43.16 CH_CLR15 Macro

File

Chart.h (see page 724)

C

```
#define CH_CLR15 RGBConvert(255, 215, 0)      // Gold
```

Description

Gold

8.1.10 Checkbox

Check Box is an Object that simulates a check box on paper. Usually it is used as an option setting where the checked or filled state means the option is enabled and the unfilled or unchecked state means the option is disabled.

Functions

	Name	Description
	CbCreate (see page 133)	This function creates a CHECKBOX (see page 138) object with the parameters given. It automatically attaches the new object into a global linked list of objects and returns the address of the object.
	CbDraw (see page 134)	This function renders the object on the screen using the current parameter settings. Location of the object is determined by the left, top, right and bottom parameters. The colors used are dependent on the state of the object. The font used is determined by the style scheme set. When rendering objects of the same type, each object must be rendered completely before the rendering of the next object is started. This is to avoid incomplete object rendering.
	CbSetText (see page 135)	This function sets the text that will be used.
	CbMsgDefault (see page 136)	This function performs the actual state change based on the translated message given. The following state changes are supported:
	CbTranslateMsg (see page 137)	This function evaluates the message from a user if the message will affect the object or not. The table below enumerates the translated messages for each event of the touch screen and keyboard inputs.

Macros

Name	Description
CbGetText (see page 135)	This macro returns the location of the text used for the check box.

Structures

Name	Description
CHECKBOX (see page 138)	The structure contains check box data

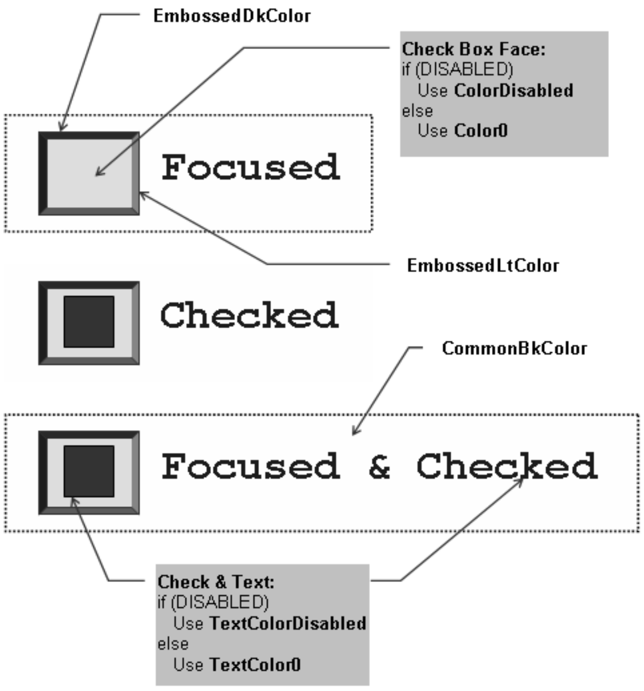
Description

Check Box supports Keyboard and Touchscreen inputs, replying to their events with the following messages:

1. CB_MSG_UNCHECKED - When the check box is unchecked.

2. CB_MSG_CHECKED - When check box is unchecked.

The Check Box Object is rendered using the assigned style scheme. The following figure illustrates the color assignments.



8.1.10.1 Check Box States

Macros

Name	Description
CB_CHECKED (see page 131)	Checked state
CB_DISABLED (see page 132)	Disabled state
CB_DRAW (see page 132)	Whole check box must be redrawn
CB_DRAW_CHECK (see page 132)	Check box mark should be redrawn
CB_DRAW_FOCUS (see page 132)	Focus must be redrawn
CB_FOCUSED (see page 132)	Focus state
CB_HIDE (see page 133)	Check box must be removed from screen

Module

Checkbox (see page 130)

Description

List of Checkbox (see page 130) bit states.

8.1.10.1.1 CB_CHECKED Macro

File

CheckBox.h (see page 748)

C

```
#define CB_CHECKED 0x0004  // Checked state
```

Description

Checked state

8.1.10.1.2 CB_DISABLED Macro

File

CheckBox.h (see page 748)

C

```
#define CB_DISABLED 0x0002  // Disabled state
```

Description

Disabled state

8.1.10.1.3 CB_DRAW Macro

File

CheckBox.h (see page 748)

C

```
#define CB_DRAW 0x4000  // Whole check box must be redrawn
```

Description

Whole check box must be redrawn

8.1.10.1.4 CB_DRAW_CHECK Macro

File

CheckBox.h (see page 748)

C

```
#define CB_DRAW_CHECK 0x1000  // Check box mark should be redrawn
```

Description

Check box mark should be redrawn

8.1.10.1.5 CB_DRAW_FOCUS Macro

File

CheckBox.h (see page 748)

C

```
#define CB_DRAW_FOCUS 0x2000  // Focus must be redrawn
```

Description

Focus must be redrawn

8.1.10.1.6 CB_FOCUSED Macro

File

CheckBox.h (see page 748)

C

```
#define CB_FOCUSED 0x0001  // Focus state
```

Description

Focus state

8.1.10.1.7 CB_HIDE Macro

File

CheckBox.h (see page 748)

C

```
#define CB_HIDE 0x8000  // Check box must be removed from screen
```

Description

Check box must be removed from screen

8.1.10.2 CbCreate Function

File

CheckBox.h (see page 748)

C

```
CHECKBOX * CbCreate(
    WORD ID,
    SHORT left,
    SHORT top,
    SHORT right,
    SHORT bottom,
    WORD state,
    XCHAR * pText,
    GOL_SCHEME * pScheme
);
```

Module

Checkbox (see page 130)

Input Parameters

Input Parameters	Description
WORD ID	Unique user defined ID for the object instance.
SHORT left	Left most position of the Object.
SHORT top	Top most position of the Object.
SHORT right	Right most position of the Object
SHORT bottom	Bottom most position of the object
WORD state	Sets the initial state of the object
XCHAR * pText	Pointer to the text of the check box.
GOL_SCHEME * pScheme	Pointer to the style scheme

Side Effects

none

Returns

Returns the pointer to the object created

Preconditions

none

Example

```
GOL_SCHEME *pScheme;
CHECKBOX *pCb[2];

    pScheme = GOLCreateScheme();
    pCb = CbCreate(ID_CHECKBOX1,             // ID
                   20,135,150,175,           // dimension
                   CB_DRAW,                  // Draw the object
                   "Scale",                  // text
                   pScheme);                 // use this scheme

    pCb = CbCreate(ID_CHECKBOX2,             // ID
                   170,135,300,175,          // dimension
                   CB_DRAW,                  // Draw the object
                   "Animate",                // text
                   pScheme);                 // use this scheme

    while(!CbDraw(pCb[0]));                  // draw the objects
    while(!CbDraw(pCb[1]));
```

Overview

This function creates a CHECKBOX (see page 138) object with the parameters given. It automatically attaches the new object into a global linked list of objects and returns the address of the object.

Syntax

CHECKBOX (see page 138) *CbCreate(WORD ID, SHORT left, SHORT top, SHORT right, SHORT bottom, WORD state, XCHAR (see page 361) *pText, GOL_SCHEME (see page 345) *pScheme)

8.1.10.3 CbDraw Function

File

CheckBox.h (see page 748)

C

```
WORD CbDraw(
    void * pObj
);
```

Module

Checkbox (see page 130)

Input Parameters

Input Parameters	Description
pCb	Pointer to the object to be rendered.

Side Effects

none

Returns

Returns the status of the drawing

- 1 - If the rendering was completed and
- 0 - If the rendering is not yet finished.

Next call to the function will resume the rendering on the pending drawing state.

Preconditions

Object must be created before this function is called.

Example

See CbCreate (see page 133)() Example.

Overview

This function renders the object on the screen using the current parameter settings. Location of the object is determined by the left, top, right and bottom parameters. The colors used are dependent on the state of the object. The font used is determined by the style scheme set.

When rendering objects of the same type, each object must be rendered completely before the rendering of the next object is started. This is to avoid incomplete object rendering.

Syntax

WORD CbDraw(void *pObj)

8.1.10.4 CbGetText Macro

File

CheckBox.h (see page 748)

C

```
#define CbGetText(pCb) pCb->pText
```

Module

Checkbox (see page 130)

Input Parameters

Input Parameters	Description
pCb	Pointer to the object

Side Effects

none

Returns

Returns the location of the text used.

Preconditions

none

Overview

This macro returns the location of the text used for the check box.

Syntax

CbGetText(pCb)

8.1.10.5 CbSetText Function

File

CheckBox.h (see page 748)

C

```
void CbSetText(
    CHECKBOX * pCb,
    XCHAR * pText
);
```

Module

Checkbox (see page 130)

Input Parameters

Input Parameters	Description
CHECKBOX * pCb	The pointer to the check box whose text will be modified.
XCHAR * pText	The pointer to the text that will be used.

Side Effects

none

Returns

none

Preconditions

none

Overview

This function sets the text that will be used.

Syntax

CbSetText(CHECKBOX (see page 138) *pCb, XCHAR (see page 361) *pText)

8.1.10.6 CbMsgDefault Function

File

CheckBox.h (see page 748)

C

```
void CbMsgDefault(
    WORD translatedMsg,
    void * pObj,
    GOL_MSG * pMsg
);
```

Module

Checkbox (see page 130)

Input Parameters

Input Parameters	Description
WORD translatedMsg	The translated message
GOL_MSG * pMsg	The pointer to the GOL (see page 64) message
pCb	The pointer to the object whose state will be modified

Side Effects

none

Returns

none

Preconditions

none

Overview

This function performs the actual state change based on the translated message given. The following state changes are supported:

Translated Message	Input Source	Set/Clear State Bit	Description
CB_MSG_CHECKED	Touch Screen, Keyboard	Set CB_CHECKED (see page 131)	Check Box will be redrawn in checked state.
CB_MSG_UNCHECKED	Touch Screen, Keyboard	Clear CB_CHECKED (see page 131)	Check Box will be redrawn in un-checked state.

Syntax

CbMsgDefault(WORD translatedMsg, void *pObj, GOL_MSG (see page 330)* pMsg)

8.1.10.7 CbTranslateMsg Function

File

CheckBox.h (see page 748)

C

```
WORD CbTranslateMsg(
    void * pObj,
    GOL_MSG * pMsg
);
```

Module

Checkbox (see page 130)

Input Parameters

Input Parameters	Description
GOL_MSG * pMsg	pointer to the message struct containing the message the user
pCb	the pointer to the object where the message will be evaluated to check if the message will affect the object

Side Effects

none

Returns

Returns the translated message depending on the received GOL (see page 64) message:

- CB_MSG_CHECKED – Check Box is checked.
- CB_MSG_UNCHECKED – Check Box is unchecked.
- OBJ_MSG_INVALID – Check Box is not affected.

Preconditions

none

Example

Usage is similar to BtnTranslateMsg (see page 90)() example.

Overview

This function evaluates the message from a user if the message will affect the object or not. The table below enumerates the translated messages for each event of the touch screen and keyboard inputs.

Translated Message	Input Source	Events	Description
CB_MSG_CHECKED	Touch Screen	EVENT_PRESS	If events occurs and the x,y position falls in the area of the check box while the check box is unchecked.
	Keyboard	EVENT_KEYSCAN	If event occurs and parameter1 passed matches the object's ID and parameter 2 passed matches SCAN_CR_PRESSED (see page 335) or SCAN_SPACE_PRESSED (see page 339) while the check box is unchecked.
CB_MSG_UNCHECKED	Touch Screen	EVENT_PRESS	If events occurs and the x,y position falls in the area of the check box while the check box is checked.
	Keyboard	EVENT_KEYSCAN	If event occurs and parameter1 passed matches the object's ID and parameter 2 passed matches SCAN_CR_PRESSED (see page 335) or SCAN_SPACE_PRESSED (see page 339) while the check box is checked.
OBJ_MSG_INVALID	Any	Any	If the message did not affect the object.

Syntax

WORD CbTranslateMsg(void *pObj, GOL_MSG (see page 330) *pMsg)

8.1.10.8 CHECKBOX Structure

File

CheckBox.h (see page 748)

C

```
typedef struct {
  OBJ_HEADER hdr;
  SHORT textHeight;
  XCHAR * pText;
} CHECKBOX;
```

Members

Members	Description
OBJ_HEADER hdr;	Generic header for all Objects (see OBJ_HEADER (see page 68)).
SHORT textHeight;	Pre-computed text height
XCHAR * pText;	Pointer to text

Module

Checkbox (see page 130)

Overview

The structure contains check box data

8.1.11 Round Dial

Dial is an Object that can be used to display emulate a turn dial that can both go in clockwise or counterclockwise.

Functions

	Name	Description
	RdiaCreate (see page 141)	This function creates a ROUNDDIAL (see page 148) object with the parameters given. It automatically attaches the new object into a global linked list of objects and returns the address of the object.

◆	RdiaDraw (see page 142)	This function renders the object on the screen using the current parameter settings. Location of the object is determined by the center (x,y) postion and the radius parameters. The colors used are dependent on the state of the object. When rendering objects of the same type, each object must be rendered completely before the rendering of the next object is started. This is to avoid incomplete object rendering.
◆	RdiaMsgDefault (see page 146)	This function performs the actual state change based on the translated message given. The following state changes are supported:
◆	RdiaTranslateMsg (see page 146)	This function evaluates the message from a user if the message will affect the object or not. The table below enumerates the translated messages for each event of the touch screen inputs.

Macros

Name	Description
RdiaIncVal (see page 143)	Used to directly increment the value. The delta change used is the resolution setting (res).
RdiaDecVal (see page 144)	Used to directly decrement the value. The delta change used is the resolution setting (res).
RdiaGetVal (see page 144)	Returns the current dial value. Value is always in the 0-max range inclusive.
RdiaSetVal (see page 145)	Sets the value to the given new value. Value set must be in 0-max range inclusive.

Structures

Name	Description
ROUNDDIAL (see page 148)	Defines the parameters required for a dial Object. The curr_xPos, curr_yPos, new_xPos and new_yPos parameters are internally generated to aid in the redrawing of the dial. User must avoid modifying these values.

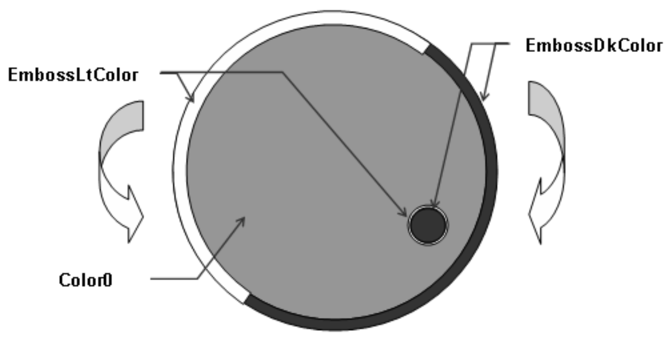
Description

Dial supports only Touchscreen inputs, replying to their events with the following messages:

1. RD_MSG_CLOCKWISE - When movement of the touch is in the face of the dial and in the clockwise direction.

2. RD_MSG_CTR_CLOCKWISE - When movement of the touch is in the face of the dial and in the counter clockwise direction.

The Dial object is rendered using the assigned style scheme. The following figure illustrates the color assignments.



CommonBkColor – used to hide the slider from the screen.

8.1.11.1 Dial States

Macros

Name	Description
RDIA_DISABLED (see page 140)	Bit for disabled state.
RDIA_DRAW (see page 140)	Bit to indicate object must be redrawn.
RDIA_HIDE (see page 140)	Bit to indicate object must be removed from screen.
RDIA_ROT_CCW (see page 141)	Bit for rotate counter clockwise state.
RDIA_ROT_CW (see page 141)	Bit for rotate clockwise state.

Module

Round Dial (see page 138)

Description

List of Dial (see page 138) bit states.

8.1.11.1.1 RDIA_DISABLED Macro

File

RoundDial.h (see page 869)

C

```
#define RDIA_DISABLED 0x0002  // Bit for disabled state.
```

Description

Bit for disabled state.

8.1.11.1.2 RDIA_DRAW Macro

File

RoundDial.h (see page 869)

C

```
#define RDIA_DRAW 0x4000  // Bit to indicate object must be redrawn.
```

Description

Bit to indicate object must be redrawn.

8.1.11.1.3 RDIA_HIDE Macro

File

RoundDial.h (see page 869)

C

```
#define RDIA_HIDE 0x8000  // Bit to indicate object must be removed from screen.
```

Description

Bit to indicate object must be removed from screen.

8.1.11.1.4 RDIA_ROT_CCW Macro

File

RoundDial.h (see page 869)

C

```
#define RDIA_ROT_CCW 0x0008  // Bit for rotate counter clockwise state.
```

Description

Bit for rotate counter clockwise state.

8.1.11.1.5 RDIA_ROT_CW Macro

File

RoundDial.h (see page 869)

C

```
#define RDIA_ROT_CW 0x0004  // Bit for rotate clockwise state.
```

Description

Bit for rotate clockwise state.

8.1.11.2 RdiaCreate Function

File

RoundDial.h (see page 869)

C

```
ROUNDDIAL * RdiaCreate(
    WORD ID,
    SHORT x,
    SHORT y,
    SHORT radius,
    WORD state,
    SHORT res,
    SHORT value,
    SHORT max,
    GOL_SCHEME * pScheme
);
```

Module

Round Dial (see page 138)

Input Parameters

Input Parameters	Description
WORD ID	Unique user defined ID for the object instance.
SHORT x	Location of the center of the dial in the x coordinate.
SHORT y	Location of the center of the dial in the y coordinate.
SHORT radius	Defines the radius of the dial.
WORD state	Sets the initial state of the object.
SHORT res	Sets the resolution of the dial when rotating clockwise or counter clockwise.
SHORT value	Sets the initial value of the dial.
SHORT max	Sets the maximum value of the dial.
GOL_SCHEME * pScheme	Pointer to the style scheme used.

Side Effects

none

Returns

Returns the pointer to the object created.

Preconditions

none

Example

```
GOL_SCHEME *pScheme;
ROUNDDIAL *pDial;
WORD state;

    pScheme = GOLCreateScheme();
    state = RDIA_DRAW;

    // creates a dial at (50,50) x,y location, with an initial value
    // of 50, a resolution of 2 and maximum value of 100.
    pDial = RdiaCreate(1,50,50,25,118,0, state, 2, 50, 100, pScheme);
    // check if dial was created
    if (pDial == NULL)
       return 0;

    return 1;
```

Overview

This function creates a ROUNDDIAL (see page 148) object with the parameters given. It automatically attaches the new object into a global linked list of objects and returns the address of the object.

Syntax

ROUNDDIAL (see page 148) *RdiaCreate(WORD ID, SHORT x, SHORT y, SHORT radius, WORD state, SHORT res, SHORT value, SHORT max, GOL_SCHEME (see page 345) *pScheme);

8.1.11.3 RdiaDraw Function

File

RoundDial.h (see page 869)

C

```
WORD RdiaDraw(
    void * pObj
);
```

Module

Round Dial (see page 138)

Input Parameters

Input Parameters	Description
pDia	Pointer to the object

Side Effects

none

Returns

Returns the status of the drawing

- 1 - If the rendering was completed and
- 0 - If the rendering is not yet finished.

Preconditions

Object must be created before this function is called.

Overview

This function renders the object on the screen using the current parameter settings. Location of the object is determined by the center (x,y) postion and the radius parameters. The colors used are dependent on the state of the object.

When rendering objects of the same type, each object must be rendered completely before the rendering of the next object is started. This is to avoid incomplete object rendering.

Syntax

WORD RdiaDraw(void *pObj)

8.1.11.4 RdiaIncVal Macro

File

RoundDial.h (see page 869)

C

```
#define RdiaIncVal(pDia) RdiaSetVal(pDia, (pDia->val + pDia->res))
```

Module

Round Dial (see page 138)

Input Parameters

Input Parameters	Description
pDia	Pointer to the object.

Side Effects

none

Returns

none

Preconditions

none

Example

```
WORD updatedVal, prevVal;
ROUNDDIAL *pDia;

    // assuming pDia is initialized to an existing dial Object
    // assume GetInput() is a function that retrieves source data
    prevVal = RdiaGetVal(pDia);
    updatedVal = GetInput();
    if (updatedVal > prevVal)
        RdiaIncVal(pDia);
    if (updatedVal < prevVal)
        RdiaDecVal(pDia);
```

Overview

Used to directly increment the value. The delta change used is the resolution setting (res).

Syntax

RdiaIncVal(pDia)

8.1.11.5 RdiaDecVal Macro

File

RoundDial.h (see page 869)

C

```
#define RdiaDecVal(pDia) RdiaSetVal(pDia, (pDia->pos - pDia->res))
```

Module

Round Dial (see page 138)

Input Parameters

Input Parameters	Description
pDia	Pointer to the object.

Side Effects

none

Returns

none

Preconditions

none

Example

Refer to RdiaIncVal (see page 143)() example.

Overview

Used to directly decrement the value. The delta change used is the resolution setting (res).

Syntax

RdiaDecVal(pDia)

8.1.11.6 RdiaGetVal Macro

File

RoundDial.h (see page 869)

C

```
#define RdiaGetVal(pDia) (pDia)->value
```

Module

Round Dial (see page 138)

Input Parameters

Input Parameters	Description
pDia	Pointer to the object.

Side Effects

none

Returns

Returns the current value of the dial.

Preconditions

none

Example

```
WORD currVal;
ROUNDDIAL *pDia;

    // assuming pDia is initialized to an existing dial Object
    currVal = RdiaGetVal(pDia);
```

Overview

Returns the current dial value. Value is always in the 0-max range inclusive.

Syntax

RdiaGetVal(pDia)

8.1.11.7 RdiaSetVal Macro

File

RoundDial.h (see page 869)

C

```
#define RdiaSetVal(pDia, newVal) (pDia)->value = newVal
```

Module

Round Dial (see page 138)

Input Parameters

Input Parameters	Description
pDia	Pointer to the object.
newVal	New dial value.

Side Effects

none

Returns

none

Preconditions

none

Example

```
WORD updatedVal;
ROUNDDIAL *pDia;

    // assuming pDia is initialized to an existing dial Object
    // assume GetInput() is a function that retrieves source data
    updatedVal = GetInput();
    RdiaSetVal(pDia, updatedVal);
```

Overview

Sets the value to the given new value. Value set must be in 0-max range inclusive.

Syntax

RdiaSetVal(pDia, newVal)

8.1.11.8 RdiaMsgDefault Function

File

RoundDial.h (see page 869)

C

```
void RdiaMsgDefault(
    WORD translatedMsg,
    void * pObj,
    GOL_MSG * pMsg
);
```

Module

Round Dial (see page 138)

Input Parameters

Input Parameters	Description
WORD translatedMsg	The translated message
GOL_MSG * pMsg	The pointer to the GOL (see page 64) message
pDia	The pointer to the object whose state will be modified

Side Effects

none

Returns

none

Preconditions

none

Example

See RdiaTranslateMsg (see page 146)() example.

Overview

This function performs the actual state change based on the translated message given. The following state changes are supported:

Translated Message	Input Source	Set/Clear State Bit	Description
RD_MSG_CLOCKWISE	Touch Screen	Set RDIA_ROT_CW (see page 141), Set RDIA_DRAW (see page 140)	Dial (see page 138) will be redrawn with clockwise update.
RD_MSG_CTR_CLOCKWISE	Touch Screen	Set RDIA_ROT_CCW (see page 141), Set RDIA_DRAW (see page 140)	Dial (see page 138) will be redrawn with counter clockwise update.

Syntax

RdiaMsgDefault(WORD translatedMsg, void *pObj, GOL_MSG (see page 330)* pMsg)

8.1.11.9 RdiaTranslateMsg Function

File

RoundDial.h (see page 869)

C

```
WORD RdiaTranslateMsg(
    void * pObj,
    GOL_MSG * pMsg
);
```

Module

Round Dial (see page 138)

Input Parameters

Input Parameters	Description
GOL_MSG * pMsg	Pointer to the message struct containing the message from the user interface.
pDia	The pointer to the object where the message will be evaluated to check if the message will affect the object.

Side Effects

none

Returns

Returns the translated message depending on the received GOL (see page 64) message:

- RD_MSG_CLOCKWISE – Dial (see page 138) is moved in a clockwise direction.
- RD_MSG_CTR_CLOCKWISE – Dial (see page 138) is moved in a counter clockwise direction.
- OBJ_MSG_INVALID – Dial (see page 138) is not affected

Preconditions

none

Example

```
void MyGOLMsg(GOL_MSG *pMsg){

    OBJ_HEADER *pCurrentObj;
    WORD objMsg;

    if(pMsg->event == EVENT_INVALID)
        return;
    pCurrentObj = GOLGetList();

    while(pCurrentObj != NULL){
        // Process only ROUNDDIAL
        if(!IsObjUpdated(pCurrentObj)){
            switch(pCurrentObj->type){
                case OBJ_ROUNDIAL:
                    objMsg = RdiaTranslateMsg((ROUNDDIAL*)pCurrentObj, pMsg);
                    if(objMsg == OBJ_MSG_INVALID)
                        break;
                    if(GOLMsgCallback(objMsg,pCurrentObj,pMsg))
                        RdiaMsgDefault(objMsg,(ROUNDDIAL*)pCurrentObj);
                    break;
                default: break;
            }
        }
    }
    pCurrentObj = pCurrentObj->pNxtObj;
}
```

Overview

This function evaluates the message from a user if the message will affect the object or not. The table below enumerates the translated messages for each event of the touch screen inputs.

Translated Message	Input Source	Events	Description
RD_MSG_CLOCKWISE	Touch Screen	EVENT_MOVE	If events occurs and the x,y position falls in the face of the Dial (see page 138) and moving in the clockwise rotation.
RD_MSG_CTR_CLOCKWISE	Touch Screen	EVENT_MOVE	If events occurs and the x,y position falls in the face of the Dial (see page 138) and moving in the counter clockwise rotation.
OBJ_MSG_INVALID	Any	Any	If the message did not affect the object.

Syntax

RdiaTranslateMsg(void *pObj, GOL_MSG (see page 330) *pMsg)

8.1.11.10 ROUNDDIAL Structure

File

RoundDial.h (see page 869)

C

```
typedef struct {
  OBJ_HEADER hdr;
  SHORT xCenter;
  SHORT yCenter;
  SHORT radius;
  SHORT value;
  WORD max;
  WORD res;
  SHORT curr_xPos;
  SHORT curr_yPos;
  SHORT new_xPos;
  SHORT new_yPos;
  SHORT vAngle;
} ROUNDDIAL;
```

Members

Members	Description
OBJ_HEADER hdr;	Generic header for all Objects (see OBJ_HEADER (see page 68)).
SHORT xCenter;	x coordinate center position.
SHORT yCenter;	y coordinate center position.
SHORT radius;	Radius of the dial.
SHORT value;	Initial value of the dial.
WORD max;	Maximum value of variable value (maximum = 65535).
WORD res;	Resolution of movement.
SHORT curr_xPos;	Current x position.
SHORT curr_yPos;	Current y position.
SHORT new_xPos;	New x position.
SHORT new_yPos;	New y position.

Module

Round Dial (see page 138)

Overview

Defines the parameters required for a dial Object. The curr_xPos, curr_yPos, new_xPos and new_yPos parameters are internally generated to aid in the redrawing of the dial. User must avoid modifying these values.

8.1.11.11 Files

8.1.12 Digital Meter

DigitalMeter is an Object that can be used to display a value of a sampled variable. This Object is ideal when fast refresh of the value is needed. The Object refreshes only the digits that needs to change. A limitation of this Object is that the font used should have equal character widths.

Functions

	Name	Description
	DmCreate (see page 152)	This function creates a DIGITALMETER (see page 157) object with the parameters given. It automatically attaches the new object into a global linked list of objects and returns the address of the object.
	DmDraw (see page 153)	This function renders the object on the screen using the current parameter settings. Location of the object is determined by the left, top, right and bottom parameters. The colors used are dependent on the state of the object. The font used is determined by the style scheme set. When rendering objects of the same type, each object must be rendered completely before the rendering of the next object is started. This is to avoid incomplete object rendering.
	DmSetValue (see page 154)	This function sets the value that will be used for the object.
	DmTranslateMsg (see page 156)	This function evaluates the message from a user if the message will affect the object or not. The table below enumerates the translated messages for each event of the touch screen and keyboard inputs.

Macros

Name	Description
DmGetValue (see page 154)	This macro returns the current value used for the object.
DmDecVal (see page 155)	This macro is used to directly decrement the value.
DmIncVal (see page 155)	This macro is used to directly increment the value.

Structures

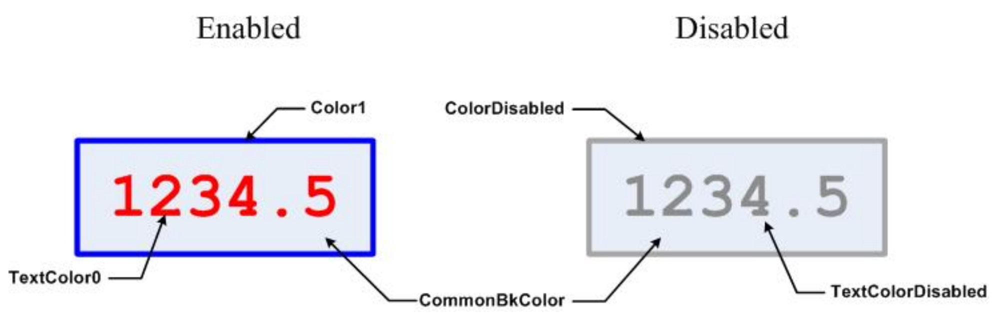
Name	Description
DIGITALMETER (see page 157)	Defines the parameters required for a Digital Meter Object.

Description

DigitalMeter supports only Touchscreen inputs, replying to touch screen events with the message:

DM_MSG_SELECTED.

The DigitalMeter object is rendered using the assigned style scheme. The following figure illustrates the color assignments for the digital meter.



8.1.12.1 Digital Meter States

Macros

Name	Description
DM_DISABLED (see page 150)	Bit for disabled state.
DM_DRAW (see page 150)	Bit to indicate object must be redrawn.
DM_HIDE (see page 151)	Bit to remove object from screen.
DM_CENTER_ALIGN (see page 151)	Bit to indicate value is center aligned.
DM_RIGHT_ALIGN (see page 151)	Bit to indicate value is left aligned.
DM_FRAME (see page 151)	Bit to indicate frame is displayed.
DM_UPDATE (see page 151)	Bit to indicate that only text must be redrawn.

Module

Digital Meter (see page 149)

Description

List of Digital Meter (see page 210) bit states.

8.1.12.1.1 DM_DISABLED Macro

File

DigitalMeter.h (see page 758)

C

```
#define DM_DISABLED 0x0002  // Bit for disabled state.
```

Description

Bit for disabled state.

8.1.12.1.2 DM_DRAW Macro

File

DigitalMeter.h (see page 758)

C

```
#define DM_DRAW 0x4000  // Bit to indicate object must be redrawn.
```

Description

Bit to indicate object must be redrawn.

8.1.12.1.3 DM_HIDE Macro

File

DigitalMeter.h (see page 758)

C

```
#define DM_HIDE 0x8000  // Bit to remove object from screen.
```

Description

Bit to remove object from screen.

8.1.12.1.4 DM_CENTER_ALIGN Macro

File

DigitalMeter.h (see page 758)

C

```
#define DM_CENTER_ALIGN 0x0008  // Bit to indicate value is center aligned.
```

Description

Bit to indicate value is center aligned.

8.1.12.1.5 DM_RIGHT_ALIGN Macro

File

DigitalMeter.h (see page 758)

C

```
#define DM_RIGHT_ALIGN 0x0004  // Bit to indicate value is left aligned.
```

Description

Bit to indicate value is left aligned.

8.1.12.1.6 DM_FRAME Macro

File

DigitalMeter.h (see page 758)

C

```
#define DM_FRAME 0x0010  // Bit to indicate frame is displayed.
```

Description

Bit to indicate frame is displayed.

8.1.12.1.7 DM_UPDATE Macro

File

DigitalMeter.h (see page 758)

C

```
#define DM_UPDATE 0x2000  // Bit to indicate that only text must be redrawn.
```

Description

Bit to indicate that only text must be redrawn.

8.1.12.2 DmCreate Function

File

DigitalMeter.h (see page 758)

C

```
DIGITALMETER * DmCreate(
    WORD ID,
    SHORT left,
    SHORT top,
    SHORT right,
    SHORT bottom,
    WORD state,
    DWORD Value,
    BYTE NoOfDigits,
    BYTE DotPos,
    GOL_SCHEME * pScheme
);
```

Module

Digital Meter (see page 149)

Input Parameters

Input Parameters	Description
WORD ID	Unique user defined ID for the object instance.
SHORT left	Left most position of the object.
SHORT top	Top most position of the object.
SHORT right	Right most position of the object.
SHORT bottom	Bottom most position of the object.
WORD state	Sets the initial state of the object.
DWORD Value	Sets the initial value to be displayed
BYTE NoOfDigits	Sets the number of digits to be displayed
BYTE DotPos	Sets the position of decimal point in the display
GOL_SCHEME * pScheme	Pointer to the style scheme. Set to NULL if default style scheme is used.

Side Effects

none

Returns

Returns the pointer to the object created.

Preconditions

none

Example

```
GOL_SCHEME *pScheme;
DIGITALMETER *pDm;

    pScheme = GOLCreateScheme();
    state = DM_DRAW | DM_FRAME | DM_CENTER_ALIGN;
    DmCreate(ID_DIGITALMETER1,         // ID
            30,80,235,160,          // dimension
            state,                  // has frame and center aligned
            789,4,1,                // to display 078.9
            pScheme);               // use given scheme

    while(!DmDraw(pDm));            // draw the object
```

Overview

This function creates a DIGITALMETER (see page 157) object with the parameters given. It automatically attaches the new object into a global linked list of objects and returns the address of the object.

Syntax

DIGITALMETER (see page 157) *DmCreate(WORD ID, SHORT left, SHORT top, SHORT right, SHORT bottom, WORD state , DWORD Value, BYTE NoOfDigits, BYTE DotPos, GOL_SCHEME (see page 345) *pScheme)

8.1.12.3 DmDraw Function

File

DigitalMeter.h (see page 758)

C

```
WORD DmDraw(
    void * pObj
);
```

Module

Digital Meter (see page 149)

Input Parameters

Input Parameters	Description
pDm	Pointer to the object to be rendered.

Side Effects

none

Returns

Returns the status of the drawing

- 1 - If the rendering was completed and
- 0 - If the rendering is not yet finished.

Next call to the function will resume the rendering on the pending drawing state.

Preconditions

Object must be created before this function is called.

Example

See DmCreate (see page 152)() Example.

Overview

This function renders the object on the screen using the current parameter settings. Location of the object is determined by the left, top, right and bottom parameters. The colors used are dependent on the state of the object. The font used is determined by the style scheme set.

When rendering objects of the same type, each object must be rendered completely before the rendering of the next object is started. This is to avoid incomplete object rendering.

Syntax

WORD DmDraw(void *pObj)

8.1.12.4 DmGetValue Macro

File

DigitalMeter.h (see page 758)

C

```
#define DmGetValue(pDm) pDm->Cvalue
```

Module

Digital Meter (see page 149)

Input Parameters

Input Parameters	Description
pDm	Pointer to the object.

Side Effects

none

Returns

Returns the value used.

Preconditions

none

Overview

This macro returns the current value used for the object.

Syntax

DmGetValue(pDm)

8.1.12.5 DmSetValue Function

File

DigitalMeter.h (see page 758)

C

```
void DmSetValue(
    DIGITALMETER * pDm,
    DWORD Value
);
```

Module

Digital Meter (see page 149)

Input Parameters

Input Parameters	Description
DIGITALMETER * pDm	The pointer to the object whose value will be modified.
DWORD Value	New value to be set for the Digital Meter (see page 149).

Side Effects

none

Returns

none

Preconditions

none

Overview

This function sets the value that will be used for the object.

Syntax

DmSetValue(DIGITALMETER (see page 157) *pDm, DWORD Value)

8.1.12.6 DmDecVal Macro

File

DigitalMeter.h (see page 758)

C

```
#define DmDecVal(pDm, deltaValue) DmSetValue(pDm, (pDm->Cvalue - deltaValue))
```

Module

Digital Meter (see page 149)

Input Parameters

Input Parameters	Description
pDm	Pointer to the object.
deltaValue	Number to be subtracted to the current Digital Meter (see page 149) value.

Side Effects

none

Returns

none

Preconditions

none

Overview

This macro is used to directly decrement the value.

Syntax

DmDecVal(pDm, deltaValue)

8.1.12.7 DmIncVal Macro

File

DigitalMeter.h (see page 758)

C

```
#define DmIncVal(pDm, deltaValue) DmSetValue(pDm, (pDm->Cvalue + deltaValue))
```

Module

Digital Meter (see page 149)

Input Parameters

Input Parameters	Description
pDm	Pointer to the object.

deltaValue	Number to be added to the current Digital Meter (see page 149) value.

Side Effects

none

Returns

none

Preconditions

none

Overview

This macro is used to directly increment the value.

Syntax

DmIncVal(pDm, deltaValue)

8.1.12.8 DmTranslateMsg Function

File

DigitalMeter.h (see page 758)

C

```
WORD DmTranslateMsg(
    void * pObj,
    GOL_MSG * pMsg
);
```

Module

Digital Meter (see page 149)

Input Parameters

Input Parameters	Description
GOL_MSG * pMsg	Pointer to the message struct containing the message from the user interface.
pDm	The pointer to the object where the message will be evaluated to check if the message will affect the object.

Side Effects

none

Returns

Returns the translated message depending on the received GOL (see page 64) message:

- DM_MSG_SELECTED – Digital Meter (see page 149) is selected
- OBJ_MSG_INVALID – Digital Meter (see page 149) is not affected

Preconditions

none

Example

Usage is similar to BtnTranslateMsg (see page 90)() example.

Overview

This function evaluates the message from a user if the message will affect the object or not. The table below enumerates the translated messages for each event of the touch screen and keyboard inputs.

Translated Message	Input Source	Events	Description
DM_MSG_SELECTED	Touch Screen	EVENT_PRESS, EVENT_RELEASE	If events occurs and the x,y position falls in the area of the Digital Meter (see page 149).
OBJ_MSG_INVALID	Any	Any	If the message did not affect the object.

Syntax

WORD DmTranslateMsg(void *pObj, GOL_MSG (see page 330) *pMsg)

8.1.12.9 DIGITALMETER Structure

File

DigitalMeter.h (see page 758)

C

```
typedef struct {
  OBJ_HEADER hdr;
  SHORT textHeight;
  DWORD Cvalue;
  DWORD Pvalue;
  BYTE NoOfDigits;
  BYTE DotPos;
} DIGITALMETER;
```

Members

Members	Description
OBJ_HEADER hdr;	Generic header for all Objects (see OBJ_HEADER (see page 68)).
SHORT textHeight;	Pre-computed text height
DWORD Cvalue;	Current value
DWORD Pvalue;	Previous value
BYTE NoOfDigits;	Number of digits to be displayed
BYTE DotPos;	Position of decimal point

Module

Digital Meter (see page 149)

Description

Structure: DIGITALMETER

Overview

Defines the parameters required for a Digital Meter (see page 149) Object.

8.1.13 Edit Box

Edit Box is is an Object that emulates a cell or a text area that can be edited dynamically.

Functions

	Name	Description
	EbCreate (see page 161)	This function creates a EDITBOX (see page 167) object with the parameters given and initializes the default settings. It automatically attaches the new object into a global linked list of objects and returns the address of the object.

◆	EbDraw (➚ see page 162)	This function renders the object on the screen using the current parameter settings. Location of the object is determined by the left, top, right and bottom parameters. The colors used are dependent on the state of the object. The font used is determined by the style scheme set. When rendering objects of the same type, each object must be rendered completely before the rendering of the next object is started. This is to avoid incomplete object rendering.
◆	EbSetText (➚ see page 163)	This function sets the text to be used for the object.
◆	EbAddChar (➚ see page 164)	This function inserts a character at the end of the text used by the object.
◆	EbDeleteChar (➚ see page 164)	This function removes a character at the end of the text used by the object.
◆	EbMsgDefault (➚ see page 165)	This function performs the actual state change based on the translated message given. The following state changes are supported:
◆	EbTranslateMsg (➚ see page 166)	This function evaluates the message from a user if the message will affect the object or not. The table below enumerates the translated messages for each event of the touch screen and keyboard inputs.

Macros

Name	Description
EbGetText (➚ see page 163)	This macro returns the address of the current text string used for the object.

Structures

Name	Description
EDITBOX (➚ see page 167)	Defines the parameters required for a Edit Box Object.

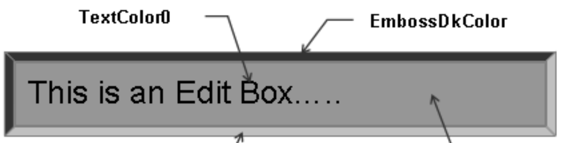
Description

Edit Box supports only Keyboard inputs, replying to their events with the following messages:

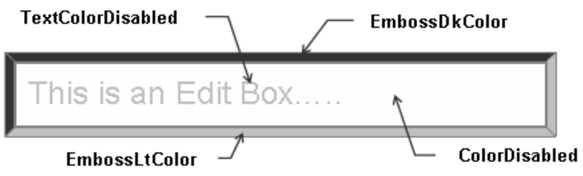
1. EB_MSG_CHAR - when a character is to be inserted at the end of the current text.

2. EB_MSG_DEL - when a character is to be removed from the current text.

The Edit Box Object is rendered using the assigned style scheme. The following figure illustrates the color assignments.



Edit Box in enabled state



Edit Box in disabled state

8.1.13.1 Edit Box States

Macros

Name	Description
EB_CENTER_ALIGN (see page 159)	Bit to indicate text is center aligned.
EB_DISABLED (see page 159)	Bit for disabled state.
EB_DRAW (see page 159)	Bit to indicate whole edit box must be redrawn.
EB_HIDE (see page 160)	Bit to remove object from screen.
EB_FOCUSED (see page 160)	Bit for focused state.
EB_RIGHT_ALIGN (see page 160)	Bit to indicate text is left aligned.
EB_DRAW_CARET (see page 160)	Bit to indicate the cursor caret will be redrawn if the EB_CARET (see page 160) state bit is set.
EB_CARET (see page 160)	Bit to indicate the cursor will always be shown. This bit can be set when focused and reset when object is disabled. Application can also set and clear the bit through SetState (see page 303)() or ClrState (see page 303)().

Module

Edit Box (see page 157)

Description

List of Edit Box bit states.

8.1.13.1.1 EB_CENTER_ALIGN Macro

File

EditBox.h (see page 769)

C

```
#define EB_CENTER_ALIGN 0x0008  // Bit to indicate text is center aligned.
```

Description

Bit to indicate text is center aligned.

8.1.13.1.2 EB_DISABLED Macro

File

EditBox.h (see page 769)

C

```
#define EB_DISABLED 0x0002  // Bit for disabled state.
```

Description

Bit for disabled state.

8.1.13.1.3 EB_DRAW Macro

File

EditBox.h (see page 769)

C

```
#define EB_DRAW 0x4000  // Bit to indicate whole edit box must be redrawn.
```

Description

Bit to indicate whole edit box must be redrawn.

8.1.13.1.4 EB_HIDE Macro

File

EditBox.h (see page 769)

C

```
#define EB_HIDE 0x8000  // Bit to remove object from screen.
```

Description

Bit to remove object from screen.

8.1.13.1.5 EB_FOCUSED Macro

File

EditBox.h (see page 769)

C

```
#define EB_FOCUSED 0x0001  // Bit for focused state.
```

Description

Bit for focused state.

8.1.13.1.6 EB_RIGHT_ALIGN Macro

File

EditBox.h (see page 769)

C

```
#define EB_RIGHT_ALIGN 0x0004  // Bit to indicate text is left aligned.
```

Description

Bit to indicate text is left aligned.

8.1.13.1.7 EB_DRAW_CARET Macro

File

EditBox.h (see page 769)

C

```
#define EB_DRAW_CARET 0x2000  // Bit to indicate the cursor caret will be redrawn if the
EB_CARET state bit is set.
```

Description

Bit to indicate the cursor caret will be redrawn if the EB_CARET (see page 160) state bit is set.

8.1.13.1.8 EB_CARET Macro

File

EditBox.h (see page 769)

C

```
#define EB_CARET 0x0010  // Bit to indicate the cursor will always be shown.
```

Description

Bit to indicate the cursor will always be shown. This bit can be set when focused and reset when object is disabled. Application can also set and clear the bit through SetState (see page 303)() or ClrState (see page 303)().

8.1.13.2 EbCreate Function

File

EditBox.h (see page 769)

C

```
EDITBOX * EbCreate(
    WORD ID,
    SHORT left,
    SHORT top,
    SHORT right,
    SHORT bottom,
    WORD state,
    XCHAR * pText,
    WORD charMax,
    GOL_SCHEME * pScheme
);
```

Module

Edit Box (see page 157)

Input Parameters

Input Parameters	Description
WORD ID	Unique user defined ID for the object instance.
SHORT left	Left most position of the Object.
SHORT top	Top most position of the Object.
SHORT right	Right most position of the Object.
SHORT bottom	Bottom most position of the object.
WORD state	Sets the initial state of the object.
XCHAR * pText	Pointer to the text to be used.
WORD charMax	Defines the maximum number of characters in the edit box.
GOL_SCHEME * pScheme	Pointer to the style scheme.

Side Effects

none

Returns

Returns the pointer to the object created.

Preconditions

none

Example

```
#define ID_MYEDITBOX    101
EDITBOX *pEb;

pEb = EbCreate(ID_MYEDITBOX,     // ID
               10,               // left
               10,               // top
               100,              // right
               30,               // bottom
```

```
                EB_DRAW,            // redraw after creation
                NULL,               // no text yet
                4,                  // display only four characters
                pScheme);           // pointer to the style scheme

if( pEb == NULL )
{
    // MEMORY ERROR. Object was not created.
}
```

Overview

This function creates a EDITBOX (see page 167) object with the parameters given and initializes the default settings. It automatically attaches the new object into a global linked list of objects and returns the address of the object.

Syntax

EDITBOX (see page 167) *EbCreate(WORD ID, SHORT left, SHORT top, SHORT right, SHORT bottom, WORD state , XCHAR (see page 361) *pText, WORD charMax, GOL_SCHEME (see page 345) *pScheme)

8.1.13.3 EbDraw Function

File

EditBox.h (see page 769)

C

```
WORD EbDraw(
    void * pObj
);
```

Module

Edit Box (see page 157)

Input Parameters

Input Parameters	Description
pEb	Pointer to the object to be rendered.

Side Effects

none

Returns

Returns the status of the drawing

- 1 - If the rendering was completed and
- 0 - If the rendering is not yet finished.

Next call to the function will resume the rendering on the pending drawing state.

Preconditions

Object must be created before this function is called.

Overview

This function renders the object on the screen using the current parameter settings. Location of the object is determined by the left, top, right and bottom parameters. The colors used are dependent on the state of the object. The font used is determined by the style scheme set.

When rendering objects of the same type, each object must be rendered completely before the rendering of the next object is started. This is to avoid incomplete object rendering.

Syntax

WORD EbDraw(void *pObj)

8.1.13.4 EbGetText Macro

File

EditBox.h (see page 769)

C

```
#define EbGetText(pEb) (pEb->pBuffer)
```

Module

Edit Box (see page 157)

Input Parameters

Input Parameters	Description
pEb	Pointer to the object

Side Effects

none

Returns

Returns pointer to the text string being used.

Preconditions

none

Overview

This macro returns the address of the current text string used for the object.

Syntax

EbGetText(pEb)

8.1.13.5 EbSetText Function

File

EditBox.h (see page 769)

C

```
void EbSetText(
    EDITBOX * pEb,
    XCHAR * pText
);
```

Module

Edit Box (see page 157)

Input Parameters

Input Parameters	Description
EDITBOX * pEb	The pointer to the object whose text will be modified.
XCHAR * pText	Pointer to the text that will be used.

Side Effects

none

Returns

none

Preconditions

none

Overview

This function sets the text to be used for the object.

Syntax

EbSetText(EDITBOX (see page 167) *pEb, XCHAR (see page 361) *pText)

8.1.13.6 EbAddChar Function

File

EditBox.h (see page 769)

C

```
void EbAddChar(
    EDITBOX * pEb,
    XCHAR ch
);
```

Module

Edit Box (see page 157)

Input Parameters

Input Parameters	Description
EDITBOX * pEb	The pointer to the object whose text will be modified.
XCHAR ch	Character to be inserted.

Side Effects

none

Returns

none

Preconditions

none

Overview

This function inserts a character at the end of the text used by the object.

Syntax

void EbAddChar(EDITBOX (see page 167)* pEb, XCHAR (see page 361) ch)

8.1.13.7 EbDeleteChar Function

File

EditBox.h (see page 769)

C

```
void EbDeleteChar(
    EDITBOX * pEb
);
```

Module

Edit Box (see page 157)

Input Parameters

Input Parameters	Description
EDITBOX * pEb	The pointer to the object to be modified.

Side Effects

none

Returns

none

Preconditions

none

Overview

This function removes a character at the end of the text used by the object.

Syntax

void EbDeleteChar(EDITBOX (see page 167)* pEb)

8.1.13.8 EbMsgDefault Function

File

EditBox.h (see page 769)

C

```
void EbMsgDefault(
    WORD translatedMsg,
    void * pObj,
    GOL_MSG * pMsg
);
```

Module

Edit Box (see page 157)

Input Parameters

Input Parameters	Description
WORD translatedMsg	The translated message.
GOL_MSG * pMsg	The pointer to the GOL (see page 64) message.
pEb	The pointer to the object whose state will be modified.

Side Effects

none

Returns

none

Preconditions

none

Example

Usage is similar to BtnMsgDefault (see page 89)() example.

Overview

This function performs the actual state change based on the translated message given. The following state changes are supported:

Translated Message	Input Source	Set/Clear State Bit	Description
EB_MSG_CHAR	Keyboard	Set EB_DRAW (see page 159)	New character is added and Edit Box will be redrawn.
EB_MSG_DEL	Keyboard	Set EB_DRAW (see page 159)	Last character is removed and Edit Box will be redrawn.

Syntax

void EbMsgDefault(WORD translatedMsg, void *pObj, GOL_MSG (see page 330) *pMsg)

8.1.13.9 EbTranslateMsg Function

File

EditBox.h (see page 769)

C

```
WORD EbTranslateMsg(
    void * pObj,
    GOL_MSG * pMsg
);
```

Module

Edit Box (see page 157)

Input Parameters

Input Parameters	Description
GOL_MSG * pMsg	Pointer to the message struct containing the message from the user interface.
pEb	The pointer to the object where the message will be evaluated to check if the message will affect the object.

Side Effects

none

Returns

Returns the translated message depending on the received GOL (see page 64) message:

- EB_MSG_CHAR – New character should be added.
- EB_MSG_DEL – Last character should be removed.
- OBJ_MSG_INVALID – Object is not affected.

Preconditions

none

Example

Usage is similar to BtnTranslateMsg (see page 90)() example.

Overview

This function evaluates the message from a user if the message will affect the object or not. The table below enumerates the translated messages for each event of the touch screen and keyboard inputs.

Translated Message	Input Source	Events	Description
EB_MSG_CHAR	Keyboard	EVENT_CHARCODE	New character should be added.
EB_MSG_DEL	Keyboard	EVENT_KEYPRESS	Last character should be removed.

OBJ_MSG_INVALID	Any	Any	If the message did not affect the object.

Syntax

WORD EbTranslateMsg(void *pObj, GOL_MSG (see page 330) *pMsg)

8.1.13.10 EDITBOX Structure

File

EditBox.h (see page 769)

C

```
typedef struct {
  OBJ_HEADER hdr;
  SHORT textHeight;
  XCHAR * pBuffer;
  WORD charMax;
  WORD length;
} EDITBOX;
```

Members

Members	Description
OBJ_HEADER hdr;	Generic header for all Objects (see OBJ_HEADER (see page 68)).
SHORT textHeight;	Pre-computed text height.
XCHAR * pBuffer;	Pointer to text buffer.
WORD charMax;	Maximum number of characters in the edit box.
WORD length;	Current text length.

Module

Edit Box (see page 157)

Overview

Defines the parameters required for a Edit Box Object.

8.1.14 Grid

Grid is an Object that draws a grid on the screen with each cell capable of displaying an image or a string.

Functions

	Name	Description
◆	GridCreate (see page 173)	This function creates a GRID (see page 183) object with the parameters given. It automatically attaches the new object into a global linked list of objects and returns the address of the object.
◆	GridDraw (see page 174)	This function renders the object on the screen using the current parameter settings. Location of the object is determined by the left, top, right and bottom parameters. The colors used are dependent on the state of the object. The font used is determined by the style scheme set. When rendering objects of the same type, each object must be rendered completely before the rendering of the next object is started. This is to avoid incomplete object rendering.
◆	GridClearCellState (see page 175)	This function clears the state of the cell (or Grid Item) specified by the column and row.
◆	GridFreeItems (see page 177)	This function removes all grid items for the given Grid and frees the memory used.

◆	GridGetCell (see page 177)	This function removes all grid items for the given Grid and frees the memory used.
◆	GridSetCell (see page 178)	This function sets the Grid Item state and data.
◆	GridSetCellState (see page 179)	This function sets the state of the Grid Item or cell.
◆	GridSetFocus (see page 180)	This function sets the focus of the specified Grid Item or cell.
◆	GridMsgDefault (see page 180)	This function performs the actual state change based on the translated message given. The following state changes are supported:
◆	GridTranslateMsg (see page 181)	This function evaluates the message from a user if the message will affect the object or not. The table below enumerates the translated messages for each event of the touch screen and keyboard inputs.

Macros

Name	Description
GridGetFocusX (see page 175)	This macro returns the x position of the focused cell.
GridGetFocusY (see page 176)	This macro returns the y position of the focused cell.
GRID_OUT_OF_BOUNDS (see page 176)	Status of an out of bounds cell GridSetCell (see page 178)() operation.
GRID_SUCCESS (see page 177)	Status of a successful GridSetCell (see page 178)() operation.

Structures

Name	Description
GRID (see page 183)	Defines the parameters required for a grid Object. Clipping is not supported in grid object.
GRIDITEM (see page 183)	Defines the grid item.

Description

Grid supports Keyboard and Touchscreen inputs, replying to their events with the following messages:

1. GRID_MSG_TOUCHED
2. GRID_MSG_ITEM_SELECTED
3. GRID_MSG_LEFT
4. GRID_MSG_RIGHT
5. GRID_MSG_UP
6. GRID_MSG_DOWN

See GridTranslateMsg (see page 181)() and GridMsgDefault (see page 180)() for details.

The Grid lines are drawn using the EmbossLitColor, the string drawn using the TextColor0 and the background is drawn using the CommonBkColor.

8.1.14.1 Grid States

Macros

Name	Description
GRID_FOCUSED (see page 169)	Bit for focused state
GRID_DISABLED (see page 169)	Bit for disabled state
GRID_SHOW_LINES (see page 169)	Display grid lines
GRID_SHOW_FOCUS (see page 169)	Highlight the focused cell.

GRID_SHOW_BORDER_ONLY (see page 170)	Draw only the outside border of the grid.
GRID_SHOW_SEPARATORS_ONLY (see page 170)	Draw only the lines between cells (like Tic-tac-toe)
GRID_DRAW_ITEMS (see page 170)	Bit to indicate that at least one item must be redrawn, but not the entire grid.
GRID_DRAW_ALL (see page 170)	Bit to indicate whole edit box must be redrawn
GRID_HIDE (see page 170)	Bit to remove object from screen

Module

Grid (see page 167)

Description

List of Grid (see page 167) bit states.

8.1.14.1.1 GRID_FOCUSED Macro

File

Grid.h (see page 782)

C

```
#define GRID_FOCUSED 0x0001  // Bit for focused state
```

Description

Bit for focused state

8.1.14.1.2 GRID_DISABLED Macro

File

Grid.h (see page 782)

C

```
#define GRID_DISABLED 0x0002  // Bit for disabled state
```

Description

Bit for disabled state

8.1.14.1.3 GRID_SHOW_LINES Macro

File

Grid.h (see page 782)

C

```
#define GRID_SHOW_LINES 0x0004  // Display grid lines
```

Description

Display grid lines

8.1.14.1.4 GRID_SHOW_FOCUS Macro

File

Grid.h (see page 782)

C

```
#define GRID_SHOW_FOCUS 0x0008  // Highlight the focused cell.
```

Description

Highlight the focused cell.

8.1.14.1.5 GRID_SHOW_BORDER_ONLY Macro

File

Grid.h (see page 782)

C

```
#define GRID_SHOW_BORDER_ONLY 0x0010  // Draw only the outside border of the grid.
```

Description

Draw only the outside border of the grid.

8.1.14.1.6 GRID_SHOW_SEPARATORS_ONLY Macro

File

Grid.h (see page 782)

C

```
#define GRID_SHOW_SEPARATORS_ONLY 0x0020  // Draw only the lines between cells (like
Tic-tac-toe)
```

Description

Draw only the lines between cells (like Tic-tac-toe)

8.1.14.1.7 GRID_DRAW_ITEMS Macro

File

Grid.h (see page 782)

C

```
#define GRID_DRAW_ITEMS 0x1000  // Bit to indicate that at least one item must be redrawn,
but not the entire grid.
```

Description

Bit to indicate that at least one item must be redrawn, but not the entire grid.

8.1.14.1.8 GRID_DRAW_ALL Macro

File

Grid.h (see page 782)

C

```
#define GRID_DRAW_ALL 0x4000  // Bit to indicate whole edit box must be redrawn
```

Description

Bit to indicate whole edit box must be redrawn

8.1.14.1.9 GRID_HIDE Macro

File

Grid.h (see page 782)

C

```
#define GRID_HIDE 0x8000  // Bit to remove object from screen
```

Description

Bit to remove object from screen

8.1.14.2 Grid Item States

Macros

Name	Description
GRIDITEM_SELECTED (see page 171)	The cell is selected.
GRIDITEM_IS_TEXT (see page 171)	The grid item is a test string.
GRIDITEM_IS_BITMAP (see page 172)	The grid item is a bitmap.
GRIDITEM_TEXTBOTTOM (see page 172)	Bit to indicate text is top aligned.
GRIDITEM_TEXTLEFT (see page 172)	Text in the cell is left aligned.
GRIDITEM_TEXTRIGHT (see page 172)	Text in the cell is right aligned.
GRIDITEM_TEXTTOP (see page 172)	Bit to indicate text is bottom aligned.
GRIDITEM_DRAW (see page 173)	Draw this cell

Module

Grid (see page 167)

Description

List of Grid (see page 167) Items bit states.

8.1.14.2.1 GRIDITEM_SELECTED Macro

File

Grid.h (see page 782)

C

```
#define GRIDITEM_SELECTED 0x0001  // The cell is selected.
```

Description

The cell is selected.

8.1.14.2.2 GRIDITEM_IS_TEXT Macro

File

Grid.h (see page 782)

C

```
#define GRIDITEM_IS_TEXT 0x0000  // The grid item is a test string.
```

Description

The grid item is a test string.

8.1.14.2.3 GRIDITEM_IS_BITMAP Macro

File

Grid.h (see page 782)

C

```
#define GRIDITEM_IS_BITMAP 0x0008  // The grid item is a bitmap.
```

Description

The grid item is a bitmap.

8.1.14.2.4 GRIDITEM_TEXTBOTTOM Macro

File

Grid.h (see page 782)

C

```
#define GRIDITEM_TEXTBOTTOM 0x0040  // Bit to indicate text is top aligned.
```

Description

Bit to indicate text is top aligned.

8.1.14.2.5 GRIDITEM_TEXTLEFT Macro

File

Grid.h (see page 782)

C

```
#define GRIDITEM_TEXTLEFT 0x0020  // Text in the cell is left aligned.
```

Description

Text in the cell is left aligned.

8.1.14.2.6 GRIDITEM_TEXTRIGHT Macro

File

Grid.h (see page 782)

C

```
#define GRIDITEM_TEXTRIGHT 0x0010  // Text in the cell is right aligned.
```

Description

Text in the cell is right aligned.

8.1.14.2.7 GRIDITEM_TEXTTOP Macro

File

Grid.h (see page 782)

C

```
#define GRIDITEM_TEXTTOP 0x0080  // Bit to indicate text is bottom aligned.
```

Description

Bit to indicate text is bottom aligned.

8.1.14.2.8 GRIDITEM_DRAW Macro

File

Grid.h (see page 782)

C

```
#define GRIDITEM_DRAW 0x0100  // Draw this cell
```

Description

Draw this cell

8.1.14.3 GridCreate Function

File

Grid.h (see page 782)

C

```
GRID * GridCreate(
    WORD ID,
    SHORT left,
    SHORT top,
    SHORT right,
    SHORT bottom,
    WORD state,
    SHORT numColumns,
    SHORT numRows,
    SHORT cellWidth,
    SHORT cellHeight,
    GOL_SCHEME * pScheme
);
```

Module

Grid (see page 167)

Input Parameters

Input Parameters	Description
WORD ID	Unique user defined ID for the object instance.
SHORT left	Left most position of the Object.
SHORT top	Top most position of the Object.
SHORT right	Right most position of the Object.
SHORT bottom	Bottom most position of the object.
WORD state	Sets the initial state of the object.
SHORT numColumns	Sets the number of columns for the grid.
SHORT numRows	Sets the number of rows for the grid.
SHORT cellWidth	Sets the width of each cell of the grid.
SHORT cellHeight	Sets the height of each cell of the grid.
GOL_SCHEME * pScheme	Pointer to the style scheme used for the object. Set to NULL if default style scheme is used.

Side Effects

none

Returns

Returns the pointer to the object created.

Preconditions

none

Overview

This function creates a GRID (see page 183) object with the parameters given. It automatically attaches the new object into a global linked list of objects and returns the address of the object.

Syntax

GRID (see page 183) *GridCreate(WORD ID, SHORT left, SHORT top, SHORT right, SHORT bottom, WORD state, SHORT numColumns, SHORT numRows, SHORT cellWidth, SHORT cellHeight, GOL_SCHEME (see page 345) *pScheme)

8.1.14.4 GridDraw Function

File

Grid.h (see page 782)

C

```
WORD GridDraw(
    void * pObj
);
```

Module

Grid (see page 167)

Input Parameters

Input Parameters	Description
pGb	Pointer to the object to be rendered.

Side Effects

none

Returns

Returns the status of the drawing

- 1 - If the rendering was completed and
- 0 - If the rendering is not yet finished.

Next call to the function will resume the rendering on the pending drawing state.

Preconditions

Object must be created before this function is called.

Overview

This function renders the object on the screen using the current parameter settings. Location of the object is determined by the left, top, right and bottom parameters. The colors used are dependent on the state of the object. The font used is determined by the style scheme set.

When rendering objects of the same type, each object must be rendered completely before the rendering of the next object is started. This is to avoid incomplete object rendering.

Syntax

WORD GridDraw(void *pObj)

8.1.14.5 GridClearCellState Function

File

Grid.h (see page 782)

C

```
void GridClearCellState(
    GRID * pGrid,
    SHORT column,
    SHORT row,
    WORD state
);
```

Module

Grid (see page 167)

Input Parameters

Input Parameters	Description
GRID * pGrid	Pointer to the object.
SHORT column	column index of the cell
SHORT row	row index of the cell
atate	specifies the state to be cleared. See Grid (see page 167) Item State.

Side Effects

none

Returns

none.

Preconditions

none

Overview

This function clears the state of the cell (or Grid (see page 167) Item) specified by the column and row.

Syntax

GridClearCellState(GRID (see page 183) *pGrid, SHORT column, SHORT row, WORD state)

8.1.14.6 GridGetFocusX Macro

File

Grid.h (see page 782)

C

```
#define GridGetFocusX(pGrid) pGrid->focusX
```

Module

Grid (see page 167)

Input Parameters

Input Parameters	Description
pGrid	Pointer to the object.

Side Effects

none

Returns

Returns the x position of the focused cell.

Preconditions

none

Overview

This macro returns the x position of the focused cell.

Syntax

GridGetFocusX(pGrid)

8.1.14.7 GridGetFocusY Macro

File

Grid.h (see page 782)

C

```
#define GridGetFocusY(pGrid) pGrid->focusY
```

Module

Grid (see page 167)

Input Parameters

Input Parameters	Description
pGrid	Pointer to the object.

Side Effects

none

Returns

Returns the y position of the focused cell.

Preconditions

none

Overview

This macro returns the y position of the focused cell.

Syntax

GridGetFocusY(pGrid)

8.1.14.8 GRID_OUT_OF_BOUNDS Macro

File

Grid.h (see page 782)

C

```
#define GRID_OUT_OF_BOUNDS 0x0001  // Status of an out of bounds cell GridSetCell()
operation.
```

Module

Grid (see page 167)

Description

Status of an out of bounds cell GridSetCell (see page 178)() operation.

8.1.14.9 GRID_SUCCESS Macro

File

Grid.h (see page 782)

C

```
#define GRID_SUCCESS 0x0000    // Status of a successful GridSetCell() operation.
```

Module

Grid (see page 167)

Description

Status of a successful GridSetCell (see page 178)() operation.

8.1.14.10 GridFreeItems Function

File

Grid.h (see page 782)

C

```
void GridFreeItems(
    void * pObj
);
```

Module

Grid (see page 167)

Input Parameters

Input Parameters	Description
pGrid	The pointer to the Grid (see page 167) object.

Side Effects

none

Returns

none.

Preconditions

Object must be created before this function is called.

Overview

This function removes all grid items for the given Grid (see page 167) and frees the memory used.

Syntax

GridFreeItems(void *pObj)

8.1.14.11 GridGetCell Function

File

Grid.h (see page 782)

C

```
void * GridGetCell(
    GRID * pGrid,
    SHORT column,
    SHORT row,
    WORD * cellType
);
```

Module

Grid (see page 167)

Input Parameters

Input Parameters	Description
GRID * pGrid	The pointer to the Grid (see page 167) object.
SHORT column	the column index of the cell
SHORT row	the row index of the cell
WORD * cellType	pointer that will receive the type of grid item or cell (GRIDITEM_IS_TEXT (see page 171) or GRIDITEM_IS_BITMAP (see page 172)).

Side Effects

none

Returns

Returns a pointer to the grid item or cell data.

Preconditions

Object must be created before this function is called.

Overview

This function removes all grid items for the given Grid (see page 167) and frees the memory used.

Syntax

*GridGetCell(GRID (see page 183) *pGrid, SHORT column, SHORT row, WORD *cellType)

8.1.14.12 GridSetCell Function

File

Grid.h (see page 782)

C

```
WORD GridSetCell(
    GRID * pGrid,
    SHORT column,
    SHORT row,
    WORD state,
    void * data
);
```

Module

Grid (see page 167)

Input Parameters

Input Parameters	Description
GRID * pGrid	The pointer to the Grid (see page 167) object.
SHORT column	the column index of the cell
SHORT row	the row index of the cell
WORD state	sets the state of the Grid (see page 167) Item specified.

void * data	pointer to the data used for the Grid (see page 167) Item.

Side Effects

none

Returns

Returns the status of the operation

- GRID_SUCCESS (see page 177) - if the set succeeded
- GRID_OUT_OF_BOUNDS (see page 176) - if the row and column given results in an out of bounds location.

Preconditions

Object must be created before this function is called.

Overview

This function sets the Grid (see page 167) Item state and data.

Syntax

WORD GridSetCell(GRID (see page 183) *pGrid, SHORT column, SHORT row, WORD state, void *data)

8.1.14.13 GridSetCellState Function

File

Grid.h (see page 782)

C

```
void GridSetCellState(
    GRID * pGrid,
    SHORT column,
    SHORT row,
    WORD state
);
```

Module

Grid (see page 167)

Input Parameters

Input Parameters	Description
GRID * pGrid	The pointer to the Grid (see page 167) object.
SHORT column	the column index of the cell
SHORT row	the row index of the cell
WORD state	sets the state of the Grid (see page 167) Item specified.

Side Effects

none

Returns

none.

Preconditions

Object must be created before this function is called.

Overview

This function sets the state of the Grid (see page 167) Item or cell.

Syntax

GridSetCellState(GRID (see page 183) *pGrid, SHORT column, SHORT row, WORD state)

8.1.14.14 GridSetFocus Function

File

Grid.h (see page 782)

C

```
void GridSetFocus(
    GRID * pGrid,
    SHORT column,
    SHORT row
);
```

Module

Grid (see page 167)

Input Parameters

Input Parameters	Description
GRID * pGrid	The pointer to the Grid (see page 167) object.
SHORT column	the column index of the cell
SHORT row	the row index of the cell

Side Effects

none

Returns

none.

Preconditions

Object must be created before this function is called.

Overview

This function sets the focus of the specified Grid (see page 167) Item or cell.

Syntax

GridSetFocus(GRID (see page 183) *pGrid, SHORT column, SHORT row)

8.1.14.15 GridMsgDefault Function

File

Grid.h (see page 782)

C

```
void GridMsgDefault(
    WORD translatedMsg,
    void * pObj,
    GOL_MSG * pMsg
);
```

Module

Grid (see page 167)

Input Parameters

Input Parameters	Description
WORD translatedMsg	The translated message.
GOL_MSG * pMsg	The pointer to the GOL (see page 64) message.

pGrid	The pointer to the object whose state will be modified.

Side Effects

none

Returns

none

Preconditions

none

Overview

This function performs the actual state change based on the translated message given. The following state changes are supported:

Translated Message	Input Source	Set/Clear State Bit	Description
GRID_MSG_TOUCHED	Touch Screen	none	Grid (see page 167) will have no state change because of this event.
GRID_MSG_ITEM_SELECTED	Keyboard	Set GRIDITEM_SELECTED (see page 171),	Grid (see page 167) Item selected will be redrawn.
		GRID_DRAW_ITEMS (see page 170)	
GRID_MSG_UP	Keyboard	Set GRIDITEM_DRAW (see page 173),	Grid (see page 167) Item above the currently focused item will be redrawn.
		GRID_DRAW_ITEMS (see page 170)	
GRID_MSG_DOWN	Keyboard	Set GRIDITEM_DRAW (see page 173),	Grid (see page 167) Item below the currently focused item will be redrawn.
		GRID_DRAW_ITEMS (see page 170)	
GRID_MSG_LEFT	Keyboard	Set GRIDITEM_DRAW (see page 173),	Grid (see page 167) Item to the left of the currently focused item will be redrawn.
		GRID_DRAW_ITEMS (see page 170)	
GRID_MSG_RIGHT	Keyboard	Set GRIDITEM_DRAW (see page 173),	Grid (see page 167) Item to the right of the currently focused item will be redrawn.
		GRID_DRAW_ITEMS (see page 170)	

Syntax

GridMsgDefault(WORD translatedMsg, void *pObj, GOL_MSG (see page 330) *pMsg)

8.1.14.16 GridTranslateMsg Function

File

Grid.h (see page 782)

C

```
WORD GridTranslateMsg(
    void * pObj,
    GOL_MSG * pMsg
);
```

Module

Grid (see page 167)

Input Parameters

Input Parameters	Description
GOL_MSG * pMsg	Pointer to the message struct containing the message from the user interface.
pGrid	The pointer to the object where the message will be evaluated to check if the message will affect the object.

Side Effects

none

Returns

Returns the translated message depending on the received GOL (see page 64) message:

- GRID_MSG_TOUCHED - when the grid object is touched.
- GRID_MSG_ITEM_SELECTED – when key scan SCAN_SPACE_PRESSED (see page 339) or SCAN_CR_PRESSED (see page 335) are detected.
- GRID_MSG_UP – when key scan SCAN_UP_PRESSED (see page 340) is detected.
- GRID_MSG_DOWN – when key scan SCAN_DOWN_PRESSED (see page 336) is detected.
- GRID_MSG_LEFT – when key scan SCAN_LEFT_PRESSED (see page 337) is detected.
- GRID_MSG_RIGHT – when key scan SCAN_RIGHT_PRESSED (see page 339) is detected.
- OBJ_MSG_INVALID – Button (see page 78) is not affected

Preconditions

none

Overview

This function evaluates the message from a user if the message will affect the object or not. The table below enumerates the translated messages for each event of the touch screen and keyboard inputs.

Translated Message	Input Source	Set/Clear State Bit	Description
GRID_MSG_TOUCHED	Touch Screen	none	If any touch events occurs and the x,y position falls in the face of the grid.
GRID_MSG_ITEM_SELECTED	Keyboard	EVENT_KEYSCAN	If event occurs and parameter1 passed matches the object's ID and parameter 2 passed matches SCAN_SPACE_PRESSED (see page 339) or SCAN_CR_PRESSED (see page 335).
GRID_MSG_UP	Keyboard	EVENT_KEYSCAN	If event occurs and parameter1 passed matches the object's ID and parameter 2 passed matches SCAN_UP_PRESSED (see page 340).
GRID_MSG_DOWN	Keyboard	EVENT_KEYSCAN	If event occurs and parameter1 passed matches the object's ID and parameter 2 passed matches SCAN_DOWN_PRESSED (see page 336).
GRID_MSG_LEFT	Keyboard	EVENT_KEYSCAN	If event occurs and parameter1 passed matches the object's ID and parameter 2 passed matches SCAN_LEFT_PRESSED (see page 337).
GRID_MSG_RIGHT	Keyboard	EVENT_KEYSCAN	If event occurs and parameter1 passed matches the object's ID and parameter 2 passed matches SCAN_RIGHT_PRESSED (see page 339).
OBJ_MSG_INVALID	Any	Any	If the message did not affect the object.

Syntax

GridTranslateMsg(void *pObj, GOL_MSG (see page 330) *pMsg)

8.1.14.17 GRID Structure

File

Grid.h (see page 782)

C

```
typedef struct {
  OBJ_HEADER hdr;
  SHORT numColumns;
  SHORT numRows;
  SHORT cellHeight;
  SHORT cellWidth;
  SHORT focusX;
  SHORT focusY;
  GRIDITEM * gridObjects;
} GRID;
```

Members

Members	Description
OBJ_HEADER hdr;	Generic header for all Objects (see OBJ_HEADER (see page 68)).
SHORT numColumns;	Number of columns drawn for the Grid (see page 167).
SHORT numRows;	Number of rows drawn for the Grid (see page 167).
SHORT cellHeight;	The height of each cell in pixels.
SHORT cellWidth;	The width of each cell in pixels.
SHORT focusX;	The x position of the cell to be focused.
SHORT focusY;	The y position of the cell to be focused.
GRIDITEM * gridObjects;	The pointer to grid items

Module

Grid (see page 167)

Overview

Defines the parameters required for a grid Object. Clipping is not supported in grid object.

8.1.14.18 GRIDITEM Structure

File

Grid.h (see page 782)

C

```
typedef struct {
  void * data;
  WORD status;
} GRIDITEM;
```

Members

Members	Description
void * data;	Indicates if the Grid (see page 167) Item is type GRIDITEM_IS_TEXT (see page 171) or GRIDITEM_IS_BITMAP (see page 172)
WORD status;	indicates the status of the Grid (see page 167) Item

Module

Grid (see page 167)

Overview

Defines the grid item.

8.1.15 Group Box

Group Box is an Object that can be used to group Objects together in the screen.

Functions

	Name	Description
	GbCreate (see page 186)	This function creates a GROUPBOX (see page 190) object with the parameters given. It automatically attaches the new object into a global linked list of objects and returns the address of the object.
	GbDraw (see page 188)	This function renders the object on the screen using the current parameter settings. Location of the object is determined by the left, top, right and bottom parameters. The colors used are dependent on the state of the object. The font used is determined by the style scheme set. When rendering objects of the same type, each object must be rendered completely before the rendering of the next object is started. This is to avoid incomplete object rendering.
	GbSetText (see page 189)	This function sets the text used by passing the pointer to the static string.
	GbTranslateMsg (see page 190)	This function evaluates the message from a user if the message will affect the object or not. The table below enumerates the translated messages for each event of the touch screen inputs.

Macros

Name	Description
GbGetText (see page 188)	This macro returns the location of the text used.

Structures

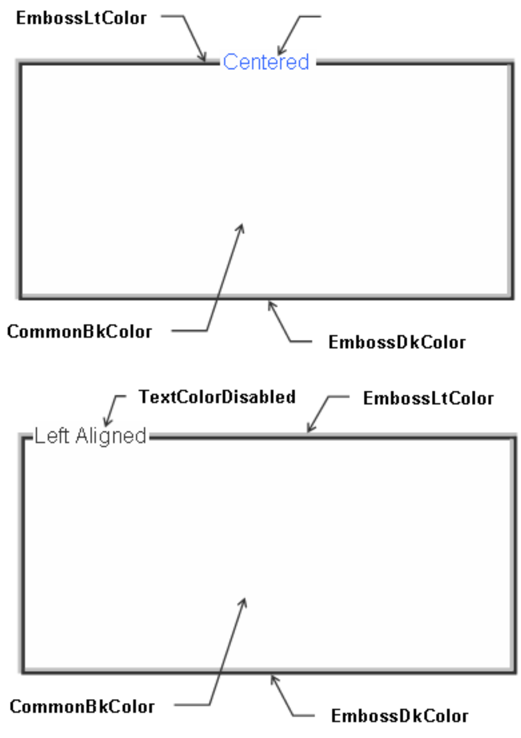
Name	Description
GROUPBOX (see page 190)	Defines the parameters required for a group box Object. The textwidth and textHeight is not checked with the actual dimension of the object. Clipping is not supported in group box object. It is possible for the text to exceed the dimension of the Object.

Description

Group Box supports only Touchscreen inputs, replying to their events with the message:

GB_MSG_SELECTED - when the touch is within the dimension of the object.

The Group box object is rendered using the assigned style scheme. The following figure illustrates the color assignments.



8.1.15.1 Group Box States

Macros

Name	Description
GB_CENTER_ALIGN (see page 185)	Bit to indicate text is center aligned
GB_DISABLED (see page 186)	Bit for disabled state
GB_DRAW (see page 186)	Bit to indicate group box must be redrawn
GB_HIDE (see page 186)	Bit to remove object from screen
GB_RIGHT_ALIGN (see page 186)	Bit to indicate text is right aligned

Module

Group Box (see page 184)

Description

List of Group Box bit states.

8.1.15.1.1 GB_CENTER_ALIGN Macro

File

GroupBox.h (see page 795)

C

```
#define GB_CENTER_ALIGN 0x0008  // Bit to indicate text is center aligned
```

Description

Bit to indicate text is center aligned

8.1.15.1.2 GB_DISABLED Macro

File

GroupBox.h (see page 795)

C

```
#define GB_DISABLED 0x0002  // Bit for disabled state
```

Description

Bit for disabled state

8.1.15.1.3 GB_DRAW Macro

File

GroupBox.h (see page 795)

C

```
#define GB_DRAW 0x4000          // Bit to indicate group box must be redrawn
```

Description

Bit to indicate group box must be redrawn

8.1.15.1.4 GB_HIDE Macro

File

GroupBox.h (see page 795)

C

```
#define GB_HIDE 0x8000          // Bit to remove object from screen
```

Description

Bit to remove object from screen

8.1.15.1.5 GB_RIGHT_ALIGN Macro

File

GroupBox.h (see page 795)

C

```
#define GB_RIGHT_ALIGN 0x0004  // Bit to indicate text is right aligned
```

Description

Bit to indicate text is right aligned

8.1.15.2 GbCreate Function

File

GroupBox.h (see page 795)

C

```
GROUPBOX * GbCreate(
    WORD ID,
    SHORT left,
    SHORT top,
    SHORT right,
    SHORT bottom,
    WORD state,
    XCHAR * pText,
    GOL_SCHEME * pScheme
);
```

Module

Group Box (see page 184)

Input Parameters

Input Parameters	Description
WORD ID	Unique user defined ID for the object instance.
SHORT left	Left most position of the Object.
SHORT top	Top most position of the Object.
SHORT right	Right most position of the Object.
SHORT bottom	Bottom most position of the object.
WORD state	Sets the initial state of the object.
XCHAR * pText	The pointer to the text used for the group box. Length of string must be checked not to exceed the object’s width. Clipping is not supported for the text of this object.
GOL_SCHEME * pScheme	Pointer to the style scheme used for the object. Set to NULL if default style scheme is used.

Side Effects

none

Returns

Returns the pointer to the object created.

Preconditions

none

Example

```
GOL_SCHEME *pScheme;
GROUPBOX *groupbox[2];
WORD state;

pScheme = GOLCreateScheme();
state = GB_DRAW | GB_RIGHT_ALIGN;
groupbox[0] = GbCreate( 10, 14,48,152,122,
                        state, "Power", scheme);
if (groupbox[0] == NULL)
    return 0;
state = GB_DRAW;
groupbox[1] = GbCreate( 11, 160,48,298,122,
                        state, "Pressure", scheme);
if (groupbox[1] == NULL)
    return 0;

while(!GbDraw(groupbox[0]));
while(!GbDraw(groupbox[1]));
return 1;
```

Overview

This function creates a GROUPBOX (see page 190) object with the parameters given. It automatically attaches the new object into a global linked list of objects and returns the address of the object.

Syntax

GROUPBOX (see page 190) *GbCreate(WORD ID, SHORT left, SHORT top, SHORT right, SHORT bottom, WORD state, XCHAR (see page 361) *pText, GOL_SCHEME (see page 345) *pScheme)

8.1.15.3 GbDraw Function

File

GroupBox.h (see page 795)

C

```
WORD GbDraw(
    void * pObj
);
```

Module

Group Box (see page 184)

Input Parameters

Input Parameters	Description
pGb	Pointer to the object to be rendered.

Side Effects

none

Returns

Returns the status of the drawing

- 1 - If the rendering was completed and
- 0 - If the rendering is not yet finished.

Next call to the function will resume the rendering on the pending drawing state.

Preconditions

Object must be created before this function is called.

Example

See GbCreate (see page 186)() example.

Overview

This function renders the object on the screen using the current parameter settings. Location of the object is determined by the left, top, right and bottom parameters. The colors used are dependent on the state of the object. The font used is determined by the style scheme set.

When rendering objects of the same type, each object must be rendered completely before the rendering of the next object is started. This is to avoid incomplete object rendering.

Syntax

WORD GbDraw(void *pObj)

8.1.15.4 GbGetText Macro

File

GroupBox.h (see page 795)

C

```
#define GbGetText(pB) pGb->pText
```

Module

Group Box (see page 184)

Input Parameters

Input Parameters	Description
pGb	Pointer to the object.

Side Effects

none

Returns

Returns the address of the text string used.

Preconditions

none

Overview

This macro returns the location of the text used.

Syntax

GbGetText(pGb)

8.1.15.5 GbSetText Function

File

GroupBox.h (see page 795)

C

```
void GbSetText(
    GROUPBOX * pGb,
    XCHAR * pText
);
```

Module

Group Box (see page 184)

Input Parameters

Input Parameters	Description
GROUPBOX * pGb	the pointer to the object whose state will be modified.
XCHAR * pText	pointer to the text that will be used.

Side Effects

none

Returns

none

Preconditions

none

Overview

This function sets the text used by passing the pointer to the static string.

Syntax

GbSetText(GROUPBOX (see page 190) *pGb, XCHAR (see page 361) *pText)

8.1.15.6 GbTranslateMsg Function

File

GroupBox.h (see page 795)

C

```
WORD GbTranslateMsg(
    void * pObj,
    GOL_MSG * pMsg
);
```

Module

Group Box (see page 184)

Input Parameters

Input Parameters	Description
GOL_MSG * pMsg	Pointer to the message struct containing the message from the user interface.
pGb	The pointer to the object where the message will be evaluated to check if the message will affect the object.

Side Effects

none

Returns

Returns the translated message depending on the received GOL (see page 64) message:

- GB_MSG_SELECTED – Group Box is selected
- OBJ_MSG_INVALID – Group Box is not affected

Preconditions

none

Example

Usage is similar to BtnTranslateMsg (see page 90)() example.

Overview

This function evaluates the message from a user if the message will affect the object or not. The table below enumerates the translated messages for each event of the touch screen inputs.

Translated Message	Input Source	Events	Description
GB_MSG_SELECTED	Touch Screen	EVENT_PRESS, EVENT_RELEASE	If events occurs and the x,y position falls in the area of the group box.
OBJ_MSG_INVALID	Any	Any	If the message did not affect the object.

Syntax

WORD GbTranslateMsg(void *pObj, GOL_MSG (see page 330) *pMsg)

8.1.15.7 GROUPBOX Structure

File

GroupBox.h (see page 795)

C

```
typedef struct {
  OBJ_HEADER hdr;
  SHORT textWidth;
  SHORT textHeight;
  XCHAR * pText;
} GROUPBOX;
```

Members

Members	Description
OBJ_HEADER hdr;	Generic header for all Objects (see OBJ_HEADER (see page 68)).
SHORT textWidth;	Pre-computed text width.
SHORT textHeight;	Pre-computed text height.
XCHAR * pText;	Text string used.

Module

Group Box (see page 184)

Overview

Defines the parameters required for a group box Object. The textwidth and textHeight is not checked with the actual dimension of the object. Clipping is not supported in group box object. It is possible for the text to exceed the dimension of the Object.

8.1.16 List Box

List Box is an Object that defines a scrollable area where items are listed. User can select a single item or set of items.

Functions

	Name	Description
	LbCreate (see page 195)	This function creates a LISTBOX (see page 209) object with the parameters given. It automatically attaches the new object into a global linked list of objects and returns the address of the object.
	LbDraw (see page 197)	This function renders the object on the screen using the current parameter settings. Location of the object is determined by the left, top, right and bottom parameters. The colors used are dependent on the state of the object. The font used is determined by the style scheme set. The text or items drawn in the visible window of the list box is dependent on the alignment set. When rendering objects of the same type, each object must be rendered completely before the rendering of the next object is started. This is to avoid incomplete object rendering.
	LbAddItem (see page 198)	This function allocates memory for the LISTITEM (see page 210) and adds it to the list box. The newly created LISTITEM (see page 210) will store the location of pText, pBitmap and other parameters describing the added item.
	LbDelItem (see page 200)	This function removes an item from the list box and frees the memory used.
	LbChangeSel (see page 200)	This function changes the selection status of an item in the list box. If the item is currently selected, it resets the selection. If the item is currently not selected it is set to be selected.
	LbGetSel (see page 202)	This function searches for selected items from the list box. A starting position can optionally be given. If starting position is set to NULL, search will begin from the first item list. It returns the pointer to the first selected item found or NULL if there are no items selected.
	LbGetFocusedItem (see page 202)	This function returns the index of the focused item in the list box.

◆	LbSetFocusedItem (see page 203)	This function sets the focus for the item with the given index.
◆	LbDelItemsList (see page 207)	This function removes all items from the list box and frees the memory used.
◆	LbMsgDefault (see page 207)	This function performs the actual state change based on the translated message given. The following state changes are supported:
◆	LbTranslateMsg (see page 208)	This function evaluates the message from a user if the message will affect the object or not. The table below enumerates the translated messages for each event of the touch screen and keyboard inputs.

Macros

Name	Description
LbGetItemList (see page 198)	This function returns the pointer to the current item list used in the list box.
LbSetSel (see page 201)	This macro sets the selection status of an item to selected.
LbGetCount (see page 203)	This macro returns the number of items in the list box.
LbGetVisibleCount (see page 204)	This macro returns the number of items visible in the list box window.
LbClrtSel (see page 205)	This macro clears the selection of an item.
LbSetBitmap (see page 205)	This macro sets the bitmap used in the item.
LbGetBitmap (see page 206)	This macro returns the location of the currently used bitmap for the item.

Structures

Name	Description
LISTBOX (see page 209)	Defines the parameters required for a list box Object.
LISTITEM (see page 210)	Defines the parameters required for a list item used in list box.

Description

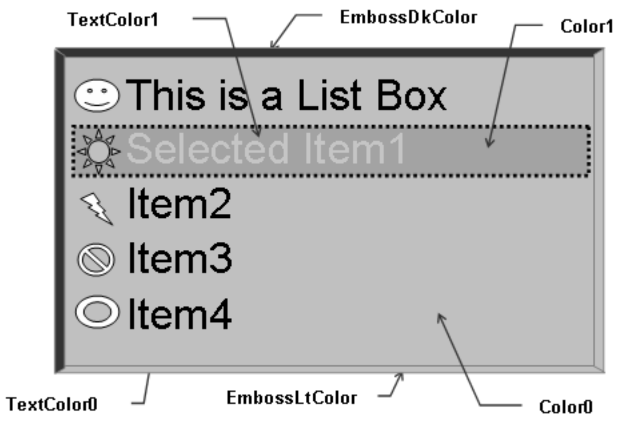
List Box supports both Touchscreen and Keyboard inputs, replying to their events with the following messages:

LB_MSG_TOUCHSCREEN – Item is selected using touch screen

LB_MSG_MOVE – Focus is moved to the next item depending on the key pressed (UP or DOWN key).

LB_MSG_SEL – Selection is set to the currently focused item.

The List Box Object is rendered using the assigned style scheme. The following figure illustrates the color assignments. Icons can be added to each item when adding items to the list using LbAddItem (see page 198)().



8.1.16.1 List Box States

Macros

Name	Description
LB_RIGHT_ALIGN (see page 193)	Bit to indicate text is left aligned
LB_SINGLE_SEL (see page 193)	Bit to indicate the only item can be selected
LB_CENTER_ALIGN (see page 193)	Bit to indicate text is center aligned
LB_DISABLED (see page 194)	Bit for disabled state
LB_DRAW (see page 194)	Bit to indicate whole edit box must be redrawn
LB_DRAW_FOCUS (see page 194)	Bit to indicate whole edit box must be redrawn
LB_DRAW_ITEMS (see page 194)	Bit to indicate whole edit box must be redrawn
LB_FOCUSED (see page 194)	Bit for focused state
LB_HIDE (see page 195)	Bit to remove object from screen

Module

List Box (see page 191)

Description

List of List Box bit states.

8.1.16.1.1 LB_RIGHT_ALIGN Macro

File

ListBox.h (see page 811)

C

```
#define LB_RIGHT_ALIGN 0x0004  // Bit to indicate text is left aligned
```

Description

Bit to indicate text is left aligned

8.1.16.1.2 LB_SINGLE_SEL Macro

File

ListBox.h (see page 811)

C

```
#define LB_SINGLE_SEL 0x0010  // Bit to indicate the only item can be selected
```

Description

Bit to indicate the only item can be selected

8.1.16.1.3 LB_CENTER_ALIGN Macro

File

ListBox.h (see page 811)

C

```
#define LB_CENTER_ALIGN 0x0008  // Bit to indicate text is center aligned
```

Description

Bit to indicate text is center aligned

8.1.16.1.4 LB_DISABLED Macro

File

ListBox.h (see page 811)

C

```
#define LB_DISABLED 0x0002  // Bit for disabled state
```

Description

Bit for disabled state

8.1.16.1.5 LB_DRAW Macro

File

ListBox.h (see page 811)

C

```
#define LB_DRAW 0x4000  // Bit to indicate whole edit box must be redrawn
```

Description

Bit to indicate whole edit box must be redrawn

8.1.16.1.6 LB_DRAW_FOCUS Macro

File

ListBox.h (see page 811)

C

```
#define LB_DRAW_FOCUS 0x2000  // Bit to indicate whole edit box must be redrawn
```

Description

Bit to indicate whole edit box must be redrawn

8.1.16.1.7 LB_DRAW_ITEMS Macro

File

ListBox.h (see page 811)

C

```
#define LB_DRAW_ITEMS 0x1000  // Bit to indicate whole edit box must be redrawn
```

Description

Bit to indicate whole edit box must be redrawn

8.1.16.1.8 LB_FOCUSED Macro

File

ListBox.h (see page 811)

C

```
#define LB_FOCUSED 0x0001  // Bit for focused state
```

Description

Bit for focused state

8.1.16.1.9 LB_HIDE Macro

File

ListBox.h (see page 811)

C

```
#define LB_HIDE 0x8000  // Bit to remove object from screen
```

Description

Bit to remove object from screen

8.1.16.2 List Item Status

Macros

Name	Description
LB_STS_SELECTED (see page 195)	Item is selected.
LB_STS_REDRAW (see page 195)	Item is to be redrawn.

Module

List Box (see page 191)

Description

List of Items status.

8.1.16.2.1 LB_STS_SELECTED Macro

File

ListBox.h (see page 811)

C

```
#define LB_STS_SELECTED 0x0001  // Item is selected.
```

Description

Item is selected.

8.1.16.2.2 LB_STS_REDRAW Macro

File

ListBox.h (see page 811)

C

```
#define LB_STS_REDRAW 0x0002  // Item is to be redrawn.
```

Description

Item is to be redrawn.

8.1.16.3 LbCreate Function

File

ListBox.h (see page 811)

C

```
LISTBOX * LbCreate(
    WORD ID,
    SHORT left,
    SHORT top,
    SHORT right,
    SHORT bottom,
    WORD state,
    XCHAR * pText,
    GOL_SCHEME * pScheme
);
```

Module

List Box (see page 191)

Input Parameters

Input Parameters	Description
WORD ID	Unique user defined ID for the object instance.
SHORT left	Left most position of the Object.
SHORT top	Top most position of the Object.
SHORT right	Right most position of the Object.
SHORT bottom	Bottom most position of the Object.
WORD state	Sets the initial state of the object.
XCHAR * pText	Pointer to the initialization text for the items.
GOL_SCHEME * pScheme	Pointer to the style scheme.

Side Effects

none

Returns

Returns the pointer to the object created.

Preconditions

none

Example

```
#define LISTBOX_ID   10

const XCHAR ItemList[] = "Line1n" "Line2n";

GOL_SCHEME *pScheme;
LISTBOX *pLb;
XCHAR *pTemp;
WORD state, counter;

    pScheme = GOLCreateScheme();
    state = LB_DRAW;

    // create an empty listbox with default style scheme
    pLb = LbCreate( LISTBOX_ID,         // ID number
                    10,10,150,200,      // dimension
                    state,              // initial state
                    NULL,               // set items to be empty
                    NULL);              // use default style scheme
    // check if Listbox was created
    if (pLb == NULL)
       return 0;

    // create the list of items to be placed in the listbox
    // Add items (each line will become one item,
    // lines must be separated by 'n' character)
    pTemp = ItemList;
    counter = 0;
    while(*pTemp){
        // since each item is appended NULL is assigned to
        // LISTITEM pointer.
        if(NULL == LbAddItem(pLb, NULL, pTemp, NULL, 0, counter))
            break;
        while((unsigned XCHAR)*pTemp++ > (unsigned XCHAR)31);
        if(*(pTemp-1) == 0)
            break;
        counter++;
    }
```

Overview

This function creates a LISTBOX (see page 209) object with the parameters given. It automatically attaches the new object into a global linked list of objects and returns the address of the object.

Syntax

LISTBOX (see page 209) *LbCreate(WORD ID, SHORT left, SHORT top, SHORT right, SHORT bottom, WORD state, XCHAR (see page 361)* pText, GOL_SCHEME (see page 345) *pScheme)

8.1.16.4 LbDraw Function

File

ListBox.h (see page 811)

C

```
WORD LbDraw(
    void * pObj
);
```

Module

List Box (see page 191)

Input Parameters

Input Parameters	Description
pLb	Pointer to the object to be rendered.

Side Effects

none

Returns

Returns the status of the drawing

- 1 - If the rendering was completed and
- 0 - If the rendering is not yet finished.

Next call to the function will resume the rendering on the pending drawing state.

Preconditions

Object must be created before this function is called.

Overview

This function renders the object on the screen using the current parameter settings. Location of the object is determined by the left, top, right and bottom parameters. The colors used are dependent on the state of the object. The font used is determined by the style scheme set.

The text or items drawn in the visible window of the list box is dependent on the alignment set.

When rendering objects of the same type, each object must be rendered completely before the rendering of the next object is started. This is to avoid incomplete object rendering.

Syntax

WORD LbDraw(void *pObj)

8.1.16.5 LbGetItemList Macro

File

ListBox.h (see page 811)

C

```
#define LbGetItemList(pLb) ((LISTITEM *)pLb->pItemList)
```

Module

List Box (see page 191)

Input Parameters

Input Parameters	Description
pLb	The pointer to the list box object.

Side Effects

none

Returns

Returns the pointer to the LISTITEM (see page 210) used in the list box.

Preconditions

none

Example

See LbAddItem (see page 198)() example.

Overview

This function returns the pointer to the current item list used in the list box.

Syntax

LISTITEM (see page 210) LbGetItemList(LISTBOX (see page 209)* pLb)

8.1.16.6 LbAddItem Function

File

ListBox.h (see page 811)

C

```
LISTITEM * LbAddItem(
    LISTBOX * pLb,
    LISTITEM * pPrevItem,
    XCHAR * pText,
    void * pBitmap,
    WORD status,
    WORD data
);
```

Module

List Box (see page 191)

Input Parameters

Input Parameters	Description
LISTBOX * pLb	The pointer to the list box object.
LISTITEM * pPrevItem	Pointer to the item after which a new item must be inserted, if this pointer is NULL, the item will be appended at the end of the items list.
XCHAR * pText	Pointer to the text that will be inserted. Text must persist in memory for as long as it is referenced by an item in the list box.
void * pBitmap	Pointer to the bitmap for the item. Bitmap must persist in memory for as long as it is referenced by the an item in the list box.
WORD status	This parameter specifies if the item being added will be selected or redrawn (LB_STS_SELECTED (see page 195) or LB_STS_REDRAW (see page 195)). Refer to LISTITEM (see page 210) structure for details.
WORD data	User assigned data associated with the item.

Side Effects

none

Returns

Return a pointer to the item created, NULL if the operation was not successful.

Preconditions

none

Example

```
const XCHAR ItemList[] = "Line1n" "Line2n" "Line3n";

extern BITMAP_FLASH myIcon;
LISTBOX *pLb;
LISTITEM *pItem, *pItemList;
XCHAR *pTemp;

// Assume that pLb is pointing to an existing list box in memory
// that is empty (no list).

// Create the list of the list box

// Initialize this to NULL to indicate that items will be added
// at the end of the list if the list exist on the list box or
// start a new list if the list box is empty.
pItem = NULL;
pTemp = ItemList;
pItem = LbAddItem(pLb, pItem, pTemp, NULL, LB_STS_SELECTED, 1)
if(pItem == NULL)
    return 0;
LbSetBitmap(pItem, &myIcon);

// Adjust pTemp to point to the next line
while((unsigned XCHAR)*pTemp++ > (unsigned XCHAR)31);

// add the next item
pItem = LbAddItem(pLb, pItem, pTemp, NULL, 0, 2)
if(pItem == NULL)
    return 0;
LbSetBitmap(pItem, &myIcon);

// Adjust pTemp to point to the next line
while((unsigned XCHAR)*pTemp++ > (unsigned XCHAR)31);

// this time insert the next item after the first item on the list
pItem = LbGetItemList(pLb);
pItem = LbAddItem(pLb, pItem, pTemp, NULL, 0, 3)
if(pItem == NULL)
    return 0;
LbSetBitmap(pItem, &myIcon);
```

Overview

This function allocates memory for the LISTITEM (see page 210) and adds it to the list box. The newly created LISTITEM (see page 210) will store the location of pText, pBitmap and other parameters describing the added item.

Syntax

LISTITEM (see page 210)* LbAddItem(LISTBOX (see page 209) *pLb, LISTITEM (see page 210) *pPrevItem, XCHAR (see page 361) *pText, void* pBitmap, WORD status, WORD data)

8.1.16.7 LbDelItem Function

File

ListBox.h (see page 811)

C

```
void LbDelItem(
    LISTBOX * pLb,
    LISTITEM * pItem
);
```

Module

List Box (see page 191)

Input Parameters

Input Parameters	Description
LISTBOX * pLb	The pointer to the list box object.
LISTITEM * pItem	The pointer to the item that will be removed.

Side Effects

none

Returns

none

Preconditions

none

Overview

This function removes an item from the list box and frees the memory used.

Syntax

void LbDelItem(LISTBOX (see page 209) *pLb, LISTITEM (see page 210) *pItem)

8.1.16.8 LbChangeSel Function

File

ListBox.h (see page 811)

C

```
void LbChangeSel(
    LISTBOX * pLb,
    LISTITEM * pItem
);
```

Module

List Box (see page 191)

Input Parameters

Input Parameters	Description
LISTBOX * pLb	The pointer to the list box object.
LISTITEM * pItem	The pointer to the item the selection status will be changed.

Side Effects

none

Returns

none

Preconditions

none

Overview

This function changes the selection status of an item in the list box. If the item is currently selected, it resets the selection. If the item is currently not selected it is set to be selected.

Syntax

void LbChangeSel(LISTBOX (see page 209) *pLb, LISTITEM (see page 210) *pItem)

8.1.16.9 LbSetSel Macro

File

ListBox.h (see page 811)

C

```
#define LbSetSel(pLb, pItem) \
    if(!(pItem->status & LB_STS_SELECTED)) \
        LbChangeSel((LISTBOX *)pLb, pItem);
```

Module

List Box (see page 191)

Input Parameters

Input Parameters	Description
pLb	The pointer to the list box object.
pItem	The pointer to the item the selection status will be set.

Side Effects

none

Returns

none

Preconditions

none

Overview

This macro sets the selection status of an item to selected.

Syntax

LbSetSel(pLb, pItem)

8.1.16.10 LbGetSel Function

File

ListBox.h (see page 811)

C

```
LISTITEM * LbGetSel(
    LISTBOX * pLb,
    LISTITEM * pFromItem
);
```

Module

List Box (see page 191)

Input Parameters

Input Parameters	Description
LISTBOX * pLb	The pointer to the list box object.
LISTITEM * pFromItem	The pointer to the item the search must start from, if the pointer is NULL the search begins from the start of the items list.

Side Effects

none

Returns

pointer to the selected item, NULL if there are no items selected

Preconditions

none

Overview

This function searches for selected items from the list box. A starting position can optionally be given. If starting position is set to NULL, search will begin from the first item list. It returns the pointer to the first selected item found or NULL if there are no items selected.

Syntax

LISTITEM (see page 210)* LbGetSel(LISTBOX (see page 209) *pLb, LISTITEM (see page 210) *pFromItem)

8.1.16.11 LbGetFocusedItem Function

File

ListBox.h (see page 811)

C

```
SHORT LbGetFocusedItem(
    LISTBOX * pLb
);
```

Module

List Box (see page 191)

Input Parameters

Input Parameters	Description
LISTBOX * pLb	The pointer to the list box object.

Side Effects

none

Returns

Returns the index of the focused item in the list box.

Preconditions

none

Overview

This function returns the index of the focused item in the list box.

Syntax

SHORT LbGetFocusedItem(LISTBOX (see page 209)* pLb)

8.1.16.12 LbSetFocusedItem Function

File

ListBox.h (see page 811)

C

```
void LbSetFocusedItem(
    LISTBOX * pLb,
    SHORT index
);
```

Module

List Box (see page 191)

Input Parameters

Input Parameters	Description
LISTBOX * pLb	The pointer to the list box object.
SHORT index	The index number of the item to be focused. First item on the list is always indexed 0.

Side Effects

none

Returns

none.

Preconditions

none

Overview

This function sets the focus for the item with the given index.

Syntax

void LbSetFocusedItem(LISTBOX (see page 209)* pLb, SHORT index)

8.1.16.13 LbGetCount Macro

File

ListBox.h (see page 811)

C

```
#define LbGetCount(pLb) ((LISTBOX *)pLb)->itemsNumber
```

Module

List Box (see page 191)

Input Parameters

Input Parameters	Description
pLb	The pointer to the list box object.

Side Effects

none

Returns

The number of items the list box contains.

Preconditions

none

Overview

This macro returns the number of items in the list box.

Syntax

LbGetCount(pLb)

8.1.16.14 LbGetVisibleCount Macro

File

ListBox.h (see page 811)

C

```
#define LbGetVisibleCount(pLb) \
        (

\
            (((LISTBOX *)pLb)->hdr.bottom - ((LISTBOX *)pLb)->hdr.top - 2 *
(GOL_EMBOSS_SIZE + LB_INDENT)) / \
                ((LISTBOX
*)pLb)->textHeight                                                  \
        )
```

Module

List Box (see page 191)

Input Parameters

Input Parameters	Description
pLb	The pointer to the list box object.

Side Effects

none

Returns

The number of items visible in the list box window.

Preconditions

none

Overview

This macro returns the number of items visible in the list box window.

Syntax

LbGetVisibleCount(pLb)

8.1.16.15 LbClrtSel Macro

File

ListBox.h (see page 811)

C

```
#define LbClrtSel(pLb, pItem) \
    if(pItem->status & LB_STS_SELECTED) \
        LbChangeSel((LISTBOX *)pLb, pItem);
```

Module

List Box (see page 191)

Input Parameters

Input Parameters	Description
pLb	The pointer to the list box.
pItem	The pointer to the item the selection status should be cleared.

Side Effects

none

Returns

none

Preconditions

none

Overview

This macro clears the selection of an item.

Syntax

LbClrSel(pLb, pItem)

8.1.16.16 LbSetBitmap Macro

File

ListBox.h (see page 811)

C

```
#define LbSetBitmap(pItem, pBtmap) ((LISTITEM *)pItem)->pBitmap = pBtmap
```

Module

List Box (see page 191)

Input Parameters

Input Parameters	Description
pItem	Pointer to the item.
pBtmap	Pointer to the bitmap to be used.

Side Effects

none

Returns

none

Preconditions

none

Example

See LbAddItem (see page 198)() example.

Overview

This macro sets the bitmap used in the item.

Syntax

LbSetBitmap(pItem, pBtmap)

8.1.16.17 LbGetBitmap Macro

File

ListBox.h (see page 811)

C

```
#define LbGetBitmap(pItem) ((LISTITEM *)pItem)->pBitmap
```

Module

List Box (see page 191)

Input Parameters

Input Parameters	Description
pItem	Pointer to the list item.

Side Effects

none

Returns

Returns the pointer to the current bitmap used.

Preconditions

none

Example

```
// Assume pLb is initialized to an existing list box
LISTITEM *pItem;
void *pBitmap;

pItem = LbGetItemList(pLb);
pBitmap = LbGetBitmap(pItem);
```

Overview

This macro returns the location of the currently used bitmap for the item.

Syntax

LbGetBitmap(pItem)

8.1.16.18 LbDelItemsList Function

File

ListBox.h (see page 811)

C

```
void LbDelItemsList(
    void * pObj
);
```

Module

List Box (see page 191)

Input Parameters

Input Parameters	Description
pLb	The pointer to the list box object.

Side Effects

none

Returns

none

Preconditions

none

Overview

This function removes all items from the list box and frees the memory used.

Syntax

void LbDelItemsList(void *pObj)

8.1.16.19 LbMsgDefault Function

File

ListBox.h (see page 811)

C

```
void LbMsgDefault(
    WORD translatedMsg,
    void * pObj,
    GOL_MSG * pMsg
);
```

Module

List Box (see page 191)

Input Parameters

Input Parameters	Description
WORD translatedMsg	The translated message
GOL_MSG * pMsg	The pointer to the GOL (see page 64) message.
pB	The pointer to the object whose state will be modified.

Side Effects

none

Returns

none

Preconditions

none

Overview

This function performs the actual state change based on the translated message given. The following state changes are supported:

Translated Message	Input Source	Set/Clear State Bit	Description
LB_MSG_TOUCHSCREEN	Touch Screen	Set LB_FOCUSED (see page 194), Set LB_DRAW_FOCUS (see page 194)	If focus is enabled, the focus state bit LB_FOCUSED (see page 194) will be set. LB_DRAW_FOCUS (see page 194) draw state bit will force the List Box to be redrawn with focus.
		Set LB_DRAW_ITEMS (see page 194)	List Box will redrawn with selected item(s).
LB_MSG_MOVE	KeyBoard	Set LB_DRAW_ITEMS (see page 194)	List Box will redrawn with focus on one item.
LB_MSG_SEL	KeyBoard	Set LB_DRAW_ITEMS (see page 194)	List Box will redrawn with selection on the current item focused.

Syntax

void LbMsgDefault(WORD translatedMsg, void *pObj, GOL_MSG (see page 330) *pMsg)

8.1.16.20 LbTranslateMsg Function

File

ListBox.h (see page 811)

C

```
WORD LbTranslateMsg(
    void * pObj,
    GOL_MSG * pMsg
);
```

Module

List Box (see page 191)

Input Parameters

Input Parameters	Description
GOL_MSG * pMsg	Pointer to the message struct containing the message from the user interface.
pLB	The pointer to the object where the message will be evaluated to check if the message will affect the object.

Side Effects

none

Returns

Returns the translated message depending on the received GOL (see page 64) message:

- LB_MSG_TOUCHSCREEN – Item is selected using touch screen.
- LB_MSG_MOVE – Focus is moved to the next item depending on the key pressed (UP or DOWN key).
- LB_MSG_SEL – Selection is set to the currently focused item.

Preconditions

none

Overview

This function evaluates the message from a user if the message will affect the object or not. The table below enumerates the translated messages for each event of the touch screen and keyboard inputs.

Translated Message	Input Source	Events	Description
LB_MSG_TOUCHSCREEN	Touch Screen	Any	Item is selected using touch screen.
LB_MSG_MOVE	Keyboard	EVENT_KEYSCAN	Focus is moved to the next item depending on the key pressed (UP or DOWN key).
LB_MSG_SEL	Keyboard	EVENT_KEYSCAN	LB_MSG_SEL – Selection is set to the currently focused item.
OBJ_MSG_INVALID	Any	Any	If the message did not affect the object.

Syntax

WORD LbTranslateMsg(void *pObj, GOL_MSG (see page 330) *pMsg)

8.1.16.21 LISTBOX Structure

File

ListBox.h (see page 811)

C

```
typedef struct {
  OBJ_HEADER hdr;
  LISTITEM * pItemList;
  LISTITEM * pFocusItem;
  WORD itemsNumber;
  SHORT scrollY;
  SHORT textHeight;
} LISTBOX;
```

Members

Members	Description
OBJ_HEADER hdr;	Generic header for all Objects (see OBJ_HEADER (see page 68)).
LISTITEM * pItemList;	Pointer to the list of items.
LISTITEM * pFocusItem;	Pointer to the focused item.
WORD itemsNumber;	Number of items in the list box.
SHORT scrollY;	Scroll (see page 439) displacement for the list.
SHORT textHeight;	Pre-computed text height.

Module

List Box (see page 191)

Overview

Defines the parameters required for a list box Object.

8.1.16.22 LISTITEM Structure

File

ListBox.h (see page 811)

C

```
typedef struct {
  void * pPrevItem;
  void * pNextItem;
  WORD status;
  XCHAR * pText;
  void * pBitmap;
  WORD data;
} LISTITEM;
```

Members

Members	Description
void * pPrevItem;	Pointer to the next item
void * pNextItem;	Pointer to the next item
WORD status;	Specifies the status of the item.
XCHAR * pText;	Pointer to the text for the item
void * pBitmap;	Pointer to the bitmap
WORD data;	Some data associated with the item

Module

List Box (see page 191)

Overview

Defines the parameters required for a list item used in list box.

8.1.17 Meter

Meter is an Object that can be used to graphically display a sampled input.

Functions

	Name	Description
	MtrCreate (see page 214)	This function creates a METER (see page 223) object with the parameters given. It automatically attaches the new object into a global linked list of objects and returns the address of the object.
	MtrDraw (see page 215)	This function renders the object on the screen using the current parameter settings. Location of the object is determined by the left, top, right and bottom parameters. The colors used are dependent on the state of the object. The font used is determined by the style scheme set. Depending on the defined settings, value of the meter will displayed or hidden. Displaying the value will require a little bit more rendering time depending on the size of the meter and font used. When rendering objects of the same type, each object must be rendered completely before the rendering of the... more (see page 215)
	MtrSetVal (see page 216)	This function sets the value of the meter to the passed newVal. newVal is checked to be in the minValue-maxValue range inclusive. If newVal is not in the range, minValue maxValue is assigned depending on the given newVal if less than minValue or above maxValue.

◆	MtrMsgDefault (see page 222)	This function performs the actual state change based on the translated message given. Meter value is set based on parameter 2 of the message given. The following state changes are supported:
◆	MtrTranslateMsg (see page 222)	This function evaluates the message from a user if the message will affect the object or not. The table below enumerates the translated messages for each event of the touch screen and keyboard inputs.

Macros

Name	Description
MtrGetVal (see page 217)	This macro returns the current value of the meter. Value is always in the minValue-maxValue range inclusive.
MtrDecVal (see page 217)	This macro is used to directly decrement the value.
MtrIncVal (see page 218)	This macro is used to directly increment the value.
MtrSetScaleColors (see page 218)	Scale colors can be used to highlight values of the meter. User can set these colors to define the arc colors and scale colors. This also sets the color of the meter value when displayed. Limitation is that color settings are set to the following angles: Color Boundaries Type Whole Type Half Type Quarter Arc (see page 375) 6 225 to 180 not used not used Arc (see page 375) 5 179 to 135 179 to 135 not used Arc (see page 375) 4 134 to 90 134 to 90 not used Arc (see page 375) 3 89 to 45 89 to 45 89 to 45 Arc (see page 375) 2 44 to 0 44... more (see page 218)
MtrSetTitleFont (see page 219)	This function sets the font of title.
MtrSetValueFont (see page 220)	This function sets the font of value.
METER_TYPE (see page 220)	This is a compile time setting to select the type if meter shape. There are three types: • MTR_WHOLE_TYPE - Meter drawn with 6 octants used. • MTR_HALF_TYPE - Meter drawn with semi circle shape. • MTR_QUARTER_TYPE - Meter drawn with quarter circle shape. Set only one value at a time. This is done to save code space. User can define the colors of the arcs for each type. MTR_WHOLE_TYPE will use all the arc colors (arcColor1 - arcColor6) MTR_HALF_TYPE will use arc colors (arcColor5, arcColor4, arcColor3, arcColor2) MTR_QUARTER_TYPE will use arc colors (arcColor3, arcColor2) Set the meter type in Meter.h (see page 834) file and... more (see page 220)
METER_DISPLAY_VALUES_ENABLE (see page 221)	This enables the display of the values.
MTR_ACCURACY (see page 221)	Sets the meter accuracy to one decimal places
RESOLUTION (see page 221)	Factor that the meter widget will divide minValue, maxValue

Structures

Name	Description
METER (see page 223)	Defines the parameters required for a meter Object. Depending on the type selected the meter is drawn with the defined shape parameters and values set on the given fields.

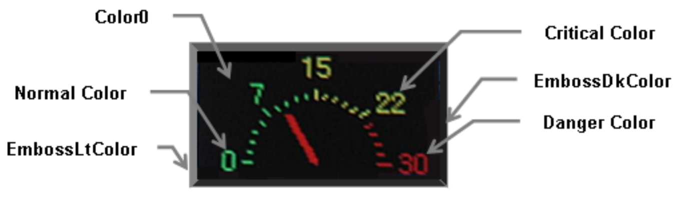
Description

There are three meter types that you can draw:

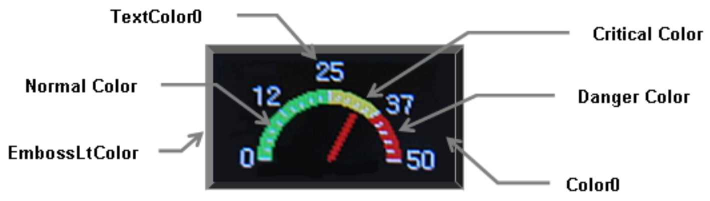
1. MTR_WHOLE_TYPE
2. MTR_HALF_TYPE
3. MTR_QUARTER_TYPE

It supports only System inputs, replying to the event EVENT_SET with the message: MTR_MSG_SET (see MtrTranslateMsg (see page 222)() for details). This action ID means that the message contains the new value of the meter on the parameter 2 of the message.

The Meter Object is rendered using the assigned style scheme, value range colors (see MtrSetScaleColors (see page 218)() for details) and compile time settings. The following figure illustrates the assignments for a MTR_HALF_TYPE meter.



Default Half Meter



Half Meter with Arc enabled

Note:
Normal, Critical and Danger Colors are not part of the style scheme struct. They are fields in the METER struct.

8.1.17.1 Meter States

Macros

Name	Description
MTR_DISABLED (see page 212)	Bit for disabled state.
MTR_DRAW (see page 213)	Bit to indicate object must be redrawn.
MTR_HIDE (see page 213)	Bit to indicate object must be removed from screen.
MTR_RING (see page 213)	Bit for ring type, scales are drawn over the ring
MTR_DRAW_UPDATE (see page 213)	Bit to indicate an update only.

Module

Meter (see page 210)

Description

List of Meter (see page 210) bit states.

8.1.17.1.1 MTR_DISABLED Macro

File

Meter.h (see page 834)

C

```
#define MTR_DISABLED 0x0002      // Bit for disabled state.
```

Description

Bit for disabled state.

8.1.17.1.2 MTR_DRAW Macro

File

Meter.h (see page 834)

C

```
#define MTR_DRAW 0x4000      // Bit to indicate object must be redrawn.
```

Description

Bit to indicate object must be redrawn.

8.1.17.1.3 MTR_HIDE Macro

File

Meter.h (see page 834)

C

```
#define MTR_HIDE 0x8000      // Bit to indicate object must be removed from screen.
```

Description

Bit to indicate object must be removed from screen.

8.1.17.1.4 MTR_RING Macro

File

Meter.h (see page 834)

C

```
#define MTR_RING 0x0004      // Bit for ring type, scales are drawn over the ring
```

Description

Bit for ring type, scales are drawn over the ring

8.1.17.1.5 MTR_DRAW_UPDATE Macro

File

Meter.h (see page 834)

C

```
#define MTR_DRAW_UPDATE 0x1000      // Bit to indicate an update only.
```

Description

Bit to indicate an update only.

8.1.17.2 MtrCreate Function

File

Meter.h (see page 834)

C

```
METER * MtrCreate(
    WORD ID,
    SHORT left,
    SHORT top,
    SHORT right,
    SHORT bottom,
    WORD state,
    SHORT value,
    SHORT minValue,
    SHORT maxValue,
    void * pTitleFont,
    void * pValueFont,
    XCHAR * pText,
    GOL_SCHEME * pScheme
);
```

Module

Meter (see page 210)

Input Parameters

Input Parameters	Description
WORD ID	Unique user defined ID for the object instance.
SHORT left	Left most position of the object.
SHORT top	Top most position of the object.
SHORT right	Right most position of the object.
SHORT bottom	Bottom most position of the object.
WORD state	Sets the initial state of the object.
SHORT value	Initial value set to the meter.
SHORT minValue	The minimum value the meter will display.
SHORT maxValue	The maximum value the meter will display.
XCHAR * pText	Pointer to the text label of the meter.
GOL_SCHEME * pScheme	Pointer to the style scheme used.

Side Effects

none

Returns

Returns the pointer to the object created.

Preconditions

none

Example

```
#define ID_METER 101

extern const FONT_FLASH GOLMediumFont;      // medium font
extern const FONT_FLASH GOLSmallFont;       // small font

GOL_SCHEME *pMeterScheme;
METER *pMtr;

    pMeterScheme = GOLCreateScheme();
```

```
      pMtr = MtrCreate(
              ID_METER,                // assign ID
              30, 50, 150, 180,        // set dimension
              MTR_DRAW|MTR_RING,       // draw object after creation
              0,                       // set initial value
              0, 100,                  // set minimum and maximum value
              (void*)&GOLMediumFont,   // set title font
              (void*)&GOLSmallFont,    // set value font
              "Speed",                 // Text Label
              pMeterScheme);           // style scheme

      // check if meter was created
      if (pMtr == NULL)
         return 0;

      // Change range colors: Normal values to WHITE
      //                      Critical values to BLUE
      //                      Danger values to RED
      // assume that WHITE, GREEN, YELLOW and RED have been defined.
      MtrSetScaleColors(pMtr, WHITE, WHITE, WHITE, GREEN, YELLOW, RED);

      // use GOLDraw() to draw the meter and all other objects you created
      while(!GOLDraw());
      // OR to draw the meter manually use this:
      //while(!MtrDraw(pMtr);
```

Overview

This function creates a METER (see page 223) object with the parameters given. It automatically attaches the new object into a global linked list of objects and returns the address of the object.

Syntax

METER (see page 223) *MtrCreate(WORD ID, SHORT left, SHORT top, SHORT right, SHORT bottom, WORD state, SHORT value, SHORT minValue, SHORT maxValue, XCHAR (see page 361) *pText, GOL_SCHEME (see page 345) *pScheme)

8.1.17.3 MtrDraw Function

File

Meter.h (see page 834)

C

```
WORD MtrDraw(
    void * pObj
);
```

Module

Meter (see page 210)

Input Parameters

Input Parameters	Description
pMtr	Pointer to the object to be rendered.

Side Effects

none

Returns

Returns the status of the drawing

- 1 - If the rendering was completed and
- 0 - If the rendering is not yet finished.

Next call to the function will resume the rendering on the pending drawing state.

Preconditions

Object must be created before this function is called.

Example

See MtrCreate (see page 214)() example.

Overview

This function renders the object on the screen using the current parameter settings. Location of the object is determined by the left, top, right and bottom parameters. The colors used are dependent on the state of the object. The font used is determined by the style scheme set.

Depending on the defined settings, value of the meter will displayed or hidden. Displaying the value will require a little bit more rendering time depending on the size of the meter and font used.

When rendering objects of the same type, each object must be rendered completely before the rendering of the next object is started. This is to avoid incomplete object rendering.

Syntax

WORD MtrDraw(void *pObj)

8.1.17.4 MtrSetVal Function

File

Meter.h (see page 834)

C

```
void MtrSetVal(
    METER * pMtr,
    SHORT newVal
);
```

Module

Meter (see page 210)

Input Parameters

Input Parameters	Description
METER * pMtr	The pointer to the object.
SHORT newVal	New value to be set for the Meter (see page 210).

Side Effects

none

Returns

none

Preconditions

none

Overview

This function sets the value of the meter to the passed newVal. newVal is checked to be in the minValue-maxValue range inclusive. If newVal is not in the range, minValue maxValue is assigned depending on the given newVal if less than minValue or above maxValue.

Syntax

MtrSetVal(METER (see page 223) *pMtr, SHORT newVal)

8.1.17.5 MtrGetVal Macro

File

Meter.h (see page 834)

C

```
#define MtrGetVal(pMtr) ((pMtr)->value)
```

Module

Meter (see page 210)

Input Parameters

Input Parameters	Description
pMtr	Pointer to the object.

Side Effects

none

Returns

Returns current value of the meter.

Preconditions

none

Overview

This macro returns the current value of the meter. Value is always in the minValue-maxValue range inclusive.

Syntax

MtrGetVal(pMtr)

8.1.17.6 MtrDecVal Macro

File

Meter.h (see page 834)

C

```
#define MtrDecVal(pMtr, deltaValue) MtrSetVal(pMtr, ((pMtr)->value - deltaValue))
```

Module

Meter (see page 210)

Input Parameters

Input Parameters	Description
pMtr	Pointer to the object.
deltaValue	Number to be subtracted to the current Meter (see page 210) value.

Side Effects

none

Returns

none

Preconditions

none

Overview

This macro is used to directly decrement the value.

Syntax

MtrDecVal(pMtr, deltaValue)

8.1.17.7 MtrIncVal Macro

File

Meter.h (see page 834)

C

```
#define MtrIncVal(pMtr, deltaValue) MtrSetVal(pMtr, ((pMtr)->value + deltaValue))
```

Module

Meter (see page 210)

Input Parameters

Input Parameters	Description
pMtr	Pointer to the object.
deltaValue	Number to be added to the current Meter (see page 210) value.

Side Effects

none

Returns

none

Preconditions

none

Overview

This macro is used to directly increment the value.

Syntax

MtrIncVal(pMtr, deltaValue)

8.1.17.8 MtrSetScaleColors Macro

File

Meter.h (see page 834)

C

```
#define MtrSetScaleColors(pMtr, arc1, arc2, arc3, arc4, arc5, arc6) \
    {                                                                \
        pMtr->arcColor6 = arc6;                                      \
        pMtr->arcColor5 = arc5;                                      \
        pMtr->arcColor4 = arc4;                                      \
        pMtr->arcColor3 = arc3;                                      \
        pMtr->arcColor2 = arc2;                                      \
        pMtr->arcColor1 = arc1;                                      \
    }
```

Module

Meter (see page 210)

Input Parameters

Input Parameters	Description
pMtr	Pointer to the object.
arc1	color for arc 1.
arc2	color for arc 2.
arc3	color for arc 3.
arc4	color for arc 4.
arc5	color for arc 5.
arc6	color for arc 6.

Side Effects

none

Returns

none

Preconditions

The object must be created (using MtrCreate (see page 214)()) before a call to this macro is performed.

Overview

Scale colors can be used to highlight values of the meter. User can set these colors to define the arc colors and scale colors. This also sets the color of the meter value when displayed. Limitation is that color settings are set to the following angles: Color Boundaries Type Whole Type Half Type Quarter Arc (see page 375) 6 225 to 180 not used not used Arc (see page 375) 5 179 to 135 179 to 135 not used Arc (see page 375) 4 134 to 90 134 to 90 not used Arc (see page 375) 3 89 to 45 89 to 45 89 to 45 Arc (see page 375) 2 44 to 0 44 to 0 44 to 0 Arc (see page 375) 1 -45 to -1 not used not used As the meter is drawn colors are changed depending on the angle of the scale and label being drawn.

Syntax

MtrSetScaleColors(pMtr, arc1, arc2, arc3, arc4, arc5, arc6) { pMtr->arcColor6=arc6; pMtr->arcColor5=arc5; pMtr->arcColor4=arc4; pMtr->arcColor3=arc3; pMtr->arcColor2=arc2; pMtr->arcColor1=arc1; }

8.1.17.9 MtrSetTitleFont Macro

File

Meter.h (see page 834)

C

```
#define MtrSetTitleFont(pMtr, pNewFont) (((METER *)pMtr)->pTitleFont = pNewFont)
```

Module

Meter (see page 210)

Input Parameters

Input Parameters	Description
pMtr	Pointer to the object.
pNewFont	Pointer to the new font used for the title.

Side Effects

none

Returns

N/A

Preconditions

Font must be created before this function is called.

Overview

This function sets the font of title.

Syntax

MtrSetTitleFont(pMtr, pNewFont) (((METER (see page 223)*)pMtr)->pTitleFont = pNewFont)

8.1.17.10 MtrSetValueFont Macro

File

Meter.h (see page 834)

C

```
#define MtrSetValueFont(pMtr, pNewFont) (((METER *)pMtr)->pValueFont = pNewFont)
```

Module

Meter (see page 210)

Input Parameters

Input Parameters	Description
pMtr	Pointer to the object.
pNewFont	Pointer to the new font used for the value.

Side Effects

none

Returns

N/A

Preconditions

Font must be created before this function is called.

Overview

This function sets the font of value.

Syntax

MtrSetValueFont(pMtr, pNewFont) (((METER (see page 223)*)pMtr)->pValueFont = pNewFont)

8.1.17.11 METER_TYPE Macro

File

Meter.h (see page 834)

C

```
#define METER_TYPE MTR_WHOLE_TYPE
```

Module

Meter (see page 210)

Overview

This is a compile time setting to select the type if meter shape. There are three types:

- MTR_WHOLE_TYPE - Meter (see page 210) drawn with 6 octants used.

- MTR_HALF_TYPE - Meter (see page 210) drawn with semi circle shape.
- MTR_QUARTER_TYPE - Meter (see page 210) drawn with quarter circle shape.

Set only one value at a time. This is done to save code space. User can define the colors of the arcs for each type. MTR_WHOLE_TYPE will use all the arc colors (arcColor1 - arcColor6) MTR_HALF_TYPE will use arc colors (arcColor5, arcColor4, arcColor3, arcColor2) MTR_QUARTER_TYPE will use arc colors (arcColor3, arcColor2) Set the meter type in Meter.h (see page 834) file and arc colors using MtrSetScaleColors (see page 218)(pMtr, arc1, arc2, arc3, arc4, arc5, arc6) macro.

8.1.17.12 METER_DISPLAY_VALUES_ENABLE Macro

File

Meter.h (see page 834)

C

```
#define METER_DISPLAY_VALUES_ENABLE
```

Module

Meter (see page 210)

Description

This enables the display of the values.

8.1.17.13 MTR_ACCURACY Macro

File

Meter.h (see page 834)

C

```
#define MTR_ACCURACY 0x0008        // Sets the meter accuracy to one decimal places
```

Module

Meter (see page 210)

Description

Sets the meter accuracy to one decimal places

8.1.17.14 RESOLUTION Macro

File

Meter.h (see page 834)

C

```
#define RESOLUTION 10              // Factor that the meter widget will divide minValue,
maxValue
```

Module

Meter (see page 210)

Description

Factor that the meter widget will divide minValue, maxValue

8.1.17.15 MtrMsgDefault Function

File

Meter.h (see page 834)

C

```
void MtrMsgDefault(
    WORD translatedMsg,
    void * pObj,
    GOL_MSG * pMsg
);
```

Module

Meter (see page 210)

Input Parameters

Input Parameters	Description
WORD translatedMsg	The translated message.
GOL_MSG * pMsg	The pointer to the GOL (see page 64) message.
pMtr	The pointer to the object whose state will be modified.

Side Effects

none

Returns

none

Preconditions

none

Overview

This function performs the actual state change based on the translated message given. Meter (see page 210) value is set based on parameter 2 of the message given. The following state changes are supported:

Translated Message	Input Source	Set/Clear State Bit	Description
MTR_MSG_SET	System	Set MTR_DRAW_UPDATE (see page 213)	Meter (see page 210) will be redrawn to update the needle position and value displayed.

Syntax

MtrMsgDefault(WORD translatedMsg, void *pObj, GOL_MSG (see page 330)* pMsg)

8.1.17.16 MtrTranslateMsg Function

File

Meter.h (see page 834)

C

```
WORD MtrTranslateMsg(
    void * pObj,
    GOL_MSG * pMsg
);
```

Module

Meter (see page 210)

Input Parameters

Input Parameters	Description
GOL_MSG * pMsg	Pointer to the message struct containing the message from the user interface.
pMtr	The pointer to the object where the message will be evaluated to check if the message will affect the object.

Side Effects

none

Returns

Returns the translated message depending on the received GOL (see page 64) message:

- MTR_MSG_SET - Meter (see page 210) ID is given in parameter 1 for a TYPE_SYSTEM message.
- OBJ_MSG_INVALID - Meter (see page 210) is not affected.

Preconditions

none

Overview

This function evaluates the message from a user if the message will affect the object or not. The table below enumerates the translated messages for each event of the touch screen and keyboard inputs.

Translated Message	Input Source	Events	Description
MTR_MSG_SET	System	EVENT_SET	If event set occurs and the meter ID is sent in parameter 1.
OBJ_MSG_INVALID	Any	Any	If the message did not affect the object.

Syntax

WORD MtrTranslateMsg(void *pObj, GOL_MSG (see page 330) *pMsg)

8.1.17.17 METER Structure

File

Meter.h (see page 834)

C

```
typedef struct {
  OBJ_HEADER hdr;
  XCHAR * pText;
  SHORT value;
  SHORT minValue;
  SHORT maxValue;
  SHORT xCenter;
  SHORT yCenter;
  SHORT radius;
  SHORT xPos;
  SHORT yPos;
  WORD arcColor6;
  WORD arcColor5;
  WORD arcColor4;
  WORD arcColor3;
  WORD arcColor2;
  WORD arcColor1;
```

```
    void * pTitleFont;
    void * pValueFont;
  } METER;
```

Members

Members	Description
OBJ_HEADER hdr;	Generic header for all Objects (see OBJ_HEADER (see page 68)).
XCHAR * pText;	The text label of the meter.
SHORT value;	Current value of the meter.
SHORT minValue;	minimum value the meter can display
SHORT maxValue;	maximum value the meter can display (range is maxValue - minValue)
SHORT xCenter;	The x coordinate center position. This is computed automatically.
SHORT yCenter;	The y coordinate center position. This is computed automatically.
SHORT radius;	Radius of the meter, also defines the needle length.
SHORT xPos;	The current x position of the needle. This is computed automatically.
SHORT yPos;	The current y position of the needle. This is computed automatically.
WORD arcColor6;	Arc (see page 375) 6 color parameter.
WORD arcColor5;	Arc (see page 375) 5 color parameter
WORD arcColor4;	Arc (see page 375) 4 color parameter
WORD arcColor3;	Arc (see page 375) 3 color parameter
WORD arcColor2;	Arc (see page 375) 2 color parameter
WORD arcColor1;	Arc (see page 375) 1 color parameter
void * pTitleFont;	Pointer to the font used in the title of the meter
void * pValueFont;	Pointer to the font used in the current reading (if displayed) of the meter

Module

Meter (see page 210)

Overview

Defines the parameters required for a meter Object. Depending on the type selected the meter is drawn with the defined shape parameters and values set on the given fields.

8.1.17.18 Files

8.1.18 Picture Control

Picture is an Object that can be used to transform a bitmap to be an Object in the screen and have control on the bitmap rendering. This object can be used to create animation using a series of bitmaps.

Functions

	Name	Description
◆	PictCreate (see page 226)	This function creates a PICTURE (see page 231) object with the parameters given. It automatically attaches the new object into a global linked list of objects and returns the address of the object.
◆	PictDraw (see page 227)	This function renders the object on the screen using the current parameter settings. Location of the object is determined by the left, top, right and bottom parameters. The colors used are dependent on the state of the object. When rendering objects of the same type, each object must be rendered completely before the rendering of the next object is started. This is to avoid incomplete object rendering.

	PictTranslateMsg (see page 230)	This function evaluates the message from a user if the message will affect the object or not. The table below enumerates the translated messages for each event accepted by the PICTURE (see page 231) Object.

Macros

Name	Description
PictSetBitmap (see page 228)	This macro sets the bitmap used in the object.
PictGetBitmap (see page 229)	This macro returns the pointer to the bitmap used in the object.
PictGetScale (see page 229)	This macro returns the current scale factor used to render the bitmap.
PictSetScale (see page 230)	This macro sets the scale factor used to render the bitmap used in the object.

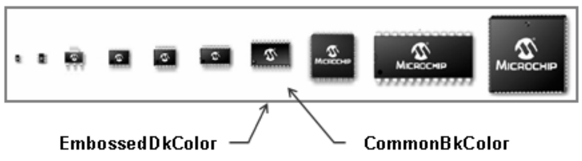
Structures

Name	Description
PICTURE (see page 231)	The structure contains data for picture control

Description

It supports only Keyboard inputs, replying to any touch screen events with the message: PICT_MSG_SELECTED.

The Picture Object is rendered using the assigned style scheme. The following figure illustrates the color assignments.



8.1.18.1 Picture States

Macros

Name	Description
PICT_DISABLED (see page 225)	Bit to indicate Picture (see page 224) is in a disabled state.
PICT_DRAW (see page 226)	Bit to indicate Picture (see page 224) will be redrawn.
PICT_FRAME (see page 226)	Bit to indicate Picture (see page 224) has a frame.
PICT_HIDE (see page 226)	Bit to indicate Picture (see page 224) must be hidden.

Module

Picture Control (see page 224)

Description

List of Picture (see page 224) Control bit states.

8.1.18.1.1 PICT_DISABLED Macro

File

Picture.h (see page 846)

C

```
#define PICT_DISABLED 0x0002  // Bit to indicate Picture is in a disabled state.
```

Description

Bit to indicate Picture (see page 224) is in a disabled state.

8.1.18.1.2 PICT_DRAW Macro

File

Picture.h (see page 846)

C

```
#define PICT_DRAW 0x4000  // Bit to indicate Picture will be redrawn.
```

Description

Bit to indicate Picture (see page 224) will be redrawn.

8.1.18.1.3 PICT_FRAME Macro

File

Picture.h (see page 846)

C

```
#define PICT_FRAME 0x0004  // Bit to indicate Picture has a frame.
```

Description

Bit to indicate Picture (see page 224) has a frame.

8.1.18.1.4 PICT_HIDE Macro

File

Picture.h (see page 846)

C

```
#define PICT_HIDE 0x8000  // Bit to indicate Picture must be hidden.
```

Description

Bit to indicate Picture (see page 224) must be hidden.

8.1.18.2 PictCreate Function

File

Picture.h (see page 846)

C

```
PICTURE * PictCreate(
    WORD ID,
    SHORT left,
    SHORT top,
    SHORT right,
    SHORT bottom,
    WORD state,
    char scale,
    void * pBitmap,
    GOL_SCHEME * pScheme
);
```

Module

Picture Control (see page 224)

Input Parameters

Input Parameters	Description
WORD ID	Unique user defined ID for the object instance.
SHORT left	Left most position of the Object.
SHORT top	Top most position of the Object.
SHORT right	Right most position of the Object.
SHORT bottom	Bottom most position of the object.
WORD state	Sets the initial state of the object.
char scale	Sets the scale factor used to render the bitmap.
void * pBitmap	Pointer to the bitmap that will be used.
GOL_SCHEME * pScheme	Pointer to the style scheme
radius	Radius of the rounded edge.

Side Effects

none

Returns

Returns the pointer to the object created

Preconditions

none

Overview

This function creates a PICTURE (see page 231) object with the parameters given. It automatically attaches the new object into a global linked list of objects and returns the address of the object.

Syntax

PICTURE (see page 231) *PictCreate(WORD ID, SHORT left, SHORT top, SHORT right, SHORT bottom, WORD state, char scale, void *pBitmap, GOL_SCHEME (see page 345) *pScheme)

8.1.18.3 PictDraw Function

File

Picture.h (see page 846)

C

```
WORD PictDraw(
    void * pObj
);
```

Module

Picture Control (see page 224)

Input Parameters

Input Parameters	Description
pPict	Pointer to the object to be rendered.

Side Effects

none

Returns

Returns the status of the drawing

- 1 - If the rendering was completed and
- 0 - If the rendering is not yet finished.

Next call to the function will resume the rendering on the pending drawing state.

Preconditions

Object must be created before this function is called.

Overview

This function renders the object on the screen using the current parameter settings. Location of the object is determined by the left, top, right and bottom parameters. The colors used are dependent on the state of the object.

When rendering objects of the same type, each object must be rendered completely before the rendering of the next object is started. This is to avoid incomplete object rendering.

Syntax

WORD PictDraw(void *pObj)

8.1.18.4 PictSetBitmap Macro

File

Picture.h (see page 846)

C

```
#define PictSetBitmap(pPict, pBtmap) ((PICTURE*)pPict)->pBitmap = pBtmap
```

Module

Picture Control (see page 224)

Input Parameters

Input Parameters	Description
pPict	Pointer to the object
pBtMap	Pointer to the bitmap to be used

Side Effects

none

Returns

none

Preconditions

none

Overview

This macro sets the bitmap used in the object.

Syntax

PictSetBitmap(pPict,pBtMap)

8.1.18.5 PictGetBitmap Macro

File

Picture.h (see page 846)

C

```
#define PictGetBitmap(pPict) ((PICTURE*)pPict)->pBitmap
```

Module

Picture Control (see page 224)

Input Parameters

Input Parameters	Description
pPict	Pointer to the object

Side Effects

none

Returns

Returns the pointer to the bitmap used.

Preconditions

none

Overview

This macro returns the pointer to the bitmap used in the object.

Syntax

PictGetBitmap(pPict)

8.1.18.6 PictGetScale Macro

File

Picture.h (see page 846)

C

```
#define PictGetScale(pPict) pPict->scale
```

Module

Picture Control (see page 224)

Input Parameters

Input Parameters	Description
pPict	Pointer to the object

Side Effects

none

Returns

Returns the current scale factor used to display the bitmap.

Preconditions

none

Overview

This macro returns the current scale factor used to render the bitmap.

Syntax

PictGetScale(pPict,scl)

8.1.18.7 PictSetScale Macro

File

Picture.h (see page 846)

C

```
#define PictSetScale(pPict, scl) pPict->scale = scl
```

Module

Picture Control (see page 224)

Input Parameters

Input Parameters	Description
pPict	Pointer to the object
scl	The scale factor that will be used to display the bitmap.

Side Effects

none

Returns

none

Preconditions

none

Overview

This macro sets the scale factor used to render the bitmap used in the object.

Syntax

PictSetScale(pPict,scl)

8.1.18.8 PictTranslateMsg Function

File

Picture.h (see page 846)

C

```
WORD PictTranslateMsg(
    void * pObj,
    GOL_MSG * pMsg
);
```

Module

Picture Control (see page 224)

Input Parameters

Input Parameters	Description
GOL_MSG * pMsg	Pointer to the message struct containing the message from the user interface.

pPict	The pointer to the object where the message will be evaluated to check if the message will affect the object.

Side Effects

none

Returns

Returns the translated message depending on the received GOL (see page 64) message:

- PICT_MSG_SELECTED – Picture (see page 224) is touched.
- OBJ_MSG_INVALID – Picture (see page 224) is not affected

Preconditions

none

Overview

This function evaluates the message from a user if the message will affect the object or not. The table below enumerates the translated messages for each event accepted by the PICTURE (see page 231) Object.

Translated Message	Input Source	Events	Description
PICT_MSG_SELECTED	Touch Screen	EVENT_PRESS, EVENT_RELEASE, EVENT_MOVE	If events occurs and the x,y position falls in the area of the picture.
OBJ_MSG_INVALID	Any	Any	If the message did not affect the object.

Syntax

WORD PictTranslateMsg(void *pObj, GOL_MSG (see page 330) *pMsg)

8.1.18.9 PICTURE Structure

File

Picture.h (see page 846)

C

```
typedef struct {
  OBJ_HEADER hdr;
  char scale;
  void * pBitmap;
} PICTURE;
```

Members

Members	Description
OBJ_HEADER hdr;	Generic header for all Objects (see OBJ_HEADER (see page 68)).
char scale;	Scale factor for the bitmap
void * pBitmap;	Pointer to the bitmap

Module

Picture Control (see page 224)

Overview

The structure contains data for picture control

8.1.19 Progress Bar

Progress Bar (see page 371) is an Object that can be used to display the progress of a task such as a file download or transfer.

Functions

	Name	Description
	PbCreate (see page 234)	This function creates a PROGRESSBAR (see page 240) object with the parameters given. It automatically attaches the new object into a global linked list of objects and returns the address of the object.
	PbDraw (see page 235)	This function renders the object on the screen using the current parameter settings. Location of the object is determined by the left, top, right and bottom parameters. The colors used are dependent on the state of the object. The font used is determined by the style scheme set. When rendering objects of the same type, each object must be rendered completely before the rendering of the next object is started. This is to avoid incomplete object rendering.
	PbSetRange (see page 236)	This function sets the range of the progress bar. Calling this function also resets the position equal to the new range value.
	PbSetPos (see page 237)	This function sets the position of the progress bar. Position should be in the given range inclusive.
	PbTranslateMsg (see page 239)	This function evaluates the message from a user if the message will affect the object or not. The table below enumerates the translated messages for each event of the touch screen inputs.

Macros

Name	Description
PbGetRange (see page 237)	This macro returns the current range of the progress bar.
PbGetPos (see page 238)	This macro returns the current progress bar position.

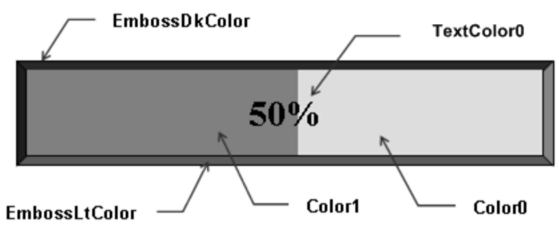
Structures

Name	Description
PROGRESSBAR (see page 240)	The structure contains data for the progress bar

Description

Progress Bar (see page 371) supports only Touchscreen inputs, replying to their events with the message: PB_MSG_SELECTED.

The Progress Bar (see page 371) Object is rendered using the assigned style scheme. The following figure illustrates the color assignments.



CommonBkColor – used to hide/remove the progress bar from the screen.

8.1.19.1 Progress Bar States

Macros

Name	Description
PB_DISABLED (see page 233)	Bit to indicate Progress Bar (see page 371) is in a disabled state.
PB_DRAW (see page 233)	Bit to indicate Progress Bar (see page 371) must be redrawn.
PB_DRAW_BAR (see page 234)	Bit to indicate Progress Bar (see page 371) must be redrawn.
PB_HIDE (see page 234)	Bit to indicate Progress Bar (see page 371) must be hidden.
PB_VERTICAL (see page 234)	Bit for orientation (0 - horizontal, 1 - vertical)

Module

Progress Bar (see page 232)

Description

List of Progress Bar (see page 232) bit states.

8.1.19.1.1 PB_DISABLED Macro

File

ProgressBar.h (see page 856)

C

```
#define PB_DISABLED 0x0002  // Bit to indicate Progress Bar is in a disabled state.
```

Description

Bit to indicate Progress Bar (see page 371) is in a disabled state.

8.1.19.1.2 PB_DRAW Macro

File

ProgressBar.h (see page 856)

C

```
#define PB_DRAW 0x4000  // Bit to indicate Progress Bar must be redrawn.
```

Description

Bit to indicate Progress Bar (see page 371) must be redrawn.

8.1.19.1.3 PB_DRAW_BAR Macro

File

ProgressBar.h (see page 856)

C

```
#define PB_DRAW_BAR 0x2000  // Bit to indicate Progress Bar must be redrawn.
```

Description

Bit to indicate Progress Bar (see page 371) must be redrawn.

8.1.19.1.4 PB_HIDE Macro

File

ProgressBar.h (see page 856)

C

```
#define PB_HIDE 0x8000  // Bit to indicate Progress Bar must be hidden.
```

Description

Bit to indicate Progress Bar (see page 371) must be hidden.

8.1.19.1.5 PB_VERTICAL Macro

File

ProgressBar.h (see page 856)

C

```
#define PB_VERTICAL 0x0004  // Bit for orientation  (0 - horizontal, 1 - vertical)
```

Description

Bit for orientation (0 - horizontal, 1 - vertical)

8.1.19.2 PbCreate Function

File

ProgressBar.h (see page 856)

C

```
PROGRESSBAR * PbCreate(
    WORD ID,
    SHORT left,
    SHORT top,
    SHORT right,
    SHORT bottom,
    WORD state,
    WORD pos,
    WORD range,
    GOL_SCHEME * pScheme
);
```

Module

Progress Bar (see page 232)

Input Parameters

Input Parameters	Description
WORD ID	Unique user defined ID for the object instance.
SHORT left	Left most position of the Object.
SHORT top	Top most position of the Object.
SHORT right	Right most position of the Object.
SHORT bottom	Bottom most position of the Object.
WORD state	Sets the initial state of the Object.
WORD pos	Defines the initial position of the progress.
WORD range	This specifies the maximum value of the progress bar when the progress bar is at 100% position.
GOL_SCHEME * pScheme	Pointer to the style scheme used for the object. Set to NULL if default style scheme is used.

Side Effects

none

Returns

Returns the pointer to the object created

Preconditions

none

Example

```
PROGRESSBAR *pPBar;
void CreateProgressBar(){
    pPBar = PbCreate(ID_PROGRESSBAR1,     // ID
                     50,90,270,140,       // dimension
                     PB_DRAW,             // Draw the object
                     25,                  // position
                     50,                  // set the range
                     NULL);               // use default GOL scheme
    while(!PbDraw(pPBar));
}
```

Overview

This function creates a PROGRESSBAR (see page 240) object with the parameters given. It automatically attaches the new object into a global linked list of objects and returns the address of the object.

Syntax

PROGRESSBAR (see page 240) *PbCreate(WORD ID, SHORT left, SHORT top, SHORT right, SHORT bottom, WORD state, WORD pos, WORD range, GOL_SCHEME (see page 345) *pScheme)

8.1.19.3 PbDraw Function

File

ProgressBar.h (see page 856)

C

```
WORD PbDraw(
    void * pObj
);
```

Module

Progress Bar (see page 232)

Input Parameters

Input Parameters	Description
pPb	Pointer to the object to be rendered.

Side Effects

none

Returns

Returns the status of the drawing

- 1 - If the rendering was completed and
- 0 - If the rendering is not yet finished.

Next call to the function will resume the rendering on the pending drawing state.

Preconditions

Object must be created before this function is called.

Example

See PbCreate (see page 234)() example.

Overview

This function renders the object on the screen using the current parameter settings. Location of the object is determined by the left, top, right and bottom parameters. The colors used are dependent on the state of the object. The font used is determined by the style scheme set.

When rendering objects of the same type, each object must be rendered completely before the rendering of the next object is started. This is to avoid incomplete object rendering.

Syntax

WORD PbDraw(void *pObj)

8.1.19.4 PbSetRange Function

File

ProgressBar.h (see page 856)

C

```
void PbSetRange(
    PROGRESSBAR * pPb,
    WORD range
);
```

Module

Progress Bar (see page 232)

Input Parameters

Input Parameters	Description
PROGRESSBAR * pPb	Pointer to the object

Side Effects

Sets the position equal to the new range.

Returns

none.

Preconditions

none

Overview

This function sets the range of the progress bar. Calling this function also resets the position equal to the new range value.

Syntax

PbSetRange(PROGRESSBAR (see page 240) *pPb, WORD range)

8.1.19.5 PbGetRange Macro

File

ProgressBar.h (see page 856)

C

```
#define PbGetRange(pPb) (pPb->range)
```

Module

Progress Bar (see page 232)

Input Parameters

Input Parameters	Description
pPb	Pointer to the object

Side Effects

none

Returns

Returns the range value.

Preconditions

none

Overview

This macro returns the current range of the progress bar.

Syntax

PbGetRange(pPb)

8.1.19.6 PbSetPos Function

File

ProgressBar.h (see page 856)

C

```
void PbSetPos(
    PROGRESSBAR * pPb,
    WORD position
);
```

Module

Progress Bar (see page 232)

Input Parameters

Input Parameters	Description
PROGRESSBAR * pPb	Pointer to the object
WORD position	New position.

Side Effects

none

Returns

none

Preconditions

none

Example

```
PROGRESSBAR *pPb;
BYTE  direction = 1;

    // this code increments and decrements the progress bar by 1
    // assume progress bar was created and initialized before
    while (1) {
        if(direction) {
            if(pPb ->pos == pPb ->range)
                direction = 0;
            else
                PbSetPos(pPb,PbGetPos(pPb)+1);
        } else {
            if(pPb ->pos == 0)
                direction = 1;
            else
                PbSetPos(pPb,PbGetPos(pPb)-1);
        }
    }
```

Overview

This function sets the position of the progress bar. Position should be in the given range inclusive.

Syntax

void PbSetPos(PROGRESSBAR (see page 240) *pPb, WORD position)

8.1.19.7 PbGetPos Macro

File

ProgressBar.h (see page 856)

C

```
#define PbGetPos(pPb) pPb->pos
```

Module

Progress Bar (see page 232)

Input Parameters

Input Parameters	Description
pPb	Pointer to the object

Side Effects

none

Returns

Returns the progress bar position.

Preconditions

none

Example

See PbSetPos (see page 237)() exmaple.

Overview

This macro returns the current progress bar position.

Syntax

PbGetPos(pPb)

8.1.19.8 PbTranslateMsg Function

File

ProgressBar.h (see page 856)

C

```
WORD PbTranslateMsg(
    PROGRESSBAR * pPb,
    GOL_MSG * pMsg
);
```

Module

Progress Bar (see page 232)

Input Parameters

Input Parameters	Description
PROGRESSBAR * pPb	The pointer to the object where the message will be evaluated to check if the message will affect the object.
GOL_MSG * pMsg	Pointer to the message struct containing the message from the user interface.

Side Effects

none

Returns

Returns the translated message depending on the received GOL (see page 64) message:

- PB_MSG_SELECTED – Progress Bar (see page 371) is selected.
- OBJ_MSG_INVALID – Progress Bar (see page 371) is not affected

Preconditions

none

Example

Usage is similar to BtnTranslateMsg (see page 90)() example.

Overview

This function evaluates the message from a user if the message will affect the object or not. The table below enumerates the translated messages for each event of the touch screen inputs.

Translated Message	Input Source	Events	Description
PB_MSG_SELECTED	Touch Screen	EVENT_PRESS, EVENT_RELEASE, EVENT_MOVE	If events occurs and the x,y position falls in the area of the progress bar.
OBJ_MSG_INVALID	Any	Any	If the message did not affect the object.

Syntax

WORD PbTranslateMsg(PROGRESSBAR (see page 240) *pPb, GOL_MSG (see page 330) *pMsg)

8.1.19.9 PROGRESSBAR Structure

File

ProgressBar.h (see page 856)

C

```
typedef struct {
  OBJ_HEADER hdr;
  WORD pos;
  WORD prevPos;
  WORD range;
} PROGRESSBAR;
```

Members

Members	Description
OBJ_HEADER hdr;	Generic header for all Objects (see OBJ_HEADER (see page 68)).
WORD pos;	Current progress position.
WORD prevPos;	Previous progress position.
WORD range;	Sets the range of the object.

Module

Progress Bar (see page 232)

Overview

The structure contains data for the progress bar

8.1.20 Radio Button

Radio Button (see page 78) is an Object that can be used to offer set of choices to the user. Only one of the choices is selectable. Changing selection automatically removes the selection on the previous option.

Functions

	Name	Description
◆	RbCreate (see page 244)	This function creates a RADIOBUTTON (see page 251) object with the parameters given. It automatically attaches the new object into a global linked list of objects and returns the address of the object.

◆	RbDraw (see page 245)	This function renders the object on the screen using the current parameter settings. Location of the object is determined by the left, top, right and bottom parameters. The colors used are dependent on the state of the object. The font used is determined by the style scheme set. When rendering objects of the same type, each object must be rendered completely before the rendering of the next object is started. This is to avoid incomplete object rendering.
◆	RbGetCheck (see page 246)	This function returns the ID of the currently checked Radio Button (see page 78) in the group.
◆	RbSetCheck (see page 247)	This function sets the Radio Button (see page 78) with the given ID to its checked state.
◆	RbSetText (see page 248)	This function sets the string used for the object.
◆	RbMsgDefault (see page 249)	This function performs the actual state change based on the translated message given. The following state changes are supported:
◆	RbTranslateMsg (see page 250)	This function evaluates the message from a user if the message will affect the object or not. The table below enumerates the translated messages for each event of the touch screen and keyboard inputs.

Macros

Name	Description
RbGetText (see page 247)	This macro returns the address of the current text string used for the object.

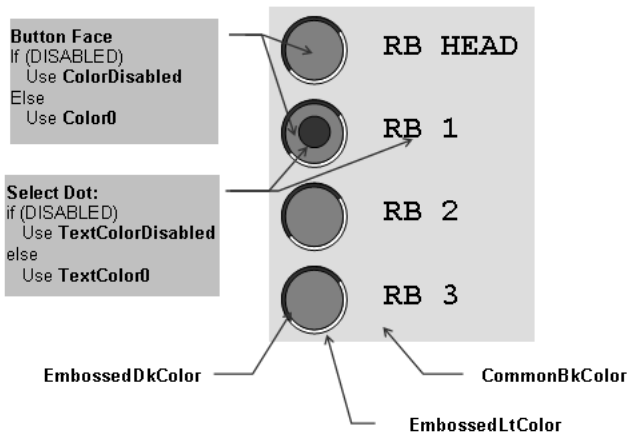
Structures

Name	Description
RADIOBUTTON (see page 251)	the structure contains data for the Radio Button (see page 78)

Description

Radio Button (see page 78) supports both Keyboard and Touchscreen inputs, replying to their events with the message: RB_MSG_CHECKED.

The Radio Button (see page 78) Object is rendered using the assigned style scheme. The following figure illustrates the color assignments.



8.1.20.1 Radio Button States

Macros

Name	Description
RB_CHECKED (⧉ see page 242)	Bit to indicate Radio Button (⧉ see page 78) is checked.
RB_DISABLED (⧉ see page 242)	Bit for disabled state.
RB_DRAW (⧉ see page 242)	Bit to indicate whole Radio Button (⧉ see page 78) must be redrawn.
RB_DRAW_CHECK (⧉ see page 243)	Bit to indicate check mark should be redrawn.
RB_DRAW_FOCUS (⧉ see page 243)	Bit to indicate focus must be redrawn.
RB_FOCUSED (⧉ see page 243)	Bit for focused state.
RB_GROUP (⧉ see page 243)	Bit to indicate the first Radio Button (⧉ see page 78) in the group.
RB_HIDE (⧉ see page 243)	Bit to indicate that button must be removed from screen.

Module

Radio Button (⧉ see page 240)

Description

List of Radio Button (⧉ see page 240) bit states.

8.1.20.1.1 RB_CHECKED Macro

File

RadioButton.h (⧉ see page 882)

C

```
#define RB_CHECKED 0x0004  // Bit to indicate Radio Button is checked.
```

Description

Bit to indicate Radio Button (⧉ see page 78) is checked.

8.1.20.1.2 RB_DISABLED Macro

File

RadioButton.h (⧉ see page 882)

C

```
#define RB_DISABLED 0x0002  // Bit for disabled state.
```

Description

Bit for disabled state.

8.1.20.1.3 RB_DRAW Macro

File

RadioButton.h (⧉ see page 882)

C

```
#define RB_DRAW 0x4000  // Bit to indicate whole Radio Button must be redrawn.
```

Description

Bit to indicate whole Radio Button (⧉ see page 78) must be redrawn.

8.1.20.1.4 RB_DRAW_CHECK Macro

File

RadioButton.h (see page 882)

C

```
#define RB_DRAW_CHECK 0x1000  // Bit to indicate check mark should be redrawn.
```

Description

Bit to indicate check mark should be redrawn.

8.1.20.1.5 RB_DRAW_FOCUS Macro

File

RadioButton.h (see page 882)

C

```
#define RB_DRAW_FOCUS 0x2000  // Bit to indicate focus must be redrawn.
```

Description

Bit to indicate focus must be redrawn.

8.1.20.1.6 RB_FOCUSED Macro

File

RadioButton.h (see page 882)

C

```
#define RB_FOCUSED 0x0001  // Bit for focused state.
```

Description

Bit for focused state.

8.1.20.1.7 RB_GROUP Macro

File

RadioButton.h (see page 882)

C

```
#define RB_GROUP 0x0008  // Bit to indicate the first Radio Button in the group.
```

Description

Bit to indicate the first Radio Button (see page 78) in the group.

8.1.20.1.8 RB_HIDE Macro

File

RadioButton.h (see page 882)

C

```
#define RB_HIDE 0x8000  // Bit to indicate that button must be removed from screen.
```

Description

Bit to indicate that button must be removed from screen.

8.1.20.2 RbCreate Function

File

RadioButton.h (see page 882)

C

```
RADIOBUTTON * RbCreate(
    WORD ID,
    SHORT left,
    SHORT top,
    SHORT right,
    SHORT bottom,
    WORD state,
    XCHAR * pText,
    GOL_SCHEME * pScheme
);
```

Module

Radio Button (see page 240)

Input Parameters

Input Parameters	Description
WORD ID	Unique user defined ID for the object instance.
SHORT left	Left most position of the Object.
SHORT top	Top most position of the Object.
SHORT right	Right most position of the Object
SHORT bottom	Bottom most position of the object
WORD state	Sets the initial state of the object pText – The pointer to the text used for the Radio Button (see page 78).
GOL_SCHEME * pScheme	Pointer to the style scheme used.

Side Effects

none

Returns

Returns the pointer to the object created

Preconditions

none

Example

```
GOL_SCHEME *pScheme;
RADIOBUTTON *pRb[3];

    pScheme = GOLCreateScheme();
    pRb[0] = RbCreate(ID_RADIOBUTTON1,              // ID
                      255,40,310,80,                // dimension
                      RB_DRAW|RB_GROUP|RB_CHECKED,  // will be dislayed and
                                                    // focused after creation
                                                    // first button in the group
                      "RB1",                        // text
                      pScheme);                     // scheme used

    pRb[1] = RbCreate(ID_RADIOBUTTON2,              // ID
                      255,85,310,125,               // dimension
                      RB_DRAW,                      // will be dislayed and
                                                    // checked after creation
                      "RB2",                        // text
                      pScheme);                     // scheme used

    pRb[2] = RbCreate(ID_RADIOBUTTON3,              // ID
                      255,130,310,170,              // dimension
                      RB_DRAW,                      // will be dislayed and
                                                    // disabled after creation
                      "RB3",                        // text
                      pScheme);                     // scheme used

    while(!RbDraw(pRb[0]));                               // draw the objects
    while(!RbDraw(pRb[1]));
    while(!RbDraw(pRb[2]));
```

Overview

This function creates a RADIOBUTTON (see page 251) object with the parameters given. It automatically attaches the new object into a global linked list of objects and returns the address of the object.

Syntax

RADIOBUTTON (see page 251) *RbCreate(WORD ID, SHORT left, SHORT top, SHORT right, SHORT bottom, WORD state, XCHAR (see page 361) *pText, GOL_SCHEME (see page 345) *pScheme)

8.1.20.3 RbDraw Function

File

RadioButton.h (see page 882)

C

```
WORD RbDraw(
    void * pObj
);
```

Module

Radio Button (see page 240)

Input Parameters

Input Parameters	Description
pB	Pointer to the object to be rendered.

Side Effects

none

Returns

Returns the status of the drawing

- 1 - If the rendering was completed and
- 0 - If the rendering is not yet finished.

Next call to the function will resume the rendering on the pending drawing state.

Preconditions

Object must be created before this function is called.

Example

See RbCreate (see page 244)() example.

Overview

This function renders the object on the screen using the current parameter settings. Location of the object is determined by the left, top, right and bottom parameters. The colors used are dependent on the state of the object. The font used is determined by the style scheme set.

When rendering objects of the same type, each object must be rendered completely before the rendering of the next object is started. This is to avoid incomplete object rendering.

Syntax

WORD RbDraw(void *pObj)

8.1.20.4 RbGetCheck Function

File

RadioButton.h (see page 882)

C

```
WORD RbGetCheck(
    RADIOBUTTON * pRb
);
```

Module

Radio Button (see page 240)

Input Parameters

Input Parameters	Description
RADIOBUTTON * pRb	Pointer to the Radio Button (see page 78) in the group.

Side Effects

none

Returns

Returns the ID of the selected button in the group. It returns -1 if there is no object checked.

Preconditions

none

Example

```
GOL_SCHEME *pScheme;
RADIOBUTTON *pRb[3];
SHORT ID;

    pScheme = GOLCreateScheme();
    pRb[0] = RbCreate(ID_RADIOBUTTON1,            // ID
                      255,40,310,80,              // dimension
                      RB_DRAW|RB_GROUP|RB_CHECKED,  // will be dislayed and
                                                  // focused after creation
                                                  // first button in the group
                      "RB1",                      // text
                      pScheme);                   // scheme used

    pRb[1] = RbCreate(ID_RADIOBUTTON2,            // ID
                      255,85,310,125,             // dimension
                      RB_DRAW,                    // will be dislayed and
                                                  // checked after creation
                      "RB2",                      // text
                      pScheme);                   // scheme used

    pRb[2] = RbCreate(ID_RADIOBUTTON3,            // ID
                      255,130,310,170,            // dimension
                      RB_DRAW,                    // will be dislayed and
                                                  // disabled after creation
                      "RB3",                      // text
                      pScheme);                   // scheme used

    // draw the Radio Buttons here

    ID = RbGetCheck(pRb[2]);                      // can also use pRb[1] or
                                                  // pRb[0] to search the
                                                  // checked radio button of the
```

```
                                                              // group. ID here should
                                                              // be ID_RADIOBUTTON1
      if (ID == ID_RADIOBUTTON1) {
          // do something here then clear the check
          ClrState(pRb[0], RB_CHECKED);
          // Change the checked object. Pointer used is any of the three.
          // the ID used will find the correct object to be checked
          RbSetCheck(pRb[3], ID_RADIOBUTTON2);
      }
```

Overview

This function returns the ID of the currently checked Radio Button (see page 78) in the group.

Syntax

WORD RbGetCheck(RADIOBUTTON (see page 251) *pRb)

8.1.20.5 RbSetCheck Function

File

RadioButton.h (see page 882)

C

```
void RbSetCheck(
    RADIOBUTTON * pRb,
    WORD ID
);
```

Module

Radio Button (see page 240)

Input Parameters

Input Parameters	Description
RADIOBUTTON * pRb	Pointer to the Radio Button (see page 78) in the group.
WORD ID	ID of the object to be checked.

Side Effects

none

Returns

none

Preconditions

none

Example

See RbGetCheck (see page 246)() example.

Overview

This function sets the Radio Button (see page 78) with the given ID to its checked state.

Syntax

void RbSetCheck(RADIOBUTTON (see page 251) *pRb, WORD ID)

8.1.20.6 RbGetText Macro

File

RadioButton.h (see page 882)

C

```
#define RbGetText(pRb) pRb->pText
```

Module

Radio Button (see page 240)

Input Parameters

Input Parameters	Description
pRb	Pointer to the object

Side Effects

none

Returns

Returns pointer to the text string being used.

Preconditions

none

Overview

This macro returns the address of the current text string used for the object.

Syntax

RbGetText(pRb)

8.1.20.7 RbSetText Function

File

RadioButton.h (see page 882)

C

```
void RbSetText(
    RADIOBUTTON * pRb,
    XCHAR * pText
);
```

Module

Radio Button (see page 240)

Input Parameters

Input Parameters	Description
RADIOBUTTON * pRb	The pointer to the object whose text will be modified
XCHAR * pText	Pointer to the text that will be used

Side Effects

none

Returns

none

Preconditions

none

Overview

This function sets the string used for the object.

Syntax

RbSetText(RADIOBUTTON (see page 251) *pRb, XCHAR (see page 361) *pText)

8.1.20.8 RbMsgDefault Function

File

RadioButton.h (see page 882)

C

```
void RbMsgDefault(
    WORD translatedMsg,
    void * pObj,
    GOL_MSG * pMsg
);
```

Module

Radio Button (see page 240)

Input Parameters

Input Parameters	Description
WORD translatedMsg	The translated message
GOL_MSG * pMsg	The pointer to the GOL (see page 64) message
pRb	The pointer to the object whose state will be modified

Side Effects

none

Returns

none

Preconditions

none

Example

See BtnTranslateMsg (see page 90)() example.

Overview

This function performs the actual state change based on the translated message given. The following state changes are supported:

Translated Message	Input Source	Set/Clear State Bit	Description
RB_MSG_CHECKED	Touch Screen,	Set RB_DRAW (see page 242),	Depending on the current value of RB_CHECKED (see page 242) Check Box will be redrawn.
	Keyboard	Set/Clear RB_CHECKED (see page 242)	

Syntax

RbMsgDefault(WORD translatedMsg, void *pObj, GOL_MSG (see page 330)* pMsg)

8.1.20.9 RbTranslateMsg Function

File

RadioButton.h (see page 882)

C

```
WORD RbTranslateMsg(
    void * pObj,
    GOL_MSG * pMsg
);
```

Module

Radio Button (see page 240)

Input Parameters

Input Parameters	Description
GOL_MSG * pMsg	Pointer to the message struct containing the message from the user interface.
pRb	The pointer to the object where the message will be evaluated to check if the message will affect the object.

Side Effects

none

Returns

Returns the translated message depending on the received GOL (see page 64) message:

- RB_MSG_CHECKED – Radio Button (see page 78) is checked
- OBJ_MSG_INVALID – Radio Button (see page 78) is not affected

Preconditions

none

Example

Usage is similar to BtnTranslateMsg (see page 90)() example.

Overview

This function evaluates the message from a user if the message will affect the object or not. The table below enumerates the translated messages for each event of the touch screen and keyboard inputs.

Translated Message	Input Source	Events	Description
RB_MSG_CHECKED	Touch Screen	EVENT_PRESS	If event occurs and the x,y position falls in the area of the Radio Button (see page 78) while the Radio Button (see page 78) is not checked.
	Keyboard	EVENT_KEYSCAN	If event occurs and parameter1 passed matches the object's ID and parameter 2 passed matches SCAN_CR_PRESSED (see page 335) or SCAN_SPACE_PRESSED (see page 339) while the Radio Button (see page 78) is not checked.
OBJ_MSG_INVALID	Any	Any	If the message did not affect the object.

Syntax

WORD RbTranslateMsg(void *pObj, GOL_MSG (see page 330) *pMsg)

8.1.20.10 RADIOBUTTON Structure

File

RadioButton.h (see page 882)

C

```
typedef struct {
  OBJ_HEADER hdr;
  OBJ_HEADER * pHead;
  OBJ_HEADER * pNext;
  SHORT textHeight;
  XCHAR * pText;
} RADIOBUTTON;
```

Members

Members	Description
OBJ_HEADER hdr;	Generic header for all Objects (see OBJ_HEADER (see page 68)).
OBJ_HEADER * pHead;	Pointer to the first Radio Button (see page 78) in the group
OBJ_HEADER * pNext;	Pointer to the next Radio Button (see page 78) in the group
SHORT textHeight;	Pre-computed text height
XCHAR * pText;	Pointer to the text

Module

Radio Button (see page 240)

Overview

the structure contains data for the Radio Button (see page 78)

8.1.21 Slider/Scroll Bar

Slider or Scrollbar is an Object that can be used to display a value or scrolling location in a predefined area.

Functions

	Name	Description
	SldCreate (see page 255)	This function creates a SLIDER (see page 266) object with the parameters given. Depending on the SLD_SCROLLBAR (see page 255) state bit slider or scrollbar mode is set. If SLD_SCROLLBAR (see page 255) is set, mode is scrollbar; if not set mode is slider. It automatically attaches the new object into a global linked list of objects and returns the address of the object.
	SldDraw (see page 257)	This function renders the object on the screen using the current parameter settings. Location of the object is determined by the left, top, right and bottom parameters. The colors used are dependent on the state of the object. When rendering objects of the same type, each object must be rendered completely before the rendering of the next object is started. This is to avoid incomplete object rendering.
	SldSetPage (see page 258)	This sets the page size of the object. Page size defines the delta change of the thumb position when incremented via SldIncPos (see page 262)() or decremented via SldDecPos (see page 263)(). Page size minimum value is 1. Maximum value is range/2.
	SldSetPos (see page 259)	This function sets the position of the slider thumb. Value should be in the set range inclusive. Object must be redrawn to reflect the change.
	SldSetRange (see page 261)	This sets the range of the thumb. If this field is changed Object must be completely redrawn to reflect the change.

	SldMsgDefault (see page 264)	This function performs the actual state change based on the translated message given. The following state changes are supported:
	SldTranslateMsg (see page 265)	This function evaluates the message from a user if the message will affect the object or not. The table below enumerates the translated messages for each event of the touch screen and keyboard inputs.

Macros

Name	Description
SldGetPage (see page 258)	Returns returns the current slider thumb position. Value is always in the 1 to range/2 inclusive.
SldGetPos (see page 260)	Returns returns the current position of the slider thumb.
SldGetRange (see page 261)	Returns the current slider page. Value is always in the 1-range/2 inclusive for both slider and scrollbar type.
SldIncPos (see page 262)	This macro increment the slider position by the delta change (page) value set. Object must be redrawn after this function is called to reflect the changes to the object.
SldDecPos (see page 263)	This macro decrement the slider position by the delta change (page) value set. Object must be redrawn after this function is called to reflect the changes to the object.

Structures

Name	Description
SLIDER (see page 266)	Defines the parameters required for a slider/scrollbar Object. Depending on the SLD_SCROLLBAR (see page 255) state bit slider or scrollbar mode is set. If SLD_SCROLLBAR (see page 255) is set, mode is scrollbar; if not set mode is slider. For scrollbar mode, focus rectangle is not drawn.

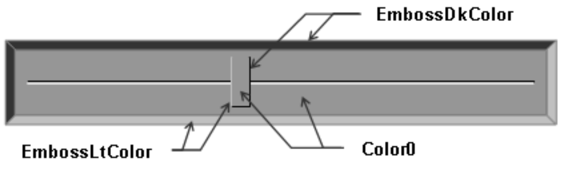
Description

Slider or Scrollbar supports both Keyboard and Touchscreen inputs, replying to their events with the following messages:

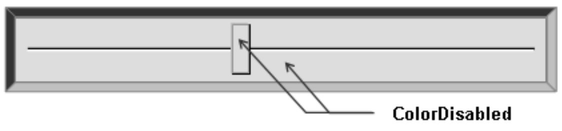
1. SLD_MSG_INC - when the thumb is to be incremented in position

2. SLD_MSG_DEC - when the thumb is to be decremented in position

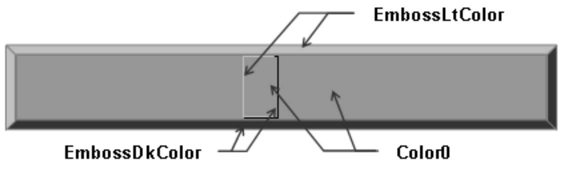
The Slider object is rendered using the assigned style scheme. The following figure illustrates the color assignments.



Slider Mode enabled state



Slider Mode disabled state



Scrollbar Mode enabled state

8.1.21.1 Slider States

Macros

Name	Description
SLD_DISABLED (↗ see page 253)	Bit for disabled state
SLD_DRAW (↗ see page 254)	Bit to indicate whole slider must be redrawn
SLD_DRAW_FOCUS (↗ see page 254)	Bit to indicate that only the focus will be redrawn
SLD_DRAW_THUMB (↗ see page 254)	Bit to indicate that only thumb area must be redrawn
SLD_FOCUSED (↗ see page 254)	Bit for focus state
SLD_HIDE (↗ see page 254)	Bit to remove object from screen
SLD_SCROLLBAR (↗ see page 255)	Bit for type usage (0 - Slider (↗ see page 251), 1 - ScrollBar)
SLD_VERTICAL (↗ see page 255)	Bit for orientation (0 - horizontal, 1 - vertical)

Module

Slider/Scroll Bar (↗ see page 251)

Description

List of Slider (↗ see page 251) bit states.

8.1.21.1.1 SLD_DISABLED Macro

File

Slider.h (↗ see page 902)

C

```
#define SLD_DISABLED 0x0002  // Bit for disabled state
```

Description

Bit for disabled state

8.1.21.1.2 SLD_DRAW Macro

File

Slider.h (see page 902)

C

```
#define SLD_DRAW 0x4000  // Bit to indicate whole slider must be redrawn
```

Description

Bit to indicate whole slider must be redrawn

8.1.21.1.3 SLD_DRAW_FOCUS Macro

File

Slider.h (see page 902)

C

```
#define SLD_DRAW_FOCUS 0x2000  // Bit to indicate that only the focus will be redrawn
```

Description

Bit to indicate that only the focus will be redrawn

8.1.21.1.4 SLD_DRAW_THUMB Macro

File

Slider.h (see page 902)

C

```
#define SLD_DRAW_THUMB 0x1000  // Bit to indicate that only thumb area must be redrawn
```

Description

Bit to indicate that only thumb area must be redrawn

8.1.21.1.5 SLD_FOCUSED Macro

File

Slider.h (see page 902)

C

```
#define SLD_FOCUSED 0x0001  // Bit for focus state
```

Description

Bit for focus state

8.1.21.1.6 SLD_HIDE Macro

File

Slider.h (see page 902)

C

```
#define SLD_HIDE 0x8000  // Bit to remove object from screen
```

Description

Bit to remove object from screen

8.1.21.1.7 SLD_SCROLLBAR Macro

File

Slider.h (see page 902)

C

```
#define SLD_SCROLLBAR 0x0010  // Bit for type usage (0 - Slider, 1 - ScrollBar)
```

Description

Bit for type usage (0 - Slider (see page 251), 1 - ScrollBar)

8.1.21.1.8 SLD_VERTICAL Macro

File

Slider.h (see page 902)

C

```
#define SLD_VERTICAL 0x0004  // Bit for orientation  (0 - horizontal, 1 - vertical)
```

Description

Bit for orientation (0 - horizontal, 1 - vertical)

8.1.21.2 SldCreate Function

File

Slider.h (see page 902)

C

```
SLIDER * SldCreate(
    WORD ID,
    SHORT left,
    SHORT top,
    SHORT right,
    SHORT bottom,
    WORD state,
    WORD range,
    WORD page,
    WORD pos,
    GOL_SCHEME * pScheme
);
```

Module

Slider/Scroll Bar (see page 251)

Input Parameters

Input Parameters	Description
WORD ID	Unique user defined ID for the object instance.
SHORT left	Left most position of the Object.
SHORT top	Top most position of the Object.
SHORT right	Right most position of the Object.
SHORT bottom	Bottom most position of the Object.
WORD state	This defines the initial state of the Object.
WORD range	This specifies the maximum value of the slider when the thumb is on the rightmost position for a horizontal orientation and bottom most position for the vertical orientation. Minimum value is always at zero.

WORD page	This is the incremental change of the slider when user action requests to move the slider thumb. This value is added or subtracted to the current position of the thumb.
WORD pos	This defines the initial position of the thumb.
GOL_SCHEME * pScheme	The pointer to the style scheme used for the Object. Set to NULL if default style scheme is used.

Side Effects

none

Returns

Returns the pointer to the object created.

Preconditions

none

Example

```
GOL_SCHEME *pScheme;
SLIDER *slider[3];
WORD state;

    pScheme = GOLCreateScheme();

    // create a slider with
    //       range = [0 – 50000]
    //       delta = 500
    //       initial position = 25000
    state = SLD_DRAW;
    slider[0] = SldCreate(  5,
                            150, 145, 285, 181,
                            state,
                            50000, 500, 25000,
                            pScheme);
    if (slider[0] == NULL)
        return 0;

    // create a scrollbar with
    //       range = [0 – 100]
    //       delta = 20
    //       initial position = 0

    state = SLD_DRAW|SLD_SCROLLBAR;
    slider[1] = SldCreate(  6,
                            150, 190, 285, 220,
                            state,
                            100, 20, 0,
                            pScheme);
    if (slider[1] == NULL)
        return 0;

    // create a vertical slider with
    //       range = [0 – 30]
    //       delta = 2
    //       initial position = 20

    state = SLD_DRAW|SLD_VERTICAL;
    slider[2] = SldCreate(  7,
                            120, 145, 140, 220,
                            state,
                            30, 2, 20,
                            pScheme);
    if (slider[2] == NULL)
        return 0;

    // draw the sliders
    while(!sldDraw(slider[0]);      // draw the horizontal slider
    while(!sldDraw(slider[1]);      // draw the horizontal scroll bar
    while(!sldDraw(slider[2]);      // draw the vertical slider
    return 1;
```

Overview

This function creates a SLIDER (see page 266) object with the parameters given. Depending on the SLD_SCROLLBAR (see page 255) state bit slider or scrollbar mode is set. If SLD_SCROLLBAR (see page 255) is set, mode is scrollbar; if not set mode is slider. It automatically attaches the new object into a global linked list of objects and returns the address of the object.

Syntax

SLIDER (see page 266) *SldCreate(WORD ID, SHORT left, SHORT top, SHORT right, SHORT bottom, WORD state, SHORT range, SHORT page, SHORT pos, GOL_SCHEME (see page 345) *pScheme);

8.1.21.3 SldDraw Function

File

Slider.h (see page 902)

C

```
WORD SldDraw(
    void * pObj
);
```

Module

Slider/Scroll Bar (see page 251)

Input Parameters

Input Parameters	Description
pSld	Pointer to the object to be rendered.

Side Effects

none

Returns

Returns the status of the drawing

- 1 - If the rendering was completed and
- 0 - If the rendering is not yet finished.

Next call to the function will resume the rendering on the pending drawing state.

Preconditions

Object must be created before this function is called.

Example

See SldCreate (see page 255)() example.

Overview

This function renders the object on the screen using the current parameter settings. Location of the object is determined by the left, top, right and bottom parameters. The colors used are dependent on the state of the object.

When rendering objects of the same type, each object must be rendered completely before the rendering of the next object is started. This is to avoid incomplete object rendering.

Syntax

WORD SldDraw(void *pObj)

8.1.21.4 SldSetPage Function

File

Slider.h (see page 902)

C

```
void SldSetPage(
    SLIDER * pSld,
    WORD newPage
);
```

Module

Slider/Scroll Bar (see page 251)

Input Parameters

Input Parameters	Description
SLIDER * pSld	Pointer to the object.
WORD newPage	Value of the new page used.

Side Effects

Position of the thumb may change when redrawn.

Returns

None.

Preconditions

none

Example

See SldIncPos (see page 262)() example.

Overview

This sets the page size of the object. Page size defines the delta change of the thumb position when incremented via SldIncPos (see page 262)() or decremented via SldDecPos (see page 263)(). Page size minimum value is 1. Maximum value is range/2.

Syntax

void SldSetPage(SLIDER (see page 266) *pSld, WORD newPage)

8.1.21.5 SldGetPage Macro

File

Slider.h (see page 902)

C

```
#define SldGetPage(pSld) (((SLIDER*)pSld)->page)
```

Module

Slider/Scroll Bar (see page 251)

Input Parameters

Input Parameters	Description
pSld	Pointer to the object.

Side Effects

none

Returns

Returns the current value of the slider page.

Preconditions

none

Example

```
WORD page;
SLIDER *pSld;

    page = SldGetPage(pSld);
```

Overview

Returns returns the current slider thumb position. Value is always in the 1 to range/2 inclusive.

Syntax

SldGetPage(pSld)

8.1.21.6 SldSetPos Function

File

Slider.h (see page 902)

C

```
void SldSetPos(
    SLIDER * pSld,
    SHORT newPos
);
```

Module

Slider/Scroll Bar (see page 251)

Input Parameters

Input Parameters	Description
SLIDER * pSld	Pointer to the object.
SHORT newPos	The new position of the slider's thumb.

Side Effects

none

Returns

none

Preconditions

none

Example

```
SLIDER *pSlider;
DWORD ctr = 0;

    // create slider here and initialize parameters
    SetState(pSlider, SLD_DRAW);
    SldDraw(pSlider);

    while("some condition") {
        SldSetPos(pSlider, ctr);
        SetState(pSlider, SLD_DRAW_THUMB);
        SldDraw(pSlider);
        // update ctr here
        ctr = "some source of value";
    }
```

Overview

This function sets the position of the slider thumb. Value should be in the set range inclusive. Object must be redrawn to reflect the change.

Syntax

SldSetPos(SLIDER (see page 266) *pSld, SHORT newPos)

8.1.21.7 SldGetPos Macro

File

Slider.h (see page 902)

C

```
#define SldGetPos(pSld) (((SLIDER*)pSld)->pos)
```

Module

Slider/Scroll Bar (see page 251)

Input Parameters

Input Parameters	Description
pSld	Pointer to the object.

Side Effects

none

Returns

Returns the current position of the slider's thumb.

Preconditions

none

Example

```
#define MAXVALUE 100;

SLIDER *pSlider;
DWORD ctr = 0;

    // create slider here and initialize parameters
    SetState(pSlider, SLD_DRAW);
    SldDraw(pSlider);

    while("some condition") {
        SldSetPos(pSlider, ctr);
        SetState(pSlider, SLD_DRAW_THUMB);
        SldDraw(pSlider);
        // update ctr here
        ctr = "some source of value";
    }

    if (SldGetPos(pSlider) > (MAXVALUE – 1))
       return 0;
    else
        "do something else"
```

Overview

Returns returns the current position of the slider thumb.

Syntax

SldGetPos(pSld)

8.1.21.8 SldSetRange Function

File

Slider.h (see page 902)

C

```
void SldSetRange(
    SLIDER * pSld,
    SHORT newRange
);
```

Module

Slider/Scroll Bar (see page 251)

Input Parameters

Input Parameters	Description
SLIDER * pSld	Pointer to the object.
SHORT newRange	Value of the new range used.

Side Effects

Position of the thumb may change when redrawn.

Returns

None.

Preconditions

none

Example

```
SLIDER *pSld;

    SldSetRange(pSld, 100);
    // to completely redraw the object when GOLDraw() is executed.
    SetState(pSld, SLD_DRAW);
```

Overview

This sets the range of the thumb. If this field is changed Object must be completely redrawn to reflect the change.

Syntax

SldSetRange(SLIDER (see page 266) *pSld, SHORT newRange)

8.1.21.9 SldGetRange Macro

File

Slider.h (see page 902)

C

```
#define SldGetRange(pSld) (((SLIDER*)pSld)->range)
```

Module

Slider/Scroll Bar (see page 251)

Input Parameters

Input Parameters	Description
pSld	Pointer to the object.

Side Effects

none

Returns

Returns the current value of the slider range.

Preconditions

none

Example

```
WORD range;
SLIDER *pSld;

    range = SldGetRange(pSld);
```

Overview

Returns the current slider page. Value is always in the 1-range/2 inclusive for both slider and scrollbar type.

Syntax

SldGetRange(pSld)

8.1.21.10 SldIncPos Macro

File

Slider.h (see page 902)

C

```
#define SldIncPos(pSld) \
    SldSetPos

\
    (

\
        pSld,

\
        (((DWORD) pSld->pos + (DWORD) ((SLIDER*)pSld)->page) <= (DWORD)
((SLIDER*)pSld)->range) ?  \
                        (((SLIDER*)pSld)->pos + ((SLIDER*)pSld)->page) :
((SLIDER*)pSld)->range    \
    )
```

Module

Slider/Scroll Bar (see page 251)

Input Parameters

Input Parameters	Description
pSld	Pointer to the object.

Side Effects

none

Returns

none

Preconditions

none

Example

```
void ControlSpeed(SLIDER* pSld, int setSpeed, int curSpeed)
{
    SldSetPage(pSld, 1);                    // set page size to 1
    if (setSpeed < curSpeed) {
        while(SldGetPos(pSld) < SetSpeed)
            SldIncPos(pSld);                // increment by 1
    }
    else if (setSpeed > curSpeed) {
        while(SldGetPos(pSld) > SetSpeed)
            SldDecPos(pSld);                // decrement by 1
    }
}
```

Overview

This macro increment the slider position by the delta change (page) value set. Object must be redrawn after this function is called to reflect the changes to the object.

Syntax

SldIncPos(pSld)

8.1.21.11 SldDecPos Macro

File

Slider.h (see page 902)

C

```
#define SldDecPos(pSld) \
    SldSetPos

\
    (

\
        pSld,

\
        (((LONG) ((SLIDER*)pSld)->pos - (LONG) ((SLIDER*)pSld)->page) >= 0)
?                               \
                                (((SLIDER*)pSld)->pos - ((SLIDER*)pSld)->page) :
0                                 \
    )
```

Module

Slider/Scroll Bar (see page 251)

Input Parameters

Input Parameters	Description
pSld	Pointer to the object.

Side Effects

none

Returns

none

Preconditions

none

Example

See SldIncPos (see page 262)() example.

Overview

This macro decrement the slider position by the delta change (page) value set. Object must be redrawn after this function is called to reflect the changes to the object.

Syntax

SldDecPos(pSld)

8.1.21.12 SldMsgDefault Function

File

Slider.h (see page 902)

C

```
void SldMsgDefault(
    WORD translatedMsg,
    void * pObj,
    GOL_MSG * pMsg
);
```

Module

Slider/Scroll Bar (see page 251)

Input Parameters

Input Parameters	Description
WORD translatedMsg	The translated message.
GOL_MSG * pMsg	The pointer to the GOL (see page 64) message.
pSld	The pointer to the object whose state will be modified.

Side Effects

none

Returns

none

Preconditions

none

Example

Usage is similar to BtnTranslateMsg (see page 90)() example.

Overview

This function performs the actual state change based on the translated message given. The following state changes are supported:

Translated Message	Input Source	Set/Clear State Bit	Description
SLD_MSG_INC	Touch Screen, Keyboard	Set SLD_DRAW_THUMB (see page 254)	Slider (see page 251) will be redrawn with thumb in the incremented position.
SLD_MSG_DEC	Touch Screen, Keyboard	Set SLD_DRAW_THUMB (see page 254)	Slider (see page 251) will be redrawn with thumb in the decremented position.

Syntax

void SldMsgDefault(WORD translatedMsg, void *pObj, GOL_MSG (see page 330)* pMsg)

8.1.21.13 SldTranslateMsg Function

File

Slider.h (see page 902)

C

```
WORD SldTranslateMsg(
    void * pObj,
    GOL_MSG * pMsg
);
```

Module

Slider/Scroll Bar (see page 251)

Input Parameters

Input Parameters	Description
GOL_MSG * pMsg	Pointer to the message struct containing the message from the user interface.
pSld	The pointer to the object where the message will be evaluated to check if the message will affect the object.

Side Effects

none

Returns

Returns the translated message depending on the received GOL (see page 64) message:

- SLD_MSG_INC – Increment slider position
- SLD_MSG_DEC – Decrement slider position
- OBJ_MSG_PASSIVE – Slider (see page 251) is not affected
- OBJ_MSG_INVALID – Slider (see page 251) is not affected

Preconditions

none

Example

Usage is similar to BtnTranslateMsg (see page 90)() example.

Overview

This function evaluates the message from a user if the message will affect the object or not. The table below enumerates the translated messages for each event of the touch screen and keyboard inputs.

Translated Message	Input Source	Events	Description
SLD_MSG_INC	Touch Screen	EVENT_PRESS, EVENT_MOVE	If events occurs and the x,y position falls in the area of the slider and the slider position is to the LEFT of the x,y position for a horizontal slider or BELOW the x,y position for a vertical slider.
	Keyboard	EVENT_KEYSCAN	If event occurs and parameter1 passed matches the object's ID and parameter 2 passed matches SCAN_UP_PRESSED (see page 340) or SCAN_LEFT_PRESSED (see page 337).

SLD_MSG_DEC	Touch Screen	EVENT_PRESS, EVENT_MOVE	If events occurs and the x,y position falls in the area of the slider and the slider position is to the RIGHT of the x,y position for a horizontal slider or ABOVE the x,y position for a vertical slider.
	Keyboard	EVENT_KEYSCAN	If event occurs and parameter1 passed matches the object's ID and parameter 2 passed matches SCAN_DOWN_PRESSED (see page 336) or SCAN_RIGHT_PRESSED (see page 339).
OBJ_MSG_PASSIVE	Touch Screen	EVENT_RELEASE	If events occurs and the x,y position falls in the area of the slider.
OBJ_MSG_INVALID	Any	Any	If the message did not affect the object.

Syntax

WORD SldTranslateMsg(void *pObj, GOL_MSG (see page 330) *pMsg)

8.1.21.14 SLIDER Structure

File

Slider.h (see page 902)

C

```
typedef struct {
  OBJ_HEADER hdr;
  WORD currPos;
  WORD prevPos;
  WORD range;
  WORD pos;
  WORD page;
  WORD thWidth;
  WORD thHeight;
} SLIDER;
```

Members

Members	Description
OBJ_HEADER hdr;	Generic header for all Objects (see OBJ_HEADER (see page 68)).
WORD currPos;	Position of the slider relative to minimum.
WORD prevPos;	Previous position of the slider relative to minimum.
WORD range;	User defined range of the slider. Minimum value at 0 and maximum at 0x7FFF.
WORD pos;	Position of the slider in range domain.
WORD page;	User specified resolution to incrementally change the position
WORD thWidth;	Thumb width. This is computed internally.
WORD thHeight;	Thumb width. This is computed internally. User must not change this value.

Module

Slider/Scroll Bar (see page 251)

Overview

Defines the parameters required for a slider/scrollbar Object. Depending on the SLD_SCROLLBAR (see page 255) state bit slider or scrollbar mode is set. If SLD_SCROLLBAR (see page 255) is set, mode is scrollbar; if not set mode is slider. For scrollbar mode, focus rectangle is not drawn.

8.1.22 Static Text

Static Text is an Object that can be used to display a single or multi-line string of text in a predefined location.

Functions

	Name	Description
	StCreate (see page 269)	This function creates a STATICTEXT (see page 273) object with the parameters given. It automatically attaches the new object into a global linked list of objects and returns the address of the object.
	StDraw (see page 270)	This function renders the object on the screen using the current parameter settings. Location of the object is determined by the left, top, right and bottom parameters. The colors used are dependent on the state of the object. The font used is determined by the style scheme set. When rendering objects of the same type, each object must be rendered completely before the rendering of the next object is started. This is to avoid incomplete object rendering.
	StSetText (see page 272)	This function sets the string that will be used for the object.
	StTranslateMsg (see page 272)	This function evaluates the message from a user if the message will affect the object or not. The table below enumerates the translated messages for each event of the touch screen and keyboard inputs.

Macros

Name	Description
StGetText (see page 271)	This macro returns the address of the current text string used for the object.

Structures

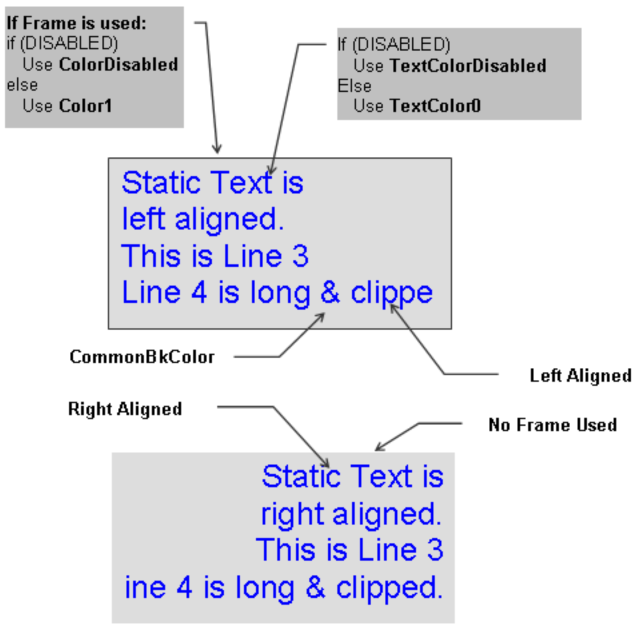
Name	Description
STATICTEXT (see page 273)	Defines the parameters required for a Static Text Object.

Description

Static Text supports only Touchscreen inputs, replying to their events with the message:

ST_MSG_SELECTED - when the touch is within the dimension of the object.

The Static Text Object is rendered using the assigned style scheme. The following figure illustrates the color assignments.



8.1.22.1 Static Text States

Macros

Name	Description
ST_CENTER_ALIGN (see page 268)	Bit to indicate text is center aligned.
ST_DISABLED (see page 268)	Bit for disabled state.
ST_DRAW (see page 268)	Bit to indicate static text must be redrawn.
ST_FRAME (see page 269)	Bit to indicate frame is displayed.
ST_HIDE (see page 269)	Bit to remove object from screen.
ST_RIGHT_ALIGN (see page 269)	Bit to indicate text is left aligned.
ST_UPDATE (see page 269)	Bit to indicate that text area only is redrawn.

Module

Static Text (see page 266)

Description

List of Static Text bit states.

8.1.22.1.1 ST_CENTER_ALIGN Macro

File

StaticText.h (see page 916)

C

```
#define ST_CENTER_ALIGN 0x0008  // Bit to indicate text is center aligned.
```

Description

Bit to indicate text is center aligned.

8.1.22.1.2 ST_DISABLED Macro

File

StaticText.h (see page 916)

C

```
#define ST_DISABLED 0x0002  // Bit for disabled state.
```

Description

Bit for disabled state.

8.1.22.1.3 ST_DRAW Macro

File

StaticText.h (see page 916)

C

```
#define ST_DRAW 0x4000  // Bit to indicate static text must be redrawn.
```

Description

Bit to indicate static text must be redrawn.

8.1.22.1.4 ST_FRAME Macro

File

StaticText.h (see page 916)

C

```
#define ST_FRAME 0x0010  // Bit to indicate frame is displayed.
```

Description

Bit to indicate frame is displayed.

8.1.22.1.5 ST_HIDE Macro

File

StaticText.h (see page 916)

C

```
#define ST_HIDE 0x8000  // Bit to remove object from screen.
```

Description

Bit to remove object from screen.

8.1.22.1.6 ST_RIGHT_ALIGN Macro

File

StaticText.h (see page 916)

C

```
#define ST_RIGHT_ALIGN 0x0004  // Bit to indicate text is left aligned.
```

Description

Bit to indicate text is left aligned.

8.1.22.1.7 ST_UPDATE Macro

File

StaticText.h (see page 916)

C

```
#define ST_UPDATE 0x2000  // Bit to indicate that text area only is redrawn.
```

Description

Bit to indicate that text area only is redrawn.

8.1.22.2 StCreate Function

File

StaticText.h (see page 916)

C

```
STATICTEXT * StCreate(
    WORD ID,
    SHORT left,
    SHORT top,
    SHORT right,
    SHORT bottom,
    WORD state,
    XCHAR * pText,
    GOL_SCHEME * pScheme
);
```

Module

Static Text (see page 266)

Input Parameters

Input Parameters	Description
WORD ID	Unique user defined ID for the object instance.
SHORT left	Left most position of the object.
SHORT top	Top most position of the object.
SHORT right	Right most position of the object.
SHORT bottom	Bottom most position of the object.
WORD state	Sets the initial state of the object.
XCHAR * pText	Pointer to the text used in the static text.
GOL_SCHEME * pScheme	Pointer to the style scheme. Set to NULL if default style scheme is used.

Side Effects

none

Returns

Returns the pointer to the object created.

Preconditions

none

Example

```
GOL_SCHEME *pScheme;
STATICTEXT *pSt;

    pScheme = GOLCreateScheme();
    state = ST_DRAW | ST_FRAME | ST_CENTER_ALIGN;
    StCreate(ID_STATICTEXT1,           // ID
             30,80,235,160,            // dimension
             state,                    // has frame and center aligned
             "Static Textn Example", // text
             pScheme);                 // use given scheme

    while(!StDraw(pSt));               // draw the object
```

Overview

This function creates a STATICTEXT (see page 273) object with the parameters given. It automatically attaches the new object into a global linked list of objects and returns the address of the object.

Syntax

STATICTEXT (see page 273) *StCreate(WORD ID, SHORT left, SHORT top, SHORT right, SHORT bottom, WORD state , XCHAR (see page 361) *pText, GOL_SCHEME (see page 345) *pScheme)

8.1.22.3 StDraw Function

File

StaticText.h (see page 916)

C

```
WORD StDraw(
    void * pObj
);
```

Module

Static Text (see page 266)

Input Parameters

Input Parameters	Description
pSt	Pointer to the object to be rendered.

Side Effects

none

Returns

Returns the status of the drawing

- 1 - If the rendering was completed and
- 0 - If the rendering is not yet finished.

Next call to the function will resume the rendering on the pending drawing state.

Preconditions

Object must be created before this function is called.

Example

See StCreate (see page 269)() Example.

Overview

This function renders the object on the screen using the current parameter settings. Location of the object is determined by the left, top, right and bottom parameters. The colors used are dependent on the state of the object. The font used is determined by the style scheme set.

When rendering objects of the same type, each object must be rendered completely before the rendering of the next object is started. This is to avoid incomplete object rendering.

Syntax

WORD StDraw(void *pObj)

8.1.22.4 StGetText Macro

File

StaticText.h (see page 916)

C

```
#define StGetText(pSt) pSt->pText
```

Module

Static Text (see page 266)

Input Parameters

Input Parameters	Description
pSt	Pointer to the object.

Side Effects

none

Returns

Returns the pointer to the text string used.

Preconditions

none

Overview

This macro returns the address of the current text string used for the object.

Syntax

StGetText(pSt)

8.1.22.5 StSetText Function

File

StaticText.h (see page 916)

C

```
void StSetText(
    STATICTEXT * pSt,
    XCHAR * pText
);
```

Module

Static Text (see page 266)

Input Parameters

Input Parameters	Description
STATICTEXT * pSt	The pointer to the object whose text string will be modified.
XCHAR * pText	The pointer to the string that will be used.

Side Effects

none

Returns

none

Preconditions

none

Overview

This function sets the string that will be used for the object.

Syntax

StSetText(STATICTEXT (see page 273) *pSt, XCHAR (see page 361) *pText)

8.1.22.6 StTranslateMsg Function

File

StaticText.h (see page 916)

C

```
WORD StTranslateMsg(
    void * pObj,
    GOL_MSG * pMsg
);
```

Module

Static Text (see page 266)

Input Parameters

Input Parameters	Description
GOL_MSG * pMsg	Pointer to the message struct containing the message from the user interface.
pSt	The pointer to the object where the message will be evaluated to check if the message will affect the object.

Side Effects

none

Returns

Returns the translated message depending on the received GOL (see page 64) message:

- ST_MSG_SELECTED – Static Text is selected
- OBJ_MSG_INVALID – Static Text is not affected

Preconditions

none

Example

Usage is similar to BtnTranslateMsg (see page 90)() example.

Overview

This function evaluates the message from a user if the message will affect the object or not. The table below enumerates the translated messages for each event of the touch screen and keyboard inputs.

Translated Message	Input Source	Events	Description
ST_MSG_SELECTED	Touch Screen	EVENT_PRESS, EVENT_RELEASE	If events occurs and the x,y position falls in the area of the static text.
OBJ_MSG_INVALID	Any	Any	If the message did not affect the object.

Syntax

WORD StTranslateMsg(void *pObj, GOL_MSG (see page 330) *pMsg)

8.1.22.7 STATICTEXT Structure

File

StaticText.h (see page 916)

C

```
typedef struct {
  OBJ_HEADER hdr;
  SHORT textHeight;
  XCHAR * pText;
} STATICTEXT;
```

Members

Members	Description
OBJ_HEADER hdr;	Generic header for all Objects (see OBJ_HEADER (see page 68)).
SHORT textHeight;	Pre-computed text height.

XCHAR * pText;	The pointer to text used.

Module

Static Text (see page 266)

Overview

Defines the parameters required for a Static Text Object.

8.1.23 Text Entry

Text Entry is an Object that can be used to emulate a key pad entry with a display area for the entered characters. The Object has a feature where you can define a key to reply with a translated message that signifies a command key was pressed. A command key example can be your enter or carriage return key or an escape key. Multiple keys can be assigned command keys. Application can utilize the command key to define the behavior of the program based on a command key press.

Functions

	Name	Description
	TeCreate (see page 279)	This function creates a TEXTENTRY (see page 290) object with the parameters given. It automatically attaches the new object into a global linked list of objects and returns the address of the object.
	TeDraw (see page 280)	This function renders the object on the screen using the current parameter settings. Location of the object is determined by the left, top, right and bottom parameters. The colors used are dependent on the state of the object. This widget will draw the keys using the function GOLPanelDraw (see page 322)(). The number of keys will depend on the horizontal and vertical parameters given (horizontalKeys*verticakKeys).
	TeSetBuffer (see page 281)	This function sets the buffer used to display text. If the buffer is initialized with a string, the string must be a null terminated string. If the string length is greater than MaxSize, string will be truncated to MaxSize. pText must point to a valid memory location with size equal to MaxSize+1. The +1 is used for the string terminator.
	TeClearBuffer (see page 282)	This function will clear the data in the display. You must set the drawing state bit TE_UPDATE_TEXT (see page 278) to update the TEXTENTRY (see page 290) on the screen.
	TeGetKeyCommand (see page 282)	This function will return the currently used command by a key with the given index.
	TeSetKeyCommand (see page 283)	This function will assign a command (TE_DELETE_COM (see page 278), TE_SPACE_COM (see page 279) or TE_ENTER_COM (see page 278)) to a key with the given index.
	TeCreateKeyMembers (see page 284)	This function will create the list of KEYMEMBERS that holds the information on each key. The number of keys is determined by the equation (verticalKeys*horizontalKeys). The object creates the information holder for each key automatically and assigns each entry in the *pText[] array with the first entry automatically assigned to the key with an index of 1. The number of entries to *pText[] must be equal or greater than (verticalKeys*horizontalKeys). The last key is assigned with an index of (verticalKeys*horizontalKeys)-1. No checking is performed on the length of *pText[] entries to match (verticalKeys*horizontalKeys).
	TeAddChar (see page 284)	This function will insert a character to the end of the buffer. The character inserted is dependent on the currently pressed key. Drawing states TE_UPDATE_TEXT (see page 278) or TE_DRAW (see page 277) must be set to see the effect of this insertion.
	TeIsKeyPressed (see page 285)	This function will test if a key given by its index in the TextEntry object has been pressed.

	TeSpaceChar (see page 286)	This function will insert a space character to the end of the buffer. Drawing states TE_UPDATE_TEXT (see page 278) or TE_DRAW (see page 277) must be set to see the effect of this insertion.
	TeDelKeyMembers (see page 286)	This function will delete the KEYMEMBER (see page 291) list assigned to the object from memory. Pointer to the KEYMEMBER (see page 291) list is then initialized to NULL.
	TeSetKeyText (see page 287)	This function will set the test assigned to a key with the given index.
	TeMsgDefault (see page 287)	This function performs the actual state change based on the translated message given. The following state changes are supported:
	TeTranslateMsg (see page 289)	This function evaluates the message from a user if the message will affect the object or not. If the message is valid, the keys in the Text Entry object will be scanned to detect which key was pressed. If True, the corresponding text will be displayed, the 'text' will also be stored in the TeOutput parameter of the object.

Macros

Name	Description
TeGetBuffer (see page 281)	This macro will return the currently used buffer in the TextEntry object.

Structures

Name	Description
TEXTENTRY (see page 290)	Defines the parameters required for a TextEntry Object.
KEYMEMBER (see page 291)	Defines the parameters and the strings assigned for each key.

Description

Text Entry supports only Touchscreen inputs, replying to their events with the following messages:

1. TE_MSG_RELEASE – A key has been released.

2. TE_MSG_PRESS – A key is pressed.

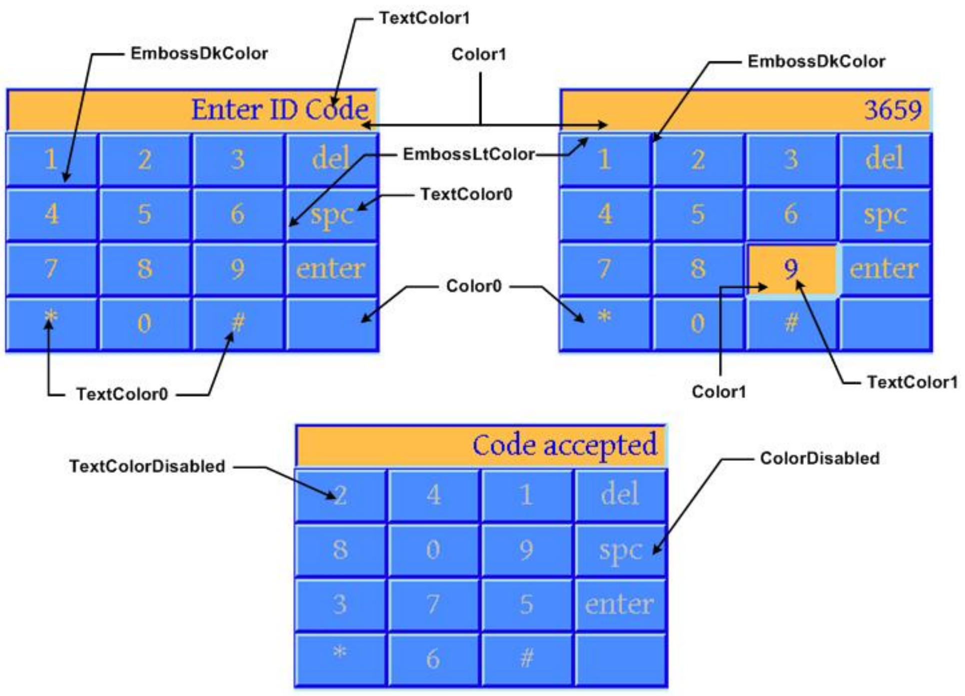
3. TE_MSG_ADD_CHAR – A key was released with character assigned.

4. TE_MSG_DELETE – A key was released with delete command assigned.

5. TE_MSG_SPACE - A key was released with space command assigned.

6. TE_MSG_ENTER - A key was released with enter command assigned.

The Text Entry Object is rendered using the assigned style scheme. The following figure illustrates the color assignments.



8.1.23.1 TextEntry States

Macros

Name	Description
TE_KEY_PRESSED (see page 276)	Bit for press state of one of the keys.
TE_DISABLED (see page 277)	Bit for disabled state.
TE_ECHO_HIDE (see page 277)	Bit to hide the entered characters and instead echo "*" characters to the display.
TE_DRAW (see page 277)	Bit to indicate object must be redrawn.
TE_HIDE (see page 277)	Bit to indicate object must be removed from screen.
TE_UPDATE_KEY (see page 277)	Bit to indicate redraw of a key is needed.
TE_UPDATE_TEXT (see page 278)	Bit to indicate redraw of the text displayed is needed.

Module

Text Entry (see page 274)

Description

List of Text Entry (see page 274) bit states.

8.1.23.1.1 TE_KEY_PRESSED Macro

File

TextEntry.h (see page 936)

C

```
#define TE_KEY_PRESSED 0x0004  // Bit for press state of one of the keys.
```

Description

Bit for press state of one of the keys.

8.1.23.1.2 TE_DISABLED Macro

File

TextEntry.h (see page 936)

C

```
#define TE_DISABLED 0x0002  // Bit for disabled state.
```

Description

Bit for disabled state.

8.1.23.1.3 TE_ECHO_HIDE Macro

File

TextEntry.h (see page 936)

C

```
#define TE_ECHO_HIDE 0x0008  // Bit to hide the entered characters and instead echo "*"
characters to the display.
```

Description

Bit to hide the entered characters and instead echo "*" characters to the display.

8.1.23.1.4 TE_DRAW Macro

File

TextEntry.h (see page 936)

C

```
#define TE_DRAW 0x4000  // Bit to indicate object must be redrawn.
```

Description

Bit to indicate object must be redrawn.

8.1.23.1.5 TE_HIDE Macro

File

TextEntry.h (see page 936)

C

```
#define TE_HIDE 0x8000  // Bit to indicate object must be removed from screen.
```

Description

Bit to indicate object must be removed from screen.

8.1.23.1.6 TE_UPDATE_KEY Macro

File

TextEntry.h (see page 936)

C

```
#define TE_UPDATE_KEY 0x2000  // Bit to indicate redraw of a key is needed.
```

Description

Bit to indicate redraw of a key is needed.

8.1.23.1.7 TE_UPDATE_TEXT Macro

File

TextEntry.h (see page 936)

C

```
#define TE_UPDATE_TEXT 0x1000  // Bit to indicate redraw of the text displayed is needed.
```

Description

Bit to indicate redraw of the text displayed is needed.

8.1.23.2 Key Command Types

Macros

Name	Description
TE_DELETE_COM (see page 278)	This macro is used to assign a "delete" command on a key.
TE_ENTER_COM (see page 278)	This macro is used to assign an "enter" (carriage return) command on a key.
TE_SPACE_COM (see page 279)	This macro is used to assign an insert "space" command on a key.

Module

Text Entry (see page 274)

Description

List of available Key command types.

8.1.23.2.1 TE_DELETE_COM Macro

File

TextEntry.h (see page 936)

C

```
#define TE_DELETE_COM 0x01    // This macro is used to assign a "delete" command on a key.
```

Description

This macro is used to assign a "delete" command on a key.

8.1.23.2.2 TE_ENTER_COM Macro

File

TextEntry.h (see page 936)

C

```
#define TE_ENTER_COM 0x03    // This macro is used to assign an "enter" (carriage return)
command on a key.
```

Description

This macro is used to assign an "enter" (carriage return) command on a key.

8.1.23.2.3 TE_SPACE_COM Macro

File

TextEntry.h (see page 936)

C

```
#define TE_SPACE_COM 0x02    // This macro is used to assign an insert "space" command on a
key.
```

Description

This macro is used to assign an insert "space" command on a key.

8.1.23.3 TeCreate Function

File

TextEntry.h (see page 936)

C

```
TEXTENTRY * TeCreate(
    WORD ID,
    SHORT left,
    SHORT top,
    SHORT right,
    SHORT bottom,
    WORD state,
    SHORT horizontalKeys,
    SHORT verticalKeys,
    XCHAR * pText[],
    void * pBuffer,
    WORD bufferLength,
    void * pDisplayFont,
    GOL_SCHEME * pScheme
);
```

Module

Text Entry (see page 274)

Input Parameters

Input Parameters	Description
WORD ID	Unique user defined ID for the object instance
SHORT left	Left most position of the object.
SHORT top	Top most position of the object.
SHORT right	Right most position of the object.
SHORT bottom	Bottom most position of the object.
WORD state	state of the widget.
SHORT horizontalKeys	Number of horizontal keys
SHORT verticalKeys	Number of vertical keys
XCHAR * pText[]	array of pointer to the custom "text" assigned by the user.
WORD bufferLength	length of the buffer assigned by the user.
void * pDisplayFont	pointer to the font image to be used on the editbox
GOL_SCHEME * pScheme	Pointer to the style scheme used. Output Returns the pointer to the object created.

Side Effects

none.

Preconditions

If the object will use customized keys, the structure CUSTOMEKEYS must be populated before calling this function.

Overview

This function creates a TEXTENTRY (see page 290) object with the parameters given. It automatically attaches the new object into a global linked list of objects and returns the address of the object.

Syntax

TEXTENTRY (see page 290) *TeCreate(WORD ID, SHORT left, SHORT top, SHORT right, SHORT bottom, WORD state, SHORT horizontalKeys, SHORT verticalKeys, XCHAR (see page 361) *pText[], void *pBuffer, WORD bufferLength,void *pDisplayFont, GOL_SCHEME (see page 345) *pScheme)

8.1.23.4 TeDraw Function

File

TextEntry.h (see page 936)

C

```
WORD TeDraw(
    void * pObj
);
```

Module

Text Entry (see page 274)

Input Parameters

Input Parameters	Description
pTe	Pointer to the object to be rendered.

Side Effects

none.

Returns

Returns the status of the drawing

- 1 - If the rendering was completed and
- 0 - If the rendering is not yet finished.

Next call to the function will resume the rendering on the pending drawing state.

Preconditions

Object must be created before this function is called.

Overview

This function renders the object on the screen using the current parameter settings. Location of the object is determined by the left, top, right and bottom parameters. The colors used are dependent on the state of the object.

This widget will draw the keys using the function GOLPanelDraw (see page 322)(). The number of keys will depend on the horizontal and vertical parameters given (horizontalKeys*verticakKeys).

Syntax

WORD TeDraw(void *pObj)

8.1.23.5 TeGetBuffer Macro

File

TextEntry.h (see page 936)

C

```
#define TeGetBuffer(pTe) (((TEXTENTRY *)pTe)->pTeOutput)
```

Module

Text Entry (see page 274)

Input Parameters

Input Parameters	Description
pTe	pointer to the object

Side Effects

none.

Returns

It will return a pointer to the buffer used.

Preconditions

none

Overview

This macro will return the currently used buffer in the TextEntry object.

Syntax

TeGetBuffer(pTe)

8.1.23.6 TeSetBuffer Function

File

TextEntry.h (see page 936)

C

```
void TeSetBuffer(
    TEXTENTRY * pTe,
    XCHAR * pText,
    WORD MaxSize
);
```

Module

Text Entry (see page 274)

Input Parameters

Input Parameters	Description
TEXTENTRY * pTe	pointer to the object
XCHAR * pText	pointer to the new text buffer to be displayed
maxSize	maximum length of the new buffer to be used.

Side Effects

none.

Returns

none.

Preconditions

none

Overview

This function sets the buffer used to display text. If the buffer is initialized with a string, the string must be a null terminated string. If the string length is greater than MaxSize, string will be truncated to MaxSize. pText must point to a valid memory location with size equal to MaxSize+1. The +1 is used for the string terminator.

Syntax

void TeSetBuffer(TEXTENTRY (see page 290) *pTe, XCHAR (see page 361) *pText, WORD MaxSize)

8.1.23.7 TeClearBuffer Function

File

TextEntry.h (see page 936)

C

```
void TeClearBuffer(
    TEXTENTRY * pTe
);
```

Module

Text Entry (see page 274)

Input Parameters

Input Parameters	Description
TEXTENTRY * pTe	pointer to the object

Side Effects

none.

Returns

none

Preconditions

none

Overview

This function will clear the data in the display. You must set the drawing state bit TE_UPDATE_TEXT (see page 278) to update the TEXTENTRY (see page 290) on the screen.

Syntax

void TeClearBuffer (TEXTENTRY (see page 290) *pTe)

8.1.23.8 TeGetKeyCommand Function

File

TextEntry.h (see page 936)

C

```
WORD TeGetKeyCommand(
    TEXTENTRY * pTe,
    WORD index
);
```

Module

Text Entry (see page 274)

Input Parameters

Input Parameters	Description
TEXTENTRY * pTe	pointer to the object
WORD index	index to the key in the link list

Side Effects

none.

Returns

It will return the command ID currently set for the key. If the given index is not in the list the function returns zero. 0x00 - no command is assigned or the index given does not exist. 0x01 - TE_DELETE_COM (see page 278) 0x02 - TE_SPACE_COM (see page 279) 0x03 - TE_ENTER_COM (see page 278)

Preconditions

none

Overview

This function will return the currently used command by a key with the given index.

Syntax

TeGetKeyCommand(pTe, index)

8.1.23.9 TeSetKeyCommand Function

File

TextEntry.h (see page 936)

C

```
BOOL TeSetKeyCommand(
    TEXTENTRY * pTe,
    WORD index,
    WORD command
);
```

Module

Text Entry (see page 274)

Input Parameters

Input Parameters	Description
TEXTENTRY * pTe	pointer to the object
WORD index	index to the key in the link list
WORD command	command assigned for the key

Side Effects

none.

Returns

Returns TRUE if successful and FALSE if not.

Preconditions

none

Overview

This function will assign a command (TE_DELETE_COM (see page 278), TE_SPACE_COM (see page 279) or TE_ENTER_COM (see page 278)) to a key with the given index.

Syntax

void TeSetKeyCommand(TEXTENTRY (see page 290) *pTe,WORD index,WORD command)

8.1.23.10 TeCreateKeyMembers Function

File

TextEntry.h (see page 936)

C

```
KEYMEMBER * TeCreateKeyMembers(
    TEXTENTRY * pTe,
    XCHAR * pText[]
);
```

Module

Text Entry (see page 274)

Input Parameters

Input Parameters	Description
TEXTENTRY * pTe	pointer to the object
XCHAR * pText[]	pointer to the text defined by the user

Side Effects

none.

Returns

Returns the pointer to the newly created KEYMEMBER (see page 291) list. A NULL is returned if the list is not created succesfully.

Preconditions

none

Overview

This function will create the list of KEYMEMBERS that holds the information on each key. The number of keys is determined by the equation (verticalKeys*horizontalKeys). The object creates the information holder for each key automatically and assigns each entry in the *pText[] array with the first entry automatically assigned to the key with an index of 1. The number of entries to *pText[] must be equal or greater than (verticalKeys*horizontalKeys). The last key is assigned with an index of (verticalKeys*horizontalKeys)-1. No checking is performed on the length of *pText[] entries to match (verticalKeys*horizontalKeys).

Syntax

KEYMEMBER (see page 291) *TeCreateKeyMembers(TEXTENTRY (see page 290) *pTe,XCHAR (see page 361) *pText[])

8.1.23.11 TeAddChar Function

File

TextEntry.h (see page 936)

C

```
void TeAddChar(
    TEXTENTRY * pTe
);
```

Module

Text Entry (see page 274)

Input Parameters

Input Parameters	Description
TEXTENTRY * pTe	pointer to the object

Side Effects

none.

Preconditions

none

Overview

This function will insert a character to the end of the buffer. The character inserted is dependent on the currently pressed key. Drawing states TE_UPDATE_TEXT (see page 278) or TE_DRAW (see page 277) must be set to see the effect of this insertion.

Syntax

void TeAddChar(TEXTENTRY (see page 290) *pTe)

8.1.23.12 TeIsKeyPressed Function

File

TextEntry.h (see page 936)

C

```
BOOL TeIsKeyPressed(
    TEXTENTRY * pTe,
    WORD index
);
```

Module

Text Entry (see page 274)

Input Parameters

Input Parameters	Description
TEXTENTRY * pTe	pointer to the object
WORD index	index to the key in the link list

Side Effects

none.

Returns

Returns a TRUE if the key is pressed. FALSE if key is not pressed or the given index does not exist in the list.

Preconditions

none

Overview

This function will test if a key given by its index in the TextEntry object has been pressed.

Syntax

BOOL TeIsKeyPressed(TEXTENTRY (see page 290) *pTe, WORD index)

8.1.23.13 TeSpaceChar Function

File

TextEntry.h (see page 936)

C

```
void TeSpaceChar(
    TEXTENTRY * pTe
);
```

Module

Text Entry (see page 274)

Input Parameters

Input Parameters	Description
TEXTENTRY * pTe	pointer to the object

Side Effects

none.

Returns

none.

Preconditions

none

Overview

This function will insert a space character to the end of the buffer. Drawing states TE_UPDATE_TEXT (see page 278) or TE_DRAW (see page 277) must be set to see the effect of this insertion.

Syntax

void TeSpaceChar(TEXTENTRY (see page 290) *pTe)

8.1.23.14 TeDelKeyMembers Function

File

TextEntry.h (see page 936)

C

```
void TeDelKeyMembers(
    void * pObj
);
```

Module

Text Entry (see page 274)

Input Parameters

Input Parameters	Description
pTe	pointer to the object

Side Effects

none.

Returns

none.

Preconditions

none

Overview

This function will delete the KEYMEMBER (see page 291) list assigned to the object from memory. Pointer to the KEYMEMBER (see page 291) list is then initialized to NULL.

Syntax

void TeDelKeyMembers(void *pObj)

8.1.23.15 TeSetKeyText Function

File

TextEntry.h (see page 936)

C

```
BOOL TeSetKeyText(
    TEXTENTRY * pTe,
    WORD index,
    XCHAR * pText
);
```

Module

Text Entry (see page 274)

Input Parameters

Input Parameters	Description
TEXTENTRY * pTe	pointer to the object
WORD index	index to the key in the link list
XCHAR * pText	pointer to the new string to be used

Side Effects

none.

Returns

Returns TRUE if successful and FALSE if not.

Preconditions

none

Overview

This function will set the test assigned to a key with the given index.

Syntax

TeSetKeyText(TEXTENTRY (see page 290) *pTe, WORD index, XCHAR (see page 361) *pText)

8.1.23.16 TeMsgDefault Function

File

TextEntry.h (see page 936)

C

```
void TeMsgDefault(
    WORD translatedMsg,
    void * pObj,
    GOL_MSG * pMsg
);
```

Module

Text Entry (see page 274)

Input Parameters

Input Parameters	Description
WORD translatedMsg	The translated message.
GOL_MSG * pMsg	The pointer to the GOL (see page 64) message.
pTe	The pointer to the object whose state will be modified.

Side Effects

none

Returns

none

Preconditions

none

Example

See BtnTranslateMsg (see page 90)() example.

Overview

This function performs the actual state change based on the translated message given. The following state changes are supported:

Translated Message	Input Source	Set/Clear State Bit	Description
TE_MSG_ADD_CHAR	Touch Screen,	Set TE_UPDATE_TEXT (see page 278), TE_UPDATE_KEY (see page 277),	Add a character in the buffer and update the text displayed.
		Clear TE_KEY_PRESSED (see page 276)	
TE_MSG_SPACE	Touch Screen,	Set TE_UPDATE_TEXT (see page 278), TE_UPDATE_KEY (see page 277),	Insert a space character in the buffer and update the text displayed.
		Clear TE_KEY_PRESSED (see page 276)	
TE_MSG_DELETE	Touch Screen,	Set TE_UPDATE_TEXT (see page 278), TE_UPDATE_KEY (see page 277),	Delete the most recent character in the buffer and update the text displayed.
		Clear TE_KEY_PRESSED (see page 276)	
TE_MSG_ENTER	Touch Screen,	Set TE_UPDATE_TEXT (see page 278), TE_UPDATE_KEY (see page 277),	User can define the use of this event in the message callback. Object will just update the key.
		Clear TE_KEY_PRESSED (see page 276)	
TE_MSG_RELEASED	Touch Screen,	Clear TE_KEY_PRESSED (see page 276)	A Key in the object will be redrawn in the unpressed state.

		Set Te_UPDATE_KEY	
TE_MSG_PRESSED	Touch Screen,	Set TE_KEY_PRESSED (see page 276) TE_UPDATE_KEY (see page 277)	A Key in the object will be redrawn in the pressed state.

Syntax

TeMsgDefault(WORD translatedMsg, void *pObj, GOL_MSG (see page 330)* pMsg)

8.1.23.17 TeTranslateMsg Function

File

TextEntry.h (see page 936)

C

```
WORD TeTranslateMsg(
    void * pObj,
    GOL_MSG * pMsg
);
```

Module

Text Entry (see page 274)

Input Parameters

Input Parameters	Description
GOL_MSG * pMsg	Pointer to the message struct containing the message from the user interface.
pTe	The pointer to the object where the message will be evaluated to check if the message will affect the object.

Side Effects

none.

Returns

Returns the translated message depending on the received GOL (see page 64) message:

- TE_MSG_PRESS – A key is pressed
- TE_MSG_RELEASED - A key was released (generic for keys with no commands or characters assigned)
- TE_MSG_ADD_CHAR – A key was released with character assigned
- TE_MSG_DELETE – A key was released with delete command assigned
- TE_MSG_SPACE - A key was released with space command assigned
- TE_MSG_ENTER - A key was released with enter command assigned
- OBJ_MSG_INVALID – Text Entry is not affected

Preconditions

none

Overview

This function evaluates the message from a user if the message will affect the object or not. If the message is valid, the keys in the Text Entry object will be scanned to detect which key was pressed. If True, the corresponding text will be displayed, the ‘text’ will also be stored in the TeOutput parameter of the object.

Translated Message	Input Source	Events	Description
TE_MSG_PRESS	Touch Screen	EVENT_PRESS, EVENT_MOVE	If the event occurs and the x,y position falls in the face of one of the keys of the object while the key is unpressed.
TE_MSG_RELEASED	Touch Screen	EVENT_MOVE	If the event occurs and the x,y position falls outside the face of one of the keys of the object while the key is pressed.
TE_MSG_RELEASED	Touch Screen	EVENT_RELEASE	If the event occurs and the x,y position falls does not falls inside any of the faces of the keys of the object.
TE_MSG_ADD_CHAR	Touch Screen	EVENT_RELEASE, EVENT_MOVE	If the event occurs and the x,y position falls in the face of one of the keys of the object while the key is unpressed and the key is associated with no commands.
TE_MSG_DELETE	Touch Screen	EVENT_RELEASE, EVENT_MOVE	If the event occurs and the x,y position falls in the face of one of the keys of the object while the key is unpressed and the key is associated with delete command.
TE_MSG_SPACE	Touch Screen	EVENT_RELEASE, EVENT_MOVE	If the event occurs and the x,y position falls in the face of one of the keys of the object while the key is unpressed and the key is associated with space command.
TE_MSG_ENTER	Touch Screen	EVENT_RELEASE, EVENT_MOVE	If the event occurs and the x,y position falls in the face of one of the keys of the object while the key is unpressed and the key is associated with enter command.
OBJ_MSG_INVALID	Any	Any	If the message did not affect the object.

Syntax

WORD TeTranslateMsg(void *pObj, GOL_MSG (see page 330) *pMsg)

8.1.23.18 TEXTENTRY Structure

File

TextEntry.h (see page 936)

C

```
typedef struct {
  OBJ_HEADER hdr;
  SHORT horizontalKeys;
  SHORT verticalKeys;
  XCHAR * pTeOutput;
  WORD CurrentLength;
  WORD outputLenMax;
  KEYMEMBER * pActiveKey;
  KEYMEMBER * pHeadOfList;
  void * pDisplayFont;
} TEXTENTRY;
```

Members

Members	Description
OBJ_HEADER hdr;	Generic header for all objects (see OBJ_HEADER (see page 68)).
SHORT horizontalKeys;	Number of horizontal keys
SHORT verticalKeys;	Number of vertical keys
XCHAR * pTeOutput;	Pointer to the buffer assigned by the user which holds the text shown in the editbox.
WORD CurrentLength;	Current length of the string in the buffer. The maximum value of this is equal to outputLenMax.
WORD outputLenMax;	Maximum expected length of output buffer pTeOutput

KEYMEMBER * pActiveKey;	Pointer to the active key KEYMEMBER (see page 291). This is only used by the Widget. User must not change
KEYMEMBER * pHeadOfList;	Pointer to head of the list
void * pDisplayFont;	Pointer to the font used in displaying the text.

Module

Text Entry (see page 274)

Overview

Defines the parameters required for a TextEntry Object.

8.1.23.19 KEYMEMBER Structure

File

TextEntry.h (see page 936)

C

```
typedef struct {
  SHORT left;
  SHORT top;
  SHORT right;
  SHORT bottom;
  SHORT index;
  WORD state;
  BOOL update;
  WORD command;
  XCHAR * pKeyName;
  SHORT textWidth;
  SHORT textHeight;
  void * pNextKey;
} KEYMEMBER;
```

Members

Members	Description
SHORT left;	Left position of the key
SHORT top;	Top position of the key
SHORT right;	Right position of the key
SHORT bottom;	Bottom position of the key
SHORT index;	Index of the key in the list
WORD state;	State of the key. Either Pressed (TE_KEY_PRESSED (see page 276)) or Released (0)
BOOL update;	flag to indicate key is to be redrawn with the current state
WORD command;	Command of the key. Either TE_DELETE_COM (see page 278), TE_SPACE_COM (see page 279) or TE_ENTER_COM (see page 278).
XCHAR * pKeyName;	Pointer to the custom text assigned to the key. This is displayed over the face of the key.
SHORT textWidth;	Computed text width, done at creation. Used to predict size and position of text on the key face.
SHORT textHeight;	Computed text height, done at creation. Used to predict size and position of text on the key face.
void * pNextKey;	Pointer to the next key parameters.

Module

Text Entry (see page 274)

Overview

Defines the parameters and the strings assigned for each key.

8.1.24 Window

Window is an Object that can be used to encapsulate objects into a group. Unlike the Group Box Object, the Window Object has additional features such as displaying an icon or a small bitmap on its Title Bar (see page 371). It also has additional controls for both Title Bar (see page 371) and Client Area.

Functions

	Name	Description
	WndCreate (see page 295)	This function creates a WINDOW (see page 299) object with the parameters given. It automatically attaches the new object into a global linked list of objects and returns the address of the object.
	WndDraw (see page 296)	This function renders the object on the screen using the current parameter settings. Location of the object is determined by the left, top, right and bottom parameters. The colors used are dependent on the state of the object. The font used is determined by the style scheme set. When rendering objects of the same type, each object must be rendered completely before the rendering of the next object is started. This is to avoid incomplete object rendering.
	WndSetText (see page 297)	This function sets the string used for the title bar.
	WndTranslateMsg (see page 298)	This function evaluates the message from a user if the message will affect the object or not. The table below enumerates the translated messages for each event of the touch screen inputs.

Macros

Name	Description
WndGetText (see page 297)	This macro returns the address of the current text string used for the title bar.

Structures

Name	Description
WINDOW (see page 299)	The structure contains data for the window

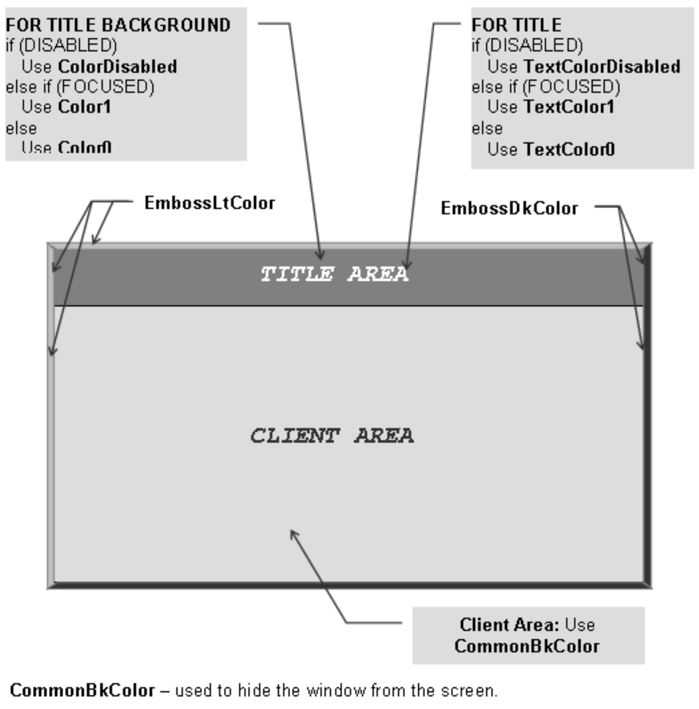
Description

Window supports only Touchscreen inputs, replying to their events with the following messages:

1. WND_MSG_TITLE – Title area is selected.

2. WND_MSG_CLIENT – Client area is selected.

The Window Object is rendered using the assigned style scheme. The following figure illustrates the color assignments.



8.1.24.1 Window States

Macros

Name	Description
WND_DISABLED (◲ see page 293)	Bit for disabled state
WND_DRAW (◲ see page 294)	Bits to indicate whole window must be redrawn
WND_DRAW_CLIENT (◲ see page 294)	Bit to indicate client area must be redrawn
WND_DRAW_TITLE (◲ see page 294)	Bit to indicate title area must be redrawn
WND_FOCUSED (◲ see page 294)	Bit for focus state
WND_HIDE (◲ see page 294)	Bit to indicate window must be removed from screen
WND_TITLECENTER (◲ see page 295)	Bit to center the text on the Title Area

Module

Window (◲ see page 292)

Description

List of Window (◲ see page 292) bit states.

8.1.24.1.1 WND_DISABLED Macro

File

Window.h (◲ see page 956)

C

```
#define WND_DISABLED 0x0002  // Bit for disabled state
```

Description

Bit for disabled state

8.1.24.1.2 WND_DRAW Macro

File

Window.h (see page 956)

C

```
#define WND_DRAW 0x6000  // Bits to indicate whole window must be redrawn
```

Description

Bits to indicate whole window must be redrawn

8.1.24.1.3 WND_DRAW_CLIENT Macro

File

Window.h (see page 956)

C

```
#define WND_DRAW_CLIENT 0x4000  // Bit to indicate client area must be redrawn
```

Description

Bit to indicate client area must be redrawn

8.1.24.1.4 WND_DRAW_TITLE Macro

File

Window.h (see page 956)

C

```
#define WND_DRAW_TITLE 0x2000  // Bit to indicate title area must be redrawn
```

Description

Bit to indicate title area must be redrawn

8.1.24.1.5 WND_FOCUSED Macro

File

Window.h (see page 956)

C

```
#define WND_FOCUSED 0x0001  // Bit for focus state
```

Description

Bit for focus state

8.1.24.1.6 WND_HIDE Macro

File

Window.h (see page 956)

C

```
#define WND_HIDE 0x8000  // Bit to indicate window must be removed from screen
```

Description

Bit to indicate window must be removed from screen

8.1.24.1.7 WND_TITLECENTER Macro

File

Window.h (see page 956)

C

```
#define WND_TITLECENTER 0x0004  // Bit to center the text on the Title Area
```

Description

Bit to center the text on the Title Area

8.1.24.2 WndCreate Function

File

Window.h (see page 956)

C

```
WINDOW * WndCreate(
    WORD ID,
    SHORT left,
    SHORT top,
    SHORT right,
    SHORT bottom,
    WORD state,
    void * pBitmap,
    XCHAR * pText,
    GOL_SCHEME * pScheme
);
```

Module

Window (see page 292)

Input Parameters

Input Parameters	Description
WORD ID	Unique user defined ID for the object instance.
SHORT left	Left most position of the Object.
SHORT top	Top most position of the Object.
SHORT right	Right most position of the Object.
SHORT bottom	Bottom most position of the object.
WORD state	Sets the initial state of the object.
void * pBitmap	Pointer to the bitmap used in the title bar.
XCHAR * pText	Pointer to the text used as a title of the window.
GOL_SCHEME * pScheme	Pointer to the style scheme used.

Side Effects

none

Returns

Returns the pointer to the object created

Preconditions

none

Example

```
WINDOW *pWindow;
    pWindow  = WndCreate(ID_WINDOW1,                // ID
                                0,0,GetMaxX(),GetMaxY(),   // whole screen dimension
                                WND_DRAW,                  // set state to draw all
                                (char*)myIcon,             // icon
                                "Place Title Here.",       // text
                                NULL);                     // use default GOL scheme

      if (pWindow == NULL)
          return 0;
      WndDraw(pWindow);
      return 1;
```

Overview

This function creates a WINDOW (see page 299) object with the parameters given. It automatically attaches the new object into a global linked list of objects and returns the address of the object.

Syntax

WINDOW (see page 299) *WndCreate(WORD ID, SHORT left, SHORT top, SHORT right, SHORT bottom, WORD state, void* pBitmap, XCHAR (see page 361)* pText, GOL_SCHEME (see page 345) *pScheme)

8.1.24.3 WndDraw Function

File

Window.h (see page 956)

C

```
WORD WndDraw(
    void * pObj
);
```

Module

Window (see page 292)

Input Parameters

Input Parameters	Description
pW	Pointer to the object to be rendered.

Side Effects

none

Returns

Returns the status of the drawing

- 1 - If the rendering was completed and
- 0 - If the rendering is not yet finished.

Next call to the function will resume the rendering on the pending drawing state.

Preconditions

Object must be created before this function is called.

Example

See WndCreate (see page 295)() example.

Overview

This function renders the object on the screen using the current parameter settings. Location of the object is determined by the left, top, right and bottom parameters. The colors used are dependent on the state of the object. The font used is determined by the style scheme set.

When rendering objects of the same type, each object must be rendered completely before the rendering of the next object is started. This is to avoid incomplete object rendering.

Syntax

WORD WndDraw(void *pObj)

8.1.24.4 WndGetText Macro

File

Window.h (see page 956)

C

```
#define WndGetText(pW) pW->pText
```

Module

Window (see page 292)

Input Parameters

Input Parameters	Description
pW	Pointer to the object

Side Effects

none

Returns

Returns pointer to the text string being used.

Preconditions

none

Example

```
WINDOW *pWindow;
XCHAR textUsed = “USE THIS!”;

    if (WndGetText(pWindow) == NULL)
        WndSetText(&textUsed);
```

Overview

This macro returns the address of the current text string used for the title bar.

Syntax

WndGetText(pW)

8.1.24.5 WndSetText Function

File

Window.h (see page 956)

C

```
void WndSetText(
    WINDOW * pW,
    XCHAR * pText
);
```

Module

Window (see page 292)

Input Parameters

Input Parameters	Description
WINDOW * pW	The pointer to the object whose text will be modified
XCHAR * pText	Pointer to the text that will be used

Side Effects

none

Returns

none

Preconditions

none

Example

See WndGetText (see page 297)() example.

Overview

This function sets the string used for the title bar.

Syntax

WndSetText(WINDOW (see page 299) *pW, XCHAR (see page 361) *pText)

8.1.24.6 WndTranslateMsg Function

File

Window.h (see page 956)

C

```
WORD WndTranslateMsg(
    void * pObj,
    GOL_MSG * pMsg
);
```

Module

Window (see page 292)

Input Parameters

Input Parameters	Description
GOL_MSG * pMsg	Pointer to the message struct containing the message from the user interface.
pW	The pointer to the object where the message will be evaluated to check if the message will affect the object.

Side Effects

none

Returns

Returns the translated message depending on the received GOL (see page 64) message:

- WND_MSG_TITLE – Title area is selected
- WND_MSG_CLIENT – Client area is selected
- OBJ_MSG_INVALID – Window (see page 292) is not affected

Preconditions

none

Example

Usage is similar to BtnTranslateMsg (see page 90)() example.

Overview

This function evaluates the message from a user if the message will affect the object or not. The table below enumerates the translated messages for each event of the touch screen inputs.

Translated Message	Input Source	Events	Description
WND_MSG_TITLE	Touch Screen	EVENT_PRESS, EVENT_RELEASE, EVENT_MOVE	If events occurs and the x,y position falls in the TITLE area of the window
WND_MSG_CLIENT	Touch Screen	EVENT_PRESS, EVENT_RELEASE, EVENT_MOVE	If events occurs and the x,y position falls in the CLIENT area of the window
OBJ_MSG_INVALID	Any	Any	If the message did not affect the object.

Syntax

WORD WndTranslateMsg(void *pObj, GOL_MSG (see page 330) *pMsg)

8.1.24.7 WINDOW Structure

File

Window.h (see page 956)

C

```
typedef struct {
  OBJ_HEADER hdr;
  SHORT textHeight;
  XCHAR * pText;
  void * pBitmap;
} WINDOW;
```

Members

Members	Description
OBJ_HEADER hdr;	Generic header for all Objects (see OBJ_HEADER (see page 68)).
SHORT textHeight;	Pre-computed text height
XCHAR * pText;	Pointer to the title text
void * pBitmap;	Pointer to the bitmap for the title bar

Module

Window (see page 292)

Overview

The structure contains data for the window

8.2 Object States

Objects rendered on the display are based on their current Property States and the Drawing States.

Macros

Name	Description
GetState (see page 302)	This macro retrieves the current value of the state bits of an object. It is possible to get several state bits.
ClrState (see page 303)	This macro clear the state bits of an object. Object must be redrawn to display the changes. It is possible to clear several state bits with this macro.
SetState (see page 303)	This macro sets the state bits of an object. Object must be redrawn to display the changes. It is possible to set several state bits with this macro.

Module

Graphics Object Layer (see page 64)

Description

The GOL (see page 64) objects follow two types of states, the Property States and the Drawing States. Property States defines action and appearance of objects. Drawing States on the other hand indicate if the object needs to be hidden, partially redrawn, or fully redrawn in the display. To store the states, the field state defined in OBJ_HEADER (see page 68) structure is used. Six most significant bits are allocated for Drawing States and the rest is allocated for the Property States. Some common Property States and Drawing States are shown in the following table.

State	Type	Bit Location	Description
OBJ_FOCUSED	P	0x0001	Object is in the focused state. This is usually used to show selection of the object. Not all objects have this feature.
OBJ_DISABLED	P	0x0002	Object is disabled and will ignore all messages.
OBJ_DRAW_FOCUS	D	0x2000	Focus for the object should be redrawn.
OBJ_DRAW	D	0x4000	Object should be redrawn completely.
OBJ_HIDE	D	0x8000	Object will be hidden by filling the area occupied by the object with the common background color. This has the highest priority over all Drawing States. When an object is set to be hidden, all other drawing states are overridden.

Where:

- OBJ – represent the prefix assigned to a GOL (see page 64) object.
- P – Property states, D – Drawing states

Individual Object drawing function (e.g. BtnDraw (see page 85)(), SldDraw (see page 257)(), etc...) does not reset the draw states instead use GOLDraw (see page 310)() to automatically reset and manage the draw states. If the call to individual drawing function cannot be avoided, draw states must be reset manually after the drawing functions returns a 1.

8.2.1 Common Object States

Macros

Name	Description
FOCUSED (see page 301)	Focus state bit.
DISABLED (see page 301)	Disabled state bit.
HIDE (see page 301)	Object hide state bit. Object will be hidden from the screen by drawing over it the common background color.
DRAW (see page 301)	Object redraw state bit. The whole Object must be redrawn.
DRAW_FOCUS (see page 302)	Focus redraw state bit. The focus rectangle must be redrawn.
DRAW_UPDATE (see page 302)	Partial Object redraw state bit. A part or parts of of the Object must be redrawn to show updated state.

Description

List of common Object bit states.

8.2.1.1 FOCUSED Macro

File

GOL.h (see page 571)

C

```
#define FOCUSED 0x0001
```

Description

Focus state bit.

8.2.1.2 DISABLED Macro

File

GOL.h (see page 571)

C

```
#define DISABLED 0x0002
```

Description

Disabled state bit.

8.2.1.3 HIDE Macro

File

GOL.h (see page 571)

C

```
#define HIDE 0x8000
```

Description

Object hide state bit. Object will be hidden from the screen by drawing over it the common background color.

8.2.1.4 DRAW Macro

File

GOL.h (see page 571)

C

```
#define DRAW 0x7C00
```

Description

Object redraw state bit. The whole Object must be redrawn.

8.2.1.5 DRAW_FOCUS Macro

File

GOL.h (see page 571)

C

```
#define DRAW_FOCUS 0x2000
```

Description

Focus redraw state bit. The focus rectangle must be redrawn.

8.2.1.6 DRAW_UPDATE Macro

File

GOL.h (see page 571)

C

```
#define DRAW_UPDATE 0x3C00
```

Description

Partial Object redraw state bit. A part or parts of of the Object must be redrawn to show updated state.

8.2.2 GetState Macro

File

GOL.h (see page 571)

C

```
#define GetState(pObj, stateBits) (((OBJ_HEADER *)pObj)->state & (stateBits))
```

Input Parameters

Input Parameters	Description
pObj	Pointer to the object of interest.
stateBits	Defines which state bits are requested. Please refer to specific objects for object state bits definition for details

Side Effects

none

Returns

Macro returns a non-zero if any bit in the stateBits mask is set.

Preconditions

none

Example

```
#define BTN_HIDE 0x8000
BUTTON *pB;
// pB is created and initialized
// do something here to set state

// Hide the button (remove from screen)
if (GetState(pB,BTN_HIDE)) {
    SetColor(pB->pGolScheme->CommonBkColor);
    Bar(pB->left,pB->top,pB->right,pB->bottom);

}
```

Overview

This macro retrieves the current value of the state bits of an object. It is possible to get several state bits.

Syntax

GetState(pObj, stateBits)

8.2.3 ClrState Macro

File

GOL.h (see page 571)

C

```
#define ClrState(pObj, stateBits) ((OBJ_HEADER *)pObj)->state &= (~(stateBits))
```

Input Parameters

Input Parameters	Description
pObj	Pointer to the object of interest.
stateBits	Defines which state bits are to be cleared. Please refer to specific objects for object state bits definition for details

Side Effects

none

Returns

none

Preconditions

none

Example

See example for SetState (see page 303)().

Overview

This macro clear the state bits of an object. Object must be redrawn to display the changes. It is possible to clear several state bits with this macro.

Syntax

ClrState(pObj, stateBits)

8.2.4 SetState Macro

File

GOL.h (see page 571)

C

```
#define SetState(pObj, stateBits) ((OBJ_HEADER *)pObj)->state |= (stateBits)
```

Input Parameters

Input Parameters	Description
pObj	Pointer to the object of interest.
stateBits	Defines which state bits are to be set. Please refer to specific objects for object state bits definition for details

Side Effects

none

Returns

none

Preconditions

none

Example

```
void BtnMsgDefault(WORD msg, BUTTON* pB){
    switch(msg){
        case BTN_MSG_PRESSED:
            // set pressed and redraw
            SetState(pB, BTN_PRESSED|BTN_DRAW);
            break;
        case BTN_MSG_RELEASED:
            ClrState(pB, BTN_PRESSED);       // reset pressed
            SetState(pB, BTN_DRAW);          // redraw
            break;
    }
}
```

Overview

This macro sets the state bits of an object. Object must be redrawn to display the changes. It is possible to set several state bits with this macro.

Syntax

SetState(pObj, stateBits)

8.3 Object Management

Functions

	Name	Description
◆	GOLAddObject (see page 306)	This function adds an object to the tail of the active list pointed to by _pGolObjects (see page 349). The new list tail is set to point to NULL.
◆	GOLFindObject (see page 307)	This function finds an object in the active list pointed to by _pGolObjects (see page 349) using the given object ID.
◆	GOLRedrawRec (see page 309)	This function marks all objects in the active list intersected by the given rectangular area to be redrawn.
◆	GOLDraw (see page 310)	This function loops through the active list and redraws objects that need to be redrawn. Partial redrawing or full redraw is performed depending on the drawing states of the objects. GOLDrawCallback (see page 311)() function is called by GOLDraw() when drawing of objects in the active list is completed.

◆	GOLDrawCallback (see page 311)	GOLDrawCallback() function MUST BE implemented by the user. This is called inside the GOLDraw (see page 310)() function when the drawing of objects in the active list is completed. User drawing must be done here. Drawing color, line type, clipping region, graphic cursor position and current font will not be changed by GOL (see page 64) if this function returns a zero. To pass drawing control to GOL (see page 64) this function must return a non-zero value. If GOL (see page 64) messaging is not using the active link list, it is safe to modify the list here.
◆	GOLFree (see page 312)	This function frees all the memory used by objects in the active list and initializes _pGolObjects (see page 349) pointer to NULL to start a new empty list. This function must be called only inside the GOLDrawCallback (see page 311)()function when using GOLDraw (see page 310)() and GOLMsg (see page 328)() functions. This requirement assures that primitive rendering settings are not altered by the rendering state machines of the objects.
◆	GOLDeleteObject (see page 315)	deletes an object to the linked list objects for the current screen.
◆	GOLDeleteObjectByID (see page 315)	Deletes an object in the current active linked list of objects using the ID parameter of the object.
◆	GOLSetFocus (see page 318)	This function sets the keyboard input focus to the object. If the object cannot accept keyboard messages focus will not be changed. This function resets FOCUSED (see page 301) state for the object was in focus previously, set FOCUSED (see page 301) state for the required object and marks the objects to be redrawn.
◆	GOLInit (see page 320)	This function initializes the graphics library and creates a default style scheme with default settings referenced by the global scheme pointer. GOLInit() function must be called before GOL (see page 64) functions can be used. It is not necessary to call GraphInit() function if this function is used.
◆	GOLCanBeFocused (see page 321)	This function returns non-zero if the object can be focused. Only button, check box, radio button, slider, edit box, list box, scroll bar can accept focus. If the object is disabled it cannot be set to focused state.
◆	GOLGetFocusNext (see page 321)	This function returns the pointer to the next object in the active linked list which is able to receive keyboard input.
◆	GOLGetFocusPrev (see page 322)	This function returns the pointer to the previous object in the active linked list which is able to receive keyboard input.
◆	GOLPanelDrawTsk (see page 324)	This function draws a panel on the screen with parameters set by GOLPanelDraw (see page 322)() macro. This function must be called repeatedly (depending on the return value) for a successful rendering of the panel.
◆	GOLTwoTonePanelDrawTsk (see page 324)	This function draws a two tone panel on the screen with parameters set by GOLPanelDraw (see page 322)() macro. This function must be called repeatedly (depending on the return value) for a successful rendering of the panel.

Macros

Name	Description
GOLRedraw (see page 308)	This macro sets the object to be redrawn. For the redraw to be effective, the object must be in the current active list. If not, the redraw action will not be performed until the list where the object is currently inserted will be set to be the active list.
GOLDrawComplete (see page 310)	This macro resets the drawing states of the object (6 MSBits of the object's state).
GetObjType (see page 313)	This macro returns the object type.
GetObjID (see page 313)	This macro returns the object ID.
GetObjNext (see page 314)	This macro returns the next object after the specified object.

GOLNewList (see page 316)	This macro starts a new linked list of objects and resets the keyboard focus to none. This macro assigns the current active list _pGolObjects (see page 349) and current receiving keyboard input _pObjectFocused (see page 349) object pointers to NULL. Any keyboard inputs at this point will be ignored. Previous active list must be saved in another pointer if to be referenced later. If not needed anymore memory used by that list should be freed by GOLFree (see page 312)() function.
GOLGetList (see page 317)	This macro gets the current active list.
GOLSetList (see page 317)	This macro sets the given object list as the active list and resets the keyboard focus to none. This macro assigns the receiving keyboard input object _pObjectFocused (see page 349) pointer to NULL. If the new active list has an object's state set to focus, the _pObjectFocused (see page 349) pointer must be set to this object or the object's state must be change to unfocused. This is to avoid two objects displaying a focused state when only one object in the active list must be set to a focused state at anytime.
IsObjUpdated (see page 319)	This macro tests if the object is pending to be redrawn. This is done by testing the 6 MSBits of object's state to detect if the object must be redrawn.
GOLGetFocus (see page 320)	This macro returns the pointer to the current object receiving keyboard input.
GOLPanelDraw (see page 322)	This macro sets the parameters to draw a panel. Panel is not an object. It will not be added to the active list. Use GOLPanelDrawTsk (see page 324)() to display the panel on the screen. The following relationships of the parameters determines the general shape of the button: 1. Panel width is determined by right - left. 2. Panel height is determined by top - bottom. 3. Panel radius - specifies if the panel will have a rounded edge. If zero then the panel will have sharp (cornered) edge. 4. If 2*radius = height = width, the panel is circular.

Module

Graphics Object Layer (see page 64)

Description

This section describes the API functions and macros that are used to create, maintain and render individual and list of objects.

8.3.1 GOLAddObject Function

File

GOL.h (see page 571)

C

```
void GOLAddObject(
    OBJ_HEADER * object
);
```

Input Parameters

Input Parameters	Description
pObj	Pointer to the object to be added on the current active list.

Side Effects

none

Returns

none

Preconditions

none

Example

```
void MoveObject(OBJ_HEADER *pSrcList, OBJ_HEADER *pDstList,
    OBJ_HEADER *pObjtoMove) {
    OBJ_HEADER *pTemp = pSrcList;

    if(pTemp != pObjtoMove) {
        while(pTemp->pNxtObj != pObjtoMove)
            pTemp = pTemp->pNxtObj;
    }

    pTemp->pNxtObj = pObjtoMove ->pNxt; // remove object from list
    GOLSetList(pDstList);               // destination as active list
    GOLAddObject(pObjtoMove);           // add object to active list
}
```

Overview

This function adds an object to the tail of the active list pointed to by _pGolObjects (see page 349). The new list tail is set to point to NULL.

Syntax

void GOLAddObject(OBJ_HEADER (see page 68)* object)

8.3.2 GOLFindObject Function

File

GOL.h (see page 571)

C

```
OBJ_HEADER * GOLFindObject(
    WORD ID
);
```

Input Parameters

Input Parameters	Description
WORD ID	User assigned value set during the creation of the object.

Side Effects

none

Returns

Pointer to the object with the given ID.

Preconditions

none

Example

```
void CopyObject(OBJ_HEADER *pSrcList, OBJ_HEADER *pDstList, WORD ID)
{
    OBJ_HEADER *pTemp;

    pTemp = GOLFindObject(ID);              // find the object
    if (pTemp != NULL) {
        GOLSetList(pDstList);               // destination as active list
        GOLAddObject(pObj);                 // add object to active list
    }
}
```

Overview

This function finds an object in the active list pointed to by _pGolObjects (see page 349) using the given object ID.

Syntax

OBJ_HEADER (see page 68)* GOLFindObject(WORD ID)

8.3.3 GOLRedraw Macro

File

GOL.h (see page 571)

C

```
#define GOLRedraw(pObj) ((OBJ_HEADER *)pObj)->state |= 0x7c00;
```

Input Parameters

Input Parameters	Description
pObj	Pointer to the object to be redrawn.

Side Effects

none

Returns

none

Preconditions

none

Example

```
void GOLRedrawRec(SHORT left, SHORT top, SHORT right, SHORT bottom) {
    // set all objects encompassed by the rectangle to be redrawn
    OBJ_HEADER *pCurrentObj;

    pCurrentObj = GOLGetList();
    while(pCurrentObj != NULL){
        if (
            ((pCurrentObj->left >= left) && (pCurrentObj->left <= right)) ||
            ((pCurrentObj->right >= left) && (pCurrentObj->right <= right))||
            ((pCurrentObj->top >= top) && (pCurrentObj->top <= bottom)) ||
            ((pCurrentObj->bottom >= top) && (pCurrentObj->bottom <= bottom))){
                GOLRedraw(pCurrentObj);
        }
        pCurrentObj = pCurrentObj->pNxtObj;
    }//end of while
}
```

Overview

This macro sets the object to be redrawn. For the redraw to be effective, the object must be in the current active list. If not, the redraw action will not be performed until the list where the object is currently inserted will be set to be the active list.

Syntax

GOLRedraw(pObj)

8.3.4 GOLRedrawRec Function

File

GOL.h (see page 571)

C

```
void GOLRedrawRec(
    SHORT left,
    SHORT top,
    SHORT right,
    SHORT bottom
);
```

Input Parameters

Input Parameters	Description
SHORT left	Defines the left most border of the rectangle area.
SHORT top	Defines the top most border of the rectangle area.
SHORT right	Defines the right most border of the rectangle area.
SHORT bottom	Defines the bottom most border of the rectangle area.

Side Effects

none

Returns

none

Preconditions

none

Example

```
OBJ_HEADER *pTemp;
OBJ_HEADER *pAllObjects;

// assume *pAllObjects points to a list of all existing objects
// created and initialized

// mark all objects inside the rectangle to be redrawn
GOLRedrawRec(10,10,100,100);

pTemp = pAllObjects;
GOLStartNewList();                      // reset active list
while(pTemp->pNxtObj != NULL) {
    if (pTemp->state&0x7C00)            // add only objects to be
    GOLAddObject(pTemp);                // redrawn to the active list
    pTemp = pTemp->pNxtObj;
}
GOLDraw();                              // redraw active list
```

Overview

This function marks all objects in the active list intersected by the given rectangular area to be redrawn.

Syntax

void GOLRedrawRec(SHORT left, SHORT top, SHORT right, SHORT bottom)

8.3.5 GOLDraw Function

File

GOL.h (see page 571)

C

```
WORD GOLDraw();
```

Side Effects

none

Returns

Non-zero if the active link list drawing is completed.

Preconditions

none

Example

```
// Assume objects are created & states are set to draw objects
while(1){
    if(GOLDraw()){              // parse active list and redraw objects that needs to be
redrawn

        // here GOL drawing is completed
        // it is safe to modify objects states and linked list

        TouchGetMsg(&msg);      // evaluate messages from touch screen device

        GOLMsg(&msg);           // evaluate each object is affected by the message
    }
}
```

Overview

This function loops through the active list and redraws objects that need to be redrawn. Partial redrawing or full redraw is performed depending on the drawing states of the objects. GOLDrawCallback (see page 311)() function is called by GOLDraw() when drawing of objects in the active list is completed.

Syntax

WORD GOLDraw()

8.3.6 GOLDrawComplete Macro

File

GOL.h (see page 571)

C

```
#define GOLDrawComplete(pObj) ((OBJ_HEADER *)pObj)->state &= 0x03ff
```

Input Parameters

Input Parameters	Description
pObj	Pointer to the object of interest.

Side Effects

none

Returns

none

Preconditions

none

Example

```
// This function should be called again whenever an incomplete
// rendering (done = 0) of an object occurs.
// internal states in the BtnDraw() or WndDraw() should pickup
// on the state where it left off to continue rendering.
void GOLDraw() {
    static OBJ_HEADER *pCurrentObj = NULL;
    SHORT done;

    if(pCurrentObj == NULL) {
        if(GOLDrawCallback()) {
            // If it's last object jump to head
            pCurrentObj = GOLGetList();
        } else {
            return;
        }
    }
    done = 0;

    while(pCurrentObj != NULL) {
        if(IsObjUpdated(pCurrentObj)) {
            done = pCurrentObj->draw(pCurrentObj);

            if(done){
                GOLDrawComplete(pCurrentObj);
            }else{
                return;
            }
        }
        pCurrentObj = pCurrentObj->pNxtObj;
    }
}
```

Overview

This macro resets the drawing states of the object (6 MSBits of the object's state).

Syntax

GOLDrawComplete(pObj)

8.3.7 GOLDrawCallback Function

File

GOL.h (see page 571)

C

```
WORD GOLDrawCallback();
```

Side Effects

none

Returns

Return a one if GOLDraw (see page 310)() will have drawing control on the active list. Return a zero if user wants to keep the drawing control.

Preconditions

none

Example

```
#define SIG_STATE_SET   0
#define SIG_STATE_DRAW  1
WORD GOLDrawCallback(){
    static BYTE state = SIG_STATE_SET;
    if(state == SIG_STATE_SET){
        // Draw the button with disabled colors
        GOLPanelDraw(SIG_PANEL_LEFT,SIG_PANEL_TOP,
                     SIG_PANEL_RIGHT,SIG_PANEL_BOTTOM, 0,
                     WHITE, altScheme->EmbossLtColor,
                     altScheme->EmbossDkColor,
                     NULL, GOL_EMBOSS_SIZE);

        state = SIG_STATE_DRAW;
    }

    if(!GOLPanelDrawTsk()){
        // do not return drawing control to GOL
        // drawing is not complete
        return 0;
    }else{
        state = SIG_STATE_SET;
        // return drawing control to GOL, drawing is complete
        return 1;
    }
}
```

Overview

GOLDrawCallback() function MUST BE implemented by the user. This is called inside the GOLDraw (see page 310)() function when the drawing of objects in the active list is completed. User drawing must be done here. Drawing color, line type, clipping region, graphic cursor position and current font will not be changed by GOL (see page 64) if this function returns a zero. To pass drawing control to GOL (see page 64) this function must return a non-zero value. If GOL (see page 64) messaging is not using the active link list, it is safe to modify the list here.

Syntax

WORD GOLDrawCallback()

8.3.8 GOLFree Function

File

GOL.h (see page 571)

C

```
void GOLFree();
```

Side Effects

All objects in the active list are deleted from memory.

Returns

none

Preconditions

none

Example

```
void DeletePage(OBJ_HEADER *pPage) {
        OBJ_HEADER *pTemp;

        // assuming pPage is different from the current active list
        pTemp = GOLGetList();                // save the active list
        GOLSetList(pPage);                   // set list as active list
        GolFree();                           // pPage objects are deleted

        GOLSetList(pTemp);                   // restore the active list
    }
```

Overview

This function frees all the memory used by objects in the active list and initializes _pGolObjects (see page 349) pointer to NULL to start a new empty list. This function must be called only inside the GOLDrawCallback (see page 311)()function when using GOLDraw (see page 310)() and GOLMsg (see page 328)() functions. This requirement assures that primitive rendering settings are not altered by the rendering state machines of the objects.

Syntax

void GOLFree()

8.3.9 GetObjType Macro

File

GOL.h (see page 571)

C

```
#define GetObjType(pObj) ((OBJ_HEADER *)pObj)->type
```

Input Parameters

Input Parameters	Description
pObj	Pointer to the object of interest.

Side Effects

none

Returns

Returns the OBJ_TYPE of the object.

Preconditions

none

Overview

This macro returns the object type.

Syntax

GetObjType(pObj)

8.3.10 GetObjID Macro

File

GOL.h (see page 571)

C

```
#define GetObjID(pObj) ((OBJ_HEADER *)pObj)->ID
```

Input Parameters

Input Parameters	Description
pObj	Pointer to the object of interest.

Side Effects

none

Returns

Returns the ID of the object.

Preconditions

none

Example

```
void UseOfGetObjID(OBJ_HEADER *pObj) {
    WORD id;
        switch(id = GetObjID(pObj)) {
            case ID_WINDOW1:
                // do something
            case ID_WINDOW2:
                // do something else
            case ID_WINDOW3:
                // do something else
            default:
                // do something else
        }
}
```

Overview

This macro returns the object ID.

Syntax

GetObjID(pObj)

8.3.11 GetObjNext Macro

File

GOL.h (see page 571)

C

```
#define GetObjNext(pObj) ((OBJ_HEADER *)pObj)->pNxtObj
```

Input Parameters

Input Parameters	Description
pObj	Pointer to the object of interest.

Side Effects

none

Returns

Returns the pointer of the next object.

Preconditions

none

Example

```
// This is the same example for the GetObjType() macro
// We just replaced one line
void RedrawButtons(void) {
    OBJ_HEADER *pCurr;

    pCurr = GOLGetList();                // get active list
    while(pCurr->pNxtObj != NULL) {
        if (GetObjType(pCurr) == BUTTON)
            pCurr->state = BTN_DRAW;     // set button to be redrawn
        pCurr = GetObjNext(pCurr);       // Use of GetObjNext() macro
        // replaces the old line
    }
    GolDraw();                           // redraw all buttons in the
                                         // active list
}
```

Overview

This macro returns the next object after the specified object.

Syntax

GetObjNext(pObj)

8.3.12 GOLDeleteObject Function

File

GOL.h (see page 571)

C

```
BOOL GOLDeleteObject(
    OBJ_HEADER * object
);
```

Side Effects

none

Returns

none

Notes

none

Preconditions

none

Overview

deletes an object to the linked list objects for the current screen.

Syntax

BOOL GOLDeleteObject(OBJ_HEADER (see page 68) * object)

8.3.13 GOLDeleteObjectByID Function

File

GOL.h (see page 571)

C

```
BOOL GOLDeleteObjectByID(
    WORD ID
);
```

Side Effects

none

Returns

none

Notes

none

Preconditions

none

Overview

Deletes an object in the current active linked list of objects using the ID parameter of the object.

Syntax

BOOL GOLDeleteObjectByID(WORD ID)

8.3.14 GOLNewList Macro

File

GOL.h (see page 571)

C

```
#define GOLNewList \
    _pGolObjects = NULL; \
    _pObjectFocused = NULL
```

Side Effects

This macro sets the focused object pointer (_pObjectFocused (see page 349)) to NULL.

Returns

none

Preconditions

none

Example

```
OBJ_HEADER *pSave;

pSave = GOLGetList();            // save current list
GOLNewList();                    // start the new list
                                 // current list is now NULL

// assume that objects are already created
// you can now add objects to the new list
GOLAddObject(pButton);
GOLAddObject(pWindow);
GOLAddObject(pSlider);
```

Overview

This macro starts a new linked list of objects and resets the keyboard focus to none. This macro assigns the current active list _pGolObjects (see page 349) and current receiving keyboard input _pObjectFocused (see page 349) object pointers to NULL. Any keyboard inputs at this point will be ignored. Previous active list must be saved in another pointer if to be referenced later. If not needed anymore memory used by that list should be freed by GOLFree (see page 312)() function.

Syntax

void GOLNewList()

8.3.15 GOLGetList Macro

File

GOL.h (see page 571)

C

```
#define GOLGetList _pGolObjects
```

Side Effects

none

Returns

Returns the pointer to the current active list.

Preconditions

none

Example

See GOLNewList (see page 316)() example.

Overview

This macro gets the current active list.

Syntax

GOLGetList()

8.3.16 GOLSetList Macro

File

GOL.h (see page 571)

C

```
#define GOLSetList(objsList) \
    _pGolObjects = objsList;     \
    _pObjectFocused = NULL
```

Input Parameters

Input Parameters	Description
objsList	The pointer to the new active list.

Side Effects

This macro sets the focused object pointer (_pObjectFocused (see page 349)) to NULL. Previous active list should be saved if needed to be referenced later. If not, use GOLFree (see page 312)() function to free the memory used by the objects before calling GOLSetList().

Returns

none

Preconditions

none

Example

```
OBJ_HEADER *pSave;
pSave = GOLGetList();           // save current list
GOLNewList();                   // start the new list
                                // current list is now NULL

// you can now add objects to the current list
// assume that objects are already created
GOLAddObject(pButton);
GOLAddObject(pWindow);
GOLAddObject(pSlider);

// do something here on the new list
// return the old list
GOLSetList(pSave);
```

Overview

This macro sets the given object list as the active list and resets the keyboard focus to none. This macro assigns the receiving keyboard input object _pObjectFocused (see page 349) pointer to NULL. If the new active list has an object's state set to focus, the _pObjectFocused (see page 349) pointer must be set to this object or the object's state must be change to unfocused. This is to avoid two objects displaying a focused state when only one object in the active list must be set to a focused state at anytime.

Syntax

GOLSetList(objsList)

8.3.17 GOLSetFocus Function

File

GOL.h (see page 571)

C

```
void GOLSetFocus(
    OBJ_HEADER * object
);
```

Input Parameters

Input Parameters	Description
OBJ_HEADER * object	Pointer to the object of interest.

Side Effects

none

Returns

none

Preconditions

none

Overview

This function sets the keyboard input focus to the object. If the object cannot accept keyboard messages focus will not be changed. This function resets FOCUSED (see page 301) state for the object was in focus previously, set FOCUSED (see page 301) state for the required object and marks the objects to be redrawn.

Syntax

void GOLSetFocus(OBJ_HEADER (see page 68)* object)

8.3.18 IsObjUpdated Macro

File

GOL.h (see page 571)

C

```
#define IsObjUpdated(pObj) (((OBJ_HEADER *)pObj)->state & 0xfc00)
```

Input Parameters

Input Parameters	Description
pObj	Pointer to the object of interest.

Side Effects

none

Returns

Returns a nonzero value if the object needs to be redrawn. Zero if not.

Preconditions

none

Example

```
int DrawButtonWindowOnly() {
    static OBJ_HEADER *pCurrentObj = NULL;
    SHORT done = 0;

    if (pCurrentObj == NULL)
        pCurrentObj = GOLGetList();         // get current list

    while(pCurrentObj != NULL){
        if(IsObjUpdated(pCurrentObj)){
            done = pCurrentObj->draw(pCurrentObj);

            // reset state of object if done
            if (done)
                GOLDrawComplete(pCurrentObj)
            // Return if not done. This means that BtnDraw()
            // was terminated prematurely by device busy status
            // and must be recalled to finish rendering of
            // objects in the list that have new states.
            else
                return 0;
        }
        // go to the next object in the list
        pCurrentObj = pCurrentObj->pNxtObj;
    }
    return 1;
}
```

Overview

This macro tests if the object is pending to be redrawn. This is done by testing the 6 MSBits of object's state to detect if the object must be redrawn.

Syntax

IsObjUpdated(pObj)

8.3.19 GOLInit Function

File

GOL.h (see page 571)

C

```
void GOLInit();
```

Side Effects

This sets the line type to SOLID_LINE (see page 369), sets the screen to all BLACK (see page 409), sets the current drawing color to WHITE (see page 415), sets the graphic cursor position to upper left corner of the screen, sets active and visual pages to page #0, clears the active page and disables clipping. This also creates a default style scheme.

Returns

none

Preconditions

none

Overview

This function initializes the graphics library and creates a default style scheme with default settings referenced by the global scheme pointer. GOLInit() function must be called before GOL (see page 64) functions can be used. It is not necessary to call GraphInit() function if this function is used.

Syntax

void GOLInit()

8.3.20 GOLGetFocus Macro

File

GOL.h (see page 571)

C

```
#define GOLGetFocus _pObjectFocused
```

Side Effects

none

Returns

Returns the pointer to the object receiving keyboard input. If there is no object in focus NULL is returned.

Preconditions

none

Overview

This macro returns the pointer to the current object receiving keyboard input.

Syntax

GOLGetFocus()

8.3.21 GOLCanBeFocused Function

File

GOL.h (see page 571)

C

```
WORD GOLCanBeFocused(
    OBJ_HEADER * object
);
```

Input Parameters

Input Parameters	Description
OBJ_HEADER * object	Pointer to the object of interest.

Side Effects

none

Returns

This returns a non-zero if the object can be focused and zero if not.

Preconditions

none

Overview

This function returns non-zero if the object can be focused. Only button, check box, radio button, slider, edit box, list box, scroll bar can accept focus. If the object is disabled it cannot be set to focused state.

Syntax

WORD GOLCanBeFocused(OBJ_HEADER (see page 68)* object)

8.3.22 GOLGetFocusNext Function

File

GOL.h (see page 571)

C

```
OBJ_HEADER * GOLGetFocusNext();
```

Side Effects

none

Returns

This returns the pointer of the next object in the active list capable of receiving keyboard input. If there is no object capable of receiving keyboard inputs (i.e. none can be focused) NULL is returned.

Preconditions

none

Overview

This function returns the pointer to the next object in the active linked list which is able to receive keyboard input.

Syntax

OBJ_HEADER (see page 68) *GOLGetFocusNext()

8.3.23 GOLGetFocusPrev Function

File

GOL.h (see page 571)

C

```
OBJ_HEADER * GOLGetFocusPrev();
```

Side Effects

none

Returns

This returns the pointer of the previous object in the active list capable of receiving keyboard input. If there is no object capable of receiving keyboard inputs (i.e. none can be focused) NULL is returned.

Preconditions

none

Overview

This function returns the pointer to the previous object in the active linked list which is able to receive keyboard input.

Syntax

OBJ_HEADER (see page 68) *GOLGetFocusNext (see page 321)()

8.3.24 GOLPanelDraw Macro

File

GOL.h (see page 571)

C

```
#define GOLPanelDraw(left, top, right, bottom, radius, faceClr, embossLtClr, embossDkClr,
pBitmap, embossSize) \
    _rpnlX1 =
left;                                                                          \
    _rpnlY1 =
top;                                                                           \
    _rpnlX2 =
right;                                                                         \
    _rpnlY2 =
bottom;                                                                        \
    _rpnlR =
radius;                                                                         \
    _rpnlFaceColor =
faceClr;                                                                 \
    _rpnlEmbossLtColor =
embossLtClr;                                                          \
    _rpnlEmbossDkColor =
embossDkClr;                                                          \
    _pRpnlBitmap =
pBitmap;                                                                \
    _rpnlEmbossSize = embossSize;
```

Input Parameters

Input Parameters	Description
left	Panel's left most position.
top	Panel's top most position.
right	Panel's right most position.
bottom	Panel's bottom most position.
radius	The radius of the rounded corner of the panel.
faceClr	Defines the face color of the panel.
embossLtClr	Defines the emboss light color.
embossDkClr	Defines the emboss dark color.
pBitmap	Defines the bitmap used in the face of the panel.
embossSize	Defines the emboss size of the panel.

Side Effects

none

Returns

none

Preconditions

none

Example

```
// Dimensions for signature box
#define SIG_PANEL_LEFT      10
#define SIG_PANEL_RIGHT    310
#define SIG_PANEL_TOP       50
#define SIG_PANEL_BOTTOM   170

#define SIG_STATE_SET   0
#define SIG_STATE_DRAW  1

GOL_SCHEME *altScheme;           // style scheme

// Draws box for signature
WORD PanelSignature() {
    static BYTE state = SIG_STATE_SET;

    if(state == SIG_STATE_SET){
        // set data for panel drawing (radius = 0)
        // assume altScheme is defined
        GOLPanelDraw(SIG_PANEL_LEFT,SIG_PANEL_TOP,
                     SIG_PANEL_RIGHT,SIG_PANEL_BOTTOM,0,
                     WHITE,
                     altScheme->EmbossLtColor,
                     altScheme->EmbossDkColor,
                     NULL, GOL_EMBOSS_SIZE);

        state = SIG_STATE_DRAW; // change state
    }

    if(!GOLPanelDrawTsk())
        return 0; // drawing is not completed
    } else {
        state = SIG_STATE_SET; // set state to initial
        return 1; // drawing is done
    }
}
```

Overview

This macro sets the parameters to draw a panel. Panel is not an object. It will not be added to the active list. Use GOLPanelDrawTsk (see page 324)() to display the panel on the screen. The following relationships of the parameters determines the general shape of the button:

1. Panel width is determined by right - left.
2. Panel height is determined by top - bottom.
3. Panel radius - specifies if the panel will have a rounded edge. If zero then the panel will have sharp (cornered) edge.
4. If 2*radius = height = width, the panel is circular.

Syntax

GOLPanelDraw(left, top, right, bottom, radius, faceClr, embossLtClr, embossDkClr, pBitmap, embossSize)

8.3.25 GOLPanelDrawTsk Function

File

GOL.h (see page 571)

C

```
WORD GOLPanelDrawTsk();
```

Side Effects

none

Returns

Returns the status of the panel rendering

```
        0 – Rendering of the panel is not yet finished.
        1 – Rendering of the panel is finished.
```

Preconditions

Parameters of the panel must be set by GOLPanelDraw (see page 322)() macro.

Example

See GOLPanelDraw (see page 322)() example.

Overview

This function draws a panel on the screen with parameters set by GOLPanelDraw (see page 322)() macro. This function must be called repeatedly (depending on the return value) for a successful rendering of the panel.

Syntax

WORD GOLPanelDrawTsk()

8.3.26 GOLTwoTonePanelDrawTsk Function

File

GOL.h (see page 571)

C

```
WORD GOLTwoTonePanelDrawTsk();
```

Side Effects

none

Returns

Returns the status of the panel rendering

```
        0 – Rendering of the panel is not yet finished.
        1 – Rendering of the panel is finished.
```

Preconditions

Parameters of the panel must be set by GOLPanelDraw (see page 322)() macro.

Example

Usage is similar to GOLPanelDraw (see page 322)() example.

Overview

This function draws a two tone panel on the screen with parameters set by GOLPanelDraw (see page 322)() macro. This function must be called repeatedly (depending on the return value) for a successful rendering of the panel.

Syntax

WORD GOLTwoTonePanelDrawTsk()

8.4 GOL Messages

The library provides an interface to accept messages from the input devices.

Enumerations

Name	Description
TRANS_MSG (see page 331)	This structure defines the list of translated messages for GOL (see page 64) Objects used in the library.
INPUT_DEVICE_EVENT (see page 333)	This structure defines the types of GOL (see page 64) message events used in the library.
INPUT_DEVICE_TYPE (see page 333)	This structure defines the types of input devices used in the library.

Functions

	Name	Description
	GOLMsg (see page 328)	This function receives a GOL (see page 64) message from user and loops through the active list of objects to check which object is affected by the message. For affected objects the message is translated and GOLMsgCallback (see page 328)() is called. In the call back function, user has the ability to implement action for the message. If the call back function returns non-zero OBJMsgDefault() is called to process message for the object by default. If zero is returned OBJMsgDefault() is not called. Please refer to GOL (see page 64) Messages section for deatils. This function should be called when GOL (see page 64) drawing is completed. It can be done... more (see page 328)
	GOLMsgCallback (see page 328)	The user MUST implement this function. GOLMsg (see page 328)() calls this function when a valid message for an object in the active list is received. User action for the message should be implemented here. If this function returns non-zero, the message for the object will be processed by default. If zero is returned, GOL (see page 64) will not perform any action.

Module

Graphics Object Layer (see page 64)

Structures

Name	Description
GOL_MSG (see page 330)	This structure defines the GOL (see page 64) message used in the library. • The types must be one of the INPUT_DEVICE_TYPE (see page 333): • TYPE_UNKNOWN • TYPE_KEYBOARD • TYPE_TOUCHSCREEN • TYPE_MOUSE • uiEvent must be one of the INPUT_DEVICE_EVENT (see page 333). • for touch screen: • EVENT_INVALID • EVENT_MOVE • EVENT_PRESS • EVENT_STILLPRESS • EVENT_RELEASE • for keyboard: • EVENT_KEYSCAN (param2 contains scan code) • EVENT_KEYCODE (param2 contains character code) • param1: • for touch screen is the x position • for keyboard ID of object receiving the message • param2 • for touch screen y position • for keyboard scan or key code

Description

To facilitate the processing of user actions on the objects, messaging are used.

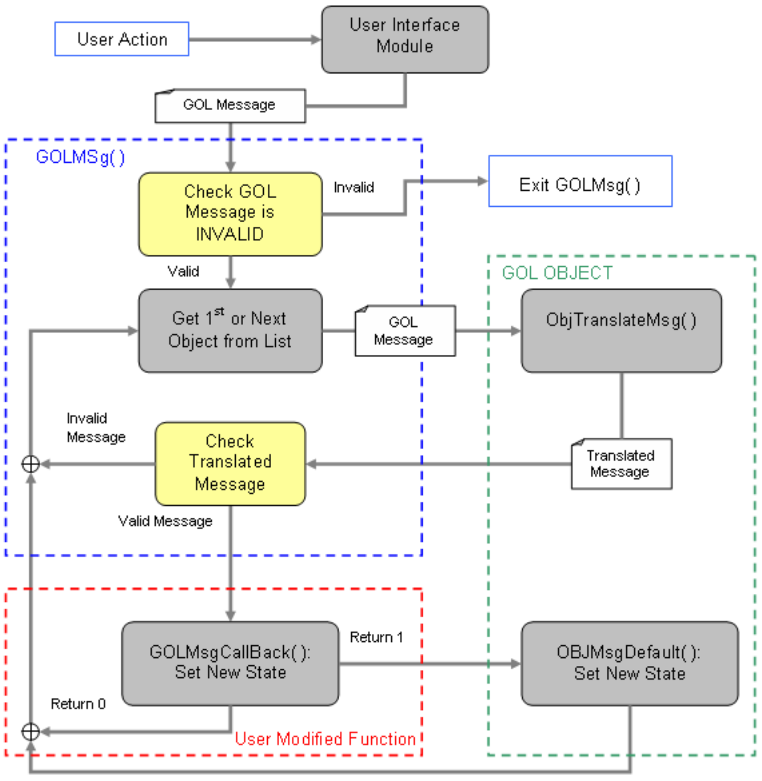
User passes messages from the input devices to GOL (see page 64) using the GOL (see page 64) message structure. The structure is described by the following table.

```
typedef struct {
    BYTE         type;
    BYTE         uiEvent;
    int          param1;
    int          param2;
} GOL_MSG;
```

Field	Description
type	Defines the type of device where the message was created. These are the devices implemented in the User Interface Layer. Possible device types are the following: TYPE_UNKNOWN TYPE_KEYBOARD TYPE_TOUCHSCREEN TYPE_MOUSE

uiEvent	Event ID of the user or device type action on the object. Possible event IDs are the following: EVENT_INVALID EVENT_MOVE EVENT_PRESS EVENT_STILLPRESS EVENT_RELEASE EVENT_KEYSCAN EVENT_CHARCODE
param1 param2	Parameters 1 and 2 definition varies from device types. For example, param1 and param2 are defined as x-coordinate position and y-coordinate position respectively for TYPE_TOUCHSCREEN. For TYPE_KEYBOARD, param1 is defined as the ID of the receiving object and param2 is defined as the keyboard scan or character code.

GOLMsg (see page 328)() function accepts this structure and processes the message for all objects in the active list.



Messaging Flow

The messaging mechanism follows this flow:

1. User Interface Module (touch screen, keypad) sends a GOL (see page 64) message (the GOL_MSG (see page 330) structure).
2. A loop evaluates which object is affected by the message. This is done inside GOLMsg (see page 328)() function.
3. Affected object returns the translated message based on the GOL (see page 64) message parameters.
4. User can change default action with the callback function. If the call back function returns a non-zero value message will be processed by default.
5. Object should be redrawn to reflect new state.

The translated message is a set of actions unique to each object type. Please refer to each object translated message ID for details.

Objects that are disabled will not accept any messages. GOLMsg (see page 328)() function must be called when GOL (

see page 64) drawing is completed. In this case all objects have been drawn and it is safe to change objects states. GOLMsg (see page 328)() call can be done if GOLDraw (see page 310)() function returns non-zero or inside GOLDrawCallback (see page 311)() function.

8.4.1 GOLMsg Function

File

GOL.h (see page 571)

C

```
void GOLMsg(
    GOL_MSG * pMsg
);
```

Input Parameters

Input Parameters	Description
GOL_MSG * pMsg	Pointer to the GOL (see page 64) message from user.

Side Effects

none

Returns

none

Preconditions

none

Example

```
// Assume objects are created & states are set to draw objects
while(1){
    if(GOLDraw()){
        // GOL drawing is completed here
        // it is safe to change objects
        TouchGetMsg(&msg);         // from user interface module
        GOLMsg(&msg);
    }
}
```

Overview

This function receives a GOL (see page 64) message from user and loops through the active list of objects to check which object is affected by the message. For affected objects the message is translated and GOLMsgCallback (see page 328)() is called. In the call back function, user has the ability to implement action for the message. If the call back function returns non-zero OBJMsgDefault() is called to process message for the object by default. If zero is returned OBJMsgDefault() is not called. Please refer to GOL (see page 64) Messages section for deatils.

This function should be called when GOL (see page 64) drawing is completed. It can be done when GOLDraw (see page 310)() returns non-zero value or inside GOLDrawCallback (see page 311)() function.

Syntax

void GOLMsg(GOL_MSG (see page 330) *pMsg)

8.4.2 GOLMsgCallback Function

File

GOL.h (see page 571)

C

```
WORD GOLMsgCallback(
    WORD objMsg,
    OBJ_HEADER * pObj,
    GOL_MSG * pMsg
);
```

Input Parameters

Input Parameters	Description
WORD objMsg	Translated message for the object or the action ID response from the object.
OBJ_HEADER * pObj	Pointer to the object that processed the message.
GOL_MSG * pMsg	Pointer to the GOL (see page 64) message from user.

Side Effects

none

Returns

Return a non-zero if the message will be processed by default. If a zero is returned, the message will not be processed by GOL (see page 64).

Preconditions

none

Example

```
WORD GOLMsgCallback(WORD objMsg, OBJ_HEADER* pObj, GOL_MSG *pMsg){
    static char focusSwitch = 1;

    switch(GetObjID(pObj)){
        case ID_BUTTON1:
            // Change text and focus state
            if(objMsg == BTN_MSG_RELEASED){
                focusSwitch ^= 1;
                if(focusSwitch){
                    BtnSetText((BUTTON*)pObj, "Focused");
                    SetState(pObj,BTN_FOCUSED);
                }else{
                    BtnSetText((BUTTON*)pObj, "Unfocused");
                    ClrState(pObj,BTN_FOCUSED);
                }
            }
            // Process by default
            return 1;
        case ID_BUTTON2:
            // Change text
            if(objMsg == BTN_MSG_PRESSED){
                BtnSetText((BUTTON*)pObj, "Pressed");
            }
            if(objMsg == BTN_MSG_RELEASED){
                BtnSetText((BUTTON*)pObj, "Released");
            }
            // Process by default
            return 1;
        case ID_BUTTON3:
            // Change face picture
            if(objMsg == BTN_MSG_PRESSED){
                BtnSetBitmap(pObj,arrowLeft);
            }
            if(objMsg == BTN_MSG_RELEASED){
                BtnSetBitmap(pObj,(char*)arrowRight);
            }
            // Process by default
            return 1;
        case ID_BUTTON_NEXT:
            if(objMsg == BTN_MSG_RELEASED){
                screenState = CREATE_CHECKBOXES;
            }
            // Process by default
            return 1;
        case ID_BUTTON_BACK:
            return 1;
        default:
            return 1;
    }
}
```

Overview

The user MUST implement this function. GOLMsg (see page 328)() calls this function when a valid message for an object in the active list is received. User action for the message should be implemented here. If this function returns non-zero, the message for the object will be processed by default. If zero is returned, GOL (see page 64) will not perform any action.

Syntax

WORD GOLMsgCallback(WORD objMsg, OBJ_HEADER (see page 68)* pObj, GOL_MSG (see page 330)* pMsg)

8.4.3 GOL_MSG Structure

File

GOL.h (see page 571)

C

```
typedef struct {
  BYTE type;
  BYTE uiEvent;
  SHORT param1;
  SHORT param2;
} GOL_MSG;
```

Members

Members	Description
BYTE type;	Type of input device.
BYTE uiEvent;	The generic events for input device.
SHORT param1;	Parameter 1 meaning is dependent on the type of input device.
SHORT param2;	Parameter 2 meaning is dependent on the type of input device.

Overview

This structure defines the GOL (see page 64) message used in the library.

- The types must be one of the INPUT_DEVICE_TYPE (see page 333):
- TYPE_UNKNOWN
- TYPE_KEYBOARD
- TYPE_TOUCHSCREEN
- TYPE_MOUSE
- uiEvent must be one of the INPUT_DEVICE_EVENT (see page 333).
- for touch screen:
- EVENT_INVALID
- EVENT_MOVE
- EVENT_PRESS
- EVENT_STILLPRESS
- EVENT_RELEASE

- for keyboard:
- EVENT_KEYSCAN (param2 contains scan code)
- EVENT_KEYCODE (param2 contains character code)
- param1:
- for touch screen is the x position
- for keyboard ID of object receiving the message
- param2
- for touch screen y position
- for keyboard scan or key code

8.4.4 TRANS_MSG Enumeration

File

GOL.h (see page 571)

C

```
typedef enum {
  OBJ_MSG_INVALID = 0,
  CB_MSG_CHECKED,
  CB_MSG_UNCHECKED,
  RB_MSG_CHECKED,
  WND_MSG_CLIENT,
  WND_MSG_TITLE,
  BTN_MSG_PRESSED,
  BTN_MSG_STILLPRESSED,
  BTN_MSG_RELEASED,
  BTN_MSG_CANCELPRESS,
  PICT_MSG_SELECTED,
  GB_MSG_SELECTED,
  CC_MSG_SELECTED,
  SLD_MSG_INC,
  SLD_MSG_DEC,
  ST_MSG_SELECTED,
  DM_MSG_SELECTED,
  PB_MSG_SELECTED,
  RD_MSG_CLOCKWISE,
  RD_MSG_CTR_CLOCKWISE,
  MTR_MSG_SET,
  EB_MSG_CHAR,
  EB_MSG_DEL,
  EB_MSG_TOUCHSCREEN,
  LB_MSG_SEL,
  LB_MSG_MOVE,
  LB_MSG_TOUCHSCREEN,
  GRID_MSG_TOUCHED,
  GRID_MSG_ITEM_SELECTED,
  GRID_MSG_UP,
  GRID_MSG_DOWN,
  GRID_MSG_LEFT,
  GRID_MSG_RIGHT,
  CH_MSG_SELECTED,
  TE_MSG_RELEASED,
  TE_MSG_PRESSED,
  TE_MSG_ADD_CHAR,
  TE_MSG_DELETE,
  TE_MSG_SPACE,
  TE_MSG_ENTER,
  AC_MSG_PRESSED,
  AC_MSG_RELEASED,
  OBJ_MSG_PASSIVE
} TRANS_MSG;
```

Members

Members	Description
OBJ_MSG_INVALID = 0	Invalid message response.
CB_MSG_CHECKED	Check Box check action ID.
CB_MSG_UNCHECKED	Check Box un-check action ID.
RB_MSG_CHECKED	Radio Button (see page 78) check action ID.
WND_MSG_CLIENT	Window (see page 292) client area selected action ID.
WND_MSG_TITLE	Window (see page 292) title bar selected action ID.
BTN_MSG_PRESSED	Button (see page 78) pressed action ID.
BTN_MSG_STILLPRESSED	Button (see page 78) is continuously pressed ID.
BTN_MSG_RELEASED	Button (see page 78) released action ID.
BTN_MSG_CANCELPRESS	Button (see page 78) released action ID with button press canceled.
PICT_MSG_SELECTED	Picture (see page 224) selected action ID.
GB_MSG_SELECTED	Group Box selected action ID.
CC_MSG_SELECTED	Custom Control selected action ID.
SLD_MSG_INC	Slider (see page 251) or Scroll (see page 439) Bar (see page 371) increment action ID.
SLD_MSG_DEC	Slider (see page 251) or Scroll (see page 439) Bar (see page 371) decrement action ID.
ST_MSG_SELECTED	Static Text selected action ID.
DM_MSG_SELECTED	Digital Meter (see page 210) selected action ID.
PB_MSG_SELECTED	Progress Bar (see page 371) selected action ID.
RD_MSG_CLOCKWISE	Dial (see page 138) move clockwise action ID.
RD_MSG_CTR_CLOCKWISE	Dial (see page 138) move counter clockwise action ID.
MTR_MSG_SET	Meter (see page 210) set value action ID.
EB_MSG_CHAR	Edit Box insert character action ID.
EB_MSG_DEL	Edit Box remove character action ID.
EB_MSG_TOUCHSCREEN	Edit Box touchscreen selected action ID.
LB_MSG_SEL	List Box item select action ID.
LB_MSG_MOVE	List Box item move action ID.
LB_MSG_TOUCHSCREEN	List Box touchscreen selected action ID.
GRID_MSG_TOUCHED	Grid (see page 167) item touched action ID.
GRID_MSG_ITEM_SELECTED	Grid (see page 167) item selected action ID.
GRID_MSG_UP	Grid (see page 167) up action ID.
GRID_MSG_DOWN	Grid (see page 167) down action ID.
GRID_MSG_LEFT	Grid (see page 167) left action ID.
GRID_MSG_RIGHT	Grid (see page 167) right action ID.
CH_MSG_SELECTED	Chart (see page 92) selected action ID
TE_MSG_RELEASED	TextEntry released action ID
TE_MSG_PRESSED	TextEntry pressed action ID
TE_MSG_ADD_CHAR	TextEntry add character action ID
TE_MSG_DELETE	TextEntry delete character action ID
TE_MSG_SPACE	TextEntry add space character action ID
TE_MSG_ENTER	TextEntry enter action ID
AC_MSG_PRESSED	Analog Clock Pressed Action
AC_MSG_RELEASED	Analog Clock Released Action
OBJ_MSG_PASSIVE	Passive message response. No change in object needed.

Overview

This structure defines the list of translated messages for GOL (see page 64) Objects used in the library.

8.4.5 INPUT_DEVICE_EVENT Enumeration

File

GOL.h (see page 571)

C

```
typedef enum {
  EVENT_INVALID = 0,
  EVENT_MOVE,
  EVENT_PRESS,
  EVENT_STILLPRESS,
  EVENT_RELEASE,
  EVENT_KEYSCAN,
  EVENT_CHARCODE,
  EVENT_SET,
  EVENT_SET_STATE,
  EVENT_CLR_STATE
} INPUT_DEVICE_EVENT;
```

Members

Members	Description
EVENT_INVALID = 0	An invalid event.
EVENT_MOVE	A move event.
EVENT_PRESS	A press event.
EVENT_STILLPRESS	A continuous press event.
EVENT_RELEASE	A release event.
EVENT_KEYSCAN	A keyscan event, parameters has the object ID keyboard scan code.
EVENT_CHARCODE	Character code is presented at the parameters.
EVENT_SET	A generic set event.
EVENT_SET_STATE	A set state event.
EVENT_CLR_STATE	A clear state event.

Overview

This structure defines the types of GOL (see page 64) message events used in the library.

8.4.6 INPUT_DEVICE_TYPE Enumeration

File

GOL.h (see page 571)

C

```
typedef enum {
  TYPE_UNKNOWN = 0,
  TYPE_KEYBOARD,
  TYPE_TOUCHSCREEN,
  TYPE_MOUSE,
  TYPE_TIMER,
  TYPE_SYSTEM
} INPUT_DEVICE_TYPE;
```

Members

Members	Description
TYPE_UNKNOWN = 0	Unknown device.
TYPE_KEYBOARD	Keyboard.
TYPE_TOUCHSCREEN	Touchscreen.
TYPE_MOUSE	Mouse.
TYPE_TIMER	Timer.
TYPE_SYSTEM	System Messages.

Overview

This structure defines the types of input devices used in the library.

8.4.7 Scan Key Codes

Macros

Name	Description
SCAN_BS_PRESSED (see page 335)	Back space key pressed.
SCAN_BS_RELEASED (see page 335)	Back space key released.
SCAN_CR_PRESSED (see page 335)	Carriage return pressed.
SCAN_CR_RELEASED (see page 335)	Carriage return released.
SCAN_DEL_PRESSED (see page 336)	Delete key pressed.
SCAN_DEL_RELEASED (see page 336)	Delete key released.
SCAN_DOWN_PRESSED (see page 336)	Down key pressed.
SCAN_DOWN_RELEASED (see page 336)	Down key released.
SCAN_END_PRESSED (see page 337)	End key pressed.
SCAN_END_RELEASED (see page 337)	End key released.
SCAN_HOME_PRESSED (see page 337)	Home key pressed.
SCAN_HOME_RELEASED (see page 337)	Home key released.
SCAN_LEFT_PRESSED (see page 337)	Left key pressed.
SCAN_LEFT_RELEASED (see page 338)	Left key released.
SCAN_PGDOWN_PRESSED (see page 338)	Page down key pressed.
SCAN_PGDOWN_RELEASED (see page 338)	Page down key released.
SCAN_PGUP_PRESSED (see page 338)	Page up key pressed.
SCAN_PGUP_RELEASED (see page 339)	Page up key released.
SCAN_RIGHT_PRESSED (see page 339)	Right key pressed.
SCAN_RIGHT_RELEASED (see page 339)	Right key released.

SCAN_SPACE_PRESSED (see page 339)	Space key pressed.
SCAN_SPACE_RELEASED (see page 339)	Space key released.
SCAN_TAB_PRESSED (see page 340)	Tab key pressed.
SCAN_TAB_RELEASED (see page 340)	Tab key released.
SCAN_UP_PRESSED (see page 340)	Up key pressed.
SCAN_UP_RELEASED (see page 340)	Up key released.

Description

The defined scan codes for AT keyboard.

8.4.7.1 SCAN_BS_PRESSED Macro

File

ScanCodes.h (see page 641)

C

```
#define SCAN_BS_PRESSED 0x0E
```

Description

Back space key pressed.

8.4.7.2 SCAN_BS_RELEASED Macro

File

ScanCodes.h (see page 641)

C

```
#define SCAN_BS_RELEASED 0x8E
```

Description

Back space key released.

8.4.7.3 SCAN_CR_PRESSED Macro

File

ScanCodes.h (see page 641)

C

```
#define SCAN_CR_PRESSED 0x1C
```

Description

Carriage return pressed.

8.4.7.4 SCAN_CR_RELEASED Macro

File

ScanCodes.h (see page 641)

C

```
#define SCAN_CR_RELEASED 0x9C
```

Description

Carriage return released.

8.4.7.5 SCAN_DEL_PRESSED Macro

File

ScanCodes.h (see page 641)

C

```
#define SCAN_DEL_PRESSED 0x53
```

Description

Delete key pressed.

8.4.7.6 SCAN_DEL_RELEASED Macro

File

ScanCodes.h (see page 641)

C

```
#define SCAN_DEL_RELEASED 0xD3
```

Description

Delete key released.

8.4.7.7 SCAN_DOWN_PRESSED Macro

File

ScanCodes.h (see page 641)

C

```
#define SCAN_DOWN_PRESSED 0x50
```

Description

Down key pressed.

8.4.7.8 SCAN_DOWN_RELEASED Macro

File

ScanCodes.h (see page 641)

C

```
#define SCAN_DOWN_RELEASED 0xD0
```

Description

Down key released.

8.4.7.9 SCAN_END_PRESSED Macro

File

ScanCodes.h (see page 641)

C

```
#define SCAN_END_PRESSED 0x4F
```

Description

End key pressed.

8.4.7.10 SCAN_END_RELEASED Macro

File

ScanCodes.h (see page 641)

C

```
#define SCAN_END_RELEASED 0xCF
```

Description

End key released.

8.4.7.11 SCAN_HOME_PRESSED Macro

File

ScanCodes.h (see page 641)

C

```
#define SCAN_HOME_PRESSED 0x47
```

Description

Home key pressed.

8.4.7.12 SCAN_HOME_RELEASED Macro

File

ScanCodes.h (see page 641)

C

```
#define SCAN_HOME_RELEASED 0xC7
```

Description

Home key released.

8.4.7.13 SCAN_LEFT_PRESSED Macro

File

ScanCodes.h (see page 641)

C

```
#define SCAN_LEFT_PRESSED 0x4B
```

Description

Left key pressed.

8.4.7.14 SCAN_LEFT_RELEASED Macro

File

ScanCodes.h (see page 641)

C

```
#define SCAN_LEFT_RELEASED 0xCB
```

Description

Left key released.

8.4.7.15 SCAN_PGDOWN_PRESSED Macro

File

ScanCodes.h (see page 641)

C

```
#define SCAN_PGDOWN_PRESSED 0x51
```

Description

Page down key pressed.

8.4.7.16 SCAN_PGDOWN_RELEASED Macro

File

ScanCodes.h (see page 641)

C

```
#define SCAN_PGDOWN_RELEASED 0xD1
```

Description

Page down key released.

8.4.7.17 SCAN_PGUP_PRESSED Macro

File

ScanCodes.h (see page 641)

C

```
#define SCAN_PGUP_PRESSED 0x49
```

Description

Page up key pressed.

8.4.7.18 SCAN_PGUP_RELEASED Macro

File

ScanCodes.h (see page 641)

C

```
#define SCAN_PGUP_RELEASED 0xC9
```

Description

Page up key released.

8.4.7.19 SCAN_RIGHT_PRESSED Macro

File

ScanCodes.h (see page 641)

C

```
#define SCAN_RIGHT_PRESSED 0x4D
```

Description

Right key pressed.

8.4.7.20 SCAN_RIGHT_RELEASED Macro

File

ScanCodes.h (see page 641)

C

```
#define SCAN_RIGHT_RELEASED 0xCD
```

Description

Right key released.

8.4.7.21 SCAN_SPACE_PRESSED Macro

File

ScanCodes.h (see page 641)

C

```
#define SCAN_SPACE_PRESSED 0x39
```

Description

Space key pressed.

8.4.7.22 SCAN_SPACE_RELEASED Macro

File

ScanCodes.h (see page 641)

C

```
#define SCAN_SPACE_RELEASED 0xB9
```

Description

Space key released.

8.4.7.23 SCAN_TAB_PRESSED Macro

File

ScanCodes.h (see page 641)

C

```
#define SCAN_TAB_PRESSED 0x0F
```

Description

Tab key pressed.

8.4.7.24 SCAN_TAB_RELEASED Macro

File

ScanCodes.h (see page 641)

C

```
#define SCAN_TAB_RELEASED 0x8F
```

Description

Tab key released.

8.4.7.25 SCAN_UP_PRESSED Macro

File

ScanCodes.h (see page 641)

C

```
#define SCAN_UP_PRESSED 0x48
```

Description

Up key pressed.

8.4.7.26 SCAN_UP_RELEASED Macro

File

ScanCodes.h (see page 641)

C

```
#define SCAN_UP_RELEASED 0xC8
```

Description

Up key released.

8.5 Style Scheme

All objects uses a style scheme structure that defines the font and colors used.

Functions

	Name	Description
	GOLCreateScheme (see page 343)	This function creates a new style scheme object and initializes the parameters to default values. Default values are based on the GOLSchemeDefault (see page 347) defined in GOLSchemeDefault.c file. Application code can override this initialization, See GOLSchemeDefault (see page 347).

Macros

Name	Description
GOLSetScheme (see page 343)	This macro sets the GOL (see page 64) scheme to be used for the object.
GOLGetScheme (see page 344)	This macro gets the GOL (see page 64) scheme used by the given object.
GOLGetSchemeDefault (see page 345)	This macro returns the default GOL (see page 64) scheme pointer.
GOL_EMBOSS_SIZE (see page 347)	This option defines the 3-D effect emboss size for objects. The default value of this is 3 set in GOL.h (see page 571). If it is not defined in GraphicsConfig.h (see page 945) file then the default value is used.
RGBConvert (see page 347)	This macro converts the color data to the selected COLOR_DEPTH (see page 48).

Module

Graphics Object Layer (see page 64)

Structures

Name	Description
GOL_SCHEME (see page 345)	GOL (see page 64) scheme defines the style scheme to be used by an object.

Variables

Name	Description
GOLFontDefault (see page 346)	This is variable GOLFontDefault.
GOLSchemeDefault (see page 347)	This defines a default GOL (see page 64) scheme that gets populated when an application calls the GOLCreateScheme (see page 343)(). The application can override this definition by defining the macro GFX_SCHEMEDEFAULT in the GraphicsConfig.h (see page 945) header file and defining GOLSchemeDefault structure in the application code. It is important to use the same structure name since the library assumes that this object exists and assigns the default style scheme pointer to this object.

Description

All objects uses a style scheme structure that defines the font and colors used. Upon the object's creation a user defined style scheme can be assigned to the object. In the absence of the user defined scheme, the default scheme is used.

```
typedef struct {
    WORD              EmbossDkColor;
    WORD              EmbossLtColor;
    WORD              TextColor0;
    WORD              TextColor1;
    WORD              TextColorDisabled;
    WORD              Color0;
    WORD              Color1;
    WORD              ColorDisabled;
    WORD              CommonBkColor;
    BYTE              *pFont;
    BYTE              AlphaValue;
```

```
        GFX_GRADIENT_STYLE gradientScheme;
    } GOL_SCHEME;
```

Field	Description
EmbossDkColor	Dark emboss color used for the 3-D effect of the object.
EmbossLtColor	Light emboss color used for the 3-D effect of the object.
TextColor0 TextColor1	Generic text colors used by the objects. Usage may vary from one object type to another.
TextColorDisabled	Text color used for objects that are disabled.
Color0 Color1	Generic colors used to render objects. Usage may vary from one object type to another.
ColorDisabled	Color used to render objects that are disabled.
CommonBkColor	A common background color of objects. Typically used to hide objects from the screen.
pFont	Pointer to the font table used by the object.
AlphaValue	Alpha value used for alpha blending, this is only available only when USE_ALPHABLEND (see page 40) is defined in the GraphicsConfig.h (see page 945).
gradientScheme	Gradient Scheme for supported widgets, this is available only when USE_GRADIENT (see page 38) is defined in the GraphicsConfig.h (see page 945).

TextColorDisabled and ColorDisabled are used when the object is in the disabled state. Otherwise, TextColor0, TextColor1, Color0 and Color1 are used. When object Draw state is set to HIDE (see page 301), the CommonBkColor is used to fill area occupied by object.

Style scheme can be created with GOLCreateScheme (see page 343)() function that returns a pointer to the newly created GOL_SCHEME (see page 345) structure with default values automatically assigned. The default settings of the style scheme for a 16bpp setup are shown below:

Style Parameter	Default Value
EmbossDkColor	EMBOSSDKCOLORDEFAULT
EmbossLtColor	EMBOSSLTCOLORDEFAULT
Textcolor0	TEXTCOLOR0DEFAULT
Textcolor1	TEXTCOLOR1DEFAULT
TextColorDisabled	TEXTCOLORDISABLEDDEFAULT
Color0	COLOR0DEFAULT
Color1	COLOR1DEFAULT
ColorDisabled	COLORDISABLEDDEFAULT
CommonBkColor	COMMONBACKGROUNDCOLORDEFAULT
pFont	FONTDEFAULT (see page 346)
AlphaValue	0
gradientScheme	{ GRAD_NONE, RGBConvert (see page 347)(0xA9, 0xDB, 0xEF), RGBConvert (see page 347)(0x26, 0xC7, 0xF2), 50 }

The default values can be changed in the GOLSchemeDefault.c file.

The application code can define its own default style scheme by defining the macro GFX_SCHEMEDEFAULT in the GraphicsConfig.h (see page 945).

Then GOL_SCHEME (see page 345) GOLSchemeDefault (see page 347) must be defined in the application code with each structure member initialized to the desired values. See GOLSchemeDefault.c file for an example on how to initialize the style scheme.

8.5.1 GOLCreateScheme Function

File

GOL.h (see page 571)

C

```
GOL_SCHEME * GOLCreateScheme();
```

Side Effects

none

Returns

Pointer to the new GOL_SCHEME (see page 345) created.

Preconditions

none

Example

```
extern const char Font22[] __attribute__((aligned(2)));
extern const char Font16[] __attribute__((aligned(2)));

GOLSCHEME *pScheme1, *pScheme2;
pScheme1 = GOLCreateScheme();
pScheme2 = GOLCreateScheme();

pScheme1->pFont = (BYTE*)Font22;
pScheme2->pFont = (BYTE*)Font16;
```

Overview

This function creates a new style scheme object and initializes the parameters to default values. Default values are based on the GOLSchemeDefault (see page 347) defined in GOLSchemeDefault.c file. Application code can override this initialization, See GOLSchemeDefault (see page 347).

Syntax

GOL_SCHEME (see page 345) *GOLCreateScheme()

8.5.2 GOLSetScheme Macro

File

GOL.h (see page 571)

C

```
#define GOLSetScheme(pObj, pScheme) ((OBJ_HEADER *)pObj)->pGolScheme = pScheme
```

Input Parameters

Input Parameters	Description
pObj	Pointer to the object of interest.
pScheme	Pointer to the style scheme to be used.

Side Effects

none

Returns

none

Preconditions

none

Example

```
extern FONT_FLASH Gentium12;
GOLSCHEME *pScheme1;
BUTTON *pButton;

pScheme1 = GOLCreateScheme();
pScheme1->pFont = &Gentium12;

// assume button is created and initialized

// reassign the scheme used by pButton to pScheme1
GOLSetScheme(pButton, pScheme1);
```

Overview

This macro sets the GOL (see page 64) scheme to be used for the object.

Syntax

GOLSetScheme(pObj, pScheme)

8.5.3 GOLGetScheme Macro

File

GOL.h (see page 571)

C

```
#define GOLGetScheme(pObj) ((OBJ_HEADER *)pObj)->pGolScheme
```

Input Parameters

Input Parameters	Description
pObj	Pointer to the object of interest.

Side Effects

none

Returns

Returns the style scheme used by the given object.

Preconditions

none

Example

```
GOLSCHEME *pScheme2;
BUTTON *pButton;

// assume button is created and initialized
// get the scheme assigned to pButton
pScheme2 = GOLGetScheme(pButton);
```

Overview

This macro gets the GOL (see page 64) scheme used by the given object.

Syntax

GOLGetScheme(pObj)

8.5.4 GOLGetSchemeDefault Macro

File

GOL.h (see page 571)

C

```
#define GOLGetSchemeDefault _pDefaultGolScheme
```

Side Effects

none

Returns

Returns the pointer to the default style scheme.

Preconditions

none

Overview

This macro returns the default GOL (see page 64) scheme pointer.

Syntax

GOLGetSchemeDefault()

8.5.5 GOL_SCHEME Structure

File

GOL.h (see page 571)

C

```
typedef struct {
  GFX_COLOR EmbossDkColor;
  GFX_COLOR EmbossLtColor;
  GFX_COLOR TextColor0;
  GFX_COLOR TextColor1;
  GFX_COLOR TextColorDisabled;
  GFX_COLOR Color0;
  GFX_COLOR Color1;
  GFX_COLOR ColorDisabled;
  GFX_COLOR CommonBkColor;
  void * pFont;
  BYTE AlphaValue;
  GFX_GRADIENT_STYLE gradientScheme;
} GOL_SCHEME;
```

Members

Members	Description
GFX_COLOR EmbossDkColor;	Emboss dark color used for 3d effect.
GFX_COLOR EmbossLtColor;	Emboss light color used for 3d effect.
GFX_COLOR TextColor0;	Character color 0 used for objects that supports text.
GFX_COLOR TextColor1;	Character color 1 used for objects that supports text.

GFX_COLOR TextColorDisabled;	Character color used when object is in a disabled state.
GFX_COLOR Color0;	Color 0 usually assigned to an Object state.
GFX_COLOR Color1;	Color 1 usually assigned to an Object state.
GFX_COLOR ColorDisabled;	Color used when an Object is in a disabled state.
GFX_COLOR CommonBkColor;	Background color used to hide Objects.
void * pFont;	Font selected for the scheme.
BYTE AlphaValue;	Alpha value used for alpha blending, this is available only when USE_ALPHABLEND (see page 40) is defined in the GraphicsConfig.h (see page 945).
GFX_GRADIENT_STYLE gradientScheme;	Gradient Scheme for widgets, this is available only when USE_GRADIENT (see page 38) is defined in the GraphicsConfig.h (see page 945).

Overview

GOL (see page 64) scheme defines the style scheme to be used by an object.

8.5.6 Default Style Scheme Settings

Variables

Name	Description
FONTDEFAULT (see page 346)	Default GOL (see page 64) font.

Description

Lists the default settings for the style scheme.

8.5.6.1 FONTDEFAULT Variable

File

GOL.h (see page 571)

C

```
const FONT_FLASH FONTDEFAULT;
```

Description

Default GOL (see page 64) font.

8.5.7 GOLFontDefault Variable

File

GOLFontDefault.c (see page 598)

C

```
const FONT_FLASH GOLFontDefault = { (FLASH | COMP_NONE), __GOLFontDefault };
```

Description

This is variable GOLFontDefault.

8.5.8 GOL_EMBOSS_SIZE Macro

File

GOL.h (see page 571)

C

```
#define GOL_EMBOSS_SIZE 3
```

Overview

This option defines the 3-D effect emboss size for objects. The default value of this is 3 set in GOL.h (see page 571). If it is not defined in GraphicsConfig.h (see page 945) file then the default value is used.

8.5.9 GOLSchemeDefault Variable

File

GOLSchemeDefault.c

C

```
const GOL_SCHEME GOLSchemeDefault = { BLACK, WHITE, WHITE, BLACK, WHITE, BLACK, WHITE,
BLACK, BLACK, RGBConvert(0x2B, 0x55, 0x87), RGBConvert(0xD4, 0xE4, 0xF7), RGBConvert(0x07,
0x1E, 0x48), RGBConvert(0xFF, 0xFF, 0xFF), RGBConvert(245, 245, 220), RGBConvert(0xA9,
0xDB, 0xEF), RGBConvert(0x26, 0xC7, 0xF2), RGBConvert(0xB6, 0xD2, 0xFB), RGBConvert(0xD4,
0xED, 0xF7), (void *)&FONTDEFAULT, 0, { GRAD_NONE, RGBConvert(0xA9, 0xDB, 0xEF),
RGBConvert(0x26, 0xC7, 0xF2), 50 } };
```

Overview

This defines a default GOL (see page 64) scheme that gets populated when an application calls the GOLCreateScheme (see page 343)(). The application can override this definition by defining the macro GFX_SCHEMEDEFAULT in the GraphicsConfig.h (see page 945) header file and defining GOLSchemeDefault structure in the application code. It is important to use the same structure name since the library assumes that this object exists and assigns the default style scheme pointer to this object.

8.5.10 RGBConvert Macro

File

gfxcolors.h

C

```
#define RGBConvert(red, green, blue) (GFX_COLOR) ((GFX_COLOR)red | (GFX_COLOR)green|
(GFX_COLOR)blue)
```

Input Parameters

Input Parameters	Description
red	red component of the color.
green	green component of the color.
blue	blue component of the color.

Side Effects

none

Returns

none

Preconditions

none

Overview

This macro converts the color data to the selected COLOR_DEPTH (see page 48).

COLOR_DEPTH (see page 48)	Conversion
1	8-8-8 to 8-8-8 conversion or no conversion
8	8-8-8 to 3-3-2 conversion
16	8-8-8 to to 5-6-5 conversion
24	8-8-8 to 8-8-8 conversion or no conversion

Syntax

RGBConvert(red, green, blue)

8.6 GOL Global Variables

Module

Graphics Object Layer (see page 64)

Variables

Name	Description
_pDefaultGolScheme (see page 349)	Pointer to the GOL (see page 64) default scheme (GOL_SCHEME (see page 345)). This scheme is created in GOLInit (see page 320)() function. GOL (see page 64) scheme defines the style scheme to be used by an object. Use GOLGetSchemeDefault (see page 345)() to get this pointer.
_pGolObjects (see page 349)	Pointer to the current linked list of objects displayed and receiving messages. GOLDraw (see page 310)() and GOLMsg (see page 328)() process objects referenced by this pointer.
_pObjectFocused (see page 349)	Pointer to the object receiving keyboad input. This pointer is used or modified by the following APIs: • GOLSetFocus (see page 318)() • GOLGetFocus (see page 320)() • GOLGetFocusNext (see page 321)() • GOLGetFocusPrev (see page 322)() • GOLCanBeFocused (see page 321)()

Description

Graphics Object Layer global variables.

8.6.1 _pDefaultGolScheme Variable

File

GOL.h (see page 571)

C

```
GOL_SCHEME * _pDefaultGolScheme;
```

Overview

Pointer to the GOL (see page 64) default scheme (GOL_SCHEME (see page 345)). This scheme is created in GOLInit (see page 320)() function. GOL (see page 64) scheme defines the style scheme to be used by an object. Use GOLGetSchemeDefault (see page 345)() to get this pointer.

8.6.2 _pGolObjects Variable

File

GOL.h (see page 571)

C

```
OBJ_HEADER * _pGolObjects;
```

Overview

Pointer to the current linked list of objects displayed and receiving messages. GOLDraw (see page 310)() and GOLMsg (see page 328)() process objects referenced by this pointer.

8.6.3 _pObjectFocused Variable

File

GOL.h (see page 571)

C

```
OBJ_HEADER * _pObjectFocused;
```

Overview

Pointer to the object receiving keyboad input. This pointer is used or modified by the following APIs:

- GOLSetFocus (see page 318)()
- GOLGetFocus (see page 320)()
- GOLGetFocusNext (see page 321)()
- GOLGetFocusPrev (see page 322)()
- GOLCanBeFocused (see page 321)()

8.7 Object Rendering

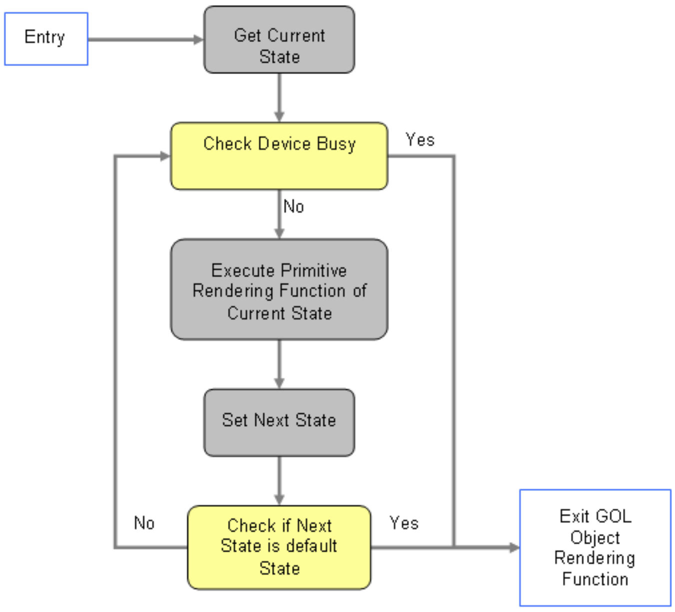
Object rendering can be configured to Blocking or Non-Blocking manner.

Module

Graphics Object Layer (see page 64)

Description

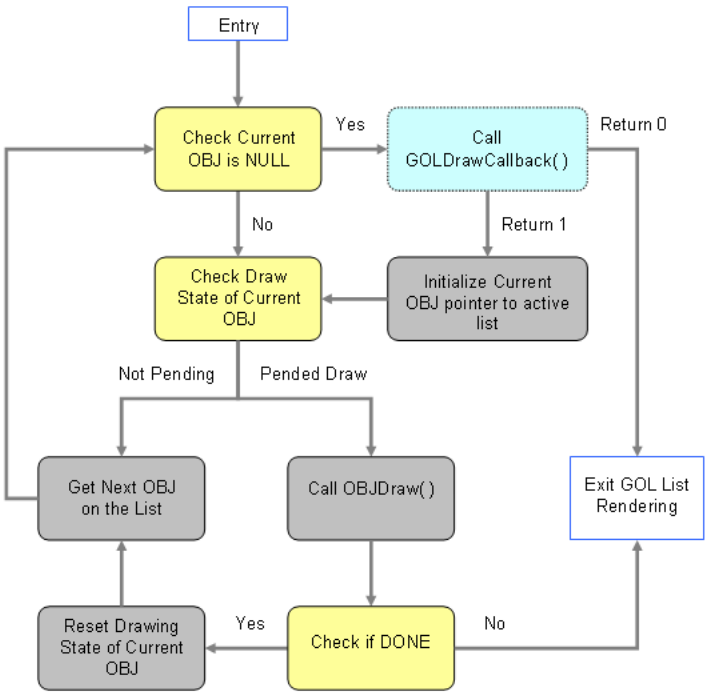
The library can render objects in a Blocking or a Non-Blocking manner. The Non-Blocking configuration is implemented by the use of drawing state machine. Each drawing functions groups the rendering steps into states. Every time a rendering step is executed, the drawing state is updated. Before each step is executed, the display device is checked if it is still busy with the previous rendering operation. If it is busy it returns a non-zero value. This indicates that the draw function must be called again to complete the rendering. The drawing function can be called several times until rendering is completed.


Entry
Get Current State
Check Device Busy
Yes
No
Execute Primitive Rendering Function of Current State
Set Next State
No
Check if Next State is default State
Yes
Exit GOL Object Rendering Function

State Machine Controlled Rendering

For Blocking configuration linear flow of rendering is executed. Display device always return a non-busy status.

The GOL (see page 64) level uses the active object linked list for drawing of objects. Each object's state in the list is parsed to determine if the object needs to be redrawn or not. The drawing order is from the head to the tail of the list. This sequence is executed by GOLDraw (see page 310)() function. The figure below explains the rendering loop of the GOLDraw (see page 310)() function.



GOL (see page 64) Object Rendering Loop

The loop shows two exit points in the sequence. First is when the end of the list is reached and the second is when an OBJDraw() returns a NOT DONE status. Reaching the end of the list is a normal exit. This means that all the state machines of the draw functions of each object have reset to default. Exiting with a NOT DONE status means that the latest executed draw function was pended and the object is not yet fully rendered. To complete the rendering, GOLDraw (see page 310)() function should be called again. The next call to GOLDraw (see page 310)() will pickup the rendering on the last object that returned a not DONE status. This operation makes the rendering functions non-blocking and gives opportunity to release control to program without waiting for the rendering completion.

When all objects in the active object linked list are drawn GOLDraw (see page 310)() calls user defined GOLDrawCallback (see page 311)() function. User drawing can be done in this callback function. If the function returns a zero, drawing of GOL (see page 64) objects in the active list is suspended. In this case color, clipping region, line type and graphic cursor will not be modified by GOL (see page 64). If it returns a 1 drawing control is returned to GOL (see page 64). GOLDraw (see page 310)() resume rendering of objects in the current active list. Inside the GOLDrawCallback (see page 311)() function, the active object list is not used by GOLDraw (see page 310)(). It is safe to perform modification of the list. Please refer to Configuration Settings (see page 44) to set Blocking or Non-Blocking configuration.

8.8 Types

8.8.1 GFX_COLOR Type

File

gfxcolors.h

C

```
typedef DWORD GFX_COLOR;
```

Module

Graphics Object Layer (see page 64)

Overview

Data type that defines the color data. This type is dependent on the COLOR_DEPTH (see page 48) setting. See COLOR_DEPTH (see page 48).

- GFX_COLOR is type BYTE if COLOR_DEPTH (see page 48) <= 8
- GFX_COLOR is type WORD if COLOR_DEPTH (see page 48) = 16
- GFX_COLOR is type DWORD if COLOR_DEPTH (see page 48) = 24

9 Graphics Primitive Layer

Enumerations

Name	Description
GFX_RESOURCE (⧉ see page 388)	Memory type enumeration to determine the source of data. Used in interpreting bitmap and font from different memory sources.

Structures

Name	Description
GFX_IMAGE_HEADER (⧉ see page 389)	Structure for images stored in various system memory (Flash, External Memory (SPI, Parallel Flash, or memory in EPMP).
IMAGE_FLASH (⧉ see page 390)	Structure for images stored in FLASH memory.
IMAGE_RAM (⧉ see page 390)	Structure for images stored in RAM memory.
GFX_EXTDATA (⧉ see page 391)	This structure is used to describe external memory.

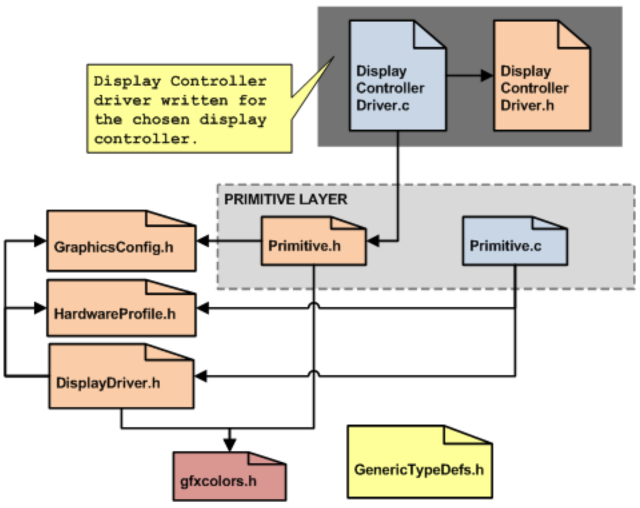
Types

Name	Description
IMAGE_EXTERNAL (⧉ see page 391)	Structure for images stored in EXTERNAL memory space. (example: External SPI or parallel Flash, EDS_EPMP)

Description

This is a hardware independent layer that contains basic rendering functions. These functions can be implemented in the device driver layer if the display device supports hardware acceleration of the function.

The Primitive Layer organization is shown on the figure below:


Display Controller driver written for the chosen display controller.
Display Controller Driver.c
Display Controller Driver.h
PRIMITIVE LAYER
GraphicsConfig.h
Primitive.h
Primitive.c
HardwareProfile.h
DisplayDriver.h
gfxcolors.h
GenericTypeDefs.h

9.1 Text Functions

Functions

	Name	Description
	SetFont (see page 356)	This function sets the current font used in OutTextXY (see page 359)(), OutText (see page 358)() and OutChar (see page 357)() functions.
	OutChar (see page 357)	This function outputs a character from the current graphic cursor position. OutChar() uses the current active font set with SetFont (see page 356)().
	OutText (see page 358)	This function outputs a string of characters starting at the current graphic cursor position. The string must be terminated by a line feed or zero. For Non-Blocking configuration, OutText() may return control to the program due to display device busy status. When this happens zero is returned and OutText() must be called again to continue the outputting of the string. For Blocking configuration, this function always returns a 1. OutText() uses the current active font set with SetFont (see page 356)().
	OutTextXY (see page 359)	This function outputs a string of characters starting at the given x, y position. The string must be terminated by a line feed or zero. For Non-Blocking configuration, OutTextXY() may return control to the program due to display device busy status. When this happens zero is returned and OutTextXY() must be called again to continue the outputting of the string. For Blocking configuration, this function always returns a 1. OutTextXY() uses the current active font set with SetFont (see page 356)().
	GetTextHeight (see page 360)	This macro returns the height of the specified font. All characters in a given font table have a constant height.
	GetTextWidth (see page 360)	This function returns the width of the specified string for the specified font. The string must be terminated by a line feed or zero.

Macros

Name	Description
GetFontOrientation (see page 356)	This macro returns font orientation (0 == horizontal, 1 == vertical).
SetFontOrientation (see page 357)	This macro sets font orientation vertical or horizontal.
XCHAR (see page 361)	This macro sets the data type for the Fonts. There are three types • #define XCHAR unsigned short // use multibyte characters (0-2^16 range) • #define XCHAR unsigned char // use unsigned char (0-255 range) • #define XCHAR char // use signed char (0-127 range)

Module

Graphics Primitive Layer (see page 353)

Structures

Name	Description
FONT_HEADER (see page 355)	Structure describing the font header.
FONT_FLASH (see page 355)	Structure for font stored in FLASH memory.

Types

Name	Description
FONT_EXTERNAL (see page 356)	Structure for font stored in EXTERNAL memory space. (example: External SPI or parallel Flash, EDS_EPMP)

Description

This lists the Primitive level text functions.

9.1.1 FONT_HEADER Structure

File

Primitive.h (see page 1028)

C

```
typedef struct {
  BYTE fontID;
  BYTE res1 : 4;
  BYTE orientation : 2;
  BYTE res2 : 2;
  WORD firstChar;
  WORD lastChar;
  BYTE height;
  BYTE reserved;
} FONT_HEADER;
```

Members

Members	Description
BYTE fontID;	User assigned value
BYTE res1 : 4;	Reserved for future use (must be set to 0).
BYTE orientation : 2;	Orientation of the character glyphs (0,90,180,270 degrees) 00 - Normal 01 - Characters rotated 270 degrees clockwise 10 - Characters rotated 180 degrees 11 - Characters rotated 90 degrees clockwise
BYTE res2 : 2;	Reserved for future use (must be set to 0).
WORD firstChar;	Character code of first character (e.g. 32).
WORD lastChar;	Character code of last character in font (e.g. 3006).
BYTE height;	Font characters height in pixels.
BYTE reserved;	Reserved for future use (must be set to 0).

Overview

Structure describing the font header.

9.1.2 FONT_FLASH Structure

File

Primitive.h (see page 1028)

C

```
typedef struct {
  GFX_RESOURCE type;
  const char * address;
} FONT_FLASH;
```

Members

Members	Description
GFX_RESOURCE type;	must be FLASH
const char * address;	font image address in FLASH

Overview

Structure for font stored in FLASH memory.

9.1.3 FONT_EXTERNAL Type

File

Primitive.h (see page 1028)

C

```
typedef GFX_EXTDATA FONT_EXTERNAL;
```

Overview

Structure for font stored in EXTERNAL memory space. (example: External SPI or parallel Flash, EDS_EPMP)

9.1.4 SetFont Function

File

Primitive.h (see page 1028)

C

```
void SetFont(
    void * font
);
```

Input Parameters

Input Parameters	Description
void * font	Pointer to the new font image to be used.

Side Effects

none

Returns

none

Example

See OutTextXY (see page 359)() example.

Overview

This function sets the current font used in OutTextXY (see page 359)(), OutText (see page 358)() and OutChar (see page 357)() functions.

Syntax

void SetFont(void* font)

9.1.5 GetFontOrientation Macro

File

Primitive.h (see page 1028)

C

```
#define GetFontOrientation _fontOrientation
```

Returns

font orientation (0 == horizontal, 1 == vertical)

Preconditions

none

Overview

This macro returns font orientation (0 == horizontal, 1 == vertical).

Syntax

GetFontOrientation()

9.1.6 SetFontOrientation Macro

File

Primitive.h (see page 1028)

C

```
#define SetFontOrientation(orient) _fontOrientation = orient;
```

Input Parameters

Input Parameters	Description
orient	should be non-zero if the font orientation is vertical

Returns

none

Preconditions

none

Overview

This macro sets font orientation vertical or horizontal.

Syntax

SetFontOrientation(orient)

9.1.7 OutChar Function

File

Primitive.h (see page 1028)

C

```
WORD OutChar(
    XCHAR ch
);
```

Input Parameters

Input Parameters	Description
XCHAR ch	The character code to be displayed.

Side Effects

After the function is completed, the graphic cursor position is moved in the horizontal direction by the character width.

Vertical position of the graphic cursor is not changed.

Returns

For NON-Blocking configuration:

- Returns 0 when device is busy and the character is not yet completely drawn.
- Returns 1 when the character is completely drawn.

For Blocking configuration:

- Always return 1.

Preconditions

none

Overview

This function outputs a character from the current graphic cursor position. OutChar() uses the current active font set with SetFont (see page 356)().

Syntax

WORD OutChar(XCHAR (see page 361) ch)

9.1.8 OutText Function

File

Primitive.h (see page 1028)

C

```
WORD OutText(
    XCHAR * textString
);
```

Input Parameters

Input Parameters	Description
XCHAR * textString	Pointer to the string to be displayed.

Side Effects

Current horizontal graphic cursor position will be moved to the end of the text. The vertical graphic cursor position will not be changed.

Returns

For NON-Blocking configuration:

- Returns 0 when string is not yet outputted completely.
- Returns 1 when string is outputted completely.

For Blocking configuration:

- Always return 1.

Overview

This function outputs a string of characters starting at the current graphic cursor position. The string must be terminated by a line feed or zero. For Non-Blocking configuration, OutText() may return control to the program due to display device busy status. When this happens zero is returned and OutText() must be called again to continue the outputting of the string. For Blocking configuration, this function always returns a 1. OutText() uses the current active font set with SetFont (see page 356)().

Syntax

WORD OutText(XCHAR (see page 361)* textString)

9.1.9 OutTextXY Function

File

Primitive.h (see page 1028)

C

```
WORD OutTextXY(
    SHORT x,
    SHORT y,
    XCHAR * textString
);
```

Input Parameters

Input Parameters	Description
SHORT x	Defines the x starting position of the string.
SHORT y	Defines the y starting position of the string.
XCHAR * textString	Pointer to the string to be displayed.

Side Effects

Current horizontal graphic cursor position will be moved to the end of the text. The vertical graphic cursor position will not be changed.

Returns

For NON-Blocking configuration:

- Returns 0 when string is not yet outputted completely.
- Returns 1 when string is outputted completely.

For Blocking configuration:

- Always return 1.

Example

```
void PlaceText(void)
{
    SHORT width, height;
    static const XCHAR text[] = "Touch screen to continue";

    SetColor(BRIGHTRED);                // set color
    SetFont(pMyFont);                   // set font to my font

    // get string width & height
    width = GetTextWidth(text, pMyFont);
    height = GetTextHeight(pMyFont);

    // place string in the middle of the screen
    OutTextXY(  (GetMaxX() - width) >> 1,
    (GetMaxY() – height) >> 1,
    (char*)text);
}
```

Overview

This function outputs a string of characters starting at the given x, y position. The string must be terminated by a line feed or zero. For Non-Blocking configuration, OutTextXY() may return control to the program due to display device busy status. When this happens zero is returned and OutTextXY() must be called again to continue the outputting of the string. For Blocking configuration, this function always returns a 1. OutTextXY() uses the current active font set with SetFont (see page 356)().

Syntax

WORD OutTextXY(SHORT x, SHORT y, XCHAR (see page 361)* textString)

9.1.10 GetTextHeight Function

File

Primitive.h (see page 1028)

C

```
SHORT GetTextHeight(
    void * font
);
```

Input Parameters

Input Parameters	Description
void * font	Pointer to the font image.

Side Effects

none

Returns

Returns the font height.

Example

See OutTextXY (see page 359)() example.

Overview

This macro returns the height of the specified font. All characters in a given font table have a constant height.

Syntax

SHORT GetTextHeight(void* font)

9.1.11 GetTextWidth Function

File

Primitive.h (see page 1028)

C

```
SHORT GetTextWidth(
    XCHAR * textString,
    void * font
);
```

Input Parameters

Input Parameters	Description
XCHAR * textString	Pointer to the string.
void * font	Pointer to the font image.

Side Effects

none

Returns

Returns the string width in the specified font.

Example

See OutTextXY (see page 359)() example.

Overview

This function returns the width of the specified string for the specified font. The string must be terminated by a line feed or zero.

Syntax

SHORT GetTextWidth(XCHAR (see page 361)* textString, void* font)

9.1.12 XCHAR Macro

File

Primitive.h (see page 1028)

C

```
#define XCHAR char
```

Overview

This macro sets the data type for the Fonts. There are three types

- #define XCHAR unsigned short // use multibyte characters (0-2^16 range)
- #define XCHAR unsigned char // use unsigned char (0-255 range)
- #define XCHAR char // use signed char (0-127 range)

9.2 Gradient

Enumerations

Name	Description
GFX_GRADIENT_TYPE (see page 364)	Enumeration for gradient type

Functions

	Name	Description
	BarGradient (see page 362)	This renders a bar onto the screen, but instead of one color a gradient is drawn depending on the direction (GFX_GRADIENT_TYPE (see page 364)), length, and colors chosen
	BevelGradient (see page 363)	This renders a gradient on the screen. It works the same as the fillbevel function, except a gradient out of color1 and color2 is drawn depending on the direction (GFX_GRADIENT_TYPE (see page 364)).

Module

Graphics Primitive Layer (see page 353)

Structures

Name	Description
GFX_GRADIENT_STYLE (see page 365)	This structure is used to describe the gradient style.

Description

Gradients can be drawn dynamically with the Microchip Graphics Library.

9.2.1 BarGradient Function

File

Primitive.h (see page 1028)

C

```
WORD BarGradient(
    SHORT left,
    SHORT top,
    SHORT right,
    SHORT bottom,
    GFX_COLOR color1,
    GFX_COLOR color2,
    DWORD length,
    BYTE direction
);
```

Input Parameters

Input Parameters	Description
SHORT left	x position of the left top corner.
SHORT top	y position of the left top corner.
SHORT right	x position of the right bottom corner.
SHORT bottom	y position of the right bottom corner.
GFX_COLOR color1	start color for the gradient
GFX_COLOR color2	end color for the gradient
DWORD length	From 0-100%. How much of a gradient is wanted
BYTE direction	Gradient Direction

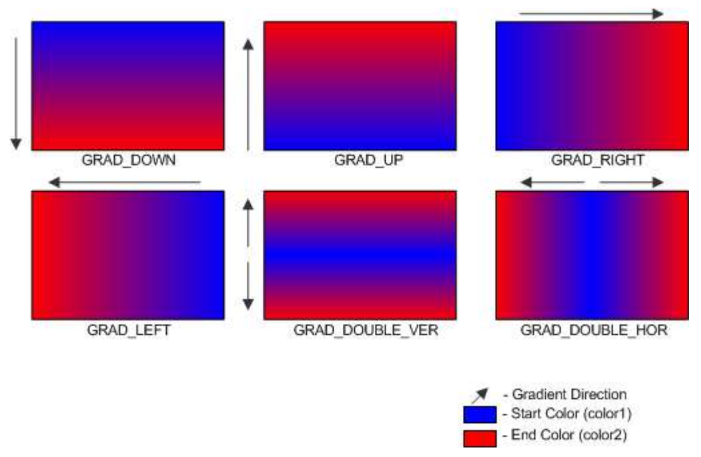
Side Effects

none

Returns

Returns 1 if the rendering is done, 0 if not yet done.

Description



Notes

none

Preconditions

none

Example

```
// draw a full screen gradient background
// with color transitioning from BRIGHTRED to
// BLACK in the upward direction.

GFX_GRADIENT_STYLE  gradScheme;

gradScheme.gradientType         = GRAD_UP;
gradScheme.gradientStartColor   = BRIGHTRED;
gradScheme.gradientEndColor     = BLACK;

 BarGradient(0,                                     //left position
             0,                                     //top position
             GetMaxX(),                             //right position
             GetMaxY(),                             //bottom position
             0,                                     // no radius, since full screen
             gradScheme.gradientStartColor,
             gradScheme.gradientEndColor,
             50,                                    // at the halfway point (50%) of
the rectangular area
                                                    // defined by the first 4
parameters (full screen),
                                                    // the color becomes BLACK and
BLACK color is used until
                                                    // the rectangle defined is filled
up
             gradScheme.gradientType);              // gradient direction is bottom->top
```

Overview

This renders a bar onto the screen, but instead of one color a gradient is drawn depending on the direction (GFX_GRADIENT_TYPE (see page 364)), length, and colors chosen

Syntax

WORD BarGradient(SHORT left, SHORT top, SHORT right, SHORT bottom, GFX_COLOR (see page 351) color1, GFX_COLOR (see page 351) color2, DWORD length, BYTE direction);

9.2.2 BevelGradient Function

File

Primitive.h (see page 1028)

C

```
WORD BevelGradient(
    SHORT left,
    SHORT top,
    SHORT right,
    SHORT bottom,
    SHORT rad,
    GFX_COLOR color1,
    GFX_COLOR color2,
    DWORD length,
    BYTE direction
);
```

Input Parameters

Input Parameters	Description
SHORT left	x coordinate position of the upper left center of the circle that draws the rounded corners.

SHORT top	y coordinate position of the upper left center of the circle that draws the rounded corners.
SHORT right	x coordinate position of the lower right center of the circle that draws the rounded corners.
SHORT bottom	y coordinate position of the lower right center of the circle that draws the rounded corners.
SHORT rad	defines the redius of the circle, that draws the rounded corners. When rad = 0, the object drawn is a rectangular gradient.
GFX_COLOR color1	start color for the gradient
GFX_COLOR color2	end color for the gradient
DWORD length	From 0-100%. How much of a gradient is wanted
BYTE direction	Gradient Direction

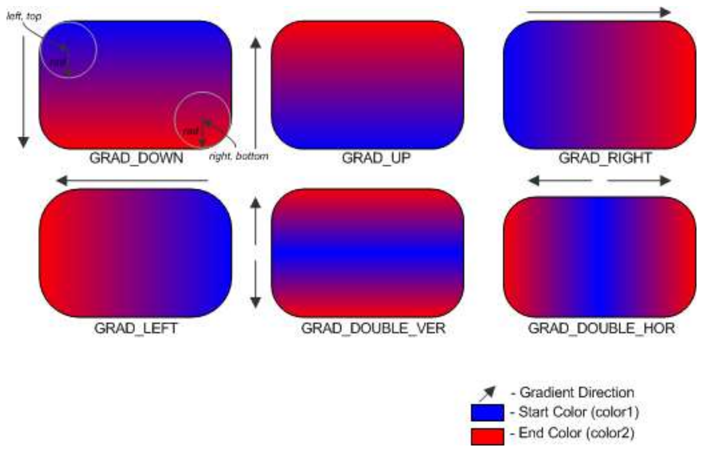
Side Effects

none

Returns

Returns 1 if the rendering is done, 0 if not yet done.

Description



Notes

none

Preconditions

none

Overview

This renders a gradient on the screen. It works the same as the fillbevel function, except a gradient out of color1 and color2 is drawn depending on the direction (GFX_GRADIENT_TYPE (see page 364)).

Syntax

BevelGradient(SHORT left, SHORT top, SHORT right, SHORT bottom, SHORT rad, GFX_COLOR (see page 351) color1, GFX_COLOR (see page 351) color2, DWORD length, BYTE direction);

9.2.3 GFX_GRADIENT_TYPE Enumeration

File

Primitive.h (see page 1028)

C

```
typedef enum {
  GRAD_NONE = 0,
  GRAD_DOWN,
  GRAD_RIGHT,
  GRAD_UP,
  GRAD_LEFT,
  GRAD_DOUBLE_VER,
  GRAD_DOUBLE_HOR
} GFX_GRADIENT_TYPE;
```

Members

Members	Description
GRAD_NONE = 0	No Gradients (see page 361) to be drawn
GRAD_DOWN	gradient changes in the vertical direction
GRAD_RIGHT	gradient change in the horizontal direction
GRAD_UP	gradient changes in the vertical direction
GRAD_LEFT	gradient change in the horizontal direction
GRAD_DOUBLE_VER	two gradient transitions in the vertical direction
GRAD_DOUBLE_HOR	two gradient transitions in the horizontal direction

Overview

Enumeration for gradient type

9.2.4 GFX_GRADIENT_STYLE Structure

File

Primitive.h (see page 1028)

C

```
typedef struct {
  GFX_GRADIENT_TYPE gradientType;
  DWORD gradientStartColor;
  DWORD gradientEndColor;
  DWORD gradientLength;
} GFX_GRADIENT_STYLE;
```

Members

Members	Description
GFX_GRADIENT_TYPE gradientType;	selected the gradient type
DWORD gradientStartColor;	sets the starting color of gradient transition
DWORD gradientEndColor;	sets the ending color of gradient transition
DWORD gradientLength;	defines the length of the gradient transition in pixels

Overview

This structure is used to describe the gradient style.

9.3 Line Functions

Functions

	Name	Description
	Line (see page 366)	This function draws a line with the current line type from the start point to the end point.

Macros

Name	Description
LineRel (see page 367)	This macro draws a line with the current line type from the current graphic cursor position to the position defined by displacement.
LineTo (see page 367)	This macro draws a line with the current line type from the current graphic cursor position to the given x, y position.
SetLineThickness (see page 368)	This macro sets sets line thickness to 1 pixel or 3 pixels.
SetLineType (see page 368)	This macro sets the line type to draw.

Module

Graphics Primitive Layer (see page 353)

Description

This lists the Primitive line text functions.

9.3.1 Line Function

File

Primitive.h (see page 1028)

C

```
WORD Line(
    SHORT x1,
    SHORT y1,
    SHORT x2,
    SHORT y2
);
```

Input Parameters

Input Parameters	Description
SHORT x1	x coordinate of the start point.
SHORT y1	y coordinate of the start point.
SHORT x2	x coordinate of the end point.
SHORT y2	y coordinate of the end point.

Side Effects

The graphic cursor position is moved to the end point of the line.

Returns

For NON-Blocking configuration:

- Returns 0 when device is busy and the shape is not yet completely drawn.
- Returns 1 when the shape is completely drawn.

For Blocking configuration:

- Always return 1.

Overview

This function draws a line with the current line type from the start point to the end point.

Syntax

WORD Line(SHORT x1, SHORT y1, SHORT x2, SHORT y2)

9.3.2 LineRel Macro

File

Primitive.h (see page 1028)

C

```
#define LineRel(dX, dY) Line(GetX(), GetY(), GetX() + dX, GetY() + dY)
```

Input Parameters

Input Parameters	Description
dX	Displacement from the current x position.
dY	Displacement from the current y position.

Side Effects

The graphic cursor position is moved to the end point of the line.

Returns

For NON-Blocking configuration:

- Returns 0 when device is busy and the shape is not yet completely drawn.
- Returns 1 when the shape is completely drawn.

For Blocking configuration:

- Always return 1.

Overview

This macro draws a line with the current line type from the current graphic cursor position to the position defined by displacement.

Syntax

LineRel(dX, dY)

9.3.3 LineTo Macro

File

Primitive.h (see page 1028)

C

```
#define LineTo(x, y) Line(_cursorX, _cursorY, x, y)
```

Input Parameters

Input Parameters	Description
x	End point x position.

y	End point y poisiton.

Side Effects

The graphic cursor position is moved to the end point of the line.

Returns

For NON-Blocking configuration:

- Returns 0 when device is busy and the shape is not yet completely drawn.
- Returns 1 when the shape is completely drawn.

For Blocking configuration:

- Always return 1.

Overview

This macro draws a line with the current line type from the current graphic cursor position to the given x, y position.

Syntax

LineTo(x,y)

9.3.4 SetLineThickness Macro

File

Primitive.h (see page 1028)

C

```
#define SetLineThickness(lnThickness) _lineThickness = lnThickness;
```

Input Parameters

Input Parameters	Description
lnThickness	Line (see page 366) thickness code (0 - 1 pixel; 1 - 3 pixels)

Side Effects

none

Returns

none

Overview

This macro sets sets line thickness to 1 pixel or 3 pixels.

Syntax

SetLineThickness(lnThickness)

9.3.5 SetLineType Macro

File

Primitive.h (see page 1028)

C

```
#define SetLineType(lnType) _lineType = lnType;
```

Input Parameters

Input Parameters	Description
lnType	The type of line to be used. Supported line types: • SOLID_LINE (see page 369) • DOTTED_LINE (see page 370) • DASHED_LINE (see page 369)

Side Effects

none

Returns

none

Overview

This macro sets the line type to draw.

Syntax

SetLineType(lnType)

9.3.6 Line Types

Macros

Name	Description
SOLID_LINE (see page 369)	Solid Line (see page 366) Style
DASHED_LINE (see page 369)	Dashed Line (see page 366) Style
DOTTED_LINE (see page 370)	Dotted Line (see page 366) Style

Description

Line type definitions.

9.3.6.1 SOLID_LINE Macro

File

Primitive.h (see page 1028)

C

```
#define SOLID_LINE 0
```

Description

Solid Line (see page 366) Style

9.3.6.2 DASHED_LINE Macro

File

Primitive.h (see page 1028)

C

```
#define DASHED_LINE 4
```

Description

Dashed Line (see page 366) Style

9.3.6.3 DOTTED_LINE Macro

File

Primitive.h (see page 1028)

C

```
#define DOTTED_LINE 1
```

Description

Dotted Line (see page 366) Style

9.3.7 Line Size

Macros

Name	Description
NORMAL_LINE (see page 370)	Normal Line (see page 366) (thickness is 1 pixel)
THICK_LINE (see page 370)	Thick Line (see page 366) (thickness is 3 pixels)

Description

Line sizes definition.

9.3.7.1 NORMAL_LINE Macro

File

Primitive.h (see page 1028)

C

```
#define NORMAL_LINE 0
```

Description

Normal Line (see page 366) (thickness is 1 pixel)

9.3.7.2 THICK_LINE Macro

File

Primitive.h (see page 1028)

C

```
#define THICK_LINE 1
```

Description

Thick Line (see page 366) (thickness is 3 pixels)

9.4 Rectangle Functions

Functions

	Name	Description
	Bar (see page 371)	This function draws a bar given the left, top and right, bottom corners with the current color.
	DrawPoly (see page 372)	This function draws a polygon with the current line type using the given number of points. The polygon points are stored in an array arranged in the following order:

Macros

Name	Description
Rectangle (see page 372)	This macro draws a rectangle with the given left, top and right, bottom corners. Current line type is used.

Module

Graphics Primitive Layer (see page 353)

Description

This lists the Primitive level rectangle functions.

9.4.1 Bar Function

File

Primitive.h (see page 1028)

C

```
WORD Bar(
    SHORT left,
    SHORT top,
    SHORT right,
    SHORT bottom
);
```

Input Parameters

Input Parameters	Description
SHORT left	x position of the left top corner.
SHORT top	y position of the left top corner.
SHORT right	x position of the right bottom corner.
SHORT bottom	y position of the right bottom corner.

Side Effects

none

Returns

For NON-Blocking configuration:

- Returns 0 when device is busy and the shape is not yet completely drawn.
- Returns 1 when the shape is completely drawn.

For Blocking configuration:

- Always return 1.

Overview

This function draws a bar given the left, top and right, bottom corners with the current color.

Syntax

WORD Bar(SHORT left, SHORT top, SHORT right, SHORT bottom)

9.4.2 Rectangle Macro

File

Primitive.h (see page 1028)

C

```
#define Rectangle(left, top, right, bottom) Bevel(left, top, right, bottom, 0)
```

Input Parameters

Input Parameters	Description
left	x position of the left top corner.
top	y position of the left top corner.
right	x position of the right bottom corner.
bottom	y position of the right bottom corner.

Side Effects

none

Returns

For NON-Blocking configuration:

- Returns 0 when device is busy and the shape is not yet completely drawn.
- Returns 1 when the shape is completely drawn.

For Blocking configuration:

- Always return 1.

Overview

This macro draws a rectangle with the given left, top and right, bottom corners. Current line type is used.

Syntax

Rectangle(left, top, right, bottom)

9.4.3 DrawPoly Function

File

Primitive.h (see page 1028)

C

```
WORD DrawPoly(
    SHORT numPoints,
    SHORT * polyPoints
);
```

Input Parameters

Input Parameters	Description
SHORT numPoints	Defines the number of points in the polygon.
SHORT * polyPoints	Pointer to the array of polygon points.

Side Effects

none

Returns

For NON-Blocking configuration:

- Returns 0 when device is busy and the shape is not yet completely drawn.
- Returns 1 when the shape is completely drawn.

For Blocking configuration:

- Always return 1.

Overview

This function draws a polygon with the current line type using the given number of points. The polygon points are stored in an array arranged in the following order:

```
SHORT polyPoints[numPoints] = {x0, y0, x1, y1, x2, y2 … xn, yn};
Where n = numPoints - 1
```

Syntax

WORD DrawPoly(SHORT numPoints, SHORT* polyPoints)

9.5 Circle Functions

Functions

	Name	Description
	Arc (see page 375)	Draws the octant arc of the beveled figure with the given centers, radii and octant mask. When octant = 0xFF and the following are true: 1. xL = xR, yT = yB , r1 = 0 and r2 = z, a filled circle is drawn with a radius of z. 2. radii have values (where r1 < r2), a full ring with thickness of (r2-r1) is drawn. 3. xL != xR, yT != yB , r1 = 0 and r2 = 0 (where xR > xL and yB > yT) a rectangle is drawn. xL, yT specifies the left top corner and xR,... more (see page 375)
	Bevel (see page 377)	Draws a beveled figure on the screen. When x1 = x2 and y1 = y2, a circular object is drawn. When x1 < x2 and y1 < y2 and rad (radius) = 0, a rectangular object is drawn.
	FillBevel (see page 378)	Draws a filled beveled figure on the screen. For a filled circular object x1 = x2 and y1 = y2. For a filled rectangular object radius = 0.

Macros

Name	Description
Circle (see page 374)	This macro draws a circle with the given center and radius.
FillCircle (see page 374)	This macro draws a filled circle. Uses the FillBevel (see page 378)() function.
SetBevelDrawType (see page 379)	This macro sets the fill bevel type to be drawn.

Module

Graphics Primitive Layer (see page 353)

Description

This lists the Primitive level circle functions.

9.5.1 Circle Macro

File

Primitive.h (see page 1028)

C

```
#define Circle(x, y, radius) Bevel(x, y, x, y, radius)
```

Input Parameters

Input Parameters	Description
x	Center x position.
y	Center y position.
radius	the radius of the circle.

Side Effects

none

Returns

For NON-Blocking configuration:

- Returns 0 when device is busy and the shape is not yet completely drawn.
- Returns 1 when the shape is completely drawn.

For Blocking configuration:

- Always return 1.

Overview

This macro draws a circle with the given center and radius.

Syntax

Circle(x, y, radius)

9.5.2 FillCircle Macro

File

Primitive.h (see page 1028)

C

```
#define FillCircle(x1, y1, rad) FillBevel(x1, y1, x1, y1, rad)
```

Input Parameters

Input Parameters	Description
x1	x coordinate position of the center of the circle.
y1	y coordinate position of the center of the circle.
rad	defines the redius of the circle.

Side Effects

none

Returns

For NON-Blocking configuration:

- Returns 0 when device is busy and the shape is not yet completely drawn.
- Returns 1 when the shape is completely drawn.

For Blocking configuration:

- Always return 1.

Overview

This macro draws a filled circle. Uses the FillBevel (see page 378)() function.

Syntax

FillCircle(SHORT x1, SHORT y1, SHORT rad)

9.5.3 Arc Function

File

Primitive.h (see page 1028)

C

```
WORD Arc(
    SHORT xL,
    SHORT yT,
    SHORT xR,
    SHORT yB,
    SHORT r1,
    SHORT r2,
    BYTE octant
);
```

Input Parameters

Input Parameters	Description
SHORT xL	x location of the upper left center in the x,y coordinate.
SHORT yT	y location of the upper left center in the x,y coordinate.
SHORT xR	x location of the lower right center in the x,y coordinate.
SHORT yB	y location of the lower right center in the x,y coordinate.
SHORT r1	The smaller radius of the two concentric cicles that defines the thickness of the object.
SHORT r2	The larger of radius the two concentric circles that defines the thickness of the object.

BYTE octant	Bitmask of the octant that will be drawn. Moving in a clockwise direction from x = 0, y = +radius • bit0 : first octant • bit1 : second octant • bit2 : third octant • bit3 : fourth octant • bit4 : fifth octant • bit5 : sixth octant • bit6 : seventh octant • bit7 : eight octant

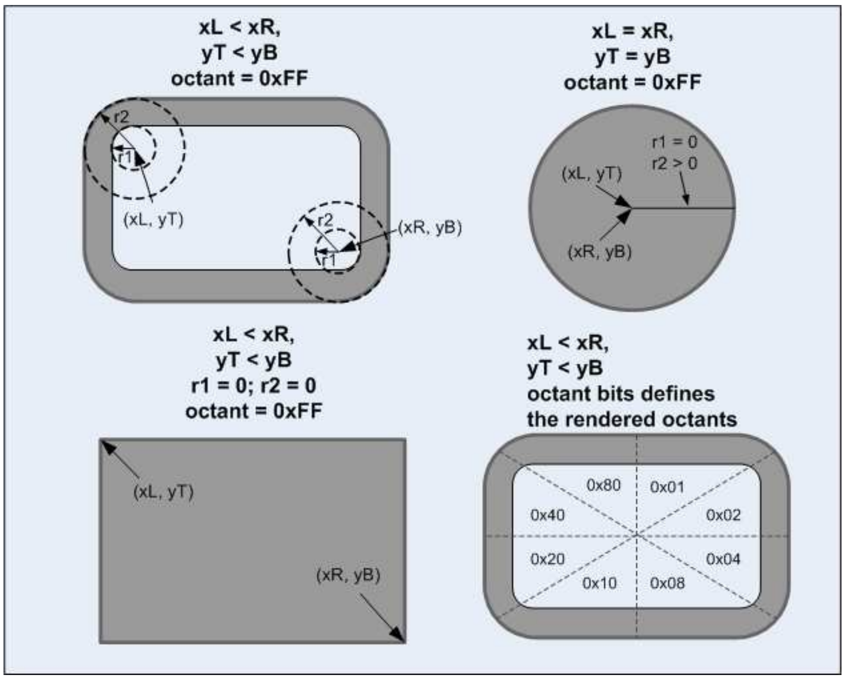
Side Effects

none

Returns

Returns the rendering status. 1 - If the rendering was completed and 0 - If the rendering is not yet finished.

Description



Preconditions

none

Overview

Draws the octant arc of the beveled figure with the given centers, radii and octant mask. When octant = 0xFF and the following are true:

1. xL = xR, yT = yB , r1 = 0 and r2 = z, a filled circle is drawn with a radius of z.
2. radii have values (where r1 < r2), a full ring with thickness of (r2-r1) is drawn.
3. xL != xR, yT != yB , r1 = 0 and r2 = 0 (where xR > xL and yB > yT) a rectangle is drawn. xL, yT specifies the left top corner and xR, yB specifies the right bottom corner.

When octant != 0xFF the figure drawn is the subsection of the 8 section figure where each non-zero bit of the octant value specifies the octants that will be drawn.

Syntax

WORD Arc(SHORT xL, SHORT yT, SHORT xR, SHORT yB, SHORT r1, SHORT r2, BYTE octant)

9.5.4 Bevel Function

File

Primitive.h (see page 1028)

C

```
WORD Bevel(
    SHORT x1,
    SHORT y1,
    SHORT x2,
    SHORT y2,
    SHORT rad
);
```

Input Parameters

Input Parameters	Description
SHORT x1	x coordinate position of the upper left center of the circle that draws the rounded corners.
SHORT y1	y coordinate position of the upper left center of the circle that draws the rounded corners.
SHORT x2	x coordinate position of the lower right center of the circle that draws the rounded corners.
SHORT y2	y coordinate position of the lower right center of the circle that draws the rounded corners.
SHORT rad	defines the redius of the circle, that draws the rounded corners.

Side Effects

none

Returns

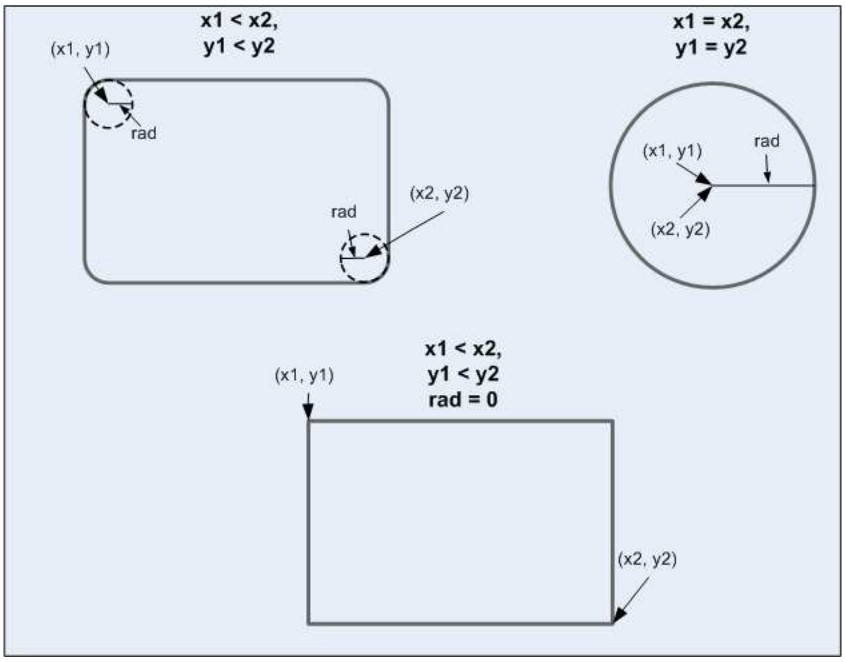
For NON-Blocking configuration:

- Returns 0 when device is busy and the shape is not yet completely drawn.
- Returns 1 when the shape is completely drawn.

For Blocking configuration:

- Always return 1.

Description



Overview

Draws a beveled figure on the screen. When x1 = x2 and y1 = y2, a circular object is drawn. When x1 < x2 and y1 < y2 and rad (radius) = 0, a rectangular object is drawn.

Syntax

WORD Bevel(SHORT x1, SHORT y1, SHORT x2, SHORT y2, SHORT rad)

9.5.5 FillBevel Function

File

Primitive.h (see page 1028)

C

```
WORD FillBevel(
    SHORT x1,
    SHORT y1,
    SHORT x2,
    SHORT y2,
    SHORT rad
);
```

Input Parameters

Input Parameters	Description
SHORT x1	x coordinate position of the upper left center of the circle that draws the rounded corners.
SHORT y1	y coordinate position of the upper left center of the circle that draws the rounded corners.
SHORT x2	x coordinate position of the lower right center of the circle that draws the rounded corners.
SHORT y2	y coordinate position of the lower right center of the circle that draws the rounded corners.
SHORT rad	defines the redius of the circle, that draws the rounded corners.

Side Effects

none

Returns

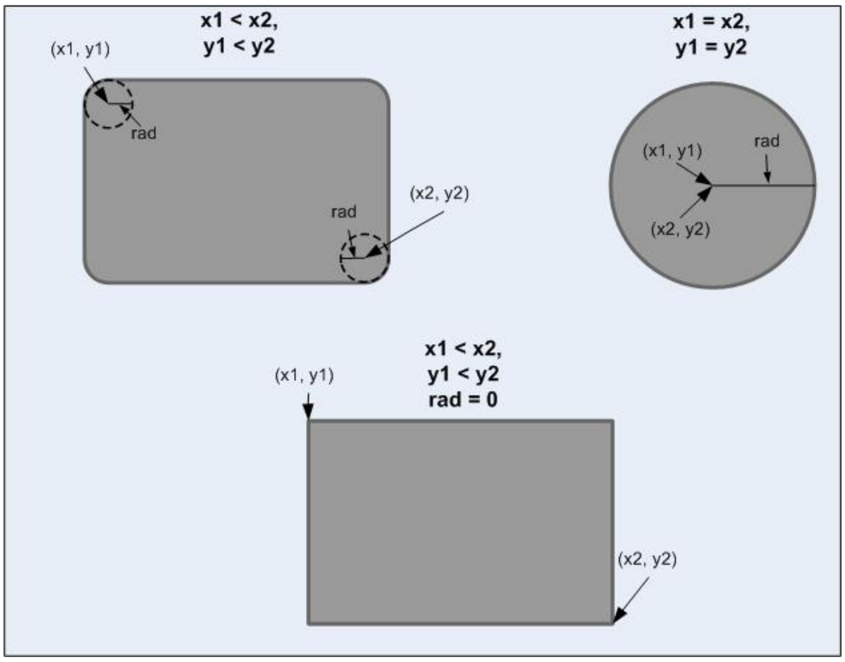
For NON-Blocking configuration:

- Returns 0 when device is busy and the shape is not yet completely drawn.
- Returns 1 when the shape is completely drawn.

For Blocking configuration:

- Always return 1.

Description



Overview

Draws a filled beveled figure on the screen. For a filled circular object x1 = x2 and y1 = y2. For a filled rectangular object radius = 0.

Syntax

WORD FillBevel(SHORT x1, SHORT y1, SHORT x2, SHORT y2, SHORT rad)

9.5.6 SetBevelDrawType Macro

File

Primitive.h (see page 1028)

C

```
#define SetBevelDrawType(type) (_bevelDrawType = type)
```

Input Parameters

Input Parameters	Description
type	is set using the following. • DRAWFULLBEVEL to draw the full shape • DRAWTOPBEVEL to draw the upper half portion • DRAWBOTTOMBEVEL to draw the lower half portion

Side Effects

none

Returns

none

Overview

This macro sets the fill bevel type to be drawn.

Syntax

SetBevelDrawType(type)

9.6 Graphic Cursor

Macros

Name	Description
GetX (see page 380)	This macro returns the current graphic cursor x-coordinate.
GetY (see page 381)	This macro returns the current graphic cursor y-coordinate.
MoveRel (see page 381)	This macro moves the graphic cursor relative to the current location. The given dX and dY displacement can be positive or negative numbers.
MoveTo (see page 382)	This macro moves the graphic cursor to new x,y position.

Module

Graphics Primitive Layer (see page 353)

Description

This lists the functions to control the graphics cursor.

9.6.1 GetX Macro

File

Primitive.h (see page 1028)

C

```
#define GetX _cursorX
```

Side Effects

none

Returns

none

Preconditions

none

Overview

This macro returns the current graphic cursor x-coordinate.

Syntax

GetX()

9.6.2 GetY Macro

File

Primitive.h (see page 1028)

C

```
#define GetY _cursorY
```

Side Effects

none

Returns

none

Preconditions

none

Overview

This macro returns the current graphic cursor y-coordinate.

Syntax

GetX (see page 380)()

9.6.3 MoveRel Macro

File

Primitive.h (see page 1028)

C

```
#define MoveRel(dX, dY) \
    _cursorX += dX;         \
    _cursorY += dY;
```

Input Parameters

Input Parameters	Description
dX	Specifies the displacement of the graphic cursor for the horizontal direction.
dY	Specifies the displacement of the graphic cursor for the vertical direction.

Side Effects

none

Returns

none

Preconditions

none

Overview

This macro moves the graphic cursor relative to the current location. The given dX and dY displacement can be positive or negative numbers.

Syntax

MoveRel(dX,dY)

9.6.4 MoveTo Macro

File

Primitive.h (see page 1028)

C

```
#define MoveTo(x, y) \
    _cursorX = x;       \
    _cursorY = y;
```

Input Parameters

Input Parameters	Description
x	Specifies the new x position of the graphic cursor.
y	Specifies the new y position of the graphic cursor.

Side Effects

none

Returns

none

Preconditions

none

Overview

This macro moves the graphic cursor to new x,y position.

Syntax

MoveTo(x,y)

9.7 Bitmap Functions

Functions

	Name	Description
◆	PutImage (see page 383)	This function outputs image starting from left,top coordinates.
◆	GetImageHeight (see page 383)	This function returns the image height.
◆	GetImageWidth (see page 384)	This function returns the image width.

Module

Graphics Primitive Layer (see page 353)

Structures

Name	Description
BITMAP_HEADER (see page 384)	Structure describing the bitmap header.

Description

This lists the functions to display bitmaps.

9.7.1 PutImage Function

File

Primitive.h (see page 1028)

C

```
WORD PutImage(
    SHORT left,
    SHORT top,
    void * bitmap,
    BYTE stretch
);
```

Input Parameters

Input Parameters	Description
SHORT left	x coordinate position of the left top corner.
SHORT top	y coordinate position of the left top corner.
void * bitmap	pointer to the bitmap.
BYTE stretch	The image stretch factor.

Side Effects

none

Returns

For NON-Blocking configuration:

- Returns 0 when device is busy and the image is not yet completely drawn.
- Returns 1 when the image is completely drawn.

For Blocking configuration:

- Always return 1.

Overview

This function outputs image starting from left,top coordinates.

Syntax

WORD PutImage(SHORT left, SHORT top, void* bitmap, BYTE stretch)

9.7.2 GetImageHeight Function

File

Primitive.h (see page 1028)

C

```
SHORT GetImageHeight(
    void * bitmap
);
```

Input Parameters

Input Parameters	Description
void * bitmap	Pointer to the bitmap.

Side Effects

none

Returns

Returns the image height in pixels.

Overview

This function returns the image height.

Syntax

SHORT GetImageHeight(void* bitmap)

9.7.3 GetImageWidth Function

File

Primitive.h (see page 1028)

C

```
SHORT GetImageWidth(
    void * bitmap
);
```

Input Parameters

Input Parameters	Description
void * bitmap	Pointer to the bitmap.

Side Effects

none

Returns

Returns the image width in pixels.

Overview

This function returns the image width.

Syntax

SHORT GetImageWidth(void* bitmap)

9.7.4 BITMAP_HEADER Structure

File

Primitive.h (see page 1028)

C

```
typedef struct {
  BYTE compression;
  BYTE colorDepth;
  SHORT height;
  SHORT width;
} BITMAP_HEADER;
```

Members

Members	Description
BYTE compression;	Compression setting
BYTE colorDepth;	Color depth used
SHORT height;	Image height
SHORT width;	Image width

Overview

Structure describing the bitmap header.

9.7.5 Bitmap Settings

Macros

Name	Description
IMAGE_NORMAL (see page 385)	Normal image stretch code
IMAGE_X2 (see page 385)	Stretched image stretch code

Description

Bitmap rendering settings.

9.7.5.1 IMAGE_NORMAL Macro

File

Primitive.h (see page 1028)

C

```
#define IMAGE_NORMAL 1
```

Description

Normal image stretch code

9.7.5.2 IMAGE_X2 Macro

File

Primitive.h (see page 1028)

C

```
#define IMAGE_X2 2
```

Description

Stretched image stretch code

9.7.6 Bitmap Source

Bitmap data structure is dependent on the location.

9.8 External Memory

This lists the external memory access functions and descriptions.

Macros

Name	Description
EXTERNAL_FONT_BUFFER_SIZE (see page 386)	This defines the size of the buffer used by font functions to retrieve font data from the external memory. The buffer size can be increased to accommodate large font sizes. The user must be aware of the expected glyph sizes of the characters stored in the font table.

Module

Graphics Primitive Layer (see page 353)

Description

Bitmaps and Fonts can be located in external memory. To refer the data, EXTDATA structure is used:

```
typedef struct _EXTDATA_
{
   TYPE_MEMORY   type;          // must be set to EXTERNAL
   WORD          ID;            // memory ID
   DWORD         address;       // bitmap or font image address
} EXTDATA;
```

where:

- type – shows type of memory used (0 – internal, 1 - external).
- ID – unique number must be assigned by application to have a way distinguishing memory chips if the application has several of them.
- address – start address of the bitmap or font image in the external memory.

To use the bitmap or font the pointer to EXTDATA structure must be passed into corresponding function (PutImage (see page 383)() or SetFont (see page 356)()). Each time the library will need data it will call special call back function ExternalMemoryCallback().

This function must be implemented in the application. Inside, the application must copy requested bytes quantity into the buffer provided. Data start address can be calculated as a sum of the start image address specified in EXTDATA structure and offset provided.

9.8.1 EXTERNAL_FONT_BUFFER_SIZE Macro

File

Primitive.h (see page 1028)

C

```
#define EXTERNAL_FONT_BUFFER_SIZE 600
```

Overview

This defines the size of the buffer used by font functions to retrieve font data from the external memory. The buffer size can be increased to accommodate large font sizes. The user must be aware of the expected glyph sizes of the characters stored in the font table.

9.8.2 Memory Type

Memory type enumeration to determine the source of data. Used in interpreting bitmap and font from different memory sources.

9.9 Set Up Functions

Functions

	Name	Description
	ClearDevice (see page 387)	This function clears the screen with the current color and sets the graphic cursor position to (0, 0). Clipping is NOT supported by ClearDevice().
	InitGraph (see page 388)	This function initializes the display controller, sets the line type to SOLID_LINE (see page 369), sets the screen to all BLACK (see page 409), sets the current drawing color to WHITE (see page 415), sets the graphic cursor position to upper left corner of the screen, sets active and visual pages to page #0, clears the active page and disables clipping. This function should be called before using the Graphics Primitive Layer.

Module

Graphics Primitive Layer (see page 353)

Description

This lists the Primitive set up and initialization functions.

9.9.1 ClearDevice Function

File

Primitive.h (see page 1028)

C

```
void ClearDevice();
```

Side Effects

none

Returns

none

Example

```
void ClearScreen(void)
{
    SetColor(WHITE);        // set color to WHITE
    ClearDevice();          // set screen to all WHITE
}
```

Overview

This function clears the screen with the current color and sets the graphic cursor position to (0, 0). Clipping is NOT supported by ClearDevice().

Syntax

void ClearDevice(void)

9.9.2 InitGraph Function

File

Primitive.h (see page 1028)

C

```
void InitGraph();
```

Side Effects

none

Returns

none

Preconditions

none

Overview

This function initializes the display controller, sets the line type to SOLID_LINE (see page 369), sets the screen to all BLACK (see page 409), sets the current drawing color to WHITE (see page 415), sets the graphic cursor position to upper left corner of the screen, sets active and visual pages to page #0, clears the active page and disables clipping. This function should be called before using the Graphics Primitive Layer.

Syntax

void InitGraph(void)

9.10 GFX_RESOURCE Enumeration

File

Primitive.h (see page 1028)

C

```
typedef enum {
  FLASH = 0x0000,
  EXTERNAL = 0x0001,
  FLASH_JPEG = 0x0002,
  EXTERNAL_JPEG = 0x0003,
  RAM = 0x0004,
  EDS_EPMP = 0x0005,
  IMAGE_MBITMAP = 0x0000,
  IMAGE_JPEG = 0x0100,
  COMP_NONE = 0x0000,
  COMP_RLE = 0x1000,
  COMP_IPU = 0x2000
} GFX_RESOURCE;
```

Members

Members	Description
FLASH = 0x0000	internal flash
EXTERNAL = 0x0001	external memory
FLASH_JPEG = 0x0002	internal flash
EXTERNAL_JPEG = 0x0003	external memory
RAM = 0x0004	RAM
EDS_EPMP = 0x0005	memory in EPMP, base addresses are are set in the hardware profile
IMAGE_MBITMAP = 0x0000	data resource is type Microchip bitmap
IMAGE_JPEG = 0x0100	data resource is type JPEG
COMP_NONE = 0x0000	no compression
COMP_RLE = 0x1000	compressed with RLE
COMP_IPU = 0x2000	compressed with DEFLATE (for IPU)

Module

Graphics Primitive Layer (see page 353)

Overview

Memory type enumeration to determine the source of data. Used in interpreting bitmap and font from different memory sources.

9.11 GFX_IMAGE_HEADER Structure

File

Primitive.h (see page 1028)

C

```
typedef struct {
  GFX_RESOURCE type;
  WORD ID;
  union {
    DWORD extAddress;
    FLASH_BYTE * progByteAddress;
    FLASH_WORD * progWordAddress;
    const char * constAddress;
    char * ramAddress;
    __eds__ char * edsAddress;
  } LOCATION;
  WORD width;
  WORD height;
  DWORD param1;
  DWORD param2;
  WORD colorDepth;
} GFX_IMAGE_HEADER;
```

Members

Members	Description
GFX_RESOURCE type;	Graphics resource type, determines the type and location of data
WORD ID;	memory ID, user defined value to differentiate between graphics resources of the same type When using EDS_EPMP the following ID values are reserved and used by the Microchip display driver 0 - reserved (do not use) 1 - reserved for base address of EPMP CS1 2 - reserved for base address of EPMP CS2
DWORD extAddress;	generic address
FLASH_BYTE * progByteAddress;	for addresses in program section

FLASH_WORD * progWordAddress;	for addresses in program section
const char * constAddress;	for addresses in FLASH
char * ramAddress;	for addresses in RAM
__eds__ char * edsAddress;	for addresses in EDS
WORD width;	width of the image
WORD height;	height of the image
DWORD param1;	size of the IPU compressed data
DWORD param2;	size of the IPU decompressed data
WORD colorDepth;	color depth of the image

Module

Graphics Primitive Layer (see page 353)

Overview

Structure for images stored in various system memory (Flash, External Memory (SPI, Parallel Flash, or memory in EPMP).

9.12 IMAGE_FLASH Structure

File

Primitive.h (see page 1028)

C

```
typedef struct {
  GFX_RESOURCE type;
  FLASH_BYTE * address;
} IMAGE_FLASH;
```

Members

Members	Description
GFX_RESOURCE type;	must be FLASH
FLASH_BYTE * address;	image address in FLASH

Module

Graphics Primitive Layer (see page 353)

Overview

Structure for images stored in FLASH memory.

9.13 IMAGE_RAM Structure

File

Primitive.h (see page 1028)

C

```
typedef struct {
  GFX_RESOURCE type;
  DWORD * address;
} IMAGE_RAM;
```

Members

Members	Description
GFX_RESOURCE type;	must be RAM
DWORD * address;	image address in RAM

Module

Graphics Primitive Layer (see page 353)

Overview

Structure for images stored in RAM memory.

9.14 GFX_EXTDATA Structure

File

Primitive.h (see page 1028)

C

```
typedef struct {
  GFX_RESOURCE type;
  WORD ID;
  DWORD address;
} GFX_EXTDATA;
```

Members

Members	Description
GFX_RESOURCE type;	must be EXTERNAL or EDS_EPMP
WORD ID;	memory ID, user defined value to differentiate between graphics resources of the same type When using EDS_EPMP the following ID values are reserved and used by the Microchip display driver 0 - reserved (do not use) 1 - reserved for base address of EPMP CS1 2 - reserved for base address of EPMP CS2
DWORD address;	Data image address (user data, bitmap or font)

Module

Graphics Primitive Layer (see page 353)

Overview

This structure is used to describe external memory.

9.15 Types

9.15.1 IMAGE_EXTERNAL Type

File

Primitive.h (see page 1028)

C

```
typedef GFX_EXTDATA IMAGE_EXTERNAL;
```

Module

Graphics Primitive Layer (see page 353)

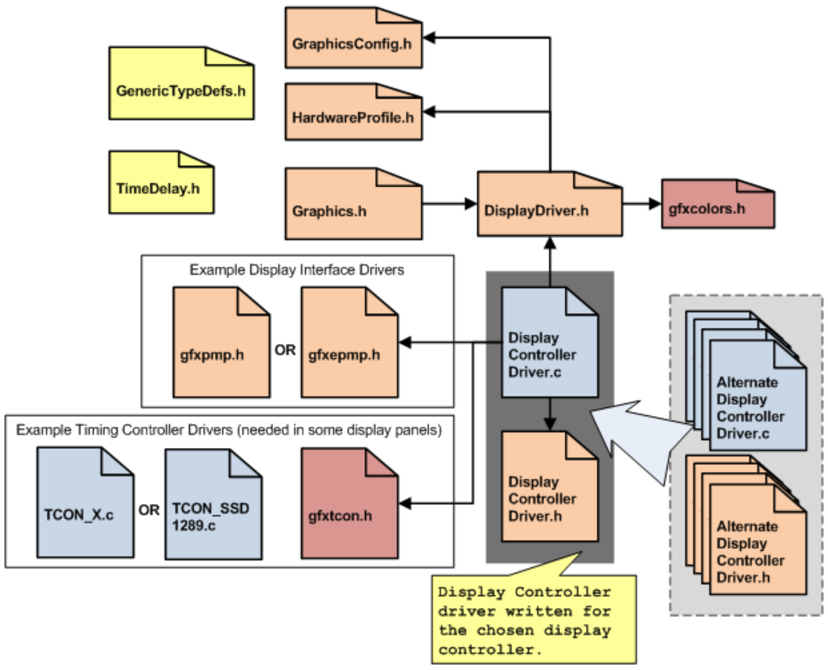
Overview

Structure for images stored in EXTERNAL memory space. (example: External SPI or parallel Flash, EDS_EPMP)

10 Display Device Driver Layer

The Device Driver Layer is the layer that comprises the selection of the display driver file based on the settings specified in the HardwareProfile.h file implemented on the application layer.

The Device Driver Layer organization is shown on the figure below:


GraphicsConfig.h
GenericTypeDefs.h
HardwareProfile.h
TimeDelay.h
Graphics.h
DisplayDriver.h
gfxcolors.h
Example Display Interface Drivers
gfxpmp.h
OR
gfxepmp.h
Display Controller Driver.c
Alternate Display Controller Driver.c
Example Timing Controller Drivers (needed in some display panels)
TCON_X.c
OR
TCON_SSD 1289.c
gfxtcon.h
Display Controller Driver.h
Alternate Display Controller Driver.h
Display Controller driver written for the chosen display controller.

An option to use a customized driver is also supported by this scheme. The application need only to define custom display macro in the HardwareProfile header file. This macro must be unique to the display driver. For example the display macro for the SSD1926 driver is GFX_USE_DISPLAY_CONTROLLER_SSD1926 (see page 57). It is recommended that the application keep the same format when naming the display macro, GFX_USE_DISPLAY_CONTROLLER_<DRIVER NAME>.

10.1 Display Device Driver Level Primitives

This lists the Device Level Primitive rendering functions and macros.

Functions

	Name	Description
	GetPixel (see page 394)	Returns pixel color at the given x,y coordinate position.
	PutPixel (see page 395)	Puts pixel with the given x,y coordinate position.
	SetClip (see page 398)	Enables/disables clipping.
	SetClipRgn (see page 398)	Sets clipping region.
	TransparentColorEnable (see page 401)	Sets current transparent color.
	DisplayBrightness (see page 404)	Sets the brightness of the display.

	CopyBlock (see page 405)	Copies a block of data from source specified by srcAddr and srcOffset to the destination specified by dstAddr and dstOffset. This is similar to the CopyWindow (see page 407)() and but instead of using left, top position of the source and destination, it uses offsets instead. This is a blocking function.
	CopyPageWindow (see page 406)	This is a blocking call. A windows is a rectangular area with the given width and height of a page. The source and destination window can be located in different pages and each page is assumed to have the same dimensions (equal width and height).
	CopyWindow (see page 407)	A windows is a rectangular area with the given width and height located in the given base source address. The source and destination window can be located in the same base address. If this is the case, then srcAddr = dstAddr. The operation is similar to CopyPageWindow (see page 406)() but instead of using page numbers, addresses are used for versatility. This is a blocking function.
	SetActivePage (see page 408)	Sets active graphic page.
	SetVisualPage (see page 408)	Sets graphic page to display.

Macros

Name	Description
GetColor (see page 396)	Returns current drawing color.
SetColor (see page 396)	Sets current drawing color.
GetMaxX (see page 397)	Returns maximum horizontal coordinate.
GetMaxY (see page 397)	Returns maximum vertical coordinate.
GetClipBottom (see page 399)	Returns bottom clipping border.
GetClipLeft (see page 399)	Returns left clipping border.
GetClipRight (see page 400)	Returns right clipping border.
GetClipTop (see page 400)	Returns top clipping border.
CLIP_DISABLE (see page 401)	Disables clipping.
CLIP_ENABLE (see page 401)	Enables clipping.
TransparentColorDisable (see page 402)	Disables the transparent color function.
GetTransparentColor (see page 403)	Returns the current transparent color value.
TRANSPARENT_COLOR_DISABLE (see page 403)	Check of transparent color is not performed
TRANSPARENT_COLOR_ENABLE (see page 404)	Check pixel if color is equal to transparent color, if equal do not render pixel
GetPageAddress (see page 405)	Returns the address of the given page.

Module

Display Device Driver Layer (see page 393)

10.1.1 GetPixel Function

File

DisplayDriver.h

C

```
GFX_COLOR GetPixel(
    SHORT x,
    SHORT y
);
```

Input Parameters

Input Parameters	Description
SHORT x	x position of the pixel.
SHORT y	y position of the pixel.

Side Effects

none

Returns

pixel color

Preconditions

none

Overview

Returns pixel color at the given x,y coordinate position.

Syntax

GFX_COLOR (see page 351) GetPixel(SHORT x, SHORT y)

10.1.2 PutPixel Function

File

DisplayDriver.h

C

```
void PutPixel(
    SHORT x,
    SHORT y
);
```

Input Parameters

Input Parameters	Description
SHORT x	x position of the pixel.
SHORT y	y position of the pixel.

Side Effects

none

Returns

none

Preconditions

none

Overview

Puts pixel with the given x,y coordinate position.

Syntax

void PutPixel(SHORT x, SHORT y)

10.1.3 GetColor Macro

File

DisplayDriver.h

C

```
#define GetColor _color
```

Side Effects

none

Returns

Color coded in 5:6:5 RGB format.

Preconditions

none

Overview

Returns current drawing color.

Syntax

GetColor()

10.1.4 SetColor Macro

File

DisplayDriver.h

C

```
#define SetColor(color) _color = (color)
```

Input Parameters

Input Parameters	Description
color	Color coded in 5:6:5 RGB format.

Side Effects

none

Returns

none

Preconditions

none

Overview

Sets current drawing color.

Syntax

SetColor(color)

10.1.5 GetMaxX Macro

File

DisplayDriver.h

C

```
#define GetMaxX (DISP_HOR_RESOLUTION - 1)
```

Side Effects

none

Returns

Maximum horizontal coordinate.

Preconditions

none

Example

```
// Create a window that will occupy the whole screen.
WndCreate(0xFF,                             // ID
          0,0,
          GetMaxX(),GetMaxY(),              // dimension
          WND_DRAW,                         // will be dislayed after creation
          (void*)&mchpIcon,                 // use icon used
          pText,                            // set to text pointed to by pText
          NULL);                            // use default scheme
```

Overview

Returns maximum horizontal coordinate.

Syntax

GetMaxX()

10.1.6 GetMaxY Macro

File

DisplayDriver.h

C

```
#define GetMaxY (DISP_VER_RESOLUTION - 1)
```

Side Effects

none

Returns

Maximum vertical coordinate.

Preconditions

none

Example

(see GetMaxX (see page 397)()) example.

Overview

Returns maximum vertical coordinate.

Syntax

GetMaxY()

10.1.7 SetClip Function

File

DisplayDriver.h

C

```
void SetClip(
    BYTE control
);
```

Input Parameters

Input Parameters	Description
BYTE control	Enables or disables the clipping. • 0: Disable clipping • 1: Enable clipping

Side Effects

none

Returns

none

Preconditions

none

Overview

Enables/disables clipping.

Syntax

SetClip(control)

10.1.8 SetClipRgn Function

File

DisplayDriver.h

C

```
void SetClipRgn(
    SHORT left,
    SHORT top,
    SHORT right,
    SHORT bottom
);
```

Input Parameters

Input Parameters	Description
SHORT left	Defines the left clipping region border.
SHORT top	Defines the top clipping region border.
SHORT right	Defines the right clipping region border.
SHORT bottom	Defines the bottom clipping region border.

Side Effects

none

Returns

none

Preconditions

none

Overview

Sets clipping region.

Syntax

SetClipRgn(left, top, right, bottom)

10.1.9 GetClipBottom Macro

File

DisplayDriver.h

C

```
#define GetClipBottom _clipBottom
```

Side Effects

none

Returns

Bottom clipping border.

Preconditions

none

Overview

Returns bottom clipping border.

Syntax

GetClipBottom()

10.1.10 GetClipLeft Macro

File

DisplayDriver.h

C

```
#define GetClipLeft _clipLeft
```

Side Effects

none

Returns

Left clipping border.

Preconditions

none

Overview

Returns left clipping border.

Syntax

GetClipLeft()

10.1.11 GetClipRight Macro

File

DisplayDriver.h

C

```
#define GetClipRight _clipRight
```

Side Effects

none

Returns

Right clipping border.

Preconditions

none

Overview

Returns right clipping border.

Syntax

GetClipRight()

10.1.12 GetClipTop Macro

File

DisplayDriver.h

C

```
#define GetClipTop _clipTop
```

Side Effects

none

Returns

Top clipping border.

Preconditions

none

Overview

Returns top clipping border.

Syntax

GetClipTop()

10.1.13 CLIP_DISABLE Macro

File

DisplayDriver.h

C

```
#define CLIP_DISABLE 0   // Disables clipping.
```

Description

Disables clipping.

10.1.14 CLIP_ENABLE Macro

File

DisplayDriver.h

C

```
#define CLIP_ENABLE 1   // Enables clipping.
```

Description

Enables clipping.

10.1.15 TransparentColorEnable Function

File

DisplayDriver.h

C

```
void TransparentColorEnable(
    GFX_COLOR color
);
```

Input Parameters

Input Parameters	Description
GFX_COLOR color	Chosen transparent color.

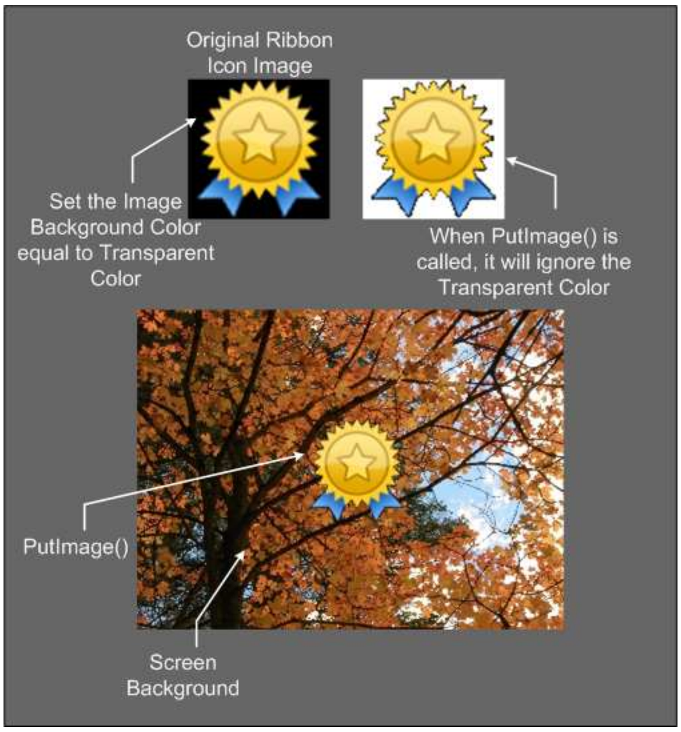
Side Effects

PutImage (see page 383)() will not render pixels that matches the set transparent color.

Returns

none

Description


Original Ribbon Icon Image
Set the Image Background Color equal to Transparent Color
When PutImage() is called, it will ignore the Transparent Color
PutImage()
Screen Background

Preconditions

none

Example

```
#define YOURSETTRANSPARENT_COLOR RGBConvert(0x0D,0x0D,0x0D)

TransparentColorEnable(YOURSETTRANSPARENT_COLOR);
PutImage(0,0, (void*)&ScreenBackground);
PutImage(0,0, (void*)&RibbonIcon);
```

Overview

Sets current transparent color.

Syntax

void TransparentColorEnable(GRFX_COLOR color)

10.1.16 TransparentColorDisable Macro

File

DisplayDriver.h

C

```
#define TransparentColorDisable _colorTransparentEnable = TRANSPARENT_COLOR_DISABLE;
```

Side Effects

none

Returns

none

Preconditions

none

Overview

Disables the transparent color function.

Syntax

TransparentColorDisable()

10.1.17 GetTransparentColor Macro

File

DisplayDriver.h

C

```
#define GetTransparentColor _colorTransparent
```

Side Effects

none

Returns

Returns the current transparent color used.

Preconditions

none

Overview

Returns the current transparent color value.

Syntax

GetTransparentColor()

10.1.18 TRANSPARENT_COLOR_DISABLE Macro

File

DisplayDriver.h

C

```
#define TRANSPARENT_COLOR_DISABLE 0   // Check of transparent color is not performed
```

Description

Check of transparent color is not performed

10.1.19 TRANSPARENT_COLOR_ENABLE Macro

File

DisplayDriver.h

C

```
#define TRANSPARENT_COLOR_ENABLE 1   // Check pixel if color is equal to transparent color,
if equal do not render pixel
```

Description

Check pixel if color is equal to transparent color, if equal do not render pixel

10.1.20 DisplayBrightness Function

File

SSD1926.h (see page 1188)

C

```
void DisplayBrightness(
    WORD level
);
```

Input Parameters

Input Parameters	Description
WORD level	Brightness level. Valid values are 0 to 100. • 0: brightness level is zero or display is turned off • 1: brightness level is maximum

Side Effects

none

Returns

none

Notes

none

Preconditions

none

Overview

Sets the brightness of the display.

Syntax

void DisplayBrightness(WORD level)

10.1.21 GetPageAddress Macro

File

DisplayDriver.h

C

```
#define GetPageAddress(page) (_PageTable[page])
```

Side Effects

none

Returns

Address in memory of the given page number. The number of pages is dictated by GFX_DRV_PAGE_COUNT value defined in the hardware profile. GFX_DRV_PAGE_COUNT is not mandatory. Drivers that do not have enough memory for paging may not define this constant. If GFX_DRV_PAGE_COUNT is not defined, all API's related to paging operation is will not be available.

Preconditions

none

Overview

Returns the address of the given page.

Syntax

GetPageAddress(page)

10.1.22 CopyBlock Function

File

DisplayDriver.h

C

```
WORD CopyBlock(
    DWORD srcAddr,
    DWORD dstAddr,
    DWORD srcOffset,
    DWORD dstOffset,
    WORD width,
    WORD height
);
```

Input Parameters

Input Parameters	Description
DWORD srcAddr	the base address of the data to be moved
DWORD dstAddr	the base address of the new location of the moved data
DWORD srcOffset	offset of the data to be moved with respect to the source base address.
DWORD dstOffset	offset of the new location of the moved data respect to the source base address.
WORD width	width of the block of data to be moved
WORD height	height of the block of data to be moved

Side Effects

none

Returns

none

Notes

none

Preconditions

none

Overview

Copies a block of data from source specified by srcAddr and srcOffset to the destination specified by dstAddr and dstOffset. This is similar to the CopyWindow (see page 407)() and but instead of using left, top position of the source and destination, it uses offsets instead. This is a blocking function.

Syntax

WORD CopyBlock(DWORD srcAddr, DWORD dstAddr, DWORD srcOffset, DWORD dstOffset, WORD width, WORD height)

10.1.23 CopyPageWindow Function

File

DisplayDriver.h

C

```
WORD CopyPageWindow(
    BYTE srcPage,
    BYTE dstPage,
    \ WORD srcX,
    WORD srcY,
    \ WORD dstX,
    WORD dstY,
    \ WORD width,
    WORD height
);
```

Input Parameters

Input Parameters	Description
BYTE srcPage	page number of the source window,
BYTE dstPage	page number of the destination window,
\ WORD srcX	x location of the left top corner of the source window respect to the srcPage.
WORD srcY	y location of the left top corner of the source window respect to the srcPage.
\ WORD dstX	x location of the left top corner of the destination window respect to the dstPage.
WORD dstY	y location of the left top corner of the destination window respect to the dstPage.
\ WORD width	the width in pixels of the window to copy
WORD height	the height in pixels of the window to copy

Side Effects

none

Returns

None

Preconditions

none

Overview

This is a blocking call. A windows is a rectangular area with the given width and height of a page. The source and destination window can be located in different pages and each page is assumed to have the same dimensions (equal width and height).

Syntax

CopyPageWindow(srcPage, dstPage, srcX, srcY, dstX, dstY, width, height)

10.1.24 CopyWindow Function

File

DisplayDriver.h

C

```
WORD CopyWindow(
    DWORD srcAddr,
    DWORD dstAddr,
    \ WORD srcX,
    WORD srcY,
    \ WORD dstX,
    WORD dstY,
    \ WORD width,
    WORD height
);
```

Input Parameters

Input Parameters	Description
DWORD srcAddr	Base Address of the source window,
\ WORD srcX	x location of the left top corner of the source window respect to the srcPage.
WORD srcY	y location of the left top corner of the source window respect to the srcPage.
\ WORD dstX	x location of the left top corner of the destination window respect to the dstPage.
WORD dstY	y location of the left top corner of the destination window respect to the dstPage.
\ WORD width	the width in pixels of the window to copy
WORD height	the height in pixels of the window to copy
dstPage	Base Address of the destination window,

Side Effects

none

Returns

None

Preconditions

none

Overview

A windows is a rectangular area with the given width and height located in the given base source address. The source and destination window can be located in the same base address. If this is the case, then srcAddr = dstAddr. The operation is similar to CopyPageWindow (see page 406)() but instead of using page numbers, addresses are used for versatility. This is a blocking function.

Syntax

WORD CopyWindow(DWORD srcAddr, DWORD dstAddr, WORD srcX, WORD srcY, WORD dstX, WORD dstY, WORD width, WORD height)

10.1.25 SetActivePage Function

File

DisplayDriver.h

C

```
void SetActivePage(
    WORD page
);
```

Input Parameters

Input Parameters	Description
WORD page	Graphic page number.

Side Effects

none

Returns

none

Description

Functions: SetActivePage(page)

Preconditions

none

Overview

Sets active graphic page.

10.1.26 SetVisualPage Function

File

DisplayDriver.h

C

```
void SetVisualPage(
    WORD page
);
```

Input Parameters

Input Parameters	Description
WORD page	Graphic page number

Side Effects

none

Returns

none

Description

Functions: SetVisualPage(page)

Preconditions

none

Overview

Sets graphic page to display.

10.1.27 Color Definition

The device driver must also implement the definition of standard color set based on the color format used.

Macros

Name	Description
BLACK (see page 409)	USE_PALETTE (see page 48)
BLUE (see page 410)	This is macro BLUE.
BRIGHTBLUE (see page 410)	This is macro BRIGHTBLUE.
BRIGHTCYAN (see page 410)	This is macro BRIGHTCYAN.
BRIGHTGREEN (see page 410)	This is macro BRIGHTGREEN.
BRIGHTMAGENTA (see page 411)	This is macro BRIGHTMAGENTA.
BRIGHTRED (see page 411)	This is macro BRIGHTRED.
BRIGHTYELLOW (see page 411)	This is macro BRIGHTYELLOW.
BROWN (see page 411)	This is macro BROWN.
CYAN (see page 411)	This is macro CYAN.
DARKGRAY (see page 412)	This is macro DARKGRAY.
GRAY0 (see page 412)	This is macro GRAY0.
GRAY1 (see page 412)	This is macro GRAY1.
GRAY2 (see page 412)	This is macro GRAY2.
GRAY4 (see page 413)	This is macro GRAY4.
GRAY6 (see page 413)	This is macro GRAY6.
GREEN (see page 413)	This is macro GREEN.
LIGHTBLUE (see page 413)	This is macro LIGHTBLUE.
LIGHTCYAN (see page 413)	This is macro LIGHTCYAN.
LIGHTGRAY (see page 414)	This is macro LIGHTGRAY.
LIGHTGREEN (see page 414)	This is macro LIGHTGREEN.
LIGHTMAGENTA (see page 414)	This is macro LIGHTMAGENTA.
LIGHTRED (see page 414)	This is macro LIGHTRED.
MAGENTA (see page 415)	This is macro MAGENTA.
RED (see page 415)	This is macro RED.
WHITE (see page 415)	This is macro WHITE.
YELLOW (see page 415)	This is macro YELLOW.

Description

The following lists sample color definitions for a 16-bpp color encoding.

10.1.27.1 BLACK Macro

File

gfxcolors.h

C

```
#define BLACK RGBConvert(0, 0, 0)
```

Description

USE_PALETTE (see page 48)

10.1.27.2 BLUE Macro

File

gfxcolors.h

C

```
#define BLUE RGBConvert(0, 0, 128)
```

Description

This is macro BLUE.

10.1.27.3 BRIGHTBLUE Macro

File

gfxcolors.h

C

```
#define BRIGHTBLUE RGBConvert(0, 0, 255)
```

Description

This is macro BRIGHTBLUE.

10.1.27.4 BRIGHTCYAN Macro

File

gfxcolors.h

C

```
#define BRIGHTCYAN RGBConvert(0, 255, 255)
```

Description

This is macro BRIGHTCYAN.

10.1.27.5 BRIGHTGREEN Macro

File

gfxcolors.h

C

```
#define BRIGHTGREEN RGBConvert(0, 255, 0)
```

Description

This is macro BRIGHTGREEN.

10.1.27.6 BRIGHTMAGENTA Macro

File

gfxcolors.h

C

```
#define BRIGHTMAGENTA RGBConvert(255, 0, 255)
```

Description

This is macro BRIGHTMAGENTA.

10.1.27.7 BRIGHTRED Macro

File

gfxcolors.h

C

```
#define BRIGHTRED RGBConvert(255, 0, 0)
```

Description

This is macro BRIGHTRED.

10.1.27.8 BRIGHTYELLOW Macro

File

gfxcolors.h

C

```
#define BRIGHTYELLOW RGBConvert(255, 255, 0)
```

Description

This is macro BRIGHTYELLOW.

10.1.27.9 BROWN Macro

File

gfxcolors.h

C

```
#define BROWN RGBConvert(255, 128, 0)
```

Description

This is macro BROWN.

10.1.27.10 CYAN Macro

File

gfxcolors.h

C

```
#define CYAN RGBConvert(0, 128, 128)
```

Description

This is macro CYAN.

10.1.27.11 DARKGRAY Macro

File

gfxcolors.h

C

```
#define DARKGRAY RGBConvert(64, 64, 64)
```

Description

This is macro DARKGRAY.

10.1.27.12 GRAY0 Macro

File

gfxcolors.h

C

```
#define GRAY0 RGBConvert(224, 224, 224)
```

Description

This is macro GRAY0.

10.1.27.13 GRAY1 Macro

File

gfxcolors.h

C

```
#define GRAY1 RGBConvert(192, 192, 192)
```

Description

This is macro GRAY1.

10.1.27.14 GRAY2 Macro

File

gfxcolors.h

C

```
#define GRAY2 RGBConvert(160, 160, 160)
```

Description

This is macro GRAY2.

10.1.27.15 GRAY4 Macro

File

gfxcolors.h

C

```
#define GRAY4 RGBConvert(96, 96, 96)
```

Description

This is macro GRAY4.

10.1.27.16 GRAY6 Macro

File

gfxcolors.h

C

```
#define GRAY6 RGBConvert(32, 32, 32)
```

Description

This is macro GRAY6.

10.1.27.17 GREEN Macro

File

gfxcolors.h

C

```
#define GREEN RGBConvert(0, 128, 0)
```

Description

This is macro GREEN.

10.1.27.18 LIGHTBLUE Macro

File

gfxcolors.h

C

```
#define LIGHTBLUE RGBConvert(128, 128, 255)
```

Description

This is macro LIGHTBLUE.

10.1.27.19 LIGHTCYAN Macro

File

gfxcolors.h

C

```
#define LIGHTCYAN RGBConvert(128, 255, 255)
```

Description

This is macro LIGHTCYAN.

10.1.27.20 LIGHTGRAY Macro

File

gfxcolors.h

C

```
#define LIGHTGRAY RGBConvert(128, 128, 128)
```

Description

This is macro LIGHTGRAY.

10.1.27.21 LIGHTGREEN Macro

File

gfxcolors.h

C

```
#define LIGHTGREEN RGBConvert(128, 255, 128)
```

Description

This is macro LIGHTGREEN.

10.1.27.22 LIGHTMAGENTA Macro

File

gfxcolors.h

C

```
#define LIGHTMAGENTA RGBConvert(255, 128, 255)
```

Description

This is macro LIGHTMAGENTA.

10.1.27.23 LIGHTRED Macro

File

gfxcolors.h

C

```
#define LIGHTRED RGBConvert(255, 128, 128)
```

Description

This is macro LIGHTRED.

10.1.27.24 MAGENTA Macro

File

gfxcolors.h

C

```
#define MAGENTA RGBConvert(128, 0, 128)
```

Description

This is macro MAGENTA.

10.1.27.25 RED Macro

File

gfxcolors.h

C

```
#define RED RGBConvert(128, 0, 0)
```

Description

This is macro RED.

10.1.27.26 WHITE Macro

File

gfxcolors.h

C

```
#define WHITE RGBConvert(255, 255, 255)
```

Description

This is macro WHITE.

10.1.27.27 YELLOW Macro

File

gfxcolors.h

C

```
#define YELLOW RGBConvert(255, 255, 128)
```

Description

This is macro YELLOW.

10.2 Display Device Driver Control

This lists the device control functions and macros.

Functions

	Name	Description
	IsDeviceBusy (see page 416)	Returns non-zero if LCD controller is busy (previous drawing operation is not completed).
	ResetDevice (see page 417)	Initializes LCD module.

Macros

Name	Description
SetPalette (see page 416)	Sets palette register.

Module

Display Device Driver Layer (see page 393)

10.2.1 IsDeviceBusy Function

File

DisplayDriver.h

C

```
WORD IsDeviceBusy();
```

Side Effects

none

Returns

Busy status.

Preconditions

none

Overview

Returns non-zero if LCD controller is busy (previous drawing operation is not completed).

Syntax

IsDeviceBusy()

10.2.2 SetPalette Macro

File

SH1101A_SSD1303.h (see page 1124)

C

```
#define SetPalette(colorNum, color)
```

Input Parameters

Input Parameters	Description
colorNum	Register number.
color	Color.

Side Effects

none

Returns

none

Preconditions

none

Overview

Sets palette register.

Syntax

SetPalette(colorNum, color)

10.2.3 ResetDevice Function

File

DisplayDriver.h

C

```
void ResetDevice();
```

Side Effects

none

Returns

none

Preconditions

none

Overview

Initializes LCD module.

Syntax

void ResetDevice()

10.3 Adding New Device Driver

This is a summary of the requirements to add a new device driver.

Module

Display Device Driver Layer (see page 393)

Description

Adding a new display device driver requires the following functions and macros to be implemented. Please refer to the API section of the Device Driver Layer for details.

Function/Macro	Description
ResetDevice (see page 417)()	Initializes the display device.
GetMaxX (see page 397)()	Returns the maximum x-coordinate for the display.
GetMaxY (see page 397)()	Returns the maximum y-coordinate for the display.
SetColor (see page 396)()	Sets the current drawing color.
GetColor (see page 396)()	Returns the current drawing color.
SetActivePage (see page 408)()	Sets the current active graphic page (optional).
SetVisualPage (see page 408)()	Sets the current visual graphic page (optional).
PutPixel (see page 395)()	Modifies pixel on the screen.
GetPixel (see page 394)()	Returns the pixel color.
PutImage (see page 383)()	Renders an image on the screen. This function is dependent on the color format used.
SetClipRgn (see page 398)()	Set the current clipping region borders.
GetClipLeft (see page 399)(), GetClipTop (see page 400)(), GetClipRight (see page 400)(), GetClipBottom (see page 399)()	Returns the left, top, right and bottom clipping borders.
SetClip (see page 398)()	Enables or disables the clipping region.
IsDeviceBusy (see page 416)()	Checks if the display controller is busy executing the previous rendering operation.
SetPalette (see page 416)()	Sets the palette register of the device.

Adding new Display Device Drivers

The DisplayDriver.h file should be used as a guide to make your new driver compatible with the Microchip Graphics Library. All the API's defined in this header file are required functions to be implemented in the driver. There are portions of that file that states optional functions. These functions are not needed to interface to the Graphics Library. These are only implemented if the display controller used has hardware features that can implement these functions.

The best way to implement this is to try to find the nearest existing driver and modify the C and H files. Most graphics controllers has a lot of control registers to be initialized. Values programmed into the registers depends on the specification of the LCD glass used. If LCD module has a built-in graphics controller, initialization code for the glass can be found in the LCD specifications or get this information from the manufacturer.

11 Advanced Display Driver Features

This section lists advanced Display Device Driver Features implemented in select Display Device Driver.

11.1 Alpha Blending

The following APIs are used to implement alpha blending features in the Epson S1D13517 Controller.

Functions

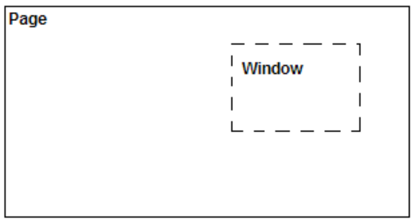
	Name	Description
	AlphaBlendWindow (see page 420)	This alphablends a foreground and a background stored in frames to a destination window. The function uses windows insides frames. Each window shares the same width and height parameters.
	GFXGetPageOriginAddress (see page 421)	This function calculates the address of a certain 0,0 location of a page in memory
	GFXGetPageXYAddress (see page 422)	This function calculates the address of a certain x,y location in memory

Module

Advanced Display Driver Features (see page 419)

Description

Alpha Blending in Epson Controller uses blocks of pixels in the memory called Windows. A window can be any rectangular area in a display buffer. The display buffer is also considered as a page. For a QVGA display buffer a page would be 320x240 pixels. A window is a certain width and height contained inside a page.

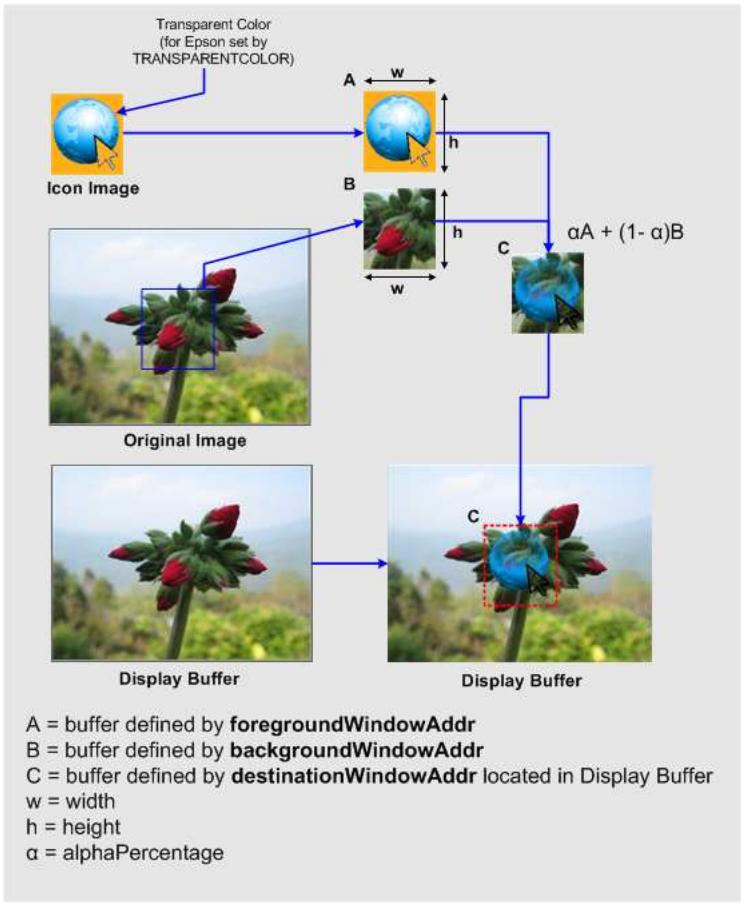


Alpha blending equation:

OutPut Window (see page 292) = Foreground Window (see page 292) * (Alpha) + Background Window (see page 292) * (1-Alpha)

when done in software requires a lot of CPU bandwith. Epson Controller implements alpha blending in hardware which offloads the CPU.

The Display Driver Layer of the Graphics Library utilizes the Epson Controller alpha blending through the AlphaBlendWindow (see page 420)() function. Three windows are specified with equal widths and heights. An alpha parameter is passed to define the level of alpha blending. The logical flow of the operation is shown below:


Transparent Color
(for Epson set by
TRANSPARENTCOLOR)
Icon Image
A
B
C
w
h
αA + (1- α)B
Original Image
Display Buffer
Display Buffer
C
A = buffer defined by **foregroundWindowAddr**
B = buffer defined by **backgroundWindowAddr**
C = buffer defined by **destinationWindowAddr** located in Display Buffer
w = width
h = height
α = alphaPercentage

An icon image with a given width (w) and height (h) is needed to be alpha blended into the display buffer.

- Buffer A is allocated in memory and its location set by foregroundWindowAddr
- Buffer B is allocated in memory and its location set by backgroundWindowAddr and
- Buffer C is allocated in memory and its location set by destinationWindowAddr. Note that the destination window can be located within the display buffer. Doing this removes an intermediate step after AlphaBlendWindow (see page 420)() call to put the result of alpha blend in the display buffer.

The final location of the icon on the Display Buffer is used to locate the affected pixels in the Display Buffer. These affected pixels are copied into Buffer B while Buffer A is filled up with the Icon Image. Once Buffers A and B are ready they are alpha blended to Buffer C. Buffer C is then copied to the Display Buffer.

Note that the Icon Image has a background color of ORANGE. To have the effect of the final output Display Buffer, set the Epson Controllers transparent color to ORANGE. This is set in the TRANSPARENTCOLOR macro defined in the Epson S1D13517 Driver. This TRANSPARENTCOLOR macro is not to be confused with the TransparentColorEnable (see page 401)() function of the Display Device Driver Level Primitives. TRANSPARENTCOLOR is set at build time. In the future release of the Epson driver, this will be converted to use the TransparentColorEnable (see page 401)() function.

11.1.1 AlphaBlendWindow Function

File

Primitive.h (see page 1028)

C

```
void AlphaBlendWindow(
    DWORD foregroundWindowAddr,
    DWORD backgroundWindowAddr,
    DWORD destinationWindowAddr,
    WORD width,
    WORD height,
    BYTE alphaPercentage
);
```

Input Parameters

Input Parameters	Description
DWORD foregroundWindowAddr	the starting address of the foreground window
DWORD backgroundWindowAddr	the starting address of the background window
DWORD destinationWindowAddr	the starting address of the destination window
WORD width	the width of the alpha blend window
WORD height	the height of the alpha blend window
BYTE alphaPercentage	the amount of transparency to give the foreground Window (see page 292)

Side Effects

none

Returns

none

Notes

none

Preconditions

none

Overview

This alphablends a foreground and a background stored in frames to a destination window. The function uses windows insides frames. Each window shares the same width and height parameters.

Syntax

void AlphaBlendWindow(DWORD foregroundWindowAddr, DWORD backgroundWindowAddr, DWORD destinationWindowAddr, WORD width, WORD height, BYTE alphaPercentage)

11.1.2 GFXGetPageOriginAddress Function

File

Primitive.h (see page 1028)

C

```
DWORD GFXGetPageOriginAddress(
    SHORT pageNumber
);
```

Input Parameters

Input Parameters	Description
SHORT pageNumber	the page number

Side Effects

none

Returns

The address of the start of a certain page in memory

Notes

none

Preconditions

none

Overview

This function calculates the address of a certain 0,0 location of a page in memory

Syntax

DWORD GFXGetPageOriginAddress(SHORT pageNumber)

11.1.3 GFXGetPageXYAddress Function

File

Primitive.h (see page 1028)

C

```
DWORD GFXGetPageXYAddress(
    SHORT pageNumber,
    WORD x,
    WORD y
);
```

Input Parameters

Input Parameters	Description
SHORT pageNumber	the page number
WORD x	the x (horizontal) offset from 0,0 of the pagenumber
WORD y	the y (vertical) offset from the 0,0 of the pagenumber

Side Effects

none

Returns

The address of an XY position of a certain page in memory

Notes

none

Preconditions

none

Overview

This function calculates the address of a certain x,y location in memory

Syntax

DWORD GFXGetPageXYAddress(SHORT pageNumber, WORD x, WORD y)

11.2 Transitions

Applications often require some transition effects while changing screens in order to enhance the look and feel which can be achieved by using Transition APIs provided with the Microchip Graphics Library. Refer to Appendix C of the application note AN1368: Developing Embedded Graphics Applications using PIC® Microcontrollers with Integrated Graphics Controller for a graphical illustration of how transitions can be achieved.

In order to translate a new screen, the new screen has to be developed in a separate buffer and has to be copied to the frame buffer (visible display buffer) part by part. The way the new screen data is copied into the frame buffer determines the transition effect. A number of transition effects can be achieved by using the API: GFXTransition (see page 425)(left, top, right, bottom, type, srcpageaddr, destpageaddr, delay_ms, param1, param2). This API copies the rectangular area defined by left, top, right and bottom from address defined by srcpageaddr to the destpageaddr as per the transition defined by type, param1 and param2. The srcpageaddr should contain the new screen data and the destpageaddr must be the frame buffer address. The speed of the transition can be configured by the parameter delay_ms which determines the delay between each copy operations. Note that this API must be called only at the end of GOLDrawCallback (see page 311)() function in order to ensure that the new screen is fully created in the RAM.

If double buffering is enabled, then using transitions is made easier by another API: GFXSetupTransition (see page 424)(left, top, right, bottom, type, delay_ms, param1, param2). This API can be called immediately after creating the new screen and the graphics library will store the request and initiate the transition after the new screen is fully created in the RAM. Note that this API doesn't have address parameters as the address of draw-buffer is already known to the double buffering subsystem of the graphics engine.

Functions

	Name	Description
◆	GFXExecutePendingTransition (see page 424)	This function executes the pending transition and returns the value returned by GFXTransition (see page 425)(). (Used with DOUBLE_BUFFERING)
◆	GFXIsTransitionPending (see page 424)	This function returns the status if there is any pending transition waiting to be executed. (Used with DOUBLE_BUFFERING)
◆	GFXSetupTransition (see page 424)	This function saves the parameters to be used and marks the transition to be pending which is executed when GFXExecutePendingTransition (see page 424)() is called. (Used with DOUBLE_BUFFERING)
◆	GFXTransition (see page 425)	This function saves the parameters to be used and marks the transition to be pending which is executed when GFXExecutePendingTransition (see page 424)() is called
◆	GFXTranslateDirection (see page 426)	This function returns the actual direction taking the screen orientation into consideration (local function)

Module

Advanced Display Driver Features (see page 419)

Description

Applications often require some transition effects while changing screens in order to enhance the look and feel which can be achieved by using Transition APIs provided with the Microchip Graphics Library. Refer to Appendix C of the application note AN1368: Developing Embedded Graphics Applications using PIC® Microcontrollers with Integrated Graphics Controller for a graphical illustration of how transitions can be achieved.

In order to translate a new screen, the new screen has to be developed in a separate buffer and has to be copied to the frame buffer (visible display buffer) part by part. The way the new screen data is copied into the frame buffer determines the transition effect. A number of transition effects can be achieved by using the API: GFXTransition (see page 425)(left, top, right, bottom, type, srcpageaddr, destpageaddr, delay_ms, param1, param2). This API copies the rectangular area defined by left, top, right and bottom from address defined by srcpageaddr to the destpageaddr as per the transition defined by type, param1 and param2. The srcpageaddr should contain the new screen data and the destpageaddr must be the frame buffer address. The speed of the transition can be configured by the parameter delay_ms which determines the delay between each copy operations. Note that this API must be called only at the end of GOLDrawCallback (see page 311)() function in order to ensure that the new screen is fully created in the RAM.

If double buffering is enabled, then using transitions is made easier by another API: GFXSetupTransition (see page 424)(left, top, right, bottom, type, delay_ms, param1, param2). This API can be called immediately after creating the new screen and the graphics library will store the request and initiate the transition after the new screen is fully created in the RAM. Note that this API doesn't have address parameters as the address of draw-buffer is already known to the double buffering subsystem of the graphics engine.

11.2.1 GFXExecutePendingTransition Function

File

Transitions.h

C

```
BYTE GFXExecutePendingTransition(
    DWORD srcpageaddr,
    DWORD destpageaddr
);
```

Returns

See the output of GFXTransition (see page 425)()

Overview

This function executes the pending transition and returns the value returned by GFXTransition (see page 425)(). (Used with DOUBLE_BUFFERING)

Syntax

BYTE GFXExecutePendingTransition(DWORD srcpageaddr, DWORD destpageaddr)

11.2.2 GFXIsTransitionPending Function

File

Transitions.h

C

```
BYTE GFXIsTransitionPending();
```

Returns

0 -> No 1 -> Yes

Overview

This function returns the status if there is any pending transition waiting to be executed. (Used with DOUBLE_BUFFERING)

Syntax

BYTE GFXIsTransitionPending(void)

11.2.3 GFXSetupTransition Function

File

Transitions.h

C

```
BYTE GFXSetupTransition(
    SHORT left,
    SHORT top,
    SHORT right,
    SHORT bottom,
    GFX_TRANSITION_TYPE type,
    WORD delay_ms,
    WORD param1,
    WORD param2
);
```

Returns

0 -> Parameters successfully saved for the new transition -1 -> Parameters not saved as a transition is still pending

Overview

This function saves the parameters to be used and marks the transition to be pending which is executed when GFXExecutePendingTransition (see page 424)() is called. (Used with DOUBLE_BUFFERING)

Syntax

BYTE GFXSetupTransition(SHORT left, SHORT top, SHORT right, SHORT bottom, GFX_TRANSITION_TYPE type, WORD delay_ms, WORD param1, WORD param2)

11.2.4 GFXTransition Function

File

Transitions.h

C

```
BYTE GFXTransition(
    SHORT left,
    SHORT top,
    SHORT right,
    SHORT bottom,
    GFX_TRANSITION_TYPE type,
    DWORD srcpageaddr,
    DWORD destpageaddr,
    WORD delay_ms,
    WORD param1,
    WORD param2
);
```

Returns

0 -> Transition executed successfully -1 -> Transition not executed

Overview

This function saves the parameters to be used and marks the transition to be pending which is executed when GFXExecutePendingTransition (see page 424)() is called

Syntax

BYTE GFXTransition(SHORT left, SHORT top, SHORT right, SHORT bottom, GFX_TRANSITION_TYPE type, DWORD srcpageaddr, DWORD destpageaddr, WORD delay_ms, WORD param1, WORD param2)

11.2.5 GFXTranslateDirection Function

File

Transitions.h

C

```
WORD GFXTranslateDirection(
    WORD direction,
    WORD orientation
);
```

Returns

The new direction taking the screen orientation into consideration

Overview

This function returns the actual direction taking the screen orientation into consideration (local function)

Syntax

WORD GFXTranslateDirection(WORD direction, WORD orientation)

11.3 Microchip Graphics Controller

This is the generic display driver is intended for the Microchip Graphics Controller Module implemented in PIC24F device family. This driver will drive TFT, CSTN and STN displays.

Module

Advanced Display Driver Features (see page 419)

Description

The Microchip Graphics Controller has several advanced features that can be enabled by declaring macros in the Graphics Config (GraphicsConfig.h (see page 945)) and Hardware Profile (HardwareProfile.h) of the project. Below is a summary of all macros that pertains to the Microchip Graphics Controller driver.

Macro Name	Description	Location
GFX_DISPLAY_BUFFER_START_ADDRESS (see page 467)	Defines the starting address of the display buffer.	Hardware Profile
GFX_DISPLAY_BUFFER_LENGTH (see page 466)	Defines the size of the display buffer. This macro is used to map memory in RAM when: 1. Double buffering is enabled. This is enabled by the macro USE_DOUBLE_BUFFERING (see page 41) 2. IPU module is used. This is enabled by the macro USE_COMP_IPU (see page 41) If the application is designed to fit into the internal memory, and with the If the double buffering and/or IPU module is enabled, the memory required must fit into the internal memory.	Hardware Profile
USE_PALETTE (see page 48)	Macro that enables the palette mode in Graphics Library and the Microchip Graphics Controller.	Graphics Config

USE_DOUBLE_BUFFERING (see page 41)	Optional feature. This enables the double buffering feature. Memory required for display buffer will double in size. There will be two display buffers used and these buffers are swapped automatically by the library draw operations or application can manage the swapping. See Double Buffering (see page 442) for details. **Buffer Location (Mapping):** Display Buffer 1 = GFX_DISPLAY_BUFFER_START_ADDRESS (see page 467) Display Buffer 2 = GFX_DISPLAY_BUFFER_START_ADDRESS (see page 467) + GFX_DISPLAY_BUFFER_LENGTH (see page 466)	

11.3.1 Rectangle Copy Operations

The following APIs are used move blocks of data from one memory location to another.

Functions

	Name	Description
	ROPBlock (see page 437)	Performs a Raster Operation (ROP) on source and destination. The type of ROP is decided by the rop and the copyOp parameter.
	Scroll (see page 439)	Scrolls the rectangular area defined by left, top, right, bottom by delta pixels.

Macros

Name	Description
CopyBlock (see page 439)	Copies a block of data from source specified by srcAddr and srcOffset to the destination specified by dstAddr and dstOffset.
RCC_SRC_ADDR_CONTINUOUS (see page 440)	Source (S) and Destination (D) data type. When performing executing commands on the Rectangle (see page 372) Copy Processing Unit (RCCGPU). The source and destination data can be treated as a continuous block of data in memory or a discontinuous data in memory. This gives flexibility to the operation where an copy operation can be performed to data already present in the display buffer or anywhere else in data memory. Both source and destination data can be set to continuous or discontinuous data. These macros are only used in RCCGPU operations. • RCC_SRC_ADDR_CONTINUOUS - source data is continuous • RCC_SRC_ADDR_DISCONTINUOUS (see page 440) - source data is discontinuous... more (see page 440)
RCC_SRC_ADDR_DISCONTINUOUS (see page 440)	Source (S) and Destination (D) data type. When performing executing commands on the Rectangle (see page 372) Copy Processing Unit (RCCGPU). The source and destination data can be treated as a continuous block of data in memory or a discontinuous data in memory. This gives flexibility to the operation where an copy operation can be performed to data already present in the display buffer or anywhere else in data memory. Both source and destination data can be set to continuous or discontinuous data. These macros are only used in RCCGPU operations. • RCC_SRC_ADDR_CONTINUOUS - source data is continuous • RCC_SRC_ADDR_DISCONTINUOUS (see page 440) - source data is discontinuous... more (see page 440)

RCC_DEST_ADDR_CONTINUOUS (see page 440)	Source (S) and Destination (D) data type. When performing executing commands on the Rectangle (see page 372) Copy Processing Unit (RCCGPU). The source and destination data can be treated as a continuous block of data in memory or a discontinuous data in memory. This gives flexibility to the operation where an copy operation can be performed to data already present in the display buffer or anywhere else in data memory. Both source and destination data can be set to continuous or discontinuous data. These macros are only used in RCCGPU operations. • RCC_SRC_ADDR_CONTINUOUS - source data is continuous • RCC_SRC_ADDR_DISCONTINUOUS (see page 440) - source data is discontinuous... more (see page 440)
RCC_DEST_ADDR_DISCONTINUOUS (see page 440)	Source (S) and Destination (D) data type. When performing executing commands on the Rectangle (see page 372) Copy Processing Unit (RCCGPU). The source and destination data can be treated as a continuous block of data in memory or a discontinuous data in memory. This gives flexibility to the operation where an copy operation can be performed to data already present in the display buffer or anywhere else in data memory. Both source and destination data can be set to continuous or discontinuous data. These macros are only used in RCCGPU operations. • RCC_SRC_ADDR_CONTINUOUS - source data is continuous • RCC_SRC_ADDR_DISCONTINUOUS (see page 440) - source data is discontinuous... more (see page 440)
RCC_ROP_0 (see page 441)	Raster Operation (ROP) option. Select one of the following 16 raster operation options whenever Rectangle (see page 372) Copy Processing Unit (RCCGPU) is used. The raster operation is performed on the source (S) and destination (D) data. and the result written to the destination (D). • RCC_ROP_0 - 0 (BLACK (see page 409)) • RCC_ROP_1 (see page 441) - not (S or D) • RCC_ROP_2 (see page 441) - (not S) and D • RCC_ROP_3 (see page 441) - not (S) • RCC_ROP_4 (see page 441) - S and not (D)) • RCC_ROP_5 (see page 441) - not (D) • RCC_ROP_6 (see page 441) - S xor D • RCC_ROP_7 (see page 441) - not (S and D) • RCC_ROP_8 (see page 441) - S and D • RCC_ROP_9 (see page 441) - not (S xor D) • RCC_ROP_A (see page 441) - D • RCC_ROP_B (see page 441)... more (see page 441)

RCC_ROP_1 (see page 441)	Raster Operation (ROP) option. Select one of the following 16 raster operation options whenever Rectangle (see page 372) Copy Processing Unit (RCCGPU) is used. The raster operation is performed on the source (S) and destination (D) data. and the result written to the destination (D). • RCC_ROP_0 - 0 (BLACK (see page 409)) • RCC_ROP_1 (see page 441) - not (S or D) • RCC_ROP_2 (see page 441) - (not S) and D • RCC_ROP_3 (see page 441) - not (S) • RCC_ROP_4 (see page 441) - S and not (D)) • RCC_ROP_5 (see page 441) - not (D) • RCC_ROP_6 (see page 441) - S xor D • RCC_ROP_7 (see page 441) - not (S and D) • RCC_ROP_8 (see page 441) - S and D • RCC_ROP_9 (see page 441) - not (S xor D) • RCC_ROP_A (see page 441) - D • RCC_ROP_B (see page 441)... more (see page 441)
RCC_ROP_2 (see page 441)	Raster Operation (ROP) option. Select one of the following 16 raster operation options whenever Rectangle (see page 372) Copy Processing Unit (RCCGPU) is used. The raster operation is performed on the source (S) and destination (D) data. and the result written to the destination (D). • RCC_ROP_0 - 0 (BLACK (see page 409)) • RCC_ROP_1 (see page 441) - not (S or D) • RCC_ROP_2 (see page 441) - (not S) and D • RCC_ROP_3 (see page 441) - not (S) • RCC_ROP_4 (see page 441) - S and not (D)) • RCC_ROP_5 (see page 441) - not (D) • RCC_ROP_6 (see page 441) - S xor D • RCC_ROP_7 (see page 441) - not (S and D) • RCC_ROP_8 (see page 441) - S and D • RCC_ROP_9 (see page 441) - not (S xor D) • RCC_ROP_A (see page 441) - D • RCC_ROP_B (see page 441)... more (see page 441)

RCC_ROP_3 (see page 441)	Raster Operation (ROP) option. Select one of the following 16 raster operation options whenever Rectangle (see page 372) Copy Processing Unit (RCCGPU) is used. The raster operation is performed on the source (S) and destination (D) data. and the result written to the destination (D). • RCC_ROP_0 - 0 (BLACK (see page 409)) • RCC_ROP_1 (see page 441) - not (S or D) • RCC_ROP_2 (see page 441) - (not S) and D • RCC_ROP_3 (see page 441) - not (S) • RCC_ROP_4 (see page 441) - S and not (D)) • RCC_ROP_5 (see page 441) - not (D) • RCC_ROP_6 (see page 441) - S xor D • RCC_ROP_7 (see page 441) - not (S and D) • RCC_ROP_8 (see page 441) - S and D • RCC_ROP_9 (see page 441) - not (S xor D) • RCC_ROP_A (see page 441) - D • RCC_ROP_B (see page 441)... more (see page 441)
RCC_ROP_4 (see page 441)	Raster Operation (ROP) option. Select one of the following 16 raster operation options whenever Rectangle (see page 372) Copy Processing Unit (RCCGPU) is used. The raster operation is performed on the source (S) and destination (D) data. and the result written to the destination (D). • RCC_ROP_0 - 0 (BLACK (see page 409)) • RCC_ROP_1 (see page 441) - not (S or D) • RCC_ROP_2 (see page 441) - (not S) and D • RCC_ROP_3 (see page 441) - not (S) • RCC_ROP_4 (see page 441) - S and not (D)) • RCC_ROP_5 (see page 441) - not (D) • RCC_ROP_6 (see page 441) - S xor D • RCC_ROP_7 (see page 441) - not (S and D) • RCC_ROP_8 (see page 441) - S and D • RCC_ROP_9 (see page 441) - not (S xor D) • RCC_ROP_A (see page 441) - D • RCC_ROP_B (see page 441)... more (see page 441)

RCC_ROP_5 (see page 441)	Raster Operation (ROP) option. Select one of the following 16 raster operation options whenever Rectangle (see page 372) Copy Processing Unit (RCCGPU) is used. The raster operation is performed on the source (S) and destination (D) data. and the result written to the destination (D). • RCC_ROP_0 - 0 (BLACK (see page 409)) • RCC_ROP_1 (see page 441) - not (S or D) • RCC_ROP_2 (see page 441) - (not S) and D • RCC_ROP_3 (see page 441) - not (S) • RCC_ROP_4 (see page 441) - S and not (D)) • RCC_ROP_5 (see page 441) - not (D) • RCC_ROP_6 (see page 441) - S xor D • RCC_ROP_7 (see page 441) - not (S and D) • RCC_ROP_8 (see page 441) - S and D • RCC_ROP_9 (see page 441) - not (S xor D) • RCC_ROP_A (see page 441) - D • RCC_ROP_B (see page 441)... more (see page 441)
RCC_ROP_6 (see page 441)	Raster Operation (ROP) option. Select one of the following 16 raster operation options whenever Rectangle (see page 372) Copy Processing Unit (RCCGPU) is used. The raster operation is performed on the source (S) and destination (D) data. and the result written to the destination (D). • RCC_ROP_0 - 0 (BLACK (see page 409)) • RCC_ROP_1 (see page 441) - not (S or D) • RCC_ROP_2 (see page 441) - (not S) and D • RCC_ROP_3 (see page 441) - not (S) • RCC_ROP_4 (see page 441) - S and not (D)) • RCC_ROP_5 (see page 441) - not (D) • RCC_ROP_6 (see page 441) - S xor D • RCC_ROP_7 (see page 441) - not (S and D) • RCC_ROP_8 (see page 441) - S and D • RCC_ROP_9 (see page 441) - not (S xor D) • RCC_ROP_A (see page 441) - D • RCC_ROP_B (see page 441)... more (see page 441)

RCC_ROP_7 (see page 441)	Raster Operation (ROP) option. Select one of the following 16 raster operation options whenever Rectangle (see page 372) Copy Processing Unit (RCCGPU) is used. The raster operation is performed on the source (S) and destination (D) data. and the result written to the destination (D). • RCC_ROP_0 - 0 (BLACK (see page 409)) • RCC_ROP_1 (see page 441) - not (S or D) • RCC_ROP_2 (see page 441) - (not S) and D • RCC_ROP_3 (see page 441) - not (S) • RCC_ROP_4 (see page 441) - S and not (D)) • RCC_ROP_5 (see page 441) - not (D) • RCC_ROP_6 (see page 441) - S xor D • RCC_ROP_7 (see page 441) - not (S and D) • RCC_ROP_8 (see page 441) - S and D • RCC_ROP_9 (see page 441) - not (S xor D) • RCC_ROP_A (see page 441) - D • RCC_ROP_B (see page 441)... more (see page 441)
RCC_ROP_8 (see page 441)	Raster Operation (ROP) option. Select one of the following 16 raster operation options whenever Rectangle (see page 372) Copy Processing Unit (RCCGPU) is used. The raster operation is performed on the source (S) and destination (D) data. and the result written to the destination (D). • RCC_ROP_0 - 0 (BLACK (see page 409)) • RCC_ROP_1 (see page 441) - not (S or D) • RCC_ROP_2 (see page 441) - (not S) and D • RCC_ROP_3 (see page 441) - not (S) • RCC_ROP_4 (see page 441) - S and not (D)) • RCC_ROP_5 (see page 441) - not (D) • RCC_ROP_6 (see page 441) - S xor D • RCC_ROP_7 (see page 441) - not (S and D) • RCC_ROP_8 (see page 441) - S and D • RCC_ROP_9 (see page 441) - not (S xor D) • RCC_ROP_A (see page 441) - D • RCC_ROP_B (see page 441)... more (see page 441)

RCC_ROP_9 (see page 441)	Raster Operation (ROP) option. Select one of the following 16 raster operation options whenever Rectangle (see page 372) Copy Processing Unit (RCCGPU) is used. The raster operation is performed on the source (S) and destination (D) data. and the result written to the destination (D). • RCC_ROP_0 - 0 (BLACK (see page 409)) • RCC_ROP_1 (see page 441) - not (S or D) • RCC_ROP_2 (see page 441) - (not S) and D • RCC_ROP_3 (see page 441) - not (S) • RCC_ROP_4 (see page 441) - S and not (D)) • RCC_ROP_5 (see page 441) - not (D) • RCC_ROP_6 (see page 441) - S xor D • RCC_ROP_7 (see page 441) - not (S and D) • RCC_ROP_8 (see page 441) - S and D • RCC_ROP_9 (see page 441) - not (S xor D) • RCC_ROP_A (see page 441) - D • RCC_ROP_B (see page 441)... more (see page 441)
RCC_ROP_A (see page 441)	Raster Operation (ROP) option. Select one of the following 16 raster operation options whenever Rectangle (see page 372) Copy Processing Unit (RCCGPU) is used. The raster operation is performed on the source (S) and destination (D) data. and the result written to the destination (D). • RCC_ROP_0 - 0 (BLACK (see page 409)) • RCC_ROP_1 (see page 441) - not (S or D) • RCC_ROP_2 (see page 441) - (not S) and D • RCC_ROP_3 (see page 441) - not (S) • RCC_ROP_4 (see page 441) - S and not (D)) • RCC_ROP_5 (see page 441) - not (D) • RCC_ROP_6 (see page 441) - S xor D • RCC_ROP_7 (see page 441) - not (S and D) • RCC_ROP_8 (see page 441) - S and D • RCC_ROP_9 (see page 441) - not (S xor D) • RCC_ROP_A (see page 441) - D • RCC_ROP_B (see page 441)... more (see page 441)

RCC_ROP_B (see page 441)	Raster Operation (ROP) option. Select one of the following 16 raster operation options whenever Rectangle (see page 372) Copy Processing Unit (RCCGPU) is used. The raster operation is performed on the source (S) and destination (D) data. and the result written to the destination (D). • RCC_ROP_0 - 0 (BLACK (see page 409)) • RCC_ROP_1 (see page 441) - not (S or D) • RCC_ROP_2 (see page 441) - (not S) and D • RCC_ROP_3 (see page 441) - not (S) • RCC_ROP_4 (see page 441) - S and not (D)) • RCC_ROP_5 (see page 441) - not (D) • RCC_ROP_6 (see page 441) - S xor D • RCC_ROP_7 (see page 441) - not (S and D) • RCC_ROP_8 (see page 441) - S and D • RCC_ROP_9 (see page 441) - not (S xor D) • RCC_ROP_A (see page 441) - D • RCC_ROP_B (see page 441)... more (see page 441)
RCC_ROP_C (see page 441)	Raster Operation (ROP) option. Select one of the following 16 raster operation options whenever Rectangle (see page 372) Copy Processing Unit (RCCGPU) is used. The raster operation is performed on the source (S) and destination (D) data. and the result written to the destination (D). • RCC_ROP_0 - 0 (BLACK (see page 409)) • RCC_ROP_1 (see page 441) - not (S or D) • RCC_ROP_2 (see page 441) - (not S) and D • RCC_ROP_3 (see page 441) - not (S) • RCC_ROP_4 (see page 441) - S and not (D)) • RCC_ROP_5 (see page 441) - not (D) • RCC_ROP_6 (see page 441) - S xor D • RCC_ROP_7 (see page 441) - not (S and D) • RCC_ROP_8 (see page 441) - S and D • RCC_ROP_9 (see page 441) - not (S xor D) • RCC_ROP_A (see page 441) - D • RCC_ROP_B (see page 441)... more (see page 441)

RCC_ROP_D (see page 441)	Raster Operation (ROP) option. Select one of the following 16 raster operation options whenever Rectangle (see page 372) Copy Processing Unit (RCCGPU) is used. The raster operation is performed on the source (S) and destination (D) data. and the result written to the destination (D). • RCC_ROP_0 - 0 (BLACK (see page 409)) • RCC_ROP_1 (see page 441) - not (S or D) • RCC_ROP_2 (see page 441) - (not S) and D • RCC_ROP_3 (see page 441) - not (S) • RCC_ROP_4 (see page 441) - S and not (D)) • RCC_ROP_5 (see page 441) - not (D) • RCC_ROP_6 (see page 441) - S xor D • RCC_ROP_7 (see page 441) - not (S and D) • RCC_ROP_8 (see page 441) - S and D • RCC_ROP_9 (see page 441) - not (S xor D) • RCC_ROP_A (see page 441) - D • RCC_ROP_B (see page 441)... more (see page 441)
RCC_ROP_E (see page 441)	Raster Operation (ROP) option. Select one of the following 16 raster operation options whenever Rectangle (see page 372) Copy Processing Unit (RCCGPU) is used. The raster operation is performed on the source (S) and destination (D) data. and the result written to the destination (D). • RCC_ROP_0 - 0 (BLACK (see page 409)) • RCC_ROP_1 (see page 441) - not (S or D) • RCC_ROP_2 (see page 441) - (not S) and D • RCC_ROP_3 (see page 441) - not (S) • RCC_ROP_4 (see page 441) - S and not (D)) • RCC_ROP_5 (see page 441) - not (D) • RCC_ROP_6 (see page 441) - S xor D • RCC_ROP_7 (see page 441) - not (S and D) • RCC_ROP_8 (see page 441) - S and D • RCC_ROP_9 (see page 441) - not (S xor D) • RCC_ROP_A (see page 441) - D • RCC_ROP_B (see page 441)... more (see page 441)

RCC_ROP_F (see page 441)	Raster Operation (ROP) option. Select one of the following 16 raster operation options whenever Rectangle (see page 372) Copy Processing Unit (RCCGPU) is used. The raster operation is performed on the source (S) and destination (D) data. and the result written to the destination (D). • RCC_ROP_0 - 0 (BLACK (see page 409)) • RCC_ROP_1 (see page 441) - not (S or D) • RCC_ROP_2 (see page 441) - (not S) and D • RCC_ROP_3 (see page 441) - not (S) • RCC_ROP_4 (see page 441) - S and not (D)) • RCC_ROP_5 (see page 441) - not (D) • RCC_ROP_6 (see page 441) - S xor D • RCC_ROP_7 (see page 441) - not (S and D) • RCC_ROP_8 (see page 441) - S and D • RCC_ROP_9 (see page 441) - not (S xor D) • RCC_ROP_A (see page 441) - D • RCC_ROP_B (see page 441)... more (see page 441)
RCC_COPY (see page 441)	Type of Rectangle (see page 372) Copy Operations. Select one of the following rectangle copy operations and together with the ROP; the source, destination, current color set and transparency are evaluated on each pixel and the result written to the destination. • RCC_COPY - Copies the source data to the destination address with the selected ROP. • RCC_SOLID_FILL (see page 441) - Fills the specified rectangle with the current color set. • RCC_TRANSPARENT_COPY (see page 441) - Operation is the same as the COPY operation except that the source data is compared against the current color set. If the values match, the source data is not written to the destination. The source... more (see page 441)
RCC_SOLID_FILL (see page 441)	Type of Rectangle (see page 372) Copy Operations. Select one of the following rectangle copy operations and together with the ROP; the source, destination, current color set and transparency are evaluated on each pixel and the result written to the destination. • RCC_COPY - Copies the source data to the destination address with the selected ROP. • RCC_SOLID_FILL (see page 441) - Fills the specified rectangle with the current color set. • RCC_TRANSPARENT_COPY (see page 441) - Operation is the same as the COPY operation except that the source data is compared against the current color set. If the values match, the source data is not written to the destination. The source... more (see page 441)

RCC_TRANSPARENT_COPY (see page 441)	Type of Rectangle (see page 372) Copy Operations. Select one of the following rectangle copy operations and together with the ROP; the source, destination, current color set and transparency are evaluated on each pixel and the result written to the destination. • RCC_COPY - Copies the source data to the destination address with the selected ROP. • RCC_SOLID_FILL (see page 441) - Fills the specified rectangle with the current color set. • RCC_TRANSPARENT_COPY (see page 441) - Operation is the same as the COPY operation except that the source data is compared against the current color set. If the values match, the source data is not written to the destination. The source... more (see page 441)

11.3.1.1 ROPBlock Function

File

mchpGfxDrv.h

C

```
WORD ROPBlock(
    DWORD srcAddr,
    DWORD dstAddr,
    DWORD srcOffset,
    DWORD dstOffset,
    WORD srcType,
    WORD dstType,
    WORD copyOp,
    WORD rop,
    WORD color,
    WORD width,
    WORD height
);
```

Input Parameters

Input Parameters	Description
DWORD srcAddr	the base address of the data to be moved
DWORD dstAddr	the base address of the new location of the moved data
DWORD srcOffset	offset of the data to be moved with respect to the source base address.
DWORD dstOffset	offset of the new location of the moved data respect to the source base address.
WORD srcType	sets the source type (RCC_SRC_ADDR_CONTINUOUS (see page 440) or RCC_SRC_ADDR_DISCONTINUOUS (see page 440))
WORD dstType	sets the source type (RCC_DEST_ADDR_CONTINUOUS (see page 440) or RCC_DEST_ADDR_DISCONTINUOUS (see page 440))
WORD copyOp	sets the type of copy operation • RCC_SOLID_FILL (see page 441): Solid fill of the set color • RCC_COPY (see page 441): direct copy of source to destination • RCC_TRANSPARENT_COPY (see page 441): copy with transparency. Transparency color is set by color

WORD rop	sets the raster operation equation • RCC_ROP_0 (see page 441): Solid black color fill • RCC_ROP_1 (see page 441): not (Source or Destination) • RCC_ROP_2 (see page 441): (not Source) and Destination • RCC_ROP_3 (see page 441): not Source • RCC_ROP_4 (see page 441): Source and (not Destination) • RCC_ROP_5 (see page 441): not Destination • RCC_ROP_6 (see page 441): Source xor Destination • RCC_ROP_7 (see page 441): not (Source and Destination) • RCC_ROP_8 (see page 441): Source and Destination • RCC_ROP_9 (see page 441): not (Source xor Destination) • RCC_ROP_A (see page 441): Destination • RCC_ROP_B (see page 441): (not Source) or Destination • RCC_ROP_C (see page 441): Source • RCC_ROP_D (see page 441): Source or (not Destination) • RCC_ROP_E (see page 441): Source or Destination • RCC_ROP_F (see page 441): Solid white color fill
WORD color	color value used when transparency operation is set or using solid color fill
WORD width	width of the block of data to be moved
WORD height	height of the block of data to be moved

Side Effects

none

Returns

For NON-Blocking configuration:

- Returns 0 when device is busy and operation is not completely performed.
- Returns 1 when the operation is completely performed.

For Blocking configuration:

- Always return 1.

Notes

none

Preconditions

none

Overview

Performs a Raster Operation (ROP) on source and destination. The type of ROP is decided by the rop and the copyOp parameter.

Syntax

WORD ROPBlock (DWORD srcAddr, DWORD dstAddr, DWORD srcOffset, DWORD dstOffset, WORD srcType, WORD dstType, WORD copyOp, WORD rop, WORD color, WORD width, WORD height)

11.3.1.2 CopyBlock Macro

File

mchpGfxDrv.h

C

```
#define CopyBlock(srcAddr, dstAddr, srcOffset, dstOffset, width, height) \
                                                                        \
        ROPBlock( srcAddr, dstAddr, srcOffset, dstOffset,                \
                  (RCC_SRC_ADDR_DISCONTINUOUS), (RCC_DEST_ADDR_DISCONTINUOUS),  \
                  RCC_COPY,  RCC_ROP_C,                                 \
                  0,  width, height)
```

Input Parameters

Input Parameters	Description
srcAddr	the base address of the data to be moved
dstAddr	the base address of the new location of the moved data
srcOffset	offset of the data to be moved with respect to the source base address.
dstOffset	offset of the new location of the moved data respect to the source base address.
width	width of the block of data to be moved
height	height of the block of data to be moved

Side Effects

none

Returns

none

Notes

none

Preconditions

none

Overview

Copies a block of data from source specified by srcAddr and srcOffset to the destination specified by dstAddr and dstOffset.

Syntax

WORD CopyBlock(DWORD srcAddr, DWORD dstAddr, DWORD srcOffset, DWORD dstOffset, WORD width, WORD height)

11.3.1.3 Scroll Function

File

mchpGfxDrv.h

C

```
WORD Scroll(
    SHORT left,
    SHORT top,
    SHORT right,
    SHORT bottom,
    SHORT delta,
    WORD dir
);
```

Input Parameters

Input Parameters	Description
SHORT left	left position of the scrolled rectangle
SHORT top	top position of the scrolled rectangle
SHORT right	right position of the scrolled rectangle
SHORT bottom	bottom position of the scrolled rectangle
SHORT delta	defines the scroll delta
WORD dir	defines the direction of the scroll. • 0 : scroll to the left • 1 : scroll to the right

Side Effects

none

Returns

none

Notes

none

Preconditions

none

Overview

Scrolls the rectangular area defined by left, top, right, bottom by delta pixels.

Syntax

WORD Scroll(SHORT left, SHORT top, SHORT right, SHORT bottom, SHORT delta)

11.3.1.4 RCC_SRC_ADDR_CONTINUOUS Macro

File

mchpGfxDrv.h

C

```
#define RCC_SRC_ADDR_CONTINUOUS 0x00000002ul
#define RCC_SRC_ADDR_DISCONTINUOUS 0x00000000ul
#define RCC_DEST_ADDR_CONTINUOUS 0x00000004ul
#define RCC_DEST_ADDR_DISCONTINUOUS 0x00000000ul
```

Overview

Source (S) and Destination (D) data type. When performing executing commands on the Rectangle (see page 372) Copy Processing Unit (RCCGPU). The source and destination data can be treated as a continuous block of data in memory or a discontinuous data in memory. This gives flexibility to the operation where an copy operation can be performed to data already present in the display buffer or anywhere else in data memory. Both source and destination data can be set to continuous or discontinuous data. These macros are only used in RCCGPU operations.

- RCC_SRC_ADDR_CONTINUOUS - source data is continuous
- RCC_SRC_ADDR_DISCONTINUOUS - source data is discontinuous
- RCC_DEST_ADDR_CONTINUOUS - destination data is continuous
- RCC_DEST_ADDR_DISCONTINUOUS - destination data is discontinuous

11.3.1.5 RCC_ROP_0 Macro

File

mchpGfxDrv.h

C

```
#define RCC_ROP_0 0x00000000ul
#define RCC_ROP_1 0x00000008ul        // not (S or D)
#define RCC_ROP_2 0x00000010ul        // (not S) and D
#define RCC_ROP_3 0x00000018ul        // not (S)
#define RCC_ROP_4 0x00000020ul        // S and not (D)
#define RCC_ROP_5 0x00000028ul        // not (D)
#define RCC_ROP_6 0x00000030ul        // S xor D
#define RCC_ROP_7 0x00000038ul        // not (S and D)
#define RCC_ROP_8 0x00000040ul        // S and D
#define RCC_ROP_9 0x00000048ul        // not (S xor D)
#define RCC_ROP_A 0x00000050ul        // D
#define RCC_ROP_B 0x00000058ul        // not (S) or D
#define RCC_ROP_C 0x00000060ul        // S
#define RCC_ROP_D 0x00000068ul        // S or not (D)
#define RCC_ROP_E 0x00000070ul        // S or D
#define RCC_ROP_F 0x00000078ul        // 1 (WHITE)
```

Overview

Raster Operation (ROP) option. Select one of the following 16 raster operation options whenever Rectangle (see page 372) Copy Processing Unit (RCCGPU) is used. The raster operation is performed on the source (S) and destination (D) data. and the result written to the destination (D).

- RCC_ROP_0 - 0 (BLACK (see page 409))
- RCC_ROP_1 - not (S or D)
- RCC_ROP_2 - (not S) and D
- RCC_ROP_3 - not (S)
- RCC_ROP_4 - S and not (D))
- RCC_ROP_5 - not (D)
- RCC_ROP_6 - S xor D
- RCC_ROP_7 - not (S and D)
- RCC_ROP_8 - S and D
- RCC_ROP_9 - not (S xor D)
- RCC_ROP_A - D
- RCC_ROP_B - not (S) or D
- RCC_ROP_C - S
- RCC_ROP_D - S or not (D)
- RCC_ROP_E - S or D
- RCC_ROP_F - 1 (WHITE (see page 415))

11.3.1.6 RCC_COPY Macro

File

mchpGfxDrv.h

C

```
#define RCC_COPY 0x00000080ul
```

```
#define RCC_SOLID_FILL 0x00000000ul
#define RCC_TRANSPARENT_COPY 0x00000300ul
```

Overview

Type of Rectangle (see page 372) Copy Operations. Select one of the following rectangle copy operations and together with the ROP; the source, destination, current color set and transparency are evaluated on each pixel and the result written to the destination.

- RCC_COPY - Copies the source data to the destination address with the selected ROP.
- RCC_SOLID_FILL - Fills the specified rectangle with the current color set.
- RCC_TRANSPARENT_COPY - Operation is the same as the COPY operation except that the source data is compared against the current color set. If the values match, the source data is not written to the destination. The source image is, therefore, transparent at such a location, allowing

11.3.2 Double Buffering

In the Microchip Graphics Library, if double-buffering is enabled, the frame buffer and draw buffer are exchanged after the changes of all the widgets on a screen are done (i.e., the new screen appears after the whole screen is updated and not after updating an individual widget).

Functions

	Name	Description
	SwitchOffDoubleBuffering (see page 444)	Switches off the double buffering. All rendering will be performed on the frame buffer. Calls to UpdateDisplayNow (see page 446)() or RequestDisplayUpdate (see page 445)() will have no effect.
	SwitchOnDoubleBuffering (see page 444)	Switches on the double buffering. Double buffering utilizes two buffers. The frame buffer and the draw buffer. The frame buffer is the buffer that is being displayed while the draw buffer is used for all rendering. When this function is called, it copies the contents of the frame buffer to the draw buffer once and all succeeding rendering will be performed on the draw buffer. To update the frame buffer with newly drawn items on the draw buffer call UpdateDisplayNow (see page 446)() or RequestDisplayUpdate (see page 445)().
	InvalidateRectangle (see page 445)	Invalidates the specified rectangular area. This increments the number of invalidated areas and if the number of invalidated areas exceed the GFX_MAX_INVALIDATE_AREAS, the whole frame buffer is invalidated.
	RequestDisplayUpdate (see page 445)	Synchronizes the draw and frame buffers at next VBlank
	UpdateDisplayNow (see page 446)	Synchronizes the draw and frame buffers immediately.

Description

Manipulating pixels on the screen requires direct writes to the frame buffer. While these changes are being executed, the screen is also refreshed. This means that the changes are displayed immediately as the frame buffer is being updated. This is not a suitable scheme when the changes are slow, for example, decoding an image or having a large number of widgets on a screen. The display may appear slow in that case and can cause user dissatisfaction. One solution to this problem is to use a double-buffering scheme supported by the Microchip Graphics Library. In this scheme, the changes are not directly written to the frame buffer, but instead, they are written to a separate buffer, called the 'Draw Buffer'. After all the changes are made, the draw buffer and frame buffer are exchanged. Now the draw buffer becomes the frame buffer, and because of all the changes drawn there, the changes appear spontaneous to the user. Of course, there will be a delay, as all the changes have to be written to the draw buffer before displaying it. This delay is generally more tolerable than displaying the changes slowly. After exchanging of the buffers, the latest buffer (which is now the frame buffer) is copied to the new draw buffer in the background and then the new draw buffer is in sync with what is being displayed. New changes are then written to the draw buffer and the cycle continues. As the double-buffering scheme uses two buffers, the RAM requirement will double.

In the Microchip Graphics Library, if double-buffering is enabled, the frame buffer and draw buffer are exchanged after the changes of all the widgets on a screen are done (i.e., the new screen appears after the whole screen is updated and not after updating an individual widget).

The workflow of double-buffering is graphically explained along with tips on deciding when to use double buffering in the APPENDIX B of the Application note AN1368: Developing Embedded Graphics Applications using PIC® Microcontrollers with Integrated Graphics Controller.

To use double buffering in an application, follow the steps described below:

1. Enable the option USE_DOUBLE_BUFFERING (see page 41) in GraphicsConfig.h (see page 945)

2. Update GFX_DISPLAY_BUFFER_LENGTH (see page 466) to include both the buffers in HardwareProfile.h

3. Check the jumper settings to enable the required RAM address space on the development board

If Graphics Objects Layer (GOL (see page 64)) is used in the application, the switching of buffers is handled automatically in order to keep the switching task transparent to the users. If double buffering is enabled in applications using only the Primitive layer, then the switching of buffers has to be handled by the application itself as explained in the following steps.

Steps required for manually handling the switching of buffers:

1. After InitGraph (see page 388)() is called, call the APIs InvalidateAll() followed by UpdateDisplayNow (see page 446)(). The two buffers are properly setup after these calls and from this point onwards, the drawing happens on the draw-buffer.

2. When a shape is drawn on the draw buffer, that rectangular area has to be marked as invalid by using the API InvalidateRectangle (see page 445)(left, top, right, bottom). Only the invalidated rectangular areas are copied to the frame buffer in order to reduce the copy operations thereby reducing the overall time and energy required to sync the two buffers. Hence, it is important to invalidate the changed rectangular areas failing which the change doesn’t show up on the display.

3. Call either RequestDisplayUpdate (see page 445)() or UpdateDisplayNow (see page 446)() to sync the two buffers and as a result the changes appear on the display. The former API exchanges the buffers during the next display blanking period on TFT LCDs causing the change to appear smooth and immediate whereas the latter API exchanges the two buffers at the time of the API call probably causing a slight flicker on the display. On displays which doesn’t support blanking periods (e.g. CSTN LCDs), the effect of RequestDisplayUpdate (see page 445)() is same as that of UpdateDisplayNow (see page 446)().

Even if double buffering is enabled at compile time, it can be switched off and on at run time using APIs SwitchOffDoubleBuffering (see page 444)() and SwitchOnDoubleBuffering (see page 444)(). Switching double buffering on/off at runtime is useful in applications which need some screens having fast updates like waveform or animation which requires double buffering to be switched off and some other screens where double buffering is beneficial.

Note: In applications using Graphics Objects Layer and double buffering, the double buffering is not immediately enabled after the API GOLInit (⧉ see page 320)() is called in order to support hassles splash screens but is automatically enabled from the second screen update onwards. If double buffering is needed from the first screen itself, then follow step 1 immediately after calling GOLInit (⧉ see page 320)().

11.3.2.1 SwitchOffDoubleBuffering Function

File

DisplayDriver.h

C

```
void SwitchOffDoubleBuffering();
```

Side Effects

none

Returns

none

Preconditions

none

Overview

Switches off the double buffering. All rendering will be performed on the frame buffer. Calls to UpdateDisplayNow (⧉ see page 446)() or RequestDisplayUpdate (⧉ see page 445)() will have no effect.

Syntax

SwitchOffDoubleBuffering()

11.3.2.2 SwitchOnDoubleBuffering Function

File

DisplayDriver.h

C

```
void SwitchOnDoubleBuffering();
```

Side Effects

none

Returns

none

Preconditions

none

Overview

Switches on the double buffering. Double buffering utilizes two buffers. The frame buffer and the draw buffer. The frame buffer is the buffer that is being displayed while the draw buffer is used for all rendering. When this function is called, it copies the contents of the frame buffer to the draw buffer once and all succeeding rendering will be performed on the draw buffer. To update the frame buffer with newly drawn items on the draw buffer call UpdateDisplayNow (⧉ see page 446)() or RequestDisplayUpdate (⧉ see page 445)().

Syntax

SwitchOnDoubleBuffering()

11.3.2.3 InvalidateRectangle Function

File

DisplayDriver.h

C

```
void InvalidateRectangle(
    WORD left,
    WORD top,
    WORD right,
    WORD bottom
);
```

Input Parameters

Input Parameters	Description
WORD left	left position
WORD top	top position
WORD right	right position
WORD bottom	bottom position

Side Effects

Copies back the invalidated areas only to the draw buffer after the exchange of draw and frame buffers.

Returns

None

Preconditions

None

Overview

Invalidates the specified rectangular area. This increments the number of invalidated areas and if the number of invalidated areas exceed the GFX_MAX_INVALIDATE_AREAS, the whole frame buffer is invalidated.

Syntax

void InvalidateRectangle(WORD left, WORD top, WORD right, WORD bottom)

11.3.2.4 RequestDisplayUpdate Function

File

DisplayDriver.h

C

```
void RequestDisplayUpdate();
```

Side Effects

none

Returns

none

Preconditions

none

Overview

Synchronizes the draw and frame buffers at next VBlank

Syntax

void RequestDisplayUpdate(void)

11.3.2.5 UpdateDisplayNow Function

File

DisplayDriver.h

C

```
void UpdateDisplayNow();
```

Side Effects

none

Returns

none

Preconditions

none

Overview

Synchronizes the draw and frame buffers immediately.

Syntax

void UpdateDisplayNow(void)

11.3.3 Decompressing DEFLATEd data

The Microchip Graphics Controller features a decompression module for data compressed using the DEFLATE algorithm. Compressed data are limited to fixed huffman codes. Compressed data with dynamic huffman codes are not supported.

Functions

	Name	Description
	Decompress (see page 446)	Decompresses the nbytes number of data at SrcAddress and places starting from DestAddress. (Blocking)

11.3.3.1 Decompress Function

File

mchpGfxDrv.h

C

```
BYTE Decompress(
    DWORD SrcAddress,
    DWORD DestAddress,
    DWORD nbytes
);
```

Input Parameters

Input Parameters	Description
DWORD SrcAddress	Source address
DWORD DestAddress	Destination address

DWORD nbytes	Number of bytes to be decompressed

Side Effects

Modifies workarea_1 & workarea_2 registers.

Returns

error flag

Preconditions

SrcAddress must point to the start of a compressed block.

Overview

Decompresses the nbytes number of data at SrcAddress and places starting from DestAddress. (Blocking)

Syntax

BYTE Decompress(DWORD SrcAddress, DWORD DestAddress, DWORD nbytes);

11.3.4 Palette Mode

The Microchip Graphics Controller features a palette mode for a smaller frame buffer requirement. This option uses the built-in 256 entry Color Look-up Table (CLUT) to represent pixels from the display buffer in memory. If the CLUT is enabled, each pixel in the display buffer is assumed to contain the color index. This color index is used as the address of the CLUT entry that contains the color value that will be used for the given pixel.

Files

Name	Description
Palette.h (see page 455)	This is file Palette.h.

Functions

	Name	Description
	ClearPaletteChangeError (see page 448)	Clears the Palette change error status
	DisablePalette (see page 448)	Disables the Palette mode.
	EnablePalette (see page 449)	Enables the Palette mode.
	GetPaletteChangeError (see page 449)	Returns the Palette change error status
	IsPaletteEnabled (see page 450)	Returns if the Palette mode is enabled or not.
	PaletteInit (see page 450)	Initializes the color look up table (CLUT).
	RequestPaletteChange (see page 450)	Loads the palettes from the flash during vertical blanking period if possible, otherwise loads immediately.
	SetPalette (see page 451)	Programs a block of palette entries starting from startEntry and until startEntry + length from the flash immediately.
	SetPaletteBpp (see page 452)	Sets the color look up table (CLUT) number of valid entries.
	SetPaletteFlash (see page 452)	Loads the palettes from the flash immediately.

Macros

Name	Description
RequestEntirePaletteChange (see page 454)	Loads all the palette entries from the flash during vertical blanking period if possible, otherwise loads immediately.
SetEntirePalette (see page 455)	Programs the whole 256 entry palette with new color values from flash.

Structures

Name	Description
PALETTE_FLASH (see page 453)	Structure for the palette stored in FLASH memory.
PALETTE_HEADER (see page 454)	Structure for the palette header.

Types

Name	Description
PALETTE_EXTERNAL (see page 454)	Structure for palette stored in EXTERNAL memory space. (example: External SPI or parallel Flash, EDS_EPMP)

Unions

Name	Description
PALETTE_ENTRY (see page 453)	Structure used for the palette entries. • For TFT: color is defined as 5-6-5 RGB format (5-bits for RED (see page 415), 6-bits for GREEN (see page 413) and 5-bits for BLUE (see page 410). • For Monochrome: 4 bits are used to represent the luma.

11.3.4.1 ClearPaletteChangeError Function

File

Palette.h (see page 455)

C

```
void ClearPaletteChangeError();
```

Side Effects

none

Returns

none

Preconditions

none

Overview

Clears the Palette change error status

Syntax

void ClearPaletteChangeError(void)

11.3.4.2 DisablePalette Function

File

Palette.h (see page 455)

C

```
void DisablePalette();
```

Returns

none

Preconditions

none

Overview

Disables the Palette mode.

Syntax

void DisablePalette(void)

11.3.4.3 EnablePalette Function

File

Palette.h (see page 455)

C

```
void EnablePalette();
```

Returns

none

Preconditions

none

Overview

Enables the Palette mode.

Syntax

void EnablePalette(void)

11.3.4.4 GetPaletteChangeError Function

File

Palette.h (see page 455)

C

```
BYTE GetPaletteChangeError();
```

Side Effects

none

Returns

Returns the palette change status. 1 - If the palette change error occured 0 - If no palette change error occured

Preconditions

none

Overview

Returns the Palette change error status

Syntax

BYTE GetPaletteChangeError(void)

11.3.4.5 IsPaletteEnabled Function

File

Palette.h (see page 455)

C

```
BYTE IsPaletteEnabled();
```

Returns

Returns the palette mode status. 1 - If the palette mode is enabled 0 - If the palette mode is disabled

Preconditions

none

Overview

Returns if the Palette mode is enabled or not.

Syntax

BYTE IsPaletteEnabled(void)

11.3.4.6 PaletteInit Function

File

Palette.h (see page 455)

C

```
void PaletteInit();
```

Side Effects

All rendering will use the new palette entries.

Returns

none

Preconditions

none

Overview

Initializes the color look up table (CLUT).

Syntax

void PaletteInit(void)

11.3.4.7 RequestPaletteChange Function

File

Palette.h (see page 455)

C

```
void RequestPaletteChange(
    void * pPalette,
    WORD startEntry,
    WORD length
);
```

Input Parameters

Input Parameters	Description
void * pPalette	Pointer to the palette structure
WORD startEntry	Start entry to load (inclusive)
WORD length	Number of entries

Side Effects

There may be a slight flicker when the Palette entries are getting loaded one by one.

Returns

none

Preconditions

Palette must be initialized by PaletteInit (see page 450)().

Overview

Loads the palettes from the flash during vertical blanking period if possible, otherwise loads immediately.

Syntax

void RequestPaletteChange(void *pPalette, WORD startEntry, WORD length)

11.3.4.8 SetPalette Function

File

Palette.h (see page 455)

C

```
BYTE SetPalette(
    void * pPalette,
    WORD startEntry,
    WORD length
);
```

Input Parameters

Input Parameters	Description
void * pPalette	Pointer to the palette structure
WORD startEntry	Start entry to load (inclusive)
WORD length	Number of entries

Side Effects

There may be a slight flicker when the Palette entries are getting loaded one by one.

Returns

Returns the status of the palette set. 0 - Set was successful 1 - Set was not successful

Preconditions

Palette must be initialized by PaletteInit (see page 450)().

Overview

Programs a block of palette entries starting from startEntry and until startEntry + length from the flash immediately.

Syntax

BYTE SetPalette(void *pPalette, WORD startEntry, WORD length)

11.3.4.9 SetPaletteBpp Function

File

Palette.h (see page 455)

C

```
BYTE SetPaletteBpp(
    BYTE bpp
);
```

Input Parameters

Input Parameters	Description
BYTE bpp	Bits per pixel

Side Effects

none

Returns

Returns the status of the change. 0 - Change was successful 1 - Change was not successful

Preconditions

Palette must be initialized by PaletteInit (see page 450)().

Overview

Sets the color look up table (CLUT) number of valid entries.

Syntax

BYTE SetPaletteBpp(BYTE bpp)

11.3.4.10 SetPaletteFlash Function

File

Palette.h (see page 455)

C

```
BYTE SetPaletteFlash(
    PALETTE_ENTRY * pPaletteEntry,
    WORD startEntry,
    WORD length
);
```

Input Parameters

Input Parameters	Description
PALETTE_ENTRY * pPaletteEntry	Pointer to the palette table in ROM
WORD startEntry	Start entry to load (inclusive)
WORD length	Number of entries

Side Effects

There may be a slight flicker when the Palette entries are getting loaded one by one.

Returns

Returns the status of the palette set. 0 - Set was successful 1 - Set was not successful

Preconditions

Palette must be initialized by PaletteInit (see page 450)().

Overview

Loads the palettes from the flash immediately.

Syntax

BYTE SetPaletteFlash(PALETTE_ENTRY (see page 453) *pPaletteEntry, WORD startEntry, WORD length)

11.3.4.11 PALETTE_ENTRY Union

File

Palette.h (see page 455)

C

```
typedef union {
  WORD value;
  struct {
    BYTE r : 5;
    BYTE g : 6;
    BYTE b : 5;
  } color;
  struct {
    BYTE luma : 4;
  } monchrome;
} PALETTE_ENTRY;
```

Members

Members	Description
WORD value;	a 16-bit value representing a color or palette entry

struct {
BYTE r : 5;
BYTE g : 6;
BYTE b : 5;
} color;
	color value in 5-6-5 RGB format

BYTE r : 5;	represents the RED (see page 415) component
BYTE g : 6;	represents the GREEN (see page 413) component
BYTE b : 5;	represents the BLUE (see page 410) component

struct {
BYTE luma : 4;
} monchrome;
	monochrome LUMA value

BYTE luma : 4;	monochrome LUMA value

Overview

Structure used for the palette entries.

- For TFT: color is defined as 5-6-5 RGB format (5-bits for RED (see page 415), 6-bits for GREEN (see page 413) and 5-bits for BLUE (see page 410).
- For Monochrome: 4 bits are used to represent the luma.

11.3.4.12 PALETTE_FLASH Structure

File

Palette.h (see page 455)

C

```
typedef struct {
  SHORT type;
  PALETTE_HEADER header;
  PALETTE_ENTRY * pPaletteEntry;
} PALETTE_FLASH;
```

Members

Members	Description
SHORT type;	Type must be FLASH
PALETTE_HEADER header;	Contains information on the palette
PALETTE_ENTRY * pPaletteEntry;	Pointer to the palette. Number of entries is determined by the header.

Overview

Structure for the palette stored in FLASH memory.

11.3.4.13 PALETTE_HEADER Structure

File

Palette.h (see page 455)

C

```
typedef struct {
  WORD id;
  WORD length;
} PALETTE_HEADER;
```

Members

Members	Description
WORD id;	User defined ID
WORD length;	number of palette entries (number of colors in the palette)

Overview

Structure for the palette header.

11.3.4.14 PALETTE_EXTERNAL Type

File

Palette.h (see page 455)

C

```
typedef GFX_EXTDATA PALETTE_EXTERNAL;
```

Overview

Structure for palette stored in EXTERNAL memory space. (example: External SPI or parallel Flash, EDS_EPMP)

11.3.4.15 RequestEntirePaletteChange Macro

File

Palette.h (see page 455)

C

```
#define RequestEntirePaletteChange(pPalette) RequestPaletteChange(pPalette, 0, 256)
```

Input Parameters

Input Parameters	Description
pPalette	Pointer to the palette structure

Side Effects

There may be a slight flicker when the Palette entries are getting loaded one by one.

Returns

none

Preconditions

PPalette must be initialized by PaletteInit (see page 450)().

Overview

Loads all the palette entries from the flash during vertical blanking period if possible, otherwise loads immediately.

Syntax

RequestEntirePaletteChange(pPalette)

11.3.4.16 SetEntirePalette Macro

File

Palette.h (see page 455)

C

```
#define SetEntirePalette(pPalette) SetPalette(pPalette, 0, 256)
```

Input Parameters

Input Parameters	Description
pPalette	Pointer to the palette structure

Side Effects

There may be a slight flicker when the Palette entries are getting loaded one by one.

Returns

Returns the status of the palette set. 0 - Set was successful 1 - Set was not successful

Preconditions

Palette must be initialized by PaletteInit (see page 450)().

Overview

Programs the whole 256 entry palette with new color values from flash.

Syntax

SetEntirePalette(pPalette)

11.3.4.17 Palette.h

Functions

	Name	Description
◆	ClearPaletteChangeError (see page 448)	Clears the Palette change error status

◆	DisablePalette (see page 448)	Disables the Palette mode.
◆	EnablePalette (see page 449)	Enables the Palette mode.
◆	GetPaletteChangeError (see page 449)	Returns the Palette change error status
◆	IsPaletteEnabled (see page 450)	Returns if the Palette mode is enabled or not.
◆	PaletteInit (see page 450)	Initializes the color look up table (CLUT).
◆	RequestPaletteChange (see page 450)	Loads the palettes from the flash during vertical blanking period if possible, otherwise loads immediately.
◆	SetPalette (see page 451)	Programs a block of palette entries starting from startEntry and until startEntry + length from the flash immediately.
◆	SetPaletteBpp (see page 452)	Sets the color look up table (CLUT) number of valid entries.
◆	SetPaletteFlash (see page 452)	Loads the palettes from the flash immediately.

Macros

Name	Description
RequestEntirePaletteChange (see page 454)	Loads all the palette entries from the flash during vertical blanking period if possible, otherwise loads immediately.
SetEntirePalette (see page 455)	Programs the whole 256 entry palette with new color values from flash.

Structures

Name	Description
PALETTE_FLASH (see page 453)	Structure for the palette stored in FLASH memory.
PALETTE_HEADER (see page 454)	Structure for the palette header.

Types

Name	Description
PALETTE_EXTERNAL (see page 454)	Structure for palette stored in EXTERNAL memory space. (example: External SPI or parallel Flash, EDS_EPMP)

Unions

Name	Description
PALETTE_ENTRY (see page 453)	Structure used for the palette entries. • For TFT: color is defined as 5-6-5 RGB format (5-bits for RED (see page 415), 6-bits for GREEN (see page 413) and 5-bits for BLUE (see page 410). • For Monochrome: 4 bits are used to represent the luma.

Description

This is file Palette.h.

Body Source

```
/*****************************************************************************
 *  Module for Microchip Graphics Library
 *  Palette Support
 *****************************************************************************
 * FileName:        Palette.h
 * Dependencies:    Graphics.h
 * Processor:       PIC24, PIC32
 * Compiler:        MPLAB C30, MPLAB C32
 * Linker:          MPLAB LINK30, MPLAB LINK32
 * Company:         Microchip Technology Incorporated
 *
```

```
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  *
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  * COST OF PROCUREMENT OF SUBSTITUTE GOODS, TECHNOLOGY, SERVICES, OR ANY
  * CLAIMS BY THIRD PARTIES (INCLUDING BUT NOT LIMITED TO ANY DEFENSE THEREOF),
  * OR OTHER SIMILAR COSTS.
  *
  * Date        Comment
  *~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
  * 11/06/09    Initial Release
  * 08/20/10    Modified PALETTE_EXTERNAL to be of type GFX_EXTDATA.
  *****************************************************************************/
#ifndef _PALETTE_H
    #define _PALETTE_H

    #include "Graphics/Graphics.h"
    #include "Primitive.h"
    #include "GenericTypeDefs.h"

    #ifdef USE_PALETTE

/*********************************************************************
* Overview: Structure used for the palette entries.
*           - For TFT: color is defined as 5-6-5 RGB format
*             (5-bits for RED, 6-bits for GREEN and 5-bits for BLUE.
*           - For Monochrome: 4 bits are used to represent the luma.
*
*********************************************************************/
typedef union
{
    WORD    value;                      // a 16-bit value representing a color or palette
entry
    struct
    {
        BYTE    r : 5;                  // represents the RED component
        BYTE    g : 6;                  // represents the GREEN component
        BYTE    b : 5;                  // represents the BLUE component
    } color;                            // color value in 5-6-5 RGB format

    struct
    {
        BYTE    luma : 4;               // monochrome LUMA value
    } monchrome;                        // monochrome LUMA value

} PALETTE_ENTRY;

/*********************************************************************
* Overview: Structure for the palette header.
*
*********************************************************************/
typedef struct
{
    WORD            id;                 // User defined ID
    WORD            length;             // number of palette entries (number of colors in
the palette)
```

```
} PALETTE_HEADER;

/*********************************************************************
* Overview: Structure for the palette stored in FLASH memory.
*
*********************************************************************/
typedef struct
{
    SHORT           type;               // Type must be FLASH
    PALETTE_HEADER  header;             // Contains information on the palette
    PALETTE_ENTRY   *pPaletteEntry;     // Pointer to the palette. Number of entries is
determined by the header.
} PALETTE_FLASH;

/*********************************************************************
* Overview: Structure for palette stored in EXTERNAL memory space.
*           (example: External SPI or parallel Flash, EDS_EPMP)
*
*********************************************************************/
typedef GFX_EXTDATA PALETTE_EXTERNAL;

/*********************************************************************
* Function: void PaletteInit(void)
*
* Overview: Initializes the color look up table (CLUT).
*
* PreCondition: none
*
* Input: none
*
* Output: none
*
* Side Effects: All rendering will use the new palette entries.
*
********************************************************************/
void    PaletteInit(void);

/*********************************************************************
* Function: void EnablePalette(void)
*
* Overview: Enables the Palette mode.
*
* PreCondition: none
*
* Input: none
*
* Output: none
*
* Side Effects:
*
********************************************************************/
void    EnablePalette(void);

/*********************************************************************
* Function: void DisablePalette(void)
*
* Overview: Disables the Palette mode.
*
* PreCondition: none
*
* Input: none
*
* Output: none
*
* Side Effects:
*
********************************************************************/
void    DisablePalette(void);

/*********************************************************************
* Function: BYTE IsPaletteEnabled(void)
*
```

```
* Overview: Returns if the Palette mode is enabled or not.
*
* PreCondition: none
*
* Input: none
*
* Output: Returns the palette mode status.
*         1 - If the palette mode is enabled
*         0 - If the palette mode is disabled
*
* Side Effects:
*
********************************************************************/
BYTE    IsPaletteEnabled(void);

/*********************************************************************
* Function: BYTE GetPaletteChangeError(void)
*
* Overview: Returns the Palette change error status
*
* PreCondition: none
*
* Input: none
*
* Output: Returns the palette change status.
*         1 - If the palette change error occured
*         0 - If no palette change error occured
*
* Side Effects: none
*
********************************************************************/
BYTE    GetPaletteChangeError(void);

/*********************************************************************
* Function: void ClearPaletteChangeError(void)
*
* Overview: Clears the Palette change error status
*
* PreCondition: none
*
* Input: none
*
* Output: none
*
* Side Effects: none
*
********************************************************************/
void    ClearPaletteChangeError(void);

/*********************************************************************
* Function: BYTE SetPaletteBpp(BYTE bpp)
*
* Overview: Sets the color look up table (CLUT) number of valid entries.
*
* PreCondition: Palette must be initialized by PaletteInit().
*
* Input: bpp - Bits per pixel
*
* Output: Returns the status of the change.
*         0 - Change was successful
*         1 - Change was not successful
*
* Side Effects: none
*
********************************************************************/
BYTE    SetPaletteBpp(BYTE bpp);

/*********************************************************************
* Function: void RequestPaletteChange(void *pPalette, WORD startEntry, WORD length)
*
* Overview: Loads the palettes from the flash during vertical blanking period
*           if possible, otherwise loads immediately.
```

```
*
* PreCondition: Palette must be initialized by PaletteInit().
*
* Input: pPalette   - Pointer to the palette structure
*        startEntry - Start entry to load (inclusive)
*        length     - Number of entries
*
* Output: none
*
* Side Effects: There may be a slight flicker when the Palette entries
*               are getting loaded one by one.
*
********************************************************************/
void    RequestPaletteChange(void *pPalette, WORD startEntry, WORD length);

/*********************************************************************
* Macro: RequestEntirePaletteChange(pPalette)
*
* Overview: Loads all the palette entries from the flash during
*           vertical blanking period if possible, otherwise
*           loads immediately.
*
* PreCondition: PPalette must be initialized by PaletteInit().
*
* Input: pPalette - Pointer to the palette structure
*
* Output: none
*
* Side Effects: There may be a slight flicker when the Palette entries
*               are getting loaded one by one.
*
********************************************************************/
        #define RequestEntirePaletteChange(pPalette)    RequestPaletteChange(pPalette, 0,
256)

/*********************************************************************
* Function: BYTE SetPalette(void *pPalette, WORD startEntry, WORD length)
*
* Overview: Programs a block of palette entries starting from startEntry and
*           until startEntry + length from the flash immediately.
*
* PreCondition: Palette must be initialized by PaletteInit().
*
* Input: pPalette   - Pointer to the palette structure
*        startEntry - Start entry to load (inclusive)
*        length     - Number of entries
*
* Output: Returns the status of the palette set.
*         0 - Set was successful
*         1 - Set was not successful
*
* Side Effects: There may be a slight flicker when the Palette entries
*               are getting loaded one by one.
*
********************************************************************/
BYTE    SetPalette(void *pPalette, WORD startEntry, WORD length);

/*********************************************************************
* Macro: SetEntirePalette(pPalette)
*
* Overview: Programs the whole 256 entry palette with new color values
*           from flash.
*
* PreCondition: Palette must be initialized by PaletteInit().
*
* Input: pPalette - Pointer to the palette structure
*
* Output: Returns the status of the palette set.
*         0 - Set was successful
*         1 - Set was not successful
*
* Side Effects: There may be a slight flicker when the Palette entries
*               are getting loaded one by one.
*
********************************************************************/
        #define SetEntirePalette(pPalette)  SetPalette(pPalette, 0, 256)

/*********************************************************************
* Function: BYTE SetPaletteFlash(PALETTE_ENTRY *pPaletteEntry, WORD startEntry, WORD length)
*
* Overview: Loads the palettes from the flash immediately.
*
* PreCondition: Palette must be initialized by PaletteInit().
*
* Input: pPaletteEntry   - Pointer to the palette table in ROM
*        startEntry      - Start entry to load (inclusive)
*        length          - Number of entries
*
* Output: Returns the status of the palette set.
*         0 - Set was successful
*         1 - Set was not successful
*
* Side Effects: There may be a slight flicker when the Palette entries
*               are getting loaded one by one.
*
********************************************************************/
BYTE    SetPaletteFlash(PALETTE_ENTRY *pPaletteEntry, WORD startEntry, WORD length);

    #endif //USE_PALETTE
#endif
```

11.3.5 Set Up Display Interface

Macros

Name	Description
GFX_GCLK_DIVIDER (⧉ see page 464)	Additional Hardware Profile macros used when using the driver for the Microchip Graphics Module that comes with the PIC Microcontroller (PIC24FJ256DA210 Device Family) (PIC24FJ256DA210_DEV_BOARD (⧉ see page 52)). • GFX_GCLK_DIVIDER - Set the clock divider for the pixel clock. • GFX_DISPLAY_BUFFER_START_ADDRESS (⧉ see page 467) - Set the Display Buffer location. • GFX_DISPLAY_BUFFER_LENGTH (⧉ see page 466) - Set the Display Buffer length (size) in bytes. This is calculated by the disply's width*height*(color depth/2). • GFX_EPMP_CS1_BASE_ADDRESS (⧉ see page 464) - Set the location of the external memory mapped to the EPMP CS1. • GFX_EPMP_CS2_BASE_ADDRESS (⧉ see page 465) - Set the location of the external memory mapped to the EPMP CS2. • GFX_EPMP_CS1_MEMORY_SIZE (⧉ see page 465) - Set the size of the memory mapped to the... more (⧉ see page 464)

GFX_EPMP_CS1_BASE_ADDRESS (see page 464)	Additional Hardware Profile macros used when using the driver for the Microchip Graphics Module that comes with the PIC Microcontroller (PIC24FJ256DA210 Device Family) (PIC24FJ256DA210_DEV_BOARD (see page 52)). • GFX_GCLK_DIVIDER - Set the clock divider for the pixel clock. • GFX_DISPLAY_BUFFER_START_ADDRESS (see page 467) - Set the Display Buffer location. • GFX_DISPLAY_BUFFER_LENGTH (see page 466) - Set the Display Buffer length (size) in bytes. This is calculated by the disply's width*height*(color depth/2). • GFX_EPMP_CS1_BASE_ADDRESS (see page 464) - Set the location of the external memory mapped to the EPMP CS1. • GFX_EPMP_CS2_BASE_ADDRESS (see page 465) - Set the location of the external memory mapped to the EPMP CS2. • GFX_EPMP_CS1_MEMORY_SIZE (see page 465) - Set the size of the memory mapped to the... more (see page 464)
GFX_EPMP_CS1_MEMORY_SIZE (see page 465)	Additional Hardware Profile macros used when using the driver for the Microchip Graphics Module that comes with the PIC Microcontroller (PIC24FJ256DA210 Device Family) (PIC24FJ256DA210_DEV_BOARD (see page 52)). • GFX_GCLK_DIVIDER - Set the clock divider for the pixel clock. • GFX_DISPLAY_BUFFER_START_ADDRESS (see page 467) - Set the Display Buffer location. • GFX_DISPLAY_BUFFER_LENGTH (see page 466) - Set the Display Buffer length (size) in bytes. This is calculated by the disply's width*height*(color depth/2). • GFX_EPMP_CS1_BASE_ADDRESS (see page 464) - Set the location of the external memory mapped to the EPMP CS1. • GFX_EPMP_CS2_BASE_ADDRESS (see page 465) - Set the location of the external memory mapped to the EPMP CS2. • GFX_EPMP_CS1_MEMORY_SIZE (see page 465) - Set the size of the memory mapped to the... more (see page 465)
GFX_EPMP_CS2_BASE_ADDRESS (see page 465)	Additional Hardware Profile macros used when using the driver for the Microchip Graphics Module that comes with the PIC Microcontroller (PIC24FJ256DA210 Device Family) (PIC24FJ256DA210_DEV_BOARD (see page 52)). • GFX_GCLK_DIVIDER - Set the clock divider for the pixel clock. • GFX_DISPLAY_BUFFER_START_ADDRESS (see page 467) - Set the Display Buffer location. • GFX_DISPLAY_BUFFER_LENGTH (see page 466) - Set the Display Buffer length (size) in bytes. This is calculated by the disply's width*height*(color depth/2). • GFX_EPMP_CS1_BASE_ADDRESS (see page 464) - Set the location of the external memory mapped to the EPMP CS1. • GFX_EPMP_CS2_BASE_ADDRESS (see page 465) - Set the location of the external memory mapped to the EPMP CS2. • GFX_EPMP_CS1_MEMORY_SIZE (see page 465) - Set the size of the memory mapped to the... more (see page 465)

GFX_EPMP_CS2_MEMORY_SIZE (see page 466)	Additional Hardware Profile macros used when using the driver for the Microchip Graphics Module that comes with the PIC Microcontroller (PIC24FJ256DA210 Device Family) (PIC24FJ256DA210_DEV_BOARD (see page 52)). • GFX_GCLK_DIVIDER - Set the clock divider for the pixel clock. • GFX_DISPLAY_BUFFER_START_ADDRESS (see page 467) - Set the Display Buffer location. • GFX_DISPLAY_BUFFER_LENGTH (see page 466) - Set the Display Buffer length (size) in bytes. This is calculated by the disply's width*height*(color depth/2). • GFX_EPMP_CS1_BASE_ADDRESS (see page 464) - Set the location of the external memory mapped to the EPMP CS1. • GFX_EPMP_CS2_BASE_ADDRESS (see page 465) - Set the location of the external memory mapped to the EPMP CS2. • GFX_EPMP_CS1_MEMORY_SIZE (see page 465) - Set the size of the memory mapped to the... more (see page 466)
GFX_DISPLAY_BUFFER_LENGTH (see page 466)	Additional Hardware Profile macros used when using the driver for the Microchip Graphics Module that comes with the PIC Microcontroller (PIC24FJ256DA210 Device Family) (PIC24FJ256DA210_DEV_BOARD (see page 52)). • GFX_GCLK_DIVIDER - Set the clock divider for the pixel clock. • GFX_DISPLAY_BUFFER_START_ADDRESS (see page 467) - Set the Display Buffer location. • GFX_DISPLAY_BUFFER_LENGTH (see page 466) - Set the Display Buffer length (size) in bytes. This is calculated by the disply's width*height*(color depth/2). • GFX_EPMP_CS1_BASE_ADDRESS (see page 464) - Set the location of the external memory mapped to the EPMP CS1. • GFX_EPMP_CS2_BASE_ADDRESS (see page 465) - Set the location of the external memory mapped to the EPMP CS2. • GFX_EPMP_CS1_MEMORY_SIZE (see page 465) - Set the size of the memory mapped to the... more (see page 466)
GFX_DISPLAY_BUFFER_START_ADDRESS (see page 467)	Additional Hardware Profile macros used when using the driver for the Microchip Graphics Module that comes with the PIC Microcontroller (PIC24FJ256DA210 Device Family) (PIC24FJ256DA210_DEV_BOARD (see page 52)). • GFX_GCLK_DIVIDER - Set the clock divider for the pixel clock. • GFX_DISPLAY_BUFFER_START_ADDRESS (see page 467) - Set the Display Buffer location. • GFX_DISPLAY_BUFFER_LENGTH (see page 466) - Set the Display Buffer length (size) in bytes. This is calculated by the disply's width*height*(color depth/2). • GFX_EPMP_CS1_BASE_ADDRESS (see page 464) - Set the location of the external memory mapped to the EPMP CS1. • GFX_EPMP_CS2_BASE_ADDRESS (see page 465) - Set the location of the external memory mapped to the EPMP CS2. • GFX_EPMP_CS1_MEMORY_SIZE (see page 465) - Set the size of the memory mapped to the... more (see page 467)

11.3.5.1 GFX_GCLK_DIVIDER Macro

File

HardwareProfile.h

C

```
#define GFX_GCLK_DIVIDER 61
```

Overview

Additional Hardware Profile macros used when using the driver for the Microchip Graphics Module that comes with the PIC Microcontroller (PIC24FJ256DA210 Device Family) (PIC24FJ256DA210_DEV_BOARD (see page 52)).

- GFX_GCLK_DIVIDER - Set the clock divider for the pixel clock.
- GFX_DISPLAY_BUFFER_START_ADDRESS (see page 467) - Set the Display Buffer location.
- GFX_DISPLAY_BUFFER_LENGTH (see page 466) - Set the Display Buffer length (size) in bytes. This is calculated by the disply's width*height*(color depth/2).
- GFX_EPMP_CS1_BASE_ADDRESS (see page 464) - Set the location of the external memory mapped to the EPMP CS1.
- GFX_EPMP_CS2_BASE_ADDRESS (see page 465) - Set the location of the external memory mapped to the EPMP CS2.
- GFX_EPMP_CS1_MEMORY_SIZE (see page 465) - Set the size of the memory mapped to the EPMP CS1. This value sets how many EPMP address lines will be used.
- GFX_EPMP_CS2_MEMORY_SIZE (see page 466) - Set the size of the memory mapped to the EPMP CS2. This value sets how many EPMP address lines will be used.

11.3.5.2 GFX_EPMP_CS1_BASE_ADDRESS Macro

File

HardwareProfile.h

C

```
#define GFX_EPMP_CS1_BASE_ADDRESS 0x00020000ul            // <COPY GFX_GCLK_DIVIDER>
```

Overview

Additional Hardware Profile macros used when using the driver for the Microchip Graphics Module that comes with the PIC Microcontroller (PIC24FJ256DA210 Device Family) (PIC24FJ256DA210_DEV_BOARD (see page 52)).

- GFX_GCLK_DIVIDER - Set the clock divider for the pixel clock.
- GFX_DISPLAY_BUFFER_START_ADDRESS (see page 467) - Set the Display Buffer location.
- GFX_DISPLAY_BUFFER_LENGTH (see page 466) - Set the Display Buffer length (size) in bytes. This is calculated by the disply's width*height*(color depth/2).
- GFX_EPMP_CS1_BASE_ADDRESS - Set the location of the external memory mapped to the EPMP CS1.
- GFX_EPMP_CS2_BASE_ADDRESS (see page 465) - Set the location of the external memory mapped to the EPMP CS2.
- GFX_EPMP_CS1_MEMORY_SIZE (see page 465) - Set the size of the memory mapped to the EPMP CS1. This value sets how many EPMP address lines will be used.
- GFX_EPMP_CS2_MEMORY_SIZE (see page 466) - Set the size of the memory mapped to the EPMP CS2. This value sets how many EPMP address lines will be used.

11.3.5.3 GFX_EPMP_CS1_MEMORY_SIZE Macro

File

HardwareProfile.h

C

```
#define GFX_EPMP_CS1_MEMORY_SIZE 0x40000ul                // <COPY GFX_GCLK_DIVIDER>
```

Overview

Additional Hardware Profile macros used when using the driver for the Microchip Graphics Module that comes with the PIC Microcontroller (PIC24FJ256DA210 Device Family) (PIC24FJ256DA210_DEV_BOARD (see page 52)).

- GFX_GCLK_DIVIDER - Set the clock divider for the pixel clock.
- GFX_DISPLAY_BUFFER_START_ADDRESS (see page 467) - Set the Display Buffer location.
- GFX_DISPLAY_BUFFER_LENGTH (see page 466) - Set the Display Buffer length (size) in bytes. This is calculated by the disply's width*height*(color depth/2).
- GFX_EPMP_CS1_BASE_ADDRESS (see page 464) - Set the location of the external memory mapped to the EPMP CS1.
- GFX_EPMP_CS2_BASE_ADDRESS (see page 465) - Set the location of the external memory mapped to the EPMP CS2.
- GFX_EPMP_CS1_MEMORY_SIZE - Set the size of the memory mapped to the EPMP CS1. This value sets how many EPMP address lines will be used.
- GFX_EPMP_CS2_MEMORY_SIZE (see page 466) - Set the size of the memory mapped to the EPMP CS2. This value sets how many EPMP address lines will be used.

11.3.5.4 GFX_EPMP_CS2_BASE_ADDRESS Macro

File

HardwareProfile.h

C

```
#define GFX_EPMP_CS2_BASE_ADDRESS 0x00020000ul            // <COPY GFX_GCLK_DIVIDER>
```

Overview

Additional Hardware Profile macros used when using the driver for the Microchip Graphics Module that comes with the PIC Microcontroller (PIC24FJ256DA210 Device Family) (PIC24FJ256DA210_DEV_BOARD (see page 52)).

- GFX_GCLK_DIVIDER - Set the clock divider for the pixel clock.
- GFX_DISPLAY_BUFFER_START_ADDRESS (see page 467) - Set the Display Buffer location.
- GFX_DISPLAY_BUFFER_LENGTH (see page 466) - Set the Display Buffer length (size) in bytes. This is calculated by the disply's width*height*(color depth/2).
- GFX_EPMP_CS1_BASE_ADDRESS (see page 464) - Set the location of the external memory mapped to the EPMP CS1.
- GFX_EPMP_CS2_BASE_ADDRESS - Set the location of the external memory mapped to the EPMP CS2.
- GFX_EPMP_CS1_MEMORY_SIZE (see page 465) - Set the size of the memory mapped to the EPMP CS1. This value sets how many EPMP address lines will be used.
- GFX_EPMP_CS2_MEMORY_SIZE (see page 466) - Set the size of the memory mapped to the EPMP CS2. This value sets how many EPMP address lines will be used.

11.3.5.5 GFX_EPMP_CS2_MEMORY_SIZE Macro

File

HardwareProfile.h

C

```
#define GFX_EPMP_CS2_MEMORY_SIZE 0x40000ul                // <COPY GFX_GCLK_DIVIDER>
```

Overview

Additional Hardware Profile macros used when using the driver for the Microchip Graphics Module that comes with the PIC Microcontroller (PIC24FJ256DA210 Device Family) (PIC24FJ256DA210_DEV_BOARD (see page 52)).

- GFX_GCLK_DIVIDER - Set the clock divider for the pixel clock.
- GFX_DISPLAY_BUFFER_START_ADDRESS (see page 467) - Set the Display Buffer location.
- GFX_DISPLAY_BUFFER_LENGTH (see page 466) - Set the Display Buffer length (size) in bytes. This is calculated by the disply's width*height*(color depth/2).
- GFX_EPMP_CS1_BASE_ADDRESS (see page 464) - Set the location of the external memory mapped to the EPMP CS1.
- GFX_EPMP_CS2_BASE_ADDRESS (see page 465) - Set the location of the external memory mapped to the EPMP CS2.
- GFX_EPMP_CS1_MEMORY_SIZE (see page 465) - Set the size of the memory mapped to the EPMP CS1. This value sets how many EPMP address lines will be used.
- GFX_EPMP_CS2_MEMORY_SIZE - Set the size of the memory mapped to the EPMP CS2. This value sets how many EPMP address lines will be used.

11.3.5.6 GFX_DISPLAY_BUFFER_LENGTH Macro

File

HardwareProfile.h

C

```
#define GFX_DISPLAY_BUFFER_LENGTH 0x00025800ul            // <COPY GFX_GCLK_DIVIDER>
```

Overview

Additional Hardware Profile macros used when using the driver for the Microchip Graphics Module that comes with the PIC Microcontroller (PIC24FJ256DA210 Device Family) (PIC24FJ256DA210_DEV_BOARD (see page 52)).

- GFX_GCLK_DIVIDER - Set the clock divider for the pixel clock.
- GFX_DISPLAY_BUFFER_START_ADDRESS (see page 467) - Set the Display Buffer location.
- GFX_DISPLAY_BUFFER_LENGTH - Set the Display Buffer length (size) in bytes. This is calculated by the disply's width*height*(color depth/2).
- GFX_EPMP_CS1_BASE_ADDRESS (see page 464) - Set the location of the external memory mapped to the EPMP CS1.
- GFX_EPMP_CS2_BASE_ADDRESS (see page 465) - Set the location of the external memory mapped to the EPMP CS2.
- GFX_EPMP_CS1_MEMORY_SIZE (see page 465) - Set the size of the memory mapped to the EPMP CS1. This value sets how many EPMP address lines will be used.
- GFX_EPMP_CS2_MEMORY_SIZE (see page 466) - Set the size of the memory mapped to the EPMP CS2. This value sets how many EPMP address lines will be used.

11.3.5.7 GFX_DISPLAY_BUFFER_START_ADDRESS Macro

File

HardwareProfile.h

C

```
#define GFX_DISPLAY_BUFFER_START_ADDRESS 0x00020000ul    // <COPY GFX_GCLK_DIVIDER>
```

Overview

Additional Hardware Profile macros used when using the driver for the Microchip Graphics Module that comes with the PIC Microcontroller (PIC24FJ256DA210 Device Family) (PIC24FJ256DA210_DEV_BOARD (see page 52)).

- GFX_GCLK_DIVIDER - Set the clock divider for the pixel clock.
- GFX_DISPLAY_BUFFER_START_ADDRESS - Set the Display Buffer location.
- GFX_DISPLAY_BUFFER_LENGTH (see page 466) - Set the Display Buffer length (size) in bytes. This is calculated by the disply's width*height*(color depth/2).
- GFX_EPMP_CS1_BASE_ADDRESS (see page 464) - Set the location of the external memory mapped to the EPMP CS1.
- GFX_EPMP_CS2_BASE_ADDRESS (see page 465) - Set the location of the external memory mapped to the EPMP CS2.
- GFX_EPMP_CS1_MEMORY_SIZE (see page 465) - Set the size of the memory mapped to the EPMP CS1. This value sets how many EPMP address lines will be used.
- GFX_EPMP_CS2_MEMORY_SIZE (see page 466) - Set the size of the memory mapped to the EPMP CS2. This value sets how many EPMP address lines will be used.

12 Image Decoders

Demo Project

Name	Description
Image Decoder Demo (see page 476)	This demo demonstrates the decoding of images with JPEG and BMP file formats.

Functions

	Name	Description
	ImageDecode (see page 471)	This function decodes and displays the image on the screen
	ImageDecoderInit (see page 472)	This function initializes the global variables to 0 and then initializes the driver. This must be called once before any other function of the library is called
	ImageLoopCallbackRegister (see page 473)	This function registers the loop callback function so that the decoder calls this function in every decoding loop. This can be used by the application program to do maintainance activities such as fetching data, updating the display, etc...
	ImageDecodeTask (see page 473)	This function completes one small part of the image decode function

Macros

Name	Description
ImageFullScreenDecode (see page 474)	This function decodes and displays the image on the screen in fullscreen mode with center aligned and downscaled if required
ImageAbort (see page 475)	This function sets the Image Decoder's Abort flag so that decoding aborts in the next decoding loop.

Structures

	Name	Description
	_BMPDECODER (see page 531)	DATA STRUCTURES
	_GIFDECODER (see page 531)	DATA STRUCTURES
	_JPEGDECODER (see page 532)	DATA STRUCTURES

Description

The Image Decoder Library supports the decoding of images in JPEG, BMP, and GIF format in PIC24, dsPIC, and PIC32 devices. This is a supplement to the Graphics Library but could be used without the Graphics Library. It not only supports input data through the Microchip's MDD file system but it can also be configured to support user specific inputs from ROM, external EEPROM, etc. The output can be sent to the Graphics Display through the driver provided with the Graphics Library or to a callback function where user can further render the decoded image (even if Graphics Library is not used). The individual decoders provided uses the stack for the work memory and hence a heap is not required.

Design

The Image Decoder library includes the following files:

1. Configuration file

- ImageDecoderConfig.h

2. Header files

- Main Header

- ImageDecoder.h (see page 499)
- Individual decoder headers
- JpegDecoder.h (see page 524)
- BmpDecoder.h (see page 483)
- GifDecoder.h (see page 494)

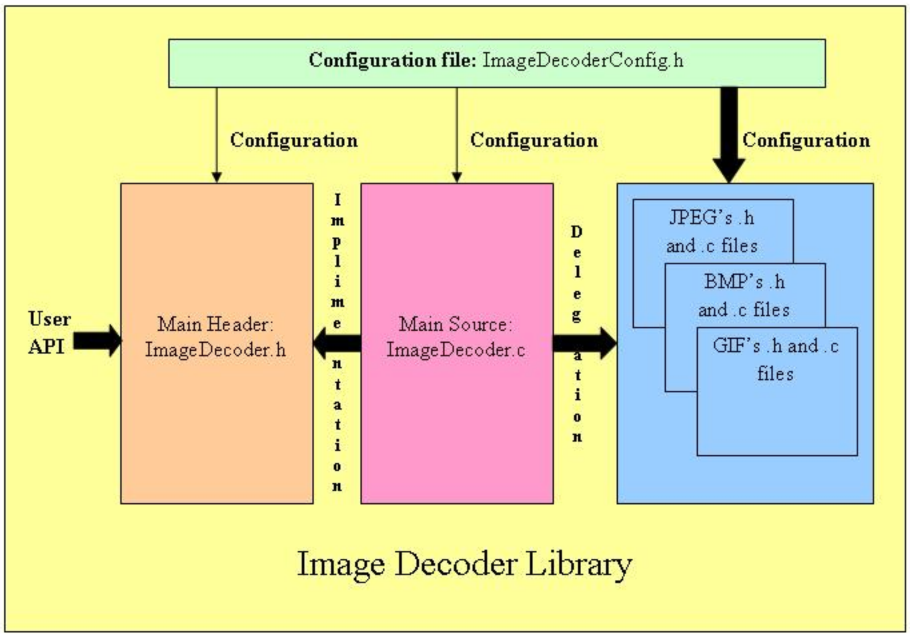
3. Source files

- Main Source file
- ImageDecoder.c (see page 495)
- Individual Source files
- JpegDecoder.c (see page 506)
- BmpDecoder.c (see page 476)
- GifDecoder.c (see page 483)

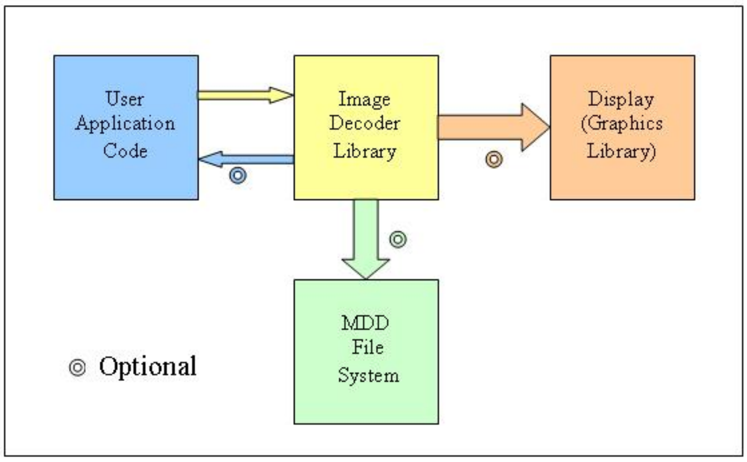
4. Support files

- jidctint.c (see page 526)

This can be diagrammatically explained as below:



The user application interacts with the Image Decoder Library as per the diagram below:



User can use the Graphics Library for output or can provide his/her own output pixel handler callback function. Similarly, user can use MDD file system or provide his/her own input source which implements some specific APIs explained later.

Configuration

The compile time configurations can be done using the ImageDecoderConfig.h file. This file must be copied into the application folder like the other config files. The options provided are as explained below:

1. Image format support

The image formats which are not required can be compiled out by commenting out the respective defines. The below section says that GIF support to be excluded.

```
/* Comment out the image formats which are not required */
#define IMG_SUPPORT_BMP
#define IMG_SUPPORT_JPEG
//#define IMG_SUPPORT_GIF
```

2. Optimize for Graphics Library

If user application requires to output the image directly to the display without any double buffering, then the code can be optimized by defining as below:

```
/* Comment out if output has to be given through a callback function */
/* If defined, the code is optimized to use only the graphics driver, only
16-bit-565-color-format is supported */
#define IMG_USE_ONLY_565_GRAPHICS_DRIVER_FOR_OUTPUT
```

If either double buffering has to be done or if user specific rendering has to be done, comment out the above mentioned line and provide a callback function to render the pixel values. The callback function will be explained in the API section. If commented out, then the width and height of the display screen has to be provided using the following defines

```
/* If the above define is commented out (Graphics driver is not included by default), then
the below defines has to be set by the user */
#ifndef IMG_USE_ONLY_565_GRAPHICS_DRIVER_FOR_OUTPUT
        #define DISP_HOR_RESOLUTION       320
        #define DISP_VER_RESOLUTION       240
#endif
```

3. Optimize for MDD file system

If user application uses only the MDD file system provided by Microchip Technology Inc., the code can be optimized by defining as below:

```
/* If defined, the code is optimized to use only the MDD file system */
#define IMG_USE_ONLY_MDD_FILE_SYSTEM_FOR_INPUT
```

If MDD file system is not used or if additional input formats have to be supported, the above define has to be commented out and a structure pointing to the required APIs (IMG_FILE_SYSTEM_API defined in ImageDecoder.h (see page 499)) must be provided by the user.

4. Loop callback support

Since decoder takes up significant amount of time decoding an image and user may want to update some information on the display or to send/receive data through communication channel, etc… it is possible to release processing power in the middle of decoding process by calling a callback function provided by the user. The user can do all the housekeeping activities inside the function. This option can be enabled by defining as below:

```
/* If defined, the a loop callback function is called in every
   decoding loop so that application can do maintenance activities such as
   getting data, updating display, etc... */
#define IMG_SUPPORT_IMAGE_DECODER_LOOP_CALLBACK
```

The JPEG decoder calls the callback function after every 8x8 pixel block decode while the BMP and GIF decoders calls after every row decode.

If this support is not required, then this define can be commented out.

Footprint

The following are typical values for PIC24 with default compiler configuration. Actual values may vary with various factors such as compiler optimization levels and device used (PIC24/PIC32).

	RAM (stack)	**ROM (no compiler optimizations)**	
Image Decoder Core Code	30 Bytes	1 KBytes	
Image Types			**Decode Time (in seconds) Using 16 MIPS & Compiler Optimization Level 3**
BMP	1 KBytes	10 KBytes	2[1]
JPEG	3 KBytes	13 KBytes	2[1]
GIF	11 KBytes(13 KBytes[2])	6 KBytes	2[1]

(1) Approximate value for average quality image file with a pixel resolution of 320x240. Additional variance in time can be observed due to image quality/image size and file access time.

(2) GIF code "Crush" optimization (GIF_CRUSH_PREV_SYMBOL_PTR_TABLE) is turned off. This compile switch can be found in GifDecoder.h (see page 494) file. Enabling this will have an additional effect on the GIF decoding time.

12.1 ImageDecode Function

File

ImageDecoder.h (see page 499)

C

```
BYTE ImageDecode(
    IMG_FILE * pImageFile,
    IMG_FILE_FORMAT eImgFormat,
    WORD wStartx,
    WORD wStarty,
    WORD wWidth,
    WORD wHeight,
    WORD wFlags,
    IMG_FILE_SYSTEM_API * pFileAPIs,
    IMG_PIXEL_OUTPUT pPixelOutput
);
```

Module

Image Decoders (see page 468)

Side Effects

None

Returns

Error code -> 0 means no error

Example

```
void main(void)
{
   IMG_FILE pImageFile;
   IMG_vInitialize();
   pImageFile = IMG_FOPEN("Image.jpg", "r");
   if(pImageFile == NULL)
   {
            <- Error handling ->
   }
   IMG_bDecode(pImageFile, IMG_JPEG, 0, 0, 320, 240, 0, NULL, NULL);
   IMG_FCLOSE(pImageFile);
   while(1);
}
```

Overview

This function decodes and displays the image on the screen

Syntax

BYTE ImageDecode(IMG_FILE *pImageFile, IMG_FILE_FORMAT eImgFormat, WORD wStartx, WORD wStarty, WORD wWidth, WORD wHeight, WORD wFlags, IMG_FILE_SYSTEM_API *pFileAPIs, IMG_PIXEL_OUTPUT pPixelOutput)

12.2 ImageDecoderInit Function

File

ImageDecoder.h (see page 499)

C

```
void ImageDecoderInit();
```

Module

Image Decoders (see page 468)

Side Effects

The graphics driver will be reset

Returns

None

Example

```
void main(void)
{
   ImageInit();
   ...
}
```

Overview

This function initializes the global variables to 0 and then initializes the driver. This must be called once before any other function of the library is called

Syntax

void ImageDecoderInit(void)

12.3 ImageLoopCallbackRegister Function

File

ImageDecoder.h (see page 499)

C

```
void ImageLoopCallbackRegister(
    IMG_LOOP_CALLBACK pFn
);
```

Module

Image Decoders (see page 468)

Side Effects

The graphics driver will be reset

Returns

None

Example

```
void Mainantance(void)
{
   ...
}

void main(void)
{
   ImageInit();
   ImageLoopCallbackRegister(Mainantance);
   ...
}
```

Overview

This function registers the loop callback function so that the decoder calls this function in every decoding loop. This can be used by the application program to do maintainance activities such as fetching data, updating the display, etc...

Syntax

void ImageLoopCallbackRegister(IMG_LOOP_CALLBACK pLoopCallbackFn)

12.4 ImageDecodeTask Function

File

ImageDecoder.h (see page 499)

C

```
BYTE ImageDecodeTask();
```

Module

Image Decoders (see page 468)

Side Effects

None

Returns

Status code - '1' means decoding is completed

- '0' means decoding is not yet completed, call this function again

Example

```
    IMG_bFullScreenDecode(pImageFile, IMG_JPEG, NULL, NULL);
    while(!ImageDecodeTask());
```

Overview

This function completes one small part of the image decode function

Syntax

BYTE ImageDecodeTask(void)

12.5 ImageFullScreenDecode Macro

File

ImageDecoder.h (see page 499)

C

```
#define ImageFullScreenDecode(pImageFile, eImgFormat, pFileAPIs, pPixelOutput) \
        ImageDecode(pImageFile, eImgFormat, 0, 0, IMG_SCREEN_WIDTH, IMG_SCREEN_HEIGHT,
(IMG_ALIGN_CENTER | IMG_DOWN_SCALE), pFileAPIs, pPixelOutput)
```

Module

Image Decoders (see page 468)

Side Effects

None

Returns

Error code -> 0 means no error

Example

```
void main(void)
{
    IMG_FILE pImageFile;
    IMG_vInitialize();
    pImageFile = IMG_FOPEN("Image.jpg", "r");
    if(pImageFile == NULL)
    {
            <- Error handling ->
    }
    IMG_bFullScreenDecode(pImageFile, IMG_JPEG, NULL, NULL);
    IMG_FCLOSE(pImageFile);
    while(1);
}
```

Overview

This function decodes and displays the image on the screen in fullscreen mode with center aligned and downscaled if required

Syntax

BYTE ImageFullScreenDecode(IMG_FILE *pImageFile, IMG_FILE_FORMAT eImgFormat, IMG_FILE_SYSTEM_API pFileAPIs, IMG_PIXEL_OUTPUT pPixelOutput)

12.6 ImageAbort Macro

File

ImageDecoder.h (see page 499)

C

```
#define ImageAbort IMG_blAbortImageDecoding = 1;
```

Module

Image Decoders (see page 468)

Side Effects

None

Returns

None

Example

```
void callback(void);
void main(void)
{
    IMG_FILE pImageFile;
    IMG_vInitialize();
    ImageLoopCallbackRegister(callback);
    pImageFile = IMG_FOPEN("Image.jpg", "r");
    if(pImageFile == NULL)
    {
            <- Error handling ->
    }
    IMG_bFullScreenDecode(pImageFile, IMG_JPEG, NULL, NULL);
    IMG_FCLOSE(pImageFile);
    while(1);
}

void callback(void)
{
    if(<- check for abort condition ->)
    {
        ImageAbort();
    }
}
```

Overview

This function sets the Image Decoder's Abort flag so that decoding aborts in the next decoding loop.

Syntax

void ImageAbort(void)

12.7 Demo Project

12.7.1 Image Decoder Demo

This demo demonstrates the decoding of images with JPEG and BMP file formats.

Module

Image Decoders (see page 468)

Description

Please refer to the getting started htm document located at <Install Directory>/Microchip/Graphics/Documents/Getting Started/Getting Started - Running the Image Decoders Demo.htm, where <Install Directory> is the root directory of the Microchip Applications Library.

12.8 Image Decoders Files

Files

Name	Description
BmpDecoder.c (see page 476)	This is file BmpDecoder.c.
BmpDecoder.h (see page 483)	This is file BmpDecoder.h.
GifDecoder.c (see page 483)	This is file GifDecoder.c.
GifDecoder.h (see page 494)	This is file GifDecoder.h.
ImageDecoder.c (see page 495)	This is file ImageDecoder.c.
ImageDecoder.h (see page 499)	This is file ImageDecoder.h.
JpegDecoder.c (see page 506)	This is file JpegDecoder.c.
JpegDecoder.h (see page 524)	This is file JpegDecoder.h.
jidctint.c (see page 526)	This is file jidctint.c.

Module

Image Decoders (see page 468)

Description

Lists all files describing the Image Decoders.

12.8.1 BmpDecoder.c

Structures

	Name	Description
◆	_BMPDECODER (see page 531)	DATA STRUCTURES

Description

This is file BmpDecoder.c.

Body Source

```
#define __BMPDECODER_C__
/******************************************************************************

* FileName:        BmpDecoder.c
* Dependencies:    Image decoding library; project requires File System library
* Processor:       PIC24/dsPIC30/dsPIC33/PIC32MX
* Compiler:        C30 v2.01/C32 v0.00.18
* Company:         Microchip Technology, Inc.

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 * CLAIMS BY THIRD PARTIES (INCLUDING BUT NOT LIMITED TO ANY DEFENSE THEREOF),
 * OR OTHER SIMILAR COSTS.

Author                   Date           Comments
--------------------------------------------------------------------------------
Pradeep Budagutta    03-Mar-2008    First release
*******************************************************************************/

#include "Image Decoders/ImageDecoder.h"

#ifdef IMG_SUPPORT_BMP

/*************************/
/**** DATA STRUCTURES ****/
/*************************/
typedef struct _BMPDECODER
{
        IMG_FILE *pImageFile;                      /* Image file pointer */
        LONG lWidth;
        LONG lHeight;
        LONG lImageOffset;
        WORD wPaletteEntries;
        BYTE bBitsPerPixel;
        BYTE bHeaderType;
        BYTE blBmMarkerFlag : 1;
        BYTE blCompressionType : 3;
        BYTE bNumOfPlanes : 3;
        BYTE b16bit565flag : 1;
        BYTE aPalette[256][3]; /* Each palette entry has RGB */
} BMPDECODER;

/**************************/
/******* FUNCTIONS  *******/
/**************************/

/*******************************************************************************
```

```
Function:       void BDEC_vResetData(BMPDECODER *pBmpDec)

Precondition:   None

Overview:       This function resets the variables so that new Bitmap image
                can be decoded

Input:          Bitmap decoder's data structure

Output:         None
********************************************************************************/
void BDEC_vResetData(BMPDECODER *pBmpDec)
{
    pBmpDec->pImageFile = NULL;
    pBmpDec->lWidth = 0;
    pBmpDec->lHeight = 0;
    pBmpDec->lImageOffset = 0;
    pBmpDec->wPaletteEntries = 0;
    pBmpDec->bBitsPerPixel = 0;
    pBmpDec->bHeaderType = 0;
    pBmpDec->blBmMarkerFlag = 0;
    pBmpDec->blCompressionType = 0;
    pBmpDec->bNumOfPlanes = 0;
    pBmpDec->b16bit565flag = 0;
}

/*******************************************************************************
Function:       BYTE BDEC_bReadHeader(BMPDECODER *pBmpDec)

Precondition:   None

Overview:       This function reads the Bitmap file header and
                fills the data structure

Input:          Bitmap decoder's data structure

Output:         Error code - '0' means no error
********************************************************************************/
BYTE BDEC_bReadHeader(BMPDECODER *pBmpDec)
{
        BYTE bByte1, bByte2;
        WORD wWord;
        LONG lLong;

        IMG_FREAD(&bByte1, sizeof(bByte1), 1, pBmpDec->pImageFile);  /* Marker */
        IMG_FREAD(&bByte2, sizeof(bByte2), 1, pBmpDec->pImageFile);  /* Marker */

        if(bByte1 == 'B' && bByte2 == 'M')
        {
                  pBmpDec->blBmMarkerFlag = 1;
        }
        else
        {
                  return(100);
        }

        IMG_FREAD(&lLong, sizeof(lLong), 1, pBmpDec->pImageFile);  /* File length */
        IMG_FREAD(&wWord, sizeof(wWord), 1, pBmpDec->pImageFile);  /* Reserved */
        IMG_FREAD(&wWord, sizeof(wWord), 1, pBmpDec->pImageFile);  /* Reserved */

        IMG_FREAD(&lLong, sizeof(lLong), 1, pBmpDec->pImageFile);  /* Image offset */
        pBmpDec->lImageOffset = lLong;

        IMG_FREAD(&lLong, sizeof(lLong), 1, pBmpDec->pImageFile);  /* Header length */
        pBmpDec->bHeaderType = (BYTE)lLong;

        if(pBmpDec->bHeaderType >= 40)
        {
                  IMG_FREAD(&lLong, sizeof(lLong), 1, pBmpDec->pImageFile);  /* Image Width
*/
                  pBmpDec->lWidth = lLong;
                  IMG_FREAD(&lLong, sizeof(lLong), 1, pBmpDec->pImageFile);  /* Image
Height */
                  pBmpDec->lHeight = lLong;

                  IMG_FREAD(&wWord, sizeof(wWord), 1, pBmpDec->pImageFile);  /* Number of
Planes */
                  pBmpDec->bNumOfPlanes = (BYTE)wWord;

                  IMG_FREAD(&wWord, sizeof(wWord), 1, pBmpDec->pImageFile);  /* Bits per
Pixel */
                  pBmpDec->bBitsPerPixel = (BYTE)wWord;

                  IMG_FREAD(&lLong, sizeof(lLong), 1, pBmpDec->pImageFile);  /* Compression
info */
                  pBmpDec->blCompressionType = (BYTE)lLong;

                  IMG_FREAD(&lLong, sizeof(lLong), 1, pBmpDec->pImageFile);  /* Image
length */
                  IMG_FREAD(&lLong, sizeof(lLong), 1, pBmpDec->pImageFile);  /* xPixels per
metre */
                  IMG_FREAD(&lLong, sizeof(lLong), 1, pBmpDec->pImageFile);  /* yPixels per
metre */

                  IMG_FREAD(&lLong, sizeof(lLong), 1, pBmpDec->pImageFile);  /* Palette
entries */
                  pBmpDec->wPaletteEntries = (WORD)lLong;

                  if(pBmpDec->wPaletteEntries == 0)
                  {
                          WORD wTemp = (WORD)(pBmpDec->lImageOffset - 14 - 40)/4;
                          if(wTemp > 0)
                          {
                                   pBmpDec->wPaletteEntries = wTemp; /* This is because of
a bug in MSPAINT */
                          }
                  }

                  IMG_FREAD(&lLong, sizeof(lLong), 1, pBmpDec->pImageFile);  /* Important
colors */
                  if(pBmpDec->bBitsPerPixel == 16 && pBmpDec->bHeaderType > 40)
                  {
                          IMG_FREAD(&lLong, sizeof(lLong), 1, pBmpDec->pImageFile);  /* Red
mask */
                          if((WORD)lLong == 0xF800)
                          {
                                     pBmpDec->b16bit565flag = 1;
                          }
                  }

                  IMG_FSEEK(pBmpDec->pImageFile, pBmpDec->bHeaderType + 14, 0);

                  if(pBmpDec->wPaletteEntries <= 256)
                  {
                          WORD wCounter;
                          for(wCounter = 0; wCounter < pBmpDec->wPaletteEntries; wCounter++)
                          {
                                     IMG_FREAD(&pBmpDec->aPalette[wCounter][2],
sizeof(BYTE), 1, pBmpDec->pImageFile); /* R */
                                     IMG_FREAD(&pBmpDec->aPalette[wCounter][1],
sizeof(BYTE), 1, pBmpDec->pImageFile); /* G */
                                     IMG_FREAD(&pBmpDec->aPalette[wCounter][0],
sizeof(BYTE), 1, pBmpDec->pImageFile); /* B */
                                     IMG_FREAD(&wWord, sizeof(BYTE), 1,
pBmpDec->pImageFile); /* Dummy */
                          }
                  }
        }
        return(0);
}

/*******************************************************************************
Function:       BYTE BMP_bDecode(IMG_FILE *pFile)
```

```
Precondition:   None

Overview:       This function decodes and displays a Bitmap image

Input:          Image file

Output:         Error code - '0' means no error
*******************************************************************************/
BYTE BMP_bDecode(IMG_FILE *pFile)
{
        BMPDECODER BmpDec;
        WORD wX, wY;
        BYTE bPadding;

        BDEC_vResetData(&BmpDec);
        BmpDec.pImageFile = pFile;
        BDEC_bReadHeader(&BmpDec);
        if(BmpDec.blBmMarkerFlag == 0 || BmpDec.bHeaderType < 40 ||
(BmpDec.blCompressionType != 0 && BmpDec.blCompressionType != 3))
        {
            return 100;
        }
        IMG_wImageWidth = (WORD)BmpDec.lWidth;
        IMG_wImageHeight = (WORD)BmpDec.lHeight;
        IMG_vSetboundaries();

        IMG_FSEEK(pFile, BmpDec.lImageOffset, 0);
        if(BmpDec.wPaletteEntries == 0 && BmpDec.bBitsPerPixel == 8) /* Grayscale Image */
        {
                bPadding = (4 - (BmpDec.lWidth % 4))%4;
                for(wY = 0; wY < BmpDec.lHeight; wY++)
                {
                         IMG_vLoopCallback();
                         IMG_vCheckAndAbort();
                         for(wX = 0; wX < BmpDec.lWidth; wX++)
                         {
                                   BYTE bY;
                                   IMG_FREAD(&bY, sizeof(bY), 1, BmpDec.pImageFile); /* Y */
                                   IMG_vSetColor(bY, bY, bY);
                                   IMG_vPutPixel(wX, BmpDec.lHeight - wY - 1);
                         }
                         for(wX = 0; wX < bPadding; wX++)
                         {
                                   BYTE bValue;
                                   IMG_FREAD(&bValue, sizeof(bValue), 1, BmpDec.pImageFile);
                         }
                }
        }
        else if(BmpDec.bBitsPerPixel == 16) /* 16-bit Color Image */
        {
                bPadding = (4 - ((BmpDec.lWidth*2) % 4))%4;
                for(wY = 0; wY < BmpDec.lHeight; wY++)
                {
                         IMG_vLoopCallback();
                         IMG_vCheckAndAbort();
                         for(wX = 0; wX < BmpDec.lWidth; wX++)
                         {
                                   WORD wColor;
                                   BYTE bR, bG, bB;
                                   IMG_FREAD(&wColor, sizeof(wColor), 1,
BmpDec.pImageFile); /* RGB */
                                   if(BmpDec.b16bit565flag == 1)
                                   {
                                              bR = (wColor >> 11) << 3;
                                              bG = ((wColor & 0x07E0) >> 5) << 2;
                                              bB = (wColor & 0x001F) << 3;
                                   }
                                   else
                                   {
                                              bR = ((wColor & 0x7FFF) >> 10) << 3;
                                              bG = ((wColor & 0x03E0) >> 5) << 3;
```

```
                                bB = (wColor & 0x001F) << 3;
                            }
                            IMG_vSetColor(bR, bG, bB);
                            IMG_vPutPixel(wX, BmpDec.lHeight - wY - 1);
                    }
                    for(wX = 0; wX < bPadding; wX++)
                    {
                            BYTE bValue;
                            IMG_FREAD(&bValue, sizeof(bValue), 1, BmpDec.pImageFile);
                    }
            }
    }
    else if(BmpDec.bBitsPerPixel == 24) /* True color Image */
    {
            bPadding = (4 - ((BmpDec.lWidth*3) % 4))%4;
            for(wY = 0; wY < BmpDec.lHeight; wY++)
            {
                    IMG_vLoopCallback();
                    IMG_vCheckAndAbort();
                    for(wX = 0; wX < BmpDec.lWidth; wX++)
                    {
                            BYTE bR, bG, bB;
                            IMG_FREAD(&bB, sizeof(bB), 1, BmpDec.pImageFile); /* B */
                            IMG_FREAD(&bG, sizeof(bG), 1, BmpDec.pImageFile); /* G */
                            IMG_FREAD(&bR, sizeof(bR), 1, BmpDec.pImageFile); /* R */
                            IMG_vSetColor(bR, bG, bB);
                            IMG_vPutPixel(wX, BmpDec.lHeight - wY - 1);
                    }
                    for(wX = 0; wX < bPadding; wX++)
                    {
                            BYTE bValue;
                            IMG_FREAD(&bValue, sizeof(bValue), 1, BmpDec.pImageFile);
                    }
            }
    }
    else if(BmpDec.wPaletteEntries != 0 && BmpDec.bBitsPerPixel == 1) /* B/W Image */
    {
            WORD wBytesPerRow = BmpDec.lWidth/8;
            BYTE bAdditionalBitsPerRow = BmpDec.lWidth % 8;
            bPadding = (4 - ((wBytesPerRow + (bAdditionalBitsPerRow?1:0)) % 4))%4;
            for(wY = 0; wY < BmpDec.lHeight; wY++)
            {
                    BYTE bBits, bValue;
                    IMG_vLoopCallback();
                    IMG_vCheckAndAbort();
                    for(wX = 0; wX < wBytesPerRow; wX++)
                    {
                            IMG_FREAD(&bValue, sizeof(bValue), 1, BmpDec.pImageFile);

                            for(bBits = 0; bBits < 8; bBits++)
                            {
                                    BYTE bIndex = (bValue & (0x80 >> bBits))?1:0;
                                    IMG_vSetColor(BmpDec.aPalette[bIndex][0],
BmpDec.aPalette[bIndex][1], BmpDec.aPalette[bIndex][2]);
                                    IMG_vPutPixel(wX*8+bBits, BmpDec.lHeight - wY

- 1);
                            }
                    }
                    if(bAdditionalBitsPerRow > 0)
                    {
                            IMG_FREAD(&bValue, sizeof(bValue), 1, BmpDec.pImageFile);

                            for(bBits = 0; bBits < bAdditionalBitsPerRow; bBits++)
                            {
                                    BYTE bIndex = (bValue & (0x80 >> bBits))?1:0;
                                    IMG_vSetColor(BmpDec.aPalette[bIndex][0],
BmpDec.aPalette[bIndex][1], BmpDec.aPalette[bIndex][2]);
                                    IMG_vPutPixel(wX*8+bBits, BmpDec.lHeight - wY

- 1);
                            }
                    }
                    for(wX = 0; wX < bPadding; wX++)
```

```
                          {
                                    BYTE bValue;
                                    IMG_FREAD(&bValue, sizeof(bValue), 1, BmpDec.pImageFile);
                          }
                 }
        }
        else if(BmpDec.wPaletteEntries != 0 && BmpDec.bBitsPerPixel == 4) /* 16 colors
Image */
        {
                 WORD wBytesPerRow = BmpDec.lWidth/2;
                 BYTE bAdditionalNibblePerRow = BmpDec.lWidth % 2;
                 bPadding = (4 - ((wBytesPerRow + bAdditionalNibblePerRow) % 4))%4;
                 for(wY = 0; wY < BmpDec.lHeight; wY++)
                 {
                          IMG_vLoopCallback();
                          IMG_vCheckAndAbort();
                          for(wX = 0; wX < wBytesPerRow; wX++)
                          {
                                    BYTE bIndex, bValue;
                                    IMG_FREAD(&bValue, sizeof(bValue), 1, BmpDec.pImageFile);
                                    bIndex = bValue >> 4;
                                    IMG_vSetColor(BmpDec.aPalette[bIndex][0],
BmpDec.aPalette[bIndex][1], BmpDec.aPalette[bIndex][2]);
                                    IMG_vPutPixel(wX*2, BmpDec.lHeight - wY - 1);
                                    bIndex = bValue & 0x0F;
                                    IMG_vSetColor(BmpDec.aPalette[bIndex][0],
BmpDec.aPalette[bIndex][1], BmpDec.aPalette[bIndex][2]);
                                    IMG_vPutPixel(wX*2+1, BmpDec.lHeight - wY - 1);
                          }
                          if(bAdditionalNibblePerRow)
                          {
                                    BYTE bIndex, bValue;
                                    IMG_FREAD(&bValue, sizeof(bValue), 1,
BmpDec.pImageFile); /* Bits8 */
                                    bIndex = bValue >> 4;
                                    IMG_vSetColor(BmpDec.aPalette[bIndex][0],
BmpDec.aPalette[bIndex][1], BmpDec.aPalette[bIndex][2]);
                                    IMG_vPutPixel(wX*2, BmpDec.lHeight - wY - 1);
                          }
                          for(wX = 0; wX < bPadding; wX++)
                          {
                                    BYTE bValue;
                                    IMG_FREAD(&bValue, sizeof(bValue), 1, BmpDec.pImageFile);
                          }
                 }
        }
        else if(BmpDec.wPaletteEntries != 0 && BmpDec.bBitsPerPixel == 8) /* 256 colors
Image */
        {
                 bPadding = (4 - (BmpDec.lWidth % 4))%4;
                 for(wY = 0; wY < BmpDec.lHeight; wY++)
                 {
                          IMG_vLoopCallback();
                          IMG_vCheckAndAbort();
                          for(wX = 0; wX < BmpDec.lWidth; wX++)
                          {
                                    BYTE bIndex;
                                    IMG_FREAD(&bIndex, sizeof(bIndex), 1, BmpDec.pImageFile);
                                    IMG_vSetColor(BmpDec.aPalette[bIndex][0],
BmpDec.aPalette[bIndex][1], BmpDec.aPalette[bIndex][2]);
                                    IMG_vPutPixel(wX, BmpDec.lHeight - wY - 1);
                          }
                          for(wX = 0; wX < bPadding; wX++)
                          {
                                    BYTE bValue;
                                    IMG_FREAD(&bValue, sizeof(bValue), 1, BmpDec.pImageFile);
                          }
                 }
        }

        return 0;
}
```

```
#endif /* #ifdef IMG_SUPPORT_BMP */

#undef __BMPDECODER_C__
```

12.8.2 BmpDecoder.h

This is file BmpDecoder.h.

Body Source

```
#ifndef __BMPDECODER_H__
 #define __BMPDECODER_H__

/******************************************************************************
* FileName:        BmpDecoder.h
* Dependencies:    Image decoding library; project requires File System library
* Processor:       PIC24/dsPIC30/dsPIC33/PIC32MX
* Compiler:        C30 v2.01/C32 v0.00.18
* Company:         Microchip Technology, Inc.

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Author                 Date           Comments
--------------------------------------------------------------------------------
Pradeep Budagutta    03-Mar-2008    First release
******************************************************************************/

/* Function prototype */
/* This function must be called after setting proper values in the global variables of
ImageDecoder.c */
BYTE BMP_bDecode(IMG_FILE *pFile);

#endif
```

12.8.3 GifDecoder.c

Structures

	Name	Description
	_GIFDECODER (see page 531)	DATA STRUCTURES

Description

This is file GifDecoder.c.

Body Source

```
#define __GIFDECODER_C__
/******************************************************************************

* FileName:        GifDecoder.c
* Dependencies:    Image decoding library; project requires File System library
* Processor:       PIC24/dsPIC30/dsPIC33/PIC32MX
* Compiler:        C30 v2.01/C32 v0.00.18
* Company:         Microchip Technology, Inc.

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Author                  Date           Comments
--------------------------------------------------------------------------------
Pradeep Budagutta    03-Mar-2008    First release
*******************************************************************************/

#include "Image Decoders/ImageDecoder.h"

#ifdef IMG_SUPPORT_GIF

/*************************/
/**** DATA STRUCTURES ****/
/*************************/
typedef struct _GIFDECODER
{
        IMG_FILE *pImageFile;                       /* Image file pointer */
        WORD wImageWidth;
        WORD wImageHeight;
        WORD wImageX;
        WORD wImageY;
        WORD wScreenWidth;
        WORD wScreenHeight;
        WORD wGlobalPaletteEntries;
        WORD wLocalPaletteEntries;
        BYTE bBgColorIndex;
        BYTE bPixelAspectRatio;
        BYTE blGifMarkerFlag : 1;
        BYTE blGloabalColorTableFlag : 1;
        BYTE blLocalColorTableFlag : 1;
        BYTE blInterlacedFlag : 1;
        BYTE blFirstcodeFlag : 1;
        BYTE bInterlacePass : 3;
        #if GIF_USE_16_BITS_PER_PIXEL == 0
        BYTE aPalette[256][3]; /* Each palette entry has RGB */
        #else
        WORD awPalette[256]; /* Each palette entry has RGB */
        #endif
        /* For decoding */
        BYTE abSymbol[4096];

        #if GIF_CRUSH_PREV_SYMBOL_PTR_TABLE == 0
        WORD awPrevSymbolPtr[4096];
        #else
        WORD awPrevSymbolPtr[(4096 * 3)/4];
        #endif

        WORD wInitialSymbols;
        WORD wMaxSymbol;
        BYTE bInitialSymbolBits;
        BYTE bMaxSymbolBits;
        LONG lGlobalColorTablePos;
        /* Work memory */
        BYTE bWorkBits;
        BYTE bRemainingDataInBlock;
        BYTE bRemainingBits;
        WORD wCurrentX;
        WORD wCurrentY;
} GIFDECODER;


/**************************/
/****** LOOKUP TABLE ******/
/**************************/
static const WORD GIF_awMask[] = { 0x000, 0x001, 0x003, 0x007, 0x00F, 0x01F, 0x03F, 0x07F,
0x0FF, 0x1FF, 0x3FF, 0x7FF, 0xFFF };

/**************************/
/******* FUNCTIONS  *******/
/**************************/
/*******************************************************************************
Function:       void GIF_vResetData(GIFDECODER *pGifDec)

Precondition:   None

Overview:       This function resets the variables so that new GIF image
                can be decoded

Input:          GIF decoder's data structure

Output:         None
*******************************************************************************/
static void GIF_vResetData(GIFDECODER *pGifDec)
{
    pGifDec->pImageFile = NULL;
    pGifDec->wImageWidth = 0;
    pGifDec->wImageHeight = 0;
    pGifDec->wImageX = 0;
    pGifDec->wImageY = 0;
    pGifDec->wScreenWidth = 0;
    pGifDec->wScreenHeight = 0;
    pGifDec->wGlobalPaletteEntries = 0;
    pGifDec->wLocalPaletteEntries = 0;
    pGifDec->bBgColorIndex = 0;
    pGifDec->bPixelAspectRatio = 0;
    pGifDec->blGifMarkerFlag = 0;
    pGifDec->blGloabalColorTableFlag = 0;
    pGifDec->blLocalColorTableFlag = 0;
    pGifDec->blInterlacedFlag = 0;
    pGifDec->blFirstcodeFlag = 1;
    pGifDec->bInterlacePass = 0;
    pGifDec->wMaxSymbol = 0;
    pGifDec->bMaxSymbolBits = 0;
    pGifDec->wInitialSymbols = 0;
    pGifDec->bInitialSymbolBits = 0;
    pGifDec->bWorkBits = 0;
    pGifDec->bRemainingDataInBlock = 0;
    pGifDec->bRemainingBits = 0;
    pGifDec->wCurrentX = 0;
    pGifDec->wCurrentY = 0;
    pGifDec->lGlobalColorTablePos = 0;
}

/*******************************************************************************
Function:       void GIF_vPutPrevCode(GIFDECODER *pGifDec, WORD wAddress, WORD wCode)

Precondition:   None

Overview:       This function puts the data(code) to the provided address

Input:          GIF decoder's data structure, Address, Data(Code)

Output:         None
*******************************************************************************/
static void GIF_vPutPrevCode(GIFDECODER *pGifDec, WORD wAddress, WORD wCode)
{
    #if GIF_CRUSH_PREV_SYMBOL_PTR_TABLE == 0
        pGifDec->awPrevSymbolPtr[wAddress] = wCode;
    #else
        WORD wCrushedAddress = (wAddress * 3) / 4;
        if((wAddress & 0x03) == 0)
        {
                  pGifDec->awPrevSymbolPtr[wCrushedAddress] &= 0xF000;
                  pGifDec->awPrevSymbolPtr[wCrushedAddress] |= (wCode & 0x0FFF);
        }
        else if((wAddress & 0x03) == 1)
        {
                  pGifDec->awPrevSymbolPtr[wCrushedAddress] &= 0x0FFF;
                  pGifDec->awPrevSymbolPtr[wCrushedAddress + 1] &= 0xFF00;
                  pGifDec->awPrevSymbolPtr[wCrushedAddress] |= (wCode << 12);
                  pGifDec->awPrevSymbolPtr[wCrushedAddress + 1] |= ((wCode >> 4) & 0x00FF);
        }
        else if((wAddress & 0x03) == 2)
        {
                  pGifDec->awPrevSymbolPtr[wCrushedAddress] &= 0x00FF;
                  pGifDec->awPrevSymbolPtr[wCrushedAddress + 1] &= 0xFFF0;
                  pGifDec->awPrevSymbolPtr[wCrushedAddress] |= (wCode << 8);
                  pGifDec->awPrevSymbolPtr[wCrushedAddress + 1] |= ((wCode >> 8) & 0x000F);
        }
        else
        {
                  pGifDec->awPrevSymbolPtr[wCrushedAddress] &= 0x000F;
                  pGifDec->awPrevSymbolPtr[wCrushedAddress] |= (wCode << 4);
        }
    #endif
}

/*******************************************************************************
Function:       WORD GIF_wGetPrevCode(GIFDECODER *pGifDec, WORD wAddress)

Precondition:   None

Overview:       This function gets the data(code) from the provided address

Input:          GIF decoder's data structure, Address

Output:         Data(Code)
*******************************************************************************/
static WORD GIF_wGetPrevCode(GIFDECODER *pGifDec, WORD wAddress)
{
        WORD wCode;
    #if GIF_CRUSH_PREV_SYMBOL_PTR_TABLE == 0
        wCode = pGifDec->awPrevSymbolPtr[wAddress];
    #else
        WORD wCrushedAddress = (wAddress * 3) / 4;
        if((wAddress & 0x03) == 0)
        {
                  wCode = (pGifDec->awPrevSymbolPtr[wCrushedAddress] & 0x0FFF);
        }
        else if((wAddress & 0x03) == 1)
        {
                  wCode = (pGifDec->awPrevSymbolPtr[wCrushedAddress] >> 12);
                  wCode |= ((pGifDec->awPrevSymbolPtr[wCrushedAddress + 1] & 0x00FF) << 4);
        }
        else if((wAddress & 0x03) == 2)
        {
                  wCode = (pGifDec->awPrevSymbolPtr[wCrushedAddress] >> 8);
                  wCode |= ((pGifDec->awPrevSymbolPtr[wCrushedAddress + 1] & 0x000F) << 8);
        }
        else
        {
                  wCode = (pGifDec->awPrevSymbolPtr[wCrushedAddress] >> 4);
        }
    #endif
        return wCode;
}

/*******************************************************************************
Function:       void GIF_vInitializeTable(GIFDECODER *pGifDec)

Precondition:   pGifDec->wInitialSymbols must be set to a proper value by
                reading the Header

Overview:       This function initializes the code table to the initial number
                of symbols

Input:          GIF decoder's data structure

Output:         None
*******************************************************************************/
static void GIF_vInitializeTable(GIFDECODER *pGifDec)
{
        WORD wCounter;
        for(wCounter = 0; wCounter < pGifDec->wInitialSymbols; wCounter++)
        {
                 pGifDec->abSymbol[wCounter] = wCounter;
                 GIF_vPutPrevCode(pGifDec, wCounter, pGifDec->wInitialSymbols);
        }
}

/*******************************************************************************
Function:       void GIF_vReadColorTable(GIFDECODER *pGifDec, WORD wNumberOfEntries)

Precondition:   None

Overview:       This function initializes the code table to the initial number
                of symbols

Input:          GIF decoder's data structure

Output:         None
*******************************************************************************/
static void GIF_vReadColorTable(GIFDECODER *pGifDec, WORD wNumberOfEntries)
{
        BYTE r, g, b;
        WORD wCounter;
        for(wCounter = 0; wCounter < wNumberOfEntries; wCounter++)
        {
                 IMG_FREAD(&r, sizeof(BYTE), 1, pGifDec->pImageFile); /* R */
                 IMG_FREAD(&g, sizeof(BYTE), 1, pGifDec->pImageFile); /* G */
                 IMG_FREAD(&b, sizeof(BYTE), 1, pGifDec->pImageFile); /* B */
                 #if GIF_USE_16_BITS_PER_PIXEL == 0
                 pGifDec->aPalette[wCounter][0] = r;
                 pGifDec->aPalette[wCounter][1] = g;
                 pGifDec->aPalette[wCounter][2] = b;
                 #else
                 pGifDec->awPalette[wCounter] = RGB565CONVERT(r, g, b);
                 #endif
        }
}
```

```
/*******************************************************************************
Function:       BYTE GIF_bReadHeader(GIFDECODER *pGifDec)

Precondition:   None

Overview:       This function reads the GIF file's header information

Input:          GIF decoder's data structure

Output:         Error code - '0' means no error
*******************************************************************************/
static BYTE GIF_bReadHeader(GIFDECODER *pGifDec)
{
        BYTE abByte[6];
        BYTE bFlags;

        IMG_FREAD(abByte, sizeof(BYTE), 6, pGifDec->pImageFile);  /* Marker */
        if(abByte[0] == 'G' && abByte[1] == 'I' && abByte[2] == 'F' &&
           abByte[3] == '8' && (abByte[4] == '7' || abByte[4] == '9') &&
           abByte[5] == 'a')
        {
                  pGifDec->blGifMarkerFlag = 1;
        }
        else
        {
            return(100);
        }

        IMG_FREAD(&pGifDec->wScreenWidth, sizeof(WORD), 1, pGifDec->pImageFile);
        IMG_FREAD(&pGifDec->wScreenHeight, sizeof(WORD), 1, pGifDec->pImageFile);
        IMG_FREAD(&bFlags, sizeof(BYTE), 1, pGifDec->pImageFile);  /* Packed fields */
        IMG_FREAD(&pGifDec->bBgColorIndex, sizeof(BYTE), 1, pGifDec->pImageFile);
        IMG_FREAD(&pGifDec->bPixelAspectRatio, sizeof(BYTE), 1, pGifDec->pImageFile);
        if(bFlags & 0x80)
        {
                  pGifDec->blGloabalColorTableFlag = 1;
        }
        pGifDec->wGlobalPaletteEntries = 0x01 << ((bFlags & 0x07) + 1);

        if(pGifDec->blGloabalColorTableFlag == 1)
        {
                  pGifDec->lGlobalColorTablePos = IMG_FTELL(pGifDec->pImageFile);
                  GIF_vReadColorTable(pGifDec, pGifDec->wGlobalPaletteEntries);
        }
        return(0);
}

/*******************************************************************************
Function:       BYTE GIF_bReadNextImageDescriptor(GIFDECODER *pGifDec)

Precondition:   File pointer must be pointing to proper location (Like start of
                extension)

Overview:       This function reads the next image descriptor

Input:          GIF decoder's data structure

Output:         Error code - '0' means no error
*******************************************************************************/
static BYTE GIF_bReadNextImageDescriptor(GIFDECODER *pGifDec)
{
       BYTE bSection, bSectionDetails, bBlockSize, bTemp;
       BYTE bFlags;
       BYTE bCounter;
       do
       {
           IMG_FREAD(&bSection, sizeof(BYTE), 1, pGifDec->pImageFile);
           if(bSection == 0x21) /* Extension block */
           {
                        IMG_FREAD(&bSectionDetails, sizeof(BYTE), 1, pGifDec->pImageFile);
                        switch(bSectionDetails)
                        {
```

```
/* GRAPHICS EXTENSION */          case 0xF9: IMG_FREAD(&bBlockSize, sizeof(BYTE), 1,
pGifDec->pImageFile);

                                             IMG_FSEEK(pGifDec->pImageFile, bBlockSize, 1);
                                             break;
/* PLAIN TEXT EXTENSION */        case 0x01:
/* APPLICATION EXTENSION */       case 0xFF: IMG_FREAD(&bBlockSize, sizeof(BYTE), 1,
pGifDec->pImageFile);

                                             IMG_FSEEK(pGifDec->pImageFile, bBlockSize, 1);
/* COMMENT EXTENSION */           case 0xFE: IMG_FREAD(&bBlockSize, sizeof(BYTE), 1,
pGifDec->pImageFile);

                                             for(bCounter = 0; bCounter < bBlockSize;
bCounter++)

                                             {
                                                   IMG_FREAD(&bTemp, sizeof(BYTE), 1,
pGifDec->pImageFile);

                                             }
                                             break;

                                  default:   return(100);
                        }
/* BLOCK TERMINATOR */  IMG_FREAD(&bTemp, sizeof(BYTE), 1, pGifDec->pImageFile);
                        if(bTemp != 0)
                        {
                                  return(100);
                        }
            }
            else if(bSection != 0x2C)
            {
                 return(100);
            }
       }
       while(bSection != 0x2C);

       pGifDec->blFirstcodeFlag = 1;
       pGifDec->bInterlacePass = 0;
       pGifDec->bWorkBits = 0;
       pGifDec->bRemainingDataInBlock = 0;
       pGifDec->bRemainingBits = 0;
       IMG_FREAD(&pGifDec->wImageX, sizeof(WORD), 1, pGifDec->pImageFile);
       IMG_FREAD(&pGifDec->wImageY, sizeof(WORD), 1, pGifDec->pImageFile);
       IMG_FREAD(&pGifDec->wImageWidth, sizeof(WORD), 1, pGifDec->pImageFile);
       IMG_FREAD(&pGifDec->wImageHeight, sizeof(WORD), 1, pGifDec->pImageFile);
       IMG_FREAD(&bFlags, sizeof(BYTE), 1, pGifDec->pImageFile);  /* Packed fields */
       if(bFlags & 0x40)
       {
            pGifDec->blInterlacedFlag = 1;
       }
       if(bFlags & 0x80)
       {
            pGifDec->blLocalColorTableFlag = 1;
       }
       pGifDec->wLocalPaletteEntries = 0x01 << ((bFlags & 0x07) + 1);
       if(pGifDec->blLocalColorTableFlag == 1)
       {
                 GIF_vReadColorTable(pGifDec, pGifDec->wLocalPaletteEntries);
       }
       pGifDec->wCurrentX = pGifDec->wImageX;
       pGifDec->wCurrentY = pGifDec->wImageY;
       return 0;
}

/*******************************************************************************
Function:       WORD GIF_wGetNextByte(GIFDECODER *pGifDec)

Precondition:   None

Overview:       This function reads the next data byte. It also handles the
                data block intra-boundaries

Input:          GIF decoder's data structure

Output:         Data byte, 0xFFFF means error
```

```
*****************************************************************************/
static WORD GIF_wGetNextByte(GIFDECODER *pGifDec)
{
	BYTE bByte;
	if(pGifDec->bRemainingDataInBlock == 0)
	{
		IMG_FREAD(&pGifDec->bRemainingDataInBlock, sizeof(BYTE), 1,
pGifDec->pImageFile);
		if(pGifDec->bRemainingDataInBlock == 0)
		{
			return 0xFFFF; /* End of data */
		}
	}
	IMG_FREAD(&bByte, sizeof(BYTE), 1, pGifDec->pImageFile);
	pGifDec->bRemainingDataInBlock--;
	return (WORD)bByte;
}

/*****************************************************************************
Function:	WORD GIF_wGetNextSymbol(GIFDECODER *pGifDec)

Precondition:	pGifDec->bMaxSymbolBits must be properly updated

Overview:	This function reads the next code symbol brom the data stream

Input:		GIF decoder's data structure

Output:		Next Code, 0xFFFF means error
*****************************************************************************/
static WORD GIF_wGetNextSymbol(GIFDECODER *pGifDec)
{
	WORD wDataBits = 0xFFFF;
	if(pGifDec->bRemainingBits < pGifDec->bMaxSymbolBits)
	{
		WORD wTemp1, wTemp2;
		BYTE bBitsRequired;

		bBitsRequired = pGifDec->bMaxSymbolBits - pGifDec->bRemainingBits;
		wDataBits = pGifDec->bWorkBits & GIF_awMask[pGifDec->bRemainingBits];
		wTemp1 = GIF_wGetNextByte(pGifDec);
		if(wTemp1 == 0xFFFF)
		{
			return 0xFFFF;
		}
		pGifDec->bWorkBits = (BYTE)wTemp1;
		if(bBitsRequired > 8)
		{
			wTemp2 = GIF_wGetNextByte(pGifDec);
			if(wTemp2 == 0xFFFF)
			{
				return 0xFFFF;
			}
			pGifDec->bWorkBits = (BYTE)wTemp2;
			wTemp1 |= wTemp2 << 8;
		}
		wDataBits |= wTemp1 << pGifDec->bRemainingBits;
		pGifDec->bRemainingBits = 8 - (bBitsRequired % 8);
		if(bBitsRequired == 8)
		{
			pGifDec->bRemainingBits = 0;
		}
		pGifDec->bWorkBits >>= 8 - pGifDec->bRemainingBits;
	}
	else
	{
		wDataBits = pGifDec->bWorkBits;
		pGifDec->bRemainingBits -= pGifDec->bMaxSymbolBits;
		pGifDec->bWorkBits >>= pGifDec->bMaxSymbolBits;
	}
	wDataBits &= GIF_awMask[pGifDec->bMaxSymbolBits];
	return wDataBits;
}
```

```
/*******************************************************************************
Function:       void GIF_vPaintData(GIFDECODER *pGifDec, BYTE bData)

Precondition:   pGifDec->blInterlacedFlag must be properly set

Overview:       This function puts the actual pixel on the display. It also
                takes care of the interlaced pixel arrangement.

Input:          GIF decoder's data structure, palette index

Output:         None
*******************************************************************************/
static void GIF_vPaintData(GIFDECODER *pGifDec, BYTE bData)
{
    #if GIF_USE_16_BITS_PER_PIXEL == 0
        IMG_vSetColor(pGifDec->aPalette[bData][0], pGifDec->aPalette[bData][1],
pGifDec->aPalette[bData][2]);
    #else
        IMG_vSetColor565(pGifDec->awPalette[bData]);
    #endif
       IMG_vPutPixel(pGifDec->wCurrentX, pGifDec->wCurrentY);
       pGifDec->wCurrentX++;
       if(pGifDec->wCurrentX >= pGifDec->wImageWidth)
       {
                IMG_vLoopCallback();
                pGifDec->wCurrentX = pGifDec->wImageX;
                if(pGifDec->blInterlacedFlag == 0)
                {
                             pGifDec->wCurrentY++;
                }
                else
                {
                             switch(pGifDec->bInterlacePass)
                             {
                               case 0: pGifDec->wCurrentY += 8;
                                       break;
                               case 1: pGifDec->wCurrentY += 8;
                                       break;
                               case 2: pGifDec->wCurrentY += 4;
                                       break;
                               case 3: pGifDec->wCurrentY += 2;
                                       break;
                             }
                             if(pGifDec->wCurrentY - pGifDec->wImageY >=
pGifDec->wImageHeight)
                             {
                                       switch(pGifDec->bInterlacePass)
                                       {
                                         case 0: pGifDec->wCurrentY = pGifDec->wImageY + 4;
                                                 break;
                                         case 1: pGifDec->wCurrentY = pGifDec->wImageY + 2;
                                                 break;
                                         case 2: pGifDec->wCurrentY = pGifDec->wImageY + 1;
                                                 break;
                                         case 3: pGifDec->wCurrentY = pGifDec->wImageY + 0;
                                                 break;
                                       }
                                       pGifDec->bInterlacePass++;
                             }
                }
       }
}

/*******************************************************************************
Function:       void GIF_vDisplayCode(GIFDECODER *pGifDec, WORD wCode)

Precondition:   None

Overview:       This function puts the stream of pixels corresponding to the
                code. This uses recursion.
```

```
Input:          GIF decoder's data structure, code

Output:         None
********************************************************************************/
static void GIF_vDisplayCode(GIFDECODER *pGifDec, WORD wCode)
{
       WORD wPrevCode = GIF_wGetPrevCode(pGifDec, wCode);
       if(wPrevCode != pGifDec->wInitialSymbols)
       {
                GIF_vDisplayCode(pGifDec, wPrevCode);
       }
       GIF_vPaintData(pGifDec, pGifDec->abSymbol[wCode]);
}

/*******************************************************************************
Function:       BYTE GIF_bTraceFirstData(GIFDECODER *pGifDec, WORD wCode)

Precondition:   None

Overview:       This function gets the first symbol of the code

Input:          GIF decoder's data structure, code

Output:         First symbol of the code
********************************************************************************/
static BYTE GIF_bTraceFirstData(GIFDECODER *pGifDec, WORD wCode)
{
       while(GIF_wGetPrevCode(pGifDec, wCode) != pGifDec->wInitialSymbols)
       {
                wCode = GIF_wGetPrevCode(pGifDec, wCode);
       }
       return pGifDec->abSymbol[wCode];
}

/*******************************************************************************
Function:       GIF_vExecuteClearCode(GIFDECODER *pGifDec)

Precondition:   None

Overview:       This function sets the code table to the initial condition

Input:          GIF decoder's data structure

Output:         None
********************************************************************************/
static void GIF_vExecuteClearCode(GIFDECODER *pGifDec)
{
       pGifDec->wMaxSymbol = pGifDec->wInitialSymbols;
       pGifDec->bMaxSymbolBits = pGifDec->bInitialSymbolBits;
       pGifDec->blFirstcodeFlag = 1;
}

/*******************************************************************************
Function:       BYTE GIF_bDecodeNextImage(GIFDECODER *pGifDec)

Precondition:   Header must be read and file pointer should point to the end
                of the previous image

Overview:       This function sets the code table to the initial condition

Input:          GIF decoder's data structure

Output:         Error code - '0' means no error
********************************************************************************/
static BYTE GIF_bDecodeNextImage(GIFDECODER *pGifDec)
{
        BYTE bBlockTerminator;
        WORD wCode;
        if(GIF_bReadNextImageDescriptor(pGifDec) != 0)
        {
            return(100);
        }
        IMG_FREAD(&pGifDec->bMaxSymbolBits, sizeof(BYTE), 1, pGifDec->pImageFile);
        if(pGifDec->bMaxSymbolBits > 11)
        {
            return(100);
        }
        pGifDec->wMaxSymbol = (0x01 << pGifDec->bMaxSymbolBits) + 1;
        pGifDec->bMaxSymbolBits++;
        pGifDec->wInitialSymbols = pGifDec->wMaxSymbol;
        pGifDec->bInitialSymbolBits = pGifDec->bMaxSymbolBits;
        GIF_vInitializeTable(pGifDec);

        /* Actual decoding starts here */
        while(!IMG_FEOF(pGifDec->pImageFile))
        {
                IMG_vCheckAndAbort();
                wCode = GIF_wGetNextSymbol(pGifDec);
                if(wCode >= 4096)
                {
                         return(100);
                }
                if(wCode == pGifDec->wInitialSymbols) /* End code */
                {
                         break;
                }
                if(wCode == pGifDec->wInitialSymbols - 1) /* Clear code */
                {
                         GIF_vExecuteClearCode(pGifDec);
                         continue;
                }
                if(wCode <= pGifDec->wMaxSymbol) /* Code exists */
                {
                         GIF_vDisplayCode(pGifDec, wCode);
                         if(pGifDec->blFirstcodeFlag == 0 && pGifDec->wMaxSymbol < 4095)
                         {
                                   pGifDec->wMaxSymbol++;
                                   pGifDec->abSymbol[pGifDec->wMaxSymbol] =
GIF_bTraceFirstData(pGifDec, wCode);
                         }
                         if(pGifDec->wMaxSymbol < 4095)
                         {
                                   GIF_vPutPrevCode(pGifDec, pGifDec->wMaxSymbol + 1,
wCode);
                         }
                         pGifDec->blFirstcodeFlag = 0;
                }
                else if(wCode == pGifDec->wMaxSymbol + 1 && wCode <= 4095)
                {
                         if(pGifDec->blFirstcodeFlag == 1)
                         {
                                   return(100);
                         }
                         pGifDec->wMaxSymbol++;
                         pGifDec->abSymbol[pGifDec->wMaxSymbol] =
GIF_bTraceFirstData(pGifDec, GIF_wGetPrevCode(pGifDec, pGifDec->wMaxSymbol));
                         GIF_vDisplayCode(pGifDec, wCode);
                         if(pGifDec->wMaxSymbol < 4095)
                         {
                                   GIF_vPutPrevCode(pGifDec, pGifDec->wMaxSymbol + 1,
wCode);
                         }
                }
                else
                {
                         return(100);
                }

                if((pGifDec->bMaxSymbolBits < 12) && (pGifDec->wMaxSymbol >= (0x01 <<
pGifDec->bMaxSymbolBits) - 1))
                {
                         pGifDec->bMaxSymbolBits++;
                }
        }
        if(pGifDec->blLocalColorTableFlag == 1) /* Restore Global color table */
        {
                if(pGifDec->lGlobalColorTablePos > 0)
                {
                         LONG lFilePos = IMG_FTELL(pGifDec->pImageFile);
                         IMG_FSEEK(pGifDec->pImageFile, pGifDec->lGlobalColorTablePos, 0);
                         GIF_vReadColorTable(pGifDec, pGifDec->wGlobalPaletteEntries);
                         IMG_FSEEK(pGifDec->pImageFile, lFilePos, 0);
                }
        }
        IMG_FREAD(&bBlockTerminator, sizeof(BYTE), 1, pGifDec->pImageFile);
        if(bBlockTerminator == 0)
        {
                BYTE bTemp;
                IMG_FREAD(&bTemp, sizeof(BYTE), 1, pGifDec->pImageFile);
                if(bTemp == 0x3B) /* End of GIF stream */
                {
                         return 0x3B;
                }
                IMG_FSEEK(pGifDec->pImageFile, -1, 1);
        }
        return bBlockTerminator;
}

/********************************************************************************
Function:       BYTE GIF_bDecode(IMG_FILE *pFile)

Precondition:   None

Overview:       This function decodes and displays a GIF image

Input:          Image file

Output:         Error code - '0' means no error
********************************************************************************/
BYTE GIF_bDecode(IMG_FILE *pFile)
{
        GIFDECODER GifDec;

        GIF_vResetData(&GifDec);
        GifDec.pImageFile = pFile;
        GIF_bReadHeader(&GifDec);
        if(GifDec.blGifMarkerFlag == 0)
        {
            return(100);
        }
        IMG_wImageWidth = GifDec.wScreenWidth;
        IMG_wImageHeight = GifDec.wScreenHeight;
        IMG_vSetboundaries();
        return GIF_bDecodeNextImage(&GifDec);
}

#endif
#undef __GIFDECODER_C__
```

12.8.4 GifDecoder.h

This is file GifDecoder.h.

Body Source

```
#ifndef __GIFDECODER_H__
 #define __GIFDECODER_H__
/*******************************************************************************
* FileName:         GifDecoder.h
* Dependencies:     Image decoding library; project requires File System library
* Processor:        PIC24/dsPIC30/dsPIC33/PIC32MX
* Compiler:        C30 v2.01/C32 v0.00.18
* Company:         Microchip Technology, Inc.

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 * OR OTHER SIMILAR COSTS.

Author                 Date           Comments
--------------------------------------------------------------------------------
Pradeep Budagutta    14-Mar-2008    First release
********************************************************************************/

/* User configuration */
#define GIF_CRUSH_PREV_SYMBOL_PTR_TABLE     1 /* If 1, this saves 2KB of RAM but requires
more time to decode */

#ifdef IMG_USE_ONLY_565_GRAPHICS_DRIVER_FOR_OUTPUT
    #define GIF_USE_16_BITS_PER_PIXEL          1 /* If this is 1, then 16 bits/pixel is
used and hence requires 256 Bytes less RAM */
#else
    #define GIF_USE_16_BITS_PER_PIXEL          0
#endif

/* User configuration */

/* Function prototype */
/* This function must be called after setting proper values in the global variables of
ImageDecoder.c */
BYTE GIF_bDecode(IMG_FILE *pFile);

#endif
```

12.8.5 ImageDecoder.c

This is file ImageDecoder.c.

Body Source

```
#define __IMAGEDECODER_C__
/*******************************************************************************

* FileName:        ImageDecoder.c
* Dependencies:    project requires File System library
* Processor:       PIC24/dsPIC30/dsPIC33/PIC32MX
* Compiler:        C30 v2.01/C32 v0.00.18
* Company:         Microchip Technology, Inc.

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 * OR OTHER SIMILAR COSTS.

Author                  Date            Comments
--------------------------------------------------------------------------------
Pradeep Budagutta    03-Mar-2008    First release
*******************************************************************************/

/* This is used as a common header for all image decoders.
   This contains interfaces to sheild the image decoders
   from project specific information like reading from
   USB drive or from sd card, etc... */

#include "Image Decoders/ImageDecoder.h"

/**************************/
/**** GLOBAL VARIABLES ****/
/**************************/

IMG_FILE *IMG_pCurrentFile;

WORD IMG_wStartX;
WORD IMG_wStartY;
WORD IMG_wWidth;
WORD IMG_wHeight;
WORD IMG_wImageWidth;
WORD IMG_wImageHeight;
BYTE IMG_bDownScalingFactor;
BYTE IMG_bAlignCenter;
BYTE IMG_blAbortImageDecoding;

#ifndef IMG_USE_ONLY_565_GRAPHICS_DRIVER_FOR_OUTPUT
IMG_PIXEL_OUTPUT IMG_pPixelOutput;
IMG_PIXEL_XY_RGB_888 IMG_PixelXYColor;
#endif

#ifndef IMG_USE_ONLY_MDD_FILE_SYSTEM_FOR_INPUT
IMG_FILE_SYSTEM_API *IMG_pFileAPIs;
#endif

#ifdef IMG_SUPPORT_IMAGE_DECODER_LOOP_CALLBACK
IMG_LOOP_CALLBACK  IMG_pLoopCallbackFn;
#endif

/**************************/
/*******************************************************************************
Function:       void ImageDecoderInit(void)

Precondition:   None

Overview:       This function resets the variables and initializes the display
```

```
Input:          None

Output:         None
********************************************************************************/
void ImageDecoderInit(void)
{
     IMG_wStartX = 0;
     IMG_wStartY = 0;
     IMG_wWidth  = 0;
     IMG_wHeight = 0;
     IMG_wImageWidth = 0;
     IMG_wImageHeight = 0;

   #ifndef IMG_USE_ONLY_565_GRAPHICS_DRIVER_FOR_OUTPUT
     IMG_pPixelOutput = NULL;
     IMG_PixelXYColor.X = 0;
     IMG_PixelXYColor.Y = 0;
     IMG_PixelXYColor.R = 0;
     IMG_PixelXYColor.G = 0;
     IMG_PixelXYColor.B = 0;
   #endif

   #ifndef IMG_USE_ONLY_MDD_FILE_SYSTEM_FOR_INPUT
     IMG_pFileAPIs = NULL;
   #endif

   #ifdef IMG_SUPPORT_IMAGE_DECODER_LOOP_CALLBACK
     IMG_pLoopCallbackFn = NULL;
   #endif
    IMG_blAbortImageDecoding = 0;

#ifdef IMG_USE_NON_BLOCKING_DECODING
    IMG_pCurrentFile = NULL;
#endif
}

/*******************************************************************************
Function:       void ImageLoopCallbackRegister(IMG_LOOP_CALLBACK pLoopCallbackFn)

Precondition:   None

Overview:       This function registers the loop callback function

Input:          Loop callback function pointer

Output:         None
********************************************************************************/
void ImageLoopCallbackRegister(IMG_LOOP_CALLBACK pLoopCallbackFn)
{
   #ifdef IMG_SUPPORT_IMAGE_DECODER_LOOP_CALLBACK
     IMG_pLoopCallbackFn = pLoopCallbackFn;
   #endif
}

/*******************************************************************************
Function:       BYTE ImageDecode(IMG_FILE *pImageFile, IMG_FILE_FORMAT eImgFormat, WORD
wStartx, WORD wStarty, WORD wWidth, WORD wHeight, WORD wFlags, IMG_FILE_SYSTEM_API
*pFileAPIs, IMG_PIXEL_OUTPUT pPixelOutput)

Precondition:   None

Overview:       This function uses the approperiate image decoding function to
                decode and display the image

Input:          File pointer, Kind of image, Image position and boundaries, If center
alignment and downscaling to fit into the display is required, File System API pointer and
function to output the decoded pixels

Output:         Error code - '0' means no error
********************************************************************************/
BYTE ImageDecode(IMG_FILE *pImageFile, IMG_FILE_FORMAT eImgFormat,
                 WORD wStartx, WORD wStarty, WORD wWidth, WORD wHeight,
                   WORD wFlags, IMG_FILE_SYSTEM_API *pFileAPIs,
                   IMG_PIXEL_OUTPUT pPixelOutput)
{
     BYTE bRetVal = 0;

     IMG_wStartX = wStartx;
     IMG_wStartY = wStarty;
     IMG_wWidth  = wWidth;
     IMG_wHeight = wHeight;
     IMG_wImageWidth = 0;
     IMG_wImageHeight = 0;

     IMG_bDownScalingFactor = (wFlags & IMG_DOWN_SCALE)? 1: 0;
     IMG_bAlignCenter = (wFlags & IMG_ALIGN_CENTER)? 1: 0;

   #ifndef IMG_USE_ONLY_565_GRAPHICS_DRIVER_FOR_OUTPUT
     IMG_pPixelOutput = pPixelOutput;
   #endif

   #ifndef IMG_USE_ONLY_MDD_FILE_SYSTEM_FOR_INPUT
     IMG_pFileAPIs = pFileAPIs;
   #endif

     switch(eImgFormat)
     {
      #ifdef IMG_SUPPORT_BMP
       case IMG_BMP: bRetVal = BMP_bDecode(pImageFile);
                     break;
      #endif
      #ifdef IMG_SUPPORT_JPEG
       case IMG_JPEG: bRetVal = JPEG_bDecode(pImageFile, TRUE);
                      IMG_pCurrentFile = pImageFile;
                     break;
      #endif
      #ifdef IMG_SUPPORT_GIF
       case IMG_GIF: bRetVal = GIF_bDecode(pImageFile);
                     break;
      #endif
       default:      bRetVal = 0xFF;
     }

     return(bRetVal);
}


/********************************************************************************
Function:       BYTE ImageDecodeTask(void)

Precondition:   ImageDecode() must have been called

Overview:       This function completes one small part of the image decode function

Input:          None

Output:         Status code - '1' means decoding is completed
                            - '0' means decoding is not yet completed, call this function
again
*******************************************************************************/
BYTE ImageDecodeTask(void)
{
    #ifdef IMG_USE_NON_BLOCKING_DECODING
    {
        if(IMG_pCurrentFile != NULL) // At present, supports only JPEG
        {
            return JPEG_bDecode(IMG_pCurrentFile, FALSE);
        }
    }
    #endif

    return 1;
}
```

```
/*******************************************************************************
Function:       BYTE IMG_vSetboundaries(void)

Precondition:   None

Overview:       This function sets the boundaries and scaling factor. THIS IS
                NOT FOR THE USER.

Input:          None

Output:         None
*******************************************************************************/
void IMG_vSetboundaries(void)
{
     if(IMG_bDownScalingFactor > 0)
     {
         WORD wXScalingFactor = IMG_wImageWidth / IMG_wWidth;
         WORD wYScalingFactor = IMG_wImageHeight / IMG_wHeight;

         if(wXScalingFactor * IMG_wWidth < IMG_wImageWidth)
         {
             wXScalingFactor++;
         }
         if(wYScalingFactor * IMG_wHeight < IMG_wImageHeight)
         {
             wYScalingFactor++;
         }

         IMG_bDownScalingFactor = (BYTE)(wXScalingFactor > wYScalingFactor)?
wXScalingFactor: wYScalingFactor;

         if(IMG_bDownScalingFactor <= 1)
         {
             IMG_bDownScalingFactor = 0;
         }
     }

     if(IMG_bAlignCenter > 0)
     {
         BYTE bDownScalingFactor = (IMG_bDownScalingFactor <= 1)? 1: IMG_bDownScalingFactor;
         if(IMG_wWidth > (IMG_wImageWidth / bDownScalingFactor))
         {
             IMG_wStartX += (IMG_wWidth - (IMG_wImageWidth / bDownScalingFactor)) / 2;
         }
         if(IMG_wHeight > (IMG_wImageHeight / bDownScalingFactor))
         {
             IMG_wStartY += (IMG_wHeight - (IMG_wImageHeight / bDownScalingFactor)) / 2;
         }
     }
}

#undef __IMAGEDECODER_C__
```

12.8.6 ImageDecoder.h

Functions

	Name	Description
◆	ImageDecode (see page 471)	This function decodes and displays the image on the screen
◆	ImageDecoderInit (see page 472)	This function initializes the global variables to 0 and then initializes the driver. This must be called once before any other function of the library is called
◆	ImageDecodeTask (see page 473)	This function completes one small part of the image decode function

	ImageLoopCallbackRegister (see page 473)	This function registers the loop callback function so that the decoder calls this function in every decoding loop. This can be used by the application program to do maintainance activities such as fetching data, updating the display, etc...

Macros

Name	Description
ImageAbort (see page 475)	This function sets the Image Decoder's Abort flag so that decoding aborts in the next decoding loop.
ImageFullScreenDecode (see page 474)	This function decodes and displays the image on the screen in fullscreen mode with center aligned and downscaled if required

Description

This is file ImageDecoder.h.

Body Source

```
#ifndef __IMAGEDECODER_H__
#define __IMAGEDECODER_H__

/******************************************************************************
* FileName:        ImageDecoder.h
* Dependencies:    project requires File System library
* Processor:       PIC24/dsPIC30/dsPIC33/PIC32MX
* Compiler:        C30 v2.01/C32 v0.00.18
* Company:         Microchip Technology, Inc.

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 * INDIRECT, PUNITIVE OR CONSEQUENTIAL DAMAGES, LOST PROFITS OR LOST DATA,
 * COST OF PROCUREMENT OF SUBSTITUTE GOODS, TECHNOLOGY, SERVICES, OR ANY
 * CLAIMS BY THIRD PARTIES (INCLUDING BUT NOT LIMITED TO ANY DEFENSE THEREOF),
 * OR OTHER SIMILAR COSTS.

Author                 Date           Comments
--------------------------------------------------------------------------------
Pradeep Budagutta    03-Mar-2008    First release
*******************************************************************************/

/* This is used as a common header for all image decoders.
   This contains interfaces to sheild the image decoders
   from project specific information like reading from
   USB drive or from sd card, etc... */

#include "GenericTypeDefs.h"
#include "stddef.h"

/************* User configuration start *************/
#include "ImageDecoderConfig.h"
/************* User configuration end *************/

/***********************************************************************
* Overview: Typedefs of the used File System APIs
```

```
*******************************************************************/
typedef size_t (*FileRead)(void *ptr, size_t size, size_t n, void *stream);
typedef int    (*FileSeek)(void *stream, long offset, int whence);
typedef long   (*FileTell)(void *fo);
typedef int    (*FileFeof)(void *stream);

/********************************************************************
* Overview: IMG_FileSystemAPI holds function pointers to the used
*           File System APIs
*******************************************************************/
typedef struct _IMG_FILE_SYSTEM_API
{
     FileRead pFread;
     FileSeek pFseek;
     FileTell pFtell;
     FileFeof pFeof;
} IMG_FILE_SYSTEM_API;

/********************************************************************
* Overview: IMG_ImageFileFormat specifies all the supported
*           image file formats
*******************************************************************/
typedef enum _IMG_FILE_FORMAT
{
     IMG_NONE = 0,
     IMG_BMP,                /* Bitmap image */
     IMG_JPEG,               /* JPEG image */
     IMG_GIF                 /* GIF image */
} IMG_FILE_FORMAT;

/********************************************************************
* Overview: IMG_PixelRgb holds the RGB information of a pixel in BYTES
*******************************************************************/
typedef struct _IMG_PIXEL_XY_RGB_888
{
     WORD X;
     WORD Y;
     BYTE R;
     BYTE G;
     BYTE B;
} IMG_PIXEL_XY_RGB_888;

/********************************************************************
* Overview: IMG_PixelOutput is a callback function which receives the
*           color information of the output pixel
*******************************************************************/
typedef void (*IMG_PIXEL_OUTPUT)(IMG_PIXEL_XY_RGB_888 *pPix);

/********************************************************************
* Overview: IMG_LoopCallback is a callback function which is called
*           in every loop of the decoding cycle so that user
*           application can do some maintainance activities
*******************************************************************/
typedef void (*IMG_LOOP_CALLBACK)(void);

/* The global variables which define the image position and size */
#ifndef __IMAGEDECODER_C__
  extern BYTE IMG_blAbortImageDecoding;
  extern WORD IMG_wStartX;
  extern WORD IMG_wStartY;
  extern WORD IMG_wWidth;
  extern WORD IMG_wHeight;
  extern WORD IMG_wImageWidth;
  extern WORD IMG_wImageHeight;
  extern BYTE IMG_bDownScalingFactor;
  extern BYTE IMG_bAlignCenter;

 #ifndef IMG_USE_ONLY_565_GRAPHICS_DRIVER_FOR_OUTPUT
  extern IMG_PIXEL_OUTPUT IMG_pPixelOutput;
  extern IMG_PIXEL_XY_RGB_888 IMG_PixelXYColor;
 #endif
```

```
  #ifndef IMG_USE_ONLY_MDD_FILE_SYSTEM_FOR_INPUT
   extern IMG_FILE_SYSTEM_API *IMG_pFileAPIs;
  #endif

  #ifdef IMG_SUPPORT_IMAGE_DECODER_LOOP_CALLBACK
   extern IMG_LOOP_CALLBACK  IMG_pLoopCallbackFn;
  #endif
#endif

#ifdef IMG_USE_ONLY_MDD_FILE_SYSTEM_FOR_INPUT

  #include <MDD File System/FSIO.h>

  #define IMG_FILE         FSFILE
  #define IMG_FREAD        FSfread
  #define IMG_FSEEK        FSfseek
  #define IMG_FTELL        FSftell
  #define IMG_FEOF         FSfeof

// added by Paolo 9/10/08 for MultiApp Demo
  #define IMG_FOPEN        FSfopen
  #define IMG_FCLOSE       FSfclose

#else

  #define IMG_FILE         void
  #define IMG_FREAD        IMG_pFileAPIs->pFread
  #define IMG_FSEEK        IMG_pFileAPIs->pFseek
  #define IMG_FTELL        IMG_pFileAPIs->pFtell
  #define IMG_FEOF         IMG_pFileAPIs->pFeof

#endif

#ifndef __IMAGEDECODER_C__

   extern IMG_FILE *IMG_pCurrentFile;

#endif

/* The individual image decoders use these defines instead of directly using those provided
in the Display driver file */
#define IMG_SCREEN_WIDTH         (GetMaxX()+1)
#define IMG_SCREEN_HEIGHT        (GetMaxY()+1)

#ifdef IMG_USE_ONLY_565_GRAPHICS_DRIVER_FOR_OUTPUT
       #include "Graphics/Graphics.h"
       #define IMG_vSetColor(r, g, b)   SetColor(RGB565CONVERT((r), (g), (b)))
       #define IMG_vSetColor565(color)  SetColor(color)
       #define _PutPixel(x, y)          PutPixel(x, y)
#else
       #define IMG_vSetColor(r, g, b)   IMG_PixelXYColor.R = r; IMG_PixelXYColor.G = g;
IMG_PixelXYColor.B = b;
       #define IMG_vSetColor565(color)  IMG_PixelXYColor.R = ((color)>>11)&0x1F;
IMG_PixelXYColor.G = ((color)>>5)&0x3F; IMG_PixelXYColor.B = (color)&0x1F;
       #define _PutPixel(x, y)          if(IMG_pPixelOutput != NULL) { IMG_PixelXYColor.X =
x; IMG_PixelXYColor.Y = y; IMG_pPixelOutput(&IMG_PixelXYColor); }
       #ifndef RGB565CONVERT
            #define RGB565CONVERT(r, g, b) (((r >> 3) << 11) | ((g >> 2) << 5) | (b >> 3))
       #endif
#endif

#define IMG_vPutPixel(x, y)      if(IMG_bDownScalingFactor <= 1)\
                                 {                           \
                                     if((x) < IMG_wImageWidth && (y) < IMG_wImageHeight) {
_PutPixel(IMG_wStartX + (x), IMG_wStartY + (y)); }\
                                 }                           \
                                 else if((x)%IMG_bDownScalingFactor == 0 &&
(y)%IMG_bDownScalingFactor == 0)     \
                                 {                           \
                                     if((x) < IMG_wImageWidth && (y) < IMG_wImageHeight) {
_PutPixel(IMG_wStartX + ((x)/IMG_bDownScalingFactor), IMG_wStartY +
((y)/IMG_bDownScalingFactor)); }\
                                 }


#ifdef IMG_SUPPORT_IMAGE_DECODER_LOOP_CALLBACK
       #define IMG_vLoopCallback() if(IMG_pLoopCallbackFn != NULL) { IMG_pLoopCallbackFn();
}
#else
       #define IMG_vLoopCallback()
#endif

#define IMG_DECODE_ABORTED 0xFF
#define IMG_vCheckAndAbort()                \
        if(IMG_blAbortImageDecoding == 1)   \
        {                                   \
              IMG_blAbortImageDecoding = 0; \
              return IMG_DECODE_ABORTED;    \
        }


#ifdef IMG_SUPPORT_BMP
 #include "BmpDecoder.h"
#endif

#ifdef IMG_SUPPORT_JPEG
 #include "JpegDecoder.h"
#endif

#ifdef IMG_SUPPORT_GIF
 #include "GifDecoder.h"
#endif

/* Function prototypes */
/* User uses only these three functions */

/*********************************************************************
* Function: void ImageDecoderInit(void)
*
* Overview: This function initializes the global variables to 0
*           and then initializes the driver.
*           This must be called once before any other function of
*           the library is called
*
* Input: None
*
* Output: None
*
* Example:
*   <PRE>
*   void main(void)
*   {
*       ImageInit();
*       ...
*   }
*   </PRE>
*
* Side Effects: The graphics driver will be reset
*
********************************************************************/
void ImageDecoderInit(void);

/*********************************************************************
* Function: void ImageLoopCallbackRegister(IMG_LOOP_CALLBACK pLoopCallbackFn)
*
* Overview: This function registers the loop callback function so that
*           the decoder calls this function in every decoding loop.
*           This can be used by the application program to do
*           maintainance activities such as fetching data, updating
*           the display, etc...
*
* Input: pLoopCallbackFn -> Loop callback function pointer
*
* Output: None
```

```
*
* Example:
*   <PRE>
*   void Mainantance(void)
*   {
*       ...
*   }
*
*   void main(void)
*   {
*       ImageInit();
*       ImageLoopCallbackRegister(Mainantance);
*       ...
*   }
*   </PRE>
*
* Side Effects: The graphics driver will be reset
*
********************************************************************/
void ImageLoopCallbackRegister(IMG_LOOP_CALLBACK pFn);

/*********************************************************************
* Function: BYTE ImageDecode(IMG_FILE *pImageFile, IMG_FILE_FORMAT eImgFormat, WORD
wStartx, WORD wStarty, WORD wWidth, WORD wHeight, WORD wFlags, IMG_FILE_SYSTEM_API
*pFileAPIs, IMG_PIXEL_OUTPUT pPixelOutput)
*
* Overview: This function decodes and displays the image on the screen
*
* Input: pImageFile -> The image file pointer
*        eImgFormat -> Type of image to be decoded
*        wStartx  -> Starting x position for the image to be displayed
*        wStarty  -> Starting y position for the image to be displayed
*        wWidth   -> The width into which the image to be displayed/compressed
*                    (This is not the width of the image)
*        wHeight  -> The height into which the image to be displayed/compressed
*                    (This is not the height of the image)
*        wFlags   -> If bit 0 is set, the image would be center aligned into the area
*                         specified by wStartx, wStarty, wWidth and wHeight
*                 -> If bit 1 is set, the image would be downscaled if required to fit
*                         into the area specified by wStartx, wStarty, wWidth
*                         and wHeight
*        pFileAPIs     -> The pointer to a structure which has function pointers
*                         to the File System APIs
*        pPixelOutput  -> The function to output (x, y) coordinates and the color
*
* Output: Error code -> 0 means no error
*
* Example:
*   <PRE>
*   void main(void)
*   {
*       IMG_FILE pImageFile;
*       IMG_vInitialize();
*       pImageFile = IMG_FOPEN("Image.jpg", "r");
*       if(pImageFile == NULL)
*       {
*                 <- Error handling ->
*       }
*       IMG_bDecode(pImageFile, IMG_JPEG, 0, 0, 320, 240, 0, NULL, NULL);
*       IMG_FCLOSE(pImageFile);
*       while(1);
*   }
*   </PRE>
*
* Side Effects: None
*
********************************************************************/
BYTE ImageDecode(IMG_FILE *pImageFile, IMG_FILE_FORMAT eImgFormat,
                 WORD wStartx, WORD wStarty, WORD wWidth, WORD wHeight,
                 WORD wFlags, IMG_FILE_SYSTEM_API *pFileAPIs,
                 IMG_PIXEL_OUTPUT pPixelOutput);
```

```
/* Flags */
#define IMG_ALIGN_CENTER 0x0001
#define IMG_DOWN_SCALE   0x0002


/*********************************************************************
* Function: BYTE ImageFullScreenDecode(IMG_FILE *pImageFile, IMG_FILE_FORMAT eImgFormat,
IMG_FILE_SYSTEM_API pFileAPIs, IMG_PIXEL_OUTPUT pPixelOutput)
*
* Overview: This function decodes and displays the image on the screen in
*           fullscreen mode with center aligned and downscaled if required
*
* Input: pImageFile -> The image file pointer
*        eImgFormat -> Type of image to be decoded
*        pFileAPIs     -> The pointer to a structure which has function pointers
*                         to the File System APIs
*        pPixelOutput -> The function to output (x, y) coordinates and the color
*
* Output: Error code -> 0 means no error
*
* Example:
*   <PRE>
*   void main(void)
*   {
*       IMG_FILE pImageFile;
*       IMG_vInitialize();
*       pImageFile = IMG_FOPEN("Image.jpg", "r");
*       if(pImageFile == NULL)
*       {
*                 <- Error handling ->
*       }
*       IMG_bFullScreenDecode(pImageFile, IMG_JPEG, NULL, NULL);
*       IMG_FCLOSE(pImageFile);
*       while(1);
*   }
*   </PRE>
*
* Side Effects: None
*
********************************************************************/
#define ImageFullScreenDecode(pImageFile, eImgFormat, pFileAPIs, pPixelOutput) \
        ImageDecode(pImageFile, eImgFormat, 0, 0, IMG_SCREEN_WIDTH, IMG_SCREEN_HEIGHT,
(IMG_ALIGN_CENTER | IMG_DOWN_SCALE), pFileAPIs, pPixelOutput)

/*********************************************************************
* Function: BYTE ImageDecodeTask(void)
*
* Overview: This function completes one small part of the image decode function
*
* Input: None
*
* Output: Status code - '1' means decoding is completed
*                     - '0' means decoding is not yet completed, call this function again
*
* Example:
*   <PRE>
*
*       IMG_bFullScreenDecode(pImageFile, IMG_JPEG, NULL, NULL);
*       while(!ImageDecodeTask());
*
*   </PRE>
*
* Side Effects: None
*
********************************************************************/
BYTE ImageDecodeTask(void);

/*********************************************************************
* Function: void ImageAbort(void)
*
* Overview: This function sets the Image Decoder's Abort flag so that
*           decoding aborts in the next decoding loop.
```

```
*
* Input: None
*
* Output: None
*
* Example:
*   <PRE>
*
*   void callback(void);
*   void main(void)
*   {
*       IMG_FILE pImageFile;
*       IMG_vInitialize();
*       ImageLoopCallbackRegister(callback);
*       pImageFile = IMG_FOPEN("Image.jpg", "r");
*       if(pImageFile == NULL)
*       {
*                 <- Error handling ->
*       }
*       IMG_bFullScreenDecode(pImageFile, IMG_JPEG, NULL, NULL);
*       IMG_FCLOSE(pImageFile);
*       while(1);
*   }
*
*   void callback(void)
*   {
*       if(<- check for abort condition ->)
*       {
*           ImageAbort();
*       }
*   }
*
*   </PRE>
*
* Side Effects: None
*
********************************************************************/
#define ImageAbort() IMG_blAbortImageDecoding = 1;

/********* This is not for the user *********/
/* This is used by the individual decoders */
void IMG_vSetboundaries(void);
/********* This is not for the user *********/
#endif
```

12.8.7 JpegDecoder.c

Structures

	Name	Description
◆	_JPEGDECODER (⧉ see page 532)	DATA STRUCTURES

Description

This is file JpegDecoder.c.

Body Source

```
#define __JPEGDECODER_C__
/******************************************************************************

* FileName:        JpegDecoder.c
* Dependencies:    Image decoding library; project requires File System library
* Processor:       PIC24/dsPIC30/dsPIC33/PIC32MX
* Compiler:        C30 v2.01/C32 v0.00.18
* Company:         Microchip Technology, Inc.
```

```
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 * OR OTHER SIMILAR COSTS.

Author                 Date           Comments
--------------------------------------------------------------------------------
Pradeep Budagutta    03-Mar-2008    First release
                     03-Sep-2010    Changed paint block to more efficient code.
*******************************************************************************/

#include "Image Decoders/ImageDecoder.h"

#ifdef IMG_SUPPORT_JPEG

#define JPEG_SAMPLE_1x1 0
#define JPEG_SAMPLE_1x2 1
#define JPEG_SAMPLE_2x1 2
#define JPEG_SAMPLE_2x2 3

/*******************************/
/**** FUNCTION PROTOTYPES ****/
/*******************************/
void jpeg_idct_islow (SHORT *inbuf, WORD *quantptr);

/*************************/
/**** DATA STRUCTURES ****/
/*************************/
typedef struct _JPEGDECODER
{
        IMG_FILE *pImageFile;                       /* Image file pointer */

        /*********** From APP0 ***********/
        BYTE blJFIF;                            /* JFIF marker found flag */
        BYTE bMajorRev;                         /* Should be 1 */
        BYTE bMinorRev;                         /* Should be 0-2 but is not a show stopper
*/
        /*------- The x/y densities and thumbnail data are ignored --------*/

        /*********** From SOF0 ***********/
        BYTE bDataBits;                         /* Data precision, can be 8(, 12 or 16) */
        WORD wWidth;                            /* Width in pixels */
        WORD wHeight;                           /* Height in pixels */
        BYTE bChannels;                         /* Number of channels e.g. YCbCr = 3 */
        BYTE abChannelType[MAX_CHANNELS];
        BYTE abChannelHSampFactor[MAX_CHANNELS];
        BYTE abChannelVSampFactor[MAX_CHANNELS];
        BYTE abChannelQuantTableMap[MAX_CHANNELS];

        /*********** From DQT ***********/
        BYTE blQuantUses16bits;                 /* If flag is set, it is an error as 16 bit
is not supported */
        WORD awQuantTable[MAX_CHANNELS][64];    /* Supports only 8 & 16 bit resolutions */
        /*********** From DRI ***********/
        WORD wRestartInterval;                  /* The restart interval in blocks */

        /*********** From DHT ***********/
        BYTE bHuffTables;
        BYTE abHuffAcSymLen[MAX_HUFF_TABLES][16];   /* Supports only 8 bit resolution */
        BYTE abHuffAcSymbol[MAX_HUFF_TABLES][256];  /* Maximum possible symbols are 256 */
        BYTE abHuffDcSymLen[MAX_HUFF_TABLES][16];   /* Supports only 8 bit resolution */
        BYTE abHuffDcSymbol[MAX_HUFF_TABLES][16];   /* Maximum possible symbols are 16 for
DC :-) */
        /*********** For Huffman-Decoding ***********/
        WORD awHuffAcSymStart[MAX_HUFF_TABLES][16]; /* Starting symbol for each length */
        WORD awHuffDcSymStart[MAX_HUFF_TABLES][16]; /* Starting symbol for each length */

        /*********** From SOS ***********/
        BYTE abChannelHuffAcTableMap[MAX_CHANNELS];
        BYTE abChannelHuffDcTableMap[MAX_CHANNELS];

        BYTE bError;

        /*********** Work memory ***********/
        WORD wWorkBits;
        BYTE bBitsAvailable;
        BYTE bBlocksInOnePass;
        SHORT asOneBlock[MAX_BLOCKS][64];     /* Temporary storage for a 8x8 block */
        WORD  wBlockNumber;
        BYTE  abChannelMap[MAX_BLOCKS];
        BYTE  bSubSampleType;
        SHORT asPrevDcValue[MAX_CHANNELS];
        BYTE *pbCurrentHuffSymLenTable;
        BYTE *pbCurrentHuffSymbolTable;
        WORD *pwCurrentHuffSymStartTable;
        WORD *pwCurrentQuantTable;
        BYTE abDataBuffer[MAX_DATA_BUF_LEN];
        WORD wBufferLen;
        WORD wBufferIndex;
        BYTE bFirstBit;

        WORD wPrevX;
        WORD wPrevY;
} JPEGDECODER;

/**************************/
/**** CONSTANT TABLES  ****/
/**************************/
static const BYTE abZigzag[64] =
{
  0,  1,  8,  16, 9,  2,  3,  10,
  17, 24, 32, 25, 18, 11, 4,  5,
  12, 19, 26, 33, 40, 48, 41, 34,
  27, 20, 13, 6,  7,  14, 21, 28,
  35, 42, 49, 56, 57, 50, 43, 36,
  29, 22, 15, 23, 30, 37, 44, 51,
  58, 59, 52, 45, 38, 31, 39, 46,
  53, 60, 61, 54, 47, 55, 62, 63
};

/**************************/
/******* FUNCTIONS  *******/
/**************************/

/*******************************************************************************
Function:       void JPEG_vResetDecoder(JPEGDECODER *pJpegDecoder)

Precondition:   None

Overview:       This function resets the variables so that new jpeg image can be
                decoded

Input:          JPEGDECODER
```

```
Output:         None
********************************************************************************/
static void JPEG_vResetDecoder(JPEGDECODER *pJpegDecoder)
{
        WORD wIndex;
        BYTE *pbptr = (BYTE*)pJpegDecoder;
        for(wIndex = 0; wIndex < sizeof(JPEGDECODER); wIndex++)
        {
                  pbptr[wIndex] = 0;
        }
}

/*******************************************************************************
Function:       WORD JPEG_wReadWord(IMG_FILE *pfile)

Precondition:   None

Overview:       This function reads and returns a single word obtained as
                Higher byte first followed by lower byte

Input:          Image file

Output:         One word
********************************************************************************/
static WORD JPEG_wReadWord(IMG_FILE *pfile)
{
     BYTE btemp;
     WORD wData;

     IMG_FREAD(&btemp, sizeof(btemp), 1, pfile);
     wData = btemp;
     IMG_FREAD(&btemp, sizeof(btemp), 1, pfile);
     wData = (wData << 8) | btemp;

     return wData;
}

/*******************************************************************************
Function:       BYTE JPEG_bReadByte(IMG_FILE *pfile)

Precondition:   None

Overview:       This function reads and returns a single byte from the file

Input:          Image file

Output:         One byte
********************************************************************************/
static BYTE JPEG_bReadByte(IMG_FILE *pfile)
{
     BYTE bData;

     IMG_FREAD(&bData, sizeof(bData), 1, pfile);

     return bData;
}

/*******************************************************************************
Function:       BYTE JPEG_bReadHeader(JPEGDECODER *pJpegDecoder)

Precondition:   None

Overview:       This function reads the JPEG file header and
                fills the data structure

Input:          JPEGDECODER

Output:         Error code - '0' means no error
********************************************************************************/
static BYTE JPEG_bReadHeader(JPEGDECODER *pJpegDecoder)
{
     BYTE blSOSOver = FALSE;
```

```
      while(!IMG_FEOF(pJpegDecoder->pImageFile))
      {
              BYTE btemp, bcount, bsection;
              WORD wSegLen, wOffset;

              if(blSOSOver == TRUE)
              {
                      if(pJpegDecoder->bChannels == 1)
                      {
                              pJpegDecoder->bBlocksInOnePass = 1;
                              pJpegDecoder->bSubSampleType = JPEG_SAMPLE_1x1;
                      }
                      else if(pJpegDecoder->bChannels == 3)
                      {
                              if((pJpegDecoder->abChannelHSampFactor[0] == 1 &&
  pJpegDecoder->abChannelVSampFactor[0] == 1) &&
                                 (pJpegDecoder->abChannelHSampFactor[1] == 1 &&
  pJpegDecoder->abChannelVSampFactor[1] == 1) &&
                                 (pJpegDecoder->abChannelHSampFactor[2] == 1 &&
  pJpegDecoder->abChannelVSampFactor[2] == 1))
                              {
                                      pJpegDecoder->bBlocksInOnePass = 3;
                                      pJpegDecoder->abChannelMap[0] = 0;
                                      pJpegDecoder->abChannelMap[1] = 1;
                                      pJpegDecoder->abChannelMap[2] = 2;
                                      pJpegDecoder->bSubSampleType = JPEG_SAMPLE_1x1;
                              }
                              else if((pJpegDecoder->abChannelHSampFactor[0] == 1 &&
  pJpegDecoder->abChannelVSampFactor[0] == 2) &&
                                      (pJpegDecoder->abChannelHSampFactor[1] == 1 &&
  pJpegDecoder->abChannelVSampFactor[1] == 1) &&
                                      (pJpegDecoder->abChannelHSampFactor[2] == 1 &&
  pJpegDecoder->abChannelVSampFactor[2] == 1))
                              {
                                      pJpegDecoder->bBlocksInOnePass = 4;
                                      pJpegDecoder->abChannelMap[0] = 0;
                                      pJpegDecoder->abChannelMap[1] = 0;
                                      pJpegDecoder->abChannelMap[2] = 1;
                                      pJpegDecoder->abChannelMap[3] = 2;
                                      pJpegDecoder->bSubSampleType = JPEG_SAMPLE_1x2;
                              }
                              else if((pJpegDecoder->abChannelHSampFactor[0] == 2 &&
  pJpegDecoder->abChannelVSampFactor[0] == 1) &&
                                      (pJpegDecoder->abChannelHSampFactor[1] == 1 &&
  pJpegDecoder->abChannelVSampFactor[1] == 1) &&
                                      (pJpegDecoder->abChannelHSampFactor[2] == 1 &&
  pJpegDecoder->abChannelVSampFactor[2] == 1))
                              {
                                      pJpegDecoder->bBlocksInOnePass = 4;
                                      pJpegDecoder->abChannelMap[0] = 0;
                                      pJpegDecoder->abChannelMap[1] = 0;
                                      pJpegDecoder->abChannelMap[2] = 1;
                                      pJpegDecoder->abChannelMap[3] = 2;
                                      pJpegDecoder->bSubSampleType = JPEG_SAMPLE_2x1;
                              }
                              else if((pJpegDecoder->abChannelHSampFactor[0] == 2 &&
  pJpegDecoder->abChannelVSampFactor[0] == 2) &&
                                      (pJpegDecoder->abChannelHSampFactor[1] == 1 &&
  pJpegDecoder->abChannelVSampFactor[1] == 1) &&
                                      (pJpegDecoder->abChannelHSampFactor[2] == 1 &&
  pJpegDecoder->abChannelVSampFactor[2] == 1))
                              {
                                      pJpegDecoder->bBlocksInOnePass = 6;
                                      pJpegDecoder->abChannelMap[0] = 0;
                                      pJpegDecoder->abChannelMap[1] = 0;
                                      pJpegDecoder->abChannelMap[2] = 0;
                                      pJpegDecoder->abChannelMap[3] = 0;
                                      pJpegDecoder->abChannelMap[4] = 1;
                                      pJpegDecoder->abChannelMap[5] = 2;
                                      pJpegDecoder->bSubSampleType = JPEG_SAMPLE_2x2;
                              }
                              else
```

```
                            {
                                    JPEG_SendError(100);
                            }
                    }
                    return 0;
            }

            IMG_FREAD(&btemp, sizeof(btemp), 1, pJpegDecoder->pImageFile);

            if(btemp != 0xFF)
            {
                    continue;
            }

            IMG_FREAD(&bsection, sizeof(bsection), 1, pJpegDecoder->pImageFile);
            switch(bsection)
            {
              case SOI:
              case TEM:
              case EOI:
              case RST0:
              case RST1:
              case RST2:
              case RST3:
              case RST4:
              case RST5:
              case RST6:
              case RST7: break;

              case SOF0: /* Start of frame */
                         wSegLen = JPEG_wReadWord(pJpegDecoder->pImageFile);
                         if(wSegLen <= 8)
                         {
                                 JPEG_SendError(100);
                                 break;
                         }
                         pJpegDecoder->bDataBits =
  JPEG_bReadByte(pJpegDecoder->pImageFile);
                         pJpegDecoder->wHeight   =
  JPEG_wReadWord(pJpegDecoder->pImageFile);
                         pJpegDecoder->wWidth    =
  JPEG_wReadWord(pJpegDecoder->pImageFile);
                         pJpegDecoder->bChannels =
  JPEG_bReadByte(pJpegDecoder->pImageFile);
                         if(wSegLen < 8 + (pJpegDecoder->bChannels * 3))
                         {
                                 JPEG_SendError(100);
                                 break;
                         }
                         for(bcount = 0; bcount < pJpegDecoder->bChannels; bcount++)
                         {
                                 pJpegDecoder->abChannelType[bcount] =
  JPEG_bReadByte(pJpegDecoder->pImageFile);
                                 btemp = JPEG_bReadByte(pJpegDecoder->pImageFile);
                                 pJpegDecoder->abChannelHSampFactor[bcount] = btemp >>
  4;
                                 pJpegDecoder->abChannelVSampFactor[bcount] = btemp &
  0x0F;
                                 pJpegDecoder->abChannelQuantTableMap[bcount] =
  JPEG_bReadByte(pJpegDecoder->pImageFile);
                         }
                         break;

              case APP0: /* Start of Application */
                         wSegLen = JPEG_wReadWord(pJpegDecoder->pImageFile);
                         if(wSegLen < 16)
                         {
                                 JPEG_SendError(100);
                                 break;
                         }
                         else
                         {
```

```
                                     unsigned char buf[5];
                                     IMG_FREAD(buf, sizeof(buf[0]), 5,
  pJpegDecoder->pImageFile);
                                     if(buf[0] == 'J' && buf[1] == 'F' && buf[2] == 'I' &&
  buf[3] == 'F' && buf[4] == '\0')
                                     {
                                               pJpegDecoder->blJFIF = TRUE;
                                     }
                          }
                          pJpegDecoder->bMajorRev =
  JPEG_bReadByte(pJpegDecoder->pImageFile);
                          pJpegDecoder->bMinorRev =
  JPEG_bReadByte(pJpegDecoder->pImageFile);
                          if(pJpegDecoder->bMajorRev != 1)
                          {
                                     JPEG_SendError(100);
                                     break;
                          }
                          /* Ignore other bytes in this segment */
                          break;

               case DRI: /* Start of Quantization table */
                          wSegLen = JPEG_wReadWord(pJpegDecoder->pImageFile);
                          if(wSegLen == 4)
                          {
                                     pJpegDecoder->wRestartInterval =
  JPEG_wReadWord(pJpegDecoder->pImageFile);
                          }
                          break;

               case DQT: /* Start of Quantization table */
                          wSegLen = JPEG_wReadWord(pJpegDecoder->pImageFile);
                          if(wSegLen < 67)
                          {
                                     JPEG_SendError(100);
                                     break;
                          }

                          do
                          {
                                     BYTE bQTableIndex, bCounter;

                                     btemp = JPEG_bReadByte(pJpegDecoder->pImageFile);
                                     bQTableIndex = btemp & 0x0F;
                                     pJpegDecoder->blQuantUses16bits |= (btemp >> 4);

                                     for(bCounter = 0; bCounter < 64; bCounter++)
                                     {
                                               BYTE bData1, bData2 = 0;
                                               if(pJpegDecoder->blQuantUses16bits == 0)
                                               {
                                                         IMG_FREAD(&bData1, sizeof(BYTE),
  1, pJpegDecoder->pImageFile);
                                                         pJpegDecoder->awQuantTable[bQTableI
  ndex][abZigzag[bCounter]]
  = bData1;
                                               }
                                               else
                                               {
                                                         IMG_FREAD(&bData1, sizeof(BYTE),
  1, pJpegDecoder->pImageFile);
                                                         IMG_FREAD(&bData2, sizeof(BYTE),
  1, pJpegDecoder->pImageFile);
                                                         pJpegDecoder->awQuantTable[bQTableI
  ndex][abZigzag[bCounter]]
  = (((WORD)bData1) << 8) + (WORD)bData2;
                                               }
                                     }
                                     wSegLen -= (pJpegDecoder->blQuantUses16bits == 0)? 65:
  129; /* Table length + information byte */
                          } while(wSegLen >= 67);
                          break;
```

```
                case DHT: /* Start of Huffmann table */
                          wSegLen = JPEG_wReadWord(pJpegDecoder->pImageFile);
                          if(wSegLen < 19)
                          {
                                    JPEG_SendError(100);
                                    break;
                          }

                          do
                          {
                                    BYTE bHTableIndex, bCounter;
                                    WORD wNumOfSymbols;
                                    BYTE blIsAc;
                                    BYTE *pbLenTable, *pbSymTable;

                                    btemp = JPEG_bReadByte(pJpegDecoder->pImageFile);
                                    bHTableIndex = btemp & 0x0F;
                                    blIsAc = (btemp >> 4) & 0x01;

                                    if(blIsAc == 0)
                                    {
                                              pbLenTable =
(BYTE*)&pJpegDecoder->abHuffDcSymLen[bHTableIndex][0];
                                              pbSymTable =
(BYTE*)&pJpegDecoder->abHuffDcSymbol[bHTableIndex][0];
                                    }
                                    else
                                    {
                                              pbLenTable =
(BYTE*)&pJpegDecoder->abHuffAcSymLen[bHTableIndex][0];
                                              pbSymTable =
(BYTE*)&pJpegDecoder->abHuffAcSymbol[bHTableIndex][0];
                                    }

                                    IMG_FREAD(pbLenTable, sizeof(BYTE), 16,
pJpegDecoder->pImageFile);

                                    for(bCounter = 0, wNumOfSymbols = 0; bCounter < 16;
bCounter++)
                                    {
                                              wNumOfSymbols += pbLenTable[bCounter];
                                    }

                                    wSegLen -= 17; /* This table length + information byte
*/

                                    if(wSegLen < wNumOfSymbols || (blIsAc == 1 &&
wNumOfSymbols > 256) || (blIsAc == 0 && wNumOfSymbols > 16))
                                    {
                                              JPEG_SendError(100);
                                              break;
                                    }

                                    IMG_FREAD(pbSymTable, sizeof(BYTE), wNumOfSymbols,
pJpegDecoder->pImageFile);
                                    wSegLen -= wNumOfSymbols; /* This table length +
information byte */
                                    pJpegDecoder->bHuffTables++;
                          } while(wSegLen >= 19);
                          break;

                case SOS: /* Start of Scan parameters */
                          wSegLen = JPEG_wReadWord(pJpegDecoder->pImageFile);
                          if(wSegLen < 3)
                          {
                                    JPEG_SendError(100);
                                    break;
                          }

                          btemp = JPEG_bReadByte(pJpegDecoder->pImageFile);
                          wOffset = wSegLen - (3 + (btemp * 2));
```

```
                              if(pJpegDecoder->bChannels != btemp || wSegLen < 3 + (btemp * 2))
                              {
                                         JPEG_SendError(100);
                                         break;
                              }
                              else
                              {
                                         BYTE bCounter, bChannelId = 0xFF;

                                         for(bCounter = 0; bCounter < pJpegDecoder->bChannels;
bCounter++)
                                         {
                                                    BYTE bindex;

                                                    btemp =
JPEG_bReadByte(pJpegDecoder->pImageFile);
                                                    for(bindex = 0; bindex < MAX_CHANNELS;
bindex++)
                                                    {
                                                               if(pJpegDecoder->abChannelType[bin
dex]
== btemp)
                                                               {
                                                                          bChannelId = bindex;
                                                                          break;
                                                               }
                                                    }

                                                    if(bChannelId < MAX_CHANNELS)
                                                    {
                                                               btemp =
JPEG_bReadByte(pJpegDecoder->pImageFile);
                                                               pJpegDecoder->abChannelHuffAcTable
Map[bChannelId]
= btemp & 0x0F;
                                                               pJpegDecoder->abChannelHuffDcTable
Map[bChannelId]
= btemp >> 4;
                                                    }
                                         }
                                         IMG_FSEEK(pJpegDecoder->pImageFile, wOffset, 1);
                              }
                              blSOSOver = TRUE;
                              break;

                   default: /* Any other segment with length */
                              wSegLen = JPEG_wReadWord(pJpegDecoder->pImageFile);
                              if(wSegLen < 2)
                              {
                                         JPEG_SendError(100);
                                         break;
                              }
                              IMG_FSEEK(pJpegDecoder->pImageFile, wSegLen - 2, 1);
               }
     }
     return 0;
}

/*******************************************************************************
Function:       BYTE JPEG_bGenerateHuffmanTables(JPEGDECODER *pJpegDecoder)

Precondition:   None

Overview:       This function generated the table required for Huffman decoding
                from the data read from the header

Input:          JPEGDECODER

Output:         Error code - '0' means no error
*******************************************************************************/
static BYTE JPEG_bGenerateHuffmanTables(JPEGDECODER *pJpegDecoder)
```

```
{
     BYTE bLength, bTable;

     for(bTable = 0; bTable < pJpegDecoder->bHuffTables / 2; bTable++)
     {
            pJpegDecoder->awHuffAcSymStart[bTable][0] = 0;
            pJpegDecoder->awHuffDcSymStart[bTable][0] = 0;

            for(bLength = 1; bLength < 16; bLength++)
            {
                   pJpegDecoder->awHuffAcSymStart[bTable][bLength] =
(pJpegDecoder->awHuffAcSymStart[bTable][bLength - 1] +
pJpegDecoder->abHuffAcSymLen[bTable][bLength - 1]) << 1;
                   pJpegDecoder->awHuffDcSymStart[bTable][bLength] =
(pJpegDecoder->awHuffDcSymStart[bTable][bLength - 1] +
pJpegDecoder->abHuffDcSymLen[bTable][bLength - 1]) << 1;
            }
     }
     return 0;
}

/*******************************************************************************
Function:       BYTE JPEG_bGet1Bit(JPEGDECODER *pJpegDecoder)

Precondition:   None

Overview:       This function returns 1 bit as the lsb of the returned byte.
                It automatically fills the buffer if it becomes empty.
                It also converts 0xFF00 into 0.

Input:          JPEGDECODER

Output:         One bit
*******************************************************************************/
static BYTE JPEG_bGet1Bit(JPEGDECODER *pJpegDecoder)
{
     BYTE bBit = 0;

     if(pJpegDecoder->wBufferIndex >= pJpegDecoder->wBufferLen)
     {
            pJpegDecoder->wBufferLen = IMG_FREAD(&pJpegDecoder->abDataBuffer[0],
sizeof(BYTE), MAX_DATA_BUF_LEN, pJpegDecoder->pImageFile);
            while(pJpegDecoder->abDataBuffer[pJpegDecoder->wBufferLen - 1] == 0xFF)
            {
                   pJpegDecoder->wBufferLen--;
                   IMG_FSEEK(pJpegDecoder->pImageFile, -1, 1);
            }
            pJpegDecoder->wBufferIndex = 0;
     }

     while(pJpegDecoder->bBitsAvailable == 0) /* Be very careful to touch this part of
code! You must know exactly what you are doing */
     {
            pJpegDecoder->bBitsAvailable = 16;
            pJpegDecoder->wWorkBits =
pJpegDecoder->abDataBuffer[pJpegDecoder->wBufferIndex++];
            pJpegDecoder->wWorkBits = (pJpegDecoder->wWorkBits << 8) +
pJpegDecoder->abDataBuffer[pJpegDecoder->wBufferIndex++];
            if(pJpegDecoder->wBufferIndex > pJpegDecoder->wBufferLen) /* wBufferIndex need
not be even because of the below condition */
            {
                   pJpegDecoder->bBitsAvailable = 8;
            }
            else if((pJpegDecoder->wWorkBits & 0x00FF) == 0x00FF)
            {
                   pJpegDecoder->bBitsAvailable = 8;
                   pJpegDecoder->wBufferIndex--;
            }
            else if(pJpegDecoder->wWorkBits >= 0xFF00)
            {
                   if(pJpegDecoder->wWorkBits == 0xFF00)
                   {
                        pJpegDecoder->bBitsAvailable = 8;
                  }
            }
      }

      bBit = (pJpegDecoder->wWorkBits & 0x8000)? 0x01: 0;

      pJpegDecoder->wWorkBits <<= 1;
      pJpegDecoder->bBitsAvailable--;

      return bBit;
}

/*******************************************************************************
Function:       WORD JPEG_wGetBits(JPEGDECODER *pJpegDecoder, BYTE bLen)

Precondition:   None

Overview:       This function returns bLen number of bits as the lsb of the
                returned word and it automatically fills the buffer
                if it becomes empty.

Input:          JPEGDECODER, Number of bits

Output:         Requested number of bits
*******************************************************************************/
static WORD JPEG_wGetBits(JPEGDECODER *pJpegDecoder, BYTE bLen)
{
      WORD wVal = 0;

      wVal = pJpegDecoder->bFirstBit = JPEG_bGet1Bit(pJpegDecoder);
      bLen--;

      while(bLen)
      {
             wVal = (wVal << 1) + JPEG_bGet1Bit(pJpegDecoder);
             bLen--;
      }

      return wVal;
}

/*******************************************************************************
Function:       WORD JPEG_wGetRestartWord(JPEGDECODER *pJpegDecoder)

Precondition:   File pointer must point to the restart word

Overview:       Returns the restart word

Input:          JPEGDECODER

Output:         Restart word
*******************************************************************************/
static WORD JPEG_wGetRestartWord(JPEGDECODER *pJpegDecoder)
{
      WORD wRestartWord;
      while((pJpegDecoder->bBitsAvailable & 0x07) != 0) /* This is to clearoff wnwanted bits
to go to fresh byte */
      {
             JPEG_bGet1Bit(pJpegDecoder);
      }
      wRestartWord = JPEG_wGetBits(pJpegDecoder, 16);
      return(wRestartWord);
}

/*******************************************************************************
Function:       SHORT JPEG_sGetBitsValue(JPEGDECODER *pJpegDecoder, BYTE bLen)

Precondition:   None

Overview:       Returns the signed value of the bLen bits of data
```

```
Input:          JPEGDECODER, Number of bits

Output:         Signed number
*******************************************************************************/
static SHORT JPEG_sGetBitsValue(JPEGDECODER *pJpegDecoder, BYTE bLen)
{
     WORD wVal = 0;

     if(bLen != 0)
     {
            wVal = JPEG_wGetBits(pJpegDecoder, bLen);
            if(pJpegDecoder->bFirstBit == 0)
            {
                   wVal = ~(wVal | (0xFFFF << bLen));
                   return ((SHORT)wVal * -1);
            }
     }
     return (SHORT)wVal;
}

/*******************************************************************************
Function:       BYTE JPEG_bGetNextHuffByte(JPEGDECODER *pJpegDecoder)

Precondition:   File pointer must point to the Huffman data

Overview:       Returns the Huffman decoded data

Input:          JPEGDECODER

Output:         Huffman decoded data
*******************************************************************************/
static BYTE JPEG_bGetNextHuffByte(JPEGDECODER *pJpegDecoder)
{
     BYTE bBits, bSymbol = 0;
     WORD wBitPattern = 0, wSymbolOffset = 0;

     for(bBits = 0; bBits < 16; bBits++)
     {
            BYTE bSymbols;
            WORD wDiff;

            wBitPattern = (wBitPattern << 1) + JPEG_bGet1Bit(pJpegDecoder);
            bSymbols = pJpegDecoder->pbCurrentHuffSymLenTable[bBits];
            if(bSymbols == 0)
            {
                   continue;
            }

            wDiff = wBitPattern - pJpegDecoder->pwCurrentHuffSymStartTable[bBits];
            if(wDiff < bSymbols)
            {
                   bSymbol = pJpegDecoder->pbCurrentHuffSymbolTable[wSymbolOffset + wDiff];
                   break;
            }
            wSymbolOffset += bSymbols;
     }
     return bSymbol;
}

#define range_limit(x) (x<0)?0:(x>0xFF)?0xFF:x
/*******************************************************************************
Function:       BYTE JPEG_bDecodeOneBlock(JPEGDECODER *pJpegDecoder)

Precondition:   File pointer must point to a new block of data

Overview:       Decodes the 8x8 pixel values of all the channels
                (A multiple of 8x8 block if subsampling is used)

Input:          JPEGDECODER

Output:         Error code - '0' means no error
*******************************************************************************/
```

```
static BYTE JPEG_bDecodeOneBlock(JPEGDECODER *pJpegDecoder)
{
     BYTE bBlock, bCounter;

     IMG_vLoopCallback();
     for(bBlock = 0; bBlock < pJpegDecoder->bBlocksInOnePass; bBlock++)
     {
            BYTE bByteCount, bHuffbyte;

            if((pJpegDecoder->wRestartInterval > 0) && (pJpegDecoder->wBlockNumber ==
pJpegDecoder->wRestartInterval * pJpegDecoder->bBlocksInOnePass))
            {
                   WORD wRestartWord = JPEG_wGetRestartWord(pJpegDecoder);
                   if(wRestartWord < 0xFFD0 || wRestartWord > 0xFFD7)
                   {
                            JPEG_SendError(100);
                   }
                   for(bCounter = 0; bCounter < MAX_CHANNELS; bCounter++)
                   {
                            pJpegDecoder->asPrevDcValue[bCounter] = 0;
                   }
                   pJpegDecoder->wBlockNumber = 0;
            }

            for(bCounter = 0; bCounter < 64; bCounter++)
            {
                   pJpegDecoder->asOneBlock[bBlock][bCounter] = 0;
            }

            pJpegDecoder->pwCurrentQuantTable =
&pJpegDecoder->awQuantTable[pJpegDecoder->abChannelQuantTableMap[pJpegDecoder->abChannelMap[
bBlock]]][0];

            /* Decode DC value */
            bByteCount = 0;
            pJpegDecoder->pbCurrentHuffSymLenTable =
&pJpegDecoder->abHuffDcSymLen[pJpegDecoder->abChannelHuffDcTableMap[pJpegDecoder->abChannelM
ap[bBlock]]][0];
            pJpegDecoder->pbCurrentHuffSymbolTable =
&pJpegDecoder->abHuffDcSymbol[pJpegDecoder->abChannelHuffDcTableMap[pJpegDecoder->abChannelM
ap[bBlock]]][0];
            pJpegDecoder->pwCurrentHuffSymStartTable =
&pJpegDecoder->awHuffDcSymStart[pJpegDecoder->abChannelHuffDcTableMap[pJpegDecoder->abChanne
lMap[bBlock]]][0];
            bHuffbyte = JPEG_bGetNextHuffByte(pJpegDecoder);
            pJpegDecoder->asOneBlock[bBlock][0] = JPEG_sGetBitsValue(pJpegDecoder,
bHuffbyte & 0x0F) + pJpegDecoder->asPrevDcValue[pJpegDecoder->abChannelMap[bBlock]];
            pJpegDecoder->asPrevDcValue[pJpegDecoder->abChannelMap[bBlock]] =
pJpegDecoder->asOneBlock[bBlock][0];

            /* Decode AC value */
            bByteCount = 1;
            pJpegDecoder->pbCurrentHuffSymLenTable =
&pJpegDecoder->abHuffAcSymLen[pJpegDecoder->abChannelHuffAcTableMap[pJpegDecoder->abChannelM
ap[bBlock]]][0];
            pJpegDecoder->pbCurrentHuffSymbolTable =
&pJpegDecoder->abHuffAcSymbol[pJpegDecoder->abChannelHuffAcTableMap[pJpegDecoder->abChannelM
ap[bBlock]]][0];
            pJpegDecoder->pwCurrentHuffSymStartTable =
&pJpegDecoder->awHuffAcSymStart[pJpegDecoder->abChannelHuffAcTableMap[pJpegDecoder->abChanne
lMap[bBlock]]][0];
            while(bByteCount < 64)
            {
                   bHuffbyte = JPEG_bGetNextHuffByte(pJpegDecoder);
                   bByteCount += (bHuffbyte >> 4);
                   if(bHuffbyte == 0 /* EOB */)
                   {
                          break;
                   }
                   if(bByteCount > 63)
                   {
                          JPEG_SendError(100);
                   }
                   pJpegDecoder->asOneBlock[bBlock][abZigzag[bByteCount++]] = 
JPEG_sGetBitsValue(pJpegDecoder, bHuffbyte & 0x0F);
            }
            pJpegDecoder->wBlockNumber++;
            jpeg_idct_islow(&pJpegDecoder->asOneBlock[bBlock][0],pJpegDecoder->pwCurrentQuan
tTable);
     }

//     SetVisualPage(1);

     return 0;
}

#define JPEG_WRITE_TO_DISPLAY
/*******************************************************************************
Function:       void JPEG_vInitDisplay(JPEGDECODER *pJpegDecoder)

Precondition:   None

Overview:       Initializes the (x, y) co-ordinates to (0, 0)

Input:          JPEGDECODER

Output:         None
*******************************************************************************/
static void JPEG_vInitDisplay(JPEGDECODER *pJpegDecoder)
{
 #ifndef JPEG_WRITE_TO_DISPLAY
     printf("%4u %4u\n", pJpegDecoder->wWidth, pJpegDecoder->wHeight);
 #else
    pJpegDecoder->wPrevX = 0;
    pJpegDecoder->wPrevY = 0;
//    SetActivePage(1);
 #endif
}

/*******************************************************************************
Function:       BYTE JPEG_bPaintOneBlock(JPEGDECODER *pJpegDecoder)

Precondition:   One block - 8x8 pixel data of all channels must be decoded

Overview:       Displays one 8x8 on the screen
                (A multiple of 8x8 block if subsampling is used)

Input:          JPEGDECODER

Output:         Error code - '0' means no error
*******************************************************************************/
static BYTE JPEG_bPaintOneBlock(JPEGDECODER *pJpegDecoder)
{
     BYTE bCounter;

 #ifndef JPEG_WRITE_TO_DISPLAY

     for(bCounter = 0; bCounter < 64; bCounter++)
     {
            printf("%3u %3u %3u\n", abBlockR[bCounter]&0xF8, abBlockG[bCounter]&0xFC, 
abBlockB[bCounter]&0xF8);
     }

 #else

     WORD wX, wY;
     bCounter = 0;
     BYTE r,g,b;

     if(pJpegDecoder->bSubSampleType == JPEG_SAMPLE_1x1)
     {
            SHORT *psY = &pJpegDecoder->asOneBlock[0][0], *psCb = 
&pJpegDecoder->asOneBlock[1][0], *psCr = &pJpegDecoder->asOneBlock[2][0];
```

```
            for(wY = 0; wY < 8; wY++)
            {
                    for(wX = 0; wX < 8; wX++)
                    {
                            LONG s1 = ((*psY) + 128)*128, s2 = (*psCb), s3 = (*psCr);
                            r = range_limit((s1 + 180*s3)>>7);
                            g = range_limit((s1 - 44*s2 - 91*s3)>>7);
                            b = range_limit((s1 + 227*s2)>>7);
                            IMG_vSetColor(r, g, b);
                            IMG_vPutPixel(pJpegDecoder->wPrevX + wX, pJpegDecoder->wPrevY +
wY);
                            psY++; psCb++; psCr++;
                    }
             }

            pJpegDecoder->wPrevX += 8;

            if(pJpegDecoder->wPrevX >= pJpegDecoder->wWidth)
            {
                    pJpegDecoder->wPrevX = 0;
                    pJpegDecoder->wPrevY += 8;
            }
    }
    else if(pJpegDecoder->bSubSampleType == JPEG_SAMPLE_1x2)
    {
            SHORT *psY, *psCb = &pJpegDecoder->asOneBlock[2][0], *psCr =
&pJpegDecoder->asOneBlock[3][0];
            BYTE bBlock, bOffsetY[2] = {0,8};

            for(bBlock = 0; bBlock < 2; bBlock++)
            {
                    psY = &pJpegDecoder->asOneBlock[bBlock][0];
                    psCb = &pJpegDecoder->asOneBlock[2][bBlock*32];
                    psCr = &pJpegDecoder->asOneBlock[3][bBlock*32];
                    for(wY = 0; wY < 8; wY++)
                    {
                            for(wX = 0; wX < 8; wX++)
                            {
                                     LONG s1 = ((*psY) + 128)*128;
                                     LONG s2 = psCb[(wY>>1)*8+wX];
                                     LONG s3 = psCr[(wY>>1)*8+wX];
                                     r = range_limit((s1 + 180*s3)>>7);
                                     g = range_limit((s1 - 44*s2 - 91*s3)>>7);
                                     b = range_limit((s1 + 227*s2)>>7);
                                     IMG_vSetColor(r, g, b);
                                     IMG_vPutPixel(pJpegDecoder->wPrevX + wX,
                                              pJpegDecoder->wPrevY + bOffsetY[bBlock] + wY);
                                     psY++;
                            }
                    }
            }

            pJpegDecoder->wPrevX += 8;

            if(pJpegDecoder->wPrevX >= pJpegDecoder->wWidth)
            {
                    pJpegDecoder->wPrevX = 0;
                    pJpegDecoder->wPrevY += 16;
            }
    }
    else if(pJpegDecoder->bSubSampleType == JPEG_SAMPLE_2x1)
    {
            SHORT *psY, *psCb = &pJpegDecoder->asOneBlock[2][0], *psCr =
&pJpegDecoder->asOneBlock[3][0];
            BYTE bBlock, bOffsetX[2] = {0,8};

            for(bBlock = 0; bBlock < 2; bBlock++)
            {
                    psY = &pJpegDecoder->asOneBlock[bBlock][0];
                    psCb = &pJpegDecoder->asOneBlock[2][bBlock*4];
                    psCr = &pJpegDecoder->asOneBlock[3][bBlock*4];
                    for(wY = 0; wY < 8; wY++)
                    {
                            for(wX = 0; wX < 8; wX++)
                            {
                                     LONG s1 = ((*psY) + 128)*128;
                                     LONG s2 = psCb[(wY*8)+(wX>>1)];
                                     LONG s3 = psCr[(wY*8)+(wX>>1)];
                                     r = range_limit((s1 + 180*s3)>>7);
                                     g = range_limit((s1 - 44*s2 - 91*s3)>>7);
                                     b = range_limit((s1 + 227*s2)>>7);
                                     IMG_vSetColor(r, g, b);
                                     IMG_vPutPixel(pJpegDecoder->wPrevX + bOffsetX[bBlock]
+ wX,
                                              pJpegDecoder->wPrevY + wY);
                                     psY++;
                            }
                    }
            }

            pJpegDecoder->wPrevX += 16;

            if(pJpegDecoder->wPrevX >= pJpegDecoder->wWidth)
            {
                    pJpegDecoder->wPrevX = 0;
                    pJpegDecoder->wPrevY += 8;
            }
     }
     else if(pJpegDecoder->bSubSampleType == JPEG_SAMPLE_2x2)
     {
            SHORT *psY, *psCb, *psCr;
            BYTE bBlock, bOffsetX[4] = {0,8,0,8}, bOffsetY[4] = {0,0,8,8}, bCbCrOffset[4] =
{0,4,32,36};

            for(bBlock = 0; bBlock < 4; bBlock++)
            {
                WORD wXPos = pJpegDecoder->wPrevX + bOffsetX[bBlock];
                WORD wYPos = pJpegDecoder->wPrevY + bOffsetY[bBlock];

                psY = &pJpegDecoder->asOneBlock[bBlock][0];
                psCb = &pJpegDecoder->asOneBlock[4][bCbCrOffset[bBlock]];
                psCr = &pJpegDecoder->asOneBlock[5][bCbCrOffset[bBlock]];
                for(wY = 0; wY < 8; wY++)
                {
                    WORD wYPos2 = wYPos + wY;

                    for(wX = 0; wX < 4; wX++)
                    {
                        WORD psCxIndex = (wY>>1)*8 + wX;
                        LONG s2 = psCb[psCxIndex];
                        LONG s3 = psCr[psCxIndex];
                        WORD wX2;

                        for(wX2 = 0; wX2 < 2; wX2++)
                        {
                            LONG s1 = ((*psY++) + 128)*128;
                            r = range_limit((s1 + 180*s3)>>7);
                            g = range_limit((s1 - 44*s2 - 91*s3)>>7);
                            b = range_limit((s1 + 227*s2)>>7);
                            IMG_vSetColor(r, g, b);
                            IMG_vPutPixel(wXPos + wX*2 + wX2, wYPos2);
                        }
                    }
                }
            }

            pJpegDecoder->wPrevX += 16;

            if(pJpegDecoder->wPrevX >= pJpegDecoder->wWidth)
            {
                    pJpegDecoder->wPrevX = 0;
                    pJpegDecoder->wPrevY += 16;
            }
     }
```

```
 #endif
    return 0;
}

#ifndef IMG_USE_NON_BLOCKING_DECODING

/*******************************************************************************
Function:       BYTE JPEG_bDecode(IMG_FILE *pfile, BOOL bFirstTime)

Precondition:   The global variables of Image decoder must be set

Overview:       This function decodes and displays a jpeg image

Input:          Image file, ignored BOOLean

Output:         Error code - '0' means no error
*******************************************************************************/
BYTE JPEG_bDecode(IMG_FILE *pfile, BOOL bFirstTime)
{
     WORD whblocks, wvblocks;
     WORD wi, wj;
     JPEGDECODER JPEG_JpegDecoder;

     JPEG_vResetDecoder(&JPEG_JpegDecoder);
     JPEG_JpegDecoder.pImageFile = pfile;
     if(JPEG_bReadHeader(&JPEG_JpegDecoder) != 0)
     {
         return JPEG_JpegDecoder.bError;
     }

     IMG_wImageWidth = JPEG_JpegDecoder.wWidth;
     IMG_wImageHeight = JPEG_JpegDecoder.wHeight;
     IMG_vSetboundaries();

     JPEG_bGenerateHuffmanTables(&JPEG_JpegDecoder);

     whblocks = JPEG_JpegDecoder.wWidth >> 3;
     wvblocks = JPEG_JpegDecoder.wHeight >> 3;

     if(whblocks * 8 < JPEG_JpegDecoder.wWidth) /* Odd sizes */
     {
         whblocks++;
     }

     if(wvblocks * 8 < JPEG_JpegDecoder.wHeight) /* Odd sizes */
     {
         wvblocks++;
     }

     if(JPEG_JpegDecoder.bSubSampleType == JPEG_SAMPLE_1x2)
     {
         wvblocks =  (wvblocks>>1) + (wvblocks&1);
     }
     else if(JPEG_JpegDecoder.bSubSampleType == JPEG_SAMPLE_2x1)
     {
         whblocks = (whblocks>>1) + (whblocks&1);
     }
     else if(JPEG_JpegDecoder.bSubSampleType == JPEG_SAMPLE_2x2)
     {
         wvblocks =  (wvblocks>>1) + (wvblocks&1);
         whblocks = (whblocks>>1) + (whblocks&1);
     }

     JPEG_vInitDisplay(&JPEG_JpegDecoder);

     for(wi = 0; wi < whblocks; wi++)
     {
            for(wj = 0; wj < wvblocks; wj++)
            {
                   IMG_vCheckAndAbort();
                   JPEG_bDecodeOneBlock(&JPEG_JpegDecoder); /* Fills a block after
```

```
correcting the zigzag, dequantizing, IDCR and color conversion to RGB */
                   JPEG_bPaintOneBlock(&JPEG_JpegDecoder); /* Sends the block to the
Graphics unit */
             }
     }
     return JPEG_JpegDecoder.bError;
}

#else

/*******************************************************************************
Function:       BYTE JPEG_bDecode(IMG_FILE *pfile, BOOL bFirstTime)

Precondition:   The global variables of Image decoder must be set

Overview:       This function decodes and displays a jpeg image

Input:          Image file, BOOLean indicating if this is the first time calling
                the JPEG_bDecode function (needed to reset internal decoding
                state variables).  If bFirstTime is TRUE, pfile must be set.
                If bFirstTime is FALSE, pfile is ignored (uses previously
                provided file handle).

Output:         Error code - '0' means not yet completed
*******************************************************************************/
BYTE JPEG_bDecode(IMG_FILE *pfile, BOOL bFirstTime)
{
    static WORD whblocks, wvblocks;
    static WORD wi, wj;
    static JPEGDECODER JPEG_JpegDecoder;
    static enum
    {
        INITIAL,
        HEADER_DECODED,
        BLOCK_DECODE,
        DECODE_DONE
    } decodestate;


    if(bFirstTime)
        decodestate = INITIAL;

    switch(decodestate)
    {

        case INITIAL:   JPEG_vResetDecoder(&JPEG_JpegDecoder);
                        JPEG_JpegDecoder.pImageFile = pfile;
                        if(JPEG_bReadHeader(&JPEG_JpegDecoder) != 0)
                        {
                            return 1;
                        }
                        decodestate = HEADER_DECODED;
                        return 0;

        case HEADER_DECODED:
                            IMG_wImageWidth = JPEG_JpegDecoder.wWidth;
                            IMG_wImageHeight = JPEG_JpegDecoder.wHeight;
                            IMG_vSetboundaries();

                            JPEG_bGenerateHuffmanTables(&JPEG_JpegDecoder);

                            whblocks = JPEG_JpegDecoder.wWidth >> 3;
                            wvblocks = JPEG_JpegDecoder.wHeight >> 3;

                            if(whblocks * 8 < JPEG_JpegDecoder.wWidth) /* Odd sizes */
                            {
                                whblocks++;
                            }

                            if(wvblocks * 8 < JPEG_JpegDecoder.wHeight) /* Odd sizes */
                            {
                                wvblocks++;
                            }

                            if(JPEG_JpegDecoder.bSubSampleType == JPEG_SAMPLE_1x2)
                            {
                                wvblocks =  (wvblocks>>1) + (wvblocks&1);
                            }
                            else if(JPEG_JpegDecoder.bSubSampleType == JPEG_SAMPLE_2x1)
                            {
                                whblocks = (whblocks>>1) + (whblocks&1);
                            }
                            else if(JPEG_JpegDecoder.bSubSampleType == JPEG_SAMPLE_2x2)
                            {
                                wvblocks =  (wvblocks>>1) + (wvblocks&1);
                                whblocks = (whblocks>>1) + (whblocks&1);
                            }

                            JPEG_vInitDisplay(&JPEG_JpegDecoder);

                            wi = 0;
                            wj = 0;

                            decodestate = BLOCK_DECODE;
                            return 0;

        case BLOCK_DECODE:      if(wi < whblocks)
                            {
                                JPEG_bDecodeOneBlock(&JPEG_JpegDecoder); /* Fills a block
after correcting the zigzag, dequantizing, IDCR and color conversion to RGB */
                                JPEG_bPaintOneBlock(&JPEG_JpegDecoder); /* Sends the block
to the Graphics unit */
                                wj++;

                                if(wj >= wvblocks)
                                {
                                    wj = 0;
                                    wi++;
                                }
                                return 0;
                            }

                            decodestate = DECODE_DONE;
                            // No break needed

        case DECODE_DONE:       return 1;

        default:                return 1;
    }
}

#endif /* #ifndef IMG_USE_NON_BLOCKING_DECODING */

#endif /* #ifdef IMG_SUPPORT_JPEG */

#undef __JPEGDECODER_C__
```

12.8.8 JpegDecoder.h

This is file JpegDecoder.h.

Body Source

```
#ifndef __JPEGDECODER_H__
 #define __JPEGDECODER_H__

/******************************************************************************
* FileName:        JpegDecoder.h
* Dependencies:    Image decoding library; project requires File System library
* Processor:       PIC24/dsPIC30/dsPIC33/PIC32MX
* Compiler:        C30 v2.01/C32 v0.00.18
* Company:         Microchip Technology, Inc.

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 * OR OTHER SIMILAR COSTS.

Author                 Date           Comments
--------------------------------------------------------------------------------
Pradeep Budagutta    03-Mar-2008    First release
********************************************************************************/

#define JPEG_SendError(x)  pJpegDecoder->bError = x; return(x); /* Point to proper error
handler routine */

#define MAX_CHANNELS      3 /* This supports only Grayscale and YCbCr images - DONT CHANGE
THIS */
#define MAX_BLOCKS        6 /* To decode one logical block, we have to decode 1 to 6 blocks
depending on channels and subsampling - DONT REDUCE THIS */
#define MAX_HUFF_TABLES   2 /* Each causes 2 tables -> One for AC and another for DC - DONT
REDUCE THIS */
#define MAX_DATA_BUF_LEN  128 /* Increase if you have more data memory */

/* Error list */
enum Errors
{
     IMAGE_FILE_NOT_AVAILABLE
};

/* JPEG Markers list */
enum Markers
{
     SOF0 = 0xC0,
     DHT  = 0xC4,
     SOI  = 0xD8,
     EOI  = 0xD9,
     SOS  = 0xDA,
     DQT  = 0xDB,
     DRI  = 0xDD,
     APP0 = 0xE0,
     COM  = 0xFE,
/* The below markers doesn't have parameters */
     TEM  = 0x01,
     RST0 = 0xD0,
     RST1 = 0xD1,
     RST2 = 0xD2,
     RST3 = 0xD3,
     RST4 = 0xD4,
     RST5 = 0xD5,
     RST6 = 0xD6,
     RST7 = 0xD7
};
```

```
/* Function prototype */
/* This function must be called after setting proper values in the global variables of
ImageDecoder.c */
BYTE JPEG_bDecode(IMG_FILE *pfile, BOOL bFirstTime);

#endif
```

12.8.9 jidctint.c

This is file jidctint.c.

Body Source

```
/*
 * jidctint.c
 *
 * Copyright (C) 1991-1998, Thomas G. Lane.
 * This file is part of the Independent JPEG Group's software.
 * For conditions of distribution and use, see the accompanying 'IJG License.pdf' file.
 *
 * This file contains a slow-but-accurate integer implementation of the
 * inverse DCT (Discrete Cosine Transform).  In the IJG code, this routine
 * must also perform dequantization of the input coefficients.
 *
 * A 2-D IDCT can be done by 1-D IDCT on each column followed by 1-D IDCT
 * on each row (or vice versa, but it's more convenient to emit a row at
 * a time).  Direct algorithms are also available, but they are much more
 * complex and seem not to be any faster when reduced to code.
 *
 * This implementation is based on an algorithm described in
 *   C. Loeffler, A. Ligtenberg and G. Moschytz, "Practical Fast 1-D DCT
 *   Algorithms with 11 Multiplications", Proc. Int'l. Conf. on Acoustics,
 *   Speech, and Signal Processing 1989 (ICASSP '89), pp. 988-991.
 * The primary algorithm described there uses 11 multiplies and 29 adds.
 * We use their alternate method with 12 multiplies and 32 adds.
 * The advantage of this method is that no data path contains more than one
 * multiplication; this allows a very simple and accurate implementation in
 * scaled fixed-point arithmetic, with a minimal number of shifts.
 */

#include "GenericTypeDefs.h"


/*
 * This module is specialized to the case DCTSIZE = 8.
 */

/*
 * The poop on this scaling stuff is as follows:
 *
 * Each 1-D IDCT step produces outputs which are a factor of sqrt(N)
 * larger than the true IDCT outputs.  The final outputs are therefore
 * a factor of N larger than desired; since N=8 this can be cured by
 * a simple right shift at the end of the algorithm.  The advantage of
 * this arrangement is that we save two multiplications per 1-D IDCT,
 * because the y0 and y4 inputs need not be divided by sqrt(N).
 *
 * We have to do addition and subtraction of the integer inputs, which
 * is no problem, and multiplication by fractional constants, which is
 * a problem to do in integer arithmetic.  We multiply all the constants
 * by CONST_SCALE and convert them to integer constants (thus retaining
 * CONST_BITS bits of precision in the constants).  After doing a
 * multiplication we have to divide the product by CONST_SCALE, with proper
 * rounding, to produce the correct output.  This division can be done
 * cheaply as a right shift of CONST_BITS bits.  We postpone shifting
 * as long as possible so that partial sums can be added together with
 * full fractional precision.
```

```
  *
  * The outputs of the first pass are scaled up by PASS1_BITS bits so that
  * they are represented to better-than-integral precision.  These outputs
  * require BITS_IN_JSAMPLE + PASS1_BITS + 3 bits; this fits in a 16-bit word
  * with the recommended scaling.  (To scale up 12-bit sample data further, an
  * intermediate INT32 array would be needed.)
  *
  * To avoid overflow of the 32-bit intermediate results in pass 2, we must
  * have BITS_IN_JSAMPLE + CONST_BITS + PASS1_BITS <= 26.  Error analysis
  * shows that the values given below are the most effective.
  */
#define DCTSIZE         8   /* The basic DCT block is 8x8 samples */
#define DCTSIZE2        64  /* DCTSIZE squared; # of elements in a block */
#define BITS_IN_JSAMPLE  8
#define NO_ZERO_ROW_TEST
#define DCTELEM LONG

#define CONST_BITS  13
#define PASS1_BITS  2

#define INT32 LONG

/* Some C compilers fail to reduce "FIX(constant)" at compile time, thus
 * causing a lot of useless floating-point operations at run time.
 * To get around this we use the following pre-calculated constants.
 * If you change CONST_BITS you may want to add appropriate values.
 * (With a reasonable C compiler, you can just rely on the FIX() macro...)
 */

#define FIX_0_298631336  ((INT32)  2446)    /* FIX(0.298631336) */
#define FIX_0_390180644  ((INT32)  3196)    /* FIX(0.390180644) */
#define FIX_0_541196100  ((INT32)  4433)    /* FIX(0.541196100) */
#define FIX_0_765366865  ((INT32)  6270)    /* FIX(0.765366865) */
#define FIX_0_899976223  ((INT32)  7373)    /* FIX(0.899976223) */
#define FIX_1_175875602  ((INT32)  9633)    /* FIX(1.175875602) */
#define FIX_1_501321110  ((INT32)  12299)   /* FIX(1.501321110) */
#define FIX_1_847759065  ((INT32)  15137)   /* FIX(1.847759065) */
#define FIX_1_961570560  ((INT32)  16069)   /* FIX(1.961570560) */
#define FIX_2_053119869  ((INT32)  16819)   /* FIX(2.053119869) */
#define FIX_2_562915447  ((INT32)  20995)   /* FIX(2.562915447) */
#define FIX_3_072711026  ((INT32)  25172)   /* FIX(3.072711026) */


/* Multiply an INT32 variable by an INT32 constant to yield an INT32 result.
 * For 8-bit samples with the recommended scaling, all the variable
 * and constant values involved are no more than 16 bits wide, so a
 * 16x16->32 bit multiply can be used instead of a full 32x32 multiply.
 * For 12-bit samples, a full 32-bit multiplication will be needed.
 */

#define DESCALE(x,n)  ((x) + ((LONG)0x01 << ((n)-1)))>>(n)
#define MULTIPLY(var,constant)  ((LONG)(var) * (constant));
#define range_limit(x) ((x)<-128)?-128:((x)>127)?127:(x)

/* Dequantize a coefficient by multiplying it by the multiplier-table
 * entry; produce an int result.  In this module, both inputs and result
 * are 16 bits or less, so either int or short multiply will work.
 */

#define DEQUANTIZE(coef,quantval)  ((LONG)(coef) * (quantval))


/*
 * Perform dequantization and inverse DCT on one block of coefficients.
 */

void jpeg_idct_islow (SHORT *inbuf, WORD *quantptr)
{
  LONG tmp0, tmp1, tmp2, tmp3;
  LONG tmp10, tmp11, tmp12, tmp13;
  LONG z1, z2, z3, z4, z5;
```

```
    BYTE ctr;
    SHORT *inptr = inbuf, *outptr;
    DCTELEM *wsptr;
    DCTELEM workspace[DCTSIZE2];  /* buffers data between passes */

    wsptr = workspace;

    /* Pass 1: process columns from input, store into work array. */
    /* Note results are scaled up by sqrt(8) compared to a true IDCT; */
    /* furthermore, we scale the results by 2**PASS1_BITS. */

    for (ctr = DCTSIZE; ctr > 0; ctr--) {
      /* Due to quantization, we will usually find that many of the input
       * coefficients are zero, especially the AC terms.  We can exploit this
       * by short-circuiting the IDCT calculation for any column in which all
       * the AC terms are zero.  In that case each output is equal to the
       * DC coefficient (with scale factor as needed).
       * With typical images and quantization tables, half or more of the
       * column DCT calculations can be simplified this way.
       */

      if (inptr[DCTSIZE*1] == 0 && inptr[DCTSIZE*2] == 0 &&
      inptr[DCTSIZE*3] == 0 && inptr[DCTSIZE*4] == 0 &&
      inptr[DCTSIZE*5] == 0 && inptr[DCTSIZE*6] == 0 &&
      inptr[DCTSIZE*7] == 0) {
        /* AC terms all zero */
        LONG dcval = DEQUANTIZE(inptr[DCTSIZE*0], quantptr[DCTSIZE*0]) << PASS1_BITS;

        wsptr[DCTSIZE*0] = dcval;
        wsptr[DCTSIZE*1] = dcval;
        wsptr[DCTSIZE*2] = dcval;
        wsptr[DCTSIZE*3] = dcval;
        wsptr[DCTSIZE*4] = dcval;
        wsptr[DCTSIZE*5] = dcval;
        wsptr[DCTSIZE*6] = dcval;
        wsptr[DCTSIZE*7] = dcval;

        inptr++;          /* advance pointers to next column */
        quantptr++;
        wsptr++;
        continue;
      }

      /* Even part: reverse the even part of the forward DCT. */
      /* The rotator is sqrt(2)*c(-6). */

      z2 = DEQUANTIZE(inptr[DCTSIZE*2], quantptr[DCTSIZE*2]);
      z3 = DEQUANTIZE(inptr[DCTSIZE*6], quantptr[DCTSIZE*6]);

      z1 = MULTIPLY(z2 + z3, FIX_0_541196100);
      tmp2 = z1 + MULTIPLY(z3, - FIX_1_847759065);
      tmp3 = z1 + MULTIPLY(z2, FIX_0_765366865);

      z2 = DEQUANTIZE(inptr[DCTSIZE*0], quantptr[DCTSIZE*0]);
      z3 = DEQUANTIZE(inptr[DCTSIZE*4], quantptr[DCTSIZE*4]);

      tmp0 = (z2 + z3) << CONST_BITS;
      tmp1 = (z2 - z3) << CONST_BITS;

      tmp10 = tmp0 + tmp3;
      tmp13 = tmp0 - tmp3;
      tmp11 = tmp1 + tmp2;
      tmp12 = tmp1 - tmp2;

      /* Odd part per figure 8; the matrix is unitary and hence its
       * transpose is its inverse.  i0..i3 are y7,y5,y3,y1 respectively.
       */

      tmp0 = DEQUANTIZE(inptr[DCTSIZE*7], quantptr[DCTSIZE*7]);
      tmp1 = DEQUANTIZE(inptr[DCTSIZE*5], quantptr[DCTSIZE*5]);
      tmp2 = DEQUANTIZE(inptr[DCTSIZE*3], quantptr[DCTSIZE*3]);
      tmp3 = DEQUANTIZE(inptr[DCTSIZE*1], quantptr[DCTSIZE*1]);
      z1 = tmp0 + tmp3;
      z2 = tmp1 + tmp2;
      z3 = tmp0 + tmp2;
      z4 = tmp1 + tmp3;
      z5 = MULTIPLY(z3 + z4, FIX_1_175875602); /* sqrt(2) * c3 */

      tmp0 = MULTIPLY(tmp0, FIX_0_298631336); /* sqrt(2) * (-c1+c3+c5-c7) */
      tmp1 = MULTIPLY(tmp1, FIX_2_053119869); /* sqrt(2) * ( c1+c3-c5+c7) */
      tmp2 = MULTIPLY(tmp2, FIX_3_072711026); /* sqrt(2) * ( c1+c3+c5-c7) */
      tmp3 = MULTIPLY(tmp3, FIX_1_501321110); /* sqrt(2) * ( c1+c3-c5-c7) */
      z1 = MULTIPLY(z1, - FIX_0_899976223); /* sqrt(2) * (c7-c3) */
      z2 = MULTIPLY(z2, - FIX_2_562915447); /* sqrt(2) * (-c1-c3) */
      z3 = MULTIPLY(z3, - FIX_1_961570560); /* sqrt(2) * (-c3-c5) */
      z4 = MULTIPLY(z4, - FIX_0_390180644); /* sqrt(2) * (c5-c3) */

      z3 += z5;
      z4 += z5;

      tmp0 += z1 + z3;
      tmp1 += z2 + z4;
      tmp2 += z2 + z3;
      tmp3 += z1 + z4;

      /* Final output stage: inputs are tmp10..tmp13, tmp0..tmp3 */

      wsptr[DCTSIZE*0] = (LONG) DESCALE((tmp10 + tmp3), (CONST_BITS-PASS1_BITS));
      wsptr[DCTSIZE*7] = (LONG) DESCALE((tmp10 - tmp3), (CONST_BITS-PASS1_BITS));
      wsptr[DCTSIZE*1] = (LONG) DESCALE((tmp11 + tmp2), (CONST_BITS-PASS1_BITS));
      wsptr[DCTSIZE*6] = (LONG) DESCALE((tmp11 - tmp2), (CONST_BITS-PASS1_BITS));
      wsptr[DCTSIZE*2] = (LONG) DESCALE((tmp12 + tmp1), (CONST_BITS-PASS1_BITS));
      wsptr[DCTSIZE*5] = (LONG) DESCALE((tmp12 - tmp1), (CONST_BITS-PASS1_BITS));
      wsptr[DCTSIZE*3] = (LONG) DESCALE((tmp13 + tmp0), (CONST_BITS-PASS1_BITS));
      wsptr[DCTSIZE*4] = (LONG) DESCALE((tmp13 - tmp0), (CONST_BITS-PASS1_BITS));

      inptr++;            /* advance pointers to next column */
      quantptr++;
      wsptr++;
    }

    /* Pass 2: process rows from work array, store into output array. */
    /* Note that we must descale the results by a factor of 8 == 2**3, */
    /* and also undo the PASS1_BITS scaling. */

    wsptr = workspace;
    outptr = &inbuf[0];
    for (ctr = 0; ctr < DCTSIZE; ctr++) {
      /* Rows of zeroes can be exploited in the same way as we did with columns.
       * However, the column calculation has created many nonzero AC terms, so
       * the simplification applies less often (typically 5% to 10% of the time).
       * On machines with very fast multiplication, it's possible that the
       * test takes more time than it's worth.  In that case this section
       * may be commented out.
       */

  #ifndef NO_ZERO_ROW_TEST
      if (wsptr[1] == 0 && wsptr[2] == 0 && wsptr[3] == 0 && wsptr[4] == 0 &&
      wsptr[5] == 0 && wsptr[6] == 0 && wsptr[7] == 0) {
        /* AC terms all zero */
        JSAMPLE dcval = range_limit[(LONG) DESCALE((INT32) wsptr[0], PASS1_BITS+3)
                    & RANGE_MASK];

        outptr[0] = dcval;
        outptr[1] = dcval;
        outptr[2] = dcval;
        outptr[3] = dcval;
        outptr[4] = dcval;
        outptr[5] = dcval;
        outptr[6] = dcval;
        outptr[7] = dcval;

        wsptr += DCTSIZE;     /* advance pointer to next row */
```

```
        continue;
      }
  #endif

      /* Even part: reverse the even part of the forward DCT. */
      /* The rotator is sqrt(2)*c(-6). */

      z2 = (INT32) wsptr[2];
      z3 = (INT32) wsptr[6];

      z1 = MULTIPLY(z2 + z3, FIX_0_541196100);
      tmp2 = z1 + MULTIPLY(z3, - FIX_1_847759065);
      tmp3 = z1 + MULTIPLY(z2, FIX_0_765366865);

      tmp0 = ((INT32) wsptr[0] + (INT32) wsptr[4]) << CONST_BITS;
      tmp1 = ((INT32) wsptr[0] - (INT32) wsptr[4]) << CONST_BITS;

      tmp10 = tmp0 + tmp3;
      tmp13 = tmp0 - tmp3;
      tmp11 = tmp1 + tmp2;
      tmp12 = tmp1 - tmp2;

      /* Odd part per figure 8; the matrix is unitary and hence its
       * transpose is its inverse.  i0..i3 are y7,y5,y3,y1 respectively.
       */

      tmp0 = (INT32) wsptr[7];
      tmp1 = (INT32) wsptr[5];
      tmp2 = (INT32) wsptr[3];
      tmp3 = (INT32) wsptr[1];

      z1 = tmp0 + tmp3;
      z2 = tmp1 + tmp2;
      z3 = tmp0 + tmp2;
      z4 = tmp1 + tmp3;
      z5 = MULTIPLY(z3 + z4, FIX_1_175875602); /* sqrt(2) * c3 */

      tmp0 = MULTIPLY(tmp0, FIX_0_298631336); /* sqrt(2) * (-c1+c3+c5-c7) */
      tmp1 = MULTIPLY(tmp1, FIX_2_053119869); /* sqrt(2) * ( c1+c3-c5+c7) */
      tmp2 = MULTIPLY(tmp2, FIX_3_072711026); /* sqrt(2) * ( c1+c3+c5-c7) */
      tmp3 = MULTIPLY(tmp3, FIX_1_501321110); /* sqrt(2) * ( c1+c3-c5-c7) */
      z1 = MULTIPLY(z1, - FIX_0_899976223); /* sqrt(2) * (c7-c3) */
      z2 = MULTIPLY(z2, - FIX_2_562915447); /* sqrt(2) * (-c1-c3) */
      z3 = MULTIPLY(z3, - FIX_1_961570560); /* sqrt(2) * (-c3-c5) */
      z4 = MULTIPLY(z4, - FIX_0_390180644); /* sqrt(2) * (c5-c3) */

      z3 += z5;
      z4 += z5;

      tmp0 += z1 + z3;
      tmp1 += z2 + z4;
      tmp2 += z2 + z3;
      tmp3 += z1 + z4;

      /* Final output stage: inputs are tmp10..tmp13, tmp0..tmp3 */

      outptr[0] = (SHORT)range_limit((LONG) DESCALE(tmp10 + tmp3, CONST_BITS+PASS1_BITS+3));
      outptr[7] = (SHORT)range_limit((LONG) DESCALE(tmp10 - tmp3, CONST_BITS+PASS1_BITS+3));
      outptr[1] = (SHORT)range_limit((LONG) DESCALE(tmp11 + tmp2, CONST_BITS+PASS1_BITS+3));
      outptr[6] = (SHORT)range_limit((LONG) DESCALE(tmp11 - tmp2, CONST_BITS+PASS1_BITS+3));
      outptr[2] = (SHORT)range_limit((LONG) DESCALE(tmp12 + tmp1, CONST_BITS+PASS1_BITS+3));
      outptr[5] = (SHORT)range_limit((LONG) DESCALE(tmp12 - tmp1, CONST_BITS+PASS1_BITS+3));
      outptr[3] = (SHORT)range_limit((LONG) DESCALE(tmp13 + tmp0, CONST_BITS+PASS1_BITS+3));
      outptr[4] = (SHORT)range_limit((LONG) DESCALE(tmp13 - tmp0, CONST_BITS+PASS1_BITS+3));

      outptr += DCTSIZE;   /* advance pointer to next row */
      wsptr += DCTSIZE;       /* advance pointer to next row */
    }
  }
```

12.9 _BMPDECODER Structure

File

BmpDecoder.c (see page 476)

C

```
struct _BMPDECODER {
  IMG_FILE * pImageFile;
  LONG lWidth;
  LONG lHeight;
  LONG lImageOffset;
  WORD wPaletteEntries;
  BYTE bBitsPerPixel;
  BYTE bHeaderType;
  BYTE blBmMarkerFlag : 1;
  BYTE blCompressionType : 3;
  BYTE bNumOfPlanes : 3;
  BYTE b16bit565flag : 1;
  BYTE aPalette[256][3];
};
```

Members

Members	Description
IMG_FILE * pImageFile;	Image file pointer
BYTE aPalette[256][3];	Each palette entry has RGB

Module

Image Decoders (see page 468)

Description

DATA STRUCTURES

12.10 _GIFDECODER Structure

File

GifDecoder.c (see page 483)

C

```
struct _GIFDECODER {
  IMG_FILE * pImageFile;
  WORD wImageWidth;
  WORD wImageHeight;
  WORD wImageX;
  WORD wImageY;
  WORD wScreenWidth;
  WORD wScreenHeight;
  WORD wGlobalPaletteEntries;
  WORD wLocalPaletteEntries;
  BYTE bBgColorIndex;
  BYTE bPixelAspectRatio;
  BYTE blGifMarkerFlag : 1;
  BYTE blGloabalColorTableFlag : 1;
  BYTE blLocalColorTableFlag : 1;
  BYTE blInterlacedFlag : 1;
  BYTE blFirstcodeFlag : 1;
```

```
    BYTE bInterlacePass : 3;
    BYTE aPalette[256][3];
    WORD awPalette[256];
    BYTE abSymbol[4096];
    WORD awPrevSymbolPtr[(4096 * 3)/4];
    WORD wInitialSymbols;
    WORD wMaxSymbol;
    BYTE bInitialSymbolBits;
    BYTE bMaxSymbolBits;
    LONG lGlobalColorTablePos;
    BYTE bWorkBits;
    BYTE bRemainingDataInBlock;
    BYTE bRemainingBits;
    WORD wCurrentX;
    WORD wCurrentY;
  };
```

Members

Members	Description
IMG_FILE * pImageFile;	Image file pointer
BYTE aPalette[256][3];	Each palette entry has RGB
WORD awPalette[256];	Each palette entry has RGB
BYTE abSymbol[4096];	For decoding
BYTE bWorkBits;	Work memory

Module

Image Decoders (see page 468)

Description

DATA STRUCTURES

12.11 _JPEGDECODER Structure

File

JpegDecoder.c (see page 506)

C

```
  struct _JPEGDECODER {
    IMG_FILE * pImageFile;
    BYTE blJFIF;
    BYTE bMajorRev;
    BYTE bMinorRev;
    BYTE bDataBits;
    WORD wWidth;
    WORD wHeight;
    BYTE bChannels;
    BYTE abChannelType[MAX_CHANNELS];
    BYTE abChannelHSampFactor[MAX_CHANNELS];
    BYTE abChannelVSampFactor[MAX_CHANNELS];
    BYTE abChannelQuantTableMap[MAX_CHANNELS];
    BYTE blQuantUses16bits;
    WORD awQuantTable[MAX_CHANNELS][64];
    WORD wRestartInterval;
    BYTE bHuffTables;
    BYTE abHuffAcSymLen[MAX_HUFF_TABLES][16];
    BYTE abHuffAcSymbol[MAX_HUFF_TABLES][256];
    BYTE abHuffDcSymLen[MAX_HUFF_TABLES][16];
    BYTE abHuffDcSymbol[MAX_HUFF_TABLES][16];
    WORD awHuffAcSymStart[MAX_HUFF_TABLES][16];
    WORD awHuffDcSymStart[MAX_HUFF_TABLES][16];
    BYTE abChannelHuffAcTableMap[MAX_CHANNELS];
    BYTE abChannelHuffDcTableMap[MAX_CHANNELS];
    BYTE bError;
    WORD wWorkBits;
    BYTE bBitsAvailable;
    BYTE bBlocksInOnePass;
    SHORT asOneBlock[MAX_BLOCKS][64];
    WORD wBlockNumber;
    BYTE abChannelMap[MAX_BLOCKS];
    BYTE bSubSampleType;
    SHORT asPrevDcValue[MAX_CHANNELS];
    BYTE * pbCurrentHuffSymLenTable;
    BYTE * pbCurrentHuffSymbolTable;
    WORD * pwCurrentHuffSymStartTable;
    WORD * pwCurrentQuantTable;
    BYTE abDataBuffer[MAX_DATA_BUF_LEN];
    WORD wBufferLen;
    WORD wBufferIndex;
    BYTE bFirstBit;
    WORD wPrevX;
    WORD wPrevY;
  };
```

Members

Members	Description
IMG_FILE * pImageFile;	Image file pointer
BYTE blJFIF;	JFIF marker found flag
BYTE bMajorRev;	Should be 1
BYTE bMinorRev;	Should be 0-2 but is not a show stopper ------- The x/y densities and thumbnail data are ignored
BYTE bDataBits;	Data precision, can be 8(, 12 or 16)
WORD wWidth;	Width in pixels
WORD wHeight;	Height in pixels
BYTE bChannels;	Number of channels e.g. YCbCr = 3
BYTE blQuantUses16bits;	If flag is set, it is an error as 16 bit is not supported
WORD awQuantTable[MAX_CHANNELS][64];	Supports only 8 & 16 bit resolutions
WORD wRestartInterval;	The restart interval in blocks
BYTE bHuffTables;	From DHT
BYTE abHuffAcSymLen[MAX_HUFF_TABLES][16];	Supports only 8 bit resolution
BYTE abHuffAcSymbol[MAX_HUFF_TABLES][256];	Maximum possible symbols are 256
BYTE abHuffDcSymLen[MAX_HUFF_TABLES][16];	Supports only 8 bit resolution
BYTE abHuffDcSymbol[MAX_HUFF_TABLES][16];	Maximum possible symbols are 16 for DC :-)
WORD awHuffAcSymStart[MAX_HUFF_TABLES][16];	Starting symbol for each length
WORD awHuffDcSymStart[MAX_HUFF_TABLES][16];	Starting symbol for each length
BYTE abChannelHuffAcTableMap[MAX_CHANNELS];	From SOS
WORD wWorkBits;	Work memory
SHORT asOneBlock[MAX_BLOCKS][64];	Temporary storage for a 8x8 block

Module

Image Decoders (see page 468)

Description

DATA STRUCTURES

13 Miscellaneous Topics

This section contains common procedures to start using the library or to modify the library.

13.1 Starting a New Project

This outlines the procedure to create a new project that uses the Microchip Graphics Library from scratch.

Description

The following is a step by step instruction to create a New Project from scratch with the Microchip Graphics Library

Step 1: Creating the directory structure - In order to easily maintain the library components the following directory structure is recommended.

```
Microchip Solutions
    |
    MyApplication
    Microchip
        |
        Help
        Graphics
        Include
            |
            Graphics
```

- MyApplication directory can be any directory that you specify.
- Microchip directory will contain all the library files.
- Under Microchip directory, the Help directory will contain the "Graphics.chm" file.
- Under Microchip directory, the Graphics directory under the Microchip directory will contain all the C files.
- Under Microchip directory, the Include directory will have another Graphics directory that will contain all the header files with the exception of one. The **“GenericTypeDefs.h”** file will be located in *Microchip->Include* directory.

Step 2: Adding library files - Before creating the MPLAB Project follow the following steps add library files to your created directory tree.

1. Place the following C files in the *Microchip->Graphics* directory.

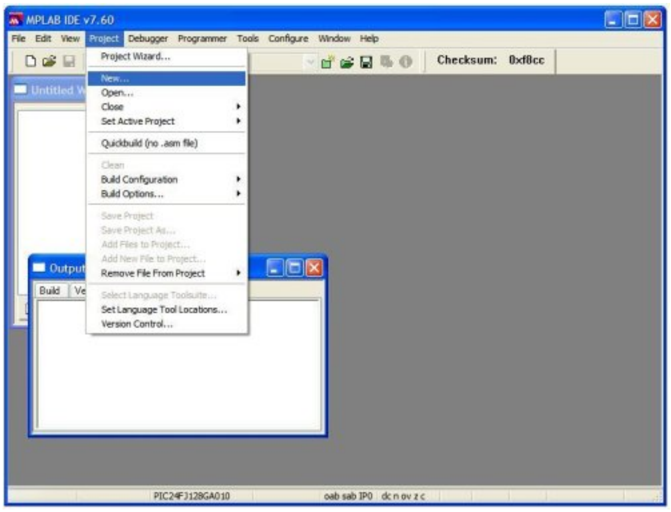
Button.c (⇗ see page 660)	**ListBox.c (⇗ see page 799)**
CheckBox.c (⇗ see page 742)	**Meter.c (⇗ see page 821)**
EditBox.c (⇗ see page 762)	**Picture.c (⇗ see page 843)**
GOL.c (⇗ see page 550)	**Primitive.c (⇗ see page 960)**
GOLFontDefault.c (⇗ see page 598)	**ProgressBar.c (⇗ see page 850)**
GroupBox.c (⇗ see page 789)	**RadioButton.c (⇗ see page 875)**
RoundDial.c (⇗ see page 861)	**Slider.c (⇗ see page 888)**
LGDP4531_R61505_S6D0129_S6D0139_SPFD5408.c	**StaticText.c (⇗ see page 911)**
Window.c (⇗ see page 950)	

2. Place the **GenericTypeDefs.h** in the *Microchip->Include* directory.
3. Place the following header files in the *Microchip->Include->Graphics* directory.

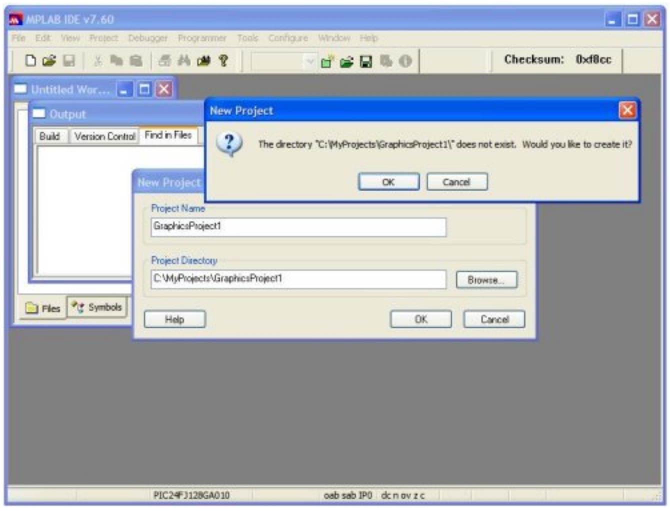
Button.h (↗ see page 672)	**ListBox.h (↗ see page 811)**
CheckBox.h (↗ see page 748)	**Meter.h (↗ see page 834)**
EditBox.h (↗ see page 769)	**Picture.h (↗ see page 846)**
GOL.h (↗ see page 571)	**Primitive.h (↗ see page 1028)**
Graphics.h (↗ see page 639)	**ProgressBar.h (↗ see page 856)**
GroupBox.h (↗ see page 795)	**RadioButton.h (↗ see page 882)**
RoundDial.h (↗ see page 869)	**Slider.h (↗ see page 902)**
LGDP4531_R61505_S6D0129_S6D0139_SPFD5408.h	**StaticText.h (↗ see page 916)**
Window.h (↗ see page 956)	

Step 3: Creating the MPLAB project

1. Open MPLAB Project.
2. Go to **Project** tab and select **New**



3. **New Project** dialog box will appear. In this dialog box enter your **Project Name** and **Project Directory**. Click **OK**. Project will be created or prompted to create the directory if your project directory does not exist (refer to figure below).

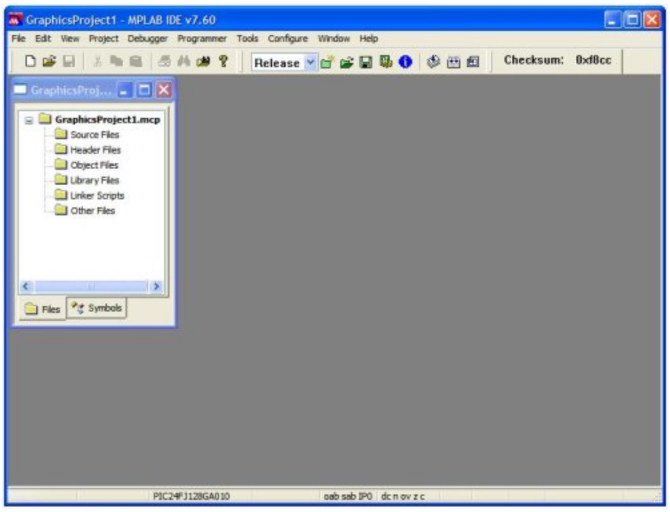


The directory "C:\MyProjects\GraphicsProject1\" does not exist. Would you like to create it?

Project Name: GraphicsProject1

Project Directory: C:\MyProjects\GraphicsProject1

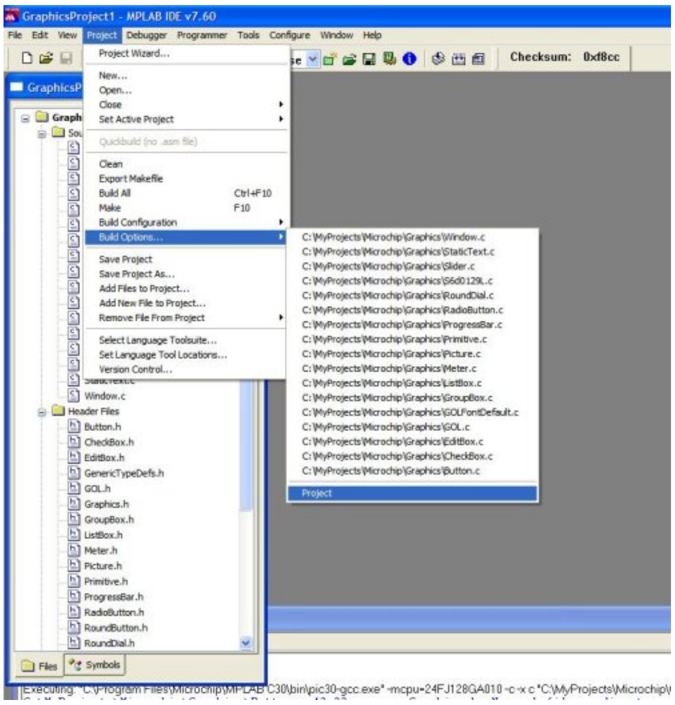
4. The MPLAB **Project** view will appear as soon as the project is created. If it does not appear go to **View** tab and click **Project**.



5. Right click on the **Source Files (⧉ see page 549)** and click **Add Files (⧉ see page 549)**. Browse to *MyApplication->Microchip->Graphics* directory. Select all the c files and click **Open**.
6. Right click on the **Header Files (⧉ see page 549)** and click **Add Files (⧉ see page 549)**. Browse to *MyApplication->Microchip->Include* directory. Select **GenericTypeDefs.h** file and click **Open**.
7. Right click on the **Header Files (⧉ see page 549)** and click **Add Files (⧉ see page 549)**. Browse to *MyApplication->Microchip->Include->Graphics* directory. Select all the h files and click **Open**.

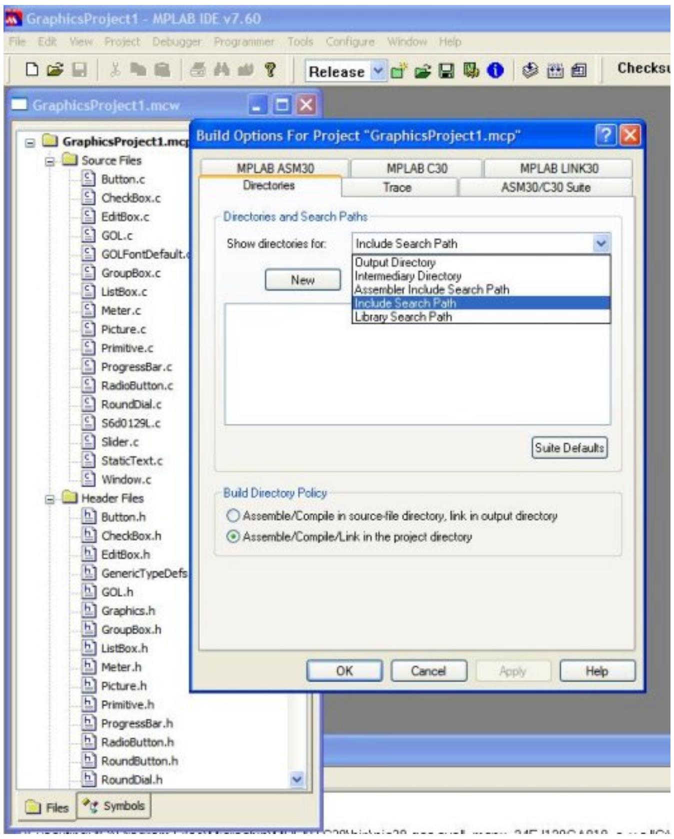
Step 4: Setting the project directories.

1. In MPLAB Project, go to **Project** tab and point to **Build Options**.

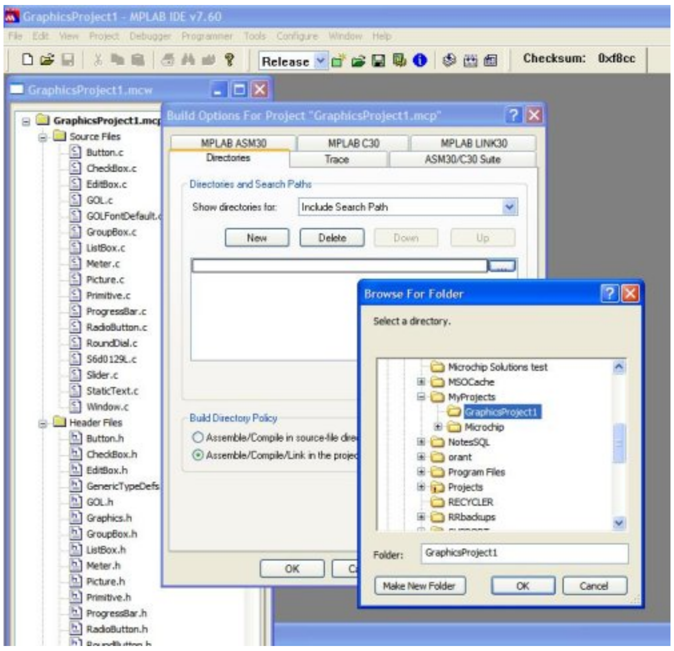

GraphicsProject1 - MPLAB IDE v7.60
File Edit View Project Debugger Programmer Tools Configure Window Help
Checksum: 0xf8cc
Project Wizard...
New...
Open...
Close
Set Active Project
Quickbuild (no .asm file)
Clean
Export Makefile
Build All Ctrl+F10
Make F10
Build Configuration
Build Options...
Save Project
Save Project As...
Add Files to Project...
Add New File to Project...
Remove File From Project
Select Language Toolsuite...
Set Language Tool Locations...
Version Control...
C:\MyProjects\Microchip\Graphics\Window.c
C:\MyProjects\Microchip\Graphics\StaticText.c
C:\MyProjects\Microchip\Graphics\Slider.c
C:\MyProjects\Microchip\Graphics\S6d0129L.c
C:\MyProjects\Microchip\Graphics\RoundDial.c
C:\MyProjects\Microchip\Graphics\RadioButton.c
C:\MyProjects\Microchip\Graphics\ProgressBar.c
C:\MyProjects\Microchip\Graphics\Primitive.c
C:\MyProjects\Microchip\Graphics\Picture.c
C:\MyProjects\Microchip\Graphics\Meter.c
C:\MyProjects\Microchip\Graphics\ListBox.c
C:\MyProjects\Microchip\Graphics\GroupBox.c
C:\MyProjects\Microchip\Graphics\GOLFontDefault.c
C:\MyProjects\Microchip\Graphics\GOL.c
C:\MyProjects\Microchip\Graphics\EditBox.c
C:\MyProjects\Microchip\Graphics\CheckBox.c
C:\MyProjects\Microchip\Graphics\Button.c
Project
Window.c
Header Files
Button.h
CheckBox.h
EditBox.h
GenericTypeDefs.h
GOL.h
Graphics.h
GroupBox.h
ListBox.h
Meter.h
Picture.h
Primitive.h
ProgressBar.h
RadioButton.h
RoundButton.h
RoundDial.h
Files
Symbols

```
Executing: "C:\Program Files\Microchip\MPLAB C30\bin\pic30-gcc.exe" -mcpu=24FJ128GA010 -c -x c "C:\MyProjects\Microchip\
```

2. A menu will appear showing all your files and the **Project** option. Select the **Project** option. The **Build Options** window will open.
3. Select the **Directories** tab.

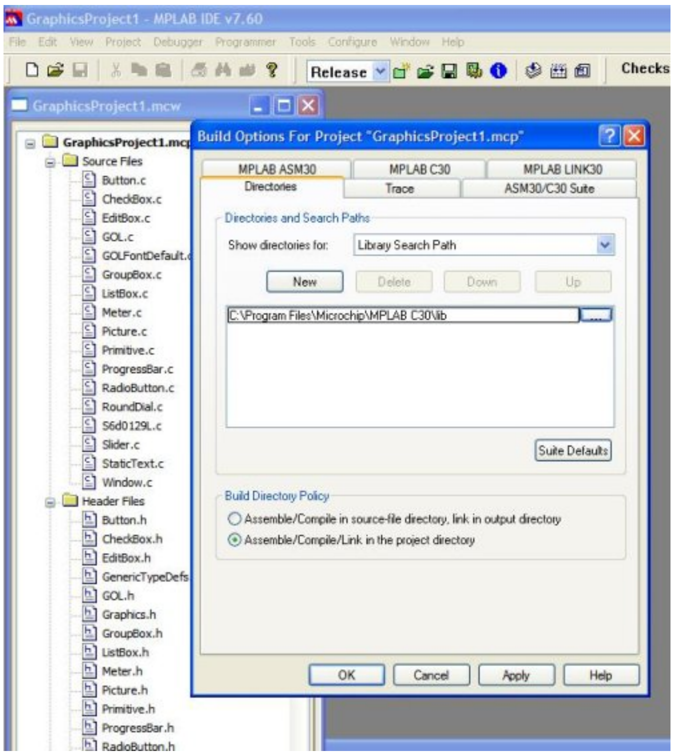

GraphicsProject1 - MPLAB IDE v7.60
File Edit View Project Debugger Programmer Tools Configure Window Help
Release
GraphicsProject1.mcw
Build Options For Project "GraphicsProject1.mcp"
MPLAB ASM30
MPLAB C30
MPLAB LINK30
Directories
Trace
ASM30/C30 Suite
Directories and Search Paths
Show directories for:
Include Search Path
Output Directory
Intermediary Directory
Assembler Include Search Path
Include Search Path
Library Search Path
New
Suite Defaults
Build Directory Policy
Assemble/Compile in source-file directory, link in output directory
Assemble/Compile/Link in the project directory
OK
Cancel
Apply
Help
Files
Symbols

4. In the **Directories** tab, **Directories and Search Paths** group box and **Show directories for:** select **Include Search Path**. Click **New**.
5. Click the button with (…) and browse and select your project directory. Click **OK**. This will add your project directory.



6. Click New again for each of the following paths:
1. ..\..\GraphicsProject1 (you already did this in previous step)
2. ..\Microchip\Include
3. ..\Microchip\Include\Graphics
4. ..\Include

5. ..\Include\Graphics
7. **Directories and Search Paths** group box and **Show directories for:** select **Library Search Path**. Click **New**.
8. Enter the path to the MPLAB C30 lib. For example: C:\Program Files (see page 549)\Microchip\MPLAB C30\lib. Click **OK**.

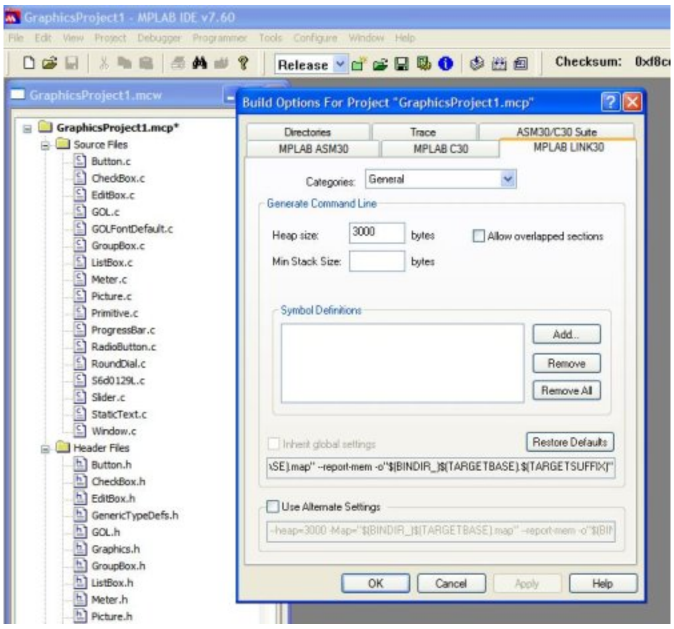


Show directories for: Library Search Path

C:\Program Files\Microchip\MPLAB C30\lib

Assemble/Compile/Link in the project directory [✓]

9. Change from the **Directories** tab to **MPLAB LINK 30** tab. In the **Generate Command Line** group box enter 3000 in the **Heap Size** setting.



Categories: General

Heap size: 3000 bytes

Min Stack Size: bytes

```
\SE).map" --report-mem -o"$(BINDIR_)$(TARGETBASE).$(TARGETSUFFIX)"
--heap=3000 -Map="$(BINDIR_)$(TARGETBASE).map" --report-mem -o"$(BIN
```

4.9. Click **Apply** and then **OK**.

Step 5: Create your application files.

1. In MPLAB Project, select **File** tab and click **New**. The file editor will open.

2. Create your **GraphicsConfig.h (see page 945)** file. For now add the following lines:

```
#define USE_NONBLOCKING_CONFIG // Comment this line to use blocking configuration
#define USE_BUTTON             // Enable Button Object.
#define USE_SLIDER             // Enable Slider or Scroll Bar Object.

#define USE_FONT_FLASH         // Support for fonts located in internal flash
#define USE_BITMAP_FLASH       // Support for bitmaps located in internal flash
```

The file name is important. If the file name is changed, library will not compile properly.

3. Save the file into your **MyApplication** directory.
4. Similarly, create your application header file code by following steps 1 and 2. For simplicity just use this code for now:

```
#define SYSCLK 32000000        // 8MHz x 4PLL Oscillator frequency
// includes
#include <p24Fxxxx.h>
#include "GenericTypeDefs.h"
#include "Graphics.h"
```

5. Save the file in your **MyApplication** directory.
6. After saving the two header files, add these files to your project. To add just perform the same sequence in **Step 3.6**.
7. Create your application code. For simplicity just use this code for now:

```
#include "GraphicsProject.h"        // header file you saved earlier
// Configuration bits
_CONFIG2(FNOSC_PRIPLL & POSCMOD_XT) // Primary XT OSC with PLL
_CONFIG1(JTAGEN_OFF & FWDTEN_OFF)   // JTAG off, watchdog timer off

int main(void){

    GOL_MSG msg; // GOL message structure to interact with GOL
    GOLInit(); // initialize graphics library &
    BtnCreate( 1,                   // object's ID
               20, 160, 150, 210,   // object's dimension
               0,                   // radius of the rounded edge
               BTN_DRAW,            // draw the object after creation
               NULL,                // no bitmap used
               "LEFT",              // use this text
               NULL);               // use alternative style scheme
    BtnCreate( 2,
               170, 160, 300, 210,
               0,
               BTN_DRAW,
               NULL,
               "RIGHT",
               NULL);
    SldCreate(3,                    // object's ID
              20, 105, 300, 150,    // object's dimension
              SLD_DRAW,             // draw the object after creation
              100,                  // range
              5,                    // page
              50,                   // initial position
              NULL);                // use default style scheme
    while(1){
        if (GOLDraw()) {            // Draw GOL object
        }
    }
}

WORD GOLMsgCallback(WORD objMsg, OBJ_HEADER* pObj, GOL_MSG* pMsg){
    return 1;
}

WORD GOLDrawCallback(){
    return 1;
}
```

8. Save the file in your **MyApplication** directory.
9. After saving the application file, add the file to your project. To add just perform the same sequence in **Step 3.5**.

Step 6: Now build your project. To build go to MPLAB **Project** tab and click **Build All**. Notice there will be some warnings that may come out in the build log. This is due to the fact that we have not used most of the Objects. We only used the Slider (see page 251) and Button (see page 78).

Step 7: Downloading your application - To download your generated code to the Explorer 16 board follow the steps below.

1. In the MPLAB **Programmer** tab click **Select Programmer**.
2. Select **MPLAB ICD2** or **REAL ICE** depending on your setup.
3. After connection and testing is done go to **Programmer** tab and click **Program**.

Note that you can also do the steps in the Downloading the Demos (see page 28) sub-section in the Getting Started (see page 21) section to download your application to the Explorer 16 board using your generated hex file.

13.2 Changing the default Font

The library comes with the default font (Gentium 18). This font can be changed in two ways.

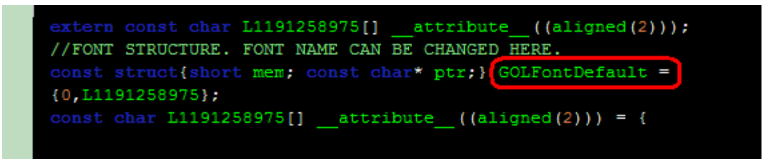
Description

This instructions assumes that you have performed the conversion of your raster font or True Type font into C file. For the conversion of your raster font please see the help file of the Graphics Resource Converter utility that comes with the Graphics Library.

There are two ways to replace the default font in the Graphics Library.

Renaming User Font to GOLFontDefault (see page 346):

1. Open the generated font file (generated by the "Graphics Resource Converter" utility) and change the font structure name to **GOLFontDefault (see page 346)** (see figure below).



```
extern const char L1191258975[] __attribute__((aligned(2)));
//FONT STRUCTURE. FONT NAME CAN BE CHANGED HERE.
const struct{short mem; const char* ptr;} GOLFontDefault =
{0,L1191258975};
const char L1191258975[] __attribute__((aligned(2))) = {
```

2. Remove the file **GOLFONTDefault.c** in the project and replace it with your own font file that contains the **GOLFontDefault (see page 346)**.
3. Build and test your new font.

Replacing the GOLFontDefault (see page 346) with any user defined fonts

1. Open the **GraphicsConfig.h (see page 945)** file and add the following lines:

```
#define FONTDEFAULT yourFontName
```

2. In the project, add the generated font file (generated by the "Graphics Resource Converter" utility).
3. Build and test your new font.

In this method, GOL.h (see page 571) and GOLFontDefault.c (see page 598) files checks if FONTDEFAULT (see page 346) is defined. If it is, it skips the declaration of the GOLFontDefault (see page 346) and uses the user defined font.

13.3 Using Primitive Rendering Functions in Blocking and Non-Blocking Modes

Basic rendering functions such as Line(), Rectangle (see page 372)(), Circle (see page 374)() etc are referred to as functions in the Graphics Primitive Layer. These functions can also be implemented in the device driver layer if the display device supports hardware acceleration of the function. Applications that directly calls these functions can take advantage of the hardware accelerated primitives. How these functions are used will depend on the "Configuration Setting (see page 44)".

Description

All primitive rendering functions returns a status.

- 0 – when the primitive was not successfully rendered
- 1 – when the primitive was successfully rendered

When using Graphics Library you can enable the non-blocking mode when calling drawing/rendering functions. This is done by adding this line in your GraphicsConfig.h (see page 945) file:

```
#define USE_NONBLOCKING_CONFIG // Comment this line to use blocking configuration
```

When using a display controller with hardware accelerated primitives (like SSD1926 which is on the Graphics PICtail™ Plus Board Version 3 (AC164127-3) faster primitive rendering on Line(), Rectangle (see page 372)() and Bar (see page 371)() functions will be performed. Compiling with the Blocking or Non-Blocking mode set will still use the accelerated primitives but the application code directly calling the primitive functions will have to be coded accordingly.

To explain the two modes when directly calling the primitive functions please take a look at the example below.

Case 1: USE_NONBLOCKING_CONFIG (see page 45) disabled

```
// all primitives are blocking calls
Line(a,b);
Rectangle(c,d,e,f);
Bar(c+2, d+2, e-2, f-2)
```

Case 2: USE_NONBLOCKING_CONFIG (see page 45) enabled

```
// all primitives are non-blocking calls
while(!Line(a,b));
while(!Rectangle(c,d,e,f));
while(!Bar(c+2, d+2, e-2, f-2));
```

If the while check is not in place, it possible that the only primitive that you will see in the screen is the Line().

For case 2, one can also be creative in the application code and implement some form of non-blocking scheme and make use of the time while waiting for the primitives to render.

Another example for case 2:

```
WORD DrawMyFigure(a, b, c, d, e, f)
{
    typedef enum {
       DRAW_LINE,
       DRAW_RECT,
       DRAW_BAR,
} DRAW_MYFIGURE_STATES;
static DRAW_MYFIGURE_STATES state = DRAW_LINE;

    if(IsDeviceBusy()) // checks if the hardware is still busy
        return 0;

    switch(state){
        case DRAW_LINE:
            if (!Line(a, b))
```

```
                return 0;
            state = DRAW_RECT;
        case DRAW_RECT:
            if(!Rectangle(c,d,e,f))
                return 0;
            state = DRAW_BAR;
        case DRAW_BAR:
            if(!Bar(c+2, d+2, e-2, f-2));
                return 0;
            state = DRAW_LINE;
            return 1;
    }
}
```

This non-blocking code can be used in the application and the application can do other tasks whenever DrawMyFigure() returns 0. Application should call DrawMyFigure() again until it return a 1 signifying that the Line, Rectangle (see page 372) and Bar (see page 371) were drawn successfully.

13.4 Using Microchip Graphics Module Color Look Up Table in Applications

Utilizing the Color Look Up Table (CLUT) of the Microchip Graphics Module saves memory for both storage and display buffer. This short instructional manual outlines the procedure to create source code files to use the CLUT of the Microchip Graphics Module and enable the Microchip Graphics Library to use the hardware feature.

Description

Apart from regular RGB scheme of representing colors, colors may also be represented using a Color Look Up Table (CLUT) also called Palette table, where there is a table of colors and the color is specified by the index of the table. Depending on the size of the table, the bits used to represent the index will vary. For example 256 entries of RGB (8 bit index), 16 entries of RGB (4 bit index), 4 entries of RGB (2 bit index) and 2 entries of RGB (1 bit index). This scheme is mainly used to save memory. See Figure-1 for an example of 16-entry (4-bit) CLUT where a shade of Green is represented by an index value of 3 consuming 4-bits. To figure the memory requirement for a give screen size at a color depth, bits per pixel, the follow equations is used: total number of pixels x bits per pixel / 8 bits per byte. For example the memory required for a 320x240 with 16 BPP screen; (320 x 240) x (16 / 8) = 153,600 Bytes. If only 16 different colors are used in the screen, then instead of using raw RGB, a 16-entry (4-bit) CLUT may be used requiring a memory of (320 x 240) x (4/8) = 38,400 bytes; thereby saving 75% of memory.

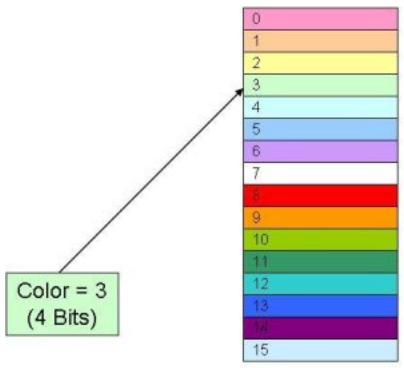


Figure 1. A 16-Entry (4-bit) Color Look Up Table

If the display driver hardware supports CLUT, the index values are translated to the RGB values by the hardware automatically when the signals are sent out to the display.

If the CLUT is enabled, since a CLUT affects the whole screen, all the color patterns like basic shapes and images which are displayed on the screen must use the same CLUT. It means that color defines like RED (see page 415), GREEN (see page 413), etc… must use the index values instead of the absolute RGB values. The bitmap images used must also use the same CLUT in order to appear properly on the screen. Note that the chosen CLUT length (1, 4, 16, or 256) must accommodate all the different colors needed by a screen. The following section explains how to create such a CLUT for a screen.

Creating CLUT

Creating CLUT has 2 steps:

1. Creating a part of CLUT manually.
2. Filling the remaining part with the colors of the images used.
3. Using the Graphics Resource Converter to generate a CLUt based on the images to convert.

Creating a part of CLUT manually - Since users need to select specific colors for the shapes and the widgets, they must enter these specific colors in the CLUT. This can be done by manually creating a new CLUT table using a text editor. Create a text file and save it with a .gpl extension with the form:

```
GIMP Palette
Name: 16_colors
Columns: 4
#
  0   0   0    BLACK
  0   0   128  BLUE
  128 0   0    RED
  0   0   0    Unused
  0   0   0    Unused
```

The second line specifies the name of the palette which must be unique. The palette table data starts with line 5 which represent index 0 with the RGB values and a caption. The number of such data lines must be equal to the length of the CLUT. In the example, only 3 colors are used.

Filling the remaining part with the colors of the images used - Suppose 256 entries CLUT is being used, since 3 colors are manually set, only 256 – 3 = 253 entries are available for the images to be displayed on the same screen. If more than one image is used on the screen, it further implies that

- All images on the screen must use the same CLUT table.
- Different colors used for all the images along with the fixed colors must not exceed the size of the CLUT table being used.

If the source images are of RGB type, they must be converted into CLUT based images. This can be done using free PC tools like GIMP (www.gimp.org).

The following steps shows how to convert the images using GIMP:

Step 1:

Create a new image with sufficient size to paste all the images required on the screen using *File->New* in the GIMP (see Figure-2).

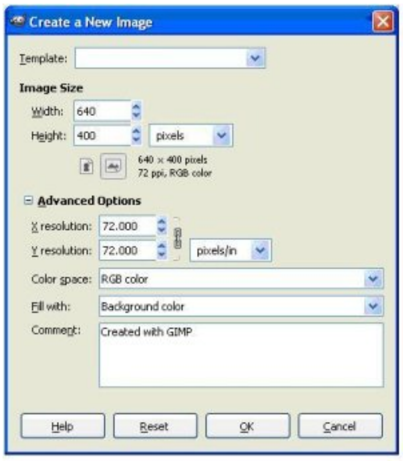

Create a New Image
Template:
Image Size
Width: 640
Height: 400 pixels
640 × 400 pixels
72 ppi, RGB color
Advanced Options
X resolution: 72.000
Y resolution: 72.000 pixels/in
Color space: RGB color
Fill with: Background color
Comment: Created with GIMP

Figure 2. Creating New File in GIMP

Step 2:

Copy and paste all the images to be displayed on the screen into this image like in Figure 3. If 256 colors is enough for the entire application, a single CLUT can be used. If not multiple CLUT can be used. Each CLUT can be configured to use one or more screens. In this case, switching from one screen to another may require re-initializing the hardware CLUT entries before the screen is displayed.

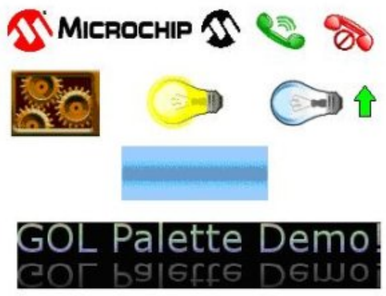


Figure 3. Images Used in One Screen

Step 3:

Set the mode to CLUT by selecting *Image->Mode->Indexed* in the GIMP. Select to generate optimum palette with 256 – 3 = 253 entries (because we already have 3 fixed entries) as shown in Figure 4 and save it as a BMP (e.g. Collage.bmp) image by selecting *File->SaveAs* menu.

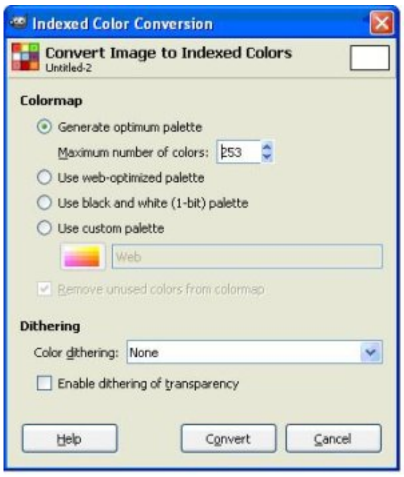

Indexed Color Conversion
Convert Image to Indexed Colors
Untitled-2
Colormap
Generate optimum palette
Maximum number of colors: 253
Use web-optimized palette
Use black and white (1-bit) palette
Use custom palette
Web
Remove unused colors from colormap
Dithering
Color dithering: None
Enable dithering of transparency
Help
Convert
Cancel

Figure 4. Generate a Palette Table (CLUT)

Step 4:

The next step is to extract the CLUT from the generated image. To do that, go to the palette selection mode by selecting *Image->Mode->RGB* and then again *Image->Mode->Indexed*. Select Use Custom Palette and open the palette selection dialog as shown in Figure 5 and import the previously saved bitmap image (Collage.bmp) as shown in Figure 6 and Figure 7. The palette file will be created in the [Home Folder]\.gimp-x.y\palettes folder as a *.gpl file.

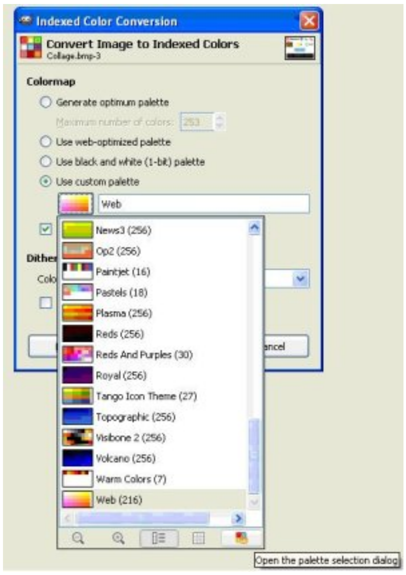


Figure 5. Palette Selection Dialog

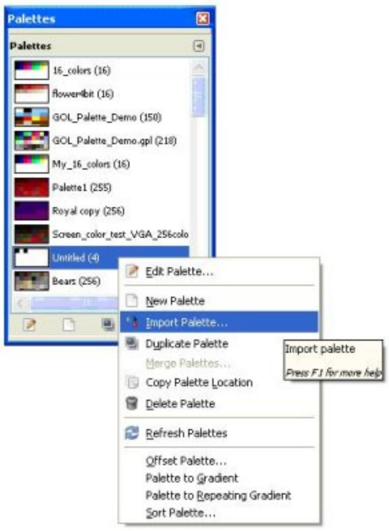


Figure 6. Import Palette Dialog

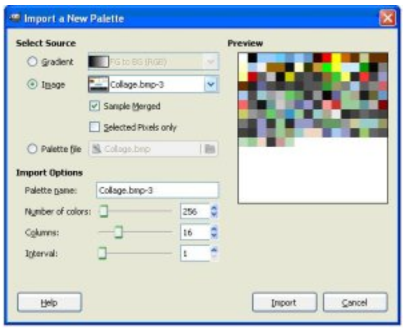


Figure 7. Import Collage Bitmap

Step 5:

Manually edit this and add the fixed color entries from the previously stored fixed palette file. (Manual step). Now a master palette file is created which has to be used in the application.

Step 6:

Open individual images in GIMP and apply this master palette to all of them through *Image->Mode->Indexed* and selecting Use Custom Palette. Select the master palette which was generated and save the images. This will make all the images palette ready.

Step 7:

The next step is to convert this Palette.gpl and the images into the format recognizable by the Microchip Graphics Library. Start the Microchip's Graphics Resource Converter tool and enable the C30 Build (palette support is currently on selected PIC24F devices only) mode as shown in Figure 8. Open the master palette file previously generated by pressing Add Palette button and save it as a .c file (for storing in internal flash) or as a .hex file (for storing in external memory) similar to bitmap or font conversion as shown in Figure 10.

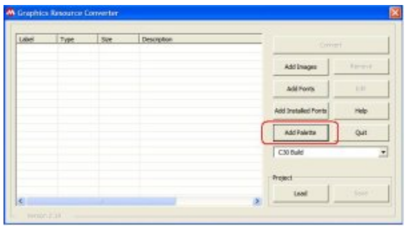
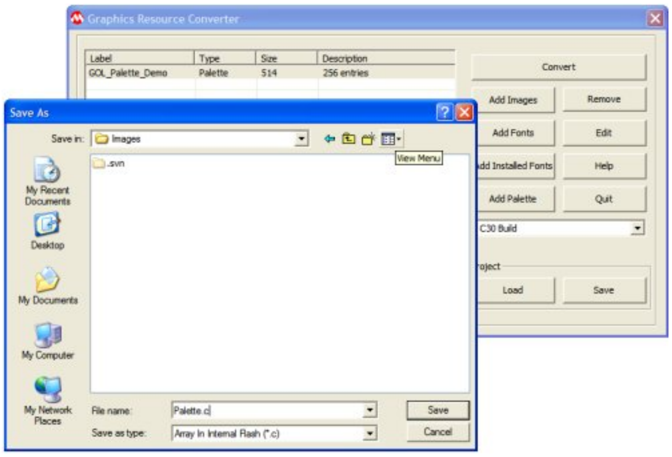


Figure 8. Load Palette



Label	Type	Size	Description
GOL_Palette_Demo	Palette	514	256 entries

File name: Palette.c

Save as type: Array In Internal Flash (*.c)

Figure 9. Convert Palette

Step 8:

Convert all the palette ready images to C file (*.c) or Hex file (*.hex) by pressing the Add Images button.

Step 9:

Import the palette with the extern statement like in "extern const PALETTE_FLASH (see page 453) _GOL_Palette_Demo;" in the application. See MainDemo.c in "Graphics Object Layer Palette Demo". Set the palette using the APIs SetPaletteBpp (see page 452)() and SetPalette (see page 416)() and then enable the palette using the API EnablePalette (see page 449)() as shown in the below code example.

```
GOLInit();
SetPaletteBpp(8);
SetPalette((void*)&_GOL_Palette_Demo, 0, 256);
EnablePalette();
```

Step 10:

Import the images as usual and use them after setting and enabling the palette.

See "Graphics Object Layer Palette Demo" as a practical example.

Using the Graphis Resource Converter to generate a CLUT based on the images to convert - The Graphics Resource

Converter will generate a CLUT based on the images to be converted. Please refer to the Graphics Resource Converter help file for more information.

13.5 How to Define Colors in your Applications

In most cases, the application will define its own set of colors and not use the default colors that comes with the Graphics Library. This section shows an example on how to do it.

Description

To override or define a new set of colors follow this steps:

1. Create a new color header file. The color values and data types will depend on the GFX_COLOR (see page 351) type used. This data type is defined by the COLOR_DEPTH (see page 48) macro. See COLOR_DEPTH (see page 48) for details.
2. In the application code, include the created color header file ahead of the #include "Graphics/Graphics.h (see page 639)". When Graphics.h (see page 639) includes the gfxcolors.h it will ignore color macros that has been defined already in the new color header file.

In the GOL (see page 64) Palette Demo, there is an example on how it is done. In that project there is a file in the application (or project directory) named PaletteColorDefines.h. This file contains all the color definition used in the demo. The main header file of the demo (Main.h) includes the PaletteColorDefines.h file ahead of the Graphics Library header files. Since the PaletteColorDefines.h declared the color values, the macros redefined in gfxcolors.h will be ignored. How is this done? If you look at the gfxcolors.h file you will notice that all colors defined have a check (for example BLACK (see page 409)):

#ifndef BLACK (see page 409)

#define BLACK (see page 409) 0

#endif

So if BLACK (see page 409) is defined previously, the definition in gfxcolors.h will not take effect.

14 Files

14.1 GOL Layer

Files

Name	Description
GOL.c (↗ see page 550)	This is file GOL.c.
GOL.h (↗ see page 571)	This is file GOL.h.
GOLFontDefault.c (↗ see page 598)	This is file GOLFontDefault.c.
Graphics.h (↗ see page 639)	This is file Graphics.h.
ScanCodes.h (↗ see page 641)	This is file ScanCodes.h.
AnalogClock.c (↗ see page 644)	This is file AnalogClock.c.
AnalogClock.h (↗ see page 655)	This is file AnalogClock.h.
Button.c (↗ see page 660)	This is file Button.c.
Button.h (↗ see page 672)	This is file Button.h.
Chart.c (↗ see page 679)	This is file Chart.c.
Chart.h (↗ see page 724)	This is file Chart.h.
CheckBox.c (↗ see page 742)	This is file CheckBox.c.
CheckBox.h (↗ see page 748)	This is file CheckBox.h.
DigitalMeter.c (↗ see page 752)	This is file DigitalMeter.c.
DigitalMeter.h (↗ see page 758)	This is file DigitalMeter.h.
EditBox.c (↗ see page 762)	This is file EditBox.c.
EditBox.h (↗ see page 769)	This is file EditBox.h.
Grid.c (↗ see page 774)	This is file Grid.c.
Grid.h (↗ see page 782)	This is file Grid.h.
GroupBox.c (↗ see page 789)	This is file GroupBox.c.
GroupBox.h (↗ see page 795)	This is file GroupBox.h.
ListBox.c (↗ see page 799)	This is file ListBox.c.
ListBox.h (↗ see page 811)	This is file ListBox.h.
Meter.c (↗ see page 821)	This is file Meter.c.
Meter.h (↗ see page 834)	This is file Meter.h.
Picture.c (↗ see page 843)	This is file Picture.c.
Picture.h (↗ see page 846)	This is file Picture.h.
ProgressBar.c (↗ see page 850)	This is file ProgressBar.c.
ProgressBar.h (↗ see page 856)	This is file ProgressBar.h.
RoundDial.c (↗ see page 861)	This is file RoundDial.c.
RoundDial.h (↗ see page 869)	This is file RoundDial.h.
RadioButton.c (↗ see page 875)	This is file RadioButton.c.
RadioButton.h (↗ see page 882)	This is file RadioButton.h.
Slider.c (↗ see page 888)	This is file Slider.c.
Slider.h (↗ see page 902)	This is file Slider.h.
StaticText.c (↗ see page 911)	This is file StaticText.c.
StaticText.h (↗ see page 916)	This is file StaticText.h.

TextEntry.c (see page 920)	This is file TextEntry.c.
TextEntry.h (see page 936)	This is file TextEntry.h.
GraphicsConfig.h (see page 945)	This is file GraphicsConfig.h.
Window.c (see page 950)	This is file Window.c.
Window.h (see page 956)	This is file Window.h.

Description

Lists all files describing the Graphic Object Layer.

14.1.1 GOL.c

This is file GOL.c.

Body Source

```
/*****************************************************************************
 *  Module for Microchip Graphics Library
 *  GOL Layer
 *****************************************************************************
 * FileName:        GOL.c
 * Processor:       PIC24F, PIC24H, dsPIC, PIC32
 * Compiler:        MPLAB C30 V3.00, MPLAB C32
 * Company:         Microchip Technology Incorporated
 *
 * Software License Agreement
 *
 * Copyright © 2008 Microchip Technology Inc.  All rights reserved.
 * Microchip licenses to you the right to use, modify, copy and distribute
 * Software only when embedded on a Microchip microcontroller or digital
 * signal controller, which is integrated into your product or third party
 * product (pursuant to the sublicense terms in the accompanying license
 * agreement).
 *
 * You should refer to the license agreement accompanying this Software
 * for additional information regarding your rights and obligations.
 *
 * SOFTWARE AND DOCUMENTATION ARE PROVIDED “AS IS” WITHOUT WARRANTY OF ANY
 * KIND, EITHER EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION, ANY WARRANTY
 * OF MERCHANTABILITY, TITLE, NON-INFRINGEMENT AND FITNESS FOR A PARTICULAR
 * PURPOSE. IN NO EVENT SHALL MICROCHIP OR ITS LICENSORS BE LIABLE OR
 * OBLIGATED UNDER CONTRACT, NEGLIGENCE, STRICT LIABILITY, CONTRIBUTION,
 * BREACH OF WARRANTY, OR OTHER LEGAL EQUITABLE THEORY ANY DIRECT OR INDIRECT
 * DAMAGES OR EXPENSES INCLUDING BUT NOT LIMITED TO ANY INCIDENTAL, SPECIAL,
 * INDIRECT, PUNITIVE OR CONSEQUENTIAL DAMAGES, LOST PROFITS OR LOST DATA,
 * COST OF PROCUREMENT OF SUBSTITUTE GOODS, TECHNOLOGY, SERVICES, OR ANY
 * CLAIMS BY THIRD PARTIES (INCLUDING BUT NOT LIMITED TO ANY DEFENSE THEREOF),
 * OR OTHER SIMILAR COSTS.
 *
 * Date                  Comment
 *~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
 * 11/12/07              Version 1.0 release
 * 06/29/09             Added multi-line support for Buttons.
 * 03/12/09             Added Double Buffering Support
 * 04/29/10             Fixed GOLGetFocusNext() issue.
 * 06/07/10             To save drawing time, add check on panel to skip
 *                      drawing the panel face and frame if the bitmap
 *                      used is greater than area of the panel.
 * 09/08/10             Removed redundant code in GOLRedrawRec().
 *                      Added EditBox in GOLCanBeFocused().
 * 03/30/11             In 1 BPP mode: Removed all references to WHITE and
 *                      BLACK color. Replaced them to use the emboss light
 *                      and dark color instead.
 *****************************************************************************/
#include "Graphics/Graphics.h"
```

```
#ifdef USE_GOL

#include <string.h>

#ifdef USE_TRANSITION_EFFECTS

    #include "Graphics/Transitions.h"

    static BYTE TransitionPendingStatus;
#endif

// Pointer to the current linked list of objects displayed and receiving messages
OBJ_HEADER  *_pGolObjects = NULL;

// Pointer to the default GOL scheme (created in GOLInit())
GOL_SCHEME  *_pDefaultGolScheme = NULL;

// Pointer to the object receiving keyboard input
OBJ_HEADER  *_pObjectFocused = NULL;

#ifdef USE_GRADIENT
GFX_GRADIENT_STYLE _gradientScheme;
#endif

    #ifdef USE_FOCUS

/*********************************************************************
* Function: OBJ_HEADER *GOLGetFocusPrev()
*
* Overview: This function returns the pointer to the previous object
*           in the active linked list which is able to receive
*           keyboard input.
*
* PreCondition: none
*
* Input: none
*
* Output: This returns the pointer of the previous object in the
*         active list capable of receiving keyboard input. If
*         there is no object capable of receiving keyboard
*         inputs (i.e. none can be focused) NULL is returned.
*
* Side Effects: none
*
********************************************************************/
OBJ_HEADER *GOLGetFocusPrev(void)
{
    OBJ_HEADER  *pPrevObj;
    OBJ_HEADER  *pCurObj;
    OBJ_HEADER  *pFocusedObj;

    if(_pGolObjects == NULL)
        return (NULL);

    if(_pObjectFocused == NULL)
    {
        pFocusedObj = _pGolObjects;
    }
    else
    {
        pFocusedObj = _pObjectFocused;
    }

    pPrevObj = NULL;
    pCurObj = pFocusedObj;

    while(1)
    {
        if(GOLCanBeFocused(pCurObj))
            pPrevObj = pCurObj;

        if(pCurObj->pNxtObj == NULL)
```

```
            if(_pGolObjects == pFocusedObj)
                return (pPrevObj);

        if(pCurObj->pNxtObj == pFocusedObj)
            return (pPrevObj);

        pCurObj = (OBJ_HEADER *)pCurObj->pNxtObj;

        if(pCurObj == NULL)
            pCurObj = _pGolObjects;
    }
}

/*********************************************************************
* Function: OBJ_HEADER *GOLGetFocusNext()
*
* Overview: This function returns the pointer to the next object
*           in the active linked list which is able to receive
*           keyboard input.
*
* PreCondition: none
*
* Input: none
*
* Output: This returns the pointer of the next object in the
*         active list capable of receiving keyboard input. If
*         there is no object capable of receiving keyboard
*         inputs (i.e. none can be focused) NULL is returned.
*
* Side Effects: none
*
********************************************************************/
OBJ_HEADER *GOLGetFocusNext(void)
{
    OBJ_HEADER  *pNextObj, *pObjStart;

    if(_pGolObjects == NULL)
        return (NULL);

    if(_pObjectFocused == NULL)
    {
        pNextObj = _pGolObjects;
    }
    else
    {
        pNextObj = _pObjectFocused;
    }

    pObjStart = pNextObj;

    do
    {
        pNextObj = (OBJ_HEADER *)pNextObj->pNxtObj;

        if(pNextObj == NULL)
            pNextObj = _pGolObjects;

        if(GOLCanBeFocused(pNextObj))
            break;
    } while(pNextObj != pObjStart);

    // if we reached the starting point and the starting point cannot
    // be focused, then all objects cannot be focused. return NULL
    if(!GOLCanBeFocused(pNextObj))
        return NULL;

    return (pNextObj);
}

/*********************************************************************
* Function: void GOLSetFocus(OBJ_HEADER* object)
*
```

```
* PreCondition: none
*
* Input: pointer to the object to be focused
*
* Output:
*
* Side Effects: none
*
* Overview: moves keyboard focus to the object
*
* Note: none
*
********************************************************************/
void GOLSetFocus(OBJ_HEADER *object)
{
    if(!GOLCanBeFocused(object))
        return;

    if(_pObjectFocused != NULL)
    {
        ClrState(_pObjectFocused, FOCUSED);
        SetState(_pObjectFocused, DRAW_FOCUS);
    }

    SetState(object, DRAW_FOCUS | FOCUSED);

    _pObjectFocused = object;
}

/*********************************************************************
* Function: WORD GOLCanBeFocused(OBJ_HEADER* object)
*
* PreCondition: none
*
* Input: pointer to the object
*
* Output: non-zero if the object supports keyboard focus, zero if not
*
* Side Effects: none
*
* Overview: checks if object support keyboard focus
*
* Note: none
*
********************************************************************/
WORD GOLCanBeFocused(OBJ_HEADER *object)
{
    if
    (
        (object->type == OBJ_BUTTON) ||
        (object->type == OBJ_CHECKBOX) ||
        (object->type == OBJ_RADIOBUTTON) ||
        (object->type == OBJ_LISTBOX) ||
        (object->type == OBJ_SLIDER) ||
        (object->type == OBJ_EDITBOX)
    )
    {
        if(!GetState(object, DISABLED))
            return (1);
    }

    return (0);
}

    #endif

/*********************************************************************
* Function: GOL_SCHEME *GOLCreateScheme(void)
*
* PreCondition: none
*
* Input: none
```

```
*
* Output: pointer to scheme object
*
* Side Effects: none
*
* Overview: creates a color scheme object and assign default colors
*
* Note: none
*
********************************************************************/
GOL_SCHEME *GOLCreateScheme(void)
{
    GOL_SCHEME  *pTemp;

    pTemp = (GOL_SCHEME *)GFX_malloc(sizeof(GOL_SCHEME));

    if(pTemp != NULL)
    {
        memcpy(pTemp, &GFX_SCHEMEDEFAULT, sizeof(GOL_SCHEME));
    }

    return (pTemp);
}

/*********************************************************************
* Function: void GOLInit()
*
* PreCondition: none
*
* Input: none
*
* Output: none
*
* Side Effects: none
*
* Overview: initializes GOL
*
* Note: none
*
********************************************************************/
void GOLInit(void)
{

    // Initialize display
    InitGraph();

    // Initialize the default GOL scheme
    _pDefaultGolScheme = GOLCreateScheme();

    #ifdef USE_TRANSITION_EFFECTS

        TransitionPendingStatus = 0;

    #endif
}

/*********************************************************************
* Function: void GOLFree()
*
* PreCondition: none
*
* Input: none
*
* Output: none
*
* Side Effects: none
*
* Overview: frees memory of all objects in the current linked list
*           and starts a new linked list. This function must be
*           called only inside the GOLDrawCallback()function when
*           using GOLDraw() and GOLMsg() to manage rendering and
*           message processing.
```

```
*
* Note: drawing and messaging must be suspended
*
********************************************************************/
void GOLFree(void)
{
    OBJ_HEADER  *pNextObj;
    OBJ_HEADER  *pCurrentObj;

    pCurrentObj = _pGolObjects;
    while(pCurrentObj != NULL)
    {
        pNextObj = (OBJ_HEADER *)pCurrentObj->pNxtObj;

        // check if there are additional items to free
        if(pCurrentObj->FreeObj)
            pCurrentObj->FreeObj(pCurrentObj);

        GFX_free(pCurrentObj);
        pCurrentObj = pNextObj;
    }

    GOLNewList();

    #ifdef USE_DOUBLE_BUFFERING

        InvalidateAll();

    #endif
}

/*********************************************************************
* Function: BOOL GOLDeleteObject(OBJ_HEADER * object)
*
* PreCondition: none
*
* Input: pointer to the object
*
* Output: none
*
* Side Effects: none
*
* Overview: Deletes an object to the linked list objects for the current screen.
*
* Note: none
*
********************************************************************/
BOOL GOLDeleteObject(OBJ_HEADER *object)
{
    if(!_pGolObjects)
        return (FALSE);

    if(object == _pGolObjects)
    {
        _pGolObjects = (OBJ_HEADER *)object->pNxtObj;
    }
    else
    {
        OBJ_HEADER  *curr;
        OBJ_HEADER  *prev;

        curr = (OBJ_HEADER *)_pGolObjects->pNxtObj;
        prev = (OBJ_HEADER *)_pGolObjects;

        while(curr)
        {
            if(curr == object)
                break;

            prev = (OBJ_HEADER *)curr;
            curr = (OBJ_HEADER *)curr->pNxtObj;
        }
        if(!curr)
            return (FALSE);

        prev->pNxtObj = curr->pNxtObj;
    }

    if(object->FreeObj)
        object->FreeObj(object);

    GFX_free(object);

    return (TRUE);
}

/*********************************************************************
* Function: BOOL GOLDeleteObject(OBJ_HEADER * object)
*
* PreCondition: none
*
* Input: pointer to the object
*
* Output: none
*
* Side Effects: none
*
* Overview: Deletes an object to the linked list objects for the current screen using
*           the given ID to search for the object.
*
* Note: none
*
********************************************************************/
BOOL GOLDeleteObjectByID(WORD ID)
{
    OBJ_HEADER  *object;

    object = GOLFindObject(ID);

    if(!object)
        return (FALSE);

    return (GOLDeleteObject(object));
}

/*********************************************************************
* Function: OBJ_HEADER* GOLFindObject(WORD ID)
*
* PreCondition: none
*
* Input: object ID
*
* Output: pointer to the object
*
* Side Effects: none
*
* Overview: searches for the object by its ID in the current objects linked list,
*           returns NULL if the object is not found
*
* Note: none
*
********************************************************************/
OBJ_HEADER *GOLFindObject(WORD ID)
{
    OBJ_HEADER  *pNextObj;

    pNextObj = _pGolObjects;
    while(pNextObj != NULL)
    {
        if(pNextObj->ID == ID)
        {
            return (pNextObj);
        }
```

```
            pNextObj = (OBJ_HEADER *)pNextObj->pNxtObj;
        }

        return (NULL);
    }

    /*********************************************************************
    * Function: void GOLAddObject(OBJ_HEADER * object)
    *
    * PreCondition: none
    *
    * Input: pointer to the object
    *
    * Output: none
    *
    * Side Effects: none
    *
    * Overview: adds an object to the linked list objects for the current screen.
    *           Object will be drawn and will receive messages.
    *
    * Note: none
    *
    ********************************************************************/
    void GOLAddObject(OBJ_HEADER *object)
    {
        OBJ_HEADER  *pNextObj;

        if(_pGolObjects == NULL)
        {
            _pGolObjects = object;
        }
        else
        {
            pNextObj = _pGolObjects;
            while(pNextObj->pNxtObj != NULL)
            {
                pNextObj = (OBJ_HEADER *)pNextObj->pNxtObj;
            }

            pNextObj->pNxtObj = (void *)object;
        }

        object->pNxtObj = NULL;
    }

    /*********************************************************************
    * Function: WORD GOLDraw()
    *
    * PreCondition: none
    *
    * Input: none
    *
    * Output: non-zero if drawing is complete
    *
    * Side Effects: none
    *
    * Overview: redraws objects in the current linked list
    *
    * Note: none
    *
    ********************************************************************/
    WORD GOLDraw(void)
    {
        static OBJ_HEADER   *pCurrentObj = NULL;
        SHORT               done;

        #ifdef USE_DOUBLE_BUFFERING
        static BYTE         DisplayUpdated = 0;
        if(IsDisplayUpdatePending())
        {
            return 0;
        }
        #endif // USE_DOUBLE_BUFFERING

        if(pCurrentObj == NULL)
        {
            if(GOLDrawCallback())
            {
                #ifdef USE_TRANSITION_EFFECTS
                    if(TransitionPendingStatus)
                    {
                        #ifdef PIC24FJ256DA210_DEV_BOARD
                        TransitionPendingStatus = 0;
                        while(IsDisplayUpdatePending());
                        GFXExecutePendingTransition(_drawbuffer, (_drawbuffer == GFX_BUFFER1)?
    GFX_BUFFER2: GFX_BUFFER1);
                        #endif
                    }
                #endif

                // It's last object jump to head
                pCurrentObj = _pGolObjects;

                #ifdef USE_DOUBLE_BUFFERING
                if(DisplayUpdated)
                {
                    RequestDisplayUpdate();
                    DisplayUpdated = 0;
                    return(0);
                }
                #endif //USE_DOUBLE_BUFFERING
            }
            else
            {
                return (0);     // drawing is not done
            }
        }

        done = 0;
        while(pCurrentObj != NULL)
        {
            if(IsObjUpdated(pCurrentObj))
            {
                done = pCurrentObj->DrawObj(pCurrentObj);

                if(done)
                {
                    GOLDrawComplete(pCurrentObj);

                #ifdef USE_DOUBLE_BUFFERING

                    InvalidateRectangle(pCurrentObj->left, pCurrentObj->top,
                                        pCurrentObj->right, pCurrentObj->bottom);
                    DisplayUpdated = 1;

                #endif //USE_DOUBLE_BUFFERING

                }
                else
                {
                    return (0); // drawing is not done
                }
            }

            pCurrentObj = (OBJ_HEADER *)pCurrentObj->pNxtObj;
        }

        #if defined(USE_TRANSITION_EFFECTS) && defined(USE_DOUBLE_BUFFERING)

            TransitionPendingStatus = GFXIsTransitionPending();
            InvalidateAll(); //If needed, invalidate only the transition rectangle instead

        #endif
        return (1);             // drawing is completed
    }

    /*********************************************************************
    * Function: void GOLRedrawRec(SHORT left, SHORT top, SHORT right, SHORT bottom)
    *
    * PreCondition: none
    *
    * Input: left,top,right,bottom - rectangle borders
    *
    * Output: none
    *
    * Side Effects: none
    *
    * Overview: marks objects with parts in the rectangle to be redrawn
    *
    * Note: none
    *
    ********************************************************************/
    void GOLRedrawRec(SHORT left, SHORT top, SHORT right, SHORT bottom)
    {
        OBJ_HEADER  *pCurrentObj;

        pCurrentObj = _pGolObjects;

        while(pCurrentObj != NULL)
        {
            if
            (
                ((pCurrentObj->left >= left) && (pCurrentObj->left <= right)) ||
                ((pCurrentObj->right >= left) && (pCurrentObj->right <= right)) ||
                ((pCurrentObj->top >= top) && (pCurrentObj->top <= bottom)) ||
                ((pCurrentObj->bottom >= top) && (pCurrentObj->bottom <= bottom))
            )
            {
                GOLRedraw(pCurrentObj);
            }

            pCurrentObj = (OBJ_HEADER *)pCurrentObj->pNxtObj;
        }   //end of while
    }

    /*********************************************************************
    * Function: void GOLMsg(GOL_MSG *pMsg)
    *
    * PreCondition: none
    *
    * Input: pointer to the message
    *
    * Output: none
    *
    * Side Effects: none
    *
    * Overview: processes message for all objects in the liked list
    *
    * Note: none
    *
    ********************************************************************/
    void GOLMsg(GOL_MSG *pMsg)
    {
        OBJ_HEADER  *pCurrentObj;
        WORD        translatedMsg;

        if(pMsg->uiEvent == EVENT_INVALID)
            return;

        pCurrentObj = _pGolObjects;

        while(pCurrentObj != NULL)
        {
            if(pCurrentObj->MsgObj)
            {
                translatedMsg = pCurrentObj->MsgObj(pCurrentObj, pMsg);

                if(translatedMsg != OBJ_MSG_INVALID)
                {
                    if(GOLMsgCallback(translatedMsg, pCurrentObj, pMsg))
                        if(pCurrentObj->MsgDefaultObj)
                            pCurrentObj->MsgDefaultObj(translatedMsg, pCurrentObj, pMsg);
                }
            }

            pCurrentObj = (OBJ_HEADER *)pCurrentObj->pNxtObj;
        }
    }

    /*********************************************************************
    * Variables for rounded panel drawing. Used by GOLRndPanelDraw and GOLRndPanelDrawTsk
    ********************************************************************/
    SHORT   _rpnlX1,        // Center x position of upper left corner
    _rpnlY1,                // Center y position of upper left corner
    _rpnlX2,                // Center x position of lower right corner
    _rpnlY2,                // Center y position of lower right corner
    _rpnlR;                 // radius
    WORD    _rpnlFaceColor, // face color
    _rpnlEmbossLtColor,     // emboss light color
    _rpnlEmbossDkColor,     // emboss dark color
    _rpnlEmbossSize;        // emboss size
    void    *_pRpnlBitmap = NULL;

    /*********************************************************************
    * Function: WORD GOLPanelDrawTsk(void)
    *
    * PreCondition: parameters must be set with
    *               GOLRndPanelDraw(x,y,radius,width,height,faceClr,embossLtClr,
    *                               embossDkClr,pBitmap,embossSize)
    *
    * Input: None
    *
    * Output: Output: non-zero if drawing is completed
    *
    * Overview: draws a rounded panel on screen. Must be called repeatedly. Drawing is done
    *           when it returns non-zero.
    *
    * Note: none
    *
    ********************************************************************/
    WORD GOLPanelDrawTsk(void)
    {

            #ifndef USE_NONBLOCKING_CONFIG

        WORD    counter;


        // check if we need to draw the panels and emboss sides
        if  (
                (_pRpnlBitmap == NULL) ||
                (
                    ((_rpnlX2 - _rpnlX1 + (_rpnlR<<1)) > GetImageWidth((void *)_pRpnlBitmap))
    &&
                    ((_rpnlY2 - _rpnlY1 + (_rpnlR<<1)) > GetImageHeight((void *)_pRpnlBitmap))
    &&
                    (_pRpnlBitmap != NULL)
                )
            )
        {
            if(_rpnlR)
            {

                // draw upper left portion of the embossed area
                SetColor(_rpnlEmbossLtColor);
                Arc(_rpnlX1, _rpnlY1, _rpnlX2, _rpnlY2, _rpnlR - _rpnlEmbossSize, _rpnlR, 0xE1);
                // draw lower right portion of the embossed area
                SetColor(_rpnlEmbossDkColor);
                Arc(_rpnlX1, _rpnlY1, _rpnlX2, _rpnlY2, _rpnlR - _rpnlEmbossSize, _rpnlR, 0x1E);
            }
            else
            {

                // object is rectangular panel draw the embossed areas
                counter = 1;
                SetColor(_rpnlEmbossLtColor);
                while(counter < _rpnlEmbossSize)
                {
                    Bar(_rpnlX1 + counter, _rpnlY1 + counter, _rpnlX2 - counter, _rpnlY1 +
    counter);    // draw top
                    Bar(_rpnlX1 + counter, _rpnlY1 + counter, _rpnlX1 + counter, _rpnlY2 -
    counter);    // draw left
                    counter++;
                }

                counter = 1;
                SetColor(_rpnlEmbossDkColor);
                while(counter < _rpnlEmbossSize)
                {
                    Bar(_rpnlX1 + counter, _rpnlY2 - counter, _rpnlX2 - counter, _rpnlY2 -
    counter);    // draw bottom
                    Bar(_rpnlX2 - counter, _rpnlY1 + counter, _rpnlX2 - counter, _rpnlY2 -
    counter);    // draw right
                    counter++;
                }
            }

            // draw the face color
            SetColor(_rpnlFaceColor);
            if(_rpnlR)
                FillBevel(_rpnlX1, _rpnlY1, _rpnlX2, _rpnlY2, _rpnlR - _rpnlEmbossSize);
            else
                Bar(_rpnlX1 + _rpnlEmbossSize, _rpnlY1 + _rpnlEmbossSize, _rpnlX2 -
    _rpnlEmbossSize, _rpnlY2 - _rpnlEmbossSize);

                    #if (COLOR_DEPTH == 1)
            if(_rpnlFaceColor == _rpnlEmbossDkColor)
            {
                SetColor(_rpnlEmbossLtColor);
                if(_rpnlR)
                    Bevel(_rpnlX1, _rpnlY1, _rpnlX2, _rpnlY2, _rpnlR - (_rpnlEmbossSize - 1));
                else
                    Bevel
                    (
                        _rpnlX1 + (_rpnlEmbossSize - 1),
                        _rpnlY1 + (_rpnlEmbossSize - 1),
                        _rpnlX2 - (_rpnlEmbossSize - 1),
                        _rpnlY2 - (_rpnlEmbossSize - 1),
                        0
                    );
            }

                    #endif
        } // end of check if we need to draw the panels and emboss sides

        // draw bitmap
        if(_pRpnlBitmap != NULL)
        {
            PutImage
            (
                (((_rpnlX2 + _rpnlX1) - (GetImageWidth((void *)_pRpnlBitmap))) >> 1) + 1,
                (((_rpnlY2 + _rpnlY1) - (GetImageHeight((void *)_pRpnlBitmap))) >> 1) + 1,
                _pRpnlBitmap,
                IMAGE_NORMAL
            );
        }
        // check if we need to draw the frame
        if
        (
            (_pRpnlBitmap == NULL) ||
            (
                ((_rpnlX2 - _rpnlX1 + _rpnlR) >= GetImageWidth((void *)_pRpnlBitmap)) &&
                ((_rpnlY2 - _rpnlY1 + _rpnlR) >= GetImageHeight((void *)_pRpnlBitmap))
            )
        )
        {

            // draw the outline
            SetColor(_rpnlEmbossDkColor);
            Bevel(_rpnlX1, _rpnlY1, _rpnlX2, _rpnlY2, _rpnlR);
        }

        return (1);

            #else

        typedef enum
        {
            BEGIN,
            ARC1,
            DRAW_EMBOSS1,
            DRAW_EMBOSS2,
            DRAW_EMBOSS3,
            DRAW_EMBOSS4,
            DRAW_FACECOLOR,
                    #if (COLOR_DEPTH == 1)
            DRAW_INNERFRAME,
                    #endif
            DRAW_FRAME,
            DRAW_IMAGE,
        } ROUND_PANEL_DRAW_STATES;

        static ROUND_PANEL_DRAW_STATES state = BEGIN;
        static WORD counter;

        while(1)
        {
            if(IsDeviceBusy())
                return (0);
            switch(state)
            {
                case BEGIN:

                    // check if we need to draw the face and emboss
                    if (_pRpnlBitmap != NULL)
                    {
                        if  (
                            ((_rpnlX2 - _rpnlX1 + (_rpnlR<<1)) <= GetImageWidth((void
    *)_pRpnlBitmap)) &&
                            ((_rpnlY2 - _rpnlY1 + (_rpnlR<<1)) <= GetImageHeight((void
    *)_pRpnlBitmap))
                            )
                        {
                            state = DRAW_IMAGE;
                            goto rnd_panel_draw_image;
                        }
                    }

                    if(_rpnlR)
                    {

                        // draw upper left portion of the embossed area
                        SetColor(_rpnlEmbossLtColor);
                        if(!Arc(_rpnlX1, _rpnlY1, _rpnlX2, _rpnlY2, _rpnlR - _rpnlEmbossSize,
    _rpnlR, 0xE1))
                            return (0);
                        state = ARC1;
                    }
```

```
                  else
                  {
                      state = DRAW_EMBOSS1;
                      counter = 1;
                      goto rnd_panel_draw_emboss;
                  }

              case ARC1:

                  // draw upper left portion of the embossed area
                  SetColor(_rpnlEmbossDkColor);
                  if(!Arc(_rpnlX1, _rpnlY1, _rpnlX2, _rpnlY2, _rpnlR - _rpnlEmbossSize,
_rpnlR, 0x1E))
                      return (0);
                  state = DRAW_FACECOLOR;
                  goto rnd_panel_draw_facecolor;

              // now draw the upper portion of the embossed area
              case DRAW_EMBOSS1:
                  rnd_panel_draw_emboss : SetColor(_rpnlEmbossLtColor);
                  while(counter < _rpnlEmbossSize)
                  {

                      // draw top
                      if(!Bar(_rpnlX1 + counter, _rpnlY1 + counter, _rpnlX2 - counter,
_rpnlY1 + counter))
                      {
                          return (0);
                      }

                      counter++;
                  }

                  counter = 1;
                  state = DRAW_EMBOSS2;
                  break;

              case DRAW_EMBOSS2:
                  while(counter < _rpnlEmbossSize)
                  {

                      // draw left
                      if(!Bar(_rpnlX1 + counter, _rpnlY1 + counter, _rpnlX1 + counter,
_rpnlY2 - counter))
                      {
                          return (0);
                      }

                      counter++;
                  }

                  counter = 1;
                  state = DRAW_EMBOSS3;
                  break;

              // now draw the lower portion of the embossed area
              case DRAW_EMBOSS3:
                  SetColor(_rpnlEmbossDkColor);
                  while(counter < _rpnlEmbossSize)
                  {

                      // draw bottom
                      if(!Bar(_rpnlX1 + counter, _rpnlY2 - counter, _rpnlX2 - counter,
_rpnlY2 - counter))
                      {
                          return (0);
                      }

                      counter++;
                  }

                  counter = 1;
```

```
                state = DRAW_EMBOSS4;
                break;

            case DRAW_EMBOSS4:
                while(counter < _rpnlEmbossSize)
                {

                    // draw right
                    if(!Bar(_rpnlX2 - counter, _rpnlY1 + counter, _rpnlX2 - counter,
_rpnlY2 - counter))
                    {
                        return (0);
                    }

                    counter++;
                }

                state = DRAW_FACECOLOR;
                break;

            // draw the face color
            case DRAW_FACECOLOR:
                rnd_panel_draw_facecolor : SetColor(_rpnlFaceColor);
                if(_rpnlR)
                {
                    #ifdef USE_GRADIENT
                    if(_gradientScheme.gradientType != GRAD_NONE)
                    {
                       BevelGradient(_rpnlX1, _rpnlY1, _rpnlX2, _rpnlY2, _rpnlR -
_rpnlEmbossSize,
                                      _gradientScheme.gradientStartColor,_gradientScheme.grad
ientEndColor,
                                     _gradientScheme.gradientLength,_gradientScheme.gradientT
ype);
                    }
                   else
                   #endif


                    if(!FillBevel(_rpnlX1, _rpnlY1, _rpnlX2, _rpnlY2, _rpnlR -
_rpnlEmbossSize))
                        return (0);
                }
                else
                {
                    if
                    (
                        !Bar
                            (
                                _rpnlX1 + _rpnlEmbossSize,
                                _rpnlY1 + _rpnlEmbossSize,
                                _rpnlX2 - _rpnlEmbossSize,
                                _rpnlY2 - _rpnlEmbossSize
                            )
                    )
                    {
                        return (0);
                    }
                }

                state = DRAW_IMAGE;
                break;

            case DRAW_IMAGE:
                rnd_panel_draw_image :
                if(_pRpnlBitmap != NULL)
                {
                    if
                    (
                        !PutImage
                            (
                                ((_rpnlX2 + _rpnlX1 - GetImageWidth((void *)_pRpnlBitmap))
>> 1) + 1,
                                ((_rpnlY2 + _rpnlY1 - GetImageHeight((void *)_pRpnlBitmap))
>> 1) + 1,
                                _pRpnlBitmap,
                                IMAGE_NORMAL
                            )
                    )
                    {
                        return (0);
                    }
                }

                        #if (COLOR_DEPTH == 1)
                state = DRAW_INNERFRAME;
                break;
                        #else
                state = DRAW_FRAME;
                        #endif
                break;

                        #if (COLOR_DEPTH == 1)

            case DRAW_INNERFRAME:
                if(_rpnlFaceColor == _rpnlEmbossDkColor)
                {
                    SetColor(_rpnlEmbossLtColor);
                    if(_rpnlR)
                    {
                        if(!Bevel(_rpnlX1, _rpnlY1, _rpnlX2, _rpnlY2, _rpnlR -
(_rpnlEmbossSize - 1)))
                        {
                            return (0);
                        }
                    }
                    else
                    {
                        if(!Bevel(  _rpnlX1 + (_rpnlEmbossSize - 1),
                                    _rpnlY1 + (_rpnlEmbossSize - 1),
                                    _rpnlX2 - (_rpnlEmbossSize - 1),
                                    _rpnlY2 - (_rpnlEmbossSize - 1),
                                    0 ))
                        {
                            return (0);
                        }
                    }
                }

                state = DRAW_FRAME;
                break;
                        #endif

            case DRAW_FRAME:

                // check if we need to draw the frame
                if
                (
                    (_pRpnlBitmap == NULL) ||
                    (
                        ((_rpnlX2 - _rpnlX1 + _rpnlR) >= GetImageWidth((void
*)_pRpnlBitmap)) &&
                        ((_rpnlY2 - _rpnlY1 + _rpnlR) >= GetImageHeight((void
*)_pRpnlBitmap))
                    )
                )
                {

                    // draw the outline frame
                            #if (COLOR_DEPTH == 1)
                    // When in 1BPP mode, the outline should always be the light color
                    // Ideally WHITE.
                    if (_rpnlEmbossLtColor > _rpnlEmbossDkColor)
```

```
                        SetColor(_rpnlEmbossLtColor);
                    else
                        SetColor(_rpnlEmbossDkColor);
                            #else
                    SetColor(_rpnlEmbossDkColor);
                            #endif
                    if(!Bevel(_rpnlX1, _rpnlY1, _rpnlX2, _rpnlY2, _rpnlR))
                    {
                        return (0);
                    }
                }

                state = BEGIN;
                return (1);
        }   // end of switch
    }       // end of while
        #endif //#ifndef USE_NONBLOCKING_CONFIG
}


/*********************************************************************
* Function: WORD GOLTwoTonePanelDrawTsk(void)
*
* PreCondition: parameters must be set with
*               GOLRndPanelDraw(x,y,radius,width,height,faceClr,embossLtClr,
*                               embossDkClr,pBitmap,embossSize)
*
* Input: None
*
* Output: Output: non-zero if drawing is completed
*
* Overview: draws a rounded panel on screen. Must be called repeatedly. Drawing is done
*           when it returns non-zero.
*
* Note: none
*
********************************************************************/
WORD GOLTwoTonePanelDrawTsk(void)
{
// In this panel draw task the emboss light and dark colors are used as
// the panel face colors and the panel face color is used as an outline color

        #ifndef USE_NONBLOCKING_CONFIG

    WORD    counter;

    SetColor(_rpnlFaceColor);
    if(_rpnlR)
    {
        // draw the outline
        Arc(_rpnlX1, _rpnlY1, _rpnlX2, _rpnlY2, _rpnlR - _rpnlEmbossSize, _rpnlR, 0xFF);
    }
    else
    {
        // object is rectangular panel draw the outline embossed areas
        counter = 1;
        while(counter < _rpnlEmbossSize)
        {
            Bar(_rpnlX1 + counter, _rpnlY1 + counter, _rpnlX2 - counter, _rpnlY1 +
counter);    // draw top
            Bar(_rpnlX1 + counter, _rpnlY1 + counter, _rpnlX1 + counter, _rpnlY2 -
counter);    // draw left
            Bar(_rpnlX1 + counter, _rpnlY2 - counter, _rpnlX2 - counter, _rpnlY2 -
counter);    // draw bottom
            Bar(_rpnlX2 - counter, _rpnlY1 + counter, _rpnlX2 - counter, _rpnlY2 -
counter);    // draw right
            counter++;
        }
    }

    // draw the top half of the face
    SetColor(_rpnlEmbossLtColor);
    if(_rpnlR)
    {
        SetBevelDrawType(DRAWTOPBEVEL);
        FillBevel(_rpnlX1, _rpnlY1, _rpnlX2, _rpnlY2, _rpnlR - _rpnlEmbossSize);
    }
    else
    {
        Bar(_rpnlX1 + _rpnlEmbossSize, _rpnlY1 + _rpnlEmbossSize,
            _rpnlX2 - _rpnlEmbossSize, (_rpnlY1 + ((_rpnlY2 - _rpnlY1) >> 1)));
    }

    // draw the bottom half of the face
    SetColor(_rpnlEmbossDkColor);
    if(_rpnlR)
    {
        SetBevelDrawType(DRAWBOTTOMBEVEL);
        FillBevel(_rpnlX1, _rpnlY1, _rpnlX2, _rpnlY2, _rpnlR - _rpnlEmbossSize);
    }
    else
    {
        Bar(_rpnlX1 + _rpnlEmbossSize, (_rpnlY1 + ((_rpnlY2 - _rpnlY1) >> 1)) + 1,
            _rpnlX2 - _rpnlEmbossSize, _rpnlY2 - _rpnlEmbossSize);
    }

    SetBevelDrawType(DRAWFULLBEVEL);


            #if (COLOR_DEPTH == 1)
    if(_rpnlFaceColor == _rpnlEmbossDkColor)
    {
        SetColor(_rpnlEmbossLtColor);
        if(_rpnlR)
            Bevel(_rpnlX1, _rpnlY1, _rpnlX2, _rpnlY2, _rpnlR - (_rpnlEmbossSize - 1));
        else
            Bevel
            (
                _rpnlX1 + (_rpnlEmbossSize - 1),
                _rpnlY1 + (_rpnlEmbossSize - 1),
                _rpnlX2 - (_rpnlEmbossSize - 1),
                _rpnlY2 - (_rpnlEmbossSize - 1),
                0
            );
    }

            #endif

    // draw bitmap
    if(_pRpnlBitmap != NULL)
    {
        PutImage
        (
            (((_rpnlX2 + _rpnlX1) - (GetImageWidth((void *)_pRpnlBitmap))) >> 1) + 1,
            (((_rpnlY2 + _rpnlY1) - (GetImageHeight((void *)_pRpnlBitmap))) >> 1) + 1,
            _pRpnlBitmap,
            IMAGE_NORMAL
        );
    }

    return (1);

        #else

    typedef enum
    {
        BEGIN,
        DRAW_EMBOSS1,
        DRAW_EMBOSS2,
        DRAW_EMBOSS3,
        DRAW_EMBOSS4,
        DRAW_FACECOLOR1,
        DRAW_FACECOLOR2,
                #if (COLOR_DEPTH == 1)
        DRAW_INNERFRAME,
                #endif
        DRAW_IMAGE,
    } ROUND_PANEL_DRAW_STATES;

    static ROUND_PANEL_DRAW_STATES state = BEGIN;
    static WORD counter;

    while(1)
    {
        if(IsDeviceBusy())
            return (0);
        switch(state)
        {
            case BEGIN:
                if(_rpnlR)
                {

                    // draw the outline
                    SetColor(_rpnlFaceColor);
                    if(!Arc(_rpnlX1, _rpnlY1, _rpnlX2, _rpnlY2, _rpnlR - _rpnlEmbossSize,
_rpnlR, 0xFF))
                        return (0);
                    state = DRAW_FACECOLOR1;
                }
                else
                {
                    state = DRAW_EMBOSS1;
                    counter = 1;
                    goto rnd_panel_draw_emboss;
                }

            // now draw the upper portion of the embossed area
            case DRAW_EMBOSS1:
                rnd_panel_draw_emboss : SetColor(_rpnlFaceColor);
                while(counter < _rpnlEmbossSize)
                {

                    // draw top
                    if(!Bar(_rpnlX1 + counter, _rpnlY1 + counter, _rpnlX2 - counter,
_rpnlY1 + counter))
                    {
                        return (0);
                    }

                    counter++;
                }

                counter = 1;
                state = DRAW_EMBOSS2;
                break;

            case DRAW_EMBOSS2:
                while(counter < _rpnlEmbossSize)
                {

                    // draw left
                    if(!Bar(_rpnlX1 + counter, _rpnlY1 + counter, _rpnlX1 + counter,
_rpnlY2 - counter))
                    {
                        return (0);
                    }

                    counter++;
                }

                counter = 1;
                state = DRAW_EMBOSS3;
                break;

            // now draw the lower portion of the embossed area
            case DRAW_EMBOSS3:
                //SetColor(_rpnlEmbossDkColor);
                while(counter < _rpnlEmbossSize)
                {

                    // draw bottom
                    if(!Bar(_rpnlX1 + counter, _rpnlY2 - counter, _rpnlX2 - counter,
_rpnlY2 - counter))
                    {
                        return (0);
                    }

                    counter++;
                }

                counter = 1;
                state = DRAW_EMBOSS4;
                break;

            case DRAW_EMBOSS4:
                while(counter < _rpnlEmbossSize)
                {

                    // draw right
                    if(!Bar(_rpnlX2 - counter, _rpnlY1 + counter, _rpnlX2 - counter,
_rpnlY2 - counter))
                    {
                        return (0);
                    }

                    counter++;
                }

                state = DRAW_FACECOLOR1;
                break;

            // draw the top half of the face
            case DRAW_FACECOLOR1:
                SetColor(_rpnlEmbossLtColor);
                if(_rpnlR)
                {
                    SetBevelDrawType(DRAWTOPBEVEL);
                    if(!FillBevel(_rpnlX1, _rpnlY1, _rpnlX2, _rpnlY2, _rpnlR -
_rpnlEmbossSize))
                        return (0);
                }
                else
                {
                    if
                    (
                        !Bar
                            (
                                _rpnlX1 + _rpnlEmbossSize,
                                _rpnlY1 + _rpnlEmbossSize,
                                _rpnlX2 - _rpnlEmbossSize,
                                (_rpnlY1 + ((_rpnlY2 - _rpnlY1) >>
1))
                            )
                    )
                    {
                        return (0);
                    }
                }

                state = DRAW_FACECOLOR2;
                break;

            // draw the bottom half of the face
            case DRAW_FACECOLOR2:
                SetColor(_rpnlEmbossDkColor);
                if(_rpnlR)
                {
                    SetBevelDrawType(DRAWBOTTOMBEVEL);
                    if(!FillBevel(_rpnlX1, _rpnlY1, _rpnlX2, _rpnlY2, _rpnlR -
_rpnlEmbossSize))
                        return (0);
                }
                else
                {
                    if
                    (
                        !Bar
                            (
                                _rpnlX1 + _rpnlEmbossSize,
                                (_rpnlY1 + ((_rpnlY2 - _rpnlY1) >> 1)) + 1,
                                _rpnlX2 - _rpnlEmbossSize,
                                _rpnlY2 - _rpnlEmbossSize
                            )
                    )
                    {
                        return (0);
                    }
                }
                SetBevelDrawType(DRAWFULLBEVEL);
                state = DRAW_IMAGE;
                break;

            case DRAW_IMAGE:
                if(_pRpnlBitmap != NULL)
                {
                    if
                    (
                        !PutImage
                            (
                                ((_rpnlX2 + _rpnlX1 - GetImageWidth((void *)_pRpnlBitmap))
>> 1) + 1,
                                ((_rpnlY2 + _rpnlY1 - GetImageHeight((void *)_pRpnlBitmap))
>> 1) + 1,
                                _pRpnlBitmap,
                                IMAGE_NORMAL
                            )
                    )
                    {
                        return (0);
                    }
                }

                        #if (COLOR_DEPTH == 1)
                state = DRAW_INNERFRAME;
                break;
                        #else
                state = BEGIN;
                return (1);
                        #endif
                break;

                        #if (COLOR_DEPTH == 1)

            case DRAW_INNERFRAME:
                if(_rpnlFaceColor == _rpnlEmbossDkColor)
                {
                    SetColor(_rpnlEmbossLtColor);
                    if(_rpnlR)
                    {
                        if(!Bevel(_rpnlX1, _rpnlY1, _rpnlX2, _rpnlY2, _rpnlR -
(_rpnlEmbossSize - 1)))
                        {
                            return (0);
                        }
                    }
                    else
                    {
                        if(!Bevel(  _rpnlX1 + (_rpnlEmbossSize - 1),
                                    _rpnlY1 + (_rpnlEmbossSize - 1),
                                    _rpnlX2 - (_rpnlEmbossSize - 1),
                                    _rpnlY2 - (_rpnlEmbossSize - 1),
                                    0 ))
                        {
                            return (0);
                        }
                    }
                }

                state = BEGIN;
                return (1);
                        #endif

        }   // end of switch
    }       // end of while
        #endif //#ifndef USE_NONBLOCKING_CONFIG
}

#endif // USE_GOL
```

14.1.2 GOL.h

Enumerations

Name	Description
GOL_OBJ_TYPE (see page 67)	This structure defines the Object types used in the library.
INPUT_DEVICE_EVENT (see page 333)	This structure defines the types of GOL (see page 64) message events used in the library.
INPUT_DEVICE_TYPE (see page 333)	This structure defines the types of input devices used in the library.
TRANS_MSG (see page 331)	This structure defines the list of translated messages for GOL (see page 64) Objects used in the library.

Functions

	Name	Description
◆	GOLAddObject (see page 306)	This function adds an object to the tail of the active list pointed to by _pGolObjects (see page 349). The new list tail is set to point to NULL.
◆	GOLCanBeFocused (see page 321)	This function returns non-zero if the object can be focused. Only button, check box, radio button, slider, edit box, list box, scroll bar can accept focus. If the object is disabled it cannot be set to focused state.
◆	GOLCreateScheme (see page 343)	This function creates a new style scheme object and initializes the parameters to default values. Default values are based on the GOLSchemeDefault (see page 347) defined in GOLSchemeDefault.c file. Application code can override this initialization, See GOLSchemeDefault (see page 347).
◆	GOLDeleteObject (see page 315)	deletes an object to the linked list objects for the current screen.
◆	GOLDeleteObjectByID (see page 315)	Deletes an object in the current active linked list of objects using the ID parameter of the object.
◆	GOLDraw (see page 310)	This function loops through the active list and redraws objects that need to be redrawn. Partial redrawing or full redraw is performed depending on the drawing states of the objects. GOLDrawCallback (see page 311)() function is called by GOLDraw() when drawing of objects in the active list is completed.
◆	GOLDrawCallback (see page 311)	GOLDrawCallback() function MUST BE implemented by the user. This is called inside the GOLDraw (see page 310)() function when the drawing of objects in the active list is completed. User drawing must be done here. Drawing color, line type, clipping region, graphic cursor position and current font will not be changed by GOL (see page 64) if this function returns a zero. To pass drawing control to GOL (see page 64) this function must return a non-zero value. If GOL (see page 64) messaging is not using the active link list, it is safe to modify the list here.

	GOLFindObject (see page 307)	This function finds an object in the active list pointed to by _pGolObjects (see page 349) using the given object ID.
	GOLFree (see page 312)	This function frees all the memory used by objects in the active list and initializes _pGolObjects (see page 349) pointer to NULL to start a new empty list. This function must be called only inside the GOLDrawCallback (see page 311)()function when using GOLDraw (see page 310)() and GOLMsg (see page 328)() functions. This requirement assures that primitive rendering settings are not altered by the rendering state machines of the objects.
	GOLGetFocusNext (see page 321)	This function returns the pointer to the next object in the active linked list which is able to receive keyboard input.
	GOLGetFocusPrev (see page 322)	This function returns the pointer to the previous object in the active linked list which is able to receive keyboard input.
	GOLInit (see page 320)	This function initializes the graphics library and creates a default style scheme with default settings referenced by the global scheme pointer. GOLInit() function must be called before GOL (see page 64) functions can be used. It is not necessary to call GraphInit() function if this function is used.
	GOLMsg (see page 328)	This function receives a GOL (see page 64) message from user and loops through the active list of objects to check which object is affected by the message. For affected objects the message is translated and GOLMsgCallback (see page 328)() is called. In the call back function, user has the ability to implement action for the message. If the call back function returns non-zero OBJMsgDefault() is called to process message for the object by default. If zero is returned OBJMsgDefault() is not called. Please refer to GOL (see page 64) Messages section for deatils. This function should be called when GOL (see page 64) drawing is completed. It can be done... more (see page 328)
	GOLMsgCallback (see page 328)	The user MUST implement this function. GOLMsg (see page 328)() calls this function when a valid message for an object in the active list is received. User action for the message should be implemented here. If this function returns non-zero, the message for the object will be processed by default. If zero is returned, GOL (see page 64) will not perform any action.
	GOLPanelDrawTsk (see page 324)	This function draws a panel on the screen with parameters set by GOLPanelDraw (see page 322)() macro. This function must be called repeatedly (depending on the return value) for a successful rendering of the panel.
	GOLRedrawRec (see page 309)	This function marks all objects in the active list intersected by the given rectangular area to be redrawn.
	GOLSetFocus (see page 318)	This function sets the keyboard input focus to the object. If the object cannot accept keyboard messages focus will not be changed. This function resets FOCUSED (see page 301) state for the object was in focus previously, set FOCUSED (see page 301) state for the required object and marks the objects to be redrawn.
	GOLTwoTonePanelDrawTsk (see page 324)	This function draws a two tone panel on the screen with parameters set by GOLPanelDraw (see page 322)() macro. This function must be called repeatedly (depending on the return value) for a successful rendering of the panel.

Macros

Name	Description
ClrState (see page 303)	This macro clear the state bits of an object. Object must be redrawn to display the changes. It is possible to clear several state bits with this macro.
DISABLED (see page 301)	Disabled state bit.
DRAW (see page 301)	Object redraw state bit. The whole Object must be redrawn.
DRAW_FOCUS (see page 302)	Focus redraw state bit. The focus rectangle must be redrawn.
DRAW_UPDATE (see page 302)	Partial Object redraw state bit. A part or parts of of the Object must be redrawn to show updated state.
FOCUSED (see page 301)	Focus state bit.
GetObjID (see page 313)	This macro returns the object ID.

GetObjNext (see page 314)	This macro returns the next object after the specified object.
GetObjType (see page 313)	This macro returns the object type.
GetState (see page 302)	This macro retrieves the current value of the state bits of an object. It is possible to get several state bits.
GOL_EMBOSS_SIZE (see page 347)	This option defines the 3-D effect emboss size for objects. The default value of this is 3 set in GOL.h. If it is not defined in GraphicsConfig.h (see page 945) file then the default value is used.
GOLDrawComplete (see page 310)	This macro resets the drawing states of the object (6 MSBits of the object's state).
GOLGetFocus (see page 320)	This macro returns the pointer to the current object receiving keyboard input.
GOLGetList (see page 317)	This macro gets the current active list.
GOLGetScheme (see page 344)	This macro gets the GOL (see page 64) scheme used by the given object.
GOLGetSchemeDefault (see page 345)	This macro returns the default GOL (see page 64) scheme pointer.
GOLNewList (see page 316)	This macro starts a new linked list of objects and resets the keyboard focus to none. This macro assigns the current active list _pGolObjects (see page 349) and current receiving keyboard input _pObjectFocused (see page 349) object pointers to NULL. Any keyboard inputs at this point will be ignored. Previous active list must be saved in another pointer if to be referenced later. If not needed anymore memory used by that list should be freed by GOLFree (see page 312)() function.
GOLPanelDraw (see page 322)	This macro sets the parameters to draw a panel. Panel is not an object. It will not be added to the active list. Use GOLPanelDrawTsk (see page 324)() to display the panel on the screen. The following relationships of the parameters determines the general shape of the button: 1. Panel width is determined by right - left. 2. Panel height is determined by top - bottom. 3. Panel radius - specifies if the panel will have a rounded edge. If zero then the panel will have sharp (cornered) edge. 4. If 2*radius = height = width, the panel is circular.
GOLRedraw (see page 308)	This macro sets the object to be redrawn. For the redraw to be effective, the object must be in the current active list. If not, the redraw action will not be performed until the list where the object is currently inserted will be set to be the active list.
GOLSetList (see page 317)	This macro sets the given object list as the active list and resets the keyboard focus to none. This macro assigns the receiving keyboard input object _pObjectFocused (see page 349) pointer to NULL. If the new active list has an object's state set to focus, the _pObjectFocused (see page 349) pointer must be set to this object or the object's state must be change to unfocused. This is to avoid two objects displaying a focused state when only one object in the active list must be set to a focused state at anytime.
GOLSetScheme (see page 343)	This macro sets the GOL (see page 64) scheme to be used for the object.
HIDE (see page 301)	Object hide state bit. Object will be hidden from the screen by drawing over it the common background color.
IsObjUpdated (see page 319)	This macro tests if the object is pending to be redrawn. This is done by testing the 6 MSBits of object's state to detect if the object must be redrawn.
SetState (see page 303)	This macro sets the state bits of an object. Object must be redrawn to display the changes. It is possible to set several state bits with this macro.

Structures

Name	Description
GOL_MSG (see page 330)	This structure defines the GOL (see page 64) message used in the library. • The types must be one of the INPUT_DEVICE_TYPE (see page 333): • TYPE_UNKNOWN • TYPE_KEYBOARD • TYPE_TOUCHSCREEN • TYPE_MOUSE • uiEvent must be one of the INPUT_DEVICE_EVENT (see page 333). • for touch screen: • EVENT_INVALID • EVENT_MOVE • EVENT_PRESS • EVENT_STILLPRESS • EVENT_RELEASE • for keyboard: • EVENT_KEYSCAN (param2 contains scan code) • EVENT_KEYCODE (param2 contains character code) • param1: • for touch screen is the x position • for keyboard ID of object receiving the message • param2 • for touch screen y position • for keyboard scan or key code
GOL_SCHEME (see page 345)	GOL (see page 64) scheme defines the style scheme to be used by an object.
OBJ_HEADER (see page 68)	This structure defines the first nine fields of the Objects structure. This allows generic operations on library Objects.

Types

Name	Description
DRAW_FUNC (see page 69)	object draw function pointer typedef
FREE_FUNC (see page 69)	object free function pointer typedef
MSG_DEFAULT_FUNC (see page 69)	object default message function pointer typedef
MSG_FUNC (see page 70)	object message function pointer typedef

Variables

Name	Description
_pDefaultGolScheme (see page 349)	Pointer to the GOL (see page 64) default scheme (GOL_SCHEME (see page 345)). This scheme is created in GOLInit (see page 320)() function. GOL (see page 64) scheme defines the style scheme to be used by an object. Use GOLGetSchemeDefault (see page 345)() to get this pointer.
_pGolObjects (see page 349)	Pointer to the current linked list of objects displayed and receiving messages. GOLDraw (see page 310)() and GOLMsg (see page 328)() process objects referenced by this pointer.

_pObjectFocused (see page 349)	Pointer to the object receiving keyboad input. This pointer is used or modified by the following APIs: • GOLSetFocus (see page 318)() • GOLGetFocus (see page 320)() • GOLGetFocusNext (see page 321)() • GOLGetFocusPrev (see page 322)() • GOLCanBeFocused (see page 321)()
FONTDEFAULT (see page 346)	Default GOL (see page 64) font.

Description

This is file GOL.h.

Body Source

```
/*****************************************************************************
 *  Module for Microchip Graphics Library
 *  GOL Layer
 *****************************************************************************
 * FileName:        GOL.h
 * Processor:       PIC24F, PIC24H, dsPIC, PIC32
 * Compiler:        MPLAB C30, MPLAB C32
 * Company:         Microchip Technology Incorporated
 *
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 *
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 * INDIRECT, PUNITIVE OR CONSEQUENTIAL DAMAGES, LOST PROFITS OR LOST DATA,
 * COST OF PROCUREMENT OF SUBSTITUTE GOODS, TECHNOLOGY, SERVICES, OR ANY
 * CLAIMS BY THIRD PARTIES (INCLUDING BUT NOT LIMITED TO ANY DEFENSE THEREOF),
 * OR OTHER SIMILAR COSTS.
 *
 * Date         Comment
 *~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
 * 11/12/07     Version 1.0 release
 * 06/29/09     Added BTN_MSG_STILLPRESSED message for
 *              button object and EVENT_STILLPRESS for
 *              INPUT_DEVICE_EVENT list.
 * 10/04/10     FONTDEFAULT can now be modified by the user without
 *              modifying the library files. To replace default font
 *              (GOLFontDefault found in the library supplied GOLFontDefault.c
 *              file) user must add this line in the GraphicsConfig.h file:
 *                  #define FONTDEFAULT userFont where "userFont" is the
 *              user supplied font.
 * 02/24/11     Replace color data type to GFX_COLOR
 *****************************************************************************/
#ifndef _GOL_H
    #define _GOL_H

/*********************************************************************
```

```
 * Section: Includes
 *********************************************************************/
#include "Graphics/Primitive.h"
#include "GenericTypeDefs.h"
#include "Graphics/gfxcolors.h"
#include "GraphicsConfig.h"

/*********************************************************************
* Overview: GOL scheme defines the style scheme to be used by an object.
*
*********************************************************************/
typedef struct
{
    GFX_COLOR    EmbossDkColor;     // Emboss dark color used for 3d effect.
    GFX_COLOR    EmbossLtColor;     // Emboss light color used for 3d effect.
    GFX_COLOR    TextColor0;        // Character color 0 used for objects that supports
text.
    GFX_COLOR    TextColor1;        // Character color 1 used for objects that supports
text.
    GFX_COLOR    TextColorDisabled; // Character color used when object is in a disabled
state.
    GFX_COLOR    Color0;            // Color 0 usually assigned to an Object state.
    GFX_COLOR    Color1;            // Color 1 usually assigned to an Object state.
    GFX_COLOR    ColorDisabled;     // Color used when an Object is in a disabled state.
    GFX_COLOR    CommonBkColor;     // Background color used to hide Objects.
    void        *pFont;             // Font selected for the scheme.

    #ifdef USE_ALPHABLEND
    BYTE    AlphaValue;             // Alpha value used for alpha blending, this is
available only when USE_ALPHABLEND is defined in the GraphicsConfig.h.
    #endif

    #ifdef USE_GRADIENT
    GFX_GRADIENT_STYLE gradientScheme;   // Gradient Scheme for widgets, this is available
only when USE_GRADIENT is defined in the GraphicsConfig.h.
    #endif
} GOL_SCHEME;

#ifdef USE_GRADIENT
extern GFX_GRADIENT_STYLE _gradientScheme;
#endif


/*********************************************************************
* Overview: Pointer to the GOL default scheme (GOL_SCHEME). This
*           scheme is created in GOLInit() function. GOL scheme
*           defines the style scheme to be used by an object.
*           Use GOLGetSchemeDefault() to get this pointer.
*
*********************************************************************/
extern GOL_SCHEME   *_pDefaultGolScheme;

/*********************************************************************
* Overview: This structure defines the Object types used in the library.
*
*********************************************************************/
typedef enum
{
    OBJ_BUTTON,                     // Type defined for Button Object.
    OBJ_WINDOW,                     // Type defined for Window Object.
    OBJ_CHECKBOX,                   // Type defined for Check Box Object.
    OBJ_RADIOBUTTON,                // Type defined for Radio Button Object.
    OBJ_EDITBOX,                    // Type defined for Edit Box Object.
    OBJ_LISTBOX,                    // Type defined for List Box Object.
    OBJ_SLIDER,                     // Type defined for Slider and/or Scroll Bar Object.
    OBJ_PROGRESSBAR,                // Type defined for Progress Object.
    OBJ_STATICTEXT,                 // Type defined for Static Text Object.
    OBJ_PICTURE,                    // Type defined for Picture or Bitmap Object.
    OBJ_GROUPBOX,                   // Type defined for Group Box Object.
    OBJ_CUSTOM,                     // Type defined for Custom Object.
    OBJ_ROUNDDIAL,                  // Type defined for Dial Object.
    OBJ_METER,                      // Type defined for Meter Object.
    OBJ_GRID,                       // Type defined for Grid Object.
    OBJ_CHART,                      // Type defined for Chart Object.
    OBJ_TEXTENTRY,                  // Type defined for Text-Entry Object.
    OBJ_DIGITALMETER,               // Type defined for DIGITALMETER Object.
    OBJ_ANALOGCLOCK,                // Type defined for ANALOGCLOCK Object.
    OBJ_UNKNOWN                     // Type is undefined and not supported by the library.
} GOL_OBJ_TYPE;

/*********************************************************************
* Overview: This structure defines the GOL message used in the library.
*    - The types must be one of the INPUT_DEVICE_TYPE:
*        - TYPE_UNKNOWN
*        - TYPE_KEYBOARD
*        - TYPE_TOUCHSCREEN
*        - TYPE_MOUSE
*    - uiEvent must be one of the INPUT_DEVICE_EVENT.
*        - for touch screen:
*            - EVENT_INVALID
*            - EVENT_MOVE
*            - EVENT_PRESS
*            - EVENT_STILLPRESS
*            - EVENT_RELEASE
*        - for keyboard:
*            - EVENT_KEYSCAN (param2 contains scan code)
*            - EVENT_KEYCODE (param2 contains character code)
*    - param1:
*        - for touch screen is the x position
*        - for keyboard ID of object receiving the message
*    - param2
*        - for touch screen y position
*        - for keyboard scan or key code
*
*********************************************************************/
typedef struct
{
    BYTE    type;                   // Type of input device.
    BYTE    uiEvent;                // The generic events for input device.
    SHORT   param1;                 // Parameter 1 meaning is dependent on the type of
input device.
    SHORT   param2;                 // Parameter 2 meaning is dependent on the type of
input device.
} GOL_MSG;

/*********************************************************************
* Overview: This structure defines the types of input devices
*           used in the library.
*
*********************************************************************/
typedef enum
{
    TYPE_UNKNOWN    = 0,            // Unknown device.
    TYPE_KEYBOARD,                  // Keyboard.
    TYPE_TOUCHSCREEN,               // Touchscreen.
    TYPE_MOUSE,                     // Mouse.
    TYPE_TIMER,                     // Timer.
    TYPE_SYSTEM                     // System Messages.
} INPUT_DEVICE_TYPE;

/*********************************************************************
* Overview: This structure defines the types of GOL message events
*           used in the library.
*
*********************************************************************/
typedef enum
{
    EVENT_INVALID   = 0,            // An invalid event.
    EVENT_MOVE,                     // A move event.
    EVENT_PRESS,                    // A press event.
    EVENT_STILLPRESS,               // A continuous press event.
    EVENT_RELEASE,                  // A release event.
    EVENT_KEYSCAN,                  // A keyscan event, parameters has the object ID
keyboard scan code.
```

```
    EVENT_CHARCODE,                 // Character code is presented at the parameters.
    EVENT_SET,                      // A generic set event.
    EVENT_SET_STATE,                // A set state event.
    EVENT_CLR_STATE                 // A clear state event.
} INPUT_DEVICE_EVENT;

/*********************************************************************
* Overview: This structure defines the list of translated messages for
*           GOL Objects used in the library.
*
*********************************************************************/
typedef enum
{
    OBJ_MSG_INVALID         = 0,    // Invalid message response.
    CB_MSG_CHECKED,                 // Check Box check action ID.
    CB_MSG_UNCHECKED,               // Check Box un-check action ID.
    RB_MSG_CHECKED,                 // Radio Button check action ID.
    WND_MSG_CLIENT,                 // Window client area selected action ID.
    WND_MSG_TITLE,                  // Window title bar selected action ID.
    BTN_MSG_PRESSED,                // Button pressed action ID.
    BTN_MSG_STILLPRESSED,           // Button is continuously pressed ID.
    BTN_MSG_RELEASED,               // Button released action ID.
    BTN_MSG_CANCELPRESS,            // Button released action ID with button press canceled.
    PICT_MSG_SELECTED,              // Picture selected action ID.
    GB_MSG_SELECTED,                // Group Box selected action ID.
    CC_MSG_SELECTED,                // Custom Control selected action ID.
    SLD_MSG_INC,                    // Slider or Scroll Bar increment action ID.
    SLD_MSG_DEC,                    // Slider or Scroll Bar decrement action ID.
    ST_MSG_SELECTED,                // Static Text selected action ID.
    DM_MSG_SELECTED,                // Digital Meter selected action ID.
    PB_MSG_SELECTED,                // Progress Bar selected action ID.
    RD_MSG_CLOCKWISE,               // Dial move clockwise action ID.
    RD_MSG_CTR_CLOCKWISE,           // Dial move counter clockwise action ID.
    MTR_MSG_SET,                    // Meter set value action ID.
    EB_MSG_CHAR,                    // Edit Box insert character action ID.
    EB_MSG_DEL,                     // Edit Box remove character action ID.
    EB_MSG_TOUCHSCREEN,             // Edit Box touchscreen selected action ID.
    LB_MSG_SEL,                     // List Box item select action ID.
    LB_MSG_MOVE,                    // List Box item move action ID.
    LB_MSG_TOUCHSCREEN,             // List Box touchscreen selected action ID.
    GRID_MSG_TOUCHED,               // Grid item touched action ID.
    GRID_MSG_ITEM_SELECTED,         // Grid item selected action ID.
    GRID_MSG_UP,                    // Grid up action ID.
    GRID_MSG_DOWN,                  // Grid down action ID.
    GRID_MSG_LEFT,                  // Grid left action ID.
    GRID_MSG_RIGHT,                 // Grid right action ID.
    CH_MSG_SELECTED,                // Chart selected action ID
    TE_MSG_RELEASED,                // TextEntry released action ID
    TE_MSG_PRESSED,                 // TextEntry pressed action ID
    TE_MSG_ADD_CHAR,                // TextEntry add character action ID
    TE_MSG_DELETE,                  // TextEntry delete character action ID
    TE_MSG_SPACE,                   // TextEntry add space character action ID
    TE_MSG_ENTER,                   // TextEntry enter action ID
    AC_MSG_PRESSED,                 // Analog Clock Pressed Action
    AC_MSG_RELEASED,                // Analog Clock Released Action
    OBJ_MSG_PASSIVE                 // Passive message response. No change in object needed.
} TRANS_MSG;

typedef WORD(*DRAW_FUNC)(void *);                        // object draw function pointer
typedef
typedef void(*FREE_FUNC)(void *);                        // object free function pointer
typedef
typedef WORD(*MSG_FUNC)(void *, GOL_MSG *);              // object message function
pointer typedef
typedef void(*MSG_DEFAULT_FUNC)(WORD, void *, GOL_MSG *);   // object default message
function pointer typedef

/*********************************************************************
* Overview: This structure defines the first nine fields of the
*           Objects structure. This allows generic operations on
*           library Objects.
*
```

```
*********************************************************************/
typedef struct
{
    WORD                ID;                                 // Unique id assigned for
referencing.
    void                *pNxtObj;                           // A pointer to the next object.
    GOL_OBJ_TYPE        type;                               // Identifies the type of GOL
object.
    WORD                state;                              // State of object.
    SHORT               left;                               // Left position of the Object.
    SHORT               top;                                // Top position of the Object.
    SHORT               right;                              // Right position of the Object.
    SHORT               bottom;                             // Bottom position of the
Object.
    GOL_SCHEME          *pGolScheme;                        // Pointer to the scheme used.
    DRAW_FUNC           DrawObj;                            // function pointer to the
object draw function
    FREE_FUNC           FreeObj;                            // function pointer to the
object free function
    MSG_FUNC            MsgObj;                             // function pointer to the
object message function
    MSG_DEFAULT_FUNC    MsgDefaultObj;                      // function pointer to the
object default message function
} OBJ_HEADER;

/*********************************************************************
* Overview: The following are the common Objcet States.
*
*********************************************************************/

// Focus state bit.
    #define FOCUSED 0x0001

// Disabled state bit.
    #define DISABLED    0x0002

// Object hide state bit. Object will be hidden from the
// screen by drawing over it the common background color.
    #define HIDE    0x8000

// Object redraw state bit. The whole Object must be redrawn.
    #define DRAW    0x7C00

// Focus redraw state bit. The focus rectangle must be redrawn.
    #define DRAW_FOCUS  0x2000

// Partial Object redraw state bit. A part or parts of
// of the Object must be redrawn to show updated state.
    #define DRAW_UPDATE 0x3C00

/*********************************************************************
* Overview: The following are the global variables of GOL.
*
*********************************************************************/

/*********************************************************************
* Overview: Pointer to the current linked list of objects displayed
*           and receiving messages. GOLDraw() and GOLMsg() process
*           objects referenced by this pointer.
*
*********************************************************************/
extern OBJ_HEADER   *_pGolObjects;

/*********************************************************************
* Overview: Pointer to the object receiving keyboad input. This pointer
*           is used or modified by the following APIs:
*           - GOLSetFocus()
*           - GOLGetFocus()
*           - GOLGetFocusNext()
*           - GOLGetFocusPrev()
*           - GOLCanBeFocused()
*
```

```
*********************************************************************/
extern OBJ_HEADER   *_pObjectFocused;

// Line type used for focus mark.
    #define FOCUS_LINE  2

/*********************************************************************
* Overview: This option defines the 3-D effect emboss size for objects.
*           The default value of this is 3 set in GOL.h. If it is not
*           defined in GraphicsConfig.h file then the default value is used.
*
*********************************************************************/
    #ifndef GOL_EMBOSS_SIZE
        #define GOL_EMBOSS_SIZE 3
    #endif

/*********************************************************************
* Overview: The default font GOLFontDefault is declared in
*           GOLFontDefault.c file included in the Graphics Library.
*           To replace this font, add this declaration in the
*           GraphicsConfig.h:
*               #define FONTDEFAULT yourFont
*           Then in the project the "yourFont" must be added.
*           The Graphics Library will then use the font that the user
*           supplied.
*********************************************************************/
    #ifndef FONTDEFAULT
        // Use the default GOL font in GOLFontDefault.c
        #define FONTDEFAULT GOLFontDefault
    #endif

    // Default GOL font.
    extern const FONT_FLASH FONTDEFAULT;

/*********************************************************************
* Overview: The following are the style scheme default settings.
*
*********************************************************************/
#ifndef GFX_SCHEMEDEFAULT
#define GFX_SCHEMEDEFAULT GOLSchemeDefault
#endif

    extern const GOL_SCHEME GFX_SCHEMEDEFAULT;


/*********************************************************************
* Function: WORD GOLCanBeFocused(OBJ_HEADER* object)
*
* Overview: This function returns non-zero if the object can
*           be focused. Only button, check box, radio button,
*           slider, edit box, list box, scroll bar can accept
*           focus. If the object is disabled it cannot be set
*           to focused state.
*
* PreCondition: none
*
* Input: object - Pointer to the object of interest.
*
* Output: This returns a non-zero if the object can be focused
*         and zero if not.
*
* Side Effects: none
*
********************************************************************/
WORD        GOLCanBeFocused(OBJ_HEADER *object);

/*********************************************************************
* Function: OBJ_HEADER *GOLGetFocusNext()
*
* Overview: This function returns the pointer to the previous object
*           in the active linked list which is able to receive
*           keyboard input.
```

```
*
* PreCondition: none
*
* Input: none
*
* Output: This returns the pointer of the previous object in the
*         active list capable of receiving keyboard input. If
*         there is no object capable of receiving keyboard
*         inputs (i.e. none can be focused) NULL is returned.
*
* Side Effects: none
*
********************************************************************/
OBJ_HEADER  *GOLGetFocusPrev(void);

/*********************************************************************
* Function: OBJ_HEADER *GOLGetFocusNext()
*
* Overview: This function returns the pointer to the next object
*           in the active linked list which is able to receive
*           keyboard input.
*
* PreCondition: none
*
* Input: none
*
* Output: This returns the pointer of the next object in the
*         active list capable of receiving keyboard input. If
*         there is no object capable of receiving keyboard
*         inputs (i.e. none can be focused) NULL is returned.
*
* Side Effects: none
*
********************************************************************/
OBJ_HEADER  *GOLGetFocusNext(void);

/*********************************************************************
* Function: void GOLSetFocus(OBJ_HEADER* object)
*
* Overview: This function sets the keyboard input focus to the
*           object. If the object cannot accept keyboard messages
*           focus will not be changed. This function resets FOCUSED
*           state for the object was in focus previously, set
*           FOCUSED state for the required object and marks the
*           objects to be redrawn.
*
* PreCondition: none
*
* Input: object - Pointer to the object of interest.
*
* Output: none
*
* Side Effects: none
*
********************************************************************/
void        GOLSetFocus(OBJ_HEADER *object);

/*********************************************************************
* Macros:  GOLGetFocus()
*
* Overview: This macro returns the pointer to the current object
*           receiving keyboard input.
*
* PreCondition: none
*
* Input: none
*
* Output: Returns the pointer to the object receiving keyboard input.
*         If there is no object in focus NULL is returned.
*
* Side Effects: none
*
```

```
 ********************************************************************/
    #define GOLGetFocus()   _pObjectFocused

/*********************************************************************
 * Macros: GetObjType(pObj)
 *
 * Overview: This macro returns the object type.
 *
 * PreCondition: none
 *
 * Input: pObj - Pointer to the object of interest.
 *
 * Output: Returns the OBJ_TYPE of the object.
 *
 * Side Effects: none
 *
 ********************************************************************/
    #define GetObjType(pObj)    ((OBJ_HEADER *)pObj)->type

/*********************************************************************
 * Macros: GetObjID(pObj)
 *
 * Overview: This macro returns the object ID.
 *
 * PreCondition: none
 *
 * Input: pObj - Pointer to the object of interest.
 *
 * Output: Returns the ID of the object.
 *
 * Example:
 *   <CODE>
 *   void UseOfGetObjID(OBJ_HEADER *pObj) {
 *       WORD id;
 *           switch(id = GetObjID(pObj)) {
 *               case ID_WINDOW1:
 *                   // do something
 *               case ID_WINDOW2:
 *                   // do something else
 *               case ID_WINDOW3:
 *                   // do something else
 *               default:
 *                   // do something else
 *           }
 *   }
 *   </CODE>
 *
 * Side Effects: none
 *
 ********************************************************************/
    #define GetObjID(pObj)  ((OBJ_HEADER *)pObj)->ID

/*********************************************************************
 * Macros: GetObjNext(pObj)
 *
 * Overview: This macro returns the next object after the specified
 *           object.
 *
 * PreCondition: none
 *
 * Input: pObj - Pointer to the object of interest.
 *
 * Output: Returns the pointer of the next object.
 *
 * Example:
 *   <CODE>
 *   // This is the same example for the GetObjType() macro
 *   // We just replaced one line
 *   void RedrawButtons(void) {
 *       OBJ_HEADER *pCurr;
 *
 *       pCurr = GOLGetList();               // get active list
 *       while(pCurr->pNxtObj != NULL) {
 *           if (GetObjType(pCurr) == BUTTON)
 *               pCurr->state = BTN_DRAW;    // set button to be redrawn
 *           pCurr = GetObjNext(pCurr);      // Use of GetObjNext() macro
 *           // replaces the old line
 *       }
 *       GolDraw();                          // redraw all buttons in the
 *                                           // active list
 *   }
 *   </CODE>
 *
 * Side Effects: none
 *
 ********************************************************************/
    #define GetObjNext(pObj)    ((OBJ_HEADER *)pObj)->pNxtObj

/*********************************************************************
 * Macros: IsObjUpdated(pObj)
 *
 * Overview: This macro tests if the object is pending to
 *           be redrawn. This is done by testing the 6 MSBits
 *           of object’s state to detect if the object must
 *           be redrawn.
 *
 * PreCondition: none
 *
 * Input: pObj - Pointer to the object of interest.
 *
 * Output: Returns a nonzero value if the object needs
 *         to be redrawn. Zero if not.
 *
 * Example:
 *   <CODE>
 *   int DrawButtonWindowOnly() {
 *       static OBJ_HEADER *pCurrentObj = NULL;
 *       SHORT done = 0;
 *
 *       if (pCurrentObj == NULL)
 *           pCurrentObj = GOLGetList();         // get current list
 *
 *       while(pCurrentObj != NULL){
 *           if(IsObjUpdated(pCurrentObj)){
 *               done = pCurrentObj->draw(pCurrentObj);
 *
 *               // reset state of object if done
 *               if (done)
 *                   GOLDrawComplete(pCurrentObj)
 *               // Return if not done. This means that BtnDraw()
 *               // was terminated prematurely by device busy status
 *               // and must be recalled to finish rendering of
 *               // objects in the list that have new states.
 *               else
 *                   return 0;
 *           }
 *           // go to the next object in the list
 *           pCurrentObj = pCurrentObj->pNxtObj;
 *       }
 *       return 1;
 *   }
 *   </CODE>
 *
 * Side Effects: none
 *
 ********************************************************************/
    #define IsObjUpdated(pObj)  (((OBJ_HEADER *)pObj)->state & 0xfc00)

/*********************************************************************
 * Macros: GOLDrawComplete(pObj)
 *
 * Overview: This macro resets the drawing states of the object
 *           (6 MSBits of the object’s state).
 *
 * PreCondition: none
 *
 * Input: pObj - Pointer to the object of interest.
 *
 * Output: none
 *
 * Example:
 *   <CODE>
 *   // This function should be called again whenever an incomplete
 *   // rendering (done = 0) of an object occurs.
 *   // internal states in the BtnDraw() or WndDraw() should pickup
 *   // on the state where it left off to continue rendering.
 *   void GOLDraw() {
 *       static OBJ_HEADER *pCurrentObj = NULL;
 *       SHORT done;
 *
 *       if(pCurrentObj == NULL) {
 *           if(GOLDrawCallback()) {
 *               // If it's last object jump to head
 *               pCurrentObj = GOLGetList();
 *           } else {
 *               return;
 *           }
 *       }
 *       done = 0;
 *
 *       while(pCurrentObj != NULL) {
 *           if(IsObjUpdated(pCurrentObj)) {
 *               done = pCurrentObj->draw(pCurrentObj);
 *
 *               if(done){
 *                   GOLDrawComplete(pCurrentObj);
 *               }else{
 *                   return;
 *               }
 *           }
 *           pCurrentObj = pCurrentObj->pNxtObj;
 *       }
 *   }
 *   </CODE>
 *
 * Side Effects: none
 *
 ********************************************************************/
    #define GOLDrawComplete(pObj)   ((OBJ_HEADER *)pObj)->state &= 0x03ff

/*********************************************************************
 * Macros:  SetState(pObj, stateBits)
 *
 * Overview: This macro sets the state bits of an object.
 *           Object must be redrawn to display the changes.
 *           It is possible to set several state bits with
 *           this macro.
 *
 * PreCondition: none
 *
 * Input: pObj - Pointer to the object of interest.
 *        stateBits - Defines which state bits are to be
 *               set. Please refer to specific objects for object
 *               state bits definition for details
 *
 * Output: none
 *
 * Example:
 *   <CODE>
 *   void BtnMsgDefault(WORD msg, BUTTON* pB){
 *       switch(msg){
 *           case BTN_MSG_PRESSED:
 *               // set pressed and redraw
 *               SetState(pB, BTN_PRESSED|BTN_DRAW);
 *               break;
 *           case BTN_MSG_RELEASED:
```

```
 *                ClrState(pB, BTN_PRESSED);       // reset pressed
 *                SetState(pB, BTN_DRAW);          // redraw
 *                break;
 *        }
 *    }
 *    </CODE>
 *
 * Side Effects: none
 *
 ********************************************************************/
    #define SetState(pObj, stateBits)   ((OBJ_HEADER *)pObj)->state |= (stateBits)

/*********************************************************************
 * Macros:  ClrState(pObj, stateBits)
 *
 * Overview: This macro clear the state bits of an object.
 *           Object must be redrawn to display the changes.
 *           It is possible to clear several state bits with
 *           this macro.
 *
 * PreCondition: none
 *
 * Input: pObj - Pointer to the object of interest.
 *        stateBits - Defines which state bits are to be
 *               cleared. Please refer to specific objects for object
 *               state bits definition for details
 *
 * Output: none
 *
 * Example:
 *    See example for SetState().
 *
 * Side Effects: none
 *
 ********************************************************************/
    #define ClrState(pObj, stateBits)   ((OBJ_HEADER *)pObj)->state &= (~(stateBits))

/*********************************************************************
 * Macros:  GetState(pObj, stateBits)
 *
 * Overview: This macro retrieves the current value of
 *           the state bits of an object. It is possible
 *           to get several state bits.
 *
 * PreCondition: none
 *
 * Input: pObj - Pointer to the object of interest.
 *        stateBits - Defines which state bits are requested.
 *               Please refer to specific objects for object
 *               state bits definition for details
 *
 * Output: Macro returns a non-zero if any bit in the
 *         stateBits mask is set.
 *
 * Example:
 *    <CODE>
 *    #define BTN_HIDE 0x8000
 *    BUTTON *pB;
 *    // pB is created and initialized
 *    // do something here to set state
 *
 *    // Hide the button (remove from screen)
 *    if (GetState(pB,BTN_HIDE)) {
 *        SetColor(pB->pGolScheme->CommonBkColor);
 *        Bar(pB->left,pB->top,pB->right,pB->bottom);
 *
 *    }
 *    </CODE>
 *
 * Side Effects: none
 *
 ********************************************************************/
```

```
    #define GetState(pObj, stateBits)   (((OBJ_HEADER *)pObj)->state & (stateBits))

/*********************************************************************
* Function: GOL_SCHEME *GOLCreateScheme()
*
* Overview: This function creates a new style scheme object
*           and initializes the parameters to default values.
*           Default values are based on the GOLSchemeDefault
*           defined in GOLSchemeDefault.c file. Application code
*           can override this initialization, See GOLSchemeDefault.
*
* PreCondition: none
*
* Input: none
*
* Output: Pointer to the new GOL_SCHEME created.
*
* Example:
*   <CODE>
*   extern const char Font22[] __attribute__((aligned(2)));
*   extern const char Font16[] __attribute__((aligned(2)));
*
*   GOLSCHEME *pScheme1, *pScheme2;
*   pScheme1 = GOLCreateScheme();
*   pScheme2 = GOLCreateScheme();
*
*   pScheme1->pFont = (BYTE*)Font22;
*   pScheme2->pFont = (BYTE*)Font16;
*   </CODE>
*
* Side Effects: none
*
********************************************************************/
GOL_SCHEME  *GOLCreateScheme(void);

/*********************************************************************
* Macros:  GOLSetScheme(pObj, pScheme)
*
* Overview: This macro sets the GOL scheme to be used for the object.
*
* PreCondition: none
*
* Input: pObj - Pointer to the object of interest.
*        pScheme - Pointer to the style scheme to be used.
*
* Output: none
*
* Example:
*   <CODE>
*   extern FONT_FLASH Gentium12;
*   GOLSCHEME *pScheme1;
*   BUTTON *pButton;
*
*   pScheme1 = GOLCreateScheme();
*   pScheme1->pFont = &Gentium12;
*
*   // assume button is created and initialized
*
*   // reassign the scheme used by pButton to pScheme1
*   GOLSetScheme(pButton, pScheme1);
*   </CODE>
*
* Side Effects: none
*
********************************************************************/
    #define GOLSetScheme(pObj, pScheme) ((OBJ_HEADER *)pObj)->pGolScheme = pScheme

/*********************************************************************
* Macros:  GOLGetScheme(pObj)
*
* Overview: This macro gets the GOL scheme used by the given object.
*
```

```
* PreCondition: none
*
* Input: pObj - Pointer to the object of interest.
*
* Output: Returns the style scheme used by the given object.
*
* Example:
*   <CODE>
*   GOLSCHEME *pScheme2;
*   BUTTON *pButton;
*
*   // assume button is created and initialized
*   // get the scheme assigned to pButton
*   pScheme2 = GOLGetScheme(pButton);
*   </CODE>
*
* Side Effects: none
*
********************************************************************/
    #define GOLGetScheme(pObj)  ((OBJ_HEADER *)pObj)->pGolScheme

/*********************************************************************
* Macros:  GOLGetSchemeDefault()
*
* Overview: This macro returns the default GOL scheme pointer.
*
* PreCondition: none
*
* Input: none
*
* Output: Returns the pointer to the default style scheme.
*
* Side Effects: none
*
********************************************************************/
    #define GOLGetSchemeDefault()   _pDefaultGolScheme

/*********************************************************************
* Function: void GOLInit()
*
* Overview: This function initializes the graphics library and
*           creates a default style scheme with default settings
*           referenced by the global scheme pointer. GOLInit()
*           function must be called before GOL functions can be
*           used. It is not necessary to call GraphInit()
*           function if this function is used.
*
* PreCondition: none
*
* Input: none
*
* Output: none
*
* Side Effects: This sets the line type to SOLID_LINE, sets the
*               screen to all BLACK, sets the current drawing color
*               to WHITE, sets the graphic cursor position to upper
*               left corner of the screen, sets active and visual
*               pages to page #0, clears the active page and disables
*               clipping. This also creates a default style scheme.
*
********************************************************************/
void GOLInit();

/*********************************************************************
* Function: void GOLAddObject(OBJ_HEADER* object)
*
* Overview: This function adds an object to the tail of the
*           active list pointed to by _pGolObjects. The new list
*           tail is set to point to NULL.
*
* PreCondition: none
*
```

```
* Input: pObj - Pointer to the object to be added on the current
*               active list.
*
* Output: none
*
* Example:
*   <CODE>
*   void MoveObject(OBJ_HEADER *pSrcList, OBJ_HEADER *pDstList,
*       OBJ_HEADER *pObjtoMove) {
*       OBJ_HEADER *pTemp = pSrcList;
*
*       if(pTemp != pObjtoMove) {
*           while(pTemp->pNxtObj != pObjtoMove)
*               pTemp = pTemp->pNxtObj;
*       }
*
*       pTemp->pNxtObj = pObjtoMove ->pNxt; // remove object from list
*       GOLSetList(pDstList);               // destination as active list
*       GOLAddObject(pObjtoMove);           // add object to active list
*   }
*   </CODE>
*
* Side Effects: none
*
********************************************************************/
void    GOLAddObject(OBJ_HEADER *object);

/*********************************************************************
* Macros: void GOLNewList()
*
* Overview: This macro starts a new linked list of objects and
*           resets the keyboard focus to none. This macro assigns
*           the current active list _pGolObjects and current receiving
*           keyboard input _pObjectFocused object pointers to NULL.
*           Any keyboard inputs at this point will be ignored.
*           Previous active list must be saved in another pointer if
*           to be referenced later. If not needed anymore memory used
*           by that list should be freed by GOLFree() function.
*
* PreCondition: none
*
* Input: none
*
* Output: none
*
* Example:
*   <CODE>
*   OBJ_HEADER *pSave;
*
*   pSave = GOLGetList();             // save current list
*   GOLNewList();                     // start the new list
*                                     // current list is now NULL
*
*   // assume that objects are already created
*   // you can now add objects to the new list
*   GOLAddObject(pButton);
*   GOLAddObject(pWindow);
*   GOLAddObject(pSlider);
*   </CODE>
*
* Side Effects: This macro sets the focused object pointer
*               (_pObjectFocused) to NULL.
*
********************************************************************/
    #define GOLNewList() \
    _pGolObjects = NULL; \
    _pObjectFocused = NULL

/*********************************************************************
* Macros: GOLGetList()
*
* Overview: This macro gets the current active list.
```

```
*
* PreCondition: none
*
* Input: none
*
* Output: Returns the pointer to the current active list.
*
* Example:
*   See GOLNewList() example.
*
* Side Effects: none
*
********************************************************************/
    #define GOLGetList()    _pGolObjects

/*********************************************************************
* Macros: GOLSetList(objsList)
*
* Overview: This macro sets the given object list as the active
*           list and resets the keyboard focus to none. This macro
*           assigns the receiving keyboard input object _pObjectFocused
*           pointer to NULL. If the new active list has an object's
*           state set to focus, the _pObjectFocused pointer must be
*           set to this object or the object's state must be change
*           to unfocused. This is to avoid two objects displaying a
*           focused state when only one object in the active list must
*           be set to a focused state at anytime.
*
* PreCondition: none
*
* Input: objsList - The pointer to the new active list.
*
* Output: none
*
* Example:
*   <CODE>
*   OBJ_HEADER *pSave;
*   pSave = GOLGetList();           // save current list
*   GOLNewList();                   // start the new list
*                                   // current list is now NULL
*
*   // you can now add objects to the current list
*   // assume that objects are already created
*   GOLAddObject(pButton);
*   GOLAddObject(pWindow);
*   GOLAddObject(pSlider);
*
*   // do something here on the new list
*   // return the old list
*   GOLSetList(pSave);
*   </CODE>
*
* Side Effects: This macro sets the focused object pointer
*               (_pObjectFocused) to NULL. Previous active list
*               should be saved if needed to be referenced later.
*               If not, use GOLFree() function to free the memory
*               used by the objects before calling GOLSetList().
*
********************************************************************/
    #define GOLSetList(objsList) \
    _pGolObjects = objsList;     \
    _pObjectFocused = NULL

/*********************************************************************
* Function: OBJ_HEADER* GOLFindObject(WORD ID)
*
* Overview: This function finds an object in the active list
*           pointed to by _pGolObjects using the given object ID.
*
* PreCondition: none
*
* Input: ID - User assigned value set during the creation of the object.
```

```
*
* Output: Pointer to the object with the given ID.
*
* Example:
*   <CODE>
*   void CopyObject(OBJ_HEADER *pSrcList, OBJ_HEADER *pDstList, WORD ID)
*   {
*       OBJ_HEADER *pTemp;
*
*       pTemp = GOLFindObject(ID);              // find the object
*       if (pTemp != NULL) {
*           GOLSetList(pDstList);               // destination as active list
*           GOLAddObject(pObj);                 // add object to active list
*       }
*   }
*   </CODE>
*
* Side Effects: none
*
********************************************************************/
OBJ_HEADER * GOLFindObject(WORD ID);

/*********************************************************************
* Function: void GOLFree()
*
* Overview: This function frees all the memory used by objects in
*           the active list and initializes _pGolObjects pointer
*           to NULL to start a new empty list. This function must
*           be called only inside the GOLDrawCallback()function when
*           using GOLDraw() and GOLMsg() functions. This requirement
*           assures that primitive rendering settings are not altered
*           by the rendering state machines of the objects.
*
* PreCondition: none
*
* Input: none
*
* Output: none
*
* Example:
*   <CODE>
*   void DeletePage(OBJ_HEADER *pPage) {
*       OBJ_HEADER *pTemp;
*
*       // assuming pPage is different from the current active list
*       pTemp = GOLGetList();               // save the active list
*       GOLSetList(pPage);                  // set list as active list
*       GolFree();                          // pPage objects are deleted
*
*       GOLSetList(pTemp);                  // restore the active list
*   }
*   </CODE>
*
* Side Effects: All objects in the active list are deleted from memory.
*
********************************************************************/
void    GOLFree(void);

/*********************************************************************
* Function: BOOL GOLDeleteObject(OBJ_HEADER * object)
*
* PreCondition: none
*
* Input: pointer to the object
*
* Output: none
*
* Side Effects: none
*
* Overview: deletes an object to the linked list objects for the current screen.
*
* Note: none
```

```
*
********************************************************************/
BOOL    GOLDeleteObject(OBJ_HEADER *object);

/*********************************************************************
* Function: BOOL GOLDeleteObjectByID(WORD ID)
*
* PreCondition: none
*
* Input: ID of the object.
*
* Output: none
*
* Side Effects: none
*
* Overview: Deletes an object in the current active linked list of objects using the ID
parameter
*           of the object.
*
* Note: none
*
********************************************************************/
BOOL    GOLDeleteObjectByID(WORD ID);

/*********************************************************************
* Function: WORD GOLDraw()
*
* Overview: This function loops through the active list and redraws
*           objects that need to be redrawn. Partial redrawing or
*           full redraw is performed depending on the drawing states
*           of the objects.
*           GOLDrawCallback() function is called by GOLDraw()
*           when drawing of objects in the active list is completed.
*
* PreCondition: none
*
* Input: none
*
* Output: Non-zero if the active link list drawing is completed.
*
* Example:
*   <CODE>
*   // Assume objects are created & states are set to draw objects
*   while(1){
*       if(GOLDraw()){              // parse active list and redraw objects that needs to
be redrawn

*           // here GOL drawing is completed
*           // it is safe to modify objects states and linked list
*
*           TouchGetMsg(&msg);      // evaluate messages from touch screen device
*
*           GOLMsg(&msg);           // evaluate each object is affected by the message
*       }
*   }
*   </CODE>
*
* Side Effects: none
*
********************************************************************/
WORD    GOLDraw(void);

/*********************************************************************
* Function: void GOLRedrawRec(SHORT left, SHORT top, SHORT right, SHORT bottom)
*
* Overview: This function marks all objects in the active
*           list intersected by the given rectangular area
*           to be redrawn.
*
* PreCondition: none
*
* Input: left - Defines the left most border of the rectangle area.
*        top - Defines the top most border of the rectangle area.
*        right - Defines the right most border of the rectangle area.
*        bottom - Defines the bottom most border of the rectangle area.
*
* Output: none
*
* Example:
*   <CODE>
*   OBJ_HEADER *pTemp;
*   OBJ_HEADER *pAllObjects;
*
*   // assume *pAllObjects points to a list of all existing objects
*   // created and initialized
*
*   // mark all objects inside the rectangle to be redrawn
*   GOLRedrawRec(10,10,100,100);
*
*   pTemp = pAllObjects;
*   GOLStartNewList();                         // reset active list
*   while(pTemp->pNxtObj != NULL) {
*       if (pTemp->state&0x7C00)               // add only objects to be
*       GOLAddObject(pTemp);                   // redrawn to the active list
*       pTemp = pTemp->pNxtObj;
*   }
*   GOLDraw();                                 // redraw active list
*   </CODE>
*
* Side Effects: none
*
********************************************************************/
void    GOLRedrawRec(SHORT left, SHORT top, SHORT right, SHORT bottom);

/*********************************************************************
* Macros: GOLRedraw(pObj)
*
* Overview: This macro sets the object to be redrawn. For the
*           redraw to be effective, the object must be in the
*           current active list. If not, the redraw action will
*           not be performed until the list where the object is
*           currently inserted will be set to be the active list.
*
* PreCondition: none
*
* Input: pObj - Pointer to the object to be redrawn.
*
* Output: none
*
* Example:
*   <CODE>
*   void GOLRedrawRec(SHORT left, SHORT top, SHORT right, SHORT bottom) {
*       // set all objects encompassed by the rectangle to be redrawn
*       OBJ_HEADER *pCurrentObj;
*
*       pCurrentObj = GOLGetList();
*       while(pCurrentObj != NULL){
*           if (
*               ((pCurrentObj->left >= left) && (pCurrentObj->left <= right)) ||
*               ((pCurrentObj->right >= left) && (pCurrentObj->right <= right))||
*               ((pCurrentObj->top >= top) && (pCurrentObj->top <= bottom)) ||
*               ((pCurrentObj->bottom >= top) && (pCurrentObj->bottom <= bottom))){
*                   GOLRedraw(pCurrentObj);
*           }
*           pCurrentObj = pCurrentObj->pNxtObj;
*       }//end of while
*   }
*   </CODE>
*
* Side Effects: none
*
********************************************************************/
    #define GOLRedraw(pObj) ((OBJ_HEADER *)pObj)->state |= 0x7c00;
```

```
/*********************************************************************
* Function: void GOLMsg(GOL_MSG *pMsg)
*
* Overview: This function receives a GOL message from user and
*           loops through the active list of objects to check
*           which object is affected by the message. For affected
*           objects the message is translated and GOLMsgCallback()
*           is called. In the call back function, user has the
*           ability to implement action for the message. If the
*           call back function returns non-zero OBJMsgDefault()
*           is called to process message for the object by default.
*           If zero is returned OBJMsgDefault() is not called.
*           Please refer to GOL Messages section for deatils.
*
*           This function should be called when GOL drawing
*           is completed. It can be done when GOLDraw() returns
*           non-zero value or inside GOLDrawCallback() function.
*
* PreCondition: none
*
* Input: pMsg - Pointer to the GOL message from user.
*
* Output: none
*
* Example:
*   <CODE>
*   // Assume objects are created & states are set to draw objects
*   while(1){
*       if(GOLDraw()){
*           // GOL drawing is completed here
*           // it is safe to change objects
*           TouchGetMsg(&msg);         // from user interface module
*           GOLMsg(&msg);
*       }
*   }
*   </CODE>
*
* Side Effects: none
*
********************************************************************/
void            GOLMsg(GOL_MSG *pMsg);

/*********************************************************************
* Function: WORD GOLMsgCallback(WORD objMsg, OBJ_HEADER* pObj, GOL_MSG* pMsg)
*
* Overview: The user MUST implement this function. GOLMsg() calls
*           this function when a valid message for an object in the
*           active list is received. User action for the message should
*           be implemented here. If this function returns non-zero,
*           the message for the object will be processed by default.
*           If zero is returned, GOL will not perform any action.
*
* PreCondition: none
*
* Input: objMsg - Translated message for the object or the action ID response from the
object.
*        pObj - Pointer to the object that processed the message.
*        pMsg - Pointer to the GOL message from user.
*
* Output: Return a non-zero if the message will be processed by default.
*         If a zero is returned, the message will not be processed by GOL.
*
* Example:
*   <CODE>
*   WORD GOLMsgCallback(WORD objMsg, OBJ_HEADER* pObj, GOL_MSG *pMsg){
*       static char focusSwitch = 1;
*
*       switch(GetObjID(pObj)){
*           case ID_BUTTON1:
*               // Change text and focus state
*               if(objMsg == BTN_MSG_RELEASED){
*                   focusSwitch ^= 1;
```

```
 *                   if(focusSwitch){
 *                       BtnSetText((BUTTON*)pObj, "Focused");
 *                       SetState(pObj,BTN_FOCUSED);
 *                   }else{
 *                       BtnSetText((BUTTON*)pObj, "Unfocused");
 *                       ClrState(pObj,BTN_FOCUSED);
 *                   }
 *               }
 *               // Process by default
 *               return 1;
 *           case ID_BUTTON2:
 *               // Change text
 *               if(objMsg == BTN_MSG_PRESSED){
 *                   BtnSetText((BUTTON*)pObj, "Pressed");
 *               }
 *               if(objMsg == BTN_MSG_RELEASED){
 *                   BtnSetText((BUTTON*)pObj, "Released");
 *               }
 *               // Process by default
 *               return 1;
 *           case ID_BUTTON3:
 *               // Change face picture
 *               if(objMsg == BTN_MSG_PRESSED){
 *                   BtnSetBitmap(pObj,arrowLeft);
 *               }
 *               if(objMsg == BTN_MSG_RELEASED){
 *                   BtnSetBitmap(pObj,(char*)arrowRight);
 *               }
 *               // Process by default
 *               return 1;
 *           case ID_BUTTON_NEXT:
 *               if(objMsg == BTN_MSG_RELEASED){
 *                   screenState = CREATE_CHECKBOXES;
 *               }
 *               // Process by default
 *               return 1;
 *           case ID_BUTTON_BACK:
 *               return 1;
 *           default:
 *               return 1;
 *       }
 *   }
 *   </CODE>
 *
 * Side Effects: none
 *
 ********************************************************************/
WORD            GOLMsgCallback(WORD objMsg, OBJ_HEADER *pObj, GOL_MSG *pMsg);

/*********************************************************************
 * Function: WORD GOLDrawCallback()
 *
 * Overview: GOLDrawCallback() function MUST BE implemented by
 *           the user. This is called inside the GOLDraw()
 *           function when the drawing of objects in the active
 *           list is completed. User drawing must be done here.
 *           Drawing color, line type, clipping region, graphic
 *           cursor position and current font will not be changed
 *           by GOL if this function returns a zero. To pass
 *           drawing control to GOL this function must return
 *           a non-zero value. If GOL messaging is not using
 *           the active link list, it is safe to modify the
 *           list here.
 *
 * PreCondition: none
 *
 * Input: none
 *
 * Output: Return a one if GOLDraw() will have drawing control
 *         on the active list. Return a zero if user wants to
 *         keep the drawing control.
 *
```

```
* Example:
*   <CODE>
*   #define SIG_STATE_SET   0
*   #define SIG_STATE_DRAW  1
*   WORD GOLDrawCallback(){
*       static BYTE state = SIG_STATE_SET;
*       if(state == SIG_STATE_SET){
*           // Draw the button with disabled colors
*           GOLPanelDraw(SIG_PANEL_LEFT,SIG_PANEL_TOP,
*                        SIG_PANEL_RIGHT,SIG_PANEL_BOTTOM, 0,
*                        WHITE, altScheme->EmbossLtColor,
*                        altScheme->EmbossDkColor,
*                        NULL, GOL_EMBOSS_SIZE);
*
*           state = SIG_STATE_DRAW;
*       }
*
*       if(!GOLPanelDrawTsk()){
*           // do not return drawing control to GOL
*           // drawing is not complete
*           return 0;
*       }else{
*           state = SIG_STATE_SET;
*           // return drawing control to GOL, drawing is complete
*           return 1;
*       }
*   }
*   </CODE>
*
* Side Effects: none
*
********************************************************************/
WORD            GOLDrawCallback(void);

/*********************************************************************
* Variables for rounded panel drawing. Used by GOLRndPanelDraw and GOLRndPanelDrawTsk
********************************************************************/
extern SHORT    _rpnlX1;            // Panel center x position of upper left corner
extern SHORT    _rpnlY1;            // Panel center y position of upper left corner
extern SHORT    _rpnlX2;            // Panel center x position of lower right corner
extern SHORT    _rpnlY2;            // Panel center y position of lower right corner
extern SHORT    _rpnlR;             // radius (defines the rounded corner size)
extern WORD     _rpnlFaceColor;     // Panel face color
extern WORD     _rpnlEmbossLtColor; // Panel emboss light color
extern WORD     _rpnlEmbossDkColor; // Panel emboss dark color
extern WORD     _rpnlEmbossSize;    // Size of panel emboss (Usually uses GOL_EMBOSS_SIZE
but maybe different

// for some objects)emboss size
extern void     *_pRpnlBitmap;      // Bitmap used in the panel

/*********************************************************************
* Macros: GOLPanelDraw( left, top, right, bottom,
*                       radius,
*                       faceClr,
*                       embossLtClr, embossDkClr,
*                       pBitmap,
*                       embossSize)
*
* Overview: This macro sets the parameters to draw a panel.
*           Panel is not an object. It will not be added to
*           the active list. Use GOLPanelDrawTsk() to display
*           the panel on the screen.
*           The following relationships of the parameters determines
*           the general shape of the button:
*           1. Panel width is determined by right - left.
*           2. Panel height is determined by top - bottom.
*           3. Panel radius - specifies if the panel will have a rounded
*                       edge. If zero then the panel will have
*                       sharp (cornered) edge.
*           4. If 2*radius = height = width, the panel is circular.
*
```

```
* PreCondition: none
*
* Input: left - Panel's left most position.
*        top - Panel's top most position.
*        right - Panel's right most position.
*        bottom - Panel's bottom most position.
*        radius - The radius of the rounded corner of the panel.
*        faceClr - Defines the face color of the panel.
*        embossLtClr - Defines the emboss light color.
*        embossDkClr - Defines the emboss dark color.
*        pBitmap - Defines the bitmap used in the face of the panel.
*        embossSize - Defines the emboss size of the panel.
*
* Output: none
*
* Example:
*   <CODE>
*   // Dimensions for signature box
*   #define SIG_PANEL_LEFT      10
*   #define SIG_PANEL_RIGHT    310
*   #define SIG_PANEL_TOP       50
*   #define SIG_PANEL_BOTTOM   170
*
*   #define SIG_STATE_SET   0
*   #define SIG_STATE_DRAW  1
*
*   GOL_SCHEME *altScheme;           // style scheme
*
*   // Draws box for signature
*   WORD PanelSignature() {
*       static BYTE state = SIG_STATE_SET;
*
*       if(state == SIG_STATE_SET){
*           // set data for panel drawing (radius = 0)
*           // assume altScheme is defined
*           GOLPanelDraw(SIG_PANEL_LEFT,SIG_PANEL_TOP,
*                        SIG_PANEL_RIGHT,SIG_PANEL_BOTTOM,0,
*                        WHITE,
*                        altScheme->EmbossLtColor,
*                        altScheme->EmbossDkColor,
*                        NULL, GOL_EMBOSS_SIZE);
*
*           state = SIG_STATE_DRAW; // change state
*       }
*
*       if(!GOLPanelDrawTsk())
*           return 0; // drawing is not completed
*       } else {
*           state = SIG_STATE_SET; // set state to initial
*           return 1; // drawing is done
*       }
*   }
*   </CODE>
*
* Side Effects: none
*
********************************************************************/
    #define GOLPanelDraw(left, top, right, bottom, radius, faceClr, embossLtClr,
embossDkClr, pBitmap, embossSize) \
    _rpnlX1 =
left;                                                                   \
    _rpnlY1 =
top;                                                                    \
    _rpnlX2 =
right;                                                                  \
    _rpnlY2 =
bottom;                                                                 \
    _rpnlR =
radius;                                                                   \
    _rpnlFaceColor =
faceClr;                                                          \
    _rpnlEmbossLtColor =
embossLtClr;                                                                   \
    _rpnlEmbossDkColor =
embossDkClr;                                                                   \
    _pRpnlBitmap =
pBitmap;                                                                             \
    _rpnlEmbossSize = embossSize;


     #ifdef USE_GRADIENT

     #define
GOLGradientPanelDraw(pGolScheme)                                                           \
         _gradientScheme.gradientStartColor =
pGolScheme->gradientScheme.gradientStartColor;       \
         _gradientScheme.gradientEndColor =
pGolScheme->gradientScheme.gradientEndColor;           \
         _gradientScheme.gradientType  =
pGolScheme->gradientScheme.gradientType;                 \
         _gradientScheme.gradientLength =
pGolScheme->gradientScheme.gradientLength;

     #endif

/*********************************************************************
* Function: WORD GOLPanelDrawTsk()
*
* Overview: This function draws a panel on the screen with parameters
*           set by GOLPanelDraw() macro. This function must be called
*           repeatedly (depending on the return value) for a successful
*           rendering of the panel.
*
* PreCondition: Parameters of the panel must be set by GOLPanelDraw() macro.
*
* Input: none
*
* Output: Returns the status of the panel rendering
*   <CODE>
*          0 – Rendering of the panel is not yet finished.
*          1 – Rendering of the panel is finished.
*   </CODE>
*
* Example:
*   See GOLPanelDraw() example.
*
* Side Effects: none
*
********************************************************************/
WORD    GOLPanelDrawTsk(void);

/*********************************************************************
* Function: WORD GOLTwoTonePanelDrawTsk()
*
* Overview: This function draws a two tone panel on the screen with parameters
*           set by GOLPanelDraw() macro. This function must be called
*           repeatedly (depending on the return value) for a successful
*           rendering of the panel.
*
* PreCondition: Parameters of the panel must be set by GOLPanelDraw() macro.
*
* Input: none
*
* Output: Returns the status of the panel rendering
*   <CODE>
*          0 – Rendering of the panel is not yet finished.
*          1 – Rendering of the panel is finished.
*   </CODE>
*
* Example:
*   Usage is similar to GOLPanelDraw() example.
*
* Side Effects: none
*
```

```
*****************************************************************************/
WORD    GOLTwoTonePanelDrawTsk(void);

#endif // _GOL_H
```

14.1.3 GOLFontDefault.c

Variables

Name	Description
GOLFontDefault (see page 346)	This is variable GOLFontDefault.

Description

This is file GOLFontDefault.c.

Body Source

```
/*****************************************************************************
 * FileName:        GOLFontDefault.c
 * Processor:       PIC24F, PIC24H, dsPIC
 * Compiler:        MPLAB C30 v3.23
 * Company:         Microchip Technology, Inc.
 *
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 * OR OTHER SIMILAR COSTS.
 *
 *
 *~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
 * AUTO-GENERATED CODE Graphics Resource Converter version: 3.0.0
 *****************************************************************************/

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* All Rights Reserved.
* Gentium font is licensed under the SIL Open Font License, Version 1.0.
* http://scripts.sil.org/OFL
*********************************************************************************/

/*****************************************************************************
 * SECTION:  Includes
 *****************************************************************************/
#include "GraphicsConfig.h"
#ifndef FONTDEFAULT
#include <Graphics/Primitive.h>
```

```
#ifdef USE_GOL
/*****************************************************************************
 * Converted Resources
 * -------------------
 *
 *
 * Fonts
 * -----
 * GOLFontDefault - Heigth: 27 pixels, range: ' ' to '~'
 *****************************************************************************/

/*****************************************************************************
 * SECTION:  Fonts
 *****************************************************************************/

/*********************************
 * TYPE_FONT_FILE Structure
 * Label: GOLFontDefault
 * Description:  Heigth: 27 pixels, range: ' ' to '~'
 ***********************************/

extern const char __GOLFontDefault[] __attribute__((aligned(2)));

const FONT_FLASH GOLFontDefault =
{
    (FLASH | COMP_NONE),
    __GOLFontDefault
};

const char __GOLFontDefault[] __attribute__((aligned(2))) =
{
/****************************************
 * Font header
 ****************************************/
    0x00,           // Information
    0x00,           // ID
    0x1C, 0x00,     // First Character
    0x7E, 0x00,     // Last Character
    0x1B,           // Height
    0x00,           // Reserved
/****************************************
 * Font Glyph Table
 ****************************************/
    0x10, 0x94, 0x01, 0x00,           // width, MSB Offset, LSB offset
    0x10, 0xCA, 0x01, 0x00,           // width, MSB Offset, LSB offset
    0x11, 0x00, 0x02, 0x00,           // width, MSB Offset, LSB offset
    0x11, 0x51, 0x02, 0x00,           // width, MSB Offset, LSB offset
    0x05, 0xA2, 0x02, 0x00,           // width, MSB Offset, LSB offset
    0x06, 0xBD, 0x02, 0x00,           // width, MSB Offset, LSB offset
    0x0A, 0xD8, 0x02, 0x00,           // width, MSB Offset, LSB offset
    0x0B, 0x0E, 0x03, 0x00,           // width, MSB Offset, LSB offset
    0x0B, 0x44, 0x03, 0x00,           // width, MSB Offset, LSB offset
    0x10, 0x7A, 0x03, 0x00,           // width, MSB Offset, LSB offset
    0x10, 0xB0, 0x03, 0x00,           // width, MSB Offset, LSB offset
    0x06, 0xE6, 0x03, 0x00,           // width, MSB Offset, LSB offset
    0x07, 0x01, 0x04, 0x00,           // width, MSB Offset, LSB offset
    0x07, 0x1C, 0x04, 0x00,           // width, MSB Offset, LSB offset
    0x0A, 0x37, 0x04, 0x00,           // width, MSB Offset, LSB offset
    0x09, 0x6D, 0x04, 0x00,           // width, MSB Offset, LSB offset
    0x05, 0xA3, 0x04, 0x00,           // width, MSB Offset, LSB offset
    0x08, 0xBE, 0x04, 0x00,           // width, MSB Offset, LSB offset
    0x05, 0xD9, 0x04, 0x00,           // width, MSB Offset, LSB offset
    0x0B, 0xF4, 0x04, 0x00,           // width, MSB Offset, LSB offset
    0x0B, 0x2A, 0x05, 0x00,           // width, MSB Offset, LSB offset
    0x0B, 0x60, 0x05, 0x00,           // width, MSB Offset, LSB offset
    0x0B, 0x96, 0x05, 0x00,           // width, MSB Offset, LSB offset
    0x0B, 0xCC, 0x05, 0x00,           // width, MSB Offset, LSB offset
    0x0B, 0x02, 0x06, 0x00,           // width, MSB Offset, LSB offset
    0x0B, 0x38, 0x06, 0x00,           // width, MSB Offset, LSB offset
    0x0B, 0x6E, 0x06, 0x00,           // width, MSB Offset, LSB offset
    0x0B, 0xA4, 0x06, 0x00,           // width, MSB Offset, LSB offset
    0x0B, 0xDA, 0x06, 0x00,           // width, MSB Offset, LSB offset
```

```
        0x0B, 0x10, 0x07, 0x00,           // width, MSB Offset, LSB offset
        0x05, 0x46, 0x07, 0x00,           // width, MSB Offset, LSB offset
        0x05, 0x61, 0x07, 0x00,           // width, MSB Offset, LSB offset
        0x0A, 0x7C, 0x07, 0x00,           // width, MSB Offset, LSB offset
        0x0A, 0xB2, 0x07, 0x00,           // width, MSB Offset, LSB offset
        0x0A, 0xE8, 0x07, 0x00,           // width, MSB Offset, LSB offset
        0x0A, 0x1E, 0x08, 0x00,           // width, MSB Offset, LSB offset
        0x13, 0x54, 0x08, 0x00,           // width, MSB Offset, LSB offset
        0x0E, 0xA5, 0x08, 0x00,           // width, MSB Offset, LSB offset
        0x0C, 0xDB, 0x08, 0x00,           // width, MSB Offset, LSB offset
        0x0C, 0x11, 0x09, 0x00,           // width, MSB Offset, LSB offset
        0x0E, 0x47, 0x09, 0x00,           // width, MSB Offset, LSB offset
        0x0B, 0x7D, 0x09, 0x00,           // width, MSB Offset, LSB offset
        0x0B, 0xB3, 0x09, 0x00,           // width, MSB Offset, LSB offset
        0x0D, 0xE9, 0x09, 0x00,           // width, MSB Offset, LSB offset
        0x0F, 0x1F, 0x0A, 0x00,           // width, MSB Offset, LSB offset
        0x07, 0x55, 0x0A, 0x00,           // width, MSB Offset, LSB offset
        0x07, 0x70, 0x0A, 0x00,           // width, MSB Offset, LSB offset
        0x0D, 0x8B, 0x0A, 0x00,           // width, MSB Offset, LSB offset
        0x0B, 0xC1, 0x0A, 0x00,           // width, MSB Offset, LSB offset
        0x13, 0xF7, 0x0A, 0x00,           // width, MSB Offset, LSB offset
        0x0F, 0x48, 0x0B, 0x00,           // width, MSB Offset, LSB offset
        0x0E, 0x7E, 0x0B, 0x00,           // width, MSB Offset, LSB offset
        0x0C, 0xB4, 0x0B, 0x00,           // width, MSB Offset, LSB offset
        0x0E, 0xEA, 0x0B, 0x00,           // width, MSB Offset, LSB offset
        0x0D, 0x20, 0x0C, 0x00,           // width, MSB Offset, LSB offset
        0x0B, 0x56, 0x0C, 0x00,           // width, MSB Offset, LSB offset
        0x0D, 0x8C, 0x0C, 0x00,           // width, MSB Offset, LSB offset
        0x0F, 0xC2, 0x0C, 0x00,           // width, MSB Offset, LSB offset
        0x0F, 0xF8, 0x0C, 0x00,           // width, MSB Offset, LSB offset
        0x14, 0x2E, 0x0D, 0x00,           // width, MSB Offset, LSB offset
        0x0E, 0x7F, 0x0D, 0x00,           // width, MSB Offset, LSB offset
        0x0E, 0xB5, 0x0D, 0x00,           // width, MSB Offset, LSB offset
        0x0C, 0xEB, 0x0D, 0x00,           // width, MSB Offset, LSB offset
        0x07, 0x21, 0x0E, 0x00,           // width, MSB Offset, LSB offset
        0x0B, 0x3C, 0x0E, 0x00,           // width, MSB Offset, LSB offset
        0x08, 0x72, 0x0E, 0x00,           // width, MSB Offset, LSB offset
        0x0B, 0x8D, 0x0E, 0x00,           // width, MSB Offset, LSB offset
        0x0B, 0xC3, 0x0E, 0x00,           // width, MSB Offset, LSB offset
        0x07, 0xF9, 0x0E, 0x00,           // width, MSB Offset, LSB offset
        0x0B, 0x14, 0x0F, 0x00,           // width, MSB Offset, LSB offset
        0x0C, 0x4A, 0x0F, 0x00,           // width, MSB Offset, LSB offset
        0x0A, 0x80, 0x0F, 0x00,           // width, MSB Offset, LSB offset
        0x0C, 0xB6, 0x0F, 0x00,           // width, MSB Offset, LSB offset
        0x0B, 0xEC, 0x0F, 0x00,           // width, MSB Offset, LSB offset
        0x07, 0x22, 0x10, 0x00,           // width, MSB Offset, LSB offset
        0x0C, 0x3D, 0x10, 0x00,           // width, MSB Offset, LSB offset
        0x0D, 0x73, 0x10, 0x00,           // width, MSB Offset, LSB offset
        0x06, 0xA9, 0x10, 0x00,           // width, MSB Offset, LSB offset
        0x06, 0xC4, 0x10, 0x00,           // width, MSB Offset, LSB offset
        0x0C, 0xDF, 0x10, 0x00,           // width, MSB Offset, LSB offset
        0x06, 0x15, 0x11, 0x00,           // width, MSB Offset, LSB offset
        0x14, 0x30, 0x11, 0x00,           // width, MSB Offset, LSB offset
        0x0D, 0x81, 0x11, 0x00,           // width, MSB Offset, LSB offset
        0x0C, 0xB7, 0x11, 0x00,           // width, MSB Offset, LSB offset
        0x0C, 0xED, 0x11, 0x00,           // width, MSB Offset, LSB offset
        0x0C, 0x23, 0x12, 0x00,           // width, MSB Offset, LSB offset
        0x09, 0x59, 0x12, 0x00,           // width, MSB Offset, LSB offset
        0x09, 0x8F, 0x12, 0x00,           // width, MSB Offset, LSB offset
        0x08, 0xC5, 0x12, 0x00,           // width, MSB Offset, LSB offset
        0x0C, 0xE0, 0x12, 0x00,           // width, MSB Offset, LSB offset
        0x0B, 0x16, 0x13, 0x00,           // width, MSB Offset, LSB offset
        0x10, 0x4C, 0x13, 0x00,           // width, MSB Offset, LSB offset
        0x0C, 0x82, 0x13, 0x00,           // width, MSB Offset, LSB offset
        0x0B, 0xB8, 0x13, 0x00,           // width, MSB Offset, LSB offset
        0x0A, 0xEE, 0x13, 0x00,           // width, MSB Offset, LSB offset
        0x08, 0x24, 0x14, 0x00,           // width, MSB Offset, LSB offset
        0x05, 0x3F, 0x14, 0x00,           // width, MSB Offset, LSB offset
        0x08, 0x5A, 0x14, 0x00,           // width, MSB Offset, LSB offset
        0x0B, 0x75, 0x14, 0x00,           // width, MSB Offset, LSB offset
/***********************************
 * Font Characters
```

```
   ***********************************/
      0x00, 0x00,         //
      0x00, 0x00,         //
      0x00, 0x00,         //
      0x00, 0x30,         //             **
      0x00, 0x38,         //            ***
      0x00, 0x3C,         //           ****
      0x00, 0x3E,         //          *****
      0x00, 0x3F,         //         ******
      0x80, 0x3F,         //        *******
      0xC0, 0x3F,         //       ********
      0xE0, 0x3F,         //      *********
      0xF0, 0x3F,         //     **********
      0xF8, 0x3F,         //    ***********
      0xFC, 0x3F,         //   ************
      0xF8, 0x3F,         //    ***********
      0xF0, 0x3F,         //     **********
      0xE0, 0x3F,         //      *********
      0xC0, 0x3F,         //       ********
      0x80, 0x3F,         //        *******
      0x00, 0x3F,         //         ******
      0x00, 0x3E,         //          *****
      0x00, 0x3C,         //           ****
      0x00, 0x38,         //            ***
      0x00, 0x30,         //             **
      0x00, 0x00,         //
      0x00, 0x00,         //
      0x00, 0x00,         //

      0x00, 0x00,         //
      0x00, 0x00,         //
      0x00, 0x00,         //
      0x0C, 0x00,         //   **
      0x1C, 0x00,         //   ***
      0x3C, 0x00,         //   ****
      0x7C, 0x00,         //   *****
      0xFC, 0x00,         //   ******
      0xFC, 0x01,         //   *******
      0xFC, 0x03,         //   ********
      0xFC, 0x07,         //   *********
      0xFC, 0x0F,         //   **********
      0xFC, 0x1F,         //   ***********
      0xFC, 0x3F,         //   ************
      0xFC, 0x1F,         //   ***********
      0xFC, 0x0F,         //   **********
      0xFC, 0x07,         //   *********
      0xFC, 0x03,         //   ********
      0xFC, 0x01,         //   *******
      0xFC, 0x00,         //   ******
      0x7C, 0x00,         //   *****
      0x3C, 0x00,         //   ****
      0x1C, 0x00,         //   ***
      0x0C, 0x00,         //   **
      0x00, 0x00,         //
      0x00, 0x00,         //
      0x00, 0x00,         //

      0x00, 0x00, 0x00,         //
      0x00, 0x00, 0x00,         //
      0x00, 0x00, 0x00,         //
      0x00, 0x01, 0x00,         //         *
      0x80, 0x03, 0x00,         //        ***
      0x80, 0x03, 0x00,         //        ***
      0x80, 0x03, 0x00,         //        ***
      0xC0, 0x07, 0x00,         //       *****
      0xC0, 0x07, 0x00,         //       *****
      0xE0, 0x0F, 0x00,         //      *******
      0xE0, 0x0F, 0x00,         //      *******
      0xE0, 0x0F, 0x00,         //      *******
      0xF0, 0x1F, 0x00,         //     *********
      0xF0, 0x1F, 0x00,         //     *********
      0xF0, 0x1F, 0x00,         //     *********
      0xF8, 0x3F, 0x00,         //    ***********
      0xF8, 0x3F, 0x00,         //    ***********
      0xF8, 0x3F, 0x00,         //    ***********
      0xFC, 0x7F, 0x00,         //   *************
      0xFC, 0x7F, 0x00,         //   *************
      0xFC, 0x7F, 0x00,         //   *************
      0xFE, 0xFF, 0x00,         //  ***************
      0xFE, 0xFF, 0x00,         //  ***************
      0xFE, 0xFF, 0x00,         //  ***************
      0x00, 0x00, 0x00,         //
      0x00, 0x00, 0x00,         //
      0x00, 0x00, 0x00,         //

      0x00, 0x00, 0x00,         //
      0x00, 0x00, 0x00,         //
      0x00, 0x00, 0x00,         //
      0xFE, 0xFF, 0x00,         //  ***************
      0xFE, 0xFF, 0x00,         //  ***************
      0xFE, 0xFF, 0x00,         //  ***************
      0xFC, 0x7F, 0x00,         //   *************
      0xFC, 0x7F, 0x00,         //   *************
      0xFC, 0x7F, 0x00,         //   *************
      0xF8, 0x3F, 0x00,         //    ***********
      0xF8, 0x3F, 0x00,         //    ***********
      0xF8, 0x3F, 0x00,         //    ***********
      0xF0, 0x1F, 0x00,         //     *********
      0xF0, 0x1F, 0x00,         //     *********
      0xF0, 0x1F, 0x00,         //     *********
      0xE0, 0x0F, 0x00,         //      *******
      0xE0, 0x0F, 0x00,         //      *******
      0xE0, 0x0F, 0x00,         //      *******
      0xC0, 0x07, 0x00,         //       *****
      0xC0, 0x07, 0x00,         //       *****
      0x80, 0x03, 0x00,         //        ***
      0x80, 0x03, 0x00,         //        ***
      0x80, 0x03, 0x00,         //        ***
      0x00, 0x01, 0x00,         //         *
      0x00, 0x00, 0x00,         //
      0x00, 0x00, 0x00,         //
      0x00, 0x00, 0x00,         //

      0x00,         //
      0x00,         //
      0x00,         //
      0x00,         //
      0x00,         //
      0x00,         //
      0x00,         //
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      0x00,         //
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      0x00,         //
      0x00,         //
      0x00,         //
      0x00,         //
      0x00,         //
      0x00,         //

      0x00,         //
      0x00,         //
      0x00,         //
      0x08,         //    *
      0x0C,         //   **
      0x0C,         //   **
      0x0C,         //   **
      0x0C,         //   **
      0x0C,         //   **
      0x0C,         //   **
      0x0C,         //   **
      0x0C,         //   **
      0x0C,         //   **
      0x0C,         //   **
      0x0C,         //   **
      0x04,         //   *
      0x00,         //
      0x0C,         //   **
      0x0C,         //   **
      0x0C,         //   **
      0x00,         //
      0x00,         //
      0x00,         //
      0x00,         //
      0x00,         //
      0x00,         //
      0x00,         //

      0x00, 0x00,         //
      0x00, 0x00,         //
      0x00, 0x00,         //
      0xCC, 0x00,         //   **  **
      0xCC, 0x00,         //   **  **
      0xCC, 0x00,         //   **  **
      0xCC, 0x00,         //   **  **
      0xCC, 0x00,         //   **  **
      0xCC, 0x00,         //   **  **
      0xCC, 0x00,         //   **  **
      0xC4, 0x00,         //   *   **
      0x00, 0x00,         //
      0x00, 0x00,         //
      0x00, 0x00,         //
      0x00, 0x00,         //
      0x00, 0x00,         //
      0x00, 0x00,         //
      0x00, 0x00,         //
      0x00, 0x00,         //
      0x00, 0x00,         //
      0x00, 0x00,         //
      0x00, 0x00,         //
      0x00, 0x00,         //
      0x00, 0x00,         //
      0x00, 0x00,         //
      0x00, 0x00,         //
      0x00, 0x00,         //

      0x00, 0x00,         //
      0x00, 0x00,         //
      0x00, 0x00,         //
      0x00, 0x00,         //
      0x00, 0x00,         //
      0x00, 0x00,         //
      0x60, 0x02,         //      **  *
      0x20, 0x03,         //      *  **
      0x20, 0x01,         //      *  *
      0x20, 0x01,         //      *  *
      0xFC, 0x07,         //   *********
      0x90, 0x01,         //     *  **
      0x90, 0x00,         //     *  *
      0x98, 0x00,         //    **  *
      0xFE, 0x03,         //  *********
      0x48, 0x00,         //    *  *
      0x4C, 0x00,         //   **  *
      0x44, 0x00,         //   *   *
      0x64, 0x00,         //   *  **
```

```
        0x00, 0x00,         //
        0x00, 0x00,         //
        0x00, 0x00,         //
        0x00, 0x00,         //
        0x00, 0x00,         //
        0x00, 0x00,         //
        0x00, 0x00,         //
        0x00, 0x00,         //

        0x00, 0x00,         //
        0x00, 0x00,         //
        0x00, 0x00,         //
        0x00, 0x00,         //
        0x60, 0x00,         //      **
        0x60, 0x00,         //      **
        0xF8, 0x01,         //    ******
        0x6C, 0x03,         //   ** ** **
        0x66, 0x01,         //  **  ** *
        0x66, 0x00,         //  **  **
        0x6E, 0x00,         //  *** **
        0x7C, 0x00,         //   *****
        0xF8, 0x01,         //    ******
        0xE0, 0x01,         //      ****
        0xE0, 0x03,         //      *****
        0x60, 0x03,         //      ** **
        0x62, 0x03,         //  *   ** **
        0x62, 0x03,         //  *   ** **
        0x66, 0x01,         //  **  ** *
        0xFC, 0x00,         //   ******
        0x60, 0x00,         //      **
        0x60, 0x00,         //      **
        0x00, 0x00,         //
        0x00, 0x00,         //
        0x00, 0x00,         //
        0x00, 0x00,         //
        0x00, 0x00,         //

        0x00, 0x00,         //
        0x00, 0x00,         //
        0x00, 0x00,         //
        0x00, 0x00,         //
        0x00, 0x00,         //
        0x00, 0x00,         //
        0x38, 0x30,         //    ***      **
        0x24, 0x18,         //   *  *     **
        0x66, 0x0C,         //  **  **   **
        0x66, 0x04,         //  **  **   *
        0x66, 0x06,         //  **  **  **
        0x66, 0x03,         //  **  ** **
        0xA4, 0x01,         //   *  * **
        0x9C, 0x38,         //   ***  *   ***
        0xC0, 0x64,         //       **  *  **
        0x60, 0x66,         //      **  **  **
        0x20, 0x66,         //      *   **  **
        0x10, 0x66,         //     *    **  **
        0x18, 0x24,         //    **     *  *
        0x0C, 0x1C,         //   **      ***
        0x00, 0x00,         //
        0x00, 0x00,         //
        0x00, 0x00,         //
        0x00, 0x00,         //
        0x00, 0x00,         //
        0x00, 0x00,         //
        0x00, 0x00,         //

        0x00, 0x00,         //
        0x00, 0x00,         //
        0x00, 0x00,         //
        0x00, 0x00,         //
        0xE0, 0x01,         //      ****
        0x30, 0x03,         //     **  **
        0x18, 0x03,         //    **   **
```

```
      0x18, 0x03,         //    **   **
      0x18, 0x01,         //    **   *
      0x98, 0x01,         //    **  **
      0x78, 0x00,         //    ****
      0x78, 0x7E,         //    ****  ******
      0x7C, 0x1C,         //   *****   ***
      0xCC, 0x18,         //   **  **   **
      0xC6, 0x19,         //  **   ***  **
      0x86, 0x1B,         //  **    *** **
      0x06, 0x0F,         //  **     ****
      0x06, 0x0E,         //  **      ***
      0x0C, 0x1A,         //   **     * **
      0xF8, 0x71,         //    ******   ***
      0x00, 0x00,         //
      0x00, 0x00,         //
      0x00, 0x00,         //
      0x00, 0x00,         //
      0x00, 0x00,         //
      0x00, 0x00,         //
      0x00, 0x00,         //

      0x00,         //
      0x00,         //
      0x00,         //
      0x0C,         //   **
      0x0C,         //   **
      0x0C,         //   **
      0x0C,         //   **
      0x0C,         //   **
      0x0C,         //   **
      0x0C,         //   **
      0x04,         //   *
      0x00,         //
      0x00,         //
      0x00,         //
      0x00,         //
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      0x22, 0x01,         //  *   *  *
      0xAE, 0x03,         //  *** * ***
      0x78, 0x00,         //    ****
      0x78, 0x00,         //    ****
      0xAE, 0x01,         //  *** * **
      0x22, 0x01,         //  *   *  *
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      0xF0, 0x00,         //     ****
      0xC8, 0x01,         //    *  ***
      0x8C, 0x01,         //   **   **
      0x84, 0x03,         //   *    ***
      0x06, 0x03,         //  **     **
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      0x06, 0x01,         //  **     *
      0x0C, 0x01,         //   **    *
      0x8C, 0x00,         //   **   *
      0x70, 0x00,         //     ***
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      0x78, 0x00,         //    ****
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      0x60, 0x00,         //      **
      0xFC, 0x03,         //   ********
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      0x78, 0x00,         //    ****
      0xC4, 0x01,         //   *   ***
      0x86, 0x01,         //  **    **
      0x82, 0x01,         //  *     **
      0x80, 0x01,         //        **
      0xC0, 0x00,         //       **
      0xC0, 0x00,         //       **
      0x60, 0x00,         //      **
      0x30, 0x00,         //     **
      0x30, 0x00,         //     **
      0x18, 0x00,         //    **
      0x0C, 0x01,         //   **    *
      0x06, 0x01,         //  **     *
      0xFE, 0x01,         //  ********
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      0xF8, 0x00,         //    *****
      0xCC, 0x01,         //   **  ***
      0x86, 0x01,         //  **    **
      0x80, 0x01,         //        **
      0x80, 0x01,         //        **
      0x40, 0x00,         //       *
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      0x86, 0x01,         //  **    **
      0x78, 0x00,         //    ****
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      0xD0, 0x00,         //     * **
      0xD8, 0x00,         //    ** **
      0xC8, 0x00,         //    *  **
      0xC4, 0x00,         //   *   **
      0xC6, 0x00,         //  **   **
      0xC2, 0x00,         //  *    **
      0xFF, 0x03,         // **********
      0xC0, 0x00,         //       **
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      0xC0, 0x00,         //       **
      0xF0, 0x03,         //     ******
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      0xFC, 0x00,         //   ******
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      0x06, 0x00,         //  **
      0x7E, 0x00,         //  ******
      0xC2, 0x00,         //  *    **
      0x80, 0x01,         //        **
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      0xC3, 0x00,         // **    **
      0x3C, 0x00,         //   ****
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      0x18, 0x00,         //    **
      0x08, 0x00,         //    *
      0x0C, 0x00,         //   **
      0xF6, 0x00,         //  ** ****
      0x8E, 0x01,         //  ***   **
      0x06, 0x03,         //  **     **
      0x06, 0x03,         //  **     **
      0x06, 0x03,         //  **     **
      0x06, 0x03,         //  **     **
      0x0C, 0x01,         //   **    *
      0x8C, 0x01,         //   **   **
      0xF0, 0x00,         //     ****
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      0xFC, 0x03,         //   ********
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      0x02, 0x01,         //  *      *
      0x80, 0x01,         //        **
      0x80, 0x00,         //        *
      0xC0, 0x00,         //       **
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      0xF8, 0x00,         //    *****
      0xCC, 0x01,         //   **  ***
      0x86, 0x01,         //  **    **
      0x86, 0x01,         //  **    **
      0x8E, 0x01,         //  ***   **
      0xDC, 0x00,         //   *** **
      0xF0, 0x00,         //     ****
      0xC8, 0x01,         //    *  ***
      0x8C, 0x03,         //   **   ***
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      0x84, 0x01,         //   *    **
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      0x78, 0x03,         //    **** **
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      0xC0, 0x00,         //       **
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        0xE0, 0x01,         //      ****
        0x3C, 0x00,         //   ****
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        0xF0, 0x00,         //     ****
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      0x3C, 0x00,         //   ****
      0xE0, 0x01,         //      ****
      0x80, 0x01,         //        **
      0xF0, 0x00,         //     ****
      0x1E, 0x00,         //  ****
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      0x00, 0x00,         //
      0xF8, 0x00,         //    *****
      0xCC, 0x01,         //   **  ***
      0x86, 0x01,         //  **    **
      0x86, 0x01,         //  **    **
      0x80, 0x01,         //        **
      0x80, 0x01,         //        **
      0xC0, 0x00,         //       **
      0x60, 0x00,         //      **
      0x60, 0x00,         //      **
      0x30, 0x00,         //     **
      0x30, 0x00,         //     **
      0x30, 0x00,         //     **
      0x10, 0x00,         //     *
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      0x30, 0x00,         //     **
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      0x00, 0x00, 0x00,         //
      0x00, 0x00, 0x00,         //
      0x00, 0x3F, 0x00,         //         ******
      0xC0, 0x70, 0x00,         //       **    ***
      0x30, 0xC0, 0x00,         //     **        **
      0x18, 0x80, 0x01,         //    **          **
      0x08, 0x80, 0x01,         //    *           **
      0x0C, 0x97, 0x03,         //   **    *** *  ***
      0x84, 0x18, 0x03,         //   *    *   **   **
      0x46, 0x18, 0x03,         //  **   *    **    **
      0x66, 0x18, 0x03,         //  **  **    **    **
      0x66, 0x18, 0x03,         //  **  **    **    **
      0x66, 0x18, 0x03,         //  **  **    **    **
      0x66, 0x18, 0x01,         //  **  **    **    *
      0x6E, 0x98, 0x01,         //  *** **    **   **
      0xCC, 0x9C, 0x00,         //   **  **  ***  *
      0x8C, 0x73, 0x00,         //   **   ***  ***
      0x18, 0x00, 0x00,         //    **
      0x38, 0x80, 0x00,         //    ***         *
      0xE0, 0xE0, 0x01,         //      ***     ****
      0x80, 0x1F, 0x00,         //        ******
      0x00, 0x00, 0x00,         //
      0x00, 0x00, 0x00,         //
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      0x00, 0x00,         //
      0x00, 0x00,         //
      0x00, 0x00,         //
      0x40, 0x00,         //       *
      0xC0, 0x00,         //       **
      0xA0, 0x00,         //      * *
      0xA0, 0x01,         //      * **
      0xA0, 0x01,         //      * **
      0x10, 0x01,         //     *   *
      0x10, 0x03,         //     *   **
      0x10, 0x03,         //     *   **
      0xF8, 0x03,         //    *******
      0x08, 0x06,         //    *     **
      0x08, 0x06,         //    *     **
      0x04, 0x0C,         //   *       **
      0x04, 0x0C,         //   *       **
      0x1F, 0x1E,         // *****    ****
      0x00, 0x00,         //
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      0x00, 0x00,         //
      0xFE, 0x00,         //  *******
      0x8D, 0x03,         // * **   ***
      0x0C, 0x03,         //   **    **
      0x0C, 0x03,         //   **    **
      0x0C, 0x03,         //   **    **
      0x8C, 0x01,         //   **   **
      0xFC, 0x01,         //   *******
      0x8C, 0x03,         //   **   ***
      0x0C, 0x07,         //   **    ***
      0x0C, 0x06,         //   **     **
      0x0C, 0x06,         //   **     **
      0x0C, 0x06,         //   **     **
      0x0C, 0x03,         //   **    **
      0xFF, 0x01,         // *********
      0x00, 0x00,         //
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      0x00, 0x00,         //
      0x00, 0x00,         //
      0x00, 0x00,         //
      0xC0, 0x07,         //       *****
      0x30, 0x0C,         //     **    **
      0x08, 0x00,         //    *
      0x0C, 0x00,         //   **
      0x04, 0x00,         //   *
      0x06, 0x00,         //  **
      0x06, 0x00,         //  **
      0x06, 0x00,         //  **
      0x06, 0x00,         //  **
      0x06, 0x00,         //  **
      0x0C, 0x00,         //   **
      0x0C, 0x08,         //   **       *
      0x38, 0x04,         //    ***    *
      0xE0, 0x03,         //      *****
      0x00, 0x00,         //
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      0x00, 0x00,         //
      0x00, 0x00,         //
      0xFE, 0x01,         //  ********
      0x0D, 0x07,         // * **    ***
      0x0C, 0x0E,         //   **     ***
      0x0C, 0x0C,         //   **      **
      0x0C, 0x18,         //   **       **
      0x0C, 0x18,         //   **       **
      0x0C, 0x18,         //   **       **
      0x0C, 0x18,         //   **       **
      0x0C, 0x18,         //   **       **
      0x0C, 0x18,         //   **       **
      0x0C, 0x0C,         //   **      **
      0x0C, 0x0E,         //   **     ***
      0x0C, 0x07,         //   **    ***
      0xFF, 0x01,         // *********
      0x00, 0x00,         //
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      0x00, 0x00,         //
      0x00, 0x00,         //
      0x00, 0x00,         //
      0xFF, 0x03,         // **********
      0x0C, 0x02,         //   **     *
      0x0C, 0x02,         //   **     *
      0x0C, 0x00,         //   **
      0x0C, 0x00,         //   **
      0x0C, 0x00,         //   **
      0xFC, 0x01,         //   *******
      0x8C, 0x00,         //   **   *
      0x0C, 0x00,         //   **
      0x0C, 0x00,         //   **
      0x0C, 0x00,         //   **
      0x0C, 0x04,         //   **      *
      0x0C, 0x06,         //   **     **
      0xFF, 0x03,         // **********
      0x00, 0x00,         //
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      0x00, 0x00,         //
      0x00, 0x00,         //
      0xFF, 0x03,         // **********
      0x0C, 0x02,         //   **     *
      0x0C, 0x02,         //   **     *
      0x0C, 0x00,         //   **
      0x0C, 0x00,         //   **
      0x0C, 0x00,         //   **
      0xFC, 0x01,         //   *******
      0x8C, 0x00,         //   **   *
      0x0C, 0x00,         //   **
      0x0C, 0x00,         //   **
      0x0C, 0x00,         //   **
      0x0C, 0x00,         //   **
      0x0C, 0x00,         //   **
      0x3F, 0x00,         // ******
      0x00, 0x00,         //
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      0x00, 0x00,         //
      0x00, 0x00,         //
      0x00, 0x00,         //
      0xE0, 0x03,         //      *****
      0x10, 0x06,         //     *    **
      0x08, 0x00,         //    *
      0x0C, 0x00,         //   **
      0x06, 0x00,         //  **
      0x06, 0x00,         //  **
      0x06, 0x00,         //  **
      0x86, 0x0F,         //  **    *****
      0x06, 0x06,         //  **      **
      0x06, 0x06,         //  **      **
      0x0C, 0x06,         //   **     **
      0x0C, 0x06,         //   **     **
      0x18, 0x06,         //    **    **
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        0xF0, 0x01,         //     *****
        0x00, 0x00,         //
        0x00, 0x00,         //
        0x00, 0x00,         //
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        0x00, 0x00,         //
        0x00, 0x00,         //
        0x00, 0x00,         //
        0x3F, 0x7E,         // ******   ******
        0x0C, 0x18,         //   **       **
        0x0C, 0x18,         //   **       **
        0x0C, 0x18,         //   **       **
        0x0C, 0x18,         //   **       **
        0x0C, 0x18,         //   **       **
        0xFC, 0x1F,         //   ***********
        0x0C, 0x18,         //   **       **
        0x0C, 0x18,         //   **       **
        0x0C, 0x18,         //   **       **
        0x0C, 0x18,         //   **       **
        0x0C, 0x18,         //   **       **
        0x0C, 0x18,         //   **       **
        0x3F, 0x7E,         // ******   ******
        0x00, 0x00,         //
        0x00, 0x00,         //
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        0x00,         //
        0x00,         //
        0x3F,         // ******
        0x0C,         //   **
        0x0C,         //   **
        0x0C,         //   **
        0x0C,         //   **
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        0x0C,         //   **
        0x3F,         // ******
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        0x00,         //
        0x00,         //
        0x7E,         //  ******
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      0x18,         //    **
      0x18,         //    **
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      0x18,         //    **
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      0x18,         //    **
      0x18,         //    **
      0x08,         //    *
      0x04,         //   *
      0x03,         // **
      0x00,         //
      0x00,         //
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      0x00, 0x00,         //
      0x00, 0x00,         //
      0x00, 0x00,         //
      0x00, 0x00,         //
      0x3F, 0x0F,         // ******  ****
      0x0C, 0x02,         //   **     *
      0x0C, 0x01,         //   **    *
      0x8C, 0x00,         //   **   *
      0x4C, 0x00,         //   **  *
      0x6C, 0x00,         //   ** **
      0x3C, 0x00,         //   ****
      0x6C, 0x00,         //   ** **
      0xEC, 0x00,         //   ** ***
      0xCC, 0x00,         //   **  **
      0x8C, 0x01,         //   **   **
      0x0C, 0x03,         //   **    **
      0x0C, 0x06,         //   **     **
      0x3F, 0x1C,         // ******    ***
      0x00, 0x00,         //
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      0x00, 0x00,         //
      0x00, 0x00,         //
      0x3F, 0x00,         // ******
      0x0C, 0x00,         //   **
      0x0C, 0x00,         //   **
      0x0C, 0x00,         //   **
      0x0C, 0x00,         //   **
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      0x0C, 0x00,         //   **
      0x0C, 0x00,         //   **
      0x0C, 0x00,         //   **
      0x0C, 0x04,         //   **      *
      0x0C, 0x02,         //   **     *
      0xFF, 0x03,         // **********
      0x00, 0x00,         //
      0x00, 0x00,         //
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        0x00, 0x00,         //
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        0x00, 0x00, 0x00,         //
        0x00, 0x00, 0x00,         //
        0x1E, 0xC0, 0x01,         //  ****         ***
        0x1C, 0xE0, 0x00,         //   ***        ***
        0x1C, 0xE0, 0x00,         //   ***        ***
        0x3C, 0xF0, 0x00,         //   ****      ****
        0x2C, 0xD0, 0x00,         //   ** *      * **
        0x6C, 0xD0, 0x00,         //   ** **     * **
        0x6C, 0xC8, 0x00,         //   ** **    *  **
        0xCC, 0xC8, 0x00,         //   **  **   *  **
        0xCC, 0xCC, 0x00,         //   **  **  **  **
        0x8C, 0xC5, 0x00,         //   **   ** *   **
        0x8C, 0xC7, 0x00,         //   **   ****   **
        0x0C, 0xC3, 0x00,         //   **    **    **
        0x0C, 0xC3, 0x00,         //   **    **    **
        0x1E, 0xE1, 0x03,         //  ****   *    *****
        0x00, 0x00, 0x00,         //
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        0x00, 0x00,         //
        0x00, 0x00,         //
        0x0F, 0x7E,         // ****     ******
        0x0C, 0x18,         //   **       **
        0x1C, 0x18,         //   ***      **
        0x3C, 0x18,         //   ****     **
        0x2C, 0x18,         //   ** *     **
        0x4C, 0x18,         //   **  *    **
        0xCC, 0x18,         //   **  **   **
        0x8C, 0x19,         //   **   **  **
        0x0C, 0x19,         //   **    *  **
        0x0C, 0x1B,         //   **    ** **
        0x0C, 0x1E,         //   **     ****
        0x0C, 0x1C,         //   **      ***
        0x0C, 0x1C,         //   **      ***
        0x3F, 0x18,         // ******     **
        0x00, 0x00,         //
        0x00, 0x00,         //
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        0x00, 0x00,         //
        0x00, 0x00,         //
        0x00, 0x00,         //
        0xE0, 0x03,         //      *****
        0x18, 0x06,         //    **    **
        0x08, 0x0C,         //    *      **
        0x0C, 0x0C,         //   **      **
        0x06, 0x18,         //  **        **
        0x06, 0x18,         //  **        **
        0x06, 0x18,         //  **        **
        0x06, 0x18,         //  **        **
        0x06, 0x18,         //  **        **
        0x06, 0x18,         //  **        **
        0x0C, 0x0C,         //   **      **
        0x0C, 0x04,         //   **      *
        0x18, 0x02,         //    **    *
        0xF0, 0x01,         //     *****
        0x00, 0x00,         //
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        0x00, 0x00,         //
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        0x00, 0x00,         //
        0x00, 0x00,         //
        0xFE, 0x01,         //  ********
        0x0D, 0x03,         // * **    **
        0x0C, 0x06,         //   **     **
        0x0C, 0x06,         //   **     **
        0x0C, 0x06,         //   **     **
        0x0C, 0x06,         //   **     **
        0x0C, 0x03,         //   **    **
        0xFC, 0x00,         //   ******
        0x0C, 0x00,         //   **
        0x0C, 0x00,         //   **
        0x0C, 0x00,         //   **
        0x0C, 0x00,         //   **
        0x0C, 0x00,         //   **
        0x3F, 0x00,         // ******
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        0x00, 0x00,         //
        0xE0, 0x03,         //      *****
        0x18, 0x06,         //    **    **
        0x08, 0x0C,         //    *      **
        0x0C, 0x0C,         //   **      **
        0x06, 0x18,         //  **        **
        0x06, 0x18,         //  **        **
        0x06, 0x18,         //  **        **
        0x06, 0x18,         //  **        **
        0x06, 0x18,         //  **        **
        0x06, 0x18,         //  **        **
        0x0C, 0x0C,         //   **      **
        0x0C, 0x0C,         //   **      **
        0x18, 0x06,         //    **    **
        0xF0, 0x01,         //     *****
        0x00, 0x03,         //         **
        0x00, 0x06,         //          **
        0x00, 0x38,         //            ***
        0x00, 0x00,         //
        0x00, 0x00,         //
        0x00, 0x00,         //
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      0x00, 0x00,         //
      0x00, 0x00,         //
      0xFE, 0x01,         //  ********
      0x0D, 0x03,         // * **    **
      0x0C, 0x06,         //   **     **
      0x0C, 0x06,         //   **     **
      0x0C, 0x06,         //   **     **
      0x0C, 0x03,         //   **    **
      0xFC, 0x00,         //   ******
      0xCC, 0x00,         //   **  **
      0xCC, 0x00,         //   **  **
      0x8C, 0x01,         //   **   **
      0x0C, 0x03,         //   **    **
      0x0C, 0x03,         //   **    **
      0x0C, 0x06,         //   **     **
      0x3F, 0x1C,         // ******    ***
      0x00, 0x00,         //
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      0xF8, 0x00,         //    *****
      0x8C, 0x01,         //   **   **
      0x06, 0x00,         //  **
      0x06, 0x00,         //  **
      0x0E, 0x00,         //  ***
      0x3C, 0x00,         //   ****
      0xF8, 0x00,         //    *****
      0xE0, 0x01,         //      ****
      0x80, 0x03,         //        ***
      0x00, 0x03,         //         **
      0x02, 0x03,         //  *      **
      0x02, 0x01,         //  *      *
      0x86, 0x01,         //  **    **
      0x7C, 0x00,         //   *****
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      0xFF, 0x0F,         // ************
      0x61, 0x08,         // *    **    *
      0x61, 0x08,         // *    **    *
      0x60, 0x00,         //      **
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      0x3F, 0x7E,         // ******   ******
      0x0C, 0x18,         //   **       **
      0x0C, 0x18,         //   **       **
      0x0C, 0x18,         //   **       **
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      0x0C, 0x18,         //   **       **
      0x18, 0x0C,         //    **     **
      0x38, 0x06,         //    ***   **
      0xE0, 0x03,         //      *****
      0x00, 0x00,         //
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      0x1F, 0x3C,         // *****     ****
      0x0C, 0x18,         //   **       **
      0x0C, 0x08,         //   **       *
      0x18, 0x08,         //    **      *
      0x18, 0x0C,         //    **     **
      0x18, 0x04,         //    **     *
      0x30, 0x06,         //     **   **
      0x30, 0x02,         //     **   *
      0x20, 0x02,         //      *   *
      0x60, 0x03,         //      ** **
      0x60, 0x01,         //      ** *
      0xC0, 0x01,         //       ***
      0xC0, 0x01,         //       ***
      0x80, 0x00,         //        *
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      0x00, 0x00, 0x00,         //
      0x1F, 0xC2, 0x07,         // *****    *    *****
      0x0C, 0x06, 0x01,         //   **     **     *
      0x0C, 0x06, 0x01,         //   **     **     *
      0x0C, 0x07, 0x01,         //   **    ***     *
      0x0C, 0x8D, 0x01,         //   **    * **   **
      0x08, 0x8D, 0x00,         //    *    * **   *
      0x98, 0x89, 0x00,         //    **  **  *   *
      0x98, 0x98, 0x00,         //    **  *   **  *
      0x98, 0x98, 0x00,         //    **  *   **  *
      0xD0, 0xD0, 0x00,         //     * **    * **
      0x70, 0x70, 0x00,         //     ***     ***
      0x70, 0x70, 0x00,         //     ***     ***
      0x70, 0x60, 0x00,         //     ***      **
      0x20, 0x60, 0x00,         //      *       **
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      0x00, 0x00,         //
      0x3F, 0x1F,         // ******  *****
      0x0C, 0x0C,         //   **      **
      0x18, 0x06,         //    **    **
      0x38, 0x03,         //    ***  **
      0x30, 0x01,         //     **  *
      0xE0, 0x01,         //      ****
      0xC0, 0x00,         //       **
      0xC0, 0x01,         //       ***
      0xA0, 0x01,         //      * **
      0x30, 0x03,         //     **  **
      0x18, 0x06,         //    **    **
      0x08, 0x0E,         //    *     ***
      0x0C, 0x0C,         //   **      **
      0x1F, 0x3E,         // *****    *****
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      0x07, 0x3E,         // ***      *****
      0x0C, 0x0C,         //   **      **
      0x18, 0x04,         //    **     *
      0x18, 0x02,         //    **    *
      0x30, 0x03,         //     **  **
      0x60, 0x01,         //      ** *
      0xE0, 0x01,         //      ****
      0xC0, 0x00,         //       **
      0xC0, 0x00,         //       **
      0xC0, 0x00,         //       **
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      0xC0, 0x00,         //       **
      0xF0, 0x03,         //     ******
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      0xFC, 0x07,         //   *********
      0x04, 0x03,         //   *     **
      0x02, 0x03,         //  *      **
      0x80, 0x01,         //        **
      0xC0, 0x00,         //       **
      0xC0, 0x00,         //       **
      0x60, 0x00,         //      **
      0x70, 0x00,         //     ***
      0x30, 0x00,         //     **
      0x18, 0x00,         //    **
      0x18, 0x00,         //    **
      0x0C, 0x04,         //   **      *
      0x06, 0x04,         //  **       *
      0xFE, 0x07,         //  **********
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      0x02, 0x00,         //  *
      0x06, 0x00,         //  **
      0x06, 0x00,         //  **
      0x04, 0x00,         //   *
      0x0C, 0x00,         //   **
      0x08, 0x00,         //    *
      0x18, 0x00,         //    **
      0x18, 0x00,         //    **
      0x10, 0x00,         //     *
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      0x40, 0x00,         //       *
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      0xC0, 0x00,         //       **
      0x80, 0x00,         //        *
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      0x80, 0x01,         //        **
      0x00, 0x01,         //         *
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      0x20, 0x00,         //      *
      0x60, 0x00,         //      **
      0x70, 0x00,         //     ***
      0xD0, 0x00,         //     * **
      0xD8, 0x00,         //    ** **
      0x88, 0x00,         //    *   *
      0x88, 0x01,         //    *   **
      0x8C, 0x01,         //   **   **
      0x04, 0x03,         //   *     **
      0x04, 0x03,         //   *     **
      0x02, 0x03,         //  *      **
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        0xFE, 0x03,         //  *********
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        0xF0, 0x00,         //     ****
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    0x8C, 0x01,         //   **   **
    0x86, 0x01,         //  **    **
    0x80, 0x01,         //        **
    0xF0, 0x01,         //     *****
    0x8C, 0x01,         //   **   **
    0x86, 0x01,         //  **    **
    0x86, 0x01,         //  **    **
    0xC6, 0x01,         //  **   ***
    0xBC, 0x07,         //   **** ****
    0x00, 0x00,         //
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    0x00, 0x00,         //
    0x0C, 0x00,         //   **
    0x0E, 0x00,         //  ***
    0x0C, 0x00,         //   **
    0x0C, 0x00,         //   **
    0x0C, 0x00,         //   **
    0x0C, 0x00,         //   **
    0x0C, 0x00,         //   **
    0xCC, 0x01,         //   **  ***
    0x3C, 0x03,         //   ****  **
    0x1C, 0x07,         //   ***   ***
    0x0C, 0x06,         //   **     **
    0x0C, 0x06,         //   **     **
    0x0C, 0x06,         //   **     **
    0x0C, 0x06,         //   **     **
    0x0C, 0x02,         //   **     *
    0x1C, 0x01,         //   ***   *
    0xF0, 0x00,         //     ****
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    0x00, 0x00,         //
    0xE0, 0x01,         //      ****
    0x18, 0x03,         //    **   **
    0x0C, 0x00,         //   **
    0x06, 0x00,         //  **
    0x06, 0x00,         //  **
    0x06, 0x00,         //  **
    0x06, 0x00,         //  **
    0x0C, 0x00,         //   **
    0x1C, 0x03,         //   ***   **
    0xF0, 0x00,         //     ****
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      0x00, 0x03,         //         **
      0xC0, 0x03,         //       ****
      0x00, 0x03,         //         **
      0x00, 0x03,         //         **
      0x00, 0x03,         //         **
      0x00, 0x03,         //         **
      0x00, 0x03,         //         **
      0xF0, 0x03,         //     ******
      0x88, 0x03,         //    *   ***
      0x04, 0x03,         //   *     **
      0x06, 0x03,         //  **     **
      0x06, 0x03,         //  **     **
      0x06, 0x03,         //  **     **
      0x06, 0x03,         //  **     **
      0x0E, 0x03,         //  ***    **
      0xCC, 0x0B,         //   **  **** *
      0x38, 0x07,         //    ***  ***
      0x00, 0x00,         //
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      0x00, 0x00,         //
      0xF0, 0x00,         //     ****
      0x08, 0x03,         //    *    **
      0x04, 0x03,         //   *     **
      0xFE, 0x03,         //  *********
      0x06, 0x00,         //  **
      0x06, 0x00,         //  **
      0x06, 0x00,         //  **
      0x0C, 0x00,         //   **
      0x1C, 0x03,         //   ***   **
      0xF0, 0x00,         //     ****
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      0x00,         //
      0x60,         //      **
      0x50,         //     * *
      0x18,         //    **
      0x0C,         //   **
      0x0C,         //   **
      0x0C,         //   **
      0x0C,         //   **
      0x7E,         //  ******
      0x0D,         // * **
      0x0C,         //   **
      0x0C,         //   **
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      0x0C,         //   **
      0x3F,         // ******
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      0xF8, 0x0C,         //    *****  **
      0x8C, 0x03,         //   **   ***
      0x06, 0x03,         //  **     **
      0x06, 0x03,         //  **     **
      0x06, 0x03,         //  **     **
      0x8C, 0x01,         //   **   **
      0xF8, 0x00,         //    *****
      0x18, 0x00,         //    **
      0x1C, 0x00,         //   ***
      0xF8, 0x03,         //    *******
      0x06, 0x0E,         //  **      ***
      0x03, 0x0C,         // **        **
      0x03, 0x0C,         // **        **
      0x06, 0x06,         //  **      **
      0xFC, 0x01,         //   *******
      0x00, 0x00,         //
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      0x00, 0x00,         //
      0x00, 0x00,         //
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      0x0C, 0x00,         //   **
      0x0F, 0x00,         // ****
      0x0C, 0x00,         //   **
      0x0C, 0x00,         //   **
      0x0C, 0x00,         //   **
      0x0C, 0x00,         //   **
      0x0C, 0x00,         //   **
      0xCC, 0x03,         //   **  ****
      0x2C, 0x06,         //   ** *   **
      0x1C, 0x06,         //   ***    **
      0x0C, 0x06,         //   **     **
      0x0C, 0x06,         //   **     **
      0x0C, 0x06,         //   **     **
      0x0C, 0x06,         //   **     **
      0x0C, 0x06,         //   **     **
      0x0C, 0x06,         //   **     **
      0xBF, 0x1F,         // ****** ******
      0x00, 0x00,         //
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    0x0F,         // ****
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    0x3F,         // ******
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    0x0C, 0x00,         //   **
    0x0F, 0x00,         // ****
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    0x0C, 0x00,         //   **
    0x0C, 0x00,         //   **
    0x0C, 0x00,         //   **
    0x8C, 0x07,         //   **   ****
    0x8C, 0x01,         //   **   **
    0xCC, 0x00,         //   **  **
    0x2C, 0x00,         //   ** *
    0x3C, 0x00,         //   ****
    0x6C, 0x00,         //   ** **
    0xCC, 0x00,         //   **  **
    0x8C, 0x01,         //   **   **
    0x0C, 0x03,         //   **    **
    0x1F, 0x0F,         // *****   ****
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    0x00, 0x00, 0x00,         //
    0x8E, 0xE3, 0x01,         //  ***   ***   ****
    0x6D, 0x16, 0x03,         // * ** **  ** *   **
    0x1C, 0x0E, 0x03,         //   ***    ***     **
    0x0C, 0x06, 0x03,         //   **     **      **
    0x0C, 0x06, 0x03,         //   **     **      **
    0x0C, 0x06, 0x03,         //   **     **      **
    0x0C, 0x06, 0x03,         //   **     **      **
    0x0C, 0x06, 0x03,         //   **     **      **
    0x0C, 0x06, 0x03,         //   **     **      **
    0xBF, 0xDF, 0x0F,         // ****** ****** ******
    0x00, 0x00, 0x00,         //
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        0x8E, 0x03,         //  ***   ***
        0x6D, 0x06,         // * ** **  **
        0x1C, 0x06,         //   ***    **
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        0x0C, 0x06,         //   **     **
        0xBF, 0x1F,         // ****** ******
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        0x00, 0x00,         //
        0xF0, 0x00,         //     ****
        0x88, 0x03,         //    *   ***
        0x04, 0x03,         //   *     **
        0x06, 0x06,         //  **       **
        0x06, 0x06,         //  **       **
        0x06, 0x06,         //  **       **
        0x06, 0x06,         //  **       **
        0x0C, 0x02,         //   **     *
        0x1C, 0x01,         //   ***   *
        0xF0, 0x00,         //     ****
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        0x00, 0x00,         //
        0x00, 0x00,         //
        0xCE, 0x01,         //  ***  ***
        0x3D, 0x03,         // * ****  **
        0x1C, 0x07,         //   ***   ***
        0x0C, 0x06,         //   **     **
        0x0C, 0x06,         //   **     **
        0x0C, 0x06,         //   **     **
        0x0C, 0x06,         //   **     **
        0x0C, 0x02,         //   **     *
        0x1C, 0x03,         //   ***   **
        0xEC, 0x00,         //   ** ***
        0x0C, 0x00,         //   **
        0x0C, 0x00,         //   **
        0x0C, 0x00,         //   **
        0x0C, 0x00,         //   **
        0x3F, 0x00,         // ******
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        0x00, 0x00,         //
        0xF0, 0x02,         //     **** *
        0x88, 0x03,         //    *   ***
        0x0C, 0x03,         //   **    **
        0x06, 0x03,         //  **     **
        0x06, 0x03,         //  **     **
        0x06, 0x03,         //  **     **
        0x06, 0x03,         //  **     **
        0x0E, 0x03,         //  ***    **
        0x8C, 0x03,         //   **   ***
        0x78, 0x03,         //    **** **
        0x00, 0x03,         //         **
        0x00, 0x03,         //         **
        0x00, 0x03,         //         **
        0x00, 0x03,         //         **
        0xC0, 0x0F,         //       ******
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        0x00, 0x00,         //
        0xCC, 0x01,         //   **  ***
        0xAF, 0x01,         // **** * **
        0x9C, 0x00,         //   ***  *
        0x1C, 0x00,         //   ***
        0x0C, 0x00,         //   **
        0x0C, 0x00,         //   **
        0x0C, 0x00,         //   **
        0x0C, 0x00,         //   **
        0x0C, 0x00,         //   **
        0x3F, 0x00,         // ******
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        0x00, 0x00,         //
        0x7C, 0x00,         //   *****
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      0x66, 0x00,         //  **  **
      0x06, 0x00,         //  **
      0x0E, 0x00,         //  ***
      0x3C, 0x00,         //   ****
      0xF0, 0x00,         //     ****
      0xC0, 0x00,         //       **
      0xC2, 0x00,         //  *    **
      0xC2, 0x00,         //  *    **
      0x3E, 0x00,         //  *****
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      0x00,         //
      0x08,         //    *
      0x0C,         //   **
      0x0C,         //   **
      0x0C,         //   **
      0xFE,         //  *******
      0x0D,         // * **
      0x0C,         //   **
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      0x8C,         //   **   *
      0x78,         //    ****
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      0x0C, 0x03,         //   **    **
      0xCE, 0x03,         //  ***  ****
      0x0C, 0x03,         //   **    **
      0x0C, 0x03,         //   **    **
      0x0C, 0x03,         //   **    **
      0x0C, 0x03,         //   **    **
      0x0C, 0x03,         //   **    **
      0x0C, 0x03,         //   **    **
      0xCC, 0x0B,         //   **  **** *
      0x38, 0x07,         //    ***  ***
      0x00, 0x00,         //
      0x00, 0x00,         //
      0x00, 0x00,         //
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        0x00, 0x00,         //
        0x00, 0x00,         //
        0x00, 0x00,         //
        0x9F, 0x07,         // *****  ****
        0x04, 0x02,         //   *      *
        0x0C, 0x01,         //   **    *
        0x0C, 0x01,         //   **    *
        0x98, 0x01,         //    **  **
        0x98, 0x00,         //    **  *
        0x90, 0x00,         //     *  *
        0x70, 0x00,         //     ***
        0x60, 0x00,         //      **
        0x20, 0x00,         //      *
        0x00, 0x00,         //
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        0x00, 0x00,         //
        0x1F, 0xF1,         // *****   *   ****
        0x04, 0x41,         //   *     *     *
        0x84, 0x23,         //   *    ***   *
        0x8C, 0x23,         //   **   ***   *
        0x88, 0x26,         //    *   * **  *
        0x48, 0x36,         //    *  *  ** **
        0x58, 0x14,         //    ** *   * *
        0x30, 0x1C,         //     **    ***
        0x30, 0x1C,         //     **    ***
        0x30, 0x08,         //     **     *
        0x00, 0x00,         //
        0x00, 0x00,         //
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        0x00, 0x00,         //
        0x00, 0x00,         //
        0x9F, 0x07,         // *****  ****
        0x0C, 0x01,         //   **    *
        0x98, 0x00,         //    **  *
        0xF0, 0x00,         //     ****
        0x60, 0x00,         //      **
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      0x70, 0x00,         //     ***
      0xD0, 0x00,         //     * **
      0x88, 0x01,         //    *   **
      0x04, 0x03,         //   *     **
      0x8F, 0x07,         // ****   ****
      0x00, 0x00,         //
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      0x00, 0x00,         //
      0x00, 0x00,         //
      0x00, 0x00,         //
      0x9F, 0x07,         // *****  ****
      0x04, 0x02,         //   *      *
      0x0C, 0x01,         //   **    *
      0x0C, 0x01,         //   **    *
      0x98, 0x01,         //    **  **
      0x98, 0x00,         //    **  *
      0x90, 0x00,         //     *  *
      0x70, 0x00,         //     ***
      0x60, 0x00,         //      **
      0x60, 0x00,         //      **
      0x20, 0x00,         //      *
      0x30, 0x00,         //     **
      0x10, 0x00,         //     *
      0x0F, 0x00,         // ****
      0x07, 0x00,         // ***
      0x00, 0x00,         //
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      0x00, 0x00,         //
      0x00, 0x00,         //
      0xFE, 0x01,         //  ********
      0x82, 0x01,         //  *     **
      0xC2, 0x00,         //  *    **
      0x60, 0x00,         //      **
      0x20, 0x00,         //      *
      0x30, 0x00,         //     **
      0x18, 0x00,         //    **
      0x0C, 0x01,         //   **    *
      0x04, 0x01,         //   *     *
      0xFE, 0x01,         //  ********
      0x00, 0x00,         //
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      0x40,         //       *
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    0x30,         //     **
    0x10,         //     *
    0x18,         //    **
    0x18,         //    **
    0x18,         //    **
    0x38,         //    ***
    0x30,         //     **
    0x30,         //     **
    0x10,         //     *
    0x08,         //    *
    0x1E,         //  ****
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    0x00,         //
    0x02,         //  *
    0x0C,         //   **
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    0x18,         //    **
    0x0C,         //   **
    0x0C,         //   **
    0x0C,         //   **
    0x0C,         //   **
    0x78,         //    ****
    0x10,         //     *
    0x08,         //    *
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    0x0C,         //   **
    0x1C,         //   ***
    0x18,         //    **
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    0x18,         //    **
    0x08,         //    *
    0x0C,         //   **
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    0x00, 0x00,         //
    0x00, 0x00,         //
    0x00, 0x00,         //
    0x00, 0x00,         //
    0x00, 0x00,         //
    0x00, 0x00,         //
    0x00, 0x00,         //
    0x18, 0x04,         //    **     *
    0x7C, 0x02,         //   *****  *
    0xF2, 0x01,         //  *  *****
    0xC2, 0x01,         //  *    ***
    0x00, 0x00,         //
    0x00, 0x00,         //
    0x00, 0x00,         //
    0x00, 0x00,         //
    0x00, 0x00,         //
    0x00, 0x00,         //
    0x00, 0x00,         //
    0x00, 0x00,         //
    0x00, 0x00,         //
    0x00, 0x00,         //
    0x00, 0x00,         //
    0x00, 0x00,         //

};

#endif // USE_GOL
#endif // #ifndef FONTDEFAULT
```

14.1.4 Graphics.h

This is file Graphics.h.

Body Source

```
/*********************************************************************
 * Module for Microchip Graphics Library
 * The header file joins all header files used in the graphics library
 * and contains compile options and defaults.
 *********************************************************************
 * FileName:        Graphics.h
 * Processor:       PIC24F, PIC24H, dsPIC, PIC32
 * Compiler:        MPLAB C30, MPLAB C32
 * Company:         Microchip Technology, Inc.
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   *
   * Date         Comment
   *~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
   * 11/12/07     Version 1.0 release
   * 02/24/11     - Removed GRAPHICS CONTROLLER and DISPLAY PANEL Codes
   *              - Changed USE_CUSTOM to USE_CUSTOM_WIDGET. When custom widgets
   *                are created and users do not want to modify files in the
   *                graphics library.
   *              - Removed the dependency of this file from HardwareProfile.h
   *              - Removed macros that defines supported controllers and
   *                display panels. Refer to Graphics Library Help file
   *                for complete list.
   *              - added #include "gfxcolors.h"
   *********************************************************************/
  #ifndef _GRAPHICS_H
      #define _GRAPHICS_H

  ////////////////////// GRAPHICS_LIBRARY_VERSION ////////////////////
  // MSB is version, LSB is subversion
      #define GRAPHICS_LIBRARY_VERSION    0x0301

  //////////////////////////// INCLUDES ////////////////////////////
      #include <stdlib.h>             // needed because of malloc()
      #include "GenericTypeDefs.h"
      #include "GraphicsConfig.h"
      #include "DisplayDriver.h"      // Display Driver layer
      #include "Primitive.h"          // Graphic Primitives layer
      #include "GOL.h"                // Graphics Object layer

      #include "ScanCodes.h"          // Scan codes for AT keyboard
      #include "gfxcolors.h"          // default color definitions, can be overidden by
  application side
                                      // see gfxcolor.h for details

      #include "Graphics/Palette.h"

      #if defined(USE_BUTTON) || defined(USE_BUTTON_MULTI_LINE)
          #include "Button.h"
      #endif
      #ifdef USE_WINDOW
          #include "Window.h"
      #endif
      #ifdef USE_GROUPBOX
          #include "GroupBox.h"
      #endif
      #ifdef USE_STATICTEXT
          #include "StaticText.h"
      #endif
      #ifdef USE_SLIDER
          #include "Slider.h"
      #endif
      #ifdef USE_CHECKBOX
          #include "CheckBox.h"
      #endif
      #ifdef USE_RADIOBUTTON
          #include "RadioButton.h"
      #endif
      #ifdef USE_PICTURE
```

```
            #include "Picture.h"
        #endif
        #ifdef USE_PROGRESSBAR
            #include "ProgressBar.h"
        #endif
        #ifdef USE_EDITBOX
            #include "EditBox.h"
        #endif
        #ifdef USE_LISTBOX
            #include "ListBox.h"
        #endif
        #ifdef USE_ROUNDDIAL
            #include "RoundDial.h"
        #endif
        #ifdef USE_METER
            #include "Meter.h"
        #endif
        #ifdef USE_GRID
            #include "Grid.h"
        #endif
        #ifdef USE_CHART
            #include "Chart.h"
        #endif
        #ifdef USE_TEXTENTRY
            #include "TextEntry.h"
        #endif
        #ifdef USE_DIGITALMETER
            #include "DigitalMeter.h"
        #endif
        #ifdef USE_ANALOGCLOCK
            #include "AnalogClock.h"
        #endif
        #ifdef USE_CUSTOM_WIDGET
            // Use this in case users wants to create a custom widget and do not want to
            // modify the Graphics Library files.
            #include "CustomControlWidget.h"
        #endif
    #endif
```

14.1.5 ScanCodes.h

Macros

Name	Description
SCAN_BS_PRESSED (see page 335)	Back space key pressed.
SCAN_BS_RELEASED (see page 335)	Back space key released.
SCAN_CR_PRESSED (see page 335)	Carriage return pressed.
SCAN_CR_RELEASED (see page 335)	Carriage return released.
SCAN_DEL_PRESSED (see page 336)	Delete key pressed.
SCAN_DEL_RELEASED (see page 336)	Delete key released.
SCAN_DOWN_PRESSED (see page 336)	Down key pressed.
SCAN_DOWN_RELEASED (see page 336)	Down key released.
SCAN_END_PRESSED (see page 337)	End key pressed.
SCAN_END_RELEASED (see page 337)	End key released.
SCAN_HOME_PRESSED (see page 337)	Home key pressed.
SCAN_HOME_RELEASED (see page 337)	Home key released.

SCAN_LEFT_PRESSED (↗ see page 337)	Left key pressed.
SCAN_LEFT_RELEASED (↗ see page 338)	Left key released.
SCAN_PGDOWN_PRESSED (↗ see page 338)	Page down key pressed.
SCAN_PGDOWN_RELEASED (↗ see page 338)	Page down key released.
SCAN_PGUP_PRESSED (↗ see page 338)	Page up key pressed.
SCAN_PGUP_RELEASED (↗ see page 339)	Page up key released.
SCAN_RIGHT_PRESSED (↗ see page 339)	Right key pressed.
SCAN_RIGHT_RELEASED (↗ see page 339)	Right key released.
SCAN_SPACE_PRESSED (↗ see page 339)	Space key pressed.
SCAN_SPACE_RELEASED (↗ see page 339)	Space key released.
SCAN_TAB_PRESSED (↗ see page 340)	Tab key pressed.
SCAN_TAB_RELEASED (↗ see page 340)	Tab key released.
SCAN_UP_PRESSED (↗ see page 340)	Up key pressed.
SCAN_UP_RELEASED (↗ see page 340)	Up key released.

Description

This is file ScanCodes.h.

Body Source

```
/*****************************************************************************
 *
 * Module for Microchip Graphics Library
 * The header file contains scan codes for the standard AT keyboard
 *
 *****************************************************************************
 * FileName:        ScanCodes.h
 * Dependencies:    None
 * Processor:       PIC24F, PIC24H, dsPIC, PIC32
 * Compiler:        MPLAB C30, MPLAB C32
 * Linker:          MPLAB LINK30, MPLAB LINK32
 * Company:         Microchip Technology Incorporated
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  * OR OTHER SIMILAR COSTS.
  *
  * Date         Comment
  *~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
  * 07/20/07     ...
  *****************************************************************************/
#ifndef _SCANCODES_H
    #define _SCANCODES_H

/*********************************************************************
* Overview: The following are the defined scan codes for AT keyboard.
*
********************************************************************/

// Carriage return pressed.
    #define SCAN_CR_PRESSED 0x1C

// Carriage return released.
    #define SCAN_CR_RELEASED    0x9C

// Carriage return alternate pressed.
    #define SCAN_CRA_PRESSED    0x2C

// Carriage return alternate released.
    #define SCAN_CRA_RELEASED   0xAC

// Delete key pressed.
    #define SCAN_DEL_PRESSED    0x53

// Delete key released.
    #define SCAN_DEL_RELEASED   0xD3

// Back space key pressed.
    #define SCAN_BS_PRESSED 0x0E

// Back space key released.
    #define SCAN_BS_RELEASED    0x8E

// Tab key pressed.
    #define SCAN_TAB_PRESSED    0x0F

// Tab key released.
    #define SCAN_TAB_RELEASED   0x8F

// Home key pressed.
    #define SCAN_HOME_PRESSED   0x47

// Home key released.
    #define SCAN_HOME_RELEASED  0xC7

// End key pressed.
    #define SCAN_END_PRESSED    0x4F

// End key released.
    #define SCAN_END_RELEASED   0xCF

// Page up key pressed.
    #define SCAN_PGUP_PRESSED   0x49

// Page up key released.
    #define SCAN_PGUP_RELEASED  0xC9

// Page down key pressed.
    #define SCAN_PGDOWN_PRESSED 0x51

// Page down key released.
    #define SCAN_PGDOWN_RELEASED    0xD1

// Up key pressed.
    #define SCAN_UP_PRESSED 0x48
```

```
// Up key released.
    #define SCAN_UP_RELEASED    0xC8

// Down key pressed.
    #define SCAN_DOWN_PRESSED   0x50

// Down key released.
    #define SCAN_DOWN_RELEASED  0xD0

// Left key pressed.
    #define SCAN_LEFT_PRESSED   0x4B

// Left key released.
    #define SCAN_LEFT_RELEASED  0xCB

// Right key pressed.
    #define SCAN_RIGHT_PRESSED  0x4D

// Right key released.
    #define SCAN_RIGHT_RELEASED 0xCD

// Space key pressed.
    #define SCAN_SPACE_PRESSED  0x39

// Space key released.
    #define SCAN_SPACE_RELEASED 0xB9
#endif // _SCANCODES_H
```

14.1.6 AnalogClock.c

This is file AnalogClock.c.

Body Source

```
/*****************************************************************************
 *  Module for Microchip Graphics Library
 *  GOL Layer
 *  Analog Clock
 *****************************************************************************
 * FileName:        AnalogClock.c
 * Dependencies:    AnalogClock.h
 * Processor:       PIC24F, PIC24H, dsPIC, PIC32
 * Compiler:        MPLAB C30 Version 3.00, C32
 * Linker:          MPLAB LINK30, LINK32
 * Company:         Microchip Technology Incorporated
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```

```
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  * OR OTHER SIMILAR COSTS.
  ****************************************************************************/
#include "Graphics/Graphics.h"

#if defined(USE_ANALOGCLOCK)

#define THICKNESS_SECOND 4

#define SECOND 1
#define MINUTE 2
#define HOUR 3

/*********************************************************************
* Function: ANALOGCLOCK  *AcCreate(WORD ID, SHORT left,SHORT top,
*                        SHORT right,SHORT bottom,SHORT hour,SHORT minute,
*                        SHORT radius,BOOL sechand,WORD state,void *pBitmap,
*                        GOL_SCHEME  *pScheme)
*
*
* Notes: Creates an ANALOGCLOCK object and adds it to the current active list.
*        If the creation is successful, the pointer to the created Object
*        is returned. If not successful, NULL is returned.
*
********************************************************************/
ANALOGCLOCK *AcCreate
(
    WORD        ID,
    SHORT       left,
    SHORT       top,
    SHORT       right,
    SHORT       bottom,
    SHORT       hour,
    SHORT       minute,
    SHORT       radius,
    BOOL        sechand,
    WORD        state,
    void        *pBitmap,
    GOL_SCHEME  *pScheme
)
{
    ANALOGCLOCK  *pAc = NULL;
    pAc = (ANALOGCLOCK *)GFX_malloc(sizeof(ANALOGCLOCK));
    if(pAc == NULL)
        return (NULL);

    pAc->hdr.ID = ID;                   // unique id assigned for referencing
    pAc->hdr.pNxtObj = NULL;            // initialize pointer to NULL
    pAc->hdr.type = OBJ_ANALOGCLOCK;    // set object type
    pAc->hdr.left = left;               // left position
    pAc->hdr.top = top;                 // top position
    pAc->hdr.right = left;              // left position
    pAc->hdr.bottom = top;              // top position
    pAc->radius = radius;
    pAc->valueS = 0;
    pAc->prev_valueS = pAc->valueS;
    pAc->valueM = minute;
    pAc->prev_valueM = pAc->valueM-1;
    pAc->valueH = (hour*5) + (minute/12);
    pAc->prev_valueH = pAc->valueH-1;
    pAc->centerx = (left + ((right-left)>>1));
    pAc->centery = (top + ((bottom-top)>>1));
    pAc->pBitmap = pBitmap;             // location of bitmap
    pAc->hdr.state = state;             // state
    pAc->hdr.DrawObj = AcDraw;          // draw function
    pAc->hdr.MsgObj = NULL;             // no message function
    pAc->hdr.MsgDefaultObj = NULL;      // no default message function
    pAc->hdr.FreeObj = NULL;

    // Set the color scheme to be used
    if(pScheme == NULL)
        pAc->hdr.pGolScheme = _pDefaultGolScheme;
    else
        pAc->hdr.pGolScheme = (GOL_SCHEME *)pScheme;

    GOLAddObject((OBJ_HEADER *)pAc);

    return (pAc);
}

/*********************************************************************
* Function: WORD AcDraw(ANALOGCLOCK *pAc)
*
*
* Notes: This is the state machine to draw the clock.
*
********************************************************************/
WORD AcDraw(void *pObj)
{
    typedef enum
    {
        REMOVE,
        BEVEL_DRAW,
        TICK
    } AC_DRAW_STATES;

    static AC_DRAW_STATES state = REMOVE;
    static SHORT width, height, radius;

    static GFX_COLOR faceClr, handClr;

    ANALOGCLOCK *pAc;

    pAc = (ANALOGCLOCK *)pObj;


   if(IsDeviceBusy())
        return (0);

    switch(state)
    {
        case REMOVE:
            if(IsDeviceBusy())
                return (0);

            if(GetState(pAc, AC_HIDE))     // Hide the button (remove from screen)
            {
                SetColor(pAc->hdr.pGolScheme->CommonBkColor);
                if(!Bar(pAc->hdr.left, pAc->hdr.top, pAc->hdr.right, pAc->hdr.bottom))
                {
                    return (0);
                }
            }

            if(GetState(pAc, AC_TICK))
            {
                   state = TICK;
                   return(1); //buthave to do goto erase
                //goto erase_current_pos;
            }

            if(GetState(pAc, UPDATE_HOUR))
            {
                   AcHandsDraw(pAc, HOUR, THICKNESS_SECOND+4, handClr, pAc->pBitmap);
                   state = TICK;
                   return(1); //buthave to do goto erase
                //goto erase_current_pos;
            }

            if(GetState(pAc, UPDATE_MINUTE))
            {
                   AcHandsDraw(pAc, MINUTE, THICKNESS_SECOND+4, handClr, pAc->pBitmap);
                   state = TICK;
                   return(1); //buthave to do goto erase
                //goto erase_current_pos;
            }

            if(GetState(pAc, UPDATE_SECOND))
            {
                   AcHandsDraw(pAc, SECOND, THICKNESS_SECOND+4, handClr, pAc->pBitmap);
                   state = TICK;
                   return(1); //buthave to do goto erase
                //goto erase_current_pos;
            }



            radius = pAc->radius;    // get radius
            width = (pAc->hdr.right - pAc->hdr.left) - (radius * 2);  // get width
            height = (pAc->hdr.bottom - pAc->hdr.top) - (radius * 2); // get height
            state = BEVEL_DRAW;

        case BEVEL_DRAW:

            faceClr = pAc->hdr.pGolScheme->Color0;
            handClr = pAc->hdr.pGolScheme->Color1;

            SetLineThickness(NORMAL_LINE);
            SetLineType(SOLID_LINE);

            SetColor(faceClr);

            FillCircle(pAc->centerx,pAc->centery, radius);  //Draw Face of Analog Clock

            SetColor(handClr);
            FillCircle(pAc->centerx,pAc->centery, 8);  //Draw Middle of Analog Clock

            AcHandsDraw(pAc, SECOND, THICKNESS_SECOND, handClr, pAc->pBitmap);
            AcHandsDraw(pAc, HOUR, THICKNESS_SECOND+4, handClr, pAc->pBitmap);
            AcHandsDraw(pAc, MINUTE, THICKNESS_SECOND+4, handClr, pAc->pBitmap);

            state = REMOVE;
            break;

        case TICK:

            AcHandsDraw(pAc, SECOND, THICKNESS_SECOND, handClr, pAc->pBitmap);

            if(pAc->valueS++ == 60)
            {
                pAc->valueS = 1;
                if(pAc->valueM++ == 60)
                {
                    pAc->valueM = 1;
                }
                if(pAc->valueM%12 == 0)
                {
                    pAc->valueH++;
                    if(pAc->valueH == 60)
                        pAc->valueH = 0;
                    AcHandsDraw(pAc, HOUR, THICKNESS_SECOND+4, handClr, pAc->pBitmap);
                }
                AcHandsDraw(pAc, MINUTE, THICKNESS_SECOND+4, handClr, pAc->pBitmap);
            }


            if( ((pAc->valueS - pAc->valueM)<4 && (pAc->valueS - pAc->valueM)>=0) ||
  ((pAc->valueS - pAc->valueM)<-56 && (pAc->valueS - pAc->valueM)>-59) )
                AcHandsDraw(pAc, MINUTE, THICKNESS_SECOND+4, handClr, pAc->pBitmap);

            if( ((pAc->valueS - pAc->valueH)<4  && (pAc->valueS - pAc->valueH)>=0) ||
  ((pAc->valueS - pAc->valueH)<-56 && (pAc->valueS - pAc->valueH)>-59) )
                AcHandsDraw(pAc, HOUR, THICKNESS_SECOND+4, handClr, pAc->pBitmap);


            if(pAc->valueS-1 == pAc->valueM)
```

```
                AcHandsDraw(pAc, MINUTE, THICKNESS_SECOND+4, handClr, pAc->pBitmap);
            if(pAc->valueS-1 == pAc->valueH)
                AcHandsDraw(pAc, HOUR, THICKNESS_SECOND+4, handClr,
pAc->pBitmap);

            state = REMOVE;
            return (1);
    }

    return (1);
}




/* */
/*********************************************************************
* Function: WORD AcHandsDraw(ANALOGCLOCK *pAc, SHORT hand, SHORT thickness, WORD color,
void *pBitmap)
*
*
* Notes: This is the state machine to draw the current hand positions of the clock.
*
********************************************************************/
WORD AcHandsDraw(ANALOGCLOCK *pAc, SHORT hand, SHORT thickness, WORD color, void *pBitmap)
{
    unsigned int templ=0,tempr, temps;
    SHORT   x1, y1, x2, y2, xi, yi;
    SHORT   x2_prev, y2_prev, xi_prev, yi_prev;
    static SHORT    value=0, prev_value=0;
    SHORT   deltaX, deltaY;
    SHORT   error, stepErrorLT, stepErrorGE;
    SHORT   stepX, stepY;
    SHORT   steep;
    SHORT   temp;
    static SHORT    cnt_thick=0;
    SHORT   radius = pAc->radius;
    BYTE    colorDepth;

    ////////////////////////////////////////////////////////
    register FLASH_WORD *flashAddress = 0;
    register FLASH_WORD *tempFlashAddress;
    static WORD                sizeX=0, sizeY=0;



    tempFlashAddress = (FLASH_WORD *)pBitmap;
    // Move pointer to size information
    if(tempFlashAddress != NULL)
    {
    flashAddress = (FLASH_WORD *)((IMAGE_FLASH *)pBitmap)->address + 1;
    colorDepth = *(flashAddress+1);
    // Read image size
    sizeY = *flashAddress;
    flashAddress++;
    sizeX = *flashAddress;
    flashAddress++;
    }

    switch(hand)
    {
        case SECOND:
            value = pAc->valueS;
            prev_value = pAc->prev_valueS;
            pAc->prev_valueS = pAc->valueS;
            radius -=10;
            break;

        case MINUTE:
            value = pAc->valueM;
            prev_value = pAc->prev_valueM;
            pAc->prev_valueM = pAc->valueM;
```

```
                radius -= 3;
                break;

            case HOUR:
                value = pAc->valueH;
                prev_value = pAc->prev_valueH;
                pAc->prev_valueH = pAc->valueH;
                radius -= 30;
                break;

            default:
                break;
        }

        x1=pAc->centerx;
        y1=pAc->centery;

        x2_prev= pAc->centerx;
        y2_prev=pAc->centery;
        x2= pAc->centerx;
        y2=pAc->centery;

        prev_value += 45;
        value += 45;

        //Added for proper orientation
        if(prev_value >= 60)
            prev_value -= 60;

        if(value >= 60)
            value -= 60;

        GetCirclePoint(radius, (prev_value*6),&x2_prev,&y2_prev);
        GetCirclePoint(radius, (value*6),&x2,&y2);

        x2_prev += pAc->centerx;
        y2_prev +=pAc->centery;
        x2      += pAc->centerx;
        y2      +=pAc->centery;

        xi=pAc->hdr.left;
        yi=pAc->hdr.top;
        xi_prev=(((pAc->hdr.right - radius + pAc->hdr.left + radius) - sizeX) >> 1) + 1;
        yi_prev=(((pAc->hdr.bottom - radius + pAc->hdr.top + radius) - sizeY) >> 1) + 1;

        if(value == 15)
            x2 += 1;

        if(prev_value == 15)
            x2_prev += 1;


        if(value == 30)
            y2 += 1;

        if(prev_value == 30)
            y2_prev += 1;

        tempr = (thickness*thickness)>>1;
        temps = ((radius-(11))*(radius-(11)));
        ////////////////////////////////////////////////////////

            #ifndef USE_NONBLOCKING_CONFIG
        while(IsDeviceBusy() != 0) Nop();

        // Ready
            #else
        if(IsDeviceBusy() != 0)
            return (0);
            #endif
```

```
    //########################################################################################
###
    //Draw the bitmap of area covered by prev hand

    if(x1 == x2_prev)
    {
        if(y1 > y2_prev)
        {
            temp = y1;
            y1 = y2_prev;
            y2_prev = temp;
        }


        for(temp = y1; temp < y2_prev + 1; temp++)   //reDraws at top and bottom
        {

                for(cnt_thick=-thickness>>2;cnt_thick<thickness>>2;cnt_thick++)
                {
                    if(prev_value==45)
                    templ = ((x1 + cnt_thick-x2_prev )*(x1 + cnt_thick-x2_prev ) + (temp -
y1 )*(temp - y1 ));
                    else if(prev_value==15)
                    templ = ((x1 + cnt_thick-x2_prev )*(x1 + cnt_thick-x2_prev ) + (temp -
y2_prev )*(temp - y2_prev ));


                    if(templ>tempr && templ<temps)
                    {
                    if(tempFlashAddress != NULL)
                    {SetColor(*(flashAddress + sizeX*(temp-yi_prev)+(x1 + cnt_thick -
xi_prev)));}
                    else SetColor(pAc->hdr.pGolScheme->Color0);
                    PutPixel(x1 + cnt_thick, temp);
                    }
                }
        }

        goto current_hand;
    }

    if(y1 == y2_prev)
    {
        if(x1 > x2_prev)
        {
            temp = x1;
            x1 = x2_prev;
            x2_prev = temp;
        }

        for(temp = x1; temp < x2_prev + 1; temp++)    //redraws at left and right
        {


                for(cnt_thick=-thickness>>2;cnt_thick<thickness>>2;cnt_thick++)
                {

                    if(prev_value==30)
                    templ = ((temp-x1 )*(temp-x1 ) + (y1 + cnt_thick - y2_prev )*(y1 +
cnt_thick - y2_prev ));
                    else
                    templ = ((temp-x2_prev )*(temp-x2_prev ) + (y1 + cnt_thick - y2_prev
)*(y1 + cnt_thick - y2_prev ));


                    if(templ>tempr && templ<temps)
                    {
                    if(tempFlashAddress != NULL)
                    {SetColor(*(flashAddress + sizeX*(y1 + cnt_thick -yi_prev)+(temp -
xi_prev)));}
                    else SetColor(pAc->hdr.pGolScheme->Color0);
                    PutPixel(temp, y1 + cnt_thick);
                    }
                }

        }

        goto current_hand;
    }

    stepX = 0;
    deltaX = x2_prev - x1;
    if(deltaX < 0)
    {
        deltaX = -deltaX;
        --stepX;
    }
    else
    {
        ++stepX;
    }

    stepY = 0;
    deltaY = y2_prev - y1;
    if(deltaY < 0)
    {
        deltaY = -deltaY;
        --stepY;
    }
    else
    {
        ++stepY;
    }

    steep = 0;
    if(deltaX < deltaY)
    {
        ++steep;
        temp = deltaX;
        deltaX = deltaY;
        deltaY = temp;
        temp = x1;
        x1 = y1;
        y1 = temp;
        temp = stepX;
        stepX = stepY;
        stepY = temp;
        PutPixel(y1, x1);
    }
    else
    {
        PutPixel(x1, y1);
    }

    // If the current error greater or equal zero
    stepErrorGE = deltaX << 1;

    // If the current error less than zero
    stepErrorLT = deltaY << 1;

    // Error for the first pixel
    error = stepErrorLT - deltaX;

    while(--deltaX >= 0)
    {
        if(error >= 0)
        {
            y1 += stepY;
            error -= stepErrorGE;
        }

        x1 += stepX;
        error += stepErrorLT;
            if(steep)
            {
                for(cnt_thick=-thickness>>2;cnt_thick<thickness>>2;cnt_thick++)
                {
                    templ = ((y1 + cnt_thick-x2_prev) *(y1 + cnt_thick-x2_prev) + (x1 -
y2_prev)*(x1 - y2_prev));

                    if(templ>tempr && templ<temps)
                    {

                    if(tempFlashAddress != NULL)
                    {SetColor(*(flashAddress + sizeX*(x1 -yi_prev)+(y1 + cnt_thick -
xi_prev)));}
                    else SetColor(pAc->hdr.pGolScheme->Color0);

                    PutPixel(y1 + cnt_thick,x1);
                    }
                }

            }
            else
            {

                for(cnt_thick=-thickness>>2;cnt_thick<thickness>>2;cnt_thick++)
                {
                    templ = ((x1-x2_prev)*(x1-x2_prev) + (y1 + cnt_thick - y2_prev)*(y1 +
cnt_thick - y2_prev));

                    if(templ>tempr && templ<temps)
                    {
                        if(tempFlashAddress != NULL){
                        SetColor(*(flashAddress + sizeX*(y1 + cnt_thick -yi_prev)+(x1 -
xi_prev)));
                        }
                        else SetColor(pAc->hdr.pGolScheme->Color0);

                        PutPixel(x1,y1 + cnt_thick);
                    }
                }

            }
        }
        //#######################################################################################
###

        //Draw the current hand
current_hand:
        SetColor(color);

                x1=pAc->centerx;
                y1=pAc->centery;


        if(x1 == x2)
        {
            if(y1 > y2)
            {
                temp = y1;
                y1 = y2;
                y2 = temp;
            }

            for(temp = y1; temp < y2 + 1; temp++)
            {

                    if(value==45)
                    templ = ((x1 + cnt_thick-x2)*(x1 + cnt_thick-x2) + (temp - y1)*(temp -
y1));
                    else if(value==15)
                    templ = ((x1 + cnt_thick-x2)*(x1 + cnt_thick-x2) + (temp - y2)*(temp -
y2));

                            if(templ>tempr && templ<temps)
                        for(cnt_thick=-thickness>>2;cnt_thick<thickness>>2;cnt_thick++)
                        {
                            PutPixel(x1 + cnt_thick, temp);
                        }

            }

            return (1);
        }

        if(y1 == y2)
        {
            if(x1 > x2)
            {
                temp = x1;
                x1 = x2;
                x2 = temp;
            }

            for(temp = x1; temp < x2 + 1; temp++)
            {

                        if(value==30)
                        templ = ((temp-x1)*(temp-x1) + (y1 + cnt_thick - y2)*(y1 + cnt_thick -
y2));
                        else// if(value==0)
                        templ = ((temp-x2)*(temp-x2) + (y1 + cnt_thick - y2)*(y1 + cnt_thick -
y2));


                        if(templ>tempr && templ<temps)

                    for(cnt_thick=-thickness>>2;cnt_thick<thickness>>2;cnt_thick++)
                    {
                        PutPixel(temp, y1 + cnt_thick);
                    }
            }

            return (1);
        }

        stepX = 0;
        deltaX = x2 - x1;
        if(deltaX < 0)
        {
            deltaX = -deltaX;
            --stepX;
        }
        else
        {
            ++stepX;
        }

        stepY = 0;
        deltaY = y2 - y1;
        if(deltaY < 0)
        {
            deltaY = -deltaY;
            --stepY;
        }
        else
        {
            ++stepY;
        }

        steep = 0;
        if(deltaX < deltaY)
        {
```

```
        ++steep;
        temp = deltaX;
        deltaX = deltaY;
        deltaY = temp;
        temp = x1;
        x1 = y1;
        y1 = temp;
        temp = stepX;
        stepX = stepY;
        stepY = temp;
        PutPixel(y1, x1);
    }
    else
    {
        PutPixel(x1, y1);
    }

    // If the current error greater or equal zero
    stepErrorGE = deltaX << 1;

    // If the current error less than zero
    stepErrorLT = deltaY << 1;

    // Error for the first pixel
    error = stepErrorLT - deltaX;


    while(--deltaX >= 0)
    {
        if(error >= 0)
        {
            y1 += stepY;
            error -= stepErrorGE;
        }

        x1 += stepX;
        error += stepErrorLT;

            if(steep)
            {
                for(cnt_thick=-thickness>>2;cnt_thick<thickness>>2;cnt_thick++)
                {

                    templ = ((y1 + cnt_thick-x2) *(y1 + cnt_thick-x2) + (x1 - y2)*(x1 -
y2));

                    if(templ>tempr && templ<temps)
                    PutPixel(y1 + cnt_thick,x1);

                }
            }
            else
            {
                for(cnt_thick=-thickness>>2;cnt_thick<thickness>>2;cnt_thick++)
                {
                    templ = ((x1-x2)*(x1-x2) + (y1 + cnt_thick - y2)*(y1 + cnt_thick - y2));

                    if(templ>tempr && templ<temps)
                    PutPixel(x1,y1 + cnt_thick);
                }
            }
    }   // end of while

    return (1);
}

/*********************************************************************
* Function: AcSetHour(STATICTEXT *pAc, XCHAR *pText)
*
* Notes: Sets the string that will be used.
*
********************************************************************/
```

```
void AcSetHour(ANALOGCLOCK *pAc, SHORT hour)
{

     pAc->valueH = (hour*5) + (pAc->valueM/12);

}

/*********************************************************************
* Function: AcSetMinute(STATICTEXT *pSt, XCHAR *pText)
*
* Notes: Sets the string that will be used.
*
********************************************************************/
void AcSetSecond(ANALOGCLOCK *pAc, SHORT second)
{

     pAc->valueS = second;

}

/*********************************************************************
* Function: AcSetMinute(STATICTEXT *pSt, XCHAR *pText)
*
* Notes: Sets the string that will be used.
*
********************************************************************/
void AcSetMinute(ANALOGCLOCK *pAc, SHORT minute)
{

     pAc->valueM = minute;

}

#endif
```

14.1.7 AnalogClock.h

Functions

	Name	Description
	AcCreate (see page 73)	This function creates an Analog Clock object with the parameters given. It automatically attaches the new object into a global linked list of objects and returns the address of the object.
	AcDraw (see page 74)	This function renders the object on the screen using the current parameter settings. Location of the object is determined by the left, top, right and bottom parameters. The colors used are dependent on the state of the object. The font used is determined by the style scheme set.
	AcHandsDraw (see page 75)	Draws the current position of the clock hands with the given thickness and color.
	AcSetHour (see page 76)	Sets the hour of the analog clock.
	AcSetMinute (see page 77)	Sets the minute of the analog clock.
	AcSetSecond (see page 77)	Sets the second of the analog clock.

Macros

Name	Description
AC_DISABLED (see page 71)	Bit for disabled state.
AC_DRAW (see page 71)	Bit to indicate button must be redrawn.
AC_HIDE (see page 72)	Bit to indicate button must be removed from screen.
AC_PRESSED (see page 72)	Bit for press state.
AC_TICK (see page 72)	Bit to tick second hand

UPDATE_HOUR (see page 72)	Bit to indicate hour hand must be redrawn
UPDATE_MINUTE (see page 72)	Bit to indicate minute hand must be redrawn
UPDATE_SECOND (see page 73)	Bit to indicate minute hand must be redrawn

Structures

Name	Description
ANALOGCLOCK (see page 78)	Defines the parameters required for a clock Object. The following relationships of the parameters determines the general shape of the button: 1. Width is determined by right - left. 2. Height is determined by top - bottom. 3. Radius - specifies if the button will have a rounded edge. If zero then the button will have sharp (cornered) edge. 4. If 2*radius = height = width, the button is a circular button.

Description

This is file AnalogClock.h.

Body Source

```
/*****************************************************************************
 *  Module for Microchip Graphics Library
 *  GOL Layer
 *  Analog Clock
 *****************************************************************************
 * FileName:        AnalogClock.h
 * Dependencies:    None
 * Processor:       PIC24F, PIC24H, dsPIC, PIC32
 * Compiler:        MPLAB C30 V3.00, MPLAB C32
 * Linker:          MPLAB LINK30, MPLAB LINK32
 * Company:         Microchip Technology Incorporated
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 * CLAIMS BY THIRD PARTIES (INCLUDING BUT NOT LIMITED TO ANY DEFENSE THEREOF),
 * OR OTHER SIMILAR COSTS.
 *
 * Author               Date        Comment
 *~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
 *****************************************************************************/
#ifndef _ANALOGCLOCK_H
    #define _ANALOGCLOCK_H

    #include <Graphics\GOL.h>
    #include "GenericTypeDefs.h"
/*********************************************************************
* Object States Definition:
```

```
*********************************************************************/
    #define AC_DISABLED    0x0002   // Bit for disabled state.
    #define AC_PRESSED     0x0004   // Bit for press state.
    #define AC_TICK        0x1000   // Bit to tick second hand
    #define UPDATE_HOUR    0x2000   // Bit to indicate hour hand must be redrawn
    #define UPDATE_MINUTE  0x0100   // Bit to indicate minute hand must be redrawn
    #define UPDATE_SECOND  0x0200   // Bit to indicate minute hand must be redrawn
    #define AC_DRAW        0x4000   // Bit to indicate button must be redrawn.
    #define AC_HIDE        0x8000   // Bit to indicate button must be removed from screen.
    #define AC_REMOVE      0x8000

/*********************************************************************
* Overview: Defines the parameters required for a clock Object.
*           The following relationships of the parameters determines
*           the general shape of the button:
*           1. Width is determined by right - left.
*           2. Height is determined by top - bottom.
*           3. Radius - specifies if the button will have a rounded
*                       edge. If zero then the button will have
*                       sharp (cornered) edge.
*           4. If 2*radius = height = width, the button is a circular button.
*
*********************************************************************/
typedef struct
{
    OBJ_HEADER    hdr;        // Generic header for all Objects (see OBJ_HEADER).
    SHORT         radius;     // Radius of the clock.
    SHORT       centerx;
    SHORT       centery;
    SHORT       valueS;
    SHORT       prev_valueS;
    SHORT       valueM;
    SHORT       prev_valueM;
    SHORT       valueH;
    SHORT       prev_valueH;
    void        *pBitmap;   // Pointer to bitmap used.
} ANALOGCLOCK;


/*********************************************************************
* Function: ANALOGCLOCK *AcCreate(WORD ID, SHORT left, SHORT top, SHORT right,
*                              SHORT bottom, SHORT radius, void *pBitmap, XCHAR *pText,
*                              GOL_SCHEME *pScheme)
*
* Overview: This function creates an Analog Clock object with the parameters given.
*           It automatically attaches the new object into a global linked list of
*           objects and returns the address of the object.
*
* PreCondition: none
*
* Input: ID - Unique user defined ID for the object instance.
*        left - Left most position of the object.
*        top - Top most position of the object.
*      right - Right most position of the object.
*      bottom - Bottom most position of the object.
*        hour - set the current hour.
*        minute - set the current minute.
*        radius - radius of the clock.
*        sechand - Flag to draw cecond hand or not.
*        state - Sets the initial state of the object.
*        pBitmap - Pointer to the bitmap used on the face of the button
*                  dimension of the bitmap must match the dimension of the
*                  button.
*        pText - Pointer to the text of the button.
*        pScheme - Pointer to the style scheme used.
*
* Output: Returns the pointer to the object created.
*
* Example:
*   <CODE>
*   GOL_SCHEME *pScheme;
```

```
 *   WORD state;
 *
 *       pScheme = GOLCreateScheme();
 *       state = AC_DRAW;
 *
 *       AnalogClock = AcCreate(1,20,64,50,118,0, state, NULL, "ON", pScheme);

 * Side Effects: none
 *
 ********************************************************************/
ANALOGCLOCK *AcCreate
(
    WORD        ID,
    SHORT       left,
    SHORT       top,
    SHORT       right,
    SHORT       bottom,
    SHORT       hour,
    SHORT       minute,
    SHORT       radius,
    BOOL        sechand,
    WORD        state,
    void        *pBitmap,
    GOL_SCHEME  *pScheme
);

/*********************************************************************
 * Function: WORD AcDraw(ANALOGCLOCK *pB)
 *
 * Overview: This function renders the object on the screen using
 *           the current parameter settings. Location of the object is
 *           determined by the left, top, right and bottom parameters.
 *           The colors used are dependent on the state of the object.
 *           The font used is determined by the style scheme set.
 *
 *
 * PreCondition: Object must be created before this function is called.
 *
 * Input: pAc - Pointer to the object to be rendered.
 *
 * Output: Returns the status of the drawing
 *         - 1 - If the rendering was completed and
 *         - 0 - If the rendering is not yet finished.
 *         Next call to the function will resume the
 *         rendering on the pending drawing state.
 *
 * Example:
 *   <CODE>
 *   void MyGOLDraw(){
 *       static OBJ_HEADER *pCurrentObj = NULL;
 *       int done;
 *
 *       // There are no objects
 *       if(GOLGetList() == NULL)
 *           return;
 *
 *       // If it's last object jump to head
 *       if(pCurrentObj == NULL)
 *           pCurrentObj = GOLGetList();
 *
 *       done = 0;
 *
 *       // this only process Button and Window
 *       while(pCurrentObj != NULL){
 *           // check if object state indicates redrawing
 *           if(pCurrentObj->state&0xFC00) {
 *               switch(pCurrentObj->type){
 *                   case OBJ_ANALOGCLOCK:
 *                       done = AcDraw((ANALOGCLOCK*)pCurrentObj);
 *                       break;
 *                   case OBJ_WINDOW:
 *                       done = WndDraw((WINDOW*)pCurrentObj);
 *                       break;
 *                   default:
 *                       done = 1;
 *                       break;
 *               }
 *               if(done){
 *                   // reset only the state if drawing was finished
 *                   pCurrentObj->state = 0;
 *               }else{
 *                   // done processing the list
 *                   return;
 *               }
 *           }
 *           // go to next object
 *           pCurrentObj = pCurrentObj->pNxtObj;
 *       }
 *   }
 *   </CODE>
 *
 * Side Effects: none
 *
 ********************************************************************/
 WORD    AcDraw(void *pObj);

 /*********************************************************************
 * Function: AcHandsDraw(ANALOGCLOCK *pAc, SHORT hand, SHORT thickness, WORD color, void
 *pBitmap);
 *
 * Overview: Draws the current position of the clock hands with the given thickness and
 color.
 *
 * PreCondition: none
 *
 * Input: pAc - The pointer to the object whose hands will be modified.
 *        hand - which hand to be drawn (second, minute, hour)
 *        thickness - thickness to draw the hand
 *        color - color to draw the hand
 *        *pBitmap - bitmap background to be redrawn
 *
 * Output: none
 *
 * Side Effects: none
 *
 ********************************************************************/
 WORD AcHandsDraw(ANALOGCLOCK *pAc, SHORT hand, SHORT thickness, WORD color, void *pBitmap);


 /*********************************************************************
 * Function: AcSetHour(ANALOGCLOCK *pAc, SHORT hour)
 *
 * Overview: Sets the hour of the analog clock.
 *
 * PreCondition: none
 *
 * Input: pAc - The pointer to the object whose hands will be modified.
 *        hour - current hour of the analog clock
 *
 * Output: none
 *
 * Side Effects: none
 *
 ********************************************************************/
 void AcSetHour(ANALOGCLOCK *pAc, SHORT hour);

 /*********************************************************************
 * Function: AcSetMinute(ANALOGCLOCK *pAc, SHORT minute)
 *
 * Overview: Sets the minute of the analog clock.
 *
 * PreCondition: none
 *
 * Input: pAc - The pointer to the object whose hands will be modified.
 *        minute - current minute of the analog clock
 *
 * Output: none
 *
 * Side Effects: none
 *
 ********************************************************************/
 void AcSetMinute(ANALOGCLOCK *pAc, SHORT minute);

 /*********************************************************************
 * Function: AcSetMinute(ANALOGCLCOK *pAc, SHORT second)
 *
 * Overview: Sets the second of the analog clock.
 *
 * PreCondition: none
 *
 * Input: pAc -     The pointer to the object whose hands will be modified.
 *        second - current minute of the analog clock
 *
 * Output: none
 *
 * Side Effects: none
 *
 ********************************************************************/
 void AcSetSecond(ANALOGCLOCK *pAc, SHORT second);

 #endif // _ANALOGCLOCK_H
```

14.1.8 Button.c

This is file Button.c.

Body Source

```
/*****************************************************************************
  *  Module for Microchip Graphics Library
  *  GOL Layer
  *  Button
 *****************************************************************************
  * FileName:        Button.c
  * Dependencies:    Button.h
  * Processor:       PIC24F, PIC24H, dsPIC, PIC32
  * Compiler:        MPLAB C30, MPLAB C32
  * Linker:          MPLAB LINK30, LINK32
  * Company:         Microchip Technology Incorporated
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  * CLAIMS BY THIRD PARTIES (INCLUDING BUT NOT LIMITED TO ANY DEFENSE THEREOF),
  * OR OTHER SIMILAR COSTS.
  *
  * Date         Comment
  *~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
  * 11/12/07     Version 1.0 release
  * 06/26/09     Added message ID BTN_MSG_STILLPRESSED
  *              to signify that a continuous touch on
  *              the button through touch screen.
  * 06/29/09     Added multi-line text support on buttons
  *              must set USE_BUTTON_MULTI_LINE in
  *              GraphicsConfig.h file.
  * 10/04/10     Added BTN_NOPANEL property state bit to make the buttons with
  *              bitmaps that is of the same size or larger than the button
  *              dimension to skip drawing of the panel.
  * 04/20/11     Fixed KEYBOARD bug on object ID and GOL_MSG param1 comparison.
  *****************************************************************************/
#include "Graphics/Graphics.h"

#if defined(USE_BUTTON) || defined(USE_BUTTON_MULTI_LINE)

/*********************************************************************
* Function: BUTTON  *BtnCreate(WORD ID, SHORT left, SHORT top, SHORT right,
*                              SHORT bottom, SHORT radius, void *pBitmap, XCHAR *pText,
*                              GOL_SCHEME *pScheme)
*
*
* Notes: Creates a BUTTON object and adds it to the current active list.
*        If the creation is successful, the pointer to the created Object
*        is returned. If not successful, NULL is returned.
*
********************************************************************/
BUTTON *BtnCreate
(
    WORD        ID,
    SHORT       left,
    SHORT       top,
    SHORT       right,
    SHORT       bottom,
    SHORT       radius,
    WORD        state,
    void        *pBitmap,
    XCHAR       *pText,
    GOL_SCHEME  *pScheme
)
{
    BUTTON  *pB = NULL;
    pB = (BUTTON *)GFX_malloc(sizeof(BUTTON));
    if(pB == NULL)
        return (NULL);

    pB->hdr.ID = ID;                          // unique id assigned for referencing
    pB->hdr.pNxtObj = NULL;                   // initialize pointer to NULL
    pB->hdr.type = OBJ_BUTTON;                // set object type
    pB->hdr.left = left;                      // left position
    pB->hdr.top = top;                        // top position
    pB->hdr.right = right;                    // right position
    pB->hdr.bottom = bottom;                  // bottom position
    pB->radius = radius;                      // radius
    pB->pBitmap = pBitmap;                    // location of bitmap
    pB->pText = pText;                        // location of the text
    pB->hdr.state = state;                    // state
    pB->hdr.DrawObj = BtnDraw;                // draw function
    pB->hdr.MsgObj = BtnTranslateMsg;         // message function
    pB->hdr.MsgDefaultObj = BtnMsgDefault;    // default message function
    pB->hdr.FreeObj = NULL;                   // free function

    // Set the color scheme to be used
    if(pScheme == NULL)
        pB->hdr.pGolScheme = _pDefaultGolScheme;
    else
        pB->hdr.pGolScheme = (GOL_SCHEME *)pScheme;
```

```
    pB->textWidth = 0;
    pB->textHeight = 0;
    if(pB->pText != NULL)
    {
        BtnSetText(pB, pText);
    }

    #ifdef USE_ALPHABLEND
    if(pB->hdr.pGolScheme->AlphaValue > 0)
            CopyPageWindow(_GFXDestinationPage,
                       _GFXBackgroundPage,
                       pB->hdr.left, pB->hdr.top,pB->hdr.left, pB->hdr.top,
                       pB->hdr.right - pB->hdr.left,
                       pB->hdr.bottom - pB->hdr.top);
    #endif

    GOLAddObject((OBJ_HEADER *)pB);

        #ifdef USE_FOCUS
    if(GetState(pB, BTN_FOCUSED))
        GOLSetFocus((OBJ_HEADER *)pB);
        #endif
    return (pB);
}

/*********************************************************************
* Function: BtnSetText(BUTTON *pB, XCHAR *pText)
*
*
* Notes: Sets the text used in the button.
*
********************************************************************/
void BtnSetText(BUTTON *pB, XCHAR *pText)
{
    #ifdef USE_BUTTON_MULTI_LINE
        int     width = 0, chCtr = 0, lineCtr = 1;
        XCHAR   ch, *pParser;
    #endif

    pB->pText = pText;

    #ifdef USE_BUTTON_MULTI_LINE

        // calculate width and height taking into account the multiple lines of text
        pParser = pB->pText;
        ch = *pText;

        // calculate the width (taken from the longest line)
        while(1)
        {
            if((ch == 0x000A) || (ch == 0x0000))
            {
                if(width < GetTextWidth(pParser, pB->hdr.pGolScheme->pFont))
                {
                    width = GetTextWidth(pParser, pB->hdr.pGolScheme->pFont);
                }

                if(ch == 0x000A)
                {
                    pParser = pText + chCtr + 1;
                    lineCtr++;
                }
                else
                {
                    break;
                }
            }

            chCtr++;
            ch = *(pText + chCtr);
        }
        pB->textWidth = width;
        pB->textHeight = GetTextHeight(pB->hdr.pGolScheme->pFont) * lineCtr;
    #else
        pB->textWidth = GetTextWidth(pText, pB->hdr.pGolScheme->pFont);
        pB->textHeight = GetTextHeight(pB->hdr.pGolScheme->pFont);
    #endif // #ifdef USE_BUTTON_MULTI_LINE
}

/*********************************************************************
* Function: BtnMsgDefault(WORD translatedMsg, void *pObj, GOL_MSG* pMsg)
*
*
* Notes: This the default operation to change the state of the button.
*        Called inside GOLMsg() when GOLMsgCallback() returns a 1.
*
********************************************************************/
void BtnMsgDefault(WORD translatedMsg, void *pObj, GOL_MSG *pMsg)
{

    BUTTON *pB;

    pB = (BUTTON *)pObj;

        #ifdef USE_FOCUS
            #ifdef USE_TOUCHSCREEN
    if(pMsg->type == TYPE_TOUCHSCREEN)
    {
        if(!GetState(pB, BTN_FOCUSED))
        {
            GOLSetFocus((OBJ_HEADER *)pB);
        }
    }

            #endif
        #endif
    switch(translatedMsg)
    {
        case BTN_MSG_PRESSED:
            SetState(pB, BTN_PRESSED | BTN_DRAW);   // set pressed and redraw
            break;

        case BTN_MSG_RELEASED:
        case BTN_MSG_CANCELPRESS:
            ClrState(pB, BTN_PRESSED);              // reset pressed
            SetState(pB, BTN_DRAW);                 // redraw
            break;

        default:

            // catch all for button messages added by users and
            // behavior defined by users in message callback
            break;
    }
}

/*********************************************************************
* Function: WORD BtnTranslateMsg(void *pObj, GOL_MSG *pMsg)
*
*
* Notes: Evaluates the message if the object will be affected by the
*        message or not.
*
********************************************************************/
WORD BtnTranslateMsg(void *pObj, GOL_MSG *pMsg)
{
    BUTTON *pB;

    pB = (BUTTON *)pObj;


    // Evaluate if the message is for the button
    // Check if disabled first
```

```
      if(GetState(pB, BTN_DISABLED))
          return (OBJ_MSG_INVALID);

          #ifdef USE_TOUCHSCREEN
      if(pMsg->type == TYPE_TOUCHSCREEN)
      {

          // Check if it falls in the button's face
          if
          (
              (pB->hdr.left < pMsg->param1) &&
              (pB->hdr.right > pMsg->param1) &&
              (pB->hdr.top < pMsg->param2) &&
              (pB->hdr.bottom > pMsg->param2)
          )
          {
              if(GetState(pB, BTN_TOGGLE))
              {
                  if(pMsg->uiEvent == EVENT_RELEASE)
                  {
                      if(GetState(pB, BTN_PRESSED))
                          return (BTN_MSG_RELEASED);
                      else
                          return (BTN_MSG_PRESSED);
                  }
              }
              else
              {
                  if(pMsg->uiEvent == EVENT_RELEASE)
                      return (BTN_MSG_RELEASED);
                  if(pMsg->uiEvent == EVENT_STILLPRESS)
                  {
                      if(GetState(pB, BTN_PRESSED))
                          return (BTN_MSG_STILLPRESSED);
                  }

                  if(!GetState(pB, BTN_PRESSED))
                      return (BTN_MSG_PRESSED);
              }
          }
          else
          {
              if(!GetState(pB, BTN_TOGGLE))
              {
                  if((pMsg->uiEvent == EVENT_MOVE) && (GetState(pB, BTN_PRESSED)))
                      return (BTN_MSG_CANCELPRESS);
              }
          }

          return (OBJ_MSG_INVALID);
      }

          #endif
          #ifdef USE_KEYBOARD
      if(pMsg->type == TYPE_KEYBOARD)
      {
          if((WORD)pMsg->param1 == pB->hdr.ID)
          {
              if(pMsg->uiEvent == EVENT_KEYSCAN)
              {
                  if(GetState(pB, BTN_TOGGLE))
                  {
                      if((pMsg->param2 == SCAN_SPACE_RELEASED) || (pMsg->param2 ==
  SCAN_CR_RELEASED))
                      {
                          if(GetState(pB, BTN_PRESSED))
                              return (BTN_MSG_RELEASED);
                          else
                              return (BTN_MSG_PRESSED);
                      }
                  }
                  else
```

```
                {
                    if((pMsg->param2 == SCAN_SPACE_PRESSED) || (pMsg->param2 ==
SCAN_CR_PRESSED))
                    {
                        return (BTN_MSG_PRESSED);
                    }

                    if((pMsg->param2 == SCAN_SPACE_RELEASED) || (pMsg->param2 ==
SCAN_CR_RELEASED))
                    {
                        return (BTN_MSG_RELEASED);
                    }
                }

                if((pMsg->param2 == SCAN_SPACE_PRESSED) || (pMsg->param2 ==
SCAN_CRA_PRESSED))
                {
                    return (BTN_MSG_PRESSED);
                }

                if((pMsg->param2 == SCAN_SPACE_RELEASED) || (pMsg->param2 ==
SCAN_CRA_RELEASED))
                {
                    return (BTN_MSG_RELEASED);
                }
            }
        }

        return (OBJ_MSG_INVALID);
    }

        #endif
    return (OBJ_MSG_INVALID);
}
/*********************************************************************
* Button draw states
********************************************************************/
typedef enum
{
    REMOVE,
    RNDBUTTON_DRAW,
    #ifdef USE_BUTTON_MULTI_LINE
    CHECK_TEXT_DRAW,
    #else
    TEXT_DRAW,
    #endif
    TEXT_DRAW_RUN,
    FOCUS_DRAW,
} BTN_DRAW_STATES;
/*********************************************************************
* Function: inline WORD __attribute__((always_inline)) DrawButtonFocus(BUTTON *button,
SHORT radius, BTN_DRAW_STATES *current_state)
********************************************************************/
inline WORD __attribute__((always_inline)) DrawButtonFocus(BUTTON *button, SHORT radius,
BTN_DRAW_STATES *current_state)
{

    *current_state = FOCUS_DRAW;

    if(IsDeviceBusy())
        return (0);

    if(GetState(button, BTN_FOCUSED))
    {
        SetLineType(FOCUS_LINE);
        if(GetState(button, BTN_PRESSED))
        {
            SetColor(button->hdr.pGolScheme->TextColor1);
        }
        else
        {
            SetColor(button->hdr.pGolScheme->TextColor0);
        }

        // check if the object has rounded corners or not
        if(!button->radius)
        {
            if
            (
                !Rectangle
                    (
                        button->hdr.left + GOL_EMBOSS_SIZE + 2,
                        button->hdr.top + GOL_EMBOSS_SIZE + 2,
                        button->hdr.right - GOL_EMBOSS_SIZE - 2,
                        button->hdr.bottom - GOL_EMBOSS_SIZE - 2
                    )
            )
            {
                return (0);
            }
        }
        else
        {

            // original center is still the same, but radius is reduced
            if
            (
                !Bevel
                    (
                        button->hdr.left + radius,
                        button->hdr.top + radius,
                        button->hdr.right - radius,
                        button->hdr.bottom - radius,
                        radius - 2 - GOL_EMBOSS_SIZE
                    )
            )
            {
                return (0);
            }
        }

        SetLineType(SOLID_LINE);
    }

    #ifdef USE_ALPHABLEND
    if(button->hdr.pGolScheme->AlphaValue > 0)
    {
        AlphaBlendWindow(GFXGetPageXYAddress(_GFXForegroundPage, button->hdr.left,
button->hdr.top),
                         GFXGetPageXYAddress(_GFXBackgroundPage, button->hdr.left,
button->hdr.top),
                         GFXGetPageXYAddress(_GFXDestinationPage, button->hdr.left,
button->hdr.top),
                         button->hdr.right - button->hdr.left,
                         button->hdr.bottom - button->hdr.top,
                         button->hdr.pGolScheme->AlphaValue);
        SetActivePage(_GFXDestinationPage);

    }
    #endif

    *current_state = REMOVE;
    return 1;
}
/*********************************************************************
* Function: WORD BtnDraw(void *pObj)
********************************************************************/
#ifdef USE_BUTTON_MULTI_LINE
inline void __attribute__((always_inline)) SetButtonTextPosition(BUTTON *button, XCHAR
*pCurLine, SHORT lineCtr)
{
    WORD xText, yText;
    SHORT textWidth;
```

```
        SetFont(button->hdr.pGolScheme->pFont);
        textWidth = GetTextWidth(pCurLine, button->hdr.pGolScheme->pFont);

        // check text alignment
        if(GetState(button, BTN_TEXTRIGHT))
        {
            xText = button->hdr.right - (textWidth + GOL_EMBOSS_SIZE + 2);
        }
        else if(GetState(button, BTN_TEXTLEFT))
        {
            xText = button->hdr.left + GOL_EMBOSS_SIZE + 2;
        }
        else
        {

            // centered text in x direction
            xText = (button->hdr.left + button->hdr.right - textWidth) >> 1;
        }

        if(GetState(button, BTN_TEXTTOP))
        {
            yText = button->hdr.top + GOL_EMBOSS_SIZE + (lineCtr *
    GetTextHeight(button->hdr.pGolScheme->pFont));
        }
        else if(GetState(button, BTN_TEXTBOTTOM))
        {
            yText = button->hdr.bottom - (GOL_EMBOSS_SIZE + button->textHeight) + (lineCtr *
    GetTextHeight(button->hdr.pGolScheme->pFont));
        }
        else
        {

            // centered text in y direction
            yText = ((button->hdr.bottom + button->hdr.top - button->textHeight) >> 1) +
    (lineCtr * GetTextHeight(button->hdr.pGolScheme->pFont));
        }

        MoveTo(xText, yText);

    }
    #endif
    /*********************************************************************
    * Function: WORD BtnDraw(void *pObj)
    *
    *
    * Notes: This is the state machine to draw the button.
    *
    ********************************************************************/
    WORD BtnDraw(void *pObj)
    {

        static BTN_DRAW_STATES state = REMOVE;
        static SHORT width, height, radius;

        #ifdef USE_BUTTON_MULTI_LINE
        static SHORT charCtr = 0, lineCtr = 0;
        static XCHAR *pCurLine = NULL;
        XCHAR ch = 0;
        #else
        WORD xText, yText;
        #endif
        WORD faceClr, embossLtClr, embossDkClr;
        BUTTON *pB;

        pB = (BUTTON *)pObj;

        if(IsDeviceBusy())
            return (0);

        switch(state)
        {
            case REMOVE:
```

```
            if(IsDeviceBusy())
                return (0);

            if(GetState(pB, BTN_HIDE))
            {                       // Hide the button (remove from screen)

                #ifdef USE_ALPHABLEND
                if(pB->hdr.pGolScheme->AlphaValue > 0)
                {

                    CopyPageWindow(_GFXBackgroundPage,
                               _GFXDestinationPage,
                               pB->hdr.left, pB->hdr.top,pB->hdr.left, pB->hdr.top,
                               pB->hdr.right - pB->hdr.left,
                               pB->hdr.bottom - pB->hdr.top);
                }
                else
                #endif

                SetColor(pB->hdr.pGolScheme->CommonBkColor);
                if(!Bar(pB->hdr.left, pB->hdr.top, pB->hdr.right, pB->hdr.bottom))
                {
                    return (0);
                }

                return (1);
            }

            /* Note: that width and height adjustment considers the following assumptions:
                    1. if circular width = height = radius*2
                    2. if vertical capsule width = radius*2
                    3. if horizontal capsule height = radius*2
                    4. radius must be less than or equal to width if height is greater than
  width
                    5. radius must be less than or equal to height if width is greater than
  height
                    6. if button is cornered, radius must be zero
            */
            radius = pB->radius;    // get radius
            width = (pB->hdr.right - pB->hdr.left) - (radius * 2);  // get width
            height = (pB->hdr.bottom - pB->hdr.top) - (radius * 2); // get height

            if(!GetState(pB, BTN_NOPANEL))
            {
                if(!GetState(pB, BTN_DISABLED))
                {
                    if(GetState(pB, BTN_PRESSED))
                    {
                        embossDkClr = pB->hdr.pGolScheme->EmbossLtColor;
                        embossLtClr = pB->hdr.pGolScheme->EmbossDkColor;
                        faceClr = pB->hdr.pGolScheme->Color1;
                    }
                    else
                    {
                        embossLtClr = pB->hdr.pGolScheme->EmbossLtColor;
                        embossDkClr = pB->hdr.pGolScheme->EmbossDkColor;
                        faceClr = pB->hdr.pGolScheme->Color0;
                    }
                }
                else
                {
                    embossLtClr = pB->hdr.pGolScheme->EmbossLtColor;
                    embossDkClr = pB->hdr.pGolScheme->EmbossDkColor;
                    faceClr = pB->hdr.pGolScheme->ColorDisabled;
                }

                #ifdef USE_ALPHABLEND
                if(pB->hdr.pGolScheme->AlphaValue > 0)
                {


                    CopyPageWindow(_GFXBackgroundPage,
                               _GFXForegroundPage,
                               pB->hdr.left, pB->hdr.top,pB->hdr.left, pB->hdr.top,
                               pB->hdr.right - pB->hdr.left,
                               pB->hdr.bottom - pB->hdr.top);

                    SetActivePage(_GFXForegroundPage);
                }
                #endif

                SetLineThickness(NORMAL_LINE);
                SetLineType(SOLID_LINE);

                #ifdef USE_GRADIENT
                GOLGradientPanelDraw(pB->hdr.pGolScheme);
                #endif

                GOLPanelDraw
                (
                    pB->hdr.left + radius,
                    pB->hdr.top + radius,
                    pB->hdr.right - radius,
                    pB->hdr.bottom - radius,
                    radius,
                    faceClr,
                    embossLtClr,
                    embossDkClr,
                    pB->pBitmap,
                    GOL_EMBOSS_SIZE
                );
            }
            state = RNDBUTTON_DRAW;

        case RNDBUTTON_DRAW:
            if (GetState(pB, BTN_NOPANEL))
            {
                // check if there is an image to be drawn
                if (pB->pBitmap != NULL)
                {
                    if
                    (
                        !PutImage
                            (
                                ((pB->hdr.right + pB->hdr.left - GetImageWidth((void
*)pB->pBitmap)) >> 1) + 1,
                                ((pB->hdr.top + pB->hdr.bottom - GetImageHeight((void
*)pB->pBitmap)) >> 1) + 1,
                                pB->pBitmap,IMAGE_NORMAL
                            )
                    )
                    {
                        return (0);
                    }
                }
            }
            else
            {
                if (GetState(pB, BTN_TWOTONE))
                {
                    if(!GOLTwoTonePanelDrawTsk())
                    {
                        return (0);
                    }
                }
                else
                {
                    if(!GOLPanelDrawTsk())
                    {
                        return (0);
                    }
                }
            }
```

```
            #ifdef USE_BUTTON_MULTI_LINE
            state = CHECK_TEXT_DRAW;
            #else
            state = TEXT_DRAW;
            #endif

        #ifdef USE_BUTTON_MULTI_LINE
        case CHECK_TEXT_DRAW:
            if(pB->pText != NULL)
            {
                if(!GetState(pB, BTN_DISABLED))
                {
                    if(GetState(pB, BTN_PRESSED))
                    {
                        SetColor(pB->hdr.pGolScheme->TextColor1);
                    }
                    else
                    {
                        SetColor(pB->hdr.pGolScheme->TextColor0);
                    }
                }
                else
                {
                    SetColor(pB->hdr.pGolScheme->TextColorDisabled);
                }

                pCurLine = pB->pText;
                lineCtr = 0;
                charCtr = 0;
                SetButtonTextPosition(pB, pCurLine, lineCtr);
                state = TEXT_DRAW_RUN;
            }
            else
            {
                return DrawButtonFocus(pB, radius, &state);
            }

        case TEXT_DRAW_RUN:
            ch = *(pCurLine + charCtr);

            // output one character at time until a newline character or a NULL character
  is sampled
            while(0x0000 != ch)
            {
                if(!OutChar(ch))
                    return (0);
                // render the character
                charCtr++;                          // update to next character
                ch = *(pCurLine + charCtr);

                if(ch == 0x000A)
                {                                       // new line character
                    pCurLine = pCurLine + charCtr + 1;  // go to first char of next line
                    lineCtr++;                          // update line counter
                    charCtr = 0;                        // reset char counter
                    SetButtonTextPosition(pB, pCurLine, lineCtr);
                    ch = *(pCurLine + charCtr);
                }
            }

            SetClip(CLIP_DISABLE);              // remove clipping
            state = FOCUS_DRAW;                 // go back to IDLE state

        #else

        case TEXT_DRAW:
            if(pB->pText != NULL)
            {
                if(!GetState(pB, BTN_DISABLED))
                {
                    if(GetState(pB, BTN_PRESSED))
                    {
                        SetColor(pB->hdr.pGolScheme->TextColor1);
                    }
                    else
                    {
                        SetColor(pB->hdr.pGolScheme->TextColor0);
                    }
                }
                else
                {
                    SetColor(pB->hdr.pGolScheme->TextColorDisabled);
                }

                SetFont(pB->hdr.pGolScheme->pFont);

                // check text alignment
                if(GetState(pB, BTN_TEXTRIGHT))
                {
                    xText = pB->hdr.right - (pB->textWidth + GOL_EMBOSS_SIZE + 2);
                }
                else if(GetState(pB, BTN_TEXTLEFT))
                {
                    xText = pB->hdr.left + GOL_EMBOSS_SIZE + 2;
                }
                else
                {

                    // centered text in x direction
                    xText = (pB->hdr.left + pB->hdr.right - pB->textWidth) >> 1;
                }

                if(GetState(pB, BTN_TEXTTOP))
                {
                    yText = pB->hdr.top + GOL_EMBOSS_SIZE + 2;
                }
                else if(GetState(pB, BTN_TEXTBOTTOM))
                {
                    yText = pB->hdr.bottom - (pB->textHeight + GOL_EMBOSS_SIZE);
                }
                else
                {

                    // centered text in y direction
                    yText = (pB->hdr.bottom + pB->hdr.top - pB->textHeight) >> 1;
                }

                MoveTo(xText, yText);
                state = TEXT_DRAW_RUN;
            }
            else
            {
                return DrawButtonFocus(pB, radius, &state);
            }

        case TEXT_DRAW_RUN:
            if(!OutText(pB->pText))
                return (0);
            state = FOCUS_DRAW;
                #endif // #ifdef USE_BUTTON_MULTI_LINE

        case FOCUS_DRAW:
            return DrawButtonFocus(pB, radius, &state);
    }

    return (1);
}

#endif //#if defined (USE_BUTTON) || defined (USE_BUTTON_MULTI_LINE)
```

14.1.9 Button.h

Functions

	Name	Description
	BtnCreate (see page 83)	This function creates a BUTTON (see page 91) object with the parameters given. It automatically attaches the new object into a global linked list of objects and returns the address of the object.
	BtnDraw (see page 85)	This function renders the object on the screen using the current parameter settings. Location of the object is determined by the left, top, right and bottom parameters. The colors used are dependent on the state of the object. The font used is determined by the style scheme set. The text on the face of the button is drawn on top of the bitmap. Text is always rendered centered on the face of the button. When rendering objects of the same type, each object must be rendered completely before the rendering of the next object is started. This is to avoid... more (see page 85)
	BtnMsgDefault (see page 89)	This function performs the actual state change based on the translated message given. The following state changes are supported:
	BtnSetText (see page 87)	This function sets the string used for the object.
	BtnTranslateMsg (see page 90)	This function evaluates the message from a user if the message will affect the object or not. The table below enumerates the translated messages for each event of the touch screen and keyboard inputs.

Macros

Name	Description
BTN_DISABLED (see page 81)	Bit for disabled state.
BTN_DRAW (see page 81)	Bit to indicate button must be redrawn.
BTN_DRAW_FOCUS (see page 81)	Bit to indicate focus must be redrawn.
BTN_FOCUSED (see page 81)	Bit for focus state.
BTN_HIDE (see page 82)	Bit to indicate button must be removed from screen.
BTN_NOPANEL (see page 83)	Bit to indicate the button will be drawn without a panel (for faster drawing when the button image used is larger than the button panel).
BTN_PRESSED (see page 82)	Bit for press state.
BTN_TEXTBOTTOM (see page 82)	Bit to indicate text is top aligned.
BTN_TEXTLEFT (see page 82)	Bit to indicate text is left aligned.
BTN_TEXTRIGHT (see page 82)	Bit to indicate text is right aligned.
BTN_TEXTTOP (see page 83)	Bit to indicate text is bottom aligned.
BTN_TOGGLE (see page 83)	Bit to indicate button will have a toggle behavior.
BTN_TWOTONE (see page 83)	Bit to indicate the button is a two tone type.
BtnGetBitmap (see page 87)	This macro returns the location of the currently used bitmap for the object.
BtnGetText (see page 86)	This macro returns the address of the current text string used for the object.
BtnSetBitmap (see page 88)	This macro sets the bitmap used in the object. The size of the bitmap must match the face of the button.

Structures

Name	Description
BUTTON (see page 91)	Defines the parameters required for a button Object. The following relationships of the parameters determines the general shape of the button: 1. Width is determined by right - left. 2. Height is determined by top - bottom. 3. Radius - specifies if the button will have a rounded edge. If zero then the button will have sharp (cornered) edge. 4. If 2*radius = height = width, the button is a circular button.

Description

This is file Button.h.

Body Source

```
/*****************************************************************************
 *  Module for Microchip Graphics Library
 *  GOL Layer
 *  Button
 *****************************************************************************
 * FileName:        Button.h
 * Dependencies:    None
 * Processor:       PIC24F, PIC24H, dsPIC, PIC32
 * Compiler:        MPLAB C30, MPLAB C32
 * Linker:          MPLAB LINK30, MPLAB LINK32
 * Company:         Microchip Technology Incorporated
 *
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 * CLAIMS BY THIRD PARTIES (INCLUDING BUT NOT LIMITED TO ANY DEFENSE THEREOF),
 * OR OTHER SIMILAR COSTS.
 *
 * Date        Comment
 *~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
 * 11/12/07 Version 1.0 release
 *****************************************************************************/
#ifndef _BUTTON_H
    #define _BUTTON_H

    #include <Graphics/GOL.h>
    #include "GenericTypeDefs.h"

/*********************************************************************
* Object States Definition:
*********************************************************************/
    #define BTN_FOCUSED     0x0001  // Bit for focus state.
    #define BTN_DISABLED    0x0002  // Bit for disabled state.
```

```
    #define BTN_PRESSED     0x0004  // Bit for press state.
    #define BTN_TOGGLE      0x0008  // Bit to indicate button will have a toggle behavior.
    #define BTN_TEXTRIGHT   0x0010  // Bit to indicate text is right aligned.
    #define BTN_TEXTLEFT    0x0020  // Bit to indicate text is left aligned.
    #define BTN_TEXTBOTTOM  0x0040  // Bit to indicate text is top aligned.
    #define BTN_TEXTTOP     0x0080  // Bit to indicate text is bottom aligned.
    #define BTN_TWOTONE     0x0100  // Bit to indicate the button is a two tone type.
    #define BTN_NOPANEL     0x0200  // Bit to indicate the button will be drawn without a
panel (for faster drawing when the button image used is larger than the button panel).

// Note that if bits[7:4] are all zero text is centered.
    #define BTN_DRAW_FOCUS  0x2000  // Bit to indicate focus must be redrawn.
    #define BTN_DRAW        0x4000  // Bit to indicate button must be redrawn.
    #define BTN_HIDE        0x8000  // Bit to indicate button must be removed from screen.
    #define BTN_REMOVE      0x8000

/*********************************************************************
* Overview: Defines the parameters required for a button Object.
*           The following relationships of the parameters determines
*           the general shape of the button:
*           1. Width is determined by right - left.
*           2. Height is determined by top - bottom.
*           3. Radius - specifies if the button will have a rounded
*                       edge. If zero then the button will have
*                       sharp (cornered) edge.
*           4. If 2*radius = height = width, the button is a circular button.
*
*********************************************************************/
typedef struct
{
    OBJ_HEADER  hdr;        // Generic header for all Objects (see OBJ_HEADER).
    SHORT       radius;     // Radius for rounded buttons.
    SHORT       textWidth;  // Computed text width, done at creation.
    SHORT       textHeight; // Computed text height, done at creation.
    XCHAR       *pText;     // Pointer to the text used.
    void        *pBitmap;   // Pointer to bitmap used.
} BUTTON;

/*********************************************************************
* Macros:  BtnSetBitmap(pB, pBitmap)
*
* Overview: This macro sets the bitmap used in the object.
*           The size of the bitmap must match the face of the button.
*
* PreCondition: none
*
* Input: pB - Pointer to the object.
*        pBitmap - Pointer to the bitmap to be used.
*
* Output: none
*
* Example:
*   <CODE>
*   extern BITMAP_FLASH myIcon;
*   BUTTON *pButton;
*
*       BtnSetBitmap(pButton , &myIcon);
*   </CODE>
*
* Side Effects: none
*
********************************************************************/
    #define BtnSetBitmap(pB, pBtmap)    ((BUTTON *)pB)->pBitmap = pBtmap

/*********************************************************************
* Macros:  BtnGetBitmap(pB)
*
* Overview: This macro returns the location of the currently
*           used bitmap for the object.
*
* PreCondition: none
*
```

```
 * Input: pB - Pointer to the object.
 *
 * Output: Returns the pointer to the current bitmap used.
 *
 * Example:
 *   <CODE>
 *   BUTTON *pButton;
 *   BITMAP_FLASH *pUsedBitmap;
 *
 *       pUsedbitmap = BtnGetBitmap(pButton);
 *   </CODE>
 *
 * Side Effects: none
 *
 ********************************************************************/
    #define BtnGetBitmap(pB)    ((BUTTON *)pB)->pBitmap

/*********************************************************************
 * Macros:  BtnGetText(pB)
 *
 * Overview: This macro returns the address of the current
 *           text string used for the object.
 *
 * PreCondition: none
 *
 * Input: pB - Pointer to the object.
 *
 * Output: Returns pointer to the text string being used.
 *
 * Example:
 *   <CODE>
 *   XCHAR *pChar;
 *   BUTTON Button[2];
 *
 *   pChar = BtnGetText(Button[0]);
 *   </CODE>
 *
 * Side Effects: none
 *
 ********************************************************************/
    #define BtnGetText(pB)  ((BUTTON *)pB)->pText

/*********************************************************************
 * Function: BtnSetText(BUTTON *pB, XCHAR *pText)
 *
 * Overview: This function sets the string used for the object.
 *
 * PreCondition: none
 *
 * Input: pB - The pointer to the object whose text will be modified.
 *        pText - Pointer to the text that will be used.
 *
 * Output: none
 *
 * Example:
 *   <CODE>
 *   XCHAR Label0[] = “ON”;
 *   XCHAR Label1[] = “OFF”;
 *   BUTTON Button[2];
 *
 *       BtnSetText(Button[0], Label0);
 *       BtnSetText(Button[1], Label1);
 *   </CODE>
 *
 * Side Effects: none
 *
 ********************************************************************/
void BtnSetText(BUTTON * pB, XCHAR * pText);

/*********************************************************************
 * Function: BUTTON *BtnCreate(WORD ID, SHORT left, SHORT top, SHORT right,
 *                              SHORT bottom, SHORT radius, void *pBitmap, XCHAR *pText,
 *                             GOL_SCHEME *pScheme)
 *
 * Overview: This function creates a BUTTON object with the parameters given.
 *           It automatically attaches the new object into a global linked list of
 *           objects and returns the address of the object.
 *
 * PreCondition: none
 *
 * Input: ID - Unique user defined ID for the object instance.
 *        left - Left most position of the object.
 *        top - Top most position of the object.
 *        right - Right most position of the object.
 *        bottom - Bottom most position of the object.
 *        radius - Radius of the rounded edge.
 *        state - Sets the initial state of the object.
 *        pBitmap - Pointer to the bitmap used on the face of the button
 *                  dimension of the bitmap must match the dimension of the
 *                  button.
 *        pText - Pointer to the text of the button.
 *        pScheme - Pointer to the style scheme used.
 *
 * Output: Returns the pointer to the object created.
 *
 * Example:
 *   <CODE>
 *   GOL_SCHEME *pScheme;
 *   BUTTON *buttons[3];
 *   WORD state;
 *
 *       pScheme = GOLCreateScheme();
 *       state = BTN_DRAW;
 *
 *       buttons[0] = BtnCreate(1,20,64,50,118,0, state, NULL, "ON", pScheme);
 *       // check if button 0 is created
 *       if (buttons[0] == NULL)
 *          return 0;
 *
 *       buttons[1] = BtnCreate(2,52,64,82,118,0, state, NULL, "OFF", pScheme);
 *       // check if button 1 is created
 *       if (buttons[1] == NULL)
 *          return 0;
 *
 *       buttons[2] = BtnCreate(3,84,64,114,118,0, state, NULL, "HI", pScheme);
 *       // check if button 2 is created
 *       if (buttons[2] == NULL)
 *          return 0;
 *
 *       return 1;
 *   </CODE>
 *
 * Side Effects: none
 *
 ********************************************************************/
BUTTON  *BtnCreate
        (
            WORD        ID,
            SHORT       left,
            SHORT       top,
            SHORT       right,
            SHORT       bottom,
            SHORT       radius,
            WORD        state,
            void        *pBitmap,
            XCHAR       *pText,
            GOL_SCHEME  *pScheme
        );

/*********************************************************************
 * Function: BtnTranslateMsg(void *pObj, GOL_MSG *pMsg)
 *
 * Overview: This function evaluates the message from a user if the
 *           message will affect the object or not. The table below enumerates the
```

```
translated
*           messages for each event of the touch screen and keyboard inputs.
*
*   <TABLE>
*       Translated Message     Input Source     Set/Clear State Bit        Description
*       ##################     ############     #######################
##############################################################################################
##############################################################################
*       BTN_MSG_PRESSED        Touch Screen     EVENT_PRESS, EVENT_MOVE    If events
occurs and the x,y position falls in the face of the button while the button is not pressed.
*                              Keyboard         EVENT_KEYSCAN              If event occurs
and parameter1 passed matches the object’s ID and parameter 2 passed matches
SCAN_CR_PRESSED or SCAN_SPACE_PRESSED while the button is not pressed.
*       BTN_MSG_STILLPRESSED   Touch Screen     EVENT_STILLPRESS           If event occurs
and the x,y position does not change from the previous press position in the face of the
button.
*       BTN_MSG_RELEASED       Touch Screen     EVENT_RELEASE              If the event
occurs and the x,y position falls in the face of the button while the button is
pressed.
*                              Keyboard         EVENT_KEYSCAN              If event occurs
and parameter1 passed matches the object’s ID and parameter 2 passed matches
SCAN_CR_RELEASED or SCAN_SPACE_RELEASED while the button is
pressed.
*       BTN_MSG_CANCELPRESS    Touch Screen     EVENT_MOVE                 If the event
occurs outside the face of the button and the button is currently
pressed.
*       OBJ_MSG_INVALID        Any              Any                        If the message
did not affect the object.
*   </TABLE>
*
* PreCondition: none
*
* Input: pObj  - The pointer to the object where the message will be
*                evaluated to check if the message will affect the object.
*        pMsg  - Pointer to the message struct containing the message from
*                the user interface.
*
* Output: Returns the translated message depending on the received GOL message:
*         - BTN_MSG_PRESSED – Button is pressed
*         - BTN_MSG_RELEASED – Button is released
*         - BTN_MSG_CANCELPRESS – Button will be released, user cancels press action on the
button
*         - OBJ_MSG_INVALID – Button is not affected
*
* Example:
*   <CODE>
*   void MyGOLMsg(GOL_MSG *pMsg){
*
*       OBJ_HEADER *pCurrentObj;
*       WORD objMsg;
*
*       if(pMsg->uiEvent == EVENT_INVALID)
*           return;
*       pCurrentObj = GOLGetList();
*
*       while(pCurrentObj != NULL){
*           // If the object must be redrawn
*           // It cannot accept message
*           if(!IsObjUpdated(pCurrentObj)){
*               translatedMsg = pCurrentObj->MsgObj(pCurrentObj, pMsg);
*
*                if(translatedMsg != OBJ_MSG_INVALID)
*                {
*                    if(GOLMsgCallback(translatedMsg, pCurrentObj, pMsg))
*                        if(pCurrentObj->MsgDefaultObj)
*                            pCurrentObj->MsgDefaultObj(translatedMsg, pCurrentObj, pMsg);
*                }
*
*           }
*       }
*       pCurrentObj = pCurrentObj->pNxtObj;
*   }
*   </CODE>
*
* Side Effects: none
*
********************************************************************/
WORD    BtnTranslateMsg(void *pObj, GOL_MSG *pMsg);

/*********************************************************************
* Function: BtnMsgDefault(WORD translatedMsg, void *pObj, GOL_MSG* pMsg)
*
* Overview: This function performs the actual state change
*           based on the translated message given. The following state changes
*           are supported:
*   <TABLE>
*       Translated Message   Input Source   Set/Clear State Bit     Description
*       ##################   ############   ######                  ###########
*       BTN_MSG_PRESSED      Touch Screen,  Set BTN_PRESSED         Button will be redrawn
in the pressed state.
*                             Keyboard
*       BTN_MSG_RELEASED     Touch Screen,  Clear BTN_PRESSED       Button will be redrawn
in the unpressed state.
*                             Keyboard
*       BTN_MSG_CANCELPRESS  Touch Screen,  Clear BTN_PRESSED       Button will be redrawn
in the unpressed state.
*
*   </TABLE>
*
* PreCondition: none
*
* Input: translatedMsg - The translated message.
*         pObj          - The pointer to the object whose state will be modified.
*         pMsg          - The pointer to the GOL message.
*
* Output: none
*
* Example:
*   See BtnTranslateMsg() example.
*
* Side Effects: none
*
********************************************************************/
void    BtnMsgDefault(WORD translatedMsg, void *pObj, GOL_MSG *pMsg);

/*********************************************************************
* Function: WORD BtnDraw(void *pObj)
*
* Overview: This function renders the object on the screen using
*           the current parameter settings. Location of the object is
*           determined by the left, top, right and bottom parameters.
*           The colors used are dependent on the state of the object.
*           The font used is determined by the style scheme set.
*
*           The text on the face of the button is drawn on top of
*           the bitmap. Text is always rendered centered on the face
*           of the button.
*
*           When rendering objects of the same type, each object
*           must be rendered completely before the rendering of the
*           next object is started. This is to avoid incomplete
*           object rendering.
*
* PreCondition: Object must be created before this function is called.
*
* Input: pB - Pointer to the object to be rendered.
*
* Output: Returns the status of the drawing
*         - 1 - If the rendering was completed and
*         - 0 - If the rendering is not yet finished.
*         Next call to the function will resume the
*         rendering on the pending drawing state.
*
* Example:
*   <CODE>
*   void MyGOLDraw(){
*       static OBJ_HEADER *pCurrentObj = NULL;
*       int done;
*
*       // There are no objects
*       if(GOLGetList() == NULL)
*           return;
*
*       // If it's last object jump to head
*       if(pCurrentObj == NULL)
*           pCurrentObj = GOLGetList();
*
*       done = 0;
*
*       // this only process Button and Window
*       while(pCurrentObj != NULL){
*           // check if object state indicates redrawing
*           done = pCurrentObj->draw(pCurrentObj);
*
*               if(done){
*                   // reset only the state if drawing was finished
*                   pCurrentObj->state = 0;
*               }else{
*                   // done processing the list
*                   return;
*               }
*           }
*           // go to next object
*           pCurrentObj = pCurrentObj->pNxtObj;
*       }
*   }
*   </CODE>
*
* Side Effects: none
*
********************************************************************/
WORD BtnDraw(void *pObj);
#endif // _BUTTON_H
```

14.1.10 Chart.c

This is file Chart.c.

Body Source

```
/*****************************************************************************
 *  Module for Microchip Graphics Library
 *  GOL Layer
 *  Chart
 *****************************************************************************
 * FileName:        Chart.c
 * Dependencies:    Chart.h
 * Processor:       PIC24F, PIC24H, dsPIC, PIC32
 * Compiler:        MPLAB C30 Version 3.00, C32
 * Linker:          MPLAB LINK30, LINK32
 * Company:         Microchip Technology Incorporated
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```
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  * OR OTHER SIMILAR COSTS.
  *
  * Author               Date        Comment
  *~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
  * Paolo A. Tamayo
  * Anton Alkhimenok     4/8/08      ...
  * PAT                  8/8/08      Centered values displayed on bar charts
  *                                  Removed line drawn on pie chart when no slices
  *                                  are present.
  * PAT                  9/30/08     3-D bar depth is now equal to chart depth.
  *                                  Flushed 2-D Bars to equal max height of chart
  *                                  when equal or greater than.
  * PAT                  6/29/09     Modified Draw Sector function to be state based.
  *****************************************************************************/
#include "Graphics/Graphics.h"
#include <math.h>

#ifdef USE_CHART

// internal functions and macros
WORD        word2xchar(WORD pSmple, XCHAR *xcharArray, WORD cnt);
void        GetCirclePoint(SHORT radius, SHORT angle, SHORT *x, SHORT *y);
WORD        DrawSector(SHORT cx, SHORT cy, SHORT radius, SHORT angleFrom, SHORT angleTo,
WORD outLineColor);
WORD        GetColorShade(WORD color, BYTE shade);
WORD        ChParseShowData(DATASERIES *pData);
DATASERIES  *ChGetNextShowData(DATASERIES *pData);
SHORT       ChSetDataSeries(CHART *pCh, WORD seriesNum, BYTE status);

// array used to define the default colors used to draw the bars or sectors of the chart
const WORD  ChartVarClr[16] = {  CH_CLR0, CH_CLR1, CH_CLR2, CH_CLR3,
    CH_CLR4, CH_CLR5, CH_CLR6, CH_CLR7,
    CH_CLR8, CH_CLR9, CH_CLR10,CH_CLR11,
    CH_CLR12,CH_CLR13,CH_CLR14,CH_CLR15};

/*********************************************************************
* Function: CHART  *ChCreate(WORD ID, SHORT left, SHORT top, SHORT right,
*                            SHORT bottom, WORD state ,CHARTDATA *pData,
*                            GOL_SCHEME *pScheme)
*
*
* Notes: Creates a CHART object and adds it to the current active list.
*        If the creation is successful, the pointer to the created Object
*        is returned. If not successful, NULL is returned.
*
********************************************************************/
CHART *ChCreate
(
    WORD        ID,
    SHORT       left,
    SHORT       top,
    SHORT       right,
    SHORT       bottom,
    WORD        state,
    DATASERIES  *pData,
    CHARTPARAM  *pParam,
    GOL_SCHEME  *pScheme
)
{
    CHART   *pCh = NULL;
```

```
    pCh = (CHART *)GFX_malloc(sizeof(CHART));

    if(pCh == NULL)
        return (NULL);

    pCh->hdr.ID = ID;           // unique id assigned for referencing
    pCh->hdr.pNxtObj = NULL;    // initialize pointer to NULL
    pCh->hdr.type = OBJ_CHART;  // set object type
    pCh->hdr.left = left;       // left position
    pCh->hdr.top = top;         // top position
    pCh->hdr.right = right;     // right position
    pCh->hdr.bottom = bottom;   // bottom position
    pCh->hdr.state = state;     // state
    pCh->hdr.DrawObj = ChDraw;              // draw function
    pCh->hdr.MsgObj = ChTranslateMsg;       // message function
    pCh->hdr.MsgDefaultObj = NULL;          // default message function
    pCh->hdr.FreeObj = ChFreeDataSeries;    // free function

    if(pParam != NULL)
    {
        pCh->prm.pTitle = pParam->pTitle;
        pCh->prm.pSmplLabel = pParam->pSmplLabel;
        pCh->prm.pValLabel = pParam->pValLabel;
        pCh->prm.smplStart = pParam->smplStart;
        pCh->prm.smplEnd = pParam->smplEnd;
        pCh->prm.valMax = pParam->valMax;
        pCh->prm.valMin = pParam->valMin;
        pCh->prm.pColor = pParam->pColor;
        pCh->prm.pTitleFont = pParam->pTitleFont;
        pCh->prm.pAxisLabelsFont = pParam->pAxisLabelsFont;
        pCh->prm.pGridLabelsFont = pParam->pGridLabelsFont;
    }
    else
    {
        pCh->prm.pTitle = NULL;
        pCh->prm.pSmplLabel = NULL;
        pCh->prm.pValLabel = NULL;
        pCh->prm.smplStart = 0;
        pCh->prm.smplEnd = 0;
        pCh->prm.valMax = 0;
        pCh->prm.valMin = 0;

        // use the default color table
        pCh->prm.pColor = (WORD *)ChartVarClr;
        pCh->prm.pTitleFont = _pDefaultGolScheme->pFont;
        pCh->prm.pAxisLabelsFont = _pDefaultGolScheme->pFont;
        pCh->prm.pGridLabelsFont = _pDefaultGolScheme->pFont;
    }

    pCh->pChData = pData;       // assign the chart data

    // check if how variables have SHOW_DATA flag set
    pCh->prm.seriesCount = ChParseShowData(pData);

    // Set the color scheme to be used
    if(pScheme == NULL)
    {
        pCh->hdr.pGolScheme = _pDefaultGolScheme;
    }
    else
    {
        pCh->hdr.pGolScheme = (GOL_SCHEME *)pScheme;
        pCh->prm.pTitleFont = pCh->hdr.pGolScheme->pFont;
        pCh->prm.pAxisLabelsFont = pCh->hdr.pGolScheme->pFont;
        pCh->prm.pGridLabelsFont = pCh->hdr.pGolScheme->pFont;
    }

    GOLAddObject((OBJ_HEADER *)pCh);

    return (pCh);
}
```

```
/*********************************************************************
* Function: WORD ChTranslateMsg(void *pObj, GOL_MSG *pMsg)
*
* Notes: Evaluates the message if the object will be affected by the
*        message or not.
*
*********************************************************************/
WORD ChTranslateMsg(void *pObj, GOL_MSG *pMsg)
{

    CHART *pCh;

    pCh = (CHART *)pObj;

    // Evaluate if the message is for the static text
    // Check if disabled first
    if(GetState(pCh, CH_DISABLED))
        return (OBJ_MSG_INVALID);

        #ifdef USE_TOUCHSCREEN
    if(pMsg->type == TYPE_TOUCHSCREEN)
    {

        // Check if it falls in static text control borders
        if
        (
            (pCh->hdr.left < pMsg->param1) &&
            (pCh->hdr.right > pMsg->param1) &&
            (pCh->hdr.top < pMsg->param2) &&
            (pCh->hdr.bottom > pMsg->param2)
        )
        {
            return (CH_MSG_SELECTED);
        }
    }

        #endif
    return (OBJ_MSG_INVALID);
}

////////////////////////////////////////////////

// internal functions
////////////////////////////////////////////////
DATASERIES *ChGetNextShowData(DATASERIES *pData)
{
    DATASERIES  *pVar = pData;

    // find the next data series that will be shown
    while(pVar->show != SHOW_DATA)
    {
        if((pVar = (DATASERIES *)pVar->pNextData) == NULL)
            return (NULL);
    }

    return (pVar);
}

/* */
WORD ChParseShowData(DATASERIES *pData)
{
    DATASERIES  *pParse;
    WORD        sCnt = 0;

    if(pData != NULL)
    {
        pParse = pData;
        while(pParse != NULL)
        {
            if(pParse->show == SHOW_DATA)
                sCnt++;
            pParse = (DATASERIES *)pParse->pNextData;
        }
    }

    return (sCnt);
}

/* */
WORD GetLongestNameLength(CHART *pCh)
{
    WORD        temp = 0;
    DATASERIES  *pVar;

    if(!GetState(pCh, CH_LEGEND))
        return (0);

    // find the data series with the longest name
    pVar = pCh->pChData;

    while(pVar)
    {

        // check if the data series is to be shown
        if(pVar->show == SHOW_DATA)
        {
            if(temp < GetTextWidth((XCHAR *)pVar->pSData, pCh->hdr.pGolScheme->pFont))
                temp = GetTextWidth((XCHAR *)pVar->pSData, pCh->hdr.pGolScheme->pFont);
        }

        pVar = pVar->pNextData;
    }

    return (temp);
}

/* */
WORD word2xchar(WORD pSmple, XCHAR *xcharArray, WORD cnt)
{
    WORD            j, z;
    static XCHAR    *pXchar;

    pXchar = xcharArray;

    // this implements sprintf(strVal, "%d", temp); faster
    // note that this is just for values >= 0, while sprintf covers negative values.
    j = 1;
    z = pSmple;

    pXchar = &(*xcharArray) + (cnt - j);
    do
    {
        *pXchar = (z % 10) + '0';
        *pXchar--;
        if((z /= 10) == 0)
            break;
        j++;
    } while(j <= cnt);
    return (j);
}

/*********************************************************************
* Function: WORD GetColorShade(WORD color, BYTE shade)
*
*
* Notes: This function gets the given color in 5-6-5 (RGB) format
*        and computes the shade of the same color by shifting
*        the rgb values depending on the shade value.
*        The idea here is to get the given r,g and b colors and
*        make them approach the gray color by shifting the each value
*        closer to 128. If rgb values are > 128 we subtract and add
*        if < 128 we add.
*
```

```
********************************************************************/
WORD GetColorShade(WORD color, BYTE shade)
{
    WORD    newColor;
    BYTE    rgb[3];

    rgb[0] = ((color >> 11) << 3);  // red
    rgb[1] = ((color >> 5) << 2);   // green
    rgb[2] = ((color) << 3);        // blue
    BYTE    i;

    for(i = 0; i < 3; i++)
    {
        if(rgb[i] > 128)
            rgb[i] = rgb[i] - ((rgb[i] - 128) >> (shade));
        else
            rgb[i] = rgb[i] + ((128 - rgb[i]) >> (shade));
    }

    newColor = RGB565CONVERT(rgb[0], rgb[1], rgb[2]);
    return (newColor);
}

/*********************************************************************
* Function: WORD ChDraw(void *pObj)
*
*
* Notes: This is the state machine to draw the button.
*
********************************************************************/
    #define STR_CHAR_CNT        11
    #define DCLR_STR_CHAR_CNT   (STR_CHAR_CNT + 1)

/* */

WORD ChDraw(void *pObj)
{
    typedef enum
    {
        REMOVE,
        FRAME_DRAW_PREP,
        FRAME_DRAW,
        CHECK_CHART_TYPE,

        // BAR type states
        GRID_PREP,
        SAMPLE_GRID_DRAW1,
        VALUE_GRID_DRAW1,
        SAMPLE_GRID_DRAW2,
        VALUE_GRID_DRAW2,
        VALUE_GRID_3D_DRAW,
        TITLE_LABEL_DRAW_SET,
        TITLE_LABEL_DRAW_RUN,
        SAMPLE_LABEL_DRAW_SET,
        SAMPLE_LABEL_DRAW_RUN,
        VALUE_LABEL_DRAW_INIT,
        VALUE_LABEL_DRAW_SET,
        VALUE_LABEL_DRAW_RUN,
        XAXIS_LABEL_DRAW_RUN,
        XAXIS_LABEL_DRAW_SET,
        YAXIS_LABEL_DRAW_RUN,
        YAXIS_LABEL_DRAW_SET,
        LEGEND_DRAW_BOX,
        LEGEND_DRAW_RUN,
        LEGEND_DRAW_UPDATE_VAR,
        DATA_DRAW_INIT,
        DATA_DRAW_SET,
        BAR_DATA_DRAW,
        BAR_DATA_DRAW_CHECK,
        BAR_DATA_DRAW_3D_PREP,
        BAR_DATA_DRAW_3D_LOOP_1,
        BAR_DATA_DRAW_3D_LOOP_2,
        BAR_DATA_DRAW_3D_OUTLINE1,
        BAR_DATA_DRAW_3D_OUTLINE2,
        BAR_DATA_DRAW_3D_OUTLINE3,
        BAR_DATA_DRAW_3D_OUTLINE4,
        BAR_DATA_DRAW_3D_OUTLINE5,
        PIE_DONUT_HOLE_DRAW,
        BAR_DATA_DRAW_VALUE,
        BAR_DATA_DRAW_VALUE_RUN,

        // PIE type states
        PIE_PREP,
        PIE_DRAW_OUTLINE1,
        PIE_DRAW_SECTOR,
        PIE_DRAW_SECTOR_LOOP,
        PIE_DRAW_SECTOR_ACTUAL,
        PIE_DRAW_SECTOR_LOOP_CONTINUE,
        PIE_DRAW_SECTOR_LOOP_CREATE_STRINGS,
        PIE_DRAW_SECTOR_LOOP_STRINGS_RUN,
    } CH_DRAW_STATES;

    static XCHAR tempXchar[2] = {'B',0};
    static XCHAR temp2Xchar[2] = {'M',0};
    static XCHAR tempStr[DCLR_STR_CHAR_CNT] = {'0','0','0','0','0','0','0','0','0','0',0};

    static CH_DRAW_STATES state = REMOVE;
    static WORD x, y, z, xStart, yStart, ctr, ctry, samplesMax, temp;
    static SHORT uLocator;
    static WORD splDelta, valDelta;
    static WORD barWidth, barDepth, chart3DDepth;

    static DATASERIES *pVar;
    static WORD *pSmple;
    static XCHAR *pXcharTemp;
    static DWORD dTemp;
    static SHORT varCtr, pieX, pieY;
    static DWORD dPercent;
    static WORD j = 0, k = 0, h = 0, i, m;
    static void *pVarFont;

    static WORD pieLabelXPos;
    static WORD pieLabelYPos, pieLabelYPos2, pieLabelYPos3;
    static WORD pieSectorXPos;
    static WORD pieSectorYPos;

    CHART *pCh;

    pCh = (CHART *)pObj;

    if(IsDeviceBusy())
        return (0);

    switch(state)
    {
        case REMOVE:
            if(IsDeviceBusy())
                return (0);

            if(GetState(pCh, CH_HIDE))
            {   // Hide the Chart (remove from screen)
                SetColor(pCh->hdr.pGolScheme->CommonBkColor);
                if(!Bar(pCh->hdr.left, pCh->hdr.top, pCh->hdr.right, pCh->hdr.bottom))
                    return (0);
                return (1);
            }

            SetLineThickness(NORMAL_LINE);
            SetLineType(SOLID_LINE);

            // check if we only need to refresh the data on the chart
            if(GetState(pCh, CH_DRAW_DATA))
            {
                // this is only performed when refreshing data in the chart
                // erase the current contents
                SetColor(pCh->hdr.pGolScheme->CommonBkColor);

                // get the ending x position where redraw will take place (if legend is
drawn,
                // we do not need to redraw this area)
                i = GetLongestNameLength(pCh) + GetTextHeight(pCh->hdr.pGolScheme->pFont) +
GOL_EMBOSS_SIZE + (CH_MARGIN << 1);

                if(GetState(pCh, CH_BAR))
                {

                    // get the starting x position where redraw will take place
                    h = xStart - GetTextWidth(tempXchar, pCh->prm.pGridLabelsFont) -
(GetTextWidth(temp2Xchar, pCh->prm.pGridLabelsFont) >> 1);

                    // get the starting y position
                    j = yStart - ((ChGetSampleRange(pCh) + 1) * splDelta);
                    if(GetState(pCh, CH_3D_ENABLE))
                    {
                        if(GetState(pCh, CH_BAR_HOR) == CH_BAR_HOR)
                        {

                            // adjust for 3D effects
                            j -= chart3DDepth;
                            if((GetState(pCh, CH_LEGEND)) && (ChGetShowSeriesCount(pCh) !=
1))
                            {
                                if(!Bar(h, j, pCh->hdr.right - i, yStart))
                                    return (0);
                            }
                            else
                            {
                                if(!Bar(h, j, pCh->hdr.right - CH_MARGIN, yStart))
                                    return (0);
                            }
                        }
                        else
                        {
                            if
                            (
                                !Bar
                                    (
                                        xStart,
                                        yStart - ((CH_YGRIDCOUNT - 1) * valDelta) -
chart3DDepth - (GetTextHeight(pCh->hdr.pGolScheme->pFont)),
                                        xStart + splDelta * (ChGetSampleRange(pCh) + 1) +
chart3DDepth,
                                        yStart + GetTextHeight(pCh->prm.pGridLabelsFont)
                                    )
                            ) return (0);
                        }
                    }
                    else
                    {
                        if(GetState(pCh, CH_BAR_HOR) == CH_BAR_HOR)
                        {
                            if((GetState(pCh, CH_LEGEND)) && (ChGetShowSeriesCount(pCh) !=
1))
                            {
                                if(!Bar(h, j, pCh->hdr.right - i, yStart))
                                    return (0);
                            }
                            else
                            {
                                if(!Bar(h, j, pCh->hdr.right - CH_MARGIN, yStart))
                                    return (0);
                            }
                        }
                        else
                        {
```

```
                        if
                        (
                            !Bar
                                (
                                    xStart,
                                    yStart - ((CH_YGRIDCOUNT - 1) * valDelta) -
  (GetTextHeight(pCh->hdr.pGolScheme->pFont)),
                                    xStart + splDelta * (ChGetSampleRange(pCh) + 1),
                                    yStart + GetTextHeight(pCh->prm.pGridLabelsFont)
                                )
                        ) return (0);
                    }
                }
            }
            else
            {
                if((GetState(pCh, CH_LEGEND)) && (ChGetShowSeriesCount(pCh) != 1))
                    i = pCh->hdr.right - i;
                else
                    i = pCh->hdr.right - GOL_EMBOSS_SIZE - CH_MARGIN;
                h = pCh->hdr.left + GOL_EMBOSS_SIZE;
                j = pCh->hdr.top + GOL_EMBOSS_SIZE + CH_MARGIN +
  GetTextHeight(pCh->prm.pTitleFont);

                // erase the current pie chart drawn
                if(!Bar(h, j, i, pCh->hdr.bottom - CH_MARGIN))
                    return (0);
            }

            // check the type of chart
            if(GetState(pCh, CH_BAR))
            {
                state = GRID_PREP;
                goto chrt_grid_prep;
            }
            else
            {
                state = PIE_PREP;
                goto chrt_pie_prep;
            }
        }

        state = FRAME_DRAW_PREP;

    /*=========================================================================*/
    //                    Draw the frame
    /*=========================================================================*/
    case FRAME_DRAW_PREP:

        // check how many data series do we need to display
        pCh->prm.seriesCount = ChParseShowData(pCh->pChData);

        // set up the frame drawing
        GOLPanelDraw
        (
            pCh->hdr.left,
            pCh->hdr.top,
            pCh->hdr.right,
            pCh->hdr.bottom,
            0,
            pCh->hdr.pGolScheme->CommonBkColor,
            pCh->hdr.pGolScheme->EmbossLtColor,
            pCh->hdr.pGolScheme->EmbossDkColor,
            NULL,
            1
        );

        state = FRAME_DRAW;

    case FRAME_DRAW:
        if(!GOLPanelDrawTsk())
        {
                return (0);
            }

            state = TITLE_LABEL_DRAW_SET;

        /*===================================================================*/
        //                    Draw the Chart Title
        /*===================================================================*/
        case TITLE_LABEL_DRAW_SET:

            // find the location of the title
            MoveTo
            (
                pCh->hdr.left + ((pCh->hdr.right + pCh->hdr.left - GetTextWidth((XCHAR
*)pCh->prm.pTitle, pCh->prm.pTitleFont)) >> 1),
                pCh->hdr.top + CH_MARGIN
            );
            state = TITLE_LABEL_DRAW_RUN;

        case TITLE_LABEL_DRAW_RUN:

            // Set the font
            SetFont(pCh->prm.pTitleFont);

            // NOTE: we use the emboss dark color here to draw the chart title.
            SetColor(pCh->hdr.pGolScheme->EmbossDkColor);

            if(!OutText(pCh->prm.pTitle))
                return (0);

            // check if legend will be drawn
            if(GetState(pCh, CH_LEGEND) && (ChGetShowSeriesCount(pCh) != 1))
            {

                // position the x and y points to the start of the first variable
                temp = GetLongestNameLength(pCh);

                x = pCh->hdr.right - (CH_MARGIN << 1) - temp -
GetTextHeight(pCh->hdr.pGolScheme->pFont);
                y = ((pCh->hdr.bottom + pCh->hdr.top) >> 1) - ((pCh->prm.seriesCount *
GetTextHeight(pCh->hdr.pGolScheme->pFont)) >> 1);

                // initialize the variable counter for the legend drawing
                temp = 0;
                pVar = (DATASERIES *)pCh->pChData;
                state = LEGEND_DRAW_BOX;
            }
            else
            {

                // legend will not be drawn, go to data drawing next
                state = CHECK_CHART_TYPE;
                goto chrt_check_chart_type;
            }

            /*===================================================================*/
            //                    Draw the Legend
            /*===================================================================*/
    chrt_draw_legend:

        case LEGEND_DRAW_BOX:

            // check if we will be showing this data series
            if(ChGetShowSeriesStatus(pVar) == SHOW_DATA)
            {
                SetColor(*(&(*pCh->prm.pColor) + temp));
                if((ChGetShowSeriesCount(pCh) == 1) && (GetState(pCh, CH_PIE)))
                { }
                else
                {
                    if
                    (
                        !Bar
                            (
                                x,
                                y + (GetTextHeight(pCh->hdr.pGolScheme->pFont) >> 2),
                                x + (GetTextHeight(pCh->hdr.pGolScheme->pFont) >> 1),
                                y +
                                    (
                                        GetTextHeight(pCh->hdr.pGolScheme->pFont) -
                                            (GetTextHeight(pCh->hdr.pGolScheme->pFont) >> 2)
                                    )
                            )
                    ) return (0);
                }

                MoveTo(x + 2 + (GetTextHeight(pCh->hdr.pGolScheme->pFont) >> 1), y);
                state = LEGEND_DRAW_RUN;
            }
            else
            {
                state = LEGEND_DRAW_UPDATE_VAR;
                goto chrt_draw_legend_update;
            }

        case LEGEND_DRAW_RUN:
            SetColor(pCh->hdr.pGolScheme->TextColor1);
            SetFont(pCh->hdr.pGolScheme->pFont);

            if(!OutText(pVar->pSData))
                return (0);

            // increment the variable counter
            temp++;
            if(temp == ChGetShowSeriesCount(pCh))
            {
                state = CHECK_CHART_TYPE;
                goto chrt_check_chart_type;
            }
            else
                state = LEGEND_DRAW_UPDATE_VAR;

    chrt_draw_legend_update:

        case LEGEND_DRAW_UPDATE_VAR:

            // update the data series pointer and y position
            if(ChGetShowSeriesStatus(pVar) == SHOW_DATA)
                y += GetTextHeight(pCh->hdr.pGolScheme->pFont);
            pVar = (DATASERIES *)pVar->pNextData;
            state = LEGEND_DRAW_BOX;
            goto chrt_draw_legend;

    chrt_check_chart_type:

        case CHECK_CHART_TYPE:
            if(GetState(pCh, CH_BAR))
            {
                state = GRID_PREP;
            }
            else if(GetState(pCh, CH_PIE))
            {
                state = PIE_PREP;
                goto chrt_pie_prep;
            }
            else
            {
                state = REMOVE;
                return (1);
            }

            /*************************************************************************/
            //                    BAR CHART states
            /*************************************************************************/
```

```
            /*=====================================================================*/
            //                    Draw the grids
            /*=====================================================================*/
    chrt_grid_prep:

        case GRID_PREP:

            /* NOTE: X or Y Grid Labels - label for each division in the x or y axis
                     X or Y Axis Labels - label to name the x or y axis. Text is
                                          user given in the CHART structure,
                                          CHARTPARAM member.
            */

            // count the number of characters needed for the axis label that
            // represents the value of the samples (or bars)
            // get the width of one character
            temp = GetTextWidth((XCHAR *)tempXchar, pCh->prm.pGridLabelsFont);

            if(GetState(pCh, CH_BAR_HOR) == CH_BAR_HOR)
            {

                // if in the horizontal orientation width will only be
                // max of 2 characters (1, 2, 3...10, 11... or A, B, C...)
                if((ChGetSampleEnd(pCh) - ChGetSampleStart(pCh)) > 9)
                    y = 2;
                else
                    y = 1;
            }
            else
            {
                if(GetState(pCh, CH_PERCENT))
                {

                    // include in the computation the space that will be occupied by '%'
sign
                    y = 4;
                }
                else
                {
                    x = ChGetValueRange(pCh);
                    y = 1;

                    // count the number of characters needed
                    while(x /= 10)
                        ++y;
                }
            }

            // estimate the space that will be occupied by the y grid labels
            temp = temp * y;

            // get x starting position
            xStart = CH_MARGIN + temp + pCh->hdr.left;

            // adjust x start to accomodate Y axis label
            xStart += (GetTextHeight(pCh->prm.pAxisLabelsFont) + (GetTextWidth(temp2Xchar,
pCh->prm.pGridLabelsFont) >> 1));

            // now get y starting position
            yStart = pCh->hdr.bottom - (GetTextHeight(pCh->prm.pGridLabelsFont) +
GetTextHeight(pCh->prm.pAxisLabelsFont) + CH_MARGIN);

            // ====================================================================
            // Sample delta (splDelta) and Value delta (valDelta) will depend if the
            // chart is drawn horizontally or vertically.
            // ====================================================================
            // find the variable with the longest name
            // to add space for the names of variables in the legend
            // Text Height here refers to the legend for colors (the drawn filled rectangle)
            if((ChGetShowSeriesCount(pCh) == 1) || (GetState(pCh, CH_LEGEND) != CH_LEGEND))
                temp = 0;
            else
                temp = GetLongestNameLength(pCh) +
GetTextHeight(pCh->hdr.pGolScheme->pFont);

            // get sample delta (space between data) and value delta (defines the grid for
the value)
            // check first if we compute in the x-axis or y-axis
            if(GetState(pCh, CH_BAR_HOR) == CH_BAR_HOR)
            {

                // if horizontally drawn sample delta is not affected by the legend
                splDelta = (yStart - (pCh->hdr.top + CH_MARGIN +
GetTextHeight(pCh->prm.pTitleFont)));

                // adjust space for displayed values
                if(GetState(pCh, CH_VALUE))
                {
                    temp += (GetTextWidth(tempXchar, pCh->hdr.pGolScheme->pFont) * 4);
                }

                // get the value delta,
                valDelta = (pCh->hdr.right - xStart - CH_MARGIN - temp);
            }
            else
            {
                if(GetState(pCh, CH_LEGEND) && (ChGetShowSeriesCount(pCh) != 1))
                {
                    splDelta =
                        (
                            pCh->hdr.right -
                            xStart -
                            ((CH_MARGIN << 2) + temp +
GetTextHeight(pCh->hdr.pGolScheme->pFont))
                        );
                }
                else
                {
                    splDelta = (pCh->hdr.right - xStart - (CH_MARGIN << 2));
                }

                // get the value delta
                valDelta =
                    (
                        yStart -
                        (pCh->hdr.top + CH_MARGIN + GetTextHeight(pCh->prm.pTitleFont) +
GetTextHeight(pCh->hdr.pGolScheme->pFont))
                    );
            }

            // adjust the splDelta for 3D effects, 12 here is the maximum depth of a bar
for the 3D effect
            if(GetState(pCh, CH_3D_ENABLE))
            {
                splDelta -= 12;
                valDelta -= 12;
            }

            // get the final splDelta value by checking the number of samples to
display
            splDelta /= (ChGetSampleRange(pCh) + 1);

            // get the final valDelta value by checking the number of samples to
display
            valDelta /= (CH_YGRIDCOUNT - 1);

            // initilize the counter for the sample axis drawing
            temp = ChGetSampleRange(pCh) + 2;
            x = xStart;
            y = yStart;
            state = SAMPLE_GRID_DRAW1;

        case SAMPLE_GRID_DRAW1:
            // draw the small grids on the x-axis
            while(temp)
            {
                SetColor(pCh->hdr.pGolScheme->Color0);
                if(GetState(pCh, CH_BAR_HOR) == CH_BAR_HOR)
                {
                    if(!Bar(x, y, x + 3, y + 1))
                        return (0);
                    y -= splDelta;
                }
                else
                {
                    if(!Bar(x, y, x + 1, y + 3))
                        return (0);
                    x += splDelta;
                }

                --temp;
            }

            // get the bar width (bar here refers to the sample data represented as bars,
where the height
            // of the bar represents the value of the sample)
            barWidth = splDelta / (2 + ChGetShowSeriesCount(pCh));

            temp = CH_YGRIDCOUNT;
            if(GetState(pCh, CH_BAR_HOR) == CH_BAR_HOR)
                y = yStart;
            else
                x = xStart;

            if(GetState(pCh, CH_3D_ENABLE))
            {

                // limit the 3-D depth to only 12 pixels.
                chart3DDepth = (barWidth > 12) ? 12 : barWidth;
                chart3DDepth = chart3DDepth >> 1;

                // set the bar 3-D depth.
                barDepth = chart3DDepth;
                state = VALUE_GRID_3D_DRAW;
            }
            else
            {
                state = VALUE_GRID_DRAW1;
                goto chrt_value_grid_draw1;
            }

        case VALUE_GRID_3D_DRAW:

            // draw the 3D grids on the value-axis
            while(temp)
            {
                SetColor(pCh->hdr.pGolScheme->Color0);
                if(GetState(pCh, CH_BAR_HOR) == CH_BAR_HOR)
                {
                    if
                    (
                        !Bar
                        (
                            x + (chart3DDepth),
                            y - (chart3DDepth) - (splDelta * (ChGetSampleRange(pCh) +
1)),
                            x + (chart3DDepth),
                            y - (chart3DDepth)
                        )
                    ) return (0);
                    x += valDelta;
                }
                else
                {
                    if
                    (
                        !Bar
                            (
                                x + (chart3DDepth),
                                y - (chart3DDepth),
                                x + (chart3DDepth) + (splDelta * (ChGetSampleRange(pCh) +
  1)),
                                y - (chart3DDepth)
                            )
                    ) return (0);
                    y -= valDelta;
                }

                --temp;
            }

            temp = CH_YGRIDCOUNT;
            x = xStart;
            y = yStart;
            state = VALUE_GRID_DRAW1;

    chrt_value_grid_draw1:

        case VALUE_GRID_DRAW1:

            // draw the grids on the y-axis
            if(GetState(pCh, CH_3D_ENABLE))
            {

                // just draw the first one to define the x-axis
                SetColor(pCh->hdr.pGolScheme->Color0);
                if(GetState(pCh, CH_BAR_HOR) == CH_BAR_HOR)
                {
                    if(!Bar(x, y - (splDelta * (ChGetSampleRange(pCh) + 1)), x, y))
                        return (0);
                }
                else
                {
                    if(!Bar(x, y, x + (splDelta * (ChGetSampleRange(pCh) + 1)), y))
                        return (0);
                }
            }
            else
            {
                while(temp)
                {
                    SetColor(pCh->hdr.pGolScheme->Color0);
                    if(GetState(pCh, CH_BAR_HOR) == CH_BAR_HOR)
                    {
                        if(!Bar(x, y - (splDelta * (ChGetSampleRange(pCh) + 1)), x, y))
                            return (0);
                        x += valDelta;
                    }
                    else
                    {
                        if(!Bar(x, y, x + (splDelta * (ChGetSampleRange(pCh) + 1)), y))
                            return (0);
                        y -= valDelta;
                    }

                    --temp;
                }
            }

            if(GetState(pCh, CH_BAR_HOR) == CH_BAR_HOR)
            {
                x = xStart;
            }
            else
            {
                y = yStart;
            }

            if(GetState(pCh, CH_3D_ENABLE))
            {
                temp = CH_YGRIDCOUNT + 1;
                state = VALUE_GRID_DRAW2;
            }
            else
            {
                temp = 2;
                state = SAMPLE_GRID_DRAW2;
                goto chrt_xgrid_draw2;
            }

        case VALUE_GRID_DRAW2:

            // draw the 3-D effect on the y axis of the chart
            SetColor(pCh->hdr.pGolScheme->Color0);
            while(temp)
            {
                if(temp == (CH_YGRIDCOUNT + 1))
                {
                    if(GetState(pCh, CH_BAR_HOR) == CH_BAR_HOR)
                    {
                        if
                        (
                            !Line
                                (
                                    x,
                                    y - (splDelta * (ChGetSampleRange(pCh) + 1)),
                                    x + chart3DDepth,
                                    y - (splDelta * (ChGetSampleRange(pCh) + 1)) -
  chart3DDepth
                                )
                        ) return (0);
                    }
                    else
                    {
                        if
                        (
                            !Line
                                (
                                    x + (splDelta * (ChGetSampleRange(pCh) + 1)),
                                    y,
                                    x + (chart3DDepth) + (splDelta * (ChGetSampleRange(pCh)
  + 1)),
                                    y - chart3DDepth
                                )
                        ) return (0);
                    }

                    --temp;
                    continue;
                }
                else if(!Line(x, y, x + chart3DDepth, y - chart3DDepth))
                    return (0);

                if(GetState(pCh, CH_BAR_HOR) == CH_BAR_HOR)
                {
                    x += valDelta;
                }
                else
                {
                    y -= valDelta;
                }

                --temp;
            }

            temp = 3;
            if(GetState(pCh, CH_BAR_HOR) == CH_BAR_HOR)
            {
                x = xStart;
            }
            else
            {
                y = yStart;
            }

            state = SAMPLE_GRID_DRAW2;

      chrt_xgrid_draw2:

        case SAMPLE_GRID_DRAW2:

            // draw the left and right edges of the chart
            while(temp)
            {
                if(GetState(pCh, CH_3D_ENABLE))
                {
                    if(temp == 3)
                    {
                        if(GetState(pCh, CH_BAR_HOR) == CH_BAR_HOR)
                        {
                            if(!Bar(x, y, x + ((CH_YGRIDCOUNT - 1) * valDelta), y))
                                return (0);
                        }
                        else
                        {
                            if(!Bar(x, y - ((CH_YGRIDCOUNT - 1) * valDelta), x, y))
                                return (0);
                        }

                        --temp;
                        continue;
                    }
                    else if(GetState(pCh, CH_BAR_HOR) == CH_BAR_HOR)
                    {
                        if
                        (
                            !Bar
                                (
                                    x + chart3DDepth,
                                    y - chart3DDepth,
                                    x + chart3DDepth + ((CH_YGRIDCOUNT - 1) * valDelta),
                                    y - chart3DDepth
                                )
                        ) return (0);
                    }
                    else
                    {
                        if
                        (
                            !Bar
                                (
                                    x + chart3DDepth,
                                    y - ((CH_YGRIDCOUNT - 1) * valDelta) - chart3DDepth,
                                    x + chart3DDepth,
                                    y - chart3DDepth
                                )
                        ) return (0);
                    }
                }
                else
                {
                    if(GetState(pCh, CH_BAR_HOR) == CH_BAR_HOR)
                    {
                        if(!Bar(x, y, x + ((CH_YGRIDCOUNT - 1) * valDelta), y))
                            return (0);
                    }
                    else
                    {
                        if(!Bar(x, y - ((CH_YGRIDCOUNT - 1) * valDelta), x, y))
                            return (0);
                    }
                }

                if(GetState(pCh, CH_BAR_HOR) == CH_BAR_HOR)
                {
                    y -= (splDelta * (ChGetSampleRange(pCh) + 1));
                }
                else
                {
                    x += (splDelta * (ChGetSampleRange(pCh) + 1));
                }

                --temp;
            }

            if(GetState(pCh, CH_BAR_HOR) == CH_BAR_HOR)
                    #ifdef USE_HORZ_ASCENDING_ORDER
                y = yStart - (ChGetSampleRange(pCh) * splDelta);
                #else
            y = yStart;
                #endif
            else
                x = xStart;
            ctr = ChGetSampleStart(pCh);

            state = SAMPLE_LABEL_DRAW_SET;

            /*=========================================================================*/
            //                    Draw the Sample Grid labels
            /*=========================================================================*/
    chrt_sample_label_draw_set:

        case SAMPLE_LABEL_DRAW_SET:

            // for data only redraw, we need to refresh the x-axis labels to indicate
            // the correct sample points being shown
            SetFont(pCh->prm.pGridLabelsFont);

            if(GetState(pCh, CH_NUMERIC))
            {
                j = word2xchar(ctr, tempStr, STR_CHAR_CNT);
            }
            else
            {

                // note that we will only have A-Z labels.
                tempStr[STR_CHAR_CNT - 1] = 'A' + (ctr - 1);
                j = 1;
            }

            temp = GetTextWidth((&tempStr[STR_CHAR_CNT - j]), pCh->prm.pGridLabelsFont);
            if(GetState(pCh, CH_BAR_HOR) == CH_BAR_HOR)
            {
                MoveTo(x - temp, y - ((splDelta + GetTextHeight(pCh->prm.pGridLabelsFont))
>> 1));
            }
            else
            {
                MoveTo(x + ((splDelta - temp) >> 1), y);
            }

            state = SAMPLE_LABEL_DRAW_RUN;

        case SAMPLE_LABEL_DRAW_RUN:

            // draw the x axis grid numbers
            SetColor(pCh->hdr.pGolScheme->TextColor0);
            if(!OutText(&tempStr[STR_CHAR_CNT - j]))
                return (0);
            if(GetState(pCh, CH_BAR_HOR) == CH_BAR_HOR)
            {
                    #ifdef USE_HORZ_ASCENDING_ORDER
                y += splDelta;
                    #else
                y -= splDelta;
                    #endif
            }
            else
            {
                x += splDelta;
            }

            ctr++;
            if(ctr > ChGetSampleEnd(pCh))
            {

                // check if we only need to redraw the data
                if(GetState(pCh, CH_DRAW_DATA))
                {
                    state = DATA_DRAW_INIT;
                    goto chrt_data_draw_init;
                }
                else
                {
                    if(GetState(pCh, CH_BAR_HOR) == CH_BAR_HOR)
                    {
                        state = YAXIS_LABEL_DRAW_SET;
                        goto chrt_yaxis_label_draw_set;
                    }
                    else
                    {
                        state = XAXIS_LABEL_DRAW_SET;
                    }
                }
            }
            else
            {
                temp = x;
                goto chrt_sample_label_draw_set;
            }

            /*=====================================================================*/
            //                    Draw the X - Axis labels
            /*=====================================================================*/
        chrt_xaxis_label_draw_set:

        case XAXIS_LABEL_DRAW_SET:

            // find the location of the label
            if(GetState(pCh, CH_BAR_HOR) == CH_BAR_HOR)
            {
                pXcharTemp = pCh->prm.pValLabel;
                uLocator = valDelta * (CH_YGRIDCOUNT - 1);
            }
            else
            {
                pXcharTemp = pCh->prm.pSmplLabel;
                uLocator = splDelta * (ChGetSampleRange(pCh) + 1);
            }

            temp = GetTextWidth(pXcharTemp, pCh->prm.pAxisLabelsFont);

            if(temp > uLocator)
                temp = xStart;
            else
                temp = xStart + ((uLocator - temp) >> 1);

            MoveTo(temp, yStart + GetTextHeight(pCh->prm.pGridLabelsFont));
            state = XAXIS_LABEL_DRAW_RUN;

        case XAXIS_LABEL_DRAW_RUN:
            SetFont(pCh->prm.pAxisLabelsFont);

            // enable clipping and set region
            SetClip(CLIP_ENABLE);
            SetClipRgn(pCh->hdr.left, pCh->hdr.top, pCh->hdr.right, pCh->hdr.bottom);

            SetColor(pCh->hdr.pGolScheme->TextColor1);
            if(!OutText(pXcharTemp))
                return (0);

            SetClip(CLIP_DISABLE);
            if(GetState(pCh, CH_BAR_HOR) == CH_BAR_HOR)
            {
                state = DATA_DRAW_INIT;
                goto chrt_data_draw_init;
            }
            else
            {
                state = VALUE_LABEL_DRAW_INIT;
            }

    chrt_value_label_draw_init:

        case VALUE_LABEL_DRAW_INIT:
            ctr = 0;

            // x is used here to represent change in value grid labels
            // Note that we add a multiplier of 10 to compute for round off errors.
            // It will not be perfect but approximations is better unless you work with
            // figures divisible by 5.
            if(GetState(pCh, CH_PERCENT))
            {

                // Scaling of the labels is included here
                x = ChGetPercentRange(pCh) * 100 / (CH_YGRIDCOUNT - 1);
            }
            else
            {
                x = (ChGetValueRange(pCh) * 100) / (CH_YGRIDCOUNT - 1);
            }

            // compute for round off error, the adjustment for the factor 100 is done in
            // conversion of the integer to string below.
            if((x % 10) < 5)
                x += 10;

            state = VALUE_LABEL_DRAW_SET;

            /*=======================================================================*/
            //                    Draw the Value Grid labels
            /*=======================================================================*/
    chrt_value_label_draw_set:

        case VALUE_LABEL_DRAW_SET:

            // note that the adjustment of the 100 factor is done here.
            if(GetState(pCh, CH_PERCENT))
            {

                // add the percent sign on the label
                tempStr[STR_CHAR_CNT - 1] = '%';

                // we have a plus 1 here since we add '%' sign already
                j = 1 + word2xchar((ctr * x / 100) + ChGetPercentMin(pCh), tempStr,
STR_CHAR_CNT - 1);
            }
            else
            {
                j = word2xchar((ctr * x / 100) + ChGetValueMin(pCh), tempStr, STR_CHAR_CNT);
            }

            if(GetState(pCh, CH_BAR_HOR) == CH_BAR_HOR)
            {
                temp = GetTextWidth((&tempStr[STR_CHAR_CNT - j]), pCh->prm.pGridLabelsFont);
                MoveTo(xStart + ((valDelta * ctr) - (temp >> 1)), yStart);
            }
            else
            {
                temp = GetTextHeight(pCh->prm.pGridLabelsFont);
                MoveTo
                (
                    xStart - GetTextWidth((&tempStr[STR_CHAR_CNT - j]),
  pCh->prm.pGridLabelsFont),
                    yStart - ((valDelta * ctr) + (temp >> 1))
                );
            }

            SetFont(pCh->prm.pGridLabelsFont);
            state = VALUE_LABEL_DRAW_RUN;

        case VALUE_LABEL_DRAW_RUN:

            // draw the y axis grid numbers
            SetColor(pCh->hdr.pGolScheme->TextColor0);
            if(!OutText(&tempStr[STR_CHAR_CNT - j]))
                return (0);
            ctr++;
            if(ctr >= CH_YGRIDCOUNT)
            {
                state = XAXIS_LABEL_DRAW_SET;
            }
            else
            {
                goto chrt_value_label_draw_set;
            }

            if(GetState(pCh, CH_BAR_HOR) == CH_BAR_HOR)
            {
                state = XAXIS_LABEL_DRAW_SET;
                goto chrt_xaxis_label_draw_set;
            }
            else
            {
                state = YAXIS_LABEL_DRAW_SET;
            }

            /*====================================================================*/
            //                    Draw the Y - Axis labels
            /*====================================================================*/
    chrt_yaxis_label_draw_set:

        case YAXIS_LABEL_DRAW_SET:

            // find the location of the label
            if(GetState(pCh, CH_BAR_HOR) == CH_BAR_HOR)
            {
                pXcharTemp = pCh->prm.pSmplLabel;
                uLocator = splDelta * (ChGetSampleRange(pCh) + 1);
            }
            else
            {
                pXcharTemp = pCh->prm.pValLabel;
                uLocator = valDelta * CH_YGRIDCOUNT;
            }

            temp = GetTextWidth(pXcharTemp, pCh->prm.pAxisLabelsFont);

            if(temp > uLocator)
                temp = (pCh->hdr.bottom + pCh->hdr.top + temp) >> 1;
            else
            {
                temp = yStart - ((uLocator - temp) >> 1);
            }

            MoveTo
            (
                xStart - GetTextWidth((&tempStr[STR_CHAR_CNT - j]),
pCh->prm.pGridLabelsFont) - (GetTextWidth(temp2Xchar, pCh->prm.pGridLabelsFont) >> 1) -
GetTextHeight(pCh->prm.pAxisLabelsFont),
                temp
            );

            state = YAXIS_LABEL_DRAW_RUN;

        case YAXIS_LABEL_DRAW_RUN:
            SetFont(pCh->prm.pAxisLabelsFont);

            // enable clipping and set region
            SetClip(CLIP_ENABLE);
            SetClipRgn(pCh->hdr.left, pCh->hdr.top, pCh->hdr.right, pCh->hdr.bottom);

            // set the orientation of text to vertical
            SetFontOrientation(ORIENT_VER);
            SetColor(pCh->hdr.pGolScheme->TextColor1);
            if(!OutText(pXcharTemp))
                return (0);

            SetClip(CLIP_DISABLE);

            // place back the orientation of text to horizontal
            SetFontOrientation(ORIENT_HOR);

            if(GetState(pCh, CH_BAR_HOR) == CH_BAR_HOR)
            {
                state = VALUE_LABEL_DRAW_INIT;
                goto chrt_value_label_draw_init;
            }
            else
            {
                state = DATA_DRAW_INIT;
            }

            /*=========================================================================*/
            //                    Draw the bars representing the data/samples
            /*=========================================================================*/
    chrt_data_draw_init:

        case DATA_DRAW_INIT:

            /* pSmple - points to the sample data of the variables
               ctr - the sample counter
               varCtr - variable counter
               temp - the width of the bars
               dTemp - the height of the bars
               x or y - the location of the first bar per sample. For single variables
                   there will be only one bar per sample. x for vertical bars and y for
horizontal bars.
            */
            ctr = 0;
            temp = splDelta / (2 + ChGetShowSeriesCount(pCh));  // <---- note this! this
can be used to calculate the minimum size limit of the chart
            state = DATA_DRAW_SET;

    chrt_data_draw_set:

        case DATA_DRAW_SET:
            varCtr = 0;

            pVar = ChGetNextShowData(pCh->pChData);

            // set the position to start bar drawing
            // x and y here are used in horizontal drawing and vertical drawing as the
variable
            // that refers to the position of the bar being drawn.
            if(GetState(pCh, CH_BAR_HOR) == CH_BAR_HOR)
            {
                    #ifdef USE_HORZ_ASCENDING_ORDER
                y = yStart - temp - ((ChGetSampleRange(pCh) - ctr) * splDelta);
```

```
                    #else
                y = yStart - (ctr * splDelta) - temp;
                    #endif
            }
            else
            {
                x = xStart + (ctr * splDelta) + temp;
            }

            state = BAR_DATA_DRAW;

    chrt_data_draw:

        case BAR_DATA_DRAW:

            // get sample data from current variable
            pSmple = (&(*pVar->pData) + (ctr + ChGetSampleStart(pCh) - 1));

            // calculate the total value of the samples to compute the percentages
            if(GetState(pCh, CH_PERCENT))
            {
                j = ChGetSampleStart(pCh);
                samplesMax = 0;

                while(j <= (ChGetSampleRange(pCh) + ChGetSampleStart(pCh)))
                {
                    samplesMax += (*(&(*pVar->pData) + (j - 1)));
                    j++;
                }

                // Get the percentage of the sample
                dTemp = ((DWORD) (*pSmple) * 100) / samplesMax;

                // check if scaling is needed
                if(ChGetPercentMax(pCh) <= dTemp)
                    dTemp = ChGetPercentRange(pCh);
                else
                {
                    if(dTemp < ChGetPercentMin(pCh))
                        dTemp = 0;
                    else
                        dTemp = dTemp - ChGetPercentMin(pCh);
                }

                dTemp = ((DWORD) (dTemp) * (valDelta * (CH_YGRIDCOUNT - 1))) /
(ChGetPercentRange(pCh));
            }
            else
            {

                // get the height of the current bar to draw
                // this should be adjusted to the min and max set values
                if(ChGetValueMax(pCh) <= (*pSmple))
                {
                    dTemp = ChGetValueRange(pCh);
                }
                else
                {
                    if((*pSmple) < ChGetValueMin(pCh))
                        dTemp = 0;
                    else
                        dTemp = (*pSmple) - ChGetValueMin(pCh);
                }

                dTemp = ((DWORD) (dTemp) * (valDelta * (CH_YGRIDCOUNT - 1)) /
ChGetValueRange(pCh));
            }

            // draw the front side of the bar
            if(ChGetShowSeriesCount(pCh) > 1)
            {
                SetColor(*(&(*pCh->prm.pColor) + varCtr));
            }
            else
            {
                SetColor(*(&(*pCh->prm.pColor) + ctr));
            }

            if(GetState(pCh, CH_3D_ENABLE))
            {
                if(GetState(pCh, CH_BAR_HOR) == CH_BAR_HOR)
                {
                    if(!Bar(xStart, y - (temp * (varCtr + 1)), xStart + dTemp, y - (temp *
  varCtr)))
                        return (0);
                }
                else
                {
                    if(!Bar(x + 1 + 1 + (temp * varCtr), yStart - dTemp, x + (temp *
  (varCtr + 1)), yStart))
                        return (0);
                }

                state = BAR_DATA_DRAW_3D_PREP;
            }
            else
            {
                if(GetState(pCh, CH_BAR_HOR) == CH_BAR_HOR)
                {
                    if(!Bar(xStart, y - (temp * (varCtr + 1)), xStart + dTemp, y - 1 -
  (temp * varCtr)))
                        return (0);
                }
                else
                {
                    if(!Bar(x + 1 + (temp * varCtr), yStart - dTemp, x + (temp * (varCtr +
  1)), yStart))
                        return (0);
                }

                if((GetState(pCh, CH_VALUE)) || (GetState(pCh, CH_PERCENT)))
                {
                    state = BAR_DATA_DRAW_VALUE;
                    goto chrt_bar_data_draw_value;
                }
                else
                {
                    state = BAR_DATA_DRAW_CHECK;
                    goto chrt_bar_data_draw_check;
                }
            }

        case BAR_DATA_DRAW_3D_PREP:

            // draw the 3-D component
            // draw the 45 degree lines
            // we will use y here as the variable to move the line drawn
            if(GetState(pCh, CH_BAR_HOR) == CH_BAR_HOR)
            {
                z = y;
                x = xStart + dTemp;
            }
            else
            {
                z = x + 1;
                y = yStart - dTemp;
            }

            state = BAR_DATA_DRAW_3D_LOOP_1;

    chrt_bar_data_draw_3d_loop_1:

        case BAR_DATA_DRAW_3D_LOOP_1:
            if(GetState(pCh, CH_BAR_HOR) == CH_BAR_HOR)
            {
                if(x <= xStart + dTemp + barDepth)
                {
                    if((x == (xStart + dTemp)) || (x == (xStart + dTemp + barDepth)))
                    {
                        SetColor(BLACK);
                    }
                    else
                    {
                        if(ChGetShowSeriesCount(pCh) > 1)
                        {
                            SetColor(GetColorShade(*(&(*pCh->prm.pColor) + varCtr), 2));
                        }
                        else
                        {
                            SetColor(GetColorShade(*(&(*pCh->prm.pColor) + ctr), 2));
                        }
                    }

                    if(!Bar(x, z - (temp * (varCtr + 1)), x, z - (temp * varCtr)))
                        return (0);

                    state = BAR_DATA_DRAW_3D_LOOP_2;
                }
                else
                {
                    state = BAR_DATA_DRAW_3D_OUTLINE1;
                    goto chrt_bar_data_draw_3d_outline_1;
                }
            }
            else
            {
                if(y >= yStart - dTemp - barDepth)
                {
                    if((y == (yStart - dTemp)) || (y == (yStart - dTemp - barDepth)))
                    {
                        SetColor(BLACK);
                    }
                    else
                    {
                        if(ChGetShowSeriesCount(pCh) > 1)
                        {
                            SetColor(GetColorShade(*(&(*pCh->prm.pColor) + varCtr), 2));
                        }
                        else
                        {
                            SetColor(GetColorShade(*(&(*pCh->prm.pColor) + ctr), 2));
                        }
                    }

                    if(!Bar(z + 1 + (temp * varCtr), y, z - 1 + (temp * (varCtr + 1)), y))
                        return (0);

                    state = BAR_DATA_DRAW_3D_LOOP_2;
                }
                else
                {
                    state = BAR_DATA_DRAW_3D_OUTLINE1;
                    goto chrt_bar_data_draw_3d_outline_1;
                }
            }

        case BAR_DATA_DRAW_3D_LOOP_2:

            // check if we are going to draw the outline or the shade
            if(GetState(pCh, CH_BAR_HOR) == CH_BAR_HOR)
            {
                if((x == (xStart + dTemp)) || (x == (xStart + dTemp + barDepth)))
                {
                    SetColor(BLACK);
                }
                else
```

```
                  {
                      if(ChGetShowSeriesCount(pCh) > 1)
                      {
                          SetColor(GetColorShade(*(&(*pCh->prm.pColor) + varCtr), 1));
                      }
                      else
                      {
                          SetColor(GetColorShade(*(&(*pCh->prm.pColor) + ctr), 1));
                      }
                  }
              }
              else
              {
                  if((y == (yStart - dTemp)) || (y == (yStart - dTemp - barDepth)))
                  {
                      SetColor(BLACK);
                  }
                  else
                  {
                      if(ChGetShowSeriesCount(pCh) > 1)
                      {
                          SetColor(GetColorShade(*(&(*pCh->prm.pColor) + varCtr), 1));
                      }
                      else
                      {
                          SetColor(GetColorShade(*(&(*pCh->prm.pColor) + ctr), 1));
                      }
                  }
              }

              // draw the outline or shade
              if(GetState(pCh, CH_BAR_HOR) == CH_BAR_HOR)
              {
                  if(!Bar(x - dTemp, z - (temp * (varCtr + 1)), x, z - (temp * (varCtr + 1))))
                      return (0);
              }
              else
              {
                  if(!Bar(z + (temp * (varCtr + 1)), y, z + (temp * (varCtr + 1)), y + dTemp))
                      return (0);
              }

              // update the loop variables
              if(GetState(pCh, CH_BAR_HOR) == CH_BAR_HOR)
              {
                  x++;
                  z--;
              }
              else
              {
                  y--;
                  z++;
              }

              state = BAR_DATA_DRAW_3D_LOOP_1;
              goto chrt_bar_data_draw_3d_loop_1;

      chrt_bar_data_draw_3d_outline_1:

          case BAR_DATA_DRAW_3D_OUTLINE1:
              SetColor(BLACK);

              if(GetState(pCh, CH_BAR_HOR) == CH_BAR_HOR)
              {
                  if(!Line(x - 1, y - (temp * varCtr) - barDepth, x - 1 - barDepth, y - (temp
  * varCtr)))
                      return (0);
              }
              else
              {
                  if
                  (
                      !Line
                          (
                              x + 1 + (temp * varCtr),
                              yStart - dTemp,
                              x + 1 + (temp * varCtr) + barDepth,
                              yStart - dTemp - barDepth
                          )
                  ) return (0);
              }

              state = BAR_DATA_DRAW_3D_OUTLINE2;

          case BAR_DATA_DRAW_3D_OUTLINE2:
              if(GetState(pCh, CH_BAR_HOR) == CH_BAR_HOR)
              {
                  if(!Line(x - 1, y - (temp * (varCtr + 1)) - barDepth, x - 1 - barDepth, y -
  (temp * (varCtr + 1))))
                      return (0);
              }
              else
              {
                  if
                  (
                      !Line
                          (
                              x + 1 + (temp * (varCtr + 1)),
                              (yStart - dTemp),
                              x + 1 + (temp * (varCtr + 1)) + barDepth,
                              (yStart - dTemp) - barDepth
                          )
                  ) return (0);
              }

              state = BAR_DATA_DRAW_3D_OUTLINE3;

          case BAR_DATA_DRAW_3D_OUTLINE3:
              if(GetState(pCh, CH_BAR_HOR) == CH_BAR_HOR)
              {
                  if
                  (
                      !Line
                          (
                              x - dTemp - 1,
                              y - (temp * (varCtr + 1)) - barDepth,
                              x - dTemp - barDepth - 1,
                              y - (temp * (varCtr + 1))
                          )
                  ) return (0);
              }
              else
              {
                  if
                  (
                      !Line
                          (
                              x + 1 + (temp * (varCtr + 1)),
                              yStart,
                              x + 1 + (temp * (varCtr + 1)) + barDepth,
                              yStart - barDepth
                          )
                  ) return (0);
              }

              state = BAR_DATA_DRAW_3D_OUTLINE4;

          case BAR_DATA_DRAW_3D_OUTLINE4:
              if(GetState(pCh, CH_BAR_HOR) == CH_BAR_HOR)
              {
                  if
                  (
                      !Bar
                          (
                              x - dTemp - barDepth - 1,
                              y - (temp * (varCtr + 1)),
                              x - dTemp - barDepth - 1,
                              y - (temp * (varCtr + 1)) + temp
                          )
                  ) return (0);
              }
              else
              {
                  if(!Bar(x + 1 + (temp * varCtr), yStart - dTemp, x + 1 + (temp * varCtr),
  yStart))
                      return (0);
              }

              state = BAR_DATA_DRAW_3D_OUTLINE5;

          case BAR_DATA_DRAW_3D_OUTLINE5:

              // draw the horizontal lines
              if(GetState(pCh, CH_BAR_HOR) == CH_BAR_HOR)
              {
                  if
                  (
                      !Bar
                          (
                              x - dTemp - barDepth - 1,
                              y - (temp * (varCtr + 1)) + temp,
                              x - barDepth - 1,
                              y - (temp * (varCtr + 1)) + temp
                          )
                  ) return (0);
              }
              else
              {
                  if(!Bar(x + 1 + (temp * varCtr), yStart, x + 1 + (temp * (varCtr + 1)),
  yStart))
                      return (0);
              }

              if((GetState(pCh, CH_VALUE)) || (GetState(pCh, CH_PERCENT)))
                  state = BAR_DATA_DRAW_VALUE;
              else
              {
                  state = BAR_DATA_DRAW_CHECK;
                  goto chrt_bar_data_draw_check;
              }

      chrt_bar_data_draw_value:

          case BAR_DATA_DRAW_VALUE:
              if(GetState(pCh, CH_VALUE))
              {
                  j = word2xchar(*pSmple, tempStr, STR_CHAR_CNT);
              }
              else
              {

                  // add the percent sign on the label
                  tempStr[STR_CHAR_CNT - 1] = '%';

                  // compute for the percentage
                  if(ChGetValueMax(pCh) <= (*pSmple))
                      dPercent = ChGetValueRange(pCh);
                  else
                  {
                      if((*pSmple) < ChGetValueMin(pCh))
                          dPercent = 0;
                      else
                          dPercent = (*pSmple) - ChGetValueMin(pCh);
                  }

                  dPercent = ((DWORD) (dPercent * 1000)) / samplesMax;
                  // check if we need to round up or not
                  if((dPercent % 10) < 5)
                      dPercent = (dPercent / 10);                 // do not round up to next
  number
                  else
                      dPercent = (dPercent / 10) + 1;             // round up the value

                  // we have a plus 1 here since we add '%' sign already
                  j = 1 + word2xchar(dPercent, tempStr, STR_CHAR_CNT - 1);
              }

              if(GetState(pCh, CH_3D_ENABLE))
              {
                  if(GetState(pCh, CH_BAR_HOR) == CH_BAR_HOR)
                  {
                      MoveTo
                      (
                          xStart + dTemp + barDepth + 3,
                          y - (temp * varCtr) - ((temp +
  GetTextHeight(pCh->hdr.pGolScheme->pFont)) >> 1) - barDepth
                      );
                  }
                  else
                  {
                      MoveTo
                      (
                          x + barDepth + (temp * varCtr) + (temp >> 1) -
  (GetTextWidth(&tempStr[STR_CHAR_CNT - j], pCh->hdr.pGolScheme->pFont) >> 1),
                          (yStart - 1) - dTemp - GetTextHeight(pCh->hdr.pGolScheme->pFont) -
  (barDepth)
                      );
                  }
              }
              else
              {
                  if(GetState(pCh, CH_BAR_HOR) == CH_BAR_HOR)
                  {
                      MoveTo
                      (
                          xStart + dTemp + 3,
                          y - (temp * varCtr) - (temp >> 1) -
  (GetTextHeight(pCh->hdr.pGolScheme->pFont) >> 1)
                      );
                  }
                  else
                  {
                      MoveTo
                      (
                          x +
                              ((temp >> 1) - (GetTextWidth(&tempStr[STR_CHAR_CNT - j],
  pCh->hdr.pGolScheme->pFont) >> 1)) +
                              (temp * varCtr),
                          (yStart - 1) - dTemp - (GetTextHeight(pCh->hdr.pGolScheme->pFont))
                      );
                  }
              }

              state = BAR_DATA_DRAW_VALUE_RUN;

          case BAR_DATA_DRAW_VALUE_RUN:

              // draw the values on top of the bars
              // NOTE: we use the emboss light color here to draw the values.
              SetColor(pCh->hdr.pGolScheme->EmbossLtColor);
              SetFont(pCh->hdr.pGolScheme->pFont);
              if(!OutText(&tempStr[STR_CHAR_CNT - j]))
                  return (0);
              state = BAR_DATA_DRAW_CHECK;

      chrt_bar_data_draw_check:
          case BAR_DATA_DRAW_CHECK:

              // find the next data series that will be shown
              pVar = ChGetNextShowData(pVar);
              if(pVar == NULL)
              {
                  state = REMOVE;
                  return (1);
              }

              // increment the variable counter
              varCtr++;
              if(varCtr < ChGetShowSeriesCount(pCh))
              {
                  pVar = (DATASERIES *)pVar->pNextData;
                  state = BAR_DATA_DRAW;
                  goto chrt_data_draw;
              }

              // increment the sample counter
              ctr++;
              if(ctr < ChGetSampleRange(pCh) + 1)
              {
                  x += (splDelta + 1);
                  state = DATA_DRAW_SET;
                  goto chrt_data_draw_set;
              }

              state = REMOVE;
              return (1);

              /***************************************************************************/
              //                  PIE CHART states
              /***************************************************************************/

              /*=========================================================================*/
              //                    Draw the pie
              /*=========================================================================*/
      chrt_pie_prep:

          case PIE_PREP:

              /* If more than two data series have their SHOW_DATA flag set
                 the pie chart is drawn to represent the values of each variable
                 at Start sample point . End sample point is ignored in this case.
                 If only one data series is set to be shown the pie chart is drawn
                 from the sample start point and sample end point (inclusive).

                 Pie chart is drawn as a percentage of the data samples.
                 Therefore: percentage is computed depending on the sample
                 points used.
                 Only 1 data series is set to be shown
                   total =    summation of the variable sample points from
                              sample start point to sample end point inclusive.
                 More than 1 data series is set to be shown
                   total =    summation of the sample points for each variable
                              using the sample start point.
              */

              /* For PIE chart variables used are the following
                  ctr = x position of the center of the pie chart
                  ctry = y position of the center of the pie chart
                  z   = radius of the pie chart
                  j   = start angle
                  k   = end angle
              */

              // calculate the needed variables
              // radius z is affected by the following: CH_LEGEND, CH_VALUE and CH_PERCENT
              temp = CH_MARGIN << 1;

              // check the largest/longest sample
              // use x here as a counter
              varCtr = ChGetShowSeriesCount(pCh);
              if(varCtr == 1)
              {
                  varCtr = ChGetSampleRange(pCh) + 1;
              }

              pVar = ChGetNextShowData(pCh->pChData);

              // y and z is used here as a temporary variable
              y = 0;

              // find the sample value that is largest (place in y)
              // also while doing this get the total of the selected data (put in dTemp)
              dTemp = 0;
              while(varCtr >= 0)
              {
                  if(ChGetShowSeriesCount(pCh) > 1)
                  {
                      z = *(&(*pVar->pData) + ChGetSampleStart(pCh) - 1);
                  }
                  else
                  {
                      z = *(&(*pVar->pData) + ChGetSampleEnd(pCh) - varCtr);
                  }

                  dTemp += z;
                  varCtr--;

                  // check if we get a larger value
                  if(z > y)
                      y = z;
                  if(varCtr == 0)
                      break;

                  if(ChGetShowSeriesCount(pCh) > 1)
                  {
                      pVar = ChGetNextShowData((DATASERIES *)pVar->pNextData);
                  }

                  // this is insurance (in case the link list is corrupted)
                  if(pVar == NULL)
                  {
                      break;
                  }
              }

              // initialize pVarFont to use pGridLabelsFont
              pVarFont = pCh->prm.pGridLabelsFont;

              // get the space occupied by the value
              if(GetState(pCh, CH_VALUE))
              {
                  z = word2xchar(y, tempStr, STR_CHAR_CNT);
                  x = (GetTextWidth(&tempStr[STR_CHAR_CNT - z], pVarFont));
              }
              else
                  x = 0;

              // get the space occupied by percent value
              if(GetState(pCh, CH_PERCENT))
              {

                  // 7 is derived from "X:100%," - seven possible characters, 1 is added for
  buffer

                  y = (8 * GetTextWidth((XCHAR *)tempXchar, pVarFont));
              }
              else
                  y = 0;

              // get the space occupied by the legend
              if((GetState(pCh, CH_LEGEND)) && (ChGetShowSeriesCount(pCh) > 1))
```

```
                temp += ((GetLongestNameLength(pCh) + 
(GetTextHeight(pCh->hdr.pGolScheme->pFont) >> 1)));

            // calculate the center of the pie chart
            ctr = (pCh->hdr.left + pCh->hdr.right - temp) >> 1;
            ctry = ((pCh->hdr.bottom + (pCh->hdr.top + GetTextHeight(pVarFont))) >> 1) + 
CH_MARGIN;

            // radius size is checked against the x and y area
            if
            (
                ((pCh->hdr.right - pCh->hdr.left) - temp - ((x + y) << 1)) <
                    (
                        (pCh->hdr.bottom - pCh->hdr.top - 
GetTextHeight(pCh->prm.pTitleFont)) - temp -
                            (GetTextHeight(pVarFont) << 1)
                    )
            )
            {

                // use dimension in the x axis
                if(x + y)
                {
                    z = ctr - (pCh->hdr.left + (x + y) + CH_MARGIN);
                }
                else
                {
                    z = ctr - pCh->hdr.left + CH_MARGIN;
                }
            }
            else
            {

                // use dimension in the y axis
                if(x + y)
                    z = ctry -
                        (
                            pCh->hdr.top + (CH_MARGIN << 1) + 
GetTextHeight(pCh->prm.pTitleFont) +
                                (GetTextHeight(pVarFont) << 1)
                        );
                else
                    z = ctry - (pCh->hdr.top + (CH_MARGIN << 1) + 
(GetTextHeight(pCh->prm.pTitleFont) << 1));
            }

            state = PIE_DRAW_OUTLINE1;

        case PIE_DRAW_OUTLINE1:

            // Required items before the pie chart can be drawn
            SetColor(LIGHTGRAY);

            // Draw pie-chart outline
            if(!Circle(ctr, ctry, z))
                return (0);
            state = PIE_DRAW_SECTOR;

        /*=====================================================================*/
        //                    Draw the sectors of the pie
        /*=====================================================================*/
        case PIE_DRAW_SECTOR:

            // now we are ready to draw the sectors
            // calculate the sector that a value will need
            k = 0;

            // check if more than one data series set to be shown , draw the pie chart of
            // the data series that are set to be shown.
            pVar = ChGetNextShowData(pCh->pChData);
            y = dTemp;
            varCtr = ChGetShowSeriesCount(pCh);
            if(varCtr == 1)
            {
                varCtr = ChGetSampleRange(pCh) + 1;
            }
            else if(varCtr == 0)
            {
                pVar = NULL;
                y = 0;
            }

            // we start at 0 degree.
            j = 0;

            // initialize the variables that position the pie sector labels.
            // this is used to minimize the occurrence of overlapped labels.
            pieLabelYPos = ctry;
            pieLabelYPos2 = pCh->hdr.bottom - (GOL_EMBOSS_SIZE + 1) -
GetTextHeight(pVarFont);
            pieLabelYPos3 = pCh->hdr.top + GOL_EMBOSS_SIZE + CH_MARGIN +
GetTextHeight(pCh->prm.pTitleFont) + GetTextHeight(pVarFont);

            state = PIE_DRAW_SECTOR_LOOP;

    chrt_pie_draw_sector_loop:

        case PIE_DRAW_SECTOR_LOOP:
            if(varCtr >= 0)
            {

                // get the value to be computed
                if(ChGetShowSeriesCount(pCh) > 1)
                {
                    temp = *(&(*pVar->pData) + ChGetSampleStart(pCh) - 1);
                }
                else
                {
                    temp = *(&(*pVar->pData) + ChGetSampleEnd(pCh) - varCtr);
                }

                // calculate the sector that the value will occupy
                dTemp = ((DWORD) (temp) * (3600)) / y;

                // check if we need to round up or not
                if((dTemp % 10) < 5)
                    dTemp = (dTemp / 10);                       // do not round up to next
number
                else
                    dTemp = (dTemp / 10) + 1;                   // round up the value

                // set the color to the color of the variable
                SetColor(*(&(*pCh->prm.pColor) + k));

                // check if the sector has zero angle if it is zero just draw the
                // line.
                if(dTemp == 0)
                {
                    state = PIE_DRAW_SECTOR_LOOP_CONTINUE;
                    goto chrt_pie_draw_sector_loop_continue;
                }

                // go to the state that draws only. Doing this separates the setup of
static variables
                // and rendering. So in cases when the rendering cannot continue, the
variables
                // are still set to correct values.
                state = PIE_DRAW_SECTOR_ACTUAL;
                goto pie_draw_sector_actual;
            }
            else
            {
                if(GetState(pCh, CH_DONUT) == CH_DONUT)
                {
```

```
                state = PIE_DONUT_HOLE_DRAW;
                goto chrt_pie_donut_hole_draw;
            }
            else
            {
                state = REMOVE;
                return (1);
            }
        }

    case PIE_DRAW_SECTOR_ACTUAL:
        pie_draw_sector_actual :

        // check if it is the last sector to be drawn
        if((varCtr == 1) || ((j + dTemp) >= 358))
        {
            if(!DrawSector(ctr, ctry, z, j, 360, LIGHTGRAY))
                return (0);
        }
        else
        {
            if(!DrawSector(ctr, ctry, z, j, (j + dTemp), LIGHTGRAY))
                return (0);
        }

        state = PIE_DRAW_SECTOR_LOOP_CREATE_STRINGS;

    case PIE_DRAW_SECTOR_LOOP_CREATE_STRINGS:

        // create the strings of the values if needed
        if(GetState(pCh, CH_VALUE) || GetState(pCh, CH_PERCENT))
        {
            h = 0;
            GetCirclePoint(z, (j + (dTemp >> 1)), &pieX, &pieY);

            pieX += ctr;
            pieY += ctry;

            // do we need to show the values? create the strings here
            if(GetState(pCh, CH_VALUE))
            {
                h = word2xchar(temp, tempStr, STR_CHAR_CNT);
            }

            // do we need to show the percentage? create the strings here
            if(GetState(pCh, CH_PERCENT))
            {

                // add the % sign
                // check if we need to add comma
                if(GetState(pCh, CH_VALUE))
                {
                    h += 1;                         // adjust h
                    tempStr[STR_CHAR_CNT - h] = ',';
                }

                h += 1;                             // adjust h
                tempStr[STR_CHAR_CNT - h] = '%';

                // now add the percentage
                dPercent = (DWORD) (dTemp * 1000) / 360;

                // check if we need to round up or not
                if((dPercent % 10) < 5)
                    dPercent = (dPercent / 10);     // do not round up to next number
                else
                    dPercent = (dPercent / 10) + 1; // round up the value
                i = word2xchar((WORD) dPercent, tempStr, STR_CHAR_CNT - h);

                // adjust the h position
                h += i;
            }
```

```
                    #ifdef USE_PIE_ENABLE_LABEL

                // add the labels
                h += 1; // adjust h
                tempStr[STR_CHAR_CNT - h] = ':';
                h += 1; // adjust h
                tempStr[STR_CHAR_CNT - h] = 'A' + (ChGetSampleStart(pCh) - 1 + k);
                    #endif
                SetColor(pCh->hdr.pGolScheme->EmbossLtColor);

                m = j;

                // we have to relocate the text depending on the position
                if((m + (dTemp >> 1) >= 0) && (m + (dTemp >> 1) <= 90))
                {

                    // check if we need to draw a line
                    if((dTemp < GetTextHeight(pVarFont)) || (pieLabelYPos > pieY))
                    {
                        pieLabelXPos = ctr + z + GetTextHeight(pVarFont);
                        pieSectorXPos = pieX + 3;
                        if((m + (dTemp >> 1)) < 45)
                            pieSectorYPos = pieY + 1;
                        else
                            pieSectorYPos = pieY + 3;

                        // The label will now exceed the chart dimension, so force the
  value to be printed near the sector
                        pieLabelXPos = ctr + z + GetTextHeight(pVarFont);
                        if((pieLabelYPos + GetTextHeight(pVarFont)) > (pCh->hdr.bottom -
  (GOL_EMBOSS_SIZE + 1)))
                        {
                            MoveTo(pieX, pieY + 1);
                        }
                        else
                        {

                            // draw the line
                            if
                            (
                                !Line
                                    (
                                        pieSectorXPos,
                                        pieSectorYPos,
                                        pieLabelXPos,
                                        pieLabelYPos + (GetTextHeight(pVarFont) >> 1)
                                    )
                            ) return (0);

                            MoveTo(pieLabelXPos, pieLabelYPos);
                            pieLabelYPos += GetTextHeight(pVarFont);
                        }
                    }
                    else
                    {
                        MoveTo(pieX + GetTextWidth(tempXchar, pVarFont), pieY);
                        pieLabelYPos = pieY + GetTextHeight(pVarFont);
                    }
                }
                else if((m + (dTemp >> 1) > 90) && (m + (dTemp >> 1) <= 180))
                {

                    // check if we need to draw a line
                    if((dTemp < GetTextHeight(pVarFont)) || (pieLabelYPos2 < pieY))
                    {
                        pieLabelXPos = ctr - z - 3;

                        pieSectorXPos = pieX - 3;

                        if((m + (dTemp >> 1)) < 135)
                            pieSectorYPos = pieY + 3;
                        else
                            pieSectorYPos = pieY;

                        // check if slope of line is greater than -1.
                        // if it is we must adjust position of text to avoid the line
                        // intersecting the circumference of the pie chart
                        if((m + (dTemp >> 1)) < 180)
                        {

                            // make the slope equal to 1, this will make sure it does not
intersect the circumference
                            if((abs(pieY - pieLabelYPos2) / abs(pieX - pieLabelXPos)) >= 1)
                            {
                                pieLabelXPos = pieX - abs(pieY - pieLabelYPos2);
                                if
                                (
                                    (SHORT) (pieLabelXPos -
GetTextWidth(&tempStr[STR_CHAR_CNT - h], pVarFont)) <=
                                        (pCh->hdr.left + CH_MARGIN)
                                )
                                {
                                    pieLabelXPos =
                                        (
                                            pCh->hdr.left +
                                            CH_MARGIN +
                                            GetTextWidth(&tempStr[STR_CHAR_CNT - h],
pVarFont)

                                        );
                                }
                            }
                        }

                        // draw the line
                        if
                        (
                            !Line
                                (
                                    pieSectorXPos,
                                    pieSectorYPos,
                                    pieLabelXPos,
                                    pieLabelYPos2 + (GetTextHeight(pVarFont) >> 1)
                                )
                        ) return (0);

                        MoveTo(pieLabelXPos - GetTextWidth(&tempStr[STR_CHAR_CNT - h],
pVarFont), pieLabelYPos2);
                        pieLabelYPos2 -= GetTextHeight(pVarFont);
                    }
                    else
                    {
                        MoveTo
                        (
                            pieX - GetTextWidth(&tempStr[STR_CHAR_CNT - h], pVarFont) -
GetTextWidth
                                (
                                    tempXchar,
                                    pVarFont
                                ),
                            pieY
                        );
                        pieLabelYPos2 = pieY - GetTextHeight(pVarFont);
                    }
                }
                else if((m + (dTemp >> 1) > 180) && (m + (dTemp >> 1) <= 270))
                {

                    // check if we need to draw a line
                    if((dTemp < GetTextHeight(pVarFont)) || (pieLabelYPos2 < pieY))
                    {
                        pieLabelXPos = ctr - z - 5;

                        if((m + (dTemp >> 1)) < 225)
```

```
                          {
                              pieSectorXPos = pieX - 3;
                              pieSectorYPos = pieY;
                          }
                          else
                          {
                              pieSectorXPos = pieX;
                              pieSectorYPos = pieY - 3;
                          }

                          // check if slope of line is greater than -1.
                          // if it is we must adjust position of text to avoid the line
                          // intersecting the circumference of the pie chart
                          if((m + (dTemp >> 1)) < 270)
                          {

                              // make the slope equal to 1, this will make sure it does not
intersect the circumference
                              if((abs(pieY - pieLabelYPos2) / abs(pieX - pieLabelXPos)) >= 1)
                              {
                                  pieLabelXPos = ctr - (z + (z >> 1)) - 5;
                                  if
                                  (
                                      (SHORT) (pieLabelXPos -
GetTextWidth(&tempStr[STR_CHAR_CNT - h], pVarFont)) <=
                                          (pCh->hdr.left + CH_MARGIN)
                                  )
                                  {
                                      pieLabelXPos =
                                          (
                                              pCh->hdr.left +
                                              CH_MARGIN +
                                              GetTextWidth(&tempStr[STR_CHAR_CNT - h],
pVarFont)

                                          );
                                  }
                              }
                          }

                          // The label will now exceed the chart dimension, so force the
value to be printed aligned in
                          // y position with the previous value printed
                          if
                          (
                              (pieLabelYPos2) <
                                  (pCh->hdr.top + GOL_EMBOSS_SIZE + CH_MARGIN +
GetTextHeight(pCh->prm.pTitleFont))
                          )
                          {
                              if
                              (
                                  !Line
                                      (
                                          pieSectorXPos,
                                          pieSectorYPos,
                                          pieLabelXPos + (GetTextWidth(&tempStr[STR_CHAR_CNT
- h], pVarFont) >> 1),

                                          pieLabelYPos2 + ((GetTextHeight(pVarFont) >> 1) * 3)
                                      )
                              ) return (0);

                              MoveTo
                              (
                                  pieLabelXPos + (GetTextWidth(&tempStr[STR_CHAR_CNT - h],
pVarFont) >> 1),

                                  pieLabelYPos2 + GetTextHeight(pVarFont)
                              );

                              // adjust the next marker
                              pieLabelYPos3 += GetTextHeight(pVarFont);
                          }
                          else
```

```
                        {

                            // draw the line
                            if
                            (
                                !Line
                                    (
                                        pieSectorXPos,
                                        pieSectorYPos,
                                        pieLabelXPos,
                                        pieLabelYPos2 + (GetTextHeight(pVarFont) >> 1)
                                    )
                            ) return (0);

                            MoveTo(pieLabelXPos - GetTextWidth(&tempStr[STR_CHAR_CNT - h],
pVarFont), pieLabelYPos2);
                            pieLabelYPos2 -= GetTextHeight(pVarFont);
                        }
                    }
                    else
                    {
                        MoveTo
                        (
                            pieX - GetTextWidth(&tempStr[STR_CHAR_CNT - h], pVarFont) -
GetTextWidth
                                (
                                    tempXchar,
                                    pVarFont
                                ),
                            pieY - GetTextHeight(pVarFont)
                        );
                        pieLabelYPos2 = pieY - (GetTextHeight(pVarFont) << 1);
                    }
                }
                else if((m + (dTemp >> 1) > 270) && (m + (dTemp >> 1) <= 360))
                {

                    // check if we need to draw a line
                    if((dTemp < GetTextHeight(pVarFont)) || (pieLabelYPos3 > pieY))
                    {
                        pieLabelXPos = ctr + z + GetTextHeight(pVarFont);

                        pieSectorXPos = pieX + 3;
                        pieSectorYPos = pieY - 2;

                        // draw the line
                        if
                        (
                            !Line
                                (
                                    pieSectorXPos,
                                    pieSectorYPos,
                                    pieLabelXPos,
                                    pieLabelYPos3 - (GetTextHeight(pVarFont) >> 1)
                                )
                        ) return (0);

                        MoveTo(pieLabelXPos, pieLabelYPos3 - GetTextHeight(pVarFont));
                        pieLabelYPos3 += GetTextHeight(pVarFont);
                    }
                    else
                    {
                        MoveTo(pieX + 5, pieY - GetTextHeight(pVarFont));
                        pieLabelYPos3 = pieY + GetTextHeight(pVarFont);
                    }
                }

                state = PIE_DRAW_SECTOR_LOOP_STRINGS_RUN;
            }
            else
            {
                state = PIE_DRAW_SECTOR_LOOP_CONTINUE;
                goto chrt_pie_draw_sector_loop_continue;
            }

        case PIE_DRAW_SECTOR_LOOP_STRINGS_RUN:

            // now draw the strings of the values and/or percentages
            SetColor(pCh->hdr.pGolScheme->EmbossLtColor);
            SetFont(pVarFont);

            if(!OutText(&tempStr[STR_CHAR_CNT - h]))
                return (0);

            state = PIE_DRAW_SECTOR_LOOP_CONTINUE;

    chrt_pie_draw_sector_loop_continue:

        case PIE_DRAW_SECTOR_LOOP_CONTINUE:
            j += dTemp;
            varCtr--;
            if(varCtr == 0)
            {
                if(GetState(pCh, CH_DONUT) == CH_DONUT)
                {
                    state = PIE_DONUT_HOLE_DRAW;
                    goto chrt_pie_donut_hole_draw;
                }
                else
                {
                    state = REMOVE;
                    return (1);
                }
            }

            // check if more than one data series to be shown
            if(ChGetShowSeriesCount(pCh) > 1)
            {
                pVar = ChGetNextShowData((DATASERIES *)pVar->pNextData);
                if(pVar == NULL)
                {
                    break;
                }
            }

            k++;
            state = PIE_DRAW_SECTOR_LOOP;
            goto chrt_pie_draw_sector_loop;

    chrt_pie_donut_hole_draw:

        case PIE_DONUT_HOLE_DRAW:
            SetColor(LIGHTGRAY);
            if(!Circle(ctr, ctry, (z >> 1) - (z >> 3)))
                return (0);
            SetColor(pCh->hdr.pGolScheme->CommonBkColor);
            if(!FillCircle(ctr, ctry, ((z >> 1) - (z >> 3)) - 1))
                return (0);

            state = REMOVE;
            return (1);
    }

    return (1);
}

/*********************************************************************
* Function: ChAddDataSeries(CHART *pCh, WORD nSamples, WORD *pData, XCHAR *pName)
*
*
* Notes: Adds a new variable data structure in the linked list
*        of variable datas. Number of samples is given with the
*        array of the samples. If there is only one data
*        nSamples is set to 1 with the address of the variable data.
```

```
*
*
********************************************************************/
DATASERIES *ChAddDataSeries(CHART *pCh, WORD nSamples, WORD *pData, XCHAR *pName)
{
    DATASERIES  *pVar = NULL, *pListVar;

    pVar = (DATASERIES *)GFX_malloc(sizeof(DATASERIES));

    if(pVar == NULL)
        return (NULL);

    // add the other parameters of the variable data
    pVar->pSData = (XCHAR *)pName;
    pVar->samples = nSamples;
    pVar->pData = (WORD *)pData;
    pVar->show = SHOW_DATA;
    pVar->pNextData = NULL;

    pListVar = pCh->pChData;
    if(pCh->pChData == NULL)
        pCh->pChData = pVar;
    else
    {

        // search the end of the list and append the new data
        while(pListVar->pNextData != NULL)
            pListVar = pListVar->pNextData;
        pListVar->pNextData = pVar;
    }

    // update the variable count before exiting
    pCh->prm.seriesCount++;
    return (DATASERIES *)pVar;
}
/*********************************************************************
* Function: void ChFreeDataSeries(void *pObj)
*
*
* Notes: Removes a data series structure in the linked list
*        of data series.
*
********************************************************************/
void ChFreeDataSeries(void *pObj)
{
    DATASERIES  *pVar = NULL, *pPrevVar = NULL;
    CHART *pCh;

    pCh = (CHART *)pObj;

    pVar = pCh->pChData;

    // check if the list is empty
    if(pVar == NULL)
        return;

    // check if there is only one entry
    if(pVar->pNextData == NULL)
    {
        GFX_free(pVar);
        pCh->pChData = NULL;
        return;
    }

    // remove all
    while(pVar != NULL)
    {
        pPrevVar = pVar;
        pVar = pVar->pNextData;

        // free the memory used by the item
        GFX_free(pPrevVar);
    }
}

/*********************************************************************
* Function: ChRemoveDataSeries(CHART *pCh, WORD number)
*
*
* Notes: Removes a data series structure in the linked list
*        of data series.
*
********************************************************************/
void ChRemoveDataSeries(CHART *pCh, WORD number)
{
    DATASERIES  *pVar = NULL, *pPrevVar = NULL;
    WORD        ctr = 1;

    pVar = pCh->pChData;

    // check if the list is empty
    if(pVar == NULL)
        return;

    // check if there is only one entry
    if(pVar->pNextData == NULL)
    {
        GFX_free(pVar);
        pCh->pChData = NULL;
        return;
    }

    if(number == 0)
    {

        // remove all
        while(pVar != NULL)
        {
            pPrevVar = pVar;
            pVar = pVar->pNextData;

            // free the memory used by the item
            GFX_free(pPrevVar);
        }

        return;
    }

    // there are more than one entry, remove the entry specified
    while(ctr < number)
    {
        pPrevVar = pVar;
        pVar = pVar->pNextData;
        ctr++;
    }

    // remove the item from the list
    pPrevVar->pNextData = pVar->pNextData;

    // free the memory used by the item
    GFX_free(pVar);

    return;
}

/*********************************************************************
* Function: ChSetDataSeries(CHART *pCh, WORD seriesNum, BYTE status)
*
*
* Notes: Sets the specified data series number show flag to be set to
*        SHOW_DATA or HIDE_DATA depending on the status.
*        If the seriesNum is 0, it sets all the data series
*        entries in the data series linked list. Returns the same passed
*        number if successful otherwise -1 if unsuccesful.
```

```
*
********************************************************************/
SHORT ChSetDataSeries(CHART *pCh, WORD seriesNum, BYTE status)
{
    DATASERIES  *pListSer;
    WORD        ctr = 1;

    pListSer = pCh->pChData;

    // check if the list is empty
    if(pListSer == NULL)
        return (-1);

    while(pListSer != NULL)
    {

        // check if we need to show all
        if(seriesNum == 0)
            pListSer->show = status;
        else if(seriesNum == ctr)
        {
            pListSer->show = status;
            break;
        }

        ctr++;
        pListSer = pListSer->pNextData;
    }

    if(seriesNum == ctr)
        return (seriesNum);
    else
        return (-1);
}

/*********************************************************************
* Function: ChSetSampleRange(CHART *pCh, WORD start, WORD end)
*
*
* Notes: Sets the sampling start and end points when drawing the chart.
*        Depending on the number of data series with SHOW_DATA flag
*        set and the values of end and start samples a single
*        data series is drawn or multiple data series are drawn.
*
********************************************************************/
void ChSetSampleRange(CHART *pCh, WORD start, WORD end)
{
    pCh->prm.smplStart = start;
    if(end < start)
        pCh->prm.smplEnd = start;
    else
        pCh->prm.smplEnd = end;
}

/*********************************************************************
* Function: ChSetValueRange(CHART *pCh, WORD min, WORD max)
*
*
* Notes: Sets the sampling start and end points when drawing the chart.
*        Depending on the number of data series with SHOW_DATA flag
*        set and the values of end and start samples a single
*        data series is drawn or multiple data series are drawn.
*
********************************************************************/
void ChSetValueRange(CHART *pCh, WORD min, WORD max)
{
    pCh->prm.valMin = min;
    if(max < min)
        pCh->prm.valMax = min;
    else
        pCh->prm.valMax = max;
}
```

```
/*********************************************************************
* Function: ChSetPercentRange(CHART *pCh, WORD min, WORD max)
*
*
* Notes: Sets the percentage range when drawing the chart. This affects
*        bar charts only and CH_PERCENTAGE bit state is set.
*
********************************************************************/
void ChSetPercentRange(CHART *pCh, WORD min, WORD max)
{
    pCh->prm.perMin = min;
    if(max < min)
        pCh->prm.perMax = min;
    else
        pCh->prm.perMax = max;
}



/* */

void FillSector(SHORT x, SHORT y, GFX_COLOR outLineColor)
{
    GFX_COLOR    pixel;
    SHORT   left, right;
    SHORT   top, bottom;
    SHORT   xc, yc;

    // scan down
    top = bottom = yc = y;
    left = right = xc = x;
    while(1)
    {

        pixel = GetPixel(xc, yc);
        if(pixel == outLineColor)
        {
            for(xc = left + 1; xc < right; xc++)
            {
                pixel = GetPixel(xc, yc);
                if(pixel != outLineColor)
                {
                    break;
                }
            }

            if(xc == right)
                break;
        }

        // left scan
        left = xc;
        do
        {
            left--;
            pixel = GetPixel(left, yc);
        } while(pixel != outLineColor);
        while(!Line(xc, yc, left + 1, yc));

        // right scan
        right = xc;
        pixel = GetPixel(right, yc);
        do
        {
            right++;
            pixel = GetPixel(right, yc);
        } while(pixel != outLineColor);
        while(!Line(xc, yc, right - 1, yc));

        xc = (left + right) >> 1;
        yc++;
    }

    // scan up
    yc = y;
    xc = x;
    while(1)
    {
        pixel = GetPixel(xc, yc);
        if(pixel == outLineColor)
        {
            for(xc = left + 1; xc < right; xc++)
            {
                pixel = GetPixel(xc, yc);
                if(pixel != outLineColor)
                {
                    break;
                }
            }

            if(xc == right)
                break;
        }

        // left scan
        left = xc;
        do
        {
            left--;
            pixel = GetPixel(left, yc);
        } while(pixel != outLineColor);
        while(!Line(xc, yc, left + 1, yc));

        // right scan
        right = xc;
        pixel = GetPixel(right, yc);
        do
        {
            right++;
            pixel = GetPixel(right, yc);
        } while(pixel != outLineColor);
        while(!Line(xc, yc, right - 1, yc));

        xc = (left + right) >> 1;
        yc--;
    }
}

/* */


/* */
WORD DrawSector(SHORT cx, SHORT cy, SHORT outRadius, SHORT angleFrom, SHORT angleTo,
GFX_COLOR outLineColor)
{
    typedef enum
    {
        SEC_DRAW_IDLE,
        SEC_DRAW_EDGE1,
        SEC_DRAW_EDGE2,
        SEC_DRAW_EDGE3,
        SEC_DRAW_EDGE4,
        SEC_DRAW_EDGE5,
        SEC_DRAW_FILLINIT,
        SEC_DRAW_FILL,
    } DRAW_SECTOR_STATES;

    static SHORT x1, y1, x2, y2, x3, y3;
    static SHORT angleMid;
    static WORD tempColor;
    LONG temp;

    static DRAW_SECTOR_STATES sectorState = SEC_DRAW_IDLE;
    switch(sectorState)
    {
        case SEC_DRAW_IDLE:

            // calculate points
            angleMid = (angleTo + angleFrom) >> 1;
            GetCirclePoint(outRadius, angleFrom, &x1, &y1);
            GetCirclePoint(outRadius, angleTo, &x2, &y2);
            x1 += cx;
            y1 += cy;
            x2 += cx;
            y2 += cy;

            // grab the current color value for later use
            tempColor = GetColor();

            // check if we need to draw the edges
            // special case for single data shown on pie chart
            // we remove the line drawn at angle 0
            if(!((angleFrom == 0) && (angleTo == 360)))
            {
                sectorState = SEC_DRAW_EDGE1;

                // special case for small angles
                GetCirclePoint(outRadius - 1, angleFrom + 1, &x3, &y3);
                x3 += cx;
                y3 += cy;
                goto sec_draw_edge1;
            }
            else
            {
                sectorState = SEC_DRAW_FILLINIT;
                goto sec_draw_fillinit;
            }

        case SEC_DRAW_EDGE1:
            sec_draw_edge1 : if(!Line(x3, y3, cx, cy)) return (0);
            GetCirclePoint(outRadius - 1, angleTo - 1, &x3, &y3);
            x3 += cx;
            y3 += cy;
            sectorState = SEC_DRAW_EDGE2;

        case SEC_DRAW_EDGE2:
            if(!Line(x3, y3, cx, cy))
                return (0);
            GetCirclePoint(outRadius - 1, angleMid, &x3, &y3);
            x3 += cx;
            y3 += cy;
            sectorState = SEC_DRAW_EDGE3;

        case SEC_DRAW_EDGE3:
            if(!Line(x3, y3, cx, cy))
                return (0);
            SetColor(outLineColor);
            sectorState = SEC_DRAW_EDGE4;

        case SEC_DRAW_EDGE4:
            if(!Line(x1, y1, cx, cy))
                return (0);
            sectorState = SEC_DRAW_EDGE5;

        case SEC_DRAW_EDGE5:
            if(!Line(x2, y2, cx, cy))
                return (0);
            sectorState = SEC_DRAW_FILLINIT;

        case SEC_DRAW_FILLINIT:
            sec_draw_fillinit : SetColor(tempColor);

            temp = ((x1 - x2) * (x1 - x2));
            temp += ((y1 - y2) * (y1 - y2));
            if(((DWORD) temp <= (DWORD) 16) && ((angleTo - angleFrom) < 90))
            {
                sectorState = SEC_DRAW_IDLE;
                return (1);
            }

            GetCirclePoint(outRadius - 2, angleMid, &x3, &y3);
            x3 += cx;
            y3 += cy;
            sectorState = SEC_DRAW_FILL;

        case SEC_DRAW_FILL:

            // FillSector() is a blocking call
            // making it non-blocking will further add delay to the rendering
            FillSector(x3, y3, outLineColor);
            sectorState = SEC_DRAW_IDLE;
            break;
    }   // end of switch()

    return (1);
}

#endif // USE_CHART
```

14.1.11 Chart.h

Functions

	Name	Description
◆	ChAddDataSeries (see page 103)	This function creates a DATASERIES (see page 124) object and populates the structure with the given parameters.
◆	ChCreate (see page 100)	This function creates a CHART (see page 124) object with the parameters given. It automatically attaches the new object into a global linked list of objects and returns the address of the object.
◆	ChDraw (see page 102)	This function renders the object on the screen using the current parameter settings. Location of the object is determined by the left, top, right and bottom parameters. The colors used are dependent on the state of the object. The font used is determined by the style scheme set. The colors of the bars of the bar chart or sectors of the pie chart can be the default color table or user defined color table set by ChSetColorTable (see page 117)() function. When rendering objects of the same type, each object must be rendered completely before the rendering of the next object is... more (see page 102)
◆	ChFreeDataSeries (see page 122)	This function removes DATASERIES (see page 124) object from the list of DATASERIES (see page 124) objects and frees the memory used of that removed object.
◆	ChRemoveDataSeries (see page 103)	This function removes DATASERIES (see page 124) object from the list of DATASERIES (see page 124) objects and frees the memory used of that removed object. The position of the object to be removed is specified by the number parameter. If the list has only one member, it removes the member regardless of the number given.
◆	ChSetPercentRange (see page 113)	This function sets the minimum and maximum range of percentage that the bar chart will show. The criteria is that min <= max. This affects bar charts only and CH_PERCENTAGE bit state is set.
◆	ChSetSampleRange (see page 114)	This function sets the sample start and sample end when drawing the chart. Together with the data series' SHOW_DATA (see page 98) flags the different way of displaying the chart data is achieved.
◆	ChSetValueRange (see page 109)	This function sets the minimum and maximum range of values that the bar chart will show. The criteria is that min <= max.

	ChTranslateMsg (see page 123)	This function evaluates the message from a user if the message will affect the object or not. The table below enumerates the translated messages for each event of the touch screen and keyboard inputs.

Macros

Name	Description
CH_3D_ENABLE (see page 96)	Bit to indicate that bar charts are to be drawn with 3-D effect
CH_BAR (see page 96)	Bit to indicate the chart is type bar. If both PIE and BAR types
CH_BAR_HOR (see page 96)	These bits (with CH_BAR (see page 96) bit set), sets the bar chart to
CH_CLR0 (see page 126)	Bright Blue
CH_CLR1 (see page 127)	Bright Red
CH_CLR10 (see page 128)	Light Orange
CH_CLR11 (see page 129)	Light Red
CH_CLR12 (see page 129)	Light Green
CH_CLR13 (see page 129)	Light Yellow
CH_CLR14 (see page 129)	Light Orange
CH_CLR15 (see page 129)	Gold
CH_CLR2 (see page 127)	Bright Green
CH_CLR3 (see page 127)	Bright Yellow
CH_CLR4 (see page 127)	Orange
CH_CLR5 (see page 127)	Blue
CH_CLR6 (see page 128)	Red
CH_CLR7 (see page 128)	Green
CH_CLR8 (see page 128)	Yellow
CH_CLR9 (see page 128)	Dark Orange
CH_DISABLED (see page 95)	Bit for disabled state.
CH_DONUT (see page 96)	These bits (with CH_PIE (see page 97) bit set), sets the pie chart to
CH_DRAW (see page 95)	Bit to indicate chart must be redrawn.
CH_DRAW_DATA (see page 95)	Bit to indicate data portion of the chart must be redrawn.
CH_HIDE (see page 98)	Bit to indicate chart must be removed from screen.
CH_LEGEND (see page 97)	Bit to indicate that legend is to be shown. Usable only when seriesCount > 1.
CH_NUMERIC (see page 97)	This bit is used only for bar charts. If this bit is set, it indicates that the
CH_PERCENT (see page 97)	Bit to indicate that the pie chart will be drawn with percentage
CH_PIE (see page 97)	Bit to indicate the chart is type pie. If both PIE and BAR types
CH_VALUE (see page 97)	Bit to indicate that the values of the bar chart data or pie chart
ChGetAxisLabelFont (see page 120)	This macro returns the location of the font used for the X and Y axis labels of the chart.
ChGetColorTable (see page 117)	This macro returns the current color table used for the pie and bar charts.
ChGetGridLabelFont (see page 121)	This macro returns the location of the font used for the X and Y axis grid labels of the chart.
ChGetPercentMax (see page 115)	This macro returns the current maximum value of the percentage range that will be drawn for bar charts when CH_PERCENTAGE bit state is set.
ChGetPercentMin (see page 116)	This macro returns the current minimum value of the percentage range that will be drawn for bar charts when CH_PERCENTAGE bit state is set.
ChGetPercentRange (see page 113)	This macro gets the percentage range for bar charts. The value returned is calculated from percentage max - min. To get the minimum use ChGetPercentMin (see page 116)() and to get the maximum use ChGetPercentMax (see page 115)().
ChGetSampleEnd (see page 112)	This macro returns the sampling end value.
ChGetSampleLabel (see page 111)	This macro returns the address of the current text string used for the sample axis label of the bar chart.

ChGetSampleRange (see page 115)	This macro gets the sample range for pie or bar charts. The value returned is calculated from smplEnd - smplStart.
ChGetSampleStart (see page 111)	This macro returns the sampling start value.
ChGetShowSeriesCount (see page 106)	This macro shows the number of data series that has its show flag set to SHOW_DATA (see page 98)
ChGetShowSeriesStatus (see page 106)	This macro returns the show ID status of the DATASERIES (see page 124).
ChGetTitle (see page 118)	This macro returns the address of the current text string used for the title of the chart.
ChGetTitleFont (see page 119)	This macro returns the location of the font used for the title of the chart.
ChGetValueLabel (see page 107)	This macro returns the address of the current text string used for the value axis label of the bar chart.
ChGetValueMax (see page 108)	This macro returns the current maximum value that will be drawn for bar charts.
ChGetValueMin (see page 108)	This macro returns the current minimum value that will be drawn for bar charts.
ChGetValueRange (see page 110)	This macro gets the current range for bar charts. The value returned is calculated from the current (valMax - valMin) set. To get the minimum use ChGetValueMin (see page 108)() and to get the maximum use ChGetValueMax (see page 108)().
ChHideSeries (see page 105)	This macro sets the specified data series number show flag to be set to HIDE_DATA (see page 98).
ChSetAxisLabelFont (see page 121)	This macro sets the location of the font used for the X and Y axis labels of the chart.
ChSetColorTable (see page 117)	This macro sets the color table used to draw the data in pie and bar charts.
ChSetGridLabelFont (see page 122)	This macro sets the location of the font used for the X and Y axis grid labels of the chart.
ChSetSampleLabel (see page 110)	This macro sets the address of the current text string used for the sample axis label of the bar chart.
ChSetTitle (see page 118)	This macro sets the address of the current text string used for the title of the chart.
ChSetTitleFont (see page 119)	This macro sets the location of the font used for the title of the chart.
ChSetValueLabel (see page 107)	This macro sets the address of the current text string used for the value axis label of the bar chart.
ChShowSeries (see page 104)	This macro sets the specified data series number show flag to be set to SHOW_DATA (see page 98).
HIDE_DATA (see page 98)	Macro used to reset the data series show flag or indicate that the data series will be not be shown when the chart is drawn.
SHOW_DATA (see page 98)	Macro used to set the data series show flag or indicate that the data series will be shown when the chart is drawn.

Structures

Name	Description
CHART (see page 124)	Defines the parameters required for a chart Object.
CHARTPARAM (see page 125)	Defines the parameters for the CHART (see page 124) object.
DATASERIES (see page 124)	Defines a variable for the CHART (see page 124) object. It specifies the number of samples, pointer to the array of samples for the data series and pointer to the next data series. A member of this structure (show) is used as a flag to determine if the series is to be drawn or not. Together with the smplStart and smplEnd it will determine what kind of chart will be drawn.

Description

This is file Chart.h.

Body Source

```
/*****************************************************************************
 *  Module for Microchip Graphics Library
 *  GOL Layer
 *  Chart
 *****************************************************************************
 * FileName:        Chart.h
 * Dependencies:    None
 * Processor:       PIC24F, PIC24H, dsPIC, PIC32
 * Compiler:        MPLAB C30, MPLAB C32
 * Linker:          MPLAB LINK30, MPLAB LINK32
 * Company:         Microchip Technology Incorporated
 *
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 * CLAIMS BY THIRD PARTIES (INCLUDING BUT NOT LIMITED TO ANY DEFENSE THEREOF),
 * OR OTHER SIMILAR COSTS.
 *
 * Date        Comment
 *~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
 * 4/8/08       ...
 *****************************************************************************/
#ifndef _CHART_H
    #define _CHART_H

    #include <Graphics/GOL.h>
    #include "GenericTypeDefs.h"

/*
        Chart Terminologies

Value Axis - This is the vertical range of a chart for normal bar charts and
             horizontal range of the chart for horizontally drawn bar charts.
             In most cases this axis will represent values ($ amounts), temperatures,
             or other numeric data. Definition for Value Axis and Sample Axis
             are flipped when chart is drawn horizontally.
Sample Axis - This is the horizontal range of a chart for normal bar charts and
              vertical range of the chart for horizontally drawn bar charts.
              In most cases this axis will represent categories, such as months,
              sample segments, or other non-numeric data. Definition for Value Axis
              and Sample Axis are flipped when chart is drawn horizontally.
Title  - The text used to define the Title of the chart.
Data Points (or the sample points) These are the individual points where a value
             is graphed, as a point on a line, a bar, or a pie slice.
Data Series - A complete series of data, distinguished by the same color and type of sample
point.
Legend - Labels that indicate how each data series is displayed on the chart.
         Each color represents a different data series. For pie charts with only one data
         series shown, each color represent one sector or one one sample point.
Data Sample Range - The scale for the data sample axis. Example: months from
        January to December. Internally, this range is represented by:
             Numeric Sequence 1, 2, 3, ... and so on
             Alphabet Sequence A, B, C, .. and so on.
Value Range - The scale for the value axis.
              Example: range of numbers from the lowest to the highest to be charted.

*/
```

```
/*********************************************************************
* Object States Definition:
*********************************************************************/
    #define CH_DISABLED 0x0002          // Bit for disabled state.
    #define CH_LEGEND   0x0001          // Bit to indicate that legend is to be shown.
Usable only when seriesCount > 1.
    #define CH_VALUE    0x0004          // Bit to indicate that the values of the bar chart
data or pie chart

// data are to be shown
    #define CH_3D_ENABLE    0x0008      // Bit to indicate that bar charts are to be drawn
with 3-D effect
    #define CH_PIE          0x0100      // Bit to indicate the chart is type pie. If both
PIE and BAR types

// are set BAR type has higher priority.
    #define CH_BAR  0x0200              // Bit to indicate the chart is type bar. If both
PIE and BAR types

// are set BAR type has higher priority.
    #define CH_PERCENT  0x0010          // Bit to indicate that the pie chart will be drawn
with percentage

// values shown for the sample data. For bar chart, if CH_VALUE is set,
// it toggles the value shown to percentage.
    #define CH_BAR_HOR  0x0240          // These bits (with CH_BAR bit set), sets the bar
chart to

// be drawn horizontally.
    #define CH_DONUT    0x0140          // These bits (with CH_PIE bit set), sets the pie
chart to

// be drawn in a donut shape.
    #define CH_NUMERIC  0x0080          // This bit is used only for bar charts. If this
bit is set, it indicates that the

// bar chart labels for variables are numeric. If this bit is not set, it indicates
// that the bar chart labels for variables are alphabets.
    #define CH_DRAW_DATA    0x2000      // Bit to indicate data portion of the chart must
be redrawn.
    #define CH_DRAW         0x4000      // Bit to indicate chart must be redrawn.
    #define CH_HIDE         0x8000      // Bit to indicate chart must be removed from
screen.

/*********************************************************************
* Data Series Show Flag Definitions:
*********************************************************************/
    #define SHOW_DATA   1               // Macro used to set the data series show flag or
indicate that the data series will be shown when the chart is drawn.
    #define HIDE_DATA   0               // Macro used to reset the data series show flag or
indicate that the data series will be not be shown when the chart is drawn.

/* Internal Definitions - used to modify some specific rendering characteristics */
    #define CH_MARGIN       2           // Margin from the edges.
    #define CH_YGRIDCOUNT   6           // defines the number of grids to be drawn on the
y-axis (includes the origin at y).
    #define USE_HORZ_ASCENDING_ORDER    // use ascending order when displaying variables on
horizontal mode (bar chart only)
    #define USE_PIE_ENABLE_LABEL        // use labels:  A:10%,30 where each sample is
labeled A-Z followed by a colon.

/*********************************************************************
* Overview: Defines a variable for the CHART object. It specifies
*           the number of samples, pointer to the array of samples
*           for the data series and pointer to the next data series.
*           A member of this structure (show) is used as a flag to
*           determine if the series is to be drawn or not. Together with
*           the smplStart and smplEnd it will determine what kind of
*           chart will be drawn.
*
*********************************************************************/
typedef struct
```

```
{
    XCHAR   *pSData;    // Pointer to the data series name.
    WORD    samples;    // Indicates the number of data samples (or data points) contained
in the array specified by pData.
    BYTE    show;       // The flag to indicate if the data series will be shown or not. If
this flag is set to SHOW_DATA, the data series will be shown. If HIDE_DATA, the data series
will not be shown.
    WORD    *pData;     // Pointer to the array of data samples.
    void    *pNextData; // Pointer to the next data series. NULL if no other data series
follows.
} DATASERIES;

/*********************************************************************
* Overview: Defines the parameters for the CHART object.
*
*********************************************************************/
typedef struct
{
    XCHAR   *pTitle;            // Pointer to the Title of the chart.
    XCHAR   *pSmplLabel;        // Pointer to the bar chart sample axis label. Depending

    // if the bar chart is drawn vertically or horizontally, the
    // location of the sample will be in the x-axis or y-axis.
    XCHAR   *pValLabel;         // Pointer to the bar chart value axis label. Depending

    // if the bar chart is drawn vertically or horizontally, the
    // location of the sample will be in the x-axis or y-axis.
    SHORT   seriesCount;        // Number of data series that will be displayed when chart
is drawn.
    WORD    smplStart;          // Start point of data sample range to be displayed
(minimum/default value = 1)
    WORD    smplEnd;            // End point of data sample range to be displayed.
    WORD    valMax;             // Maximum value of a sample that can be displayed.
    WORD    valMin;             // Minimum value of a sample that can be displayed.
    WORD    perMax;             // Maximum value of the percentage range that can be
displayed.
    WORD    perMin;             // Minimum value of the percentage range that can be
displayed.
    WORD    *pColor;            // Pointer to the color table used to draw the chart data.
    void    *pTitleFont;        // Pointer to the font used for the title label of the
chart.
    void    *pAxisLabelsFont;   // Pointer to the font used for X and Y axis labels.
    void    *pGridLabelsFont;   // Pointer to the font used for X and Y axis grid labels.
} CHARTPARAM;

/*********************************************************************
* Overview: Defines the parameters required for a chart Object.
*
*********************************************************************/
typedef struct
{
    OBJ_HEADER  hdr;                    // Generic header for all Objects (see OBJ_HEADER).
    CHARTPARAM  prm;                    // Structure for the parameters of the chart.
    DATASERIES  *pChData;               // Pointer to the first chart data series in the
link list of data series.
} CHART;

/*********************************************************************
*   Data Color Table
*   - The following macroses defines the default colors used when
*     rendering chart data.
*********************************************************************/
#ifdef USE_PALETTE

    #include "PaletteColorDefines.h"

#else

    #define CH_CLR0     BRIGHTBLUE      // Bright Blue
    #define CH_CLR1     BRIGHTRED       // Bright Red
    #define CH_CLR2     BRIGHTGREEN     // Bright Green
    #define CH_CLR3     BRIGHTYELLOW    // Bright Yellow
    #define CH_CLR4     RGBConvert(0xFF, 0xBB, 0x4C) // Orange
    #define CH_CLR5     BLUE                           // Blue
    #define CH_CLR6     RED                            // Red
    #define CH_CLR7     GREEN                          // Green
    #define CH_CLR8     YELLOW                         // Yellow
    #define CH_CLR9     RGBConvert(255, 140, 0)      // Dark Orange
    #define CH_CLR10    LIGHTBLUE                      // Light Orange
    #define CH_CLR11    LIGHTRED                       // Light Red
    #define CH_CLR12    LIGHTGREEN                     // Light Green
    #define CH_CLR13    RGBConvert(255, 255, 150)    // Light Yellow
    #define CH_CLR14    RGBConvert(255, 200, 0)      // Light Orange
    #define CH_CLR15    RGBConvert(255, 215, 0)      // Gold

  #endif

  SHORT       ChSetDataSeries(CHART *pCh, WORD seriesNum, BYTE status);

  /*********************************************************************
  * Function: CHART  *ChCreate( WORD ID, SHORT left, SHORT top,
  *                             SHORT right, SHORT bottom,
  *                             WORD state, DATASERIES *pData,
  *                             CHARTPARAM *pParam, GOL_SCHEME *pScheme)
  *
  * Overview: This function creates a CHART object with the parameters given.
  *           It automatically attaches the new object into a global linked list of
  *           objects and returns the address of the object.
  *
  * PreCondition: none
  *
  * Input: ID - Unique user defined ID for the object instance.
  *        left - Left most position of the object.
  *        top - Top most position of the object.
  *        right - Right most position of the object.
  *        bottom - Bottom most position of the object.
  *        state - Sets the initial state of the object.
  *        pData - Pointer to the data for the contents of the chart. NULL can
  *                be assigned initially when creating the object.
  *        pParam - Pointer to the chart parameters. NULL can be assigned initially
  *                 when creating the object and the chart parameters can be
  *                 populated using the API provided.
  *        pScheme - Pointer to the style scheme used. When set to NULL,
  *                  the default style scheme will be used.
  *
  * Output: Returns the pointer to the object created.
  *
  * Example:
  *   <CODE>
  *
  *   extern const FONT_FLASH GOLSmallFont;
  *   extern const FONT_FLASH GOLMediumFont;
  *
  *   // Note that strings are declared as such to cover cases
  *   // where XCHAR type is declared as short (2 bytes).
  *   XCHAR ChTitle[]      = {'E','x','a','m','p','l','e',0};
  *   XCHAR SampleName[]   = {'C','a','t','e','g','o','r','y',0};
  *   XCHAR ValueName[]    = {'#','H','i','t','s',0};
  *   XCHAR SeriesName[2] = {
  *                           {'V','1',0},
  *                           {'V','2',0},
  *                          };
  *   V1Data[2] = { 50, 100};
  *   V2Data[2] = { 5,  10};
  *
  *   GOL_SCHEME  *pScheme;
  *   CHART       *pChart;
  *   CHARTPARAM   Contents;
  *   WORD         state;
  *
  *       pScheme = GOLCreateScheme();
  *       state = CH_BAR|CH_DRAW|CH_BAR_HOR;  // Bar Chart to be drawn with horizontal
  orientation
  *
```

```
*
*       pChart = ChCreate(0x01,                             // ID
*                         0, 0,                             // dimensions
*                         GetMaxX(),
*                         GetMaxY(),
*                         state,                            // state of the chart
*                         NULL,                             // data not initialized yet
*                         NULL,                             // no parameters yet
*                         pScheme);                         // style scheme used
*
*       if (pMyChart == NULL)                               // check if chart was allocated
memory
*           return 0;
*
*       ChSetTitleFont(pChart, (void*)&GOLMediumFont);
*       ChSetTitle(pChart, ChTitle);                        // set the title
*
*       // set the grid labels and axis labels font
*       ChSetGridLabelFont(pChart, (void*)&GOLSmallFont);
*       ChSetAxisLabelFont(pChart, (void*)&GOLSmallFont);
*
*       // set the labels for the X and Y axis
*       ChSetSampleLabel(pChart, (XCHAR*)SampleName);
*       ChSetValueLabel(pChart, (XCHAR*)ValueName);
*
*       ChAddDataSeries(pChart, 2, V1Data, (XCHAR*)SeriesName[0]);
*       ChAddDataSeries(pChart, 2, V2Data, (XCHAR*)SeriesName[1]);
*
*       // set the range of the sample values
*       ChSetValueRange(pChart, 0, 100);
*
*       // show all two samples to be displayed (start = 1, end = 2)
*       ChSetSampleRange(pChart, 1, 2);
*
*       GOLDraw();                                          // draw the chart
*
*   </CODE>
*
* Side Effects: none
*
********************************************************************/
CHART       *ChCreate
            (
                WORD        ID,
                SHORT       left,
                SHORT       top,
                SHORT       right,
                SHORT       bottom,
                WORD        state,
                DATASERIES  *pData,
                CHARTPARAM  *pParam,
                GOL_SCHEME  *pScheme
            );

/*********************************************************************
* Function: ChAddDataSeries(CHART *pCh, WORD nSamples, WORD *pData, XCHAR *pName)
*
* Overview: This function creates a DATASERIES object and
*           populates the structure with the given parameters.
*
* PreCondition: none
*
* Input: pCh - Pointer to the chart object.
*        nSamples - The number of samples or data points.
*        pData - Pointer to the array of samples or data points.
*        pName - Pointer to the string used to label the data series.
*
* Output: Returns the pointer to the data variable (DATASERIES) object created.
*          If NULL is returned, the addition of the new object failed due to
*          not enough memory for the object.
*
* Example: See ChCreate() example.
```

```
*
* Side Effects: Appends to the list of DATASERIES that the chart is operating on.
*               By default, the show flag of the newly added data series is set to
*               SHOW_DATA or enabled.
*
********************************************************************/
DATASERIES  *ChAddDataSeries(CHART *pCh, WORD nSamples, WORD *pData, XCHAR *pName);

/*********************************************************************
* Function: void ChFreeDataSeries(void *pObj)
*
* Overview: This function removes DATASERIES object from the list of
*           DATASERIES objects and frees the memory used of that removed object.
*
* PreCondition: none
*
* Input: pCh - Pointer to the chart object.
*
* Output: none.
*
*
* Example:
*   <CODE>
*
*   void ClearChartData(CHART *pCh) {
*       if(pCh->pChData != NULL)
*           // remove the all data series
*           ChFreeDataSeries(pCh;
*   }
*   </CODE>
*
* Side Effects: none.
*
********************************************************************/
void ChFreeDataSeries(void *pObj);

/*********************************************************************
* Function: ChRemoveDataSeries(CHART *pCh, WORD number)
*
* Overview: This function removes DATASERIES object from the list of
*           DATASERIES objects and frees the memory used of that removed object.
*           The position of the object to be removed is specified by the number
*           parameter. If the list has only one member, it removes the member
*           regardless of the number given.
*
* PreCondition: none
*
* Input: pCh - Pointer to the chart object.
*        number - The position of the object to be removed in the list where
*                 the first object in the list is assigned a value of 1.
*                 If this parameter is set to zero, the whole list of
*                 DATA_SERIES is removed.
*
* Output: none.
*
*
* Example:
*   <CODE>
*
*   void ClearChartData(CHART *pCh) {
*       if(pCh->pChData != NULL)
*           // remove the all data series
*           ChRemoveDataSeries(pCh, 0);
*   }
*   </CODE>
*
* Side Effects: none.
*
********************************************************************/
void        ChRemoveDataSeries(CHART *pCh, WORD number);

/*********************************************************************
```

```
* Macros: SHORT ChShowSeries(CHART *pCh, WORD seriesNum)
*
* Overview: This macro sets the specified data series number
*           show flag to be set to SHOW_DATA.
*
* PreCondition: none
*
* Input: pCh - Pointer to the chart object.
*        seriesNum - The data series number that will be modified.
*                    If this number is zero, all the entries' flag in the
*                    list will be set to SHOW_DATA.
*
* Output: Returns the same passed number if successful otherwise
*         -1 if unsuccesful.
*
* Example:
*   <CODE>
*   // from the example in  ChCreate() we change the items to be shown when
*   // GOLDraw() is called.
*
*   // reset all data series to be HIDE_DATA
*   ChHideSeries(pMyChart, 0);
*   // set data series 1 (V1Data) to be shown
*   ChShowSeries(pMyChart, 1);
*   // draw the chart
*   GOLDraw();
*   .....
*   </CODE> *
* Side Effects: none
*
********************************************************************/
    #define ChShowSeries(pCh, seriesNum)    (ChSetDataSeries(pCh, seriesNum, SHOW_DATA))

/*********************************************************************
* Macros: SHORT ChHideSeries(CHART *pCh, WORD seriesNum)
*
* Overview: This macro sets the specified data series number
*           show flag to be set to HIDE_DATA.
*
* PreCondition: none
*
* Input: pCh - Pointer to the chart object.
*        seriesNum - The data series number that will be modified.
*                    If this number is zero, all the entries' flag in the
*                    list will be set to HIDE_DATA.
*
* Output: Returns the same passed number if successful otherwise
*         -1 if unsuccesful.
*
* Example: See ChShowSeries() example.
*
* Side Effects: none
*
********************************************************************/
    #define ChHideSeries(pCh, seriesNum)    (ChSetDataSeries(pCh, seriesNum, HIDE_DATA))

/*********************************************************************
* Macros: ChGetShowSeriesCount(pCh)
*
* Overview: This macro shows the number of data series that has
*           its show flag set to SHOW_DATA
*
* PreCondition: none
*
* Input: pCh - Pointer to the object.
*
* Output: Returns the number of data series with its show flag set to
*         SHOW_DATA.
*
* Side Effects: none
*
********************************************************************/
```

```
    #define ChGetShowSeriesCount(pCh)   (pCh->prm.seriesCount)

/*********************************************************************
* Macros: ChGetShowSeriesStatus(pDSeries)
*
* Overview: This macro returns the show ID status of the DATASERIES.
*
* PreCondition: none
*
* Input: pDSeries - Pointer to the data series(DATASERIES) that is
*                   being checked.
*
* Output: Returns the status of the show flag.
*         1 - (SHOW_DATA) means that the show status flag is set.
*         0 - (HIDE_DATA) means that the show status flag is not set.
*
* Side Effects: none
*
********************************************************************/
    #define ChGetShowSeriesStatus(pDSeries) (pDSeries->show)

/*********************************************************************
* Macros: ChGetValueMax(pCh)
*
* Overview: This macro returns the current maximum value that will
*           be drawn for bar charts.
*
* PreCondition: none
*
* Input: pCh - Pointer to the object.
*
* Output: Returns the maximum value set when bar charts are drawn.
*
* Side Effects: none
*
********************************************************************/
    #define ChGetValueMax(pCh)  (pCh->prm.valMax)

/*********************************************************************
* Macros: ChGetValueMin(pCh)
*
* Overview: This macro returns the current minimum value that will
*           be drawn for bar charts.
*
* PreCondition: none
*
* Input: pCh - Pointer to the object.
*
* Output: Returns the minimum value set when bar charts are drawn.
*
* Side Effects: none
*
********************************************************************/
    #define ChGetValueMin(pCh)  (pCh->prm.valMin)

/*********************************************************************
* Function: ChSetValueRange(CHART *pCh, WORD min, WORD max)
*
* Overview: This function sets the minimum and maximum range of values
*           that the bar chart will show.
*           The criteria is that min <= max.
*
* PreCondition: none
*
* Input: pCh - Pointer to the chart object.
*        min - Minimum value that will be displayed in the bar chart.
*        max - Maximum value that will be displayed in the bar chart.
*
* Output: none.
*
* Side Effects: none.
*
```

```
********************************************************************/
void    ChSetValueRange(CHART *pCh, WORD min, WORD max);

/*********************************************************************
* Function: ChGetValueRange(pCh)
*
* Overview: This macro gets the current range for bar charts.
*           The value returned is calculated from the current (valMax - valMin) set.
*           To get the minimum use ChGetValueMin() and to get the
*           maximum use ChGetValueMax().
*
* PreCondition: none
*
* Input: pCh - Pointer to the chart object.
*
* Output: Value range computed from valMax-valMin.
*
* Side Effects: none.
*
********************************************************************/
    #define ChGetValueRange(pCh)    (pCh->prm.valMax - pCh->prm.valMin)

/*********************************************************************
* Macros: ChGetPercentMax(pCh)
*
* Overview: This macro returns the current maximum value of the percentage
*           range that will be drawn for bar charts when CH_PERCENTAGE bit state
*           is set.
*
* PreCondition: none
*
* Input: pCh - Pointer to the object.
*
* Output: Returns the maximum percentage value set when bar charts are drawn.
*
* Side Effects: none
*
********************************************************************/
    #define ChGetPercentMax(pCh)    (pCh->prm.perMax)

/*********************************************************************
* Macros: ChGetPercentMin(pCh)
*
* Overview: This macro returns the current minimum value of the percentage
*           range that will be drawn for bar charts when CH_PERCENTAGE bit state
*           is set.
*
* PreCondition: none
*
* Input: pCh - Pointer to the object.
*
* Output: Returns the minimum percentage value when bar charts are drawn.
*
* Side Effects: none
*
********************************************************************/
    #define ChGetPercentMin(pCh)    (pCh->prm.perMin)

/*********************************************************************
* Function: ChSetPercentRange(CHART *pCh, WORD min, WORD max)
*
* Overview: This function sets the minimum and maximum range of
*           percentage that the bar chart will show.
*           The criteria is that min <= max.
*           This affects bar charts only and CH_PERCENTAGE bit state is set.
*
* PreCondition: none
*
* Input: pCh - Pointer to the chart object.
*        min - Minimum percentage value that will be displayed in the bar chart.
*        max - Maximum percentage value that will be displayed in the bar chart.
*
```

```
 * Output: none.
 *
 * Side Effects: none.
 *
 ********************************************************************/
 void    ChSetPercentRange(CHART *pCh, WORD min, WORD max);

 /*********************************************************************
 * Function: ChGetPercentRange(pCh)
 *
 * Overview: This macro gets the percentage range for bar charts.
 *           The value returned is calculated from percentage max - min.
 *           To get the minimum use ChGetPercentMin() and to get the
 *           maximum use ChGetPercentMax().
 *
 * PreCondition: none
 *
 * Input: pCh - Pointer to the chart object.
 *
 * Output: Percentage range computed from max-min.
 *
 * Side Effects: none.
 *
 ********************************************************************/
     #define ChGetPercentRange(pCh)  (pCh->prm.perMax - pCh->prm.perMin)

 /*********************************************************************
 * Function: ChSetSampleRange(CHART *pCh, WORD start, WORD end)
 *
 * Overview: This function sets the sample start and sample end when
 *           drawing the chart. Together with the data series' SHOW_DATA
 *           flags the different way of displaying the chart data is achieved.
 *
 *   <TABLE>
 *       Start & End Value           The # of Data Series Flag Set   Chart Description
 *       ##################          #############################   ###########
 *       Start <= End                1                               Show the data indicated
 by Start and End points of the DATASERIES with the flag set
 *       Start  = End                1                               Show the data indicated
 by Start or End points of the DATASERIES with the flag set
 *       Start, End = don't care     > 1                             Show the data indicated
 by Start point of the DATASERIES with the flag set. Each samples of all checked data series
 are grouped together according to sample number.
 *   </TABLE>
 *
 * PreCondition: none
 *
 * Input: pCh - Pointer to the chart object.
 *         start - Start point of the data samples to be displayed.
 *         end - End point of the data samples to be displayed.
 *
 * Output: none.
 *
 * Example: See ChCreate() example.
 *
 * Side Effects: none.
 *
 ********************************************************************/
 void    ChSetSampleRange(CHART *pCh, WORD start, WORD end);

 /*********************************************************************
 * Function: ChGetSampleRange(pCh)
 *
 * Overview: This macro gets the sample range for pie or bar charts.
 *           The value returned is calculated from smplEnd - smplStart.
 *
 * PreCondition: none
 *
 * Input: pCh - Pointer to the chart object.
 *
 * Output: Sample range computed from smplEnd - smplStart.
 *
 * Side Effects: none.
 *
 ********************************************************************/
    #define ChGetSampleRange(pCh)   (ChGetSampleEnd(pCh) - ChGetSampleStart(pCh))

/*********************************************************************
 * Macros:  ChGetSampleStart(pCh)
 *
 * Overview: This macro returns the sampling start value.
 *
 * PreCondition: none
 *
 * Input: pCh - Pointer to the object.
 *
 * Output: Returns the sample start point.
 *
 * Side Effects: none
 *
 ********************************************************************/
    #define ChGetSampleStart(pCh)   (((CHART *)pCh)->prm.smplStart)

/*********************************************************************
 * Macros:  ChGetSampleEnd(pCh)
 *
 * Overview: This macro returns the sampling end value.
 *
 * PreCondition: none
 *
 * Input: pCh - Pointer to the object.
 *
 * Output: Returns the sample end point.
 *
 * Side Effects: none
 *
 ********************************************************************/
    #define ChGetSampleEnd(pCh) ((CHART *)pCh)->prm.smplEnd

/*********************************************************************
 * Macros: ChSetTitle(pCh, pNewTitle)
 *
 * Overview: This macro sets the address of the current
 *           text string used for the title of the chart.
 *
 * PreCondition: none
 *
 * Input: pCh - Pointer to the object.
 *        pNewTitle - pointer to the string to be used as a title
 *                    of the chart.
 *
 * Output: none.
 *
 * Example: See ChCreate() example.
 *
 * Side Effects: none
 *
 ********************************************************************/
    #define ChSetTitle(pCh, pNewTitle)  (((CHART *)pCh)->prm.pTitle = pNewTitle)

/*********************************************************************
 * Macros: ChGetTitle(pCh)
 *
 * Overview: This macro returns the address of the current
 *           text string used for the title of the chart.
 *
 * PreCondition: none
 *
 * Input: pCh - Pointer to the object.
 *
 * Output: Returns the pointer to the current title text used.
 *
 * Side Effects: none
 *
```

```
********************************************************************/
    #define ChGetTitle(pCh) (((CHART *)pCh)->prm.pTitle)

/*********************************************************************
* Macros: ChSetAxisLabelFont(pCh, pNewFont)
*
* Overview: This macro sets the location of the font used for
*           the X and Y axis labels of the chart.
*
* PreCondition: none
*
* Input: pCh - Pointer to the object.
*        pNewFont - Pointer to the font used.
*
* Output: none.
*
* Example: See ChCreate() example.
*
* Side Effects: none
*
********************************************************************/
    #define ChSetAxisLabelFont(pCh, pNewFont)   (((CHART *)pCh)->prm.pAxisLabelsFont =
pNewFont)

/*********************************************************************
* Macros: ChGetAxisLabelFont(pCh)
*
* Overview: This macro returns the location of the font used for
*           the X and Y axis labels of the chart.
*
* PreCondition: none
*
* Input: pCh - Pointer to the object.
*
* Output: Returns the address of the current font used for the title text.
*
* Side Effects: none
*
********************************************************************/
    #define ChGetAxisLabelFont(pCh) (((CHART *)pCh)->prm.pAxisLabelsFont)

/*********************************************************************
* Macros: ChSetGridLabelFont(pCh, pNewFont)
*
* Overview: This macro sets the location of the font used for
*           the X and Y axis grid labels of the chart.
*
* PreCondition: none
*
* Input: pCh - Pointer to the object.
*        pNewFont - Pointer to the font used.
*
* Output: none.
*
* Example: See ChCreate() example.
*
* Side Effects: none
*
********************************************************************/
    #define ChSetGridLabelFont(pCh, pNewFont)   (((CHART *)pCh)->prm.pGridLabelsFont =
pNewFont)

/*********************************************************************
* Macros: ChGetGridLabelFont(pCh)
*
* Overview: This macro returns the location of the font used for
*           the X and Y axis grid labels of the chart.
*
* PreCondition: none
*
* Input: pCh - Pointer to the object.
*
```

```
* Output: Returns the address of the current font used for the title text.
*
* Side Effects: none
*
********************************************************************/
    #define ChGetGridLabelFont(pCh) (((CHART *)pCh)->prm.pGridLabelsFont)

/*********************************************************************
* Macros: ChSetTitleFont(pCh, pNewFont)
*
* Overview: This macro sets the location of the font used for
*           the title of the chart.
*
* PreCondition: none
*
* Input: pCh - Pointer to the object.
*        pNewFont - Pointer to the font used.
*
* Output: none.
*
* Example: See ChCreate() example.
*
* Side Effects: none
*
********************************************************************/
    #define ChSetTitleFont(pCh, pNewFont)   (((CHART *)pCh)->prm.pTitleFont = pNewFont)

/*********************************************************************
* Macros: ChGetTitleFont(pCh)
*
* Overview: This macro returns the location of the font used for
*           the title of the chart.
*
* PreCondition: none
*
* Input: pCh - Pointer to the object.
*
* Output: Returns the address of the current font used for the title text.
*
* Side Effects: none
*
********************************************************************/
    #define ChGetTitleFont(pCh) (((CHART *)pCh)->prm.pTitleFont)

/*********************************************************************
* Macros: ChSetSampleLabel(pCh, pNewXLabel)
*
* Overview: This macro sets the address of the current
*           text string used for the sample axis label of the bar chart.
*
* PreCondition: none
*
* Input: pCh - Pointer to the object.
*        pNewXLabel - pointer to the string to be used as an sample
*                     axis label of the bar chart.
*
* Output: none.
*
* Example: See ChCreate() example.
*
* Side Effects: none
*
********************************************************************/
    #define ChSetSampleLabel(pCh, pNewXLabel)   (((CHART *)pCh)->prm.pSmplLabel =
pNewXLabel)

/*********************************************************************
* Macros: ChGetSampleLabel(pCh)
*
* Overview: This macro returns the address of the current
*           text string used for the sample axis label of the bar chart.
*
```

```
* PreCondition: none
*
* Input: pCh - Pointer to the object.
*
* Output: Returns the pointer to the current sample axis label text
*         of the bar chart.
*
* Side Effects: none
*
********************************************************************/
    #define ChGetSampleLabel(pCh)   (((CHART *)pCh)->prm.pSmplLabel)

/*********************************************************************
* Macros: ChSetValueLabel(pCh, pNewYLabel)
*
* Overview: This macro sets the address of the current
*           text string used for the value axis label of the bar chart.
*
* PreCondition: none
*
* Input: pCh - Pointer to the object.
*        pNewYLabel - pointer to the string to be used as an value
*                     axis label of the bar chart.
*
* Output: none.
*
* Example: See ChCreate() example.
*
* Side Effects: none
*
********************************************************************/
    #define ChSetValueLabel(pCh, pNewValueLabel)    (((CHART *)pCh)->prm.pValLabel =
pNewValueLabel)

/*********************************************************************
* Macros: ChGetValueLabel(pCh)
*
* Overview: This macro returns the address of the current
*           text string used for the value axis label of the bar chart.
*
* PreCondition: none
*
* Input: pCh - Pointer to the object.
*
* Output: Returns the pointer to the current value axis label text
*         of the bar chart.
*
* Side Effects: none
*
********************************************************************/
    #define ChGetValueLabel(pCh)    (((CHART *)pCh)->prm.pValLabel)

/*********************************************************************
* Macros: ChSetColorTable(pCh, pNewTable)
*
* Overview: This macro sets the color table used to draw the data
*           in pie and bar charts.
*
* PreCondition: none
*
* Input: pCh - Pointer to the object.
*        pNewTable - Pointer to the color table that will be used.
*
* Output: none.
*
* Side Effects: none
*
********************************************************************/
    #define ChSetColorTable(pCh, pNewTable) ((((CHART *)pCh)->prm.pColor) = pNewTable)

/*********************************************************************
* Macros: ChGetColorTable(pCh)
```

```
*
* Overview: This macro returns the current color table used for
*           the pie and bar charts.
*
* PreCondition: none
*
* Input: pCh - Pointer to the object.
*
* Output: Returns the address of the color table used.
*
* Side Effects: none
*
********************************************************************/
    #define ChGetColorTable(pCh)    (((CHART *)pCh)->prm.pColor)

/*********************************************************************
* Function: ChTranslateMsg(void *pObj, GOL_MSG *pMsg)
*
* Overview: This function evaluates the message from a user if the
*           message will affect the object or not. The table below enumerates
*           the translated messages for each event of the touch screen
*           and keyboard inputs.
*
*    <TABLE>
*       Translated Message   Input Source  Events
Description
*       ##################   ############  ######
###########
*       CH_MSG_SELECTED      Touch Screen  EVENT_PRESS, EVENT_RELEASE, EVENT_MOVE   If
events occurs and the x,y position falls in the area of the chart.
*       OBJ_MSG_INVALID      Any           Any                                      If the
message did not affect the object.
*    </TABLE>
*
* PreCondition: none
*
* Input: pCh    - The pointer to the object where the message will be
*                 evaluated to check if the message will affect the object.
*        pMsg  - Pointer to the message struct containing the message from
*                 the user interface.
*
* Output: Returns the translated message depending on the received GOL message:
*       - CH_MSG_SELECTED – Chart area is selected
*       - OBJ_MSG_INVALID – Chart is not affected
*
* Output: none.
*
* Side Effects: none
*
********************************************************************/
WORD    ChTranslateMsg(void *pObj, GOL_MSG *pMsg);

/*********************************************************************
* Function: WORD ChDraw(void *pObj)
*
* Overview: This function renders the object on the screen using
*           the current parameter settings. Location of the object is
*           determined by the left, top, right and bottom parameters.
*           The colors used are dependent on the state of the object.
*           The font used is determined by the style scheme set.
*
*           The colors of the bars of the bar chart or sectors of the
*           pie chart can be the default color table  or user defined
*           color table set by ChSetColorTable() function.
*
*           When rendering objects of the same type, each object
*           must be rendered completely before the rendering of the
*           next object is started. This is to avoid incomplete
*           object rendering.
*
* PreCondition: Object must be created before this function is called.
*
```

```
* Input: pCh - Pointer to the object to be rendered.
*
* Output: Returns the status of the drawing
*         - 1 - If the rendering was completed and
*         - 0 - If the rendering is not yet finished.
*         Next call to the function will resume the
*         rendering on the pending drawing state.
*
* Side Effects: none.
*
********************************************************************/
WORD ChDraw(void *pObj);
#endif // _CHART_H
```

14.1.12 CheckBox.c

This is file CheckBox.c.

Body Source

```
/*****************************************************************************
  *  Module for Microchip Graphics Library
  *  GOL Layer
  *  Check Box
  *****************************************************************************
  * FileName:        CheckBox.c
  * Dependencies:    None
  * Processor:       PIC24F, PIC24H, dsPIC, PIC32
  * Compiler:        MPLAB C30 V3.00, C32
  * Linker:          MPLAB LINK30, LINK32
  * Company:         Microchip Technology Incorporated
  *
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  * OR OTHER SIMILAR COSTS.
  *
  * Date         Comment
  *~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
  * 11/12/07     Version 1.0 release
  * 04/20/11     Fixed KEYBOARD bug on object ID and GOL_MSG param1 comparison.
  *****************************************************************************/
#include "Graphics/Graphics.h"

#ifdef USE_CHECKBOX

/*********************************************************************
* Function: CHECKBOX  *CbCreate(WORD ID, SHORT left, SHORT top, SHORT right,
*                               SHORT bottom, WORD state, XCHAR *pText,
```

```
*                               GOL_SCHEME *pScheme)
*
* Overview: Creates the check box.
*
********************************************************************/
CHECKBOX *CbCreate
(
    WORD        ID,
    SHORT       left,
    SHORT       top,
    SHORT       right,
    SHORT       bottom,
    WORD        state,
    XCHAR       *pText,
    GOL_SCHEME  *pScheme
)
{
    CHECKBOX    *pCb = NULL;

    pCb = (CHECKBOX *)GFX_malloc(sizeof(CHECKBOX));
    if(pCb == NULL)
        return (pCb);

    pCb->hdr.ID = ID;
    pCb->hdr.pNxtObj = NULL;
    pCb->hdr.type = OBJ_CHECKBOX;
    pCb->hdr.left = left;
    pCb->hdr.top = top;
    pCb->hdr.right = right;
    pCb->hdr.bottom = bottom;
    pCb->pText = pText;
    pCb->hdr.state = state;
    pCb->hdr.DrawObj = CbDraw;              // draw function
    pCb->hdr.MsgObj = CbTranslateMsg;       // message function
    pCb->hdr.MsgDefaultObj = CbMsgDefault;  // default message function
    pCb->hdr.FreeObj = NULL;                // free function

    // Set the style scheme
    if(pScheme == NULL)
        pCb->hdr.pGolScheme = _pDefaultGolScheme;
    else
        pCb->hdr.pGolScheme = (GOL_SCHEME *)pScheme;

    // Set the text height
    pCb->textHeight = 0;
    if(pText != NULL)
    {
        pCb->textHeight = GetTextHeight(pCb->hdr.pGolScheme->pFont);
    }

    GOLAddObject((OBJ_HEADER *)pCb);

    return (pCb);
}

/*********************************************************************
* Function: CbSetText(CHECKBOX *pCb, char *pText)
*
* Overview: Sets the text.
*
********************************************************************/
void CbSetText(CHECKBOX *pCb, XCHAR *pText)
{
    pCb->pText = pText;
    pCb->textHeight = GetTextHeight((BYTE *)pCb->hdr.pGolScheme->pFont);
}

/*********************************************************************
* Function: CbMsgDefault(WORD translatedMsg, void *pObj, GOL_MSG* pMsg)
*
* Overview: Changes the state of the check box by default.
*
```

```
 *********************************************************************/
void CbMsgDefault(WORD translatedMsg, void *pObj, GOL_MSG *pMsg)
{
    CHECKBOX *pCb;

    pCb = (CHECKBOX *)pObj;

        #ifdef USE_FOCUS
            #ifdef USE_TOUCHSCREEN
    if(pMsg->type == TYPE_TOUCHSCREEN)
    {
        if(!GetState(pCb, CB_FOCUSED))
        {
            GOLSetFocus((OBJ_HEADER *)pCb);
        }
    }

            #endif
        #endif
    switch(translatedMsg)
    {
        case CB_MSG_CHECKED:
            SetState(pCb, CB_CHECKED | CB_DRAW_CHECK);  // Set checked and redraw
            break;

        case CB_MSG_UNCHECKED:
            ClrState(pCb, CB_CHECKED);                  // Reset check
            SetState(pCb, CB_DRAW_CHECK);               // Redraw
            break;
    }
}

/*********************************************************************
* Function: WORD CbTranslateMsg(void *pObj, GOL_MSG *pMsg)
*
* Overview: Checks if the check box will be affected by the message
*           and returns translated message.
*
*********************************************************************/
WORD CbTranslateMsg(void *pObj, GOL_MSG *pMsg)
{

    CHECKBOX *pCb;

    pCb = (CHECKBOX *)pObj;

    // Evaluate if the message is for the check box
    // Check if disabled first
    if(GetState(pCb, CB_DISABLED))
        return (OBJ_MSG_INVALID);

        #ifdef USE_TOUCHSCREEN
    if(pMsg->type == TYPE_TOUCHSCREEN)
    {

        // Check if it falls in the check box borders
        if
        (
            (pCb->hdr.left < pMsg->param1) &&
            (pCb->hdr.right > pMsg->param1) &&
            (pCb->hdr.top < pMsg->param2) &&
            (pCb->hdr.bottom > pMsg->param2)
        )
        {
            if(pMsg->uiEvent == EVENT_PRESS)
            {
                if(GetState(pCb, CB_CHECKED))
                    return (CB_MSG_UNCHECKED);
                else
                    return (CB_MSG_CHECKED);
            }
        }
        return (OBJ_MSG_INVALID);
    }

        #endif
        #ifdef USE_KEYBOARD
    if(pMsg->type == TYPE_KEYBOARD)
    {
        if((WORD)pMsg->param1 == pCb->hdr.ID)
        {
            if(pMsg->uiEvent == EVENT_KEYSCAN)
            {
                if((pMsg->param2 == SCAN_SPACE_PRESSED) || (pMsg->param2 ==
SCAN_CR_PRESSED))
                {
                    if(GetState(pCb, CB_CHECKED))
                        return (CB_MSG_UNCHECKED);
                    else
                        return (CB_MSG_CHECKED);
                }
            }
        }

        return (OBJ_MSG_INVALID);
    }

        #endif
    return (OBJ_MSG_INVALID);
}

/*********************************************************************
* Function: WORD CbDraw(void *pObj)
*
* Output: returns the status of the drawing
*         0 - not complete
*         1 - done
*
* Overview: Draws check box.
*
********************************************************************/
WORD CbDraw(void *pObj)
{
    typedef enum
    {
        REMOVE,
        BOX_DRAW,
        RUN_DRAW,
        TEXT_DRAW,
        TEXT_DRAW_RUN,
        CHECK_DRAW,
        FOCUS_DRAW
    } CB_DRAW_STATES;

    static CB_DRAW_STATES state = REMOVE;

    SHORT checkIndent;
    CHECKBOX *pCb;

    pCb = (CHECKBOX *)pObj;

    if(IsDeviceBusy())
        return (0);

    switch(state)
    {
        case REMOVE:
            if(GetState(pCb, CB_HIDE | CB_DRAW))
            {
                SetColor(pCb->hdr.pGolScheme->CommonBkColor);
                if(!Bar(pCb->hdr.left, pCb->hdr.top, pCb->hdr.right, pCb->hdr.bottom))
                {
                    return (0);
                }

                if(GetState(pCb, CB_HIDE))
                    return (1);
            }

            state = BOX_DRAW;

        case BOX_DRAW:
            if(GetState(pCb, CB_DRAW))
            {
                if(!GetState(pCb, CB_DISABLED))
                {
                    GOLPanelDraw
                    (
                        pCb->hdr.left + CB_INDENT,
                        pCb->hdr.top + CB_INDENT,
                        pCb->hdr.left + (pCb->hdr.bottom - pCb->hdr.top) - CB_INDENT,
                        pCb->hdr.bottom - CB_INDENT,
                        0,
                        pCb->hdr.pGolScheme->Color0,
                        pCb->hdr.pGolScheme->EmbossDkColor,
                        pCb->hdr.pGolScheme->EmbossLtColor,
                        NULL,
                        GOL_EMBOSS_SIZE
                    );
                }
                else
                {
                    GOLPanelDraw
                    (
                        pCb->hdr.left + CB_INDENT,
                        pCb->hdr.top + CB_INDENT,
                        pCb->hdr.left + (pCb->hdr.bottom - pCb->hdr.top) - CB_INDENT,
                        pCb->hdr.bottom - CB_INDENT,
                        0,
                        pCb->hdr.pGolScheme->ColorDisabled,
                        pCb->hdr.pGolScheme->EmbossDkColor,
                        pCb->hdr.pGolScheme->EmbossLtColor,
                        NULL,
                        GOL_EMBOSS_SIZE
                    );
                }

                state = RUN_DRAW;

            case RUN_DRAW:
                if(!GOLPanelDrawTsk())
                    return (0);
                state = TEXT_DRAW;

            case TEXT_DRAW:
                if(pCb->pText != NULL)
                {
                    SetFont(pCb->hdr.pGolScheme->pFont);

                    if(!GetState(pCb, CB_DISABLED))
                    {
                        SetColor(pCb->hdr.pGolScheme->TextColor0);
                    }
                    else
                    {
                        SetColor(pCb->hdr.pGolScheme->TextColorDisabled);
                    }

                    MoveTo
                    (
                        pCb->hdr.left + pCb->hdr.bottom - pCb->hdr.top + CB_INDENT,
                        (pCb->hdr.bottom + pCb->hdr.top - pCb->textHeight) >> 1
                    );

                    state = TEXT_DRAW_RUN;
                case TEXT_DRAW_RUN:
                    if(!OutText(pCb->pText))
                        return (0);
                }
            }

            state = CHECK_DRAW;

        case CHECK_DRAW:
            if(GetState(pCb, CB_DRAW | CB_DRAW_CHECK))
            {
                if(!GetState(pCb, CB_DISABLED))
                {
                    if(GetState(pCb, CB_CHECKED))
                    {
                        SetColor(pCb->hdr.pGolScheme->TextColor0);
                    }
                    else
                    {
                        SetColor(pCb->hdr.pGolScheme->Color0);
                    }
                }
                else
                {
                    if(GetState(pCb, CB_CHECKED))
                    {
                        SetColor(pCb->hdr.pGolScheme->TextColorDisabled);
                    }
                    else
                    {
                        SetColor(pCb->hdr.pGolScheme->ColorDisabled);
                    }
                }

                checkIndent = (pCb->hdr.bottom - pCb->hdr.top) >> 2;

                if
                (
                    !Bar
                        (
                            pCb->hdr.left + checkIndent + GOL_EMBOSS_SIZE,
                            pCb->hdr.top + checkIndent + GOL_EMBOSS_SIZE,
                            pCb->hdr.left + (pCb->hdr.bottom - pCb->hdr.top) - checkIndent
  - GOL_EMBOSS_SIZE,
                            pCb->hdr.bottom - checkIndent - GOL_EMBOSS_SIZE
                        )
                )
                {
                    return (0);
                }
            }

            state = FOCUS_DRAW;

        case FOCUS_DRAW:
            if(GetState(pCb, CB_DRAW | CB_DRAW_FOCUS))
            {
                if(GetState(pCb, CB_FOCUSED))
                {
                    SetColor(pCb->hdr.pGolScheme->TextColor0);
                }
                else
                {
                    SetColor(pCb->hdr.pGolScheme->CommonBkColor);
                }

                SetLineType(FOCUS_LINE);
                if(!Rectangle(pCb->hdr.left, pCb->hdr.top, pCb->hdr.right, pCb->hdr.bottom))
                {
                    return (0);
                }
                SetLineType(SOLID_LINE);
            }

            state = REMOVE;
            return (1);
    }

    return (1);
}

#endif // USE_CHECKBOX
```

14.1.13 CheckBox.h

Functions

	Name	Description
	CbCreate (see page 133)	This function creates a CHECKBOX (see page 138) object with the parameters given. It automatically attaches the new object into a global linked list of objects and returns the address of the object.
	CbDraw (see page 134)	This function renders the object on the screen using the current parameter settings. Location of the object is determined by the left, top, right and bottom parameters. The colors used are dependent on the state of the object. The font used is determined by the style scheme set. When rendering objects of the same type, each object must be rendered completely before the rendering of the next object is started. This is to avoid incomplete object rendering.
	CbMsgDefault (see page 136)	This function performs the actual state change based on the translated message given. The following state changes are supported:
	CbSetText (see page 135)	This function sets the text that will be used.
	CbTranslateMsg (see page 137)	This function evaluates the message from a user if the message will affect the object or not. The table below enumerates the translated messages for each event of the touch screen and keyboard inputs.

Macros

Name	Description
CB_CHECKED (see page 131)	Checked state
CB_DISABLED (see page 132)	Disabled state
CB_DRAW (see page 132)	Whole check box must be redrawn
CB_DRAW_CHECK (see page 132)	Check box mark should be redrawn
CB_DRAW_FOCUS (see page 132)	Focus must be redrawn
CB_FOCUSED (see page 132)	Focus state
CB_HIDE (see page 133)	Check box must be removed from screen
CbGetText (see page 135)	This macro returns the location of the text used for the check box.

Structures

Name	Description
CHECKBOX (see page 138)	The structure contains check box data

Description

This is file CheckBox.h.

Body Source

```
/*****************************************************************************
 *  Module for Microchip Graphics Library
 *  GOL Layer
 *  Check box
 *****************************************************************************
 * FileName:        CheckBox.h
 * Dependencies:    None
 * Processor:       PIC24F, PIC24H, dsPIC, PIC32
 * Compiler:        MPLAB C30 V3.00, MPLAB C32
 * Linker:          MPLAB LINK30, MPLAB LINK32
 * Company:         Microchip Technology Incorporated
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 * CLAIMS BY THIRD PARTIES (INCLUDING BUT NOT LIMITED TO ANY DEFENSE THEREOF),
 * OR OTHER SIMILAR COSTS.
 *
 * Date         Comment
 *~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
 * 11/12/07     Version 1.0 release
 *****************************************************************************/
#ifndef _CHECKBOX_H
    #define _CHECKBOX_H

    #include <Graphics/GOL.h>
    #include "GenericTypeDefs.h"
// This is indent from outside borders
    #define CB_INDENT   2

/*********************************************************************
* Object States Definition:
*********************************************************************/
    #define CB_FOCUSED      0x0001  // Focus state
    #define CB_DISABLED     0x0002  // Disabled state
    #define CB_CHECKED      0x0004  // Checked state
    #define CB_HIDE         0x8000  // Check box must be removed from screen
    #define CB_DRAW_FOCUS   0x2000  // Focus must be redrawn
    #define CB_DRAW         0x4000  // Whole check box must be redrawn
    #define CB_DRAW_CHECK   0x1000  // Check box mark should be redrawn

/*********************************************************************
* Overview: The structure contains check box data
*********************************************************************/
typedef struct
{
    OBJ_HEADER  hdr;        // Generic header for all Objects (see OBJ_HEADER).
    SHORT       textHeight; // Pre-computed text height
    XCHAR       *pText;     // Pointer to text
} CHECKBOX;

/*********************************************************************
* Macros: CbGetText(pCb)
*
* Overview: This macro returns the location of the text
*           used for the check box.
*
* PreCondition: none
```

```
 *
 * Input: pCb - Pointer to the object
 *
 * Output: Returns the location of the text used.
 *
 * Side Effects: none
 *
 ********************************************************************/
    #define CbGetText(pCb)  pCb->pText

/*********************************************************************
 * Function: CbSetText(CHECKBOX *pCb, XCHAR *pText)
 *
 * Overview: This function sets the text that will be used.
 *
 * PreCondition: none
 *
 * Input: pCb - The pointer to the check box whose text will be modified.
 *        pText - The pointer to the text that will be used.
 *
 * Output: none
 *
 * Side Effects: none
 *
 ********************************************************************/
void        CbSetText(CHECKBOX *pCb, XCHAR *pText);

/*********************************************************************
 * Function: CHECKBOX  *CbCreate(WORD ID, SHORT left, SHORT top, SHORT right,
 *                               SHORT bottom, WORD state, XCHAR *pText,
 *                               GOL_SCHEME *pScheme)
 *
 * Overview: This function creates a CHECKBOX object with the parameters
 *           given. It automatically attaches the new object into a
 *           global linked list of objects and returns the address
 *           of the object.
 *
 * PreCondition: none
 *
 * Input: ID - Unique user defined ID for the object instance.
 *        left - Left most position of the Object.
 *        top - Top most position of the Object.
 *        right - Right most position of the Object
 *        bottom - Bottom most position of the object
 *        state - Sets the initial state of the object
 *        pText - Pointer to the text of the check box.
 *        pScheme - Pointer to the style scheme
 *
 * Output: Returns the pointer to the object created
 *
 * Example:
 *   <CODE>
 *   GOL_SCHEME *pScheme;
 *   CHECKBOX *pCb[2];
 *
 *       pScheme = GOLCreateScheme();
 *       pCb = CbCreate(ID_CHECKBOX1,          // ID
 *                      20,135,150,175,        // dimension
 *                      CB_DRAW,               // Draw the object
 *                      "Scale",               // text
 *                      pScheme);              // use this scheme
 *
 *       pCb = CbCreate(ID_CHECKBOX2,          // ID
 *                      170,135,300,175,       // dimension
 *                      CB_DRAW,               // Draw the object
 *                      "Animate",             // text
 *                      pScheme);              // use this scheme
 *
 *       while(!CbDraw(pCb[0]));               // draw the objects
 *       while(!CbDraw(pCb[1]));
 *   </CODE>
 *
```

```
* Side Effects: none
*
********************************************************************/
CHECKBOX    *CbCreate
            (
                WORD        ID,
                SHORT       left,
                SHORT       top,
                SHORT       right,
                SHORT       bottom,
                WORD        state,
                XCHAR       *pText,
                GOL_SCHEME  *pScheme
            );

/*********************************************************************
* Function: WORD CbTranslateMsg(void *pObj, GOL_MSG *pMsg)
*
* Overview: This function evaluates the message from a user if
*           the message will affect the object or not. The table
*           below enumerates the translated messages for each event
*           of the touch screen and keyboard inputs.
*
*   <TABLE>
*       Translated Message   Input Source  Events           Description
*       ##################   ############  ######           ###########
*       CB_MSG_CHECKED       Touch Screen  EVENT_PRESS      If events occurs and the x,y
position falls in the area of the check box while the check box is unchecked.
*                            Keyboard      EVENT_KEYSCAN    If event occurs and parameter1
passed matches the object’s ID and parameter 2 passed matches SCAN_CR_PRESSED or
SCAN_SPACE_PRESSED while the check box is unchecked.
*       CB_MSG_UNCHECKED     Touch Screen  EVENT_PRESS      If events occurs and the x,y
position falls in the area of the check box while the check box is checked.
*                            Keyboard      EVENT_KEYSCAN    If event occurs and parameter1
passed matches the object’s ID and parameter 2 passed matches SCAN_CR_PRESSED or
SCAN_SPACE_PRESSED while the check box is checked.
*       OBJ_MSG_INVALID      Any           Any              If the message did not affect
the object.
*   </TABLE>
*
* PreCondition: none
*
* Input: pMsg - pointer to the message struct containing the message the user
*        pCb - the pointer to the object where the message will be
*              evaluated to check if the message will affect the object
*
* Output: Returns the translated message depending on the received GOL message:
*         - CB_MSG_CHECKED – Check Box is checked.
*         - CB_MSG_UNCHECKED – Check Box is unchecked.
*         - OBJ_MSG_INVALID – Check Box is not affected.
*
* Example:
*   Usage is similar to BtnTranslateMsg() example.
*
* Side Effects: none
*
********************************************************************/
WORD        CbTranslateMsg(void *pObj, GOL_MSG *pMsg);

/*********************************************************************
* Function: CbMsgDefault(WORD translatedMsg, void *pObj, GOL_MSG* pMsg)
*
* Overview: This function performs the actual state change
*           based on the translated message given. The following state changes
*           are supported:
*   <TABLE>
*       Translated Message   Input Source    Set/Clear State Bit   Description
*       ##################   ############    ######                ###########
*       CB_MSG_CHECKED       Touch Screen,  Set CB_CHECKED        Check Box will be
redrawn in checked state.
*                             Keyboard
*       CB_MSG_UNCHECKED     Touch Screen,  Clear CB_CHECKED      Check Box will be
```

```
redrawn in un-checked state.
*                              Keyboard
*   </TABLE>
*
* PreCondition: none
*
* Input: translatedMsg - The translated message
*        pCb           - The pointer to the object whose state will be modified
*        pMsg          - The pointer to the GOL message
*
* Output: none
*
* Side Effects: none
*
********************************************************************/
void        CbMsgDefault(WORD translatedMsg, void *pObj, GOL_MSG *pMsg);

/*********************************************************************
* Function: WORD CbDraw(void *pObj)
*
* Overview: This function renders the object on the screen using
*           the current parameter settings. Location of the object
*           is determined by the left, top, right and bottom parameters.
*           The colors used are dependent on the state of the object.
*           The font used is determined by the style scheme set.
*
*           When rendering objects of the same type, each object must
*           be rendered completely before the rendering of the next
*           object is started. This is to avoid incomplete object rendering.
*
* PreCondition: Object must be created before this function is called.
*
* Input: pCb - Pointer to the object to be rendered.
*
* Output: Returns the status of the drawing
*         - 1 - If the rendering was completed and
*         - 0 - If the rendering is not yet finished.
*
*         Next call to the function will resume the
*         rendering on the pending drawing state.
*
* Example:
*   See CbCreate() Example.
*
* Side Effects: none
*
********************************************************************/
WORD CbDraw(void *pObj);
#endif // _CHECKBOX_H
```

14.1.14 DigitalMeter.c

This is file DigitalMeter.c.

Body Source

```
/*****************************************************************************
 *  Module for Microchip Graphics Library
 *  GOL Layer
 *  DigitalMeter
 *****************************************************************************
 * FileName:        DigitalMeter.c
 * Dependencies:    None
 * Processor:       PIC24F, PIC24H, dsPIC, PIC32
 * Compiler:        MPLAB C30 V3.00, MPLAB C32
 * Linker:          MPLAB LINK30, MPLAB LINK32
 * Company:         Microchip Technology Incorporated
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 * OR OTHER SIMILAR COSTS.
 *
 * Author               Date        Comment
 *~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
 * Arpan kumar        06/11/09    Version 1.0 release
 * PAT                01/18/10    Added draw state to redraw only text.
 *****************************************************************************/
#include "Graphics/Graphics.h"

#ifdef USE_DIGITALMETER

/*********************************************************************************
* Function: NumberToString(DWORD Value,XCHAR *pText, BYTE NoOfDigits, BYTE DotPos )
*
* Notes: convert the number to string
*
**********************************************************************************/
static void NumberToString(DWORD Value, XCHAR *pText, BYTE NoOfDigits, BYTE DotPos)
{
    BYTE    i;
    BYTE    bIndex;

    for(bIndex = 0; bIndex < NoOfDigits; bIndex++)
    {
        pText[NoOfDigits - bIndex - 1] = '0' + (Value % 10);
        Value /= 10;
    }

    if(DotPos != 0 && DotPos <= NoOfDigits)
    {
        for(i = 0; i < DotPos; i++)
        {
            pText[NoOfDigits - i] = pText[NoOfDigits - 1 - i];
        }

        pText[NoOfDigits - DotPos] = '.';
        pText[NoOfDigits + 1] = '\0';
    }

    //If dot position is 0 or greater than number of digits, then don't put dot in the
display
    else
    {
        pText[NoOfDigits] = '\0';
    }
}

/*********************************************************************************************
**************
* Function: DIGITALMETER  *DmCreate(WORD ID, SHORT left, SHORT top, SHORT right, SHORT
```

```
bottom, WORD state,
*                                DWORD Value, BYTE NoOfDigits, BYTE DotPos, GOL_SCHEME
*pScheme)
*
* Notes: Creates a DIGITALMETER object and adds it to the current active list.
*        If the creation is successful, the pointer to the created Object
*        is returned. If not successful, NULL is returned.
*
********************************************************************************************
**************/
DIGITALMETER *DmCreate
(
    WORD        ID,
    SHORT       left,
    SHORT       top,
    SHORT       right,
    SHORT       bottom,
    WORD        state,
    DWORD       Value,
    BYTE        NoOfDigits,
    BYTE        DotPos,
    GOL_SCHEME  *pScheme
)
{
    DIGITALMETER    *pDm = NULL;
    pDm = GFX_malloc(sizeof(DIGITALMETER));
    if(pDm == NULL)
        return (pDm);

    pDm->hdr.ID = ID;                   // unique id assigned for referencing
    pDm->hdr.pNxtObj = NULL;            // initialize pointer to NULL
    pDm->hdr.type = OBJ_DIGITALMETER;   // set object type
    pDm->hdr.left = left;               // left,top corner
    pDm->hdr.top = top;
    pDm->hdr.right = right;             // right buttom corner
    pDm->hdr.bottom = bottom;
    pDm->Cvalue = Value;                // initial value to be displayed
    pDm->hdr.state = state;
    pDm->NoOfDigits = NoOfDigits;       // number of digits to be displayed
    pDm->DotPos = DotPos;               // position of decimal point
    pDm->hdr.DrawObj = DmDraw;          // draw function
    pDm->hdr.MsgObj = DmTranslateMsg;   // message function
    pDm->hdr.MsgDefaultObj = NULL;      // default message function
    pDm->hdr.FreeObj = NULL;            // free function

    // Set the color scheme to be used
    if(pScheme == NULL)
        pDm->hdr.pGolScheme = _pDefaultGolScheme;
    else
        pDm->hdr.pGolScheme = (GOL_SCHEME *)pScheme;

    pDm->textHeight = 0;
    if(pDm->Cvalue != 0)
    {

        // Set the text height
        pDm->textHeight = GetTextHeight(pDm->hdr.pGolScheme->pFont);
    }

    GOLAddObject((OBJ_HEADER *)pDm);

    return (pDm);
}

/*********************************************************************
* Function: DmSetValue(DIGITALMETER *pDm, DWORD Value)
*
* Notes: Sets the value to be displayed.
*
********************************************************************/
void DmSetValue(DIGITALMETER *pDm, DWORD Value)
{
    // store the previous and current value to be displayed
    pDm->Pvalue = pDm->Cvalue;
    pDm->Cvalue = Value;

    pDm->textHeight = GetTextHeight(pDm->hdr.pGolScheme->pFont);
}

/*********************************************************************
* Function: WORD DmTranslateMsg(void *pObj, GOL_MSG *pMsg)
*
* Notes: Evaluates the message if the object will be affected by the
*        message or not.
*
**********************************************************************/
WORD DmTranslateMsg(void *pObj, GOL_MSG *pMsg)
{

    DIGITALMETER *pDm;

    pDm = (DIGITALMETER *)pObj;

    // Evaluate if the message is for the static text
    // Check if disabled first
    if(GetState(pDm, DM_DISABLED))
        return (OBJ_MSG_INVALID);

        #ifdef USE_TOUCHSCREEN
    if(pMsg->type == TYPE_TOUCHSCREEN)
    {

        // Check if it falls in static text control borders
        if
        (
            (pDm->hdr.left < pMsg->param1) &&
            (pDm->hdr.right > pMsg->param1) &&
            (pDm->hdr.top < pMsg->param2) &&
            (pDm->hdr.bottom > pMsg->param2)
        )
        {
            return (DM_MSG_SELECTED);
        }
    }

        #endif
    return (OBJ_MSG_INVALID);
}

/*********************************************************************
* Function: WORD DmDraw(void *pObj)
*
* Notes: This is the state machine to display the changing numbers.
*
**********************************************************************/
WORD DmDraw(void *pObj)
{
    typedef enum
    {
        DM_STATE_IDLE,
        DM_STATE_FRAME,
        DM_STATE_INIT,
        DM_STATE_SETALIGN,
        DM_STATE_DRAWTEXT
    } DM_DRAW_STATES;

    static DIGITALMETER *pDm = NULL;
    static DM_DRAW_STATES state = DM_STATE_IDLE;
    static SHORT charCtr = 0, lineCtr = 0;
    static XCHAR CurValue[DM_WIDTH], PreValue[DM_WIDTH];
    SHORT textWidth = 0;
    XCHAR ch = 0, pch = 0;
    pDm = (DIGITALMETER *)pObj;

    if(IsDeviceBusy())
        return (0);

    switch(state)
    {
        case DM_STATE_IDLE:
            SetClip(CLIP_DISABLE);

            if(GetState(pDm, DM_HIDE) || GetState(pDm, DM_DRAW))
            {
                SetColor(pDm->hdr.pGolScheme->CommonBkColor);
                if(Bar(pDm->hdr.left, pDm->hdr.top, pDm->hdr.right, pDm->hdr.bottom) == 0)
                    return (0);
            }
            // if the draw state was to hide then state is still IDLE STATE so no need to
change state
            if (GetState(pDm, DM_HIDE))
                return (1);
            state = DM_STATE_FRAME;

        case DM_STATE_FRAME:
            if(GetState(pDm, DM_DRAW | DM_FRAME) == (DM_DRAW | DM_FRAME))
            {
                // show frame if specified to be shown
                SetLineType(SOLID_LINE);
                SetLineThickness(NORMAL_LINE);
                if(!GetState(pDm, DM_DISABLED))
                {

                    // show enabled color
                    SetColor(pDm->hdr.pGolScheme->Color1);
                    if(Rectangle(pDm->hdr.left, pDm->hdr.top, pDm->hdr.right,
pDm->hdr.bottom) == 0)
                        return (0);
                }
                else
                {

                    // show disabled color
                    SetColor(pDm->hdr.pGolScheme->ColorDisabled);
                    if(Rectangle(pDm->hdr.left, pDm->hdr.top, pDm->hdr.right,
pDm->hdr.bottom) == 0)
                        return (0);
                }
            }

            // set clipping area, text will only appear inside the static text area.
            SetClip(CLIP_ENABLE);
            SetClipRgn(pDm->hdr.left + DM_INDENT, pDm->hdr.top, pDm->hdr.right - DM_INDENT,
pDm->hdr.bottom);
            state = DM_STATE_INIT;

        case DM_STATE_INIT:
            if(IsDeviceBusy())
                return (0);

            // set the text color
            if(!GetState(pDm, DM_DISABLED))
            {
                SetColor(pDm->hdr.pGolScheme->TextColor0);
            }
            else
            {
                SetColor(pDm->hdr.pGolScheme->TextColorDisabled);
            }

            // convert the values to be displayed in string format
            NumberToString(pDm->Pvalue, PreValue, pDm->NoOfDigits, pDm->DotPos);
            NumberToString(pDm->Cvalue, CurValue, pDm->NoOfDigits, pDm->DotPos);
            // use the font specified in the object
            SetFont(pDm->hdr.pGolScheme->pFont);

            state = DM_STATE_SETALIGN;  // go to drawing of text

        case DM_STATE_SETALIGN:
            if(!charCtr)
            {

                // set position of the next character (based on alignment and next
character)
                textWidth = GetTextWidth(CurValue, pDm->hdr.pGolScheme->pFont);

                // Display text with center alignment
                if(GetState(pDm, (DM_CENTER_ALIGN)))
                {
                    MoveTo((pDm->hdr.left + pDm->hdr.right - textWidth) >> 1, pDm->hdr.top
+ (lineCtr * pDm->textHeight));
                }

                // Display text with right alignment
                else if(GetState(pDm, (DM_RIGHT_ALIGN)))
                {
                    MoveTo((pDm->hdr.right - textWidth - DM_INDENT), pDm->hdr.top +
(lineCtr * pDm->textHeight));
                }

                // Display text with left alignment
                else
                {
                    MoveTo(pDm->hdr.left + DM_INDENT, pDm->hdr.top + (lineCtr *
pDm->textHeight));
                }
            }

            state = DM_STATE_DRAWTEXT;

        case DM_STATE_DRAWTEXT:
            pch = *(PreValue + charCtr);
            ch = *(CurValue + charCtr);

            // output one character at time until a newline character or a NULL character
is sampled
            while((0x0000 != ch))
            {
                if(IsDeviceBusy())
                {
                    return (0);         // device is busy return
                }

                if(GetState(pDm, DM_DRAW))
                {
                    SetColor(pDm->hdr.pGolScheme->CommonBkColor);
                    if(Bar(GetX(), pDm->hdr.top + 1, GetX() + textWidth, pDm->hdr.bottom -
1) == 0)

                        return (0);
                }
                else if(GetState(pDm, DM_UPDATE))
                {
                    if(pch != ch)
                    {
                        SetColor(pDm->hdr.pGolScheme->CommonBkColor);
                        if(Bar(GetX(), pDm->hdr.top + 1, GetX() + textWidth,
pDm->hdr.bottom - 1) == 0)
                            return (0);
                    }
                }

                SetColor(pDm->hdr.pGolScheme->TextColor0);

                // render the character
                while(!OutChar(ch));
                charCtr++;              // update to next character
                ch = *(CurValue + charCtr);
                pch = *(PreValue + charCtr);
            }

            // end of text string is reached no more lines to display
            lineCtr = 0;
            charCtr = 0;
            SetClip(CLIP_DISABLE);      // remove clipping
            state = DM_STATE_IDLE;      // go back to IDLE state
            return (1);
    }

    return (1);
}

#endif // USE_DIGITALMETER
```

14.1.15 DigitalMeter.h

Functions

	Name	Description
◆	DmCreate (see page 152)	This function creates a DIGITALMETER (see page 157) object with the parameters given. It automatically attaches the new object into a global linked list of objects and returns the address of the object.
◆	DmDraw (see page 153)	This function renders the object on the screen using the current parameter settings. Location of the object is determined by the left, top, right and bottom parameters. The colors used are dependent on the state of the object. The font used is determined by the style scheme set. When rendering objects of the same type, each object must be rendered completely before the rendering of the next object is started. This is to avoid incomplete object rendering.
◆	DmSetValue (see page 154)	This function sets the value that will be used for the object.
◆	DmTranslateMsg (see page 156)	This function evaluates the message from a user if the message will affect the object or not. The table below enumerates the translated messages for each event of the touch screen and keyboard inputs.

Macros

Name	Description
DM_CENTER_ALIGN (see page 151)	Bit to indicate value is center aligned.
DM_DISABLED (see page 150)	Bit for disabled state.
DM_DRAW (see page 150)	Bit to indicate object must be redrawn.
DM_FRAME (see page 151)	Bit to indicate frame is displayed.
DM_HIDE (see page 151)	Bit to remove object from screen.
DM_RIGHT_ALIGN (see page 151)	Bit to indicate value is left aligned.
DM_UPDATE (see page 151)	Bit to indicate that only text must be redrawn.
DmDecVal (see page 155)	This macro is used to directly decrement the value.
DmGetValue (see page 154)	This macro returns the current value used for the object.
DmIncVal (see page 155)	This macro is used to directly increment the value.

Structures

Name	Description
DIGITALMETER (see page 157)	Defines the parameters required for a Digital Meter (see page 149) Object.

Description

This is file DigitalMeter.h.

Body Source

```
/*****************************************************************************
 *  Module for Microchip Graphics Library
 *  GOL Layer
 *  Static text
 *****************************************************************************
 * FileName:        DigitalMeter.h
 * Dependencies:    None
 * Processor:       PIC24F, PIC24H, dsPIC, PIC32
 * Compiler:        MPLAB C30, MPLAB C32
 * Linker:          MPLAB LINK30, MPLAB LINK32
 * Company:         Microchip Technology Incorporated
 *
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 * CLAIMS BY THIRD PARTIES (INCLUDING BUT NOT LIMITED TO ANY DEFENSE THEREOF),
 * OR OTHER SIMILAR COSTS.
 *
 * Date        Comment
 *~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
 * 06/11/09    Version 1.0 release
 * 01/18/10    Added draw state to redraw only text.
 *****************************************************************************/
#ifndef _DIGITALMETER_H
    #define _DIGITALMETER_H

    #include <Graphics/GOL.h>
    #include "GenericTypeDefs.h"

/*********************************************************************
* Object States Definition:
*********************************************************************/
    #define DM_DISABLED     0x0002  // Bit for disabled state.
    #define DM_RIGHT_ALIGN  0x0004  // Bit to indicate value is left aligned.
    #define DM_CENTER_ALIGN 0x0008  // Bit to indicate value is center aligned.
    #define DM_FRAME        0x0010  // Bit to indicate frame is displayed.
    #define DM_DRAW         0x4000  // Bit to indicate object must be redrawn.
    #define DM_UPDATE       0x2000  // Bit to indicate that only text must be redrawn.
    #define DM_HIDE         0x8000  // Bit to remove object from screen.

/* Indent constant for the text used in the frame. */
    #define DM_INDENT   0x02        // Text indent constant.

/* User should change this value depending on the number of digits he wants to display */
    #define DM_WIDTH    0x0A        // This value should be more than the no of digits
displayed

/*********************************************************************
* Structure:   DIGITALMETER
* Overview: Defines the parameters required for a <link Digital Meter> Object.
*********************************************************************/
```

```
typedef struct
{
    OBJ_HEADER  hdr;        // Generic header for all Objects (see OBJ_HEADER).
    SHORT       textHeight; // Pre-computed text height
    DWORD       Cvalue;     // Current value
    DWORD       Pvalue;     // Previous value
    BYTE        NoOfDigits; // Number of digits to be displayed
    BYTE        DotPos;     // Position of decimal point
} DIGITALMETER;

/*********************************************************************
* Macros:  DmGetValue(pDm)
*
* Overview: This macro returns the current
*           value used for the object.
*
* PreCondition: none
*
* Input: pDm - Pointer to the object.
*
* Output: Returns the value used.
*
* Side Effects: none
*
********************************************************************/
    #define DmGetValue(pDm) pDm->Cvalue

/*********************************************************************
* Function: DmSetValue(DIGITALMETER *pDm,  DWORD Value)
*
* Overview: This function sets the value that will be used for the object.
*
* PreCondition: none
*
* Input: pDm - The pointer to the object whose value will be modified.
*        Value -  New value to be set for the <link Digital Meter>.
*
* Output: none
*
* Side Effects: none
*
********************************************************************/
void    DmSetValue(DIGITALMETER *pDm, DWORD Value);

/*********************************************************************
* Macros:  DmIncVal(pDm, deltaValue)
*
* Overview: This macro is used to directly increment the value.
*
* PreCondition: none
*
* Input: pDm - Pointer to the object.
*        deltaValue - Number to be added to the current <link Digital Meter> value.
*
* Output: none
*
* Side Effects: none
*
********************************************************************/
    #define DmIncVal(pDm, deltaValue)    DmSetValue(pDm, (pDm->Cvalue + deltaValue))

/*********************************************************************
* Macros:  DmDecVal(pDm, deltaValue)
*
* Overview: This macro is used to directly decrement the value.
*
* PreCondition: none
*
* Input: pDm - Pointer to the object.
*        deltaValue - Number to be subtracted to the current <link Digital Meter> value.
*
* Output: none
```

```
*
* Side Effects: none
*
********************************************************************/
    #define DmDecVal(pDm, deltaValue)    DmSetValue(pDm, (pDm->Cvalue - deltaValue))

/*********************************************************************
* Function: DIGITALMETER  *DmCreate(WORD ID, SHORT left, SHORT top, SHORT right, SHORT
bottom,
*                                  WORD state , DWORD Value, BYTE NoOfDigits, BYTE DotPos,
GOL_SCHEME *pScheme)
*
* Overview: This function creates a DIGITALMETER object with the
*           parameters given. It automatically attaches the new
*           object into a global linked list of objects and returns
*           the address of the object.
*
* PreCondition: none
*
* Input: ID - Unique user defined ID for the object instance.
*        left - Left most position of the object.
*        top - Top most position of the object.
*        right - Right most position of the object.
*        bottom - Bottom most position of the object.
*        state - Sets the initial state of the object.
*        Value - Sets the initial value to be displayed
*        NoOfDigits - Sets the number of digits to be displayed
*        DotPos - Sets the position of decimal point in the display
*        pScheme - Pointer to the style scheme. Set to NULL if
*                  default style scheme is used.
*
* Output: Returns the pointer to the object created.
*
* Example:
*   <PRE>
*   GOL_SCHEME *pScheme;
*   DIGITALMETER *pDm;
*
*       pScheme = GOLCreateScheme();
*       state = DM_DRAW | DM_FRAME | DM_CENTER_ALIGN;
*       DmCreate(ID_DIGITALMETER1,          // ID
*                30,80,235,160,           // dimension
*                state,                   // has frame and center aligned
*                789,4,1,                 // to display 078.9
*                pScheme);                // use given scheme
*
*       while(!DmDraw(pDm));              // draw the object
*   </PRE>
*
* Side Effects: none
*
********************************************************************/
DIGITALMETER    *DmCreate
                (
                    WORD        ID,
                    SHORT       left,
                    SHORT       top,
                    SHORT       right,
                    SHORT       bottom,
                    WORD        state,
                    DWORD       Value,
                    BYTE        NoOfDigits,
                    BYTE        DotPos,
                    GOL_SCHEME  *pScheme
                );

/*********************************************************************
* Function: WORD DmTranslateMsg(void *pObj, GOL_MSG *pMsg)
*
* Overview: This function evaluates the message from a user if the
*           message will affect the object or not. The table below
*           enumerates the translated messages for each event of the
*           touch screen and keyboard inputs.
*
*   <TABLE>
*       Translated Message   Input Source  Events                        Description
*       ##################   ############  ######                        ###########
*       DM_MSG_SELECTED      Touch Screen  EVENT_PRESS, EVENT_RELEASE    If events occurs
and the x,y position falls in the area of the <link Digital Meter>.
*       OBJ_MSG_INVALID      Any           Any                           If the message did
not affect the object.
*   </TABLE>
*
* PreCondition: none
*
* Input: pDm   - The pointer to the object where the message will be
*                evaluated to check if the message will affect the object.
*        pMsg  - Pointer to the message struct containing the message from
*                the user interface.
*
* Output: Returns the translated message depending on the received GOL message:
*         - DM_MSG_SELECTED – <link Digital Meter> is selected
*         - OBJ_MSG_INVALID – <link Digital Meter> is not affected
*
* Example:
*   Usage is similar to BtnTranslateMsg() example.
*
* Side Effects: none
*
********************************************************************/
WORD            DmTranslateMsg(void *pObj, GOL_MSG *pMsg);

/*********************************************************************
* Function: WORD DmDraw(void *pObj)
*
* Overview: This function renders the object on the screen using
*           the current parameter settings. Location of the object
*           is determined by the left, top, right and bottom
*           parameters. The colors used are dependent on the state
*           of the object. The font used is determined by the style
*           scheme set.
*
*           When rendering objects of the same type, each object must
*           be rendered completely before the rendering of the next
*           object is started. This is to avoid incomplete object rendering.
*
* PreCondition: Object must be created before this function is called.
*
* Input: pDm - Pointer to the object to be rendered.
*
* Output: Returns the status of the drawing
*         - 1 - If the rendering was completed and
*         - 0 - If the rendering is not yet finished.
*         Next call to the function will resume the
*         rendering on the pending drawing state.
*
* Example:
*   See DmCreate() Example.
*
* Side Effects: none
*
********************************************************************/
WORD DmDraw(void *pObj);
#endif // _DIGITALMETER_H
```

14.1.16 EditBox.c

This is file EditBox.c.

Body Source

```
/*****************************************************************************
 *  Module for Microchip Graphics Library
 *  GOL Layer
 *  Edit Box
 *****************************************************************************
 * FileName:        EditBox.c
 * Dependencies:    None
 * Processor:       PIC24F, PIC24H, dsPIC, PIC32
 * Compiler:        MPLAB C30 V3.00, C32
 * Linker:          MPLAB LINK30, LINK32
 * Company:         Microchip Technology Incorporated
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 * CLAIMS BY THIRD PARTIES (INCLUDING BUT NOT LIMITED TO ANY DEFENSE THEREOF),
 * OR OTHER SIMILAR COSTS.
 *
 * Date         Comment
 *~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
 * 11/12/07     Version 1.0 release
 * 09/16/10     Fixed issue on focus. Modified EB_CARET behavior. Caret
 *              is now controlled by the EB_CARET state bit. If this bit
 *              is set, focus or manual user set of EB_DRAW_CARET will draw
 *              the caret. If this bit is not set, the caret will never
 *              be shown.
 * 02/24/11     Modified draw state machine to remove incorrect loops.
 *****************************************************************************/
#include "Graphics/Graphics.h"

#ifdef USE_EDITBOX

/*********************************************************************
* Function: EDITBOX  *EbCreate(WORD ID, SHORT left, SHORT top, SHORT right, SHORT bottom,
*                             WORD state , XCHAR *pText, WORD charMax, GOL_SCHEME *pScheme)
*
* Notes: Create the EDITBOX Object.
*
********************************************************************/
EDITBOX  *EbCreate(WORD ID, SHORT left, SHORT top, SHORT right, SHORT bottom,
                   WORD state , XCHAR *pText, WORD charMax, GOL_SCHEME *pScheme){

    EDITBOX *pEb = NULL;

    pEb = (EDITBOX*)GFX_malloc(sizeof(EDITBOX)+ (charMax + 1)*sizeof(XCHAR)); // ending
zero is not included into charMax
    if (pEb == NULL)
        return pEb;

    pEb->pBuffer  = (XCHAR*)((BYTE*)pEb+sizeof(EDITBOX));
    *pEb->pBuffer = 0;
```

```
    pEb->length   = 0;
    pEb->charMax  = charMax;

    if(pText != NULL)
        EbSetText(pEb, pText);

    pEb->hdr.ID               = ID;
    pEb->hdr.pNxtObj          = NULL;
    pEb->hdr.type             = OBJ_EDITBOX;
    pEb->hdr.left             = left;
    pEb->hdr.top              = top;
    pEb->hdr.right            = right;
    pEb->hdr.bottom           = bottom;
    pEb->hdr.state            = state;
    pEb->hdr.DrawObj          = EbDraw;         // draw function
    pEb->hdr.MsgObj           = EbTranslateMsg;// message function
    pEb->hdr.MsgDefaultObj    = EbMsgDefault;  // default message function
    pEb->hdr.FreeObj          = NULL;           // free function

    // Set the style scheme to be used
    if (pScheme == NULL)
        pEb->hdr.pGolScheme = _pDefaultGolScheme;
    else
        pEb->hdr.pGolScheme = (GOL_SCHEME *)pScheme;

    pEb->textHeight = GetTextHeight(pEb->hdr.pGolScheme->pFont);

    GOLAddObject((OBJ_HEADER*) pEb);
    return pEb;
}

/*********************************************************************
* Function: EbSetText(EDITBOX *pEb, XCHAR *pText)
*
* Notes: Sets a new text.
*
*********************************************************************/
void EbSetText(EDITBOX *pEb, XCHAR *pText){
WORD  ch;
WORD  length;
XCHAR* pointerFrom;
XCHAR* pointerTo;

    // Copy and count length
    pointerFrom = pText;
    pointerTo = pEb->pBuffer;
    length = 0;

    do{
        ch = *pointerFrom++;
        *pointerTo++ = ch;
        length++;
        if(length >= pEb->charMax){
            *pointerTo = 0;
            break;
        }
    }while(ch);


    pEb->length = length-1;
}

/*********************************************************************
* Function: void  EbAddChar(EDITBOX* pEb, XCHAR ch)
*
* Notes: Adds character at the end.
*
*********************************************************************/
void EbAddChar(EDITBOX* pEb, XCHAR ch){

    if(pEb->length >= pEb->charMax)
        return;
    // Add character
    pEb->pBuffer[pEb->length] = ch;
    pEb->length++;
    pEb->pBuffer[pEb->length] = 0;
}

/*********************************************************************
* Function: void  EbDeleteChar(EDITBOX* pEb)
*
* Notes: Deletes character at the end.
*
********************************************************************/
void EbDeleteChar(EDITBOX* pEb){

    if(pEb->length == 0)
        return;

    // Delete charachter
    pEb->length--;
    pEb->pBuffer[pEb->length] = 0;

}

/*********************************************************************
* Function: WORD EbTranslateMsg(void *pObj, GOL_MSG *pMsg)
*
* Notes: Translates GOL message for the edit box
*
********************************************************************/
WORD EbTranslateMsg(void *pObj, GOL_MSG *pMsg)
{
    EDITBOX *pEb;

    pEb = (EDITBOX *)pObj;

    // Evaluate if the message is for the edit box
    // Check if disabled first
    if (GetState(pEb, EB_DISABLED))
      return OBJ_MSG_INVALID;

#ifdef  USE_FOCUS
#ifdef  USE_TOUCHSCREEN
    if(pMsg->type == TYPE_TOUCHSCREEN) {
        // Check if it falls in edit box borders
        if( (pEb->hdr.left     < pMsg->param1) &&
            (pEb->hdr.right    > pMsg->param1) &&
            (pEb->hdr.top      < pMsg->param2) &&
            (pEb->hdr.bottom   > pMsg->param2) )
            return EB_MSG_TOUCHSCREEN;

        return OBJ_MSG_INVALID;
    }
#endif
#endif

#ifdef  USE_KEYBOARD
    if(pMsg->type == TYPE_KEYBOARD) {

        if(pMsg->uiEvent == EVENT_CHARCODE)
            return EB_MSG_CHAR;

        if(pMsg->uiEvent == EVENT_KEYSCAN)
            if(pMsg->param2 == SCAN_BS_PRESSED)
                return EB_MSG_DEL;

        return OBJ_MSG_INVALID;
    }
#endif


    return OBJ_MSG_INVALID;
```

```
}

/*********************************************************************
* Function: void EbMsgDefault(WORD translatedMsg, void *pObj, GOL_MSG *pMsg)
*
* Notes: Changes the state of the edit box by default.
*
*********************************************************************/
void EbMsgDefault(WORD translatedMsg, void *pObj, GOL_MSG *pMsg){

    EDITBOX *pEb;

    pEb = (EDITBOX *)pObj;

#ifdef  USE_FOCUS
#ifdef  USE_TOUCHSCREEN
    if(pMsg->type == TYPE_TOUCHSCREEN){
        if(!GetState(pEb,EB_FOCUSED)){
                GOLSetFocus((OBJ_HEADER*)pEb);
        }
    }
#endif
#endif

    switch(translatedMsg){

        case EB_MSG_CHAR:
            EbAddChar(pEb,(XCHAR)pMsg->param2);
            SetState(pEb, EB_DRAW);
            break;

        case EB_MSG_DEL:
            EbDeleteChar(pEb);
            SetState(pEb, EB_DRAW);
            break;

    }
}

/*********************************************************************
* Function: WORD EbDraw(void *pObj)
*
* Notes: This is the state machine to draw the button.
*
*********************************************************************/
WORD EbDraw(void *pObj)
{
typedef enum {
    EB_STATE_START,
    EB_STATE_DRAW_PANEL,
    EB_STATE_PREPARE_FOR_TEXT,
    EB_STATE_POSITION_TEXT,
    EB_STATE_TEXT,
    EB_STATE_CARET,
} EB_DRAW_STATES;

static EB_DRAW_STATES state = EB_STATE_START;
static XCHAR* pText;
SHORT temp;
SHORT width = 0;
EDITBOX *pEb;

    pEb = (EDITBOX *)pObj;

    while(!IsDeviceBusy())
    {
        switch(state){

            case EB_STATE_START:

                if(GetState(pEb, EB_HIDE)){
                    SetColor(pEb->hdr.pGolScheme->CommonBkColor);
                    if(!Bar(pEb->hdr.left,pEb->hdr.top,pEb->hdr.right,pEb->hdr.bottom))
return 0;
                    return 1;
                }

                if(GetState(pEb,EB_DISABLED)){
                    temp = pEb->hdr.pGolScheme->ColorDisabled;
                    ClrState(pEb,EB_CARET);
                    SetState(pEb,EB_DRAW_CARET);
                }else{
                    temp = pEb->hdr.pGolScheme->Color0;
                    if(GetState(pEb,EB_FOCUSED|EB_DRAW_CARET) ==
(EB_FOCUSED|EB_DRAW_CARET)){
                        SetState(pEb,EB_DRAW_CARET);
                    }
                }

                if(GetState(pEb,EB_DRAW))
                {

                    GOLPanelDraw(pEb->hdr.left,pEb->hdr.top,pEb->hdr.right,pEb->hdr.bottom,0
,
                        temp,
                        pEb->hdr.pGolScheme->EmbossDkColor,
                        pEb->hdr.pGolScheme->EmbossLtColor,
                        NULL,
                        GOL_EMBOSS_SIZE);

                    state = EB_STATE_DRAW_PANEL;
                    // no break here since it will always go to the EB_STATE_DRAW_PANEL
state
                }
                else
                {
                    state = EB_STATE_PREPARE_FOR_TEXT;
                    break;
                }

            case EB_STATE_DRAW_PANEL:
                if(!GOLPanelDrawTsk())
                    return 0;
                state = EB_STATE_PREPARE_FOR_TEXT;

                // no break here since it will always go to the EB_STATE_PREPARE_FOR_TEXT
state

            case EB_STATE_PREPARE_FOR_TEXT:

                SetClip(CLIP_ENABLE);

                SetClipRgn(pEb->hdr.left+GOL_EMBOSS_SIZE+EB_INDENT,
                           pEb->hdr.top+GOL_EMBOSS_SIZE+EB_INDENT,
                           pEb->hdr.right-GOL_EMBOSS_SIZE-EB_INDENT,
                           pEb->hdr.bottom-GOL_EMBOSS_SIZE-EB_INDENT);

                SetFont(pEb->hdr.pGolScheme->pFont);

                if(GetState(pEb,EB_DISABLED)){
                    SetColor(pEb->hdr.pGolScheme->TextColorDisabled);
                }else{
                    SetColor(pEb->hdr.pGolScheme->TextColor0);
                }

                // get the string buffer
                pText = pEb->pBuffer;
                temp = 1;

                // calculate how many lines are expected so we know where to
                // place the starting point
                while((XCHAR)*pText != (XCHAR)0){
                    if((XCHAR)*pText == (XCHAR)'\n')
                        temp++;
                    pText++;
                }

                // go back to the start of the buffer
                pText = pEb->pBuffer;
                // position the cursor
                MoveTo(GetX(),(pEb->hdr.top+pEb->hdr.bottom-temp*pEb->textHeight)>>1);

                // set state to actual string rendering loop
                state = EB_STATE_POSITION_TEXT;

                // no break here since it will always go to the EB_STATE_POSITION_TEXT state

            case EB_STATE_POSITION_TEXT:

                // get width of the string to render
                width = GetTextWidth(pText,pEb->hdr.pGolScheme->pFont);

                // place the starting point based on text alignment
                if (!GetState(pEb, EB_CENTER_ALIGN|EB_RIGHT_ALIGN)) {
                    MoveTo(pEb->hdr.left+GOL_EMBOSS_SIZE+EB_INDENT, GetY());
                }else{
                    if (GetState(pEb, EB_RIGHT_ALIGN)) {
                        MoveTo(pEb->hdr.right-width-EB_INDENT-GOL_EMBOSS_SIZE, GetY());
                    }else{
                        MoveTo((pEb->hdr.left+pEb->hdr.right-width)>>1,GetY());
                    }
                }

                state = EB_STATE_TEXT;

                // no break here since it will always go to the EB_STATE_TEXT state

            case EB_STATE_TEXT:

                // this is the actual string rendering

                if(GetState(pEb,EB_DRAW)){
                    if(!OutText(pText))
                        return 0;
                }else{
                    MoveRel(width, 0);
                }
                while((XCHAR)*pText>(XCHAR)15)
                    pText++;

                if((XCHAR)*pText == (XCHAR)'\n')
                {
                    MoveRel(0, pEb->textHeight);
                }

                // check if end of string
                if (*pText != 0)
                {
                    state = EB_STATE_POSITION_TEXT;
                    pText++;
                    break;
                }

                state = EB_STATE_CARET;

                // no break here since it will always go to the EB_STATE_CARET state

            case EB_STATE_CARET:

                // draw the caret if required

                if(!GetState(pEb,EB_DISABLED)){

                    if(GetState(pEb,EB_DRAW_CARET) && GetState(pEb,EB_CARET)){
                        SetColor(pEb->hdr.pGolScheme->TextColor0);
                    }else{
```

```
                            SetColor(pEb->hdr.pGolScheme->Color0);
                        }

                        if(!Bar(GetX(),GetY(),GetX()+EB_CARET_WIDTH,GetY()+pEb->textHeight))
                            return 0;
                    }

                    SetClip(CLIP_DISABLE);

                    state = EB_STATE_START;

                    return 1;

            } // switch()

        }//  while(!IsDeviceBusy())

        return 0;
}

#endif // USE_EDITBOX
```

14.1.17 EditBox.h

Functions

	Name	Description
	EbAddChar (see page 164)	This function inserts a character at the end of the text used by the object.
	EbCreate (see page 161)	This function creates a EDITBOX (see page 167) object with the parameters given and initializes the default settings. It automatically attaches the new object into a global linked list of objects and returns the address of the object.
	EbDeleteChar (see page 164)	This function removes a character at the end of the text used by the object.
	EbDraw (see page 162)	This function renders the object on the screen using the current parameter settings. Location of the object is determined by the left, top, right and bottom parameters. The colors used are dependent on the state of the object. The font used is determined by the style scheme set. When rendering objects of the same type, each object must be rendered completely before the rendering of the next object is started. This is to avoid incomplete object rendering.
	EbMsgDefault (see page 165)	This function performs the actual state change based on the translated message given. The following state changes are supported:
	EbSetText (see page 163)	This function sets the text to be used for the object.
	EbTranslateMsg (see page 166)	This function evaluates the message from a user if the message will affect the object or not. The table below enumerates the translated messages for each event of the touch screen and keyboard inputs.

Macros

Name	Description
EB_CARET (see page 160)	Bit to indicate the cursor will always be shown. This bit can be set when focused and reset when object is disabled. Application can also set and clear the bit through SetState (see page 303)() or ClrState (see page 303)().
EB_CENTER_ALIGN (see page 159)	Bit to indicate text is center aligned.
EB_DISABLED (see page 159)	Bit for disabled state.
EB_DRAW (see page 159)	Bit to indicate whole edit box must be redrawn.
EB_DRAW_CARET (see page 160)	Bit to indicate the cursor caret will be redrawn if the EB_CARET (see page 160) state bit is set.
EB_FOCUSED (see page 160)	Bit for focused state.
EB_HIDE (see page 160)	Bit to remove object from screen.

EB_RIGHT_ALIGN (see page 160)	Bit to indicate text is left aligned.
EbGetText (see page 163)	This macro returns the address of the current text string used for the object.

Structures

Name	Description
EDITBOX (see page 167)	Defines the parameters required for a Edit Box Object.

Description

This is file EditBox.h.

Body Source

```
/*****************************************************************************
 *  Module for Microchip Graphics Library
 *  GOL Layer
 *  Edit box
 *****************************************************************************
 * FileName:        EditBox.h
 * Dependencies:    None
 * Processor:       PIC24F, PIC24H, dsPIC, PIC32
 * Compiler:        MPLAB C30, MPLAB C32
 * Linker:          MPLAB LINK30, MPLAB LINK32
 * Company:         Microchip Technology Incorporated
 *
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 * CLAIMS BY THIRD PARTIES (INCLUDING BUT NOT LIMITED TO ANY DEFENSE THEREOF),
 * OR OTHER SIMILAR COSTS.
 *
 * Date         Comment
 *~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
 * 11/12/07     Version 1.0 release
 * 09/16/10     Modified use of EB_DRAW_CARET, & EB_CARET.
 *              EB_DRAW_CARET when set will draw the caret. EB_DRAW_CARET can
 *              also be enabled by the EB_FOCUSED bit.
 *              EB_CARET when set will always draw the caret.
 *****************************************************************************/
#ifndef _EDITBOX_H
    #define _EDITBOX_H

    #include <Graphics/GOL.h>
    #include "GenericTypeDefs.h"

/*********************************************************************
* Object States Definition:
*********************************************************************/
    #define EB_FOCUSED      0x0001  // Bit for focused state.
    #define EB_DISABLED     0x0002  // Bit for disabled state.
    #define EB_RIGHT_ALIGN  0x0004  // Bit to indicate text is left aligned.
    #define EB_CENTER_ALIGN 0x0008  // Bit to indicate text is center aligned.
```

```
    #define EB_CARET        0x0010  // Bit to indicate the cursor will always be shown.
                                    // This bit can be set when focused and reset when
object is disabled.
                                    // Application can also set and clear the bit through
SetState() or ClrState().
    #define EB_DRAW_CARET   0x2000  // Bit to indicate the cursor caret will be redrawn if
the EB_CARET state bit is set.
    #define EB_DRAW         0x4000  // Bit to indicate whole edit box must be redrawn.
    #define EB_HIDE         0x8000  // Bit to remove object from screen.
    #define EB_INDENT       0x02    // Indent for the text from the frame.
    #define EB_CARET_WIDTH  0x02    // Caret line width.

/*********************************************************************
* Overview: Defines the parameters required for a Edit Box Object.
*********************************************************************/
typedef struct
{
    OBJ_HEADER  hdr;        // Generic header for all Objects (see OBJ_HEADER).
    SHORT       textHeight; // Pre-computed text height.
    XCHAR       *pBuffer;   // Pointer to text buffer.
    WORD        charMax;    // Maximum number of characters in the edit box.
    WORD        length;     // Current text length.
} EDITBOX;

/*********************************************************************
* Function: EDITBOX  *EbCreate(WORD ID, SHORT left, SHORT top, SHORT right, SHORT bottom,
*                              WORD state , XCHAR *pText, WORD charMax, GOL_SCHEME *pScheme)
*
* Overview: This function creates a EDITBOX object with the parameters given and
*           initializes the default settings. It automatically attaches the new
*           object into a global linked list of objects and returns the address
*           of the object.
*
* PreCondition: none
*
* Input: ID - Unique user defined ID for the object instance.
*        left - Left most position of the Object.
*        top - Top most position of the Object.
*        right - Right most position of the Object.
*        bottom - Bottom most position of the object.
*        state - Sets the initial state of the object.
*        pText - Pointer to the text to be used.
*        charMax - Defines the maximum number of characters in the edit box.
*        pScheme - Pointer to the style scheme.
*
* Output: Returns the pointer to the object created.
*
* Example:
*   <CODE>
*   #define ID_MYEDITBOX    101
*   EDITBOX *pEb;
*
*   pEb = EbCreate(ID_MYEDITBOX,    // ID
*                  10,              // left
*                  10,              // top
*                  100,             // right
*                  30,              // bottom
*                  EB_DRAW,         // redraw after creation
*                  NULL,            // no text yet
*                  4,               // display only four characters
*                  pScheme);        // pointer to the style scheme
*
*   if( pEb == NULL )
*   {
*       // MEMORY ERROR. Object was not created.
*   }
*
*   </CODE>
*
* Side Effects: none
*
********************************************************************/
```

```
EDITBOX *EbCreate
        (
            WORD        ID,
            SHORT       left,
            SHORT       top,
            SHORT       right,
            SHORT       bottom,
            WORD        state,
            XCHAR       *pText,
            WORD        charMax,
            GOL_SCHEME  *pScheme
        );

/*********************************************************************
* Function: EbSetText(EDITBOX *pEb, XCHAR *pText)
*
* Overview: This function sets the text to be used for the object.
*
* PreCondition: none
*
* Input: pEb - The pointer to the object whose text will be modified.
*        pText - Pointer to the text that will be used.
*
* Output: none
*
* Side Effects: none
*
********************************************************************/
void    EbSetText(EDITBOX *pEb, XCHAR *pText);

/*********************************************************************
* Macros:  EbGetText(pEb)
*
* Overview: This macro returns the address of the current
*           text string used for the object.
*
* PreCondition: none
*
* Input: pEb - Pointer to the object
*
* Output: Returns pointer to the text string being used.
*
* Side Effects: none
*
********************************************************************/
    #define EbGetText(pEb)  (pEb->pBuffer)

/*********************************************************************
* Function: void  EbAddChar(EDITBOX* pEb, XCHAR ch)
*
* Overview: This function inserts a character at the end of the
*           text used by the object.
*
* PreCondition: none
*
* Input: pEb - The pointer to the object whose text will be modified.
*        ch - Character to be inserted.
*
* Output: none
*
* Side Effects: none
*
********************************************************************/
void    EbAddChar(EDITBOX *pEb, XCHAR ch);

/*********************************************************************
* Function: void  EbDeleteChar(EDITBOX* pEb)
*
* Overview: This function removes a character at the end of the
*           text used by the object.
*
* PreCondition: none
```

```
*
* Input: pEb - The pointer to the object to be modified.
*
* Output: none
*
* Side Effects: none
*
********************************************************************/
void    EbDeleteChar(EDITBOX *pEb);

/*********************************************************************
* Function: WORD EbTranslateMsg(void *pObj, GOL_MSG *pMsg)
*
* Overview: This function evaluates the message from a user if the
*           message will affect the object or not. The table below enumerates the
translated
*           messages for each event of the touch screen and keyboard inputs.
*
*   <TABLE>
*       Translated Message   Input Source  Events                            Description
*       ##################   ############  ######                            ###########
*       EB_MSG_CHAR          Keyboard      EVENT_CHARCODE                    New character
should be added.
*       EB_MSG_DEL           Keyboard      EVENT_KEYPRESS                    Last character
should be removed.
*       OBJ_MSG_INVALID      Any           Any                               If the message
did not affect the object.
*   </TABLE>
*
* PreCondition: none
*
* Input: pEb   - The pointer to the object where the message will be
*                evaluated to check if the message will affect the object.
*        pMsg  - Pointer to the message struct containing the message from
*                the user interface.
*
* Output: Returns the translated message depending on the received GOL message:
*         - EB_MSG_CHAR – New character should be added.
*         - EB_MSG_DEL – Last character should be removed.
*         - OBJ_MSG_INVALID – Object is not affected.
*
* Example:
*   Usage is similar to BtnTranslateMsg() example.
*
* Side Effects: none
*
********************************************************************/
WORD    EbTranslateMsg(void *pObj, GOL_MSG *pMsg);

/*********************************************************************
* Function: void EbMsgDefault(WORD translatedMsg, void *pObj, GOL_MSG *pMsg)
*
* Overview: This function performs the actual state change
*           based on the translated message given. The following state changes
*           are supported:
*   <TABLE>
*       Translated Message   Input Source    Set/Clear State Bit   Description
*       ##################   ############    ######                ###########
*       EB_MSG_CHAR          Keyboard        Set EB_DRAW           New character is added
and Edit Box will be redrawn.
*       EB_MSG_DEL           Keyboard        Set EB_DRAW           Last character is
removed and Edit Box will be redrawn.
*   </TABLE>
*
* PreCondition: none
*
* Input: translatedMsg - The translated message.
*        pEb           - The pointer to the object whose state will be modified.
*        pMsg          - The pointer to the GOL message.
*
* Output: none
*
```

```
* Example:
*   Usage is similar to BtnMsgDefault() example.
*
* Side Effects: none
*
********************************************************************/
void    EbMsgDefault(WORD translatedMsg, void *pObj, GOL_MSG *pMsg);

/*********************************************************************
* Function: WORD EbDraw(void *pObj)
*
* Overview: This function renders the object on the screen using
*           the current parameter settings. Location of the object is
*           determined by the left, top, right and bottom parameters.
*           The colors used are dependent on the state of the object.
*           The font used is determined by the style scheme set.
*
*           When rendering objects of the same type, each object
*           must be rendered completely before the rendering of the
*           next object is started. This is to avoid incomplete
*           object rendering.
*
* PreCondition: Object must be created before this function is called.
*
* Input: pEb - Pointer to the object to be rendered.
*
* Output: Returns the status of the drawing
*         - 1 - If the rendering was completed and
*         - 0 - If the rendering is not yet finished.
*
*         Next call to the function will resume the
*         rendering on the pending drawing state.
*
* Side Effects: none
*
********************************************************************/
WORD EbDraw(void *pObj);
#endif // _EDITBOX_H
```

14.1.18 Grid.c

This is file Grid.c.

Body Source

```
/*****************************************************************************
 *  Module for Microchip Graphics Library
 *  Grid control
 *****************************************************************************
 * FileName:        Grid.c
 * Dependencies:    string.h, Graphics.h
 * Processor:       PIC24F, PIC24H, dsPIC, PIC32
 * Compiler:        MPLAB C30 V3.00, MPLAB C32
 * Linker:          MPLAB LINK30, MPLAB LINK32
 * Company:         Microchip Technology Incorporated
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 * CLAIMS BY THIRD PARTIES (INCLUDING BUT NOT LIMITED TO ANY DEFENSE THEREOF),
 * OR OTHER SIMILAR COSTS.
 *
 * Date         Comment
 *~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
 * 02/29/08    ...
 * 04/16/10    Added Grid Item as text.
 * 04/20/11    Fixed KEYBOARD bug on object ID and GOL_MSG param1 comparison.
 *****************************************************************************/

/*
    Grid Object

TODO: Currently the grid does not support scroll bars. It must fit on the screen.

*/
#include <string.h>
#include "Graphics/Graphics.h"

#ifdef USE_GRID
    #define CELL_AT(c, r)   ((c * pGrid->numRows) + r)

/* */

GRID *GridCreate
(
    WORD        ID,
    SHORT       left,
    SHORT       top,
    SHORT       right,
    SHORT       bottom,
    WORD        state,
    SHORT       numColumns,
    SHORT       numRows,
    SHORT       cellWidth,
    SHORT       cellHeight,
    GOL_SCHEME  *pScheme
)
{
    GRID    *pGrid = NULL;

    if((pGrid = (GRID *)GFX_malloc(sizeof(GRID))) == NULL)
    {
        return (NULL);
    }

    if((pGrid->gridObjects = GFX_malloc(sizeof(GRIDITEM) * numColumns * numRows)) == NULL)
    {
        GFX_free(pGrid);
        return (NULL);
    }

    // Initialize grid items to default.
    memset(pGrid->gridObjects, 0, sizeof(GRIDITEM) * numColumns * numRows);

    // Initialize grid
    pGrid->hdr.ID = ID;
    pGrid->hdr.pNxtObj = NULL;
    pGrid->hdr.type = OBJ_GRID;
    pGrid->hdr.state = state;
    pGrid->hdr.left = left;
    pGrid->hdr.top = top;
    pGrid->hdr.right = right;
```

```
    pGrid->hdr.bottom = bottom;
    pGrid->numColumns = numColumns;
    pGrid->numRows = numRows;
    pGrid->cellWidth = cellWidth;
    pGrid->cellHeight = cellHeight;
    pGrid->focusX = 0;
    pGrid->focusY = 0;
    pGrid->hdr.DrawObj = GridDraw;              // draw function
    pGrid->hdr.MsgObj = GridTranslateMsg;       // message function
    pGrid->hdr.MsgDefaultObj = GridMsgDefault;  // default message function
    pGrid->hdr.FreeObj = GridFreeItems;         // free function

    // Set the color scheme to be used
    if(pScheme == NULL)
    {
        pGrid->hdr.pGolScheme = _pDefaultGolScheme;
    }
    else
    {
        pGrid->hdr.pGolScheme = (GOL_SCHEME *)pScheme;
    }

    GOLAddObject((OBJ_HEADER *)pGrid);

    return (pGrid);
}

    #define CELL_LEFT       (1 + pGrid->hdr.left + (i * (pGrid->cellWidth + 1)))
    #define CELL_TOP        (1 + pGrid->hdr.top + (j * (pGrid->cellHeight + 1)))
    #define CELL_RIGHT      (CELL_LEFT + pGrid->cellWidth - 1)
    #define CELL_BOTTOM     (CELL_TOP + pGrid->cellHeight - 1)
    #define BITMAP_SCALE    1

/* */

WORD GridDraw(void *pObj)
{
    SHORT   i;
    SHORT   j;
    SHORT   xText, yText;
    GRID *pGrid;

    pGrid = (GRID *)pObj;

    if
    (
        (pGrid->hdr.state & GRID_DRAW_ITEMS) ||
        (pGrid->hdr.state & GRID_DRAW_ALL) ||
        (pGrid->hdr.state & GRID_SHOW_FOCUS)
    )
    {
        if(pGrid->hdr.state & GRID_DRAW_ALL)
        {

            // Clear the entire region.
            SetColor(pGrid->hdr.pGolScheme->CommonBkColor);
            while(!Bar(pGrid->hdr.left, pGrid->hdr.top, pGrid->hdr.right,
pGrid->hdr.bottom));

            // initialize the global cursor positions to the Grid left top position.
            _cursorX = pGrid->hdr.left;
            _cursorY = pGrid->hdr.top;

            // Draw the grid lines
            if(pGrid->hdr.state & (GRID_SHOW_LINES | GRID_SHOW_BORDER_ONLY |
GRID_SHOW_SEPARATORS_ONLY))
            {
                SetLineType(SOLID_LINE);
                SetColor(pGrid->hdr.pGolScheme->EmbossLtColor);

                // Draw the outside of the box
                // TODO This should have some 3D effects added with GOL_EMBOSS_SIZE
                if(pGrid->hdr.state & (GRID_SHOW_LINES | GRID_SHOW_BORDER_ONLY))
                {
                    while(!Line(pGrid->hdr.left, pGrid->hdr.top, pGrid->hdr.right,
  pGrid->hdr.top));
                    LineTo(_cursorX, pGrid->hdr.bottom);
                    LineTo(pGrid->hdr.left, _cursorY);
                    LineTo(pGrid->hdr.left, pGrid->hdr.top);
                }

                // Draw the lines between each cell
                if(pGrid->hdr.state & (GRID_SHOW_LINES | GRID_SHOW_SEPARATORS_ONLY))
                {
                    for(i = 1; i < pGrid->numColumns; i++)
                    {
                        while
                        (
                            !Line
                                (
                                    pGrid->hdr.left + i * (pGrid->cellWidth + 1),
                                    pGrid->hdr.top,
                                    pGrid->hdr.left + i * (pGrid->cellWidth + 1),
                                    pGrid->hdr.top + pGrid->numRows * (pGrid->cellHeight +
  1)
                                )
                        );
                    }

                    for(i = 1; i < pGrid->numRows; i++)
                    {
                        while
                        (
                            !Line
                                (
                                    pGrid->hdr.left,
                                    pGrid->hdr.top + i * (pGrid->cellHeight + 1),
                                    pGrid->hdr.right,
                                    pGrid->hdr.top + i * (pGrid->cellHeight + 1)
                                )
                        );
                    }
                }
            }
        }

        for(i = 0; i < pGrid->numColumns; i++)
        {
            for(j = 0; j < pGrid->numRows; j++)
            {
                if
                (
                    (pGrid->hdr.state & GRID_DRAW_ALL) ||
                    (
                        (pGrid->hdr.state & GRID_DRAW_ITEMS) &&
                        (pGrid->gridObjects[CELL_AT(i, j)].status & GRIDITEM_DRAW)
                    ) ||
                    ((pGrid->hdr.state & GRID_SHOW_FOCUS) && (i == pGrid->focusX) && (j ==
  pGrid->focusY))
                )
                {

                    // Clear the cell
                    SetColor(pGrid->hdr.pGolScheme->CommonBkColor);
                    while(!Bar(CELL_LEFT, CELL_TOP, CELL_RIGHT, CELL_BOTTOM));

                    // Draw the cell
                    if((pGrid->gridObjects[CELL_AT(i, j)].status & GRID_TYPE_MASK) ==
  GRIDITEM_IS_BITMAP)
                    {

                        // Draw the bitmap
                        if(pGrid->gridObjects[CELL_AT(i, j)].data)
                        {
                            while(!PutImage(CELL_LEFT, CELL_TOP,
pGrid->gridObjects[CELL_AT(i, j)].data, BITMAP_SCALE));
                        }
                    }
                    else
                    {

                        // Draw the text
                        if(pGrid->gridObjects[CELL_AT(i, j)].data)
                        {
                            SetFont(pGrid->hdr.pGolScheme->pFont);
                            SetColor(pGrid->hdr.pGolScheme->TextColor0);

                            if(GetState(pGrid, GRIDITEM_TEXTRIGHT))
                            {
                                xText =
CELL_LEFT+pGrid->cellWidth-GetTextWidth(pGrid->gridObjects[CELL_AT(i,
j)].data,pGrid->hdr.pGolScheme->pFont);
                            }
                            else if(GetState(pGrid, GRIDITEM_TEXTLEFT))
                            {
                                xText = CELL_LEFT;
                            }
                            else
                            {
                                xText =
CELL_LEFT+(pGrid->cellWidth>>1)-(GetTextWidth(pGrid->gridObjects[CELL_AT(i,
j)].data,pGrid->hdr.pGolScheme->pFont)>>1);
                            }
                            if(GetState(pGrid, GRIDITEM_TEXTBOTTOM))
                            {
                                yText =
CELL_TOP+pGrid->cellHeight-GetTextHeight(pGrid->hdr.pGolScheme->pFont);
                            }
                            else if(GetState(pGrid, GRIDITEM_TEXTTOP))
                            {
                                yText = CELL_TOP;
                            }
                            else
                            {
                                yText =
CELL_TOP+(pGrid->cellHeight>>1)-(GetTextHeight(pGrid->hdr.pGolScheme->pFont)>>1);
                            }

                            while(!OutTextXY( xText, yText, pGrid->gridObjects[CELL_AT(i,
j)].data));
                        }
                    }

                    // Draw the focus if applicable.
                    if((pGrid->hdr.state & GRID_SHOW_FOCUS) && (i == pGrid->focusX) && (j
== pGrid->focusY))
                    {
                        SetColor(pGrid->hdr.pGolScheme->EmbossLtColor);
                        SetLineType(DOTTED_LINE);
                        SetLineThickness(NORMAL_LINE);
                        while(!Rectangle(CELL_LEFT, CELL_TOP, CELL_RIGHT, CELL_BOTTOM));
                    }

                    // If the cell is selected, indicate it.
                    if(pGrid->gridObjects[CELL_AT(pGrid->focusX, pGrid->focusY)].status &
GRIDITEM_SELECTED)
                    {
                        SetColor(pGrid->hdr.pGolScheme->EmbossLtColor);
                        SetLineType(SOLID_LINE);
                        if(pGrid->hdr.state & GRID_SHOW_LINES)
                        {
                            SetLineThickness(THICK_LINE);
                        }
                        else
                        {
                            SetLineThickness(NORMAL_LINE);
```

```
                        }

                        while(!Rectangle(CELL_LEFT - 1, CELL_TOP - 1, CELL_RIGHT + 1, 
CELL_BOTTOM + 1));
                    }

                    GridClearCellState(pGrid, i, j, GRIDITEM_DRAW);
                }
            }
        }

        //pGrid->state &= ~(GRID_DRAW_ITEMS || GRID_DRAW_ALL || GRID_SHOW_FOCUS);
        pGrid->hdr.state &= ~(GRID_DRAW_ITEMS || GRID_DRAW_ALL);

        // Set line state
        SetLineType(SOLID_LINE);
    }

    return (1);
}

/* */
void GridFreeItems(void *pObj)
{
    GRID *pGrid;

    pGrid = (GRID *)pObj;

    if(pGrid && pGrid->gridObjects)
    {
        GFX_free(pGrid->gridObjects);
        pGrid->gridObjects = NULL;  // Just in case...
    }
}

/* */
WORD GridSetCell(GRID *pGrid, SHORT column, SHORT row, WORD state, void *data)
{
    if((column >= pGrid->numColumns) || (row >= pGrid->numRows))
    {
        return (GRID_OUT_OF_BOUNDS);
    }

    pGrid->gridObjects[CELL_AT(column, row)].data = data;
    pGrid->gridObjects[CELL_AT(column, row)].status = state;    // This overwrites 
GRIDITEM_SELECTED
    return (GRID_SUCCESS);
}

/* */
void GridClearCellState(GRID *pGrid, SHORT column, SHORT row, WORD state)
{
    if((column >= pGrid->numColumns) || (row >= pGrid->numRows))
    {
        return;
    }

    pGrid->gridObjects[CELL_AT(column, row)].status &= ~state;

    return;
}

/* */
void GridSetFocus(GRID *pGrid, SHORT column, SHORT row)
{
    if((column >= pGrid->numColumns) || (row >= pGrid->numRows))
    {
        return;
    }

    pGrid->focusX = column;
    pGrid->focusY = row;
```

```
}

/* */
void GridSetCellState(GRID *pGrid, SHORT column, SHORT row, WORD state)
{
    if((column >= pGrid->numColumns) || (row >= pGrid->numRows))
    {
        return;
    }

    pGrid->gridObjects[CELL_AT(column, row)].status |= state;

    return;
}

/* */
void *GridGetCell(GRID *pGrid, SHORT column, SHORT row, WORD *cellType)
{
    if((column >= pGrid->numColumns) || (row >= pGrid->numRows))
    {
        return (NULL);
    }

    *cellType = pGrid->gridObjects[CELL_AT(column, row)].status & GRID_TYPE_MASK;

    return (pGrid->gridObjects[CELL_AT(column, row)].data);
}

/* */
void GridMsgDefault(WORD translatedMsg, void *pObj, GOL_MSG *pMsg)
{
    GRID *pGrid;

    pGrid = (GRID *)pObj;

    switch(translatedMsg)
    {
        case GRID_MSG_ITEM_SELECTED:

            // Currently, only a single item can be selected.  This can be expanded later,
            // when touchscreen support is enhanced.
            pGrid->gridObjects[CELL_AT(pGrid->focusX, pGrid->focusY)].status ^=
GRIDITEM_SELECTED;

            //              SetState( pGrid, GRID_SHOW_FOCUS | GRID_DRAW_ITEMS );
            SetState(pGrid, GRID_DRAW_ITEMS);
            break;

        case GRID_MSG_UP:
            if(pGrid->focusY > 0)
            {
                pGrid->gridObjects[CELL_AT(pGrid->focusX, pGrid->focusY)].status |=
GRIDITEM_DRAW;
                pGrid->focusY--;

                //              SetState( pGrid, GRID_SHOW_FOCUS | GRID_DRAW_ITEMS );
                SetState(pGrid, GRID_DRAW_ITEMS);
            }

            break;

        case GRID_MSG_DOWN:
            if(pGrid->focusY < (pGrid->numRows - 1))
            {
                pGrid->gridObjects[CELL_AT(pGrid->focusX, pGrid->focusY)].status |=
GRIDITEM_DRAW;
                pGrid->focusY++;

                //              SetState( pGrid, GRID_SHOW_FOCUS | GRID_DRAW_ITEMS );
                SetState(pGrid, GRID_DRAW_ITEMS);
            }
            break;

        case GRID_MSG_LEFT:
            if(pGrid->focusX > 0)
            {
                pGrid->gridObjects[CELL_AT(pGrid->focusX, pGrid->focusY)].status |=
GRIDITEM_DRAW;
                pGrid->focusX--;

                //            SetState( pGrid, GRID_SHOW_FOCUS | GRID_DRAW_ITEMS );
                SetState(pGrid, GRID_DRAW_ITEMS);
            }

            break;

        case GRID_MSG_RIGHT:
            if(pGrid->focusX < (pGrid->numColumns - 1))
            {
                pGrid->gridObjects[CELL_AT(pGrid->focusX, pGrid->focusY)].status |=
GRIDITEM_DRAW;
                pGrid->focusX++;

                //            SetState( pGrid, GRID_SHOW_FOCUS | GRID_DRAW_ITEMS );
                SetState(pGrid, GRID_DRAW_ITEMS);
            }

            break;
    }
}

/* */
WORD GridTranslateMsg(void *pObj, GOL_MSG *pMsg)
{

    GRID *pGrid;

    pGrid = (GRID *)pObj;

    // Evaluate if the message is for the check box
    // Check if disabled first
    if(GetState(pGrid, GRID_DISABLED))
    {
        return (OBJ_MSG_INVALID);
    }

        #ifdef USE_TOUCHSCREEN
    if(pMsg->type == TYPE_TOUCHSCREEN)
    {

        // Check if it falls in the check box borders
        if
        (
            (pGrid->hdr.left <= pMsg->param1) &&
            (pGrid->hdr.right >= pMsg->param1) &&
            (pGrid->hdr.top <= pMsg->param2) &&
            (pGrid->hdr.bottom >= pMsg->param2)
        )
        {
            return (GRID_MSG_TOUCHED);
        }

        return (OBJ_MSG_INVALID);
    }

        #endif
        #ifdef USE_KEYBOARD
    if((pMsg->uiEvent == EVENT_KEYSCAN) && (pMsg->type == TYPE_KEYBOARD) &&
((WORD)pMsg->param1 == pGrid->hdr.ID))
    {
        if((pMsg->param2 == SCAN_SPACE_PRESSED) || (pMsg->param2 == SCAN_CR_PRESSED))
        {
            return (GRID_MSG_ITEM_SELECTED);
        }
        else if(pMsg->param2 == SCAN_LEFT_PRESSED)
        {
            return (GRID_MSG_LEFT);
        }
        else if(pMsg->param2 == SCAN_RIGHT_PRESSED)
        {
            return (GRID_MSG_RIGHT);
        }
        else if(pMsg->param2 == SCAN_UP_PRESSED)
        {
            return (GRID_MSG_UP);
        }
        else if(pMsg->param2 == SCAN_DOWN_PRESSED)
        {
            return (GRID_MSG_DOWN);
        }
    }

    return (OBJ_MSG_INVALID);
        #endif
    return (OBJ_MSG_INVALID);
}

#endif // USE_GRID
```

14.1.19 Grid.h

Functions

	Name	Description
	GridClearCellState (see page 175)	This function clears the state of the cell (or Grid (see page 167) Item) specified by the column and row.
	GridCreate (see page 173)	This function creates a GRID (see page 183) object with the parameters given. It automatically attaches the new object into a global linked list of objects and returns the address of the object.
	GridDraw (see page 174)	This function renders the object on the screen using the current parameter settings. Location of the object is determined by the left, top, right and bottom parameters. The colors used are dependent on the state of the object. The font used is determined by the style scheme set. When rendering objects of the same type, each object must be rendered completely before the rendering of the next object is started. This is to avoid incomplete object rendering.
	GridFreeItems (see page 177)	This function removes all grid items for the given Grid (see page 167) and frees the memory used.
	GridGetCell (see page 177)	This function removes all grid items for the given Grid (see page 167) and frees the memory used.
	GridMsgDefault (see page 180)	This function performs the actual state change based on the translated message given. The following state changes are supported:
	GridSetCell (see page 178)	This function sets the Grid (see page 167) Item state and data.
	GridSetCellState (see page 179)	This function sets the state of the Grid (see page 167) Item or cell.
	GridSetFocus (see page 180)	This function sets the focus of the specified Grid (see page 167) Item or cell.
	GridTranslateMsg (see page 181)	This function evaluates the message from a user if the message will affect the object or not. The table below enumerates the translated messages for each event of the touch screen and keyboard inputs.

Macros

Name	Description
GRID_DISABLED (see page 169)	Bit for disabled state
GRID_DRAW_ALL (see page 170)	Bit to indicate whole edit box must be redrawn
GRID_DRAW_ITEMS (see page 170)	Bit to indicate that at least one item must be redrawn, but not the entire grid.
GRID_FOCUSED (see page 169)	Bit for focused state
GRID_HIDE (see page 170)	Bit to remove object from screen
GRID_OUT_OF_BOUNDS (see page 176)	Status of an out of bounds cell GridSetCell (see page 178)() operation.
GRID_SHOW_BORDER_ONLY (see page 170)	Draw only the outside border of the grid.
GRID_SHOW_FOCUS (see page 169)	Highlight the focused cell.
GRID_SHOW_LINES (see page 169)	Display grid lines
GRID_SHOW_SEPARATORS_ONLY (see page 170)	Draw only the lines between cells (like Tic-tac-toe)
GRID_SUCCESS (see page 177)	Status of a successful GridSetCell (see page 178)() operation.
GridGetFocusX (see page 175)	This macro returns the x position of the focused cell.
GridGetFocusY (see page 176)	This macro returns the y position of the focused cell.
GRIDITEM_DRAW (see page 173)	Draw this cell
GRIDITEM_IS_BITMAP (see page 172)	The grid item is a bitmap.
GRIDITEM_IS_TEXT (see page 171)	The grid item is a test string.
GRIDITEM_SELECTED (see page 171)	The cell is selected.
GRIDITEM_TEXTBOTTOM (see page 172)	Bit to indicate text is top aligned.
GRIDITEM_TEXTLEFT (see page 172)	Text in the cell is left aligned.
GRIDITEM_TEXTRIGHT (see page 172)	Text in the cell is right aligned.
GRIDITEM_TEXTTOP (see page 172)	Bit to indicate text is bottom aligned.

Structures

Name	Description
GRID (see page 183)	Defines the parameters required for a grid Object. Clipping is not supported in grid object.
GRIDITEM (see page 183)	Defines the grid item.

Description

This is file Grid.h.

Body Source

```
/*****************************************************************************
 *  Module for Microchip Graphics Library
 *  Grid control
 *****************************************************************************
 * FileName:        Grid.h
 * Dependencies:    none
 * Processor:       PIC24F, PIC24H, dsPIC, PIC32
 * Compiler:        MPLAB C30, MPLAB C32
 * Linker:          MPLAB LINK30, MPLAB LINK32
 * Company:         Microchip Technology Incorporated
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 * CLAIMS BY THIRD PARTIES (INCLUDING BUT NOT LIMITED TO ANY DEFENSE THEREOF),
 * OR OTHER SIMILAR COSTS.
 *
 * Date        Comment
 *~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
 * 02/29/08    ...
 * 04/16/10    Added Grid Item as text.
 *****************************************************************************/
#ifndef _GRID_H_
    #define _GRID_H_

    #include <Graphics/GOL.h>
    #include "GenericTypeDefs.h"

//******************************************************************************
// Grid Object State Definitions
//******************************************************************************
    #define GRID_FOCUSED                0x0001  // Bit for focused state
    #define GRID_DISABLED               0x0002  // Bit for disabled state
    #define GRID_SHOW_LINES             0x0004  // Display grid lines
    #define GRID_SHOW_FOCUS             0x0008  // Highlight the focused cell.
    #define GRID_SHOW_BORDER_ONLY       0x0010  // Draw only the outside border of the grid.
    #define GRID_SHOW_SEPARATORS_ONLY   0x0020  // Draw only the lines between cells (like
Tic-tac-toe)
    #define GRID_DRAW_ITEMS             0x1000  // Bit to indicate that at least one item
must be redrawn, but not the entire grid.
    #define GRID_DRAW_ALL               0x4000  // Bit to indicate whole edit box must be
redrawn
    #define GRID_HIDE                   0x8000  // Bit to remove object from screen

//******************************************************************************
// Grid Item State Definitions
//******************************************************************************
    #define GRIDITEM_SELECTED           0x0001  // The cell is selected.
    #define GRIDITEM_IS_TEXT            0x0000  // The grid item is a test string.
    #define GRIDITEM_IS_BITMAP          0x0008  // The grid item is a bitmap.
    #define GRIDITEM_TEXTRIGHT          0x0010  // Text in the cell is right aligned.
    #define GRIDITEM_TEXTLEFT           0x0020  // Text in the cell is left aligned.
    #define GRIDITEM_TEXTBOTTOM         0x0040  // Bit to indicate text is top aligned.
    #define GRIDITEM_TEXTTOP            0x0080  // Bit to indicate text is bottom aligned.
    #define GRIDITEM_DRAW               0x0100  // Draw this cell


    #define GRID_TYPE_MASK              (0x0C)
    #define GRID_SUCCESS                0x0000  // Status of a successful GridSetCell()
operation.
    #define GRID_OUT_OF_BOUNDS          0x0001  // Status of an out of bounds cell
GridSetCell() operation.

    #define GRID_MAX_COLUMNS(rw, cw)    ((rw - (GOL_EMBOSS_SIZE * 2) + 1) / (cw + 1))
    #define GRID_MAX_ROWS(rh, ch)       ((rh - (GOL_EMBOSS_SIZE * 2) + 1) / (ch + 1))
    #define GRID_WIDTH(c, cw)           ((GOL_EMBOSS_SIZE * 2) + (c * (cw + 1)) - 1)
    #define GRID_HEIGHT(r, ch)          ((GOL_EMBOSS_SIZE * 2) + (r * (ch + 1)) - 1)

/*********************************************************************
* Overview: Defines the grid item.
*
*********************************************************************/
```

```
typedef struct
{
    void    *data;                          // Indicates if the Grid Item is type
GRIDITEM_IS_TEXT or GRIDITEM_IS_BITMAP
    WORD    status;                         // indicates the status of the Grid Item
} GRIDITEM;

/*********************************************************************
* Overview: Defines the parameters required for a grid Object.
*           Clipping is not supported in grid object.
*
*********************************************************************/
typedef struct
{
    OBJ_HEADER  hdr;                        // Generic header for all Objects (see
OBJ_HEADER).
    SHORT       numColumns;                 // Number of columns drawn for the Grid.
    SHORT       numRows;                    // Number of rows drawn for the Grid.
    SHORT       cellHeight;                 // The height of each cell in pixels.
    SHORT       cellWidth;                  // The width of each cell in pixels.
    SHORT       focusX;                     // The x position of the cell to be focused.
    SHORT       focusY;                     // The y position of the cell to be focused.
    GRIDITEM    *gridObjects;               // The pointer to grid items
} GRID;

/*********************************************************************
* Function: GRID *GridCreate(WORD ID, SHORT left, SHORT top, SHORT right, SHORT bottom,
*                            WORD state, SHORT numColumns, SHORT numRows,
*                            SHORT cellWidth, SHORT cellHeight, GOL_SCHEME *pScheme)
*
* Overview: This function creates a GRID object with the parameters
*           given. It automatically attaches the new object into a global
*           linked list of objects and returns the address of the object.
*
* PreCondition: none
*
* Input: ID - Unique user defined ID for the object instance.
*        left - Left most position of the Object.
*        top - Top most position of the Object.
*        right - Right most position of the Object.
*        bottom - Bottom most position of the object.
*        state - Sets the initial state of the object.
*        numColumns - Sets the number of columns for the grid.
*        numRows - Sets the number of rows for the grid.
*        cellWidth - Sets the width of each cell of the grid.
*        cellHeight - Sets the height of each cell of the grid.
*        pScheme - Pointer to the style scheme used for the object.
*                  Set to NULL if default style scheme is used.
*
* Output: Returns the pointer to the object created.
*
* Side Effects: none
*
********************************************************************/
GRID    *GridCreate
        (
            WORD        ID,
            SHORT       left,
            SHORT       top,
            SHORT       right,
            SHORT       bottom,
            WORD        state,
            SHORT       numColumns,
            SHORT       numRows,
            SHORT       cellWidth,
            SHORT       cellHeight,
            GOL_SCHEME  *pScheme
        );

/*********************************************************************
* Function: GridClearCellState(GRID *pGrid, SHORT column, SHORT row, WORD state)
*
```

```
* Overview: This function clears the state of the cell (or Grid Item) specified
*           by the column and row.
*
* PreCondition: none
*
* Input: pGrid - Pointer to the object.
*        column - column index of the cell
*        row - row index of the cell
*        atate - specifies the state to be cleared. See Grid Item State.
*
* Output: none.
*
* Side Effects: none
*
********************************************************************/
void    GridClearCellState(GRID *pGrid, SHORT column, SHORT row, WORD state);


/*********************************************************************
* Function: WORD GridDraw(void *pObj)
*
* Overview: This function renders the object on the screen using
*           the current parameter settings. Location of the object
*           is determined by the left, top, right and bottom parameters.
*           The colors used are dependent on the state of the object.
*           The font used is determined by the style scheme set.
*
*           When rendering objects of the same type, each object must
*           be rendered completely before the rendering of the next object
*           is started. This is to avoid incomplete object rendering.
*
* PreCondition: Object must be created before this function is called.
*
* Input: pGb - Pointer to the object to be rendered.
*
* Output: Returns the status of the drawing
*         - 1 - If the rendering was completed and
*         - 0 - If the rendering is not yet finished.
*         Next call to the function will resume the
*         rendering on the pending drawing state.
*
* Side Effects: none
*
********************************************************************/
WORD GridDraw(void *pObj);

/*********************************************************************
* Function: GridFreeItems(void *pObj)
*
* Overview: This function removes all grid items for the given Grid
*           and frees the memory used.
*
* PreCondition: Object must be created before this function is called.
*
* Input: pGrid - The pointer to the Grid object.
*
* Output: none.
*
* Side Effects: none
*
********************************************************************/
void    GridFreeItems(void *pObj);

/*********************************************************************
* Function: *GridGetCell(GRID *pGrid, SHORT column, SHORT row, WORD *cellType)
*
* Overview: This function removes all grid items for the given Grid
*           and frees the memory used.
*
* PreCondition: Object must be created before this function is called.
*
* Input: pGrid - The pointer to the Grid object.
*        column - the column index of the cell
*        row - the row index of the cell
*        cellType - pointer that will receive the type of grid item
*                   or cell (GRIDITEM_IS_TEXT or GRIDITEM_IS_BITMAP).
*
* Output: Returns a pointer to the grid item or cell data.
*
* Side Effects: none
*
********************************************************************/
void    *GridGetCell(GRID *pGrid, SHORT column, SHORT row, WORD *cellType);

/*********************************************************************
* Macros:  GridGetFocusX(pGrid)
*
* Overview: This macro returns the x position of the focused cell.
*
* PreCondition: none
*
* Input: pGrid - Pointer to the object.
*
* Output: Returns the x position of the focused cell.
*
* Side Effects: none
*
********************************************************************/
#define GridGetFocusX(pGrid)    pGrid->focusX

/*********************************************************************
* Macros:  GridGetFocusY(pGrid)
*
* Overview: This macro returns the y position of the focused cell.
*
* PreCondition: none
*
* Input: pGrid - Pointer to the object.
*
* Output: Returns the y position of the focused cell.
*
* Side Effects: none
*
********************************************************************/
#define GridGetFocusY(pGrid)    pGrid->focusY

/*********************************************************************
* Function: GridMsgDefault(WORD translatedMsg, void *pObj, GOL_MSG *pMsg)
*
* Overview: This function performs the actual state change
*           based on the translated message given. The following state changes
*           are supported:
*   <TABLE>
*       Translated Message      Input Source    Set/Clear State Bit     Description
*       ##################      ############    ######                  ###########
*       GRID_MSG_TOUCHED        Touch Screen    none                    Grid will have no
state change because of this event.
*       GRID_MSG_ITEM_SELECTED  Keyboard        Set GRIDITEM_SELECTED,  Grid Item selected
will be redrawn.
*                                               GRID_DRAW_ITEMS
*       GRID_MSG_UP             Keyboard        Set GRIDITEM_DRAW,      Grid Item above the
currently focused item will be redrawn.
*                                               GRID_DRAW_ITEMS
*       GRID_MSG_DOWN           Keyboard        Set GRIDITEM_DRAW,      Grid Item below the
currently focused item will be redrawn.
*                                               GRID_DRAW_ITEMS
*       GRID_MSG_LEFT           Keyboard        Set GRIDITEM_DRAW,      Grid Item to the
left of the currently focused item will be redrawn.
*                                               GRID_DRAW_ITEMS
*       GRID_MSG_RIGHT          Keyboard        Set GRIDITEM_DRAW,      Grid Item to the
right of the currently focused item will be redrawn.
*
GRID_DRAW_ITEMS
*   </TABLE>
```

```
*
* PreCondition: none
*
* Input: translatedMsg - The translated message.
*        pGrid         - The pointer to the object whose state will be modified.
*        pMsg          - The pointer to the GOL message.
*
* Output: none
*
* Side Effects: none
*
********************************************************************/
void    GridMsgDefault(WORD translatedMsg, void *pObj, GOL_MSG *pMsg);

/*********************************************************************
* Function: GridTranslateMsg(void *pObj, GOL_MSG *pMsg)
*
* Overview: This function evaluates the message from a user if the
*           message will affect the object or not. The table below enumerates the
translated
*           messages for each event of the touch screen and keyboard inputs.
*
*   <TABLE>
*       Translated Message       Input Source       Set/Clear State Bit         Description
*       ##################       ############       #######################
##############################################################################################
######################################################################
*       GRID_MSG_TOUCHED         Touch Screen       none                        If any
touch events occurs and the x,y position falls in the face of the grid.
*       GRID_MSG_ITEM_SELECTED   Keyboard           EVENT_KEYSCAN               If event
occurs and parameter1 passed matches the object's ID and parameter 2 passed matches
SCAN_SPACE_PRESSED or SCAN_CR_PRESSED.
*       GRID_MSG_UP              Keyboard           EVENT_KEYSCAN               If event
occurs and parameter1 passed matches the object's ID and parameter 2 passed matches
SCAN_UP_PRESSED.
*       GRID_MSG_DOWN            Keyboard           EVENT_KEYSCAN               If event
occurs and parameter1 passed matches the object's ID and parameter 2 passed matches
SCAN_DOWN_PRESSED.
*       GRID_MSG_LEFT            Keyboard           EVENT_KEYSCAN               If event
occurs and parameter1 passed matches the object's ID and parameter 2 passed matches
SCAN_LEFT_PRESSED.
*       GRID_MSG_RIGHT           Keyboard           EVENT_KEYSCAN               If event
occurs and parameter1 passed matches the object's ID and parameter 2 passed matches
SCAN_RIGHT_PRESSED.
*       OBJ_MSG_INVALID          Any                Any                         If the
message did not affect the object.
*   </TABLE>
*
* PreCondition: none
*
* Input: pGrid - The pointer to the object where the message will be
*                evaluated to check if the message will affect the object.
*        pMsg  - Pointer to the message struct containing the message from
*                the user interface.
*
* Output: Returns the translated message depending on the received GOL message:
*          - GRID_MSG_TOUCHED - when the grid object is touched.
*          - GRID_MSG_ITEM_SELECTED – when key scan SCAN_SPACE_PRESSED or SCAN_CR_PRESSED
are detected.
*          - GRID_MSG_UP – when key scan SCAN_UP_PRESSED is detected.
*          - GRID_MSG_DOWN – when key scan SCAN_DOWN_PRESSED is detected.
*          - GRID_MSG_LEFT – when key scan SCAN_LEFT_PRESSED is detected.
*          - GRID_MSG_RIGHT – when key scan SCAN_RIGHT_PRESSED is detected.
*          - OBJ_MSG_INVALID – Button is not affected
*
*
* Side Effects: none
*
********************************************************************/
WORD    GridTranslateMsg(void *pObj, GOL_MSG *pMsg);

/*********************************************************************
```

```
* Function: WORD    GridSetCell(GRID *pGrid, SHORT column, SHORT row, WORD state, void
*data)
*
* Overview: This function sets the Grid Item state and data.
*
* PreCondition: Object must be created before this function is called.
*
* Input: pGrid - The pointer to the Grid object.
*        column - the column index of the cell
*        row - the row index of the cell
*        state - sets the state of the Grid Item specified.
*        data - pointer to the data used for the Grid Item.
*
* Output: Returns the status of the operation
*         - GRID_SUCCESS - if the set succeeded
*         - GRID_OUT_OF_BOUNDS - if the row and column given results in an out of bounds
location.
*
* Side Effects: none
*
********************************************************************/
WORD    GridSetCell(GRID *pGrid, SHORT column, SHORT row, WORD state, void *data);

/*********************************************************************
* Function: GridSetCellState(GRID *pGrid, SHORT column, SHORT row, WORD state)
*
* Overview: This function sets the state of the Grid Item or cell.
*
* PreCondition: Object must be created before this function is called.
*
* Input: pGrid - The pointer to the Grid object.
*        column - the column index of the cell
*        row - the row index of the cell
*        state - sets the state of the Grid Item specified.
*
* Output: none.
*
* Side Effects: none
*
********************************************************************/
void    GridSetCellState(GRID *pGrid, SHORT column, SHORT row, WORD state);

/*********************************************************************
* Function: GridSetFocus(GRID *pGrid, SHORT column, SHORT row)
*
* Overview: This function sets the focus of the specified Grid Item or cell.
*
* PreCondition: Object must be created before this function is called.
*
* Input: pGrid - The pointer to the Grid object.
*        column - the column index of the cell
*        row - the row index of the cell
*
* Output: none.
*
* Side Effects: none
*
********************************************************************/
void    GridSetFocus(GRID *pGrid, SHORT column, SHORT row);

#endif
```

14.1.20 GroupBox.c

This is file GroupBox.c.

Body Source

```
/*****************************************************************************
 *  Module for Microchip Graphics Library
 *  GOL Layer
 *  Group Box
 *****************************************************************************
 * FileName:        GroupBox.c
 * Dependencies:
 * Processor:       PIC24F, PIC24H, dsPIC, PIC32
 * Compiler:        MPLAB C30 V3.00, MPLAB C32
 * Linker:          MPLAB LINK30, MPLAB LINK32
 * Company:         Microchip Technology Incorporated
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 * OR OTHER SIMILAR COSTS.
 *
 * Author               Date        Comment
 *~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
 * Paolo A. Tamayo      11/12/07    Version 1.0 release
 *****************************************************************************/
#include "Graphics/Graphics.h"

#ifdef USE_GROUPBOX

/*********************************************************************
* Function: GROUPBOX *GbCreate(WORD ID, SHORT left, SHORT top, SHORT right,
*                              SHORT bottom, WORD state, XCHAR *pText,
*                              GOL_SCHEME *pScheme)
*
* Notes: Creates a GROUPBOX object and adds it to the current active list.
*        If the creation is successful, the pointer to the created Object
*        is returned. If not successful, NULL is returned.
*
********************************************************************/
GROUPBOX *GbCreate
(
    WORD        ID,
    SHORT       left,
    SHORT       top,
    SHORT       right,
    SHORT       bottom,
    WORD        state,
    XCHAR       *pText,
    GOL_SCHEME  *pScheme
)
{
    GROUPBOX    *pGb = NULL;

    pGb = (GROUPBOX *)GFX_malloc(sizeof(GROUPBOX));
```

```
    if(pGb == NULL)
        return (pGb);

    pGb->hdr.ID = ID;                   // unique id assigned for referencing
    pGb->hdr.pNxtObj = NULL;
    pGb->hdr.type = OBJ_GROUPBOX;       // set object type
    pGb->hdr.left = left;               // left position
    pGb->hdr.top = top;                 // top position
    pGb->hdr.right = right;             // right position
    pGb->hdr.bottom = bottom;           // bottom position
    pGb->hdr.state = state;             // initial state
    pGb->pText = pText;                 // text label used
    pGb->hdr.DrawObj = GbDraw;          // draw function
    pGb->hdr.MsgObj = GbTranslateMsg;   // message function
    pGb->hdr.MsgDefaultObj = NULL;      // default message function
    pGb->hdr.FreeObj = NULL;            // free function

    // Set the color scheme and font to be used
    if(pScheme == NULL)
        pGb->hdr.pGolScheme = _pDefaultGolScheme;
    else
        pGb->hdr.pGolScheme = (GOL_SCHEME *)pScheme;

    pGb->textWidth = 0;
    pGb->textHeight = 0;
    if(pText != NULL)
    {

        // Set the text width & height
        pGb->textWidth = GetTextWidth(pText, pGb->hdr.pGolScheme->pFont);
        pGb->textHeight = GetTextHeight(pGb->hdr.pGolScheme->pFont);
    }

    GOLAddObject((OBJ_HEADER *)pGb);
    return (pGb);
}

/*********************************************************************
* Function: WORD GbTranslateMsg(void *pObj, GOL_MSG *pMsg)
*
* Notes: Evaluates the message if the object will be affected by the
*        message or not.
*
********************************************************************/
WORD GbTranslateMsg(void *pObj, GOL_MSG *pMsg)
{

    GROUPBOX *pGb;

    pGb = (GROUPBOX *)pObj;

    // Evaluate if the message is for the button
    // Check if disabled first
    if(!GetState(pGb, GB_DISABLED))
    {
            #ifdef USE_TOUCHSCREEN
        if(pMsg->type == TYPE_TOUCHSCREEN)
        {

            // Check if it falls to the left or right of the center of the thumb's face
            if
            (
                (pGb->hdr.left < pMsg->param1) &&
                (pGb->hdr.right > pMsg->param1) &&
                (pGb->hdr.top < pMsg->param2) &&
                (pGb->hdr.bottom > pMsg->param2)
            )
            {
                if((pMsg->uiEvent == EVENT_PRESS) || (pMsg->uiEvent == EVENT_RELEASE))
                    return (GB_MSG_SELECTED);
            }
        }
```

```
            #endif
    }

    return (OBJ_MSG_INVALID);
}

/*********************************************************************
* Function: WORD GbDraw(void *pObj)
*
* Notes: This is the state machine to draw the button.
*
********************************************************************/
    #if (COLOR_DEPTH == 1)
        #define THREE_D_EFFECT  0
    #else
        #define THREE_D_EFFECT  1
    #endif

/* */
WORD GbDraw(void *pObj)
{
    typedef enum
    {
        GB_STATE_IDLE,
        GB_STATE_HIDETEXT,
        GB_STATE_SETDIMENSION,
        GB_STATE_DRAWTEXT,
        GB_STATE_DRAWTOPRIGHT,
        GB_STATE_DRAWTOPLEFT,
        GB_STATE_DRAWSIDELEFT,
        GB_STATE_DRAWSIDERIGHT,
        GB_STATE_DRAWBOTTOM,
            #if (COLOR_DEPTH != 1)
        GB_STATE_2DRAWTOPRIGHT,
        GB_STATE_2DRAWTOPLEFT,
        GB_STATE_2DRAWSIDELEFT,
        GB_STATE_2DRAWSIDERIGHT,
        GB_STATE_2DRAWBOTTOM,
            #endif
    } GB_DRAW_STATES;

    static GB_DRAW_STATES state = GB_STATE_IDLE;
    static SHORT textLeft, textRight, top;                      // used to draw lines that
start/stops at text.
    GROUPBOX *pGb;

    pGb = (GROUPBOX *)pObj;

    if(IsDeviceBusy())
        return (0);

    switch(state)
    {
        case GB_STATE_IDLE:

            if(GetState(pGb, GB_HIDE))
            {                                                   // Hide the Group Box
(remove from screen)
                SetColor(pGb->hdr.pGolScheme->CommonBkColor);
                if(!Bar(pGb->hdr.left, pGb->hdr.top, pGb->hdr.right, pGb->hdr.bottom))
                    return 0;
                return (1);
            }

            state = GB_STATE_HIDETEXT;

        case GB_STATE_HIDETEXT:                                 // hide the text first
            if(pGb->pText != NULL)
            {                                                   // needed when dynamically
changing
                SetColor(pGb->hdr.pGolScheme->CommonBkColor);   // the alignement of text
                if(!Bar(pGb->hdr.left, pGb->hdr.top, pGb->hdr.right, pGb->hdr.top +
pGb->textHeight))
                    return 0;
            }

            state = GB_STATE_SETDIMENSION;

        case GB_STATE_SETDIMENSION:
            if(IsDeviceBusy())
                return (0);

            if(GetState(pGb, GB_DISABLED))
            {   // set color to inactive color
                SetColor(pGb->hdr.pGolScheme->TextColorDisabled);
            }
            else
            {
                SetColor(pGb->hdr.pGolScheme->TextColor0);  // active color
            }

            if(pGb->pText == NULL)
            {   // there is no text, use full dimensions
                top = pGb->hdr.top;
                textLeft = pGb->hdr.left + 1;
                textRight = textLeft;
                state = GB_STATE_DRAWTOPRIGHT;  // go to drawing of right top line
                goto gb_state_draw_lines;
            }
            else
            {   // text is present, set up dimensions with text
                SetFont(pGb->hdr.pGolScheme->pFont);
                top = pGb->hdr.top + (pGb->textHeight >> 1);
// adjust lines on top
                if(pGb->hdr.state & GB_RIGHT_ALIGN)
                {

                    // do right aligned
                    textLeft = pGb->hdr.right - pGb->textWidth - 2;
                    textRight = pGb->hdr.right - 2;
                }
                else if(pGb->hdr.state & GB_CENTER_ALIGN)
                {

                    // do center aligned
                    textLeft = (pGb->hdr.left + pGb->hdr.right - pGb->textWidth) >> 1;
                    textRight = textLeft + pGb->textWidth;
                }
                else
                {

                    // do left aligned
                    textLeft = pGb->hdr.left + 2;
                    textRight = pGb->hdr.left + 2 + pGb->textWidth;
                }

                MoveTo(textLeft, pGb->hdr.top);
// move cursor to start of text
                state = GB_STATE_DRAWTEXT;
            }

        case GB_STATE_DRAWTEXT:
            if(!OutText(pGb->pText))
                return (0);
                #if (COLOR_DEPTH == 1)
            SetColor(WHITE);
                #else
            SetColor(pGb->hdr.pGolScheme->EmbossDkColor);
                #endif
            state = GB_STATE_DRAWTOPRIGHT;

    gb_state_draw_lines:
        case GB_STATE_DRAWTOPRIGHT:
            if(!Line(textRight, top + THREE_D_EFFECT, pGb->hdr.right, top + THREE_D_EFFECT))
                return 0;    // top line at right
            state = GB_STATE_DRAWTOPLEFT;

        case GB_STATE_DRAWTOPLEFT:
            if(!Line(pGb->hdr.left + THREE_D_EFFECT, top + THREE_D_EFFECT, textLeft, top +
THREE_D_EFFECT))
                return 0;                    // top line at left
            state = GB_STATE_DRAWSIDELEFT;

        case GB_STATE_DRAWSIDELEFT:
            if(!Line(pGb->hdr.left + THREE_D_EFFECT, top + THREE_D_EFFECT, pGb->hdr.left +
THREE_D_EFFECT, pGb->hdr.bottom))
                return 0;    // side line at left
            state = GB_STATE_DRAWSIDERIGHT;

        case GB_STATE_DRAWSIDERIGHT:
            if(!Line(pGb->hdr.right, top + THREE_D_EFFECT, pGb->hdr.right, pGb->hdr.bottom))
                return 0;            // side line at right
            state = GB_STATE_DRAWBOTTOM;

        case GB_STATE_DRAWBOTTOM:
            if(!Line(pGb->hdr.left + THREE_D_EFFECT, pGb->hdr.bottom, pGb->hdr.right,
pGb->hdr.bottom))
                return 0; // bottom line
                #if (COLOR_DEPTH == 1)
            state = GB_STATE_IDLE;
                #else
            state = GB_STATE_2DRAWTOPLEFT;
                #endif
                #if (COLOR_DEPTH != 1)

        case GB_STATE_2DRAWTOPLEFT:
            SetColor(pGb->hdr.pGolScheme->EmbossLtColor);                              //
2nd line top line at left
            if(!Line(pGb->hdr.left, top, textLeft, top))
                return 0;
            state = GB_STATE_2DRAWTOPRIGHT;

        case GB_STATE_2DRAWTOPRIGHT:
            if(!Line(textRight, top, pGb->hdr.right, top))
                return 0;                             // 2nd line top line at right
            state = GB_STATE_2DRAWSIDELEFT;

        case GB_STATE_2DRAWSIDELEFT:
            if(!Line(pGb->hdr.left, top, pGb->hdr.left, pGb->hdr.bottom - 1))
                return 0;               // 2nd line left
            state = GB_STATE_2DRAWSIDERIGHT;

        case GB_STATE_2DRAWSIDERIGHT:
            if(!Line(pGb->hdr.right - 1, top + 2, pGb->hdr.right - 1, pGb->hdr.bottom - 1))
                return 0; // 2nd line right
            state = GB_STATE_2DRAWBOTTOM;

        case GB_STATE_2DRAWBOTTOM:
            if(!Line(pGb->hdr.left + 2, pGb->hdr.bottom - 1, pGb->hdr.right - 1,
pGb->hdr.bottom - 1))
                return 0;  // 2nd line bottom
            state = GB_STATE_IDLE;
                #endif
    }

    return (1);
}

#endif // USE_GROUPBOX
```

14.1.21 GroupBox.h

Functions

	Name	Description
◆	GbCreate (see page 186)	This function creates a GROUPBOX (see page 190) object with the parameters given. It automatically attaches the new object into a global linked list of objects and returns the address of the object.
◆	GbDraw (see page 188)	This function renders the object on the screen using the current parameter settings. Location of the object is determined by the left, top, right and bottom parameters. The colors used are dependent on the state of the object. The font used is determined by the style scheme set. When rendering objects of the same type, each object must be rendered completely before the rendering of the next object is started. This is to avoid incomplete object rendering.
◆	GbSetText (see page 189)	This function sets the text used by passing the pointer to the static string.
◆	GbTranslateMsg (see page 190)	This function evaluates the message from a user if the message will affect the object or not. The table below enumerates the translated messages for each event of the touch screen inputs.

Macros

Name	Description
GB_CENTER_ALIGN (see page 185)	Bit to indicate text is center aligned
GB_DISABLED (see page 186)	Bit for disabled state
GB_DRAW (see page 186)	Bit to indicate group box must be redrawn
GB_HIDE (see page 186)	Bit to remove object from screen
GB_RIGHT_ALIGN (see page 186)	Bit to indicate text is right aligned
GbGetText (see page 188)	This macro returns the location of the text used.

Structures

Name	Description
GROUPBOX (see page 190)	Defines the parameters required for a group box Object. The textwidth and textHeight is not checked with the actual dimension of the object. Clipping is not supported in group box object. It is possible for the text to exceed the dimension of the Object.

Description

This is file GroupBox.h.

Body Source

```
/*****************************************************************************
 *  Module for Microchip Graphics Library
 *  GOL Layer
 *  Group Box
 *****************************************************************************
 * FileName:        GroupBox.h
 * Dependencies:    None
 * Processor:       PIC24F, PIC24H, dsPIC, PIC32
 * Compiler:        MPLAB C30, MPLAB C32
 * Linker:          MPLAB LINK30, MPLAB LINK32
 * Company:         Microchip Technology Incorporated
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```

```
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  * CLAIMS BY THIRD PARTIES (INCLUDING BUT NOT LIMITED TO ANY DEFENSE THEREOF),
  * OR OTHER SIMILAR COSTS.
  *
  * Date         Comment
  *~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
  * 11/12/07     Version 1.0 release
  *****************************************************************************/
#ifndef _GROUPBOX_H
    #define _GROUPBOX_H

    #include <Graphics/GOL.h>
    #include "GenericTypeDefs.h"

/*********************************************************************
* Object States Definition:
*********************************************************************/
    #define GB_DISABLED     0x0002  // Bit for disabled state
    #define GB_RIGHT_ALIGN  0x0004  // Bit to indicate text is right aligned
    #define GB_CENTER_ALIGN 0x0008  // Bit to indicate text is center aligned

// When center and right bits are zero alignment is left
    #define GB_DRAW 0x4000          // Bit to indicate group box must be redrawn
    #define GB_HIDE 0x8000          // Bit to remove object from screen

/*********************************************************************
* Overview: Defines the parameters required for a group box Object.
*           The textwidth and textHeight is not checked with the actual
*           dimension of the object. Clipping is not supported in
*           group box object. It is possible for the text to exceed
*           the dimension of the Object.
*
*********************************************************************/
typedef struct
{
    OBJ_HEADER  hdr;        // Generic header for all Objects (see OBJ_HEADER).
    SHORT       textWidth;  // Pre-computed text width.
    SHORT       textHeight; // Pre-computed text height.
    XCHAR       *pText;     // Text string used.
} GROUPBOX;

/*********************************************************************
* Macros:  GbGetText(pGb)
*
* Overview: This macro returns the location of the text used.
*
* PreCondition: none
*
* Input: pGb - Pointer to the object.
*
* Output: Returns the address of the text string used.
*
* Side Effects: none
*
********************************************************************/
    #define GbGetText(pB)   pGb->pText

/*********************************************************************
```

```
* Function: GbSetText(GROUPBOX *pGb, XCHAR *pText)
*
* Overview: This function sets the text used by passing the pointer
*           to the static string.
*
* PreCondition: none
*
* Input: pGb - the pointer to the object whose state will be modified.
*        pText - pointer to the text that will be used.
*
* Output: none
*
* Side Effects: none
*
********************************************************************/
void        GbSetText(GROUPBOX *pGb, XCHAR *pText);

/*********************************************************************
* Function: WORD GbTranslateMsg(void *pObj, GOL_MSG *pMsg)
*
* Overview: This function evaluates the message from a user if the
*           message will affect the object or not. The table below
*           enumerates the translated messages for each event of
*           the touch screen inputs.
*
*   <TABLE>
*       Translated Message   Input Source  Events                         Description
*       ##################   ############  ######                         ###########
*       GB_MSG_SELECTED      Touch Screen  EVENT_PRESS, EVENT_RELEASE     If events occurs
and the x,y position falls in the area of the group box.
*       OBJ_MSG_INVALID      Any           Any                            If the message did
not affect the object.
*   </TABLE>
*
* PreCondition: none
*
* Input: pGb   - The pointer to the object where the message will be
*                evaluated to check if the message will affect the object.
*        pMsg  - Pointer to the message struct containing the message from
*                the user interface.
*
* Output: Returns the translated message depending on the received GOL message:
*         - GB_MSG_SELECTED – Group Box is selected
*         - OBJ_MSG_INVALID – Group Box is not affected
*
* Example:
*   Usage is similar to BtnTranslateMsg() example.
*
* Side Effects: none
*
********************************************************************/
WORD        GbTranslateMsg(void *pObj, GOL_MSG *pMsg);

/*********************************************************************
* Function: GROUPBOX *GbCreate(WORD ID, SHORT left, SHORT top, SHORT right, SHORT bottom,
*                              WORD state, XCHAR *pText, GOL_SCHEME *pScheme)
*
* Overview: This function creates a GROUPBOX object with the parameters
*           given. It automatically attaches the new object into a global
*           linked list of objects and returns the address of the object.
*
* PreCondition: none
*
* Input: ID - Unique user defined ID for the object instance.
*        left - Left most position of the Object.
*        top - Top most position of the Object.
*        right - Right most position of the Object.
*        bottom - Bottom most position of the object.
*        state - Sets the initial state of the object.
*        pText - The pointer to the text used for the group box.
*                Length of string must be checked not to exceed the
*                object’s width. Clipping is not supported for the
```

```
 *                text of this object.
 *        pScheme - Pointer to the style scheme used for the object.
 *                  Set to NULL if default style scheme is used.
 *
 * Output: Returns the pointer to the object created.
 *
 * Example:
 *   <CODE>
 *   GOL_SCHEME *pScheme;
 *   GROUPBOX *groupbox[2];
 *   WORD state;
 *
 *   pScheme = GOLCreateScheme();
 *   state = GB_DRAW | GB_RIGHT_ALIGN;
 *   groupbox[0] = GbCreate( 10, 14,48,152,122,
 *                          state, "Power", scheme);
 *   if (groupbox[0] == NULL)
 *       return 0;
 *   state = GB_DRAW;
 *   groupbox[1] = GbCreate( 11, 160,48,298,122,
 *                          state, "Pressure", scheme);
 *   if (groupbox[1] == NULL)
 *       return 0;
 *
 *   while(!GbDraw(groupbox[0]));
 *   while(!GbDraw(groupbox[1]));
 *   return 1;
 *   </CODE>
 *
 * Side Effects: none
 *
 ********************************************************************/
 GROUPBOX    *GbCreate
             (
                 WORD        ID,
                 SHORT       left,
                 SHORT       top,
                 SHORT       right,
                 SHORT       bottom,
                 WORD        state,
                 XCHAR       *pText,
                 GOL_SCHEME  *pScheme
             );

 /*********************************************************************
 * Function: WORD GbDraw(void *pObj)
 *
 * Overview: This function renders the object on the screen using
 *           the current parameter settings. Location of the object
 *           is determined by the left, top, right and bottom parameters.
 *           The colors used are dependent on the state of the object.
 *           The font used is determined by the style scheme set.
 *
 *           When rendering objects of the same type, each object must
 *           be rendered completely before the rendering of the next object
 *           is started. This is to avoid incomplete object rendering.
 *
 * PreCondition: Object must be created before this function is called.
 *
 * Input: pGb - Pointer to the object to be rendered.
 *
 * Output: Returns the status of the drawing
 *          - 1 - If the rendering was completed and
 *          - 0 - If the rendering is not yet finished.
 *          Next call to the function will resume the
 *          rendering on the pending drawing state.
 *
 * Example:
 *   See GbCreate() example.
 *
 * Side Effects: none
 *
```

```
********************************************************************/
WORD GbDraw(void *pObj);
#endif //_GROUPBOX_H
```

14.1.22 ListBox.c

This is file ListBox.c.

Body Source

```
/*****************************************************************************
 *  Module for Microchip Graphics Library
 *  GOL Layer
 *  List Box
 *****************************************************************************
 * FileName:        ListBox.c
 * Dependencies:    None
 * Processor:       PIC24F, PIC24H, dsPIC, PIC32
 * Compiler:        MPLAB C30 V3.00, MPLAB C32
 * Linker:          MPLAB LINK30, MPLAB LINK32
 * Company:         Microchip Technology Incorporated
 *
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 * OR OTHER SIMILAR COSTS.
 *
 * Date         Comment
 *~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
 * 11/12/07     Version 1.0 release
 * 11/18/10     Fixed bug on icons drawn after the bottom edge of the list box.
 * 12/21/10     Fixed bug on the list count to rest back to zero when
 *              LbDelItemsList() is used to clear the list.
 * 04/20/11     Fixed KEYBOARD bug on object ID and GOL_MSG param1 comparison.
 *****************************************************************************/
#include "Graphics/Graphics.h"

#ifdef USE_LISTBOX

/*********************************************************************
* Function: LISTBOX  *LbCreate(WORD ID, SHORT left, SHORT top, SHORT right, SHORT bottom,
*                             WORD state, XCHAR* pText, GOL_SCHEME *pScheme)
*
* Overview: creates the list box
*
********************************************************************/
LISTBOX *LbCreate
(
    WORD        ID,
```

```
    SHORT       left,
    SHORT       top,
    SHORT       right,
    SHORT       bottom,
    WORD        state,
    XCHAR       *pText,
    GOL_SCHEME  *pScheme
)
{
    LISTBOX *pLb = NULL;
    XCHAR   *pointer;
    WORD    counter;

    pLb = (LISTBOX *)GFX_malloc(sizeof(LISTBOX));

    if(pLb == NULL)
        return (pLb);

    pLb->hdr.ID         = ID;
    pLb->hdr.pNxtObj    = NULL;
    pLb->hdr.type       = OBJ_LISTBOX;
    pLb->hdr.left       = left;
    pLb->hdr.top        = top;
    pLb->hdr.right      = right;
    pLb->hdr.bottom     = bottom;
    pLb->hdr.state      = state;
    pLb->pItemList      = NULL;
    pLb->scrollY        = 0;
    pLb->itemsNumber    = 0;
    pLb->hdr.DrawObj    = LbDraw;           // draw function
    pLb->hdr.MsgObj     = LbTranslateMsg;   // message function
    pLb->hdr.MsgDefaultObj = LbMsgDefault;  // default message function
    pLb->hdr.FreeObj    = LbDelItemsList;   // free function

    // Set the style scheme to be used
    if(pScheme == NULL)
        pLb->hdr.pGolScheme = _pDefaultGolScheme;
    else
        pLb->hdr.pGolScheme = (GOL_SCHEME *)pScheme;

    pLb->textHeight = GetTextHeight(pLb->hdr.pGolScheme->pFont);

    GOLAddObject((OBJ_HEADER *)pLb);

    // Add items if there's an initialization text (each line will become one item,
    // lines must be separated by '\n' character)
    if(pText != NULL)
    {
        pointer = pText;
        counter = 0;
        while(*pointer)
        {
            if(NULL == LbAddItem(pLb, NULL, pointer, NULL, 0, counter))
                break;
            while((XCHAR) *pointer++ > (XCHAR)31);
            if(*(pointer - 1) == 0)
                break;
            counter++;
        }
    }

    pLb->pFocusItem = pLb->pItemList;

    // Set focus for the object if FOCUSED state is set
        #ifdef USE_FOCUS
    if(GetState(pLb, LB_FOCUSED))
        GOLSetFocus((OBJ_HEADER *)pLb);
        #endif
    return (pLb);
}

/*********************************************************************
```

```
* Function: LISTITEM* LbAddItem(LISTBOX *pLb, LISTITEM *pPrevItem, XCHAR *pText, void*
pBitmap, WORD status, WORD data)
*
* Input: pLb - the pointer to the list box,
*        pPrevItem - pointer to the item after which a new item must be inserted,
*                    if this pointer is NULL, the item will be appended at the end of the
items list,
*        pText -  pointer to the text,
*        pBitmap - pointer to the bitmap,
*        status - status after creation,
*        data -  some data associated with the item
*
* Output: pointer to the item created, NULL if the operation was not successful
*
* Overview: allocates memory for a new item and adds it to the list box
*
********************************************************************/
LISTITEM *LbAddItem(LISTBOX *pLb, LISTITEM *pPrevItem, XCHAR *pText, void *pBitmap, WORD
status, WORD data)
{
    LISTITEM    *pItem;
    LISTITEM    *pCurItem;

    pItem = (LISTITEM *)GFX_malloc(sizeof(LISTITEM));

    if(pItem == NULL)
    {
        return (NULL);
    }

    pLb->itemsNumber++;

    if(pLb->pItemList == NULL)
    {
        pLb->pItemList = pItem;
        pItem->pNextItem = NULL;
        pItem->pPrevItem = NULL;
    }
    else
    {
        if(pPrevItem == NULL)
        {

            // Find last item
            pCurItem = (LISTITEM *)pLb->pItemList;
            while(pCurItem->pNextItem != NULL)
                pCurItem = (LISTITEM *)pCurItem->pNextItem;
        }
        else
        {
            pCurItem = (LISTITEM *)pPrevItem;
        }

        // Insert a new item
        pItem->pNextItem = pCurItem->pNextItem;
        pItem->pPrevItem = pCurItem;
        pCurItem->pNextItem = pItem;
    }

    pItem->pText = pText;
    pItem->pBitmap = pBitmap;
    pItem->status = status;
    pItem->data = data;

    return (pItem);
}

/*********************************************************************
* Function: void LbDelItem(LISTBOX *pLb, LISTITEM *pItem)
*
* Input: pLb - the pointer to the object,
*        pItem - the pointer to the item must be deleted
```

```
*
* Output: none
*
* Overview: removes an item from the list box and frees memory
*
********************************************************************/
void LbDelItem(LISTBOX *pLb, LISTITEM *pItem)
{
    if(pItem->pNextItem != NULL)
    {
        ((LISTITEM *)pItem->pNextItem)->pPrevItem = pItem->pPrevItem;
        if(pItem->pPrevItem == NULL)
            pLb->pItemList = (LISTITEM *)pItem->pNextItem;
    }

    if(pItem->pPrevItem != NULL)
        ((LISTITEM *)pItem->pPrevItem)->pNextItem = pItem->pNextItem;

    GFX_free(pItem);

    pLb->itemsNumber--;

    if(pLb->itemsNumber == 0)
        pLb->pItemList = NULL;
}

/*********************************************************************
* Function: void LbDelItemsList(void *pObj)
*
* Input: pLb - the pointer to the object
*
* Output: none
*
* Overview: removes all items from list box and frees memory
*
********************************************************************/
void LbDelItemsList(void *pObj)
{
    LISTITEM    *pCurItem;
    LISTITEM    *pItem;
    LISTBOX     *pLb;

    pLb = (LISTBOX *)pObj;

    pCurItem = pLb->pItemList;

    while(pCurItem != NULL)
    {
        pItem = pCurItem;
        pCurItem = (LISTITEM *)pCurItem->pNextItem;
        GFX_free(pItem);
    }

    pLb->pItemList = NULL;
    pLb->itemsNumber = 0;
}

/*********************************************************************
* Function: LISTITEM* LbGetSel(LISTBOX *pLb, LISTITEM *pFromItem)
*
* Input: pLb - the pointer to the object,
*        pFromItem - pointer to the item the seach must start from,
*                    if the pointer is NULL the search begins from the start of the items
list
*
* Output: pointer to the selected item, NULL if there are no items selected
*
* Overview: seaches for selected items
*
********************************************************************/
LISTITEM *LbGetSel(LISTBOX *pLb, LISTITEM *pFromItem)
{
    if(pFromItem == NULL)
    {
        pFromItem = pLb->pItemList;
    }

    while(pFromItem != NULL)
    {
        if(pFromItem->status & LB_STS_SELECTED)
            break;
        pFromItem = (LISTITEM *)pFromItem->pNextItem;
    }

    return (pFromItem);
}

/*********************************************************************
* Function: void LbChangeSel(LISTBOX *pLb, LISTITEM *pItem)
*
* Input: pLb - the pointer to the object,
*        pItem - pointer to the item the selection status will be changed
*
* Output: none
*
* Overview: changes selection status of an item
*
********************************************************************/
void LbChangeSel(LISTBOX *pLb, LISTITEM *pItem)
{
    LISTITEM    *pCurItem;

    if(GetState(pLb, LB_SINGLE_SEL))
    {

        // Remove selection from all items
        pCurItem = pLb->pItemList;
        while(pCurItem != NULL)
        {
            if(pCurItem->status & LB_STS_SELECTED)
            {
                pCurItem->status &= ~LB_STS_SELECTED;
                pCurItem->status |= LB_STS_REDRAW;
            }

            pCurItem = (LISTITEM *)pCurItem->pNextItem;
        }
    }

    pItem->status ^= LB_STS_SELECTED;
    pItem->status |= LB_STS_REDRAW;
}

/*********************************************************************
* Function: void LbSetFocusedItem(LISTBOX* pLb, SHORT index)
*
* Input: pLb - the pointer to the object
*        index - item number from the list beginning
*
* Output: none
*
* Overview: sets focus for the item with index defined
*
********************************************************************/
void LbSetFocusedItem(LISTBOX *pLb, SHORT index)
{
    LISTITEM    *pCurItem;

    // Look for item to be focused
    pCurItem = pLb->pItemList;

    if(pCurItem == NULL)
        return;
    while(pCurItem->pNextItem != NULL)
    {
        if(index <= 0)
            break;
        index--;
        pCurItem = (LISTITEM *)pCurItem->pNextItem;
    }

    if(pCurItem != NULL)
    {
        if(pLb->pFocusItem != NULL)
        {
            pLb->pFocusItem->status |= LB_STS_REDRAW;
        }

        pLb->pFocusItem = pCurItem;
        pCurItem->status |= LB_STS_REDRAW;
    }
}

/*********************************************************************
* Function: SHORT LbGetFocusedItem(LISTBOX* pLb)
*
* Input: pLb - the pointer to the list box
*
* Output: index of the focused item, -1 if there's no item in focus
*
* Overview: returns focused item number from the list beginning
*
********************************************************************/
SHORT LbGetFocusedItem(LISTBOX *pLb)
{
    LISTITEM    *pCurItem;
    SHORT       index;

    if(pLb->pFocusItem == NULL)
        return (-1);

    // Look for the focused item index
    index = 0;
    pCurItem = pLb->pItemList;
    while(pCurItem->pNextItem != NULL)
    {
        if(pCurItem == pLb->pFocusItem)
            break;
        index++;
        pCurItem = (LISTITEM *)pCurItem->pNextItem;
    }

    return (index);
}

/*********************************************************************
* Function: WORD LbTranslateMsg(void *pObj, GOL_MSG *pMsg)
*
* Overview: translates the GOL message for the list box
*
********************************************************************/
WORD LbTranslateMsg(void *pObj, GOL_MSG *pMsg)
{
    LISTBOX *pLb;

    pLb = (LISTBOX *)pObj;

    // Evaluate if the message is for the list box
    // Check if disabled first
    if(GetState(pLb, LB_DISABLED))
        return (OBJ_MSG_INVALID);

        #ifdef USE_TOUCHSCREEN
    if(pMsg->type == TYPE_TOUCHSCREEN)
    {
        // Check if it falls in list box borders
        if
        (
            (pLb->hdr.left < pMsg->param1) &&
            (pLb->hdr.right > pMsg->param1) &&
            (pLb->hdr.top < pMsg->param2) &&
            (pLb->hdr.bottom > pMsg->param2)
        ) return (LB_MSG_TOUCHSCREEN);

        return (OBJ_MSG_INVALID);
    }

        #endif
        #ifdef USE_KEYBOARD
    if(pMsg->type == TYPE_KEYBOARD)
        if((WORD)pMsg->param1 == pLb->hdr.ID)
        {
            if(pMsg->uiEvent == EVENT_KEYSCAN)
            {
                if((pMsg->param2 == SCAN_UP_PRESSED) || (pMsg->param2 == SCAN_DOWN_PRESSED))
                    return (LB_MSG_MOVE);

                if((pMsg->param2 == SCAN_SPACE_PRESSED) || (pMsg->param2 ==
SCAN_CR_PRESSED))
                    return (LB_MSG_SEL);
            }

            return (OBJ_MSG_INVALID);
        }

        #endif
    return (OBJ_MSG_INVALID);
}

/*********************************************************************
* Function: void LbMsgDefault(WORD translatedMsg, void *pObj, GOL_MSG *pMsg)
*
* Overview: changes the state of the list box by default
*
********************************************************************/
void LbMsgDefault(WORD translatedMsg, void *pObj, GOL_MSG *pMsg)
{

    LISTBOX *pLb;

    pLb = (LISTBOX *)pObj;

        #ifdef USE_TOUCHSCREEN

    SHORT       pos;
    LISTITEM    *pItem;

    if(pMsg->type == TYPE_TOUCHSCREEN)
    {
                #ifdef USE_FOCUS
        if(pMsg->type == TYPE_TOUCHSCREEN)
        {
            if(!GetState(pLb, LB_FOCUSED))
            {
                GOLSetFocus((OBJ_HEADER *)pLb);
            }
        }

                #endif
        if(pMsg->uiEvent == EVENT_PRESS)
        {
            pos = (pMsg->param2 - pLb->scrollY - pLb->hdr.top - LB_INDENT -
GOL_EMBOSS_SIZE) / pLb->textHeight;
            pItem = (LISTITEM *)pLb->pItemList;
            while(pos)
            {
                if(pItem == NULL)
                    break;
                if(pItem->pNextItem == NULL)
                    break;
                pItem = (LISTITEM *)pItem->pNextItem;
                pos--;
            }

            if(pLb->pFocusItem != pItem)
            {
                pItem->status |= LB_STS_REDRAW;
                pLb->pFocusItem->status |= LB_STS_REDRAW;
                pLb->pFocusItem = pItem;
                SetState(pLb, LB_DRAW_ITEMS);
            }

            LbChangeSel(pLb, pItem);
            SetState(pLb, LB_DRAW_ITEMS);
        }
    }

        #endif
        #ifdef USE_KEYBOARD
    if(pMsg->type == TYPE_KEYBOARD)
    {
        switch(translatedMsg)
        {
            case LB_MSG_SEL:
                if(pLb->pFocusItem != NULL)
                    LbChangeSel(pLb, pLb->pFocusItem);
                SetState(pLb, LB_DRAW_ITEMS);
                break;

            case LB_MSG_MOVE:
                switch(pMsg->param2)
                {
                    case SCAN_UP_PRESSED:
                        LbSetFocusedItem(pLb, LbGetFocusedItem(pLb) - 1);
                        SetState(pLb, LB_DRAW_ITEMS);
                        break;

                    case SCAN_DOWN_PRESSED:
                        LbSetFocusedItem(pLb, LbGetFocusedItem(pLb) + 1);
                        SetState(pLb, LB_DRAW_ITEMS);
                        break;
                }

                break;
        }
    }   // end of if
        #endif
}

/*********************************************************************
* Function: WORD LbDraw(void *pObj)
*
* Output: returns the status of the drawing
*         0 - not completed
*         1 - done
*
* Overview: draws edit box
*
********************************************************************/
WORD LbDraw(void *pObj)
{
    typedef enum
    {
        LB_STATE_START,
        LB_STATE_PANEL,
        LB_STATE_ERASEITEM,
        LB_STATE_ITEMFOCUS,
        LB_STATE_BITMAP,
        LB_STATE_TEXT
    } LB_DRAW_STATES;

    static LB_DRAW_STATES state = LB_STATE_START;
    static LISTITEM *pCurItem;
    static SHORT temp;
    LISTBOX *pLb;

    pLb = (LISTBOX *)pObj;

    switch(state)
    {

        ///////////////////////////////////////////////////////////////////////
        // REMOVE FROM SCREEN
        ///////////////////////////////////////////////////////////////////////
        case LB_STATE_START:
            if(GetState(pLb, LB_HIDE))
            {
                SetColor(pLb->hdr.pGolScheme->CommonBkColor);
                if(!Bar(pLb->hdr.left, pLb->hdr.top, pLb->hdr.right, pLb->hdr.bottom))
                    return (0);
                return (1);
            }

            if(GetState(pLb, LB_DRAW_FOCUS))
            {
                if(pLb->pFocusItem != NULL)
                    ((LISTITEM *)pLb->pFocusItem)->status |= LB_STS_REDRAW;
                SetState(pLb, LB_DRAW_ITEMS);
            }

            ///////////////////////////////////////////////////////////////////////
            // DRAW PANEL
            ///////////////////////////////////////////////////////////////////////
            if(GetState(pLb, LB_DRAW))
            {
                if(GetState(pLb, LB_DISABLED))
                {
                    temp = pLb->hdr.pGolScheme->ColorDisabled;
                }
                else
                {
                    temp = pLb->hdr.pGolScheme->Color0;
                }

                GOLPanelDraw
                (
                    pLb->hdr.left,
                    pLb->hdr.top,
                    pLb->hdr.right,
                    pLb->hdr.bottom,
                    0,
                    temp,
                    pLb->hdr.pGolScheme->EmbossDkColor,
                    pLb->hdr.pGolScheme->EmbossLtColor,
                    NULL,
                    GOL_EMBOSS_SIZE
                );

                state = LB_STATE_PANEL;

            case LB_STATE_PANEL:
                if(!GOLPanelDrawTsk())
                    return (0);
            }

            ///////////////////////////////////////////////////////////////////////
            // DRAW ITEMS
            ///////////////////////////////////////////////////////////////////////
    L_LB_DRAW:
            SetClip(CLIP_ENABLE);
            SetClipRgn
            (
                pLb->hdr.left + GOL_EMBOSS_SIZE + LB_INDENT,
                pLb->hdr.top + GOL_EMBOSS_SIZE + LB_INDENT,
                pLb->hdr.right - GOL_EMBOSS_SIZE - LB_INDENT,
                pLb->hdr.bottom - GOL_EMBOSS_SIZE - LB_INDENT
            );

            SetFont(pLb->hdr.pGolScheme->pFont);

            // Set graphics cursor
            MoveTo(pLb->hdr.left + GOL_EMBOSS_SIZE + LB_INDENT, pLb->hdr.top +
GOL_EMBOSS_SIZE + LB_INDENT + pLb->scrollY);

            pCurItem = pLb->pItemList;

            /////////////////////////////////////////////////////////////////////
            // DRAW CURRENT ITEM
            /////////////////////////////////////////////////////////////////////
    L_LB_DRAWITEM:
            if(pCurItem == NULL)
            {
                state = LB_STATE_START;
                SetClip(CLIP_DISABLE);
                return (1);
            }

            /////////////////////////////////////////////////////////////////////
            if(GetY() < pLb->hdr.bottom - GOL_EMBOSS_SIZE - LB_INDENT)
                if((GetY() + pLb->textHeight) >= (pLb->hdr.top + GOL_EMBOSS_SIZE +
LB_INDENT))
                {
                    if(!GetState(pLb, LB_DRAW))
                        if(!(pCurItem->status & LB_STS_REDRAW))
                            goto L_LB_NEXTITEM;

                    pCurItem->status &= ~LB_STS_REDRAW;

                    state = LB_STATE_ERASEITEM;

                case LB_STATE_ERASEITEM:
                    if(IsDeviceBusy())
                        return (0);

                    if(GetState(pLb, LB_DISABLED))
                    {
                        SetColor(pLb->hdr.pGolScheme->ColorDisabled);
                    }
                    else
                    {
                        SetColor(pLb->hdr.pGolScheme->Color0);
                        if(pCurItem != NULL)
                            if(pCurItem->status & LB_STS_SELECTED)
                            {
                                SetColor(pLb->hdr.pGolScheme->Color1);
                            }
                    }

                    if
                    (
                        !Bar
                            (
                                pLb->hdr.left + GOL_EMBOSS_SIZE + LB_INDENT,
                                GetY(),
                                pLb->hdr.right - GOL_EMBOSS_SIZE - LB_INDENT,
                                GetY() + pLb->textHeight
                            )
                    ) return (0);

                    if(!GetState(pLb, LB_CENTER_ALIGN | LB_RIGHT_ALIGN))
                    {
                        MoveTo(pLb->hdr.left + GOL_EMBOSS_SIZE + LB_INDENT, GetY());
                    }
                    else
                    {
                        temp = GetTextWidth(pCurItem->pText, pLb->hdr.pGolScheme->pFont);
                        if(pCurItem->pBitmap != NULL)
                        {
                            temp += GetImageWidth(pCurItem->pBitmap) + LB_INDENT;
                        }

                        if(GetState(pLb, LB_RIGHT_ALIGN))
                        {
                            MoveTo(pLb->hdr.right - temp - LB_INDENT - GOL_EMBOSS_SIZE,
GetY());
                        }
                        else
                        {
                            MoveTo((pLb->hdr.left + pLb->hdr.right - temp) >> 1, GetY());
                        }
                    }

                    if(GetState(pLb, LB_DISABLED))
                    {
                        SetColor(pLb->hdr.pGolScheme->TextColorDisabled);
                    }
                    else
                    {
                        if(pCurItem->status & LB_STS_SELECTED)
                        {
                            SetColor(pLb->hdr.pGolScheme->TextColor1);
                        }
                        else
                        {
                            SetColor(pLb->hdr.pGolScheme->TextColor0);
                        }
                    }

                    state = LB_STATE_BITMAP;

                case LB_STATE_BITMAP:
                    if(pCurItem->pBitmap != NULL)
                    {
                        // check if the image will go beyond the list box (bottom check
only)
                        if ((GetY() + GetImageHeight(pCurItem->pBitmap)) < pLb->hdr.bottom)
                        {
                            if
                            (
                                !PutImage
                                    (
                                        GetX(),
                                        GetY() + ((pLb->textHeight -
GetImageHeight(pCurItem->pBitmap)) >> 1),
                                        pCurItem->pBitmap,
                                        1
                                    )
                            ) return (0);
                        }

                        MoveRel(GetImageWidth(pCurItem->pBitmap) + LB_INDENT, 0);
                    }

                    state = LB_STATE_TEXT;

                case LB_STATE_TEXT:
                    if(!OutText(pCurItem->pText))
                        return (0);
                }

            ////////////////////////////////////////////////////////////////////
    L_LB_NEXTITEM:
            state = LB_STATE_ITEMFOCUS;
```

```
        case LB_STATE_ITEMFOCUS:
            if(pLb->pFocusItem == pCurItem)
            {
                if(IsDeviceBusy())
                    return (0);

                if(GetState(pLb, LB_FOCUSED))
                {
                    SetColor(pLb->hdr.pGolScheme->TextColor1);
                }
                else
                {
                    SetColor(pLb->hdr.pGolScheme->TextColor0);
                }

                SetLineType(FOCUS_LINE);
                temp = GetY();
                if
                (
                    !Rectangle
                        (
                            pLb->hdr.left + GOL_EMBOSS_SIZE + LB_INDENT,
                            GetY(),
                            pLb->hdr.right - GOL_EMBOSS_SIZE - LB_INDENT,
                            GetY() + pLb->textHeight - 1
                        )
                ) return (0);
                MoveTo(0, temp);
                SetLineType(SOLID_LINE);

                // Scroll if needed
                if(GetY() < (pLb->hdr.top + GOL_EMBOSS_SIZE + LB_INDENT))
                {
                    pLb->scrollY += (pLb->hdr.top + GOL_EMBOSS_SIZE + LB_INDENT) - GetY();
                    SetState(pLb, LB_DRAW);
                    goto L_LB_DRAW;
                }

                if((GetY() + pLb->textHeight) > (pLb->hdr.bottom - GOL_EMBOSS_SIZE -
LB_INDENT))
                {
                    pLb->scrollY += pLb->hdr.bottom - GetY() - pLb->textHeight -
GOL_EMBOSS_SIZE - LB_INDENT;
                    SetState(pLb, LB_DRAW);
                    goto L_LB_DRAW;
                }
            }

            pCurItem = (LISTITEM *)pCurItem->pNextItem;
            MoveRel(0, pLb->textHeight);

            goto L_LB_DRAWITEM;
    }   // end of switch

    return (1);
}

#endif // USE_LISTBOX
```

14.1.23 ListBox.h

Functions

	Name	Description
	LbAddItem (see page 198)	This function allocates memory for the LISTITEM (see page 210) and adds it to the list box. The newly created LISTITEM (see page 210) will store the location of pText, pBitmap and other parameters describing the added item.
	LbChangeSel (see page 200)	This function changes the selection status of an item in the list box. If the item is currently selected, it resets the selection. If the item is currently not selected it is set to be selected.
	LbCreate (see page 195)	This function creates a LISTBOX (see page 209) object with the parameters given. It automatically attaches the new object into a global linked list of objects and returns the address of the object.
	LbDelItem (see page 200)	This function removes an item from the list box and frees the memory used.
	LbDelItemsList (see page 207)	This function removes all items from the list box and frees the memory used.
	LbDraw (see page 197)	This function renders the object on the screen using the current parameter settings. Location of the object is determined by the left, top, right and bottom parameters. The colors used are dependent on the state of the object. The font used is determined by the style scheme set. The text or items drawn in the visible window of the list box is dependent on the alignment set. When rendering objects of the same type, each object must be rendered completely before the rendering of the next object is started. This is to avoid incomplete object rendering.
	LbGetFocusedItem (see page 202)	This function returns the index of the focused item in the list box.
	LbGetSel (see page 202)	This function searches for selected items from the list box. A starting position can optionally be given. If starting position is set to NULL, search will begin from the first item list. It returns the pointer to the first selected item found or NULL if there are no items selected.
	LbMsgDefault (see page 207)	This function performs the actual state change based on the translated message given. The following state changes are supported:
	LbSetFocusedItem (see page 203)	This function sets the focus for the item with the given index.
	LbTranslateMsg (see page 208)	This function evaluates the message from a user if the message will affect the object or not. The table below enumerates the translated messages for each event of the touch screen and keyboard inputs.

Macros

Name	Description
LB_CENTER_ALIGN (see page 193)	Bit to indicate text is center aligned
LB_DISABLED (see page 194)	Bit for disabled state
LB_DRAW (see page 194)	Bit to indicate whole edit box must be redrawn
LB_DRAW_FOCUS (see page 194)	Bit to indicate whole edit box must be redrawn
LB_DRAW_ITEMS (see page 194)	Bit to indicate whole edit box must be redrawn
LB_FOCUSED (see page 194)	Bit for focused state
LB_HIDE (see page 195)	Bit to remove object from screen
LB_RIGHT_ALIGN (see page 193)	Bit to indicate text is left aligned
LB_SINGLE_SEL (see page 193)	Bit to indicate the only item can be selected
LB_STS_REDRAW (see page 195)	Item is to be redrawn.
LB_STS_SELECTED (see page 195)	Item is selected.

LbClrtSel (see page 205)	This macro clears the selection of an item.
LbGetBitmap (see page 206)	This macro returns the location of the currently used bitmap for the item.
LbGetCount (see page 203)	This macro returns the number of items in the list box.
LbGetItemList (see page 198)	This function returns the pointer to the current item list used in the list box.
LbGetVisibleCount (see page 204)	This macro returns the number of items visible in the list box window.
LbSetBitmap (see page 205)	This macro sets the bitmap used in the item.
LbSetSel (see page 201)	This macro sets the selection status of an item to selected.

Structures

Name	Description
LISTBOX (see page 209)	Defines the parameters required for a list box Object.
LISTITEM (see page 210)	Defines the parameters required for a list item used in list box.

Description

This is file ListBox.h.

Body Source

```
/*****************************************************************************
 *  Module for Microchip Graphics Library
 *  GOL Layer
 *  List box
 *****************************************************************************
 * FileName:        ListBox.h
 * Dependencies:    None
 * Processor:       PIC24F, PIC24H, dsPIC, PIC32
 * Compiler:        MPLAB C30, MPLAB C32
 * Linker:          MPLAB LINK30, MPLAB LINK32
 * Company:         Microchip Technology Incorporated
 *
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 * CLAIMS BY THIRD PARTIES (INCLUDING BUT NOT LIMITED TO ANY DEFENSE THEREOF),
 * OR OTHER SIMILAR COSTS.
 *
 * Date         Comment
 *~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
 * 11/12/07     Version 1.0 release
 *****************************************************************************/
#ifndef _LISTBOX_H
    #define _LISTBOX_H

    #include <Graphics/GOL.h>
    #include "GenericTypeDefs.h"

/*********************************************************************
* Object States Definition:
```

```
*********************************************************************/
    #define LB_FOCUSED      0x0001  // Bit for focused state
    #define LB_DISABLED     0x0002  // Bit for disabled state
    #define LB_RIGHT_ALIGN  0x0004  // Bit to indicate text is left aligned
    #define LB_CENTER_ALIGN 0x0008  // Bit to indicate text is center aligned
    #define LB_SINGLE_SEL   0x0010  // Bit to indicate the only item can be selected
    #define LB_DRAW_ITEMS   0x1000  // Bit to indicate whole edit box must be redrawn
    #define LB_DRAW_FOCUS   0x2000  // Bit to indicate whole edit box must be redrawn
    #define LB_DRAW         0x4000  // Bit to indicate whole edit box must be redrawn
    #define LB_HIDE         0x8000  // Bit to remove object from screen
    #define LB_INDENT       0x02    // Indentation constant for the text from the frame

/*********************************************************************
* Overview: Defines the parameters required for a list item used in
*           list box.
*
*********************************************************************/
typedef struct
{
    void    *pPrevItem;             // Pointer to the next item
    void    *pNextItem;             // Pointer to the next item
    WORD    status;                 // Specifies the status of the item.

    // The following values are defined for
    // the status: LB_STS_SELECTED, LB_STS_REDRAW.
    XCHAR   *pText;                 // Pointer to the text for the item
    void    *pBitmap;               // Pointer to the bitmap
    WORD    data;                   // Some data associated with the item
} LISTITEM;

/*********************************************************************
* Bit definitions for the status of an item
*********************************************************************/
    #define LB_STS_SELECTED 0x0001  // Item is selected.
    #define LB_STS_REDRAW   0x0002  // Item is to be redrawn.

/*********************************************************************
* Overview: Defines the parameters required for a list box Object.
*
*********************************************************************/
typedef struct
{
    OBJ_HEADER  hdr;            // Generic header for all Objects (see OBJ_HEADER).
    LISTITEM    *pItemList;     // Pointer to the list of items.
    LISTITEM    *pFocusItem;    // Pointer to the focused item.
    WORD        itemsNumber;    // Number of items in the list box.
    SHORT       scrollY;        // Scroll displacement for the list.
    SHORT       textHeight;     // Pre-computed text height.
} LISTBOX;

/*********************************************************************
* Macros:  LbSetBitmap(pItem, pBtmap)
*
* Overview: This macro sets the bitmap used in the item.
*
* PreCondition: none
*
* Input: pItem - Pointer to the item.
*        pBtmap - Pointer to the bitmap to be used.
*
* Output: none
*
* Example:
*   See LbAddItem() example.
*
* Side Effects: none
*
********************************************************************/
    #define LbSetBitmap(pItem, pBtmap)  ((LISTITEM *)pItem)->pBitmap = pBtmap

/*********************************************************************
* Macros:  LbGetBitmap(pItem)
```

```
 *
 * Overview: This macro returns the location of the currently
 *           used bitmap for the item.
 *
 * PreCondition: none
 *
 * Input: pItem - Pointer to the list item.
 *
 * Output: Returns the pointer to the current bitmap used.
 *
 * Example:
 *   <CODE>
 *   // Assume pLb is initialized to an existing list box
 *   LISTITEM *pItem;
 *   void *pBitmap;
 *
 *   pItem = LbGetItemList(pLb);
 *   pBitmap = LbGetBitmap(pItem);
 *   </CODE>
 *
 * Side Effects: none
 *
 ********************************************************************/
    #define LbGetBitmap(pItem)  ((LISTITEM *)pItem)->pBitmap

 /*********************************************************************
 * Function: LISTBOX  *LbCreate(WORD ID, SHORT left, SHORT top, SHORT right,
 *                              SHORT bottom, WORD state, XCHAR* pText,
 *                              GOL_SCHEME *pScheme)
 *
 * Overview: This function creates a LISTBOX object with the parameters given.
 *           It automatically attaches the new object into a global linked list of
 *           objects and returns the address of the object.
 *
 * PreCondition: none
 *
 * Input: ID - Unique user defined ID for the object instance.
 *        left - Left most position of the Object.
 *        top - Top most position of the Object.
 *        right - Right most position of the Object.
 *        bottom - Bottom most position of the Object.
 *        state - Sets the initial state of the object.
 *        pText - Pointer to the initialization text for the items.
 *        pScheme - Pointer to the style scheme.
 *
 * Output: Returns the pointer to the object created.
 *
 * Example:
 *   <CODE>
 *   #define LISTBOX_ID   10
 *
 *   const XCHAR ItemList[] = "Line1\n" "Line2\n";
 *
 *   GOL_SCHEME *pScheme;
 *   LISTBOX *pLb;
 *   XCHAR *pTemp;
 *   WORD state, counter;
 *
 *       pScheme = GOLCreateScheme();
 *       state = LB_DRAW;
 *
 *       // create an empty listbox with default style scheme
 *       pLb = LbCreate( LISTBOX_ID,         // ID number
 *                       10,10,150,200,      // dimension
 *                       state,              // initial state
 *                       NULL,               // set items to be empty
 *                       NULL);              // use default style scheme
 *       // check if Listbox was created
 *       if (pLb == NULL)
 *          return 0;
 *
 *       // create the list of items to be placed in the listbox
 *       // Add items (each line will become one item,
 *       // lines must be separated by '\n' character)
 *       pTemp = ItemList;
 *       counter = 0;
 *       while(*pTemp){
 *           // since each item is appended NULL is assigned to
 *           // LISTITEM pointer.
 *           if(NULL == LbAddItem(pLb, NULL, pTemp, NULL, 0, counter))
 *               break;
 *           while((unsigned XCHAR)*pTemp++ > (unsigned XCHAR)31);
 *           if(*(pTemp-1) == 0)
 *               break;
 *           counter++;
 *       }
 *   </CODE>
 *
 * Side Effects: none
 *
 ********************************************************************/
 LISTBOX * LbCreate
     (WORD ID, SHORT left, SHORT top, SHORT right, SHORT bottom, WORD state, XCHAR * pText,
 GOL_SCHEME * pScheme);

 /*********************************************************************
 * Function: LISTITEM* LbAddItem(LISTBOX *pLb, LISTITEM *pPrevItem,
 *                               XCHAR *pText, void* pBitmap, WORD status, WORD data)
 *
 * Overview: This function allocates memory for the LISTITEM and adds
 *           it to the list box. The newly created LISTITEM will store
 *           the location of pText, pBitmap and other parameters describing
 *           the added item.
 *
 * PreCondition: none
 *
 * Input: pLb - The pointer to the list box object.
 *        pPrevItem - Pointer to the item after which a new item must
 *                    be inserted, if this pointer is NULL, the item
 *                    will be appended at the end of the items list.
 *        pText -  Pointer to the text that will be inserted. Text must
 *                 persist in memory for as long as it is referenced
 *                 by an item in the list box.
 *        pBitmap - Pointer to the bitmap for the item. Bitmap must
 *                 persist in memory for as long as it is referenced
 *                 by the an item in the list box.
 *        status - This parameter specifies if the item being added
 *                 will be selected or redrawn
 *                 (LB_STS_SELECTED or LB_STS_REDRAW). Refer to
 *                 LISTITEM structure for details.
 *        data -  User assigned data associated with the item.
 *
 * Output: Return a pointer to the item created,
 *         NULL if the operation was not successful.
 *
 * Example:
 *   <CODE>
 *   const XCHAR ItemList[] = "Line1\n" "Line2\n" "Line3\n";
 *
 *   extern BITMAP_FLASH myIcon;
 *   LISTBOX *pLb;
 *   LISTITEM *pItem, *pItemList;
 *   XCHAR *pTemp;
 *
 *   // Assume that pLb is pointing to an existing list box in memory
 *   // that is empty (no list).
 *
 *   // Create the list of the list box
 *
 *   // Initialize this to NULL to indicate that items will be added
 *   // at the end of the list if the list exist on the list box or
 *   // start a new list if the list box is empty.
 *   pItem = NULL;
 *   pTemp = ItemList;
```

```
*   pItem = LbAddItem(pLb, pItem, pTemp, NULL, LB_STS_SELECTED, 1)
*   if(pItem == NULL)
*       return 0;
*   LbSetBitmap(pItem, &myIcon);
*
*   // Adjust pTemp to point to the next line
*   while((unsigned XCHAR)*pTemp++ > (unsigned XCHAR)31);
*
*   // add the next item
*   pItem = LbAddItem(pLb, pItem, pTemp, NULL, 0, 2)
*   if(pItem == NULL)
*       return 0;
*   LbSetBitmap(pItem, &myIcon);
*
*   // Adjust pTemp to point to the next line
*   while((unsigned XCHAR)*pTemp++ > (unsigned XCHAR)31);
*
*   // this time insert the next item after the first item on the list
*   pItem = LbGetItemList(pLb);
*   pItem = LbAddItem(pLb, pItem, pTemp, NULL, 0, 3)
*   if(pItem == NULL)
*       return 0;
*   LbSetBitmap(pItem, &myIcon);
*
*   </CODE>
*
* Side Effects: none
*
********************************************************************/
LISTITEM    *LbAddItem(LISTBOX *pLb, LISTITEM *pPrevItem, XCHAR *pText, void *pBitmap, WORD
status, WORD data);

/*********************************************************************
* Function: void LbDelItem(LISTBOX *pLb, LISTITEM *pItem)
*
* Overview: This function removes an item from the list box
*           and frees the memory used.
*
* PreCondition: none
*
* Input: pLb - The pointer to the list box object.
*        pItem -  The pointer to the item that will be removed.
*
* Output: none
*
* Side Effects: none
*
********************************************************************/
void        LbDelItem(LISTBOX *pLb, LISTITEM *pItem);

/*********************************************************************
* Function: void LbDelItemsList(void *pObj)
*
* Overview: This function removes all items from the list box
*           and frees the memory used.
*
* PreCondition: none
*
* Input: pLb - The pointer to the list box object.
*
* Output: none
*
* Side Effects: none
*
********************************************************************/
void        LbDelItemsList(void *pObj);

/*********************************************************************
* Function: LISTITEM* LbGetSel(LISTBOX *pLb, LISTITEM *pFromItem)
*
* Overview: This function searches for selected items from the list box.
*           A starting position can optionally be given. If starting
*           position is set to NULL, search will begin from the first
*           item list. It returns the pointer to the first selected item
*           found or NULL if there are no items selected.
*
* PreCondition: none
*
* Input: pLb        - The pointer to the list box object.
*        pFromItem  - The pointer to the item the search must start from,
*                     if the pointer is NULL the search begins from the
*                     start of the items list.
*
* Output: pointer to the selected item, NULL if there are no items selected
*
*
* Side Effects: none
*
********************************************************************/
LISTITEM    *LbGetSel(LISTBOX *pLb, LISTITEM *pFromItem);

/*********************************************************************
* Function: void LbChangeSel(LISTBOX *pLb, LISTITEM *pItem)
*
* Overview: This function changes the selection status of an item
*           in the list box. If the item is currently selected, it
*           resets the selection. If the item is currently not
*           selected it is set to be selected.
*
* PreCondition: none
*
* Input: pLb    - The pointer to the list box object.
*        pItem  - The pointer to the item the selection status
*                     will be changed.
*
* Output: none
*
* Side Effects: none
*
********************************************************************/
void        LbChangeSel(LISTBOX *pLb, LISTITEM *pItem);

/*********************************************************************
* Macro: LbSetSel(pLb, pItem)
*
* Overview: This macro sets the selection status of an item to
*           selected.
*
* PreCondition: none
*
* Input: pLb    - The pointer to the list box object.
*        pItem  - The pointer to the item the selection status
*                     will be set.
*
* Output: none
*
* Side Effects: none
*
********************************************************************/
    #define LbSetSel(pLb, pItem)           \
    if(!(pItem->status & LB_STS_SELECTED)) \
        LbChangeSel((LISTBOX *)pLb, pItem);

/*********************************************************************
* Macro: LbClrSel(pLb, pItem)
*
* Overview: This macro clears the selection of an item.
*
* PreCondition: none
*
* Input: pLb - The pointer to the list box.
*        pItem - The pointer to the item the selection status should be cleared.
*
* Output: none
```

```
*
* Side Effects: none
*
********************************************************************/
    #define LbClrtSel(pLb, pItem)       \
    if(pItem->status & LB_STS_SELECTED) \
        LbChangeSel((LISTBOX *)pLb, pItem);

/*********************************************************************
* Macro: LbGetCount(pLb)
*
* Overview: This macro returns the number of items in the list box.
*
* PreCondition: none
*
* Input: pLb - The pointer to the list box object.
*
* Output: The number of items the list box contains.
*
* Side Effects: none
*
********************************************************************/
    #define LbGetCount(pLb) ((LISTBOX *)pLb)->itemsNumber

/*********************************************************************
* Macro: LbGetVisibleCount(pLb)
*
* Overview: This macro returns the number of items visible in the
*           list box window.
*
* PreCondition: none
*
* Input: pLb - The pointer to the list box object.
*
* Output: The number of items visible in the list box window.
*
* Side Effects: none
*
********************************************************************/
    #define
LbGetVisibleCount(pLb)

\
        (

\
            (((LISTBOX *)pLb)->hdr.bottom - ((LISTBOX *)pLb)->hdr.top - 2 *
(GOL_EMBOSS_SIZE + LB_INDENT)) / \
                ((LISTBOX
*)pLb)->textHeight                                                  \
        )

/*********************************************************************
* Function: void LbSetFocusedItem(LISTBOX* pLb, SHORT index)
*
* Overview: This function sets the focus for the item with the
*           given index.
*
* PreCondition: none
*
* Input: pLb   - The pointer to the list box object.
*        index - The index number of the item to be focused.
*                First item on the list is always indexed 0.
*
* Output: none.
*
* Side Effects: none
*
********************************************************************/
void    LbSetFocusedItem(LISTBOX *pLb, SHORT index);

/*********************************************************************
```

```
* Function: SHORT LbGetFocusedItem(LISTBOX* pLb)
*
* Overview: This function returns the index of the focused item
*           in the list box.
*
* PreCondition: none
*
* Input: pLb   - The pointer to the list box object.
*
* Output: Returns the index of the focused item in the list box.
*
* Side Effects: none
*
********************************************************************/
SHORT   LbGetFocusedItem(LISTBOX *pLb);

/*********************************************************************
* Macro: LISTITEM LbGetItemList(LISTBOX* pLb)
*
* Overview: This function returns the pointer to the current
*           item list used in the list box.
*
* PreCondition: none
*
* Input: pLb   - The pointer to the list box object.
*
* Output: Returns the pointer to the LISTITEM used in the list box.
*
* Example:
*   See LbAddItem() example.
*
* Side Effects: none
*
********************************************************************/
    #define LbGetItemList(pLb)  ((LISTITEM *)pLb->pItemList)

/*********************************************************************
* Function: WORD LbTranslateMsg(void *pObj, GOL_MSG *pMsg)
*
* Overview: This function evaluates the message from a user if the
*           message will affect the object or not. The table below enumerates the
translated
*           messages for each event of the touch screen and keyboard inputs.
*
*   <TABLE>
*       Translated Message   Input Source  Events                       Description
*       ##################   ############  ######                       ###########
*       LB_MSG_TOUCHSCREEN   Touch Screen  Any                          Item is selected
using touch screen.
*       LB_MSG_MOVE          Keyboard      EVENT_KEYSCAN                Focus is moved to
the next item depending on the key pressed (UP or DOWN key).
*       LB_MSG_SEL           Keyboard      EVENT_KEYSCAN                LB_MSG_SEL –
Selection is set to the currently focused item.
*       OBJ_MSG_INVALID      Any           Any                          If the message did
not affect the object.
*   </TABLE>
*
* PreCondition: none
*
* Input: pLB   - The pointer to the object where the message will be
*                evaluated to check if the message will affect the object.
*         pMsg  - Pointer to the message struct containing the message from
*                the user interface.
*
* Output: Returns the translated message depending on the received GOL message:
*         - LB_MSG_TOUCHSCREEN – Item is selected using touch screen.
*         - LB_MSG_MOVE – Focus is moved to the next item depending on the key pressed (UP
or DOWN key).
*         - LB_MSG_SEL – Selection is set to the currently focused item.
*
* Side Effects: none
*
```

```
*********************************************************************/
WORD    LbTranslateMsg(void *pObj, GOL_MSG *pMsg);

/*********************************************************************
* Function: void LbMsgDefault(WORD translatedMsg, void *pObj, GOL_MSG *pMsg)
*
* Overview: This function performs the actual state change
*           based on the translated message given. The following state changes
*           are supported:
*   <TABLE>
*       Translated Message   Input Source  Set/Clear State Bit      Description
*       ##################   ############  ######                   ###########
*       LB_MSG_TOUCHSCREEN   Touch Screen  Set LB_FOCUSED,          If focus is enabled,
the focus state bit LB_FOCUSED will be set. LB_DRAW_FOCUS draw state bit will force
*                                           Set LB_DRAW_FOCUS        the List Box to be
redrawn with focus.
*                                           Set LB_DRAW_ITEMS       List Box will redrawn
with selected item(s).
*       LB_MSG_MOVE          KeyBoard      Set LB_DRAW_ITEMS        List Box will redrawn
with focus on one item.
*       LB_MSG_SEL           KeyBoard      Set LB_DRAW_ITEMS        List Box will redrawn
with selection on the current item focused.
*   </TABLE>
*
* PreCondition: none
*
* Input: translatedMsg - The translated message
*         pB            - The pointer to the object whose state will be modified.
*         pMsg          - The pointer to the GOL message.
*
* Output: none
*
* Side Effects: none
*
*********************************************************************/
void    LbMsgDefault(WORD translatedMsg, void *pObj, GOL_MSG *pMsg);

/*********************************************************************
* Function: WORD LbDraw(void *pObj)
*
* Overview: This function renders the object on the screen using
*           the current parameter settings. Location of the object is
*           determined by the left, top, right and bottom parameters.
*           The colors used are dependent on the state of the object.
*           The font used is determined by the style scheme set.
*
*           The text or items drawn in the visible window of the
*           list box is dependent on the alignment set.
*
*           When rendering objects of the same type, each object
*           must be rendered completely before the rendering of the
*           next object is started. This is to avoid incomplete
*           object rendering.
*
* PreCondition: Object must be created before this function is called.
*
* Input: pLb - Pointer to the object to be rendered.
*
* Output: Returns the status of the drawing
*         - 1 - If the rendering was completed and
*         - 0 - If the rendering is not yet finished.
*         Next call to the function will resume the
*         rendering on the pending drawing state.
*
* Side Effects: none
*
*********************************************************************/
WORD LbDraw(void *pObj);
#endif // _LISTBOX_H
```

14.1.24 Meter.c

This is file Meter.c.

Body Source

```
/*****************************************************************************
 *  Module for Microchip Graphics Library
 *  GOL Layer
 *  Meter
 *****************************************************************************
 * FileName:        Meter.c
 * Processor:       PIC24F, PIC24H, dsPIC, PIC32
 * Compiler:        MPLAB C30 Version 3.00, MPLAB C32
 * Company:         Microchip Technology Incorporated
 *
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 * OR OTHER SIMILAR COSTS.
 *
 * Date         Comment
 *~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
 * 11/12/07     Version 1.0 release
 * 07/31/08     Added arc colors options
 * 08/20/08     Added accuracy option for displaying values
 * 04/01/11     Removed sineTable[], use the one in the Primitive.c instead.
 *****************************************************************************/
#include "Graphics/Graphics.h"
#include <math.h>
#include <stdio.h>

#ifdef USE_METER

/* Internal Functions */
void    MtrCalcDimensions(METER *pMtr); // used to calculate the meter dimensions

// which is dependent on meter type

/*********************************************************************
* Function: METER  *MtrCreate(WORD ID, SHORT left, SHORT top, SHORT right,
*                              SHORT bottom, WORD state, SHORT value,
*                              SHORT minValue, SHORT maxValue, XCHAR *pText,
*                              GOL_SCHEME *pScheme)
*
*
* Notes: Creates a METER object and adds it to the current active list.
*        If the creation is successful, the pointer to the created Object
```

```
*        is returned. If not successful, NULL is returned.
*
********************************************************************/
METER *MtrCreate
(
    WORD        ID,
    SHORT       left,
    SHORT       top,
    SHORT       right,
    SHORT       bottom,
    WORD        state,
    SHORT       value,
    SHORT       minValue,
    SHORT       maxValue,
    void        *pTitleFont,
    void        *pValueFont,
    XCHAR       *pText,
    GOL_SCHEME  *pScheme
)
{
    METER   *pMtr = NULL;

    pMtr = (METER *)GFX_malloc(sizeof(METER));
    if(pMtr == NULL)
        return (NULL);

    pMtr->hdr.ID = ID;           // unique id assigned for referencing
    pMtr->hdr.pNxtObj = NULL;   // initialize pointer to NULL
    pMtr->hdr.type = OBJ_METER; // set object type
    pMtr->hdr.left = left;      // left,top coordinate
    pMtr->hdr.top = top;        //
    pMtr->hdr.right = right;    // right,bottom coordinate
    pMtr->hdr.bottom = bottom;  //
    pMtr->minValue = minValue;
    pMtr->maxValue = maxValue;
    pMtr->value = value;
    pMtr->hdr.state = state;    // state
    pMtr->pText = pText;
    pMtr->hdr.DrawObj = MtrDraw;                // draw function
    pMtr->hdr.MsgObj = MtrTranslateMsg;         // message function
    pMtr->hdr.MsgDefaultObj = MtrMsgDefault;    // default message function
    pMtr->hdr.FreeObj = NULL;                   // free function

    // set the default scale colors
    MtrSetScaleColors(pMtr, LIGHTGREEN, YELLOW, BRIGHTGREEN, BRIGHTBLUE, RED, BRIGHTRED);

    // Set the color scheme to be used
    if(pScheme == NULL)
        pMtr->hdr.pGolScheme = _pDefaultGolScheme;
    else
        pMtr->hdr.pGolScheme = pScheme;

    // Set the Title Font to be used
    if(pTitleFont == NULL)
        pMtr->pTitleFont = (void *) &FONTDEFAULT;
    else
        pMtr->pTitleFont = pTitleFont;

    // Set the Value Font to be used
    if(pValueFont == NULL)
        pMtr->pValueFont = (void *) &FONTDEFAULT;
    else
        pMtr->pValueFont = pValueFont;

    // calculate dimensions of the meter
    MtrCalcDimensions(pMtr);

    GOLAddObject((OBJ_HEADER *)pMtr);

    return (pMtr);
}
```

```
/*********************************************************************
* Function: MtrCalcDimensions(void)
*
* Notes: Calculates the dimension of the meter. Dependent on the
*        meter type set.
*
********************************************************************/
void MtrCalcDimensions(METER *pMtr)
{
    SHORT   tempHeight, tempWidth;
    SHORT   left, top, right, bottom;
    XCHAR   tempChar[2] = {'8',0};

    left = pMtr->hdr.left;
    right = pMtr->hdr.right;
    top = pMtr->hdr.top;
    bottom = pMtr->hdr.bottom;

    // get the text width reference. This is used to scale the meter
    if(pMtr->pText != NULL)
    {
        tempHeight = (GOL_EMBOSS_SIZE << 1) + GetTextHeight(pMtr->hdr.pGolScheme->pFont);
    }
    else
    {
        tempHeight = (GOL_EMBOSS_SIZE << 1);
    }

    tempWidth = (GOL_EMBOSS_SIZE << 1) + (GetTextWidth(tempChar,
pMtr->hdr.pGolScheme->pFont) * SCALECHARCOUNT);

    // Meter size is dependent on the width or height.
    // The radius is also adjusted to add space for the scales
        #if (METER_TYPE == MTR_WHOLE_TYPE)

    // choose the radius
    if((right - left - tempWidth) > (bottom - top - tempHeight -
GetTextHeight(pMtr->pTitleFont)))
    {
        pMtr->radius = ((bottom - top - tempHeight - GetTextHeight(pMtr->pTitleFont)) >> 1)
- ((tempHeight + bottom - top) >> 3);
    }
    else
        pMtr->radius = ((right - left) >> 1) - (tempWidth + ((right - left) >> 3));

    // center the meter on the given dimensions
    pMtr->xCenter = (left + right) >> 1;
    pMtr->yCenter = ((bottom + top) >> 1) - (tempHeight >> 1);

        #elif (METER_TYPE == MTR_HALF_TYPE)

    // choose the radius
    if((right - left) >> 1 > (bottom - top))
    {
        pMtr->radius = (bottom - top) - ((tempHeight << 1) + ((bottom - top) >> 3));
        pMtr->yCenter = ((bottom + top) >> 1) + ((pMtr->radius + ((bottom - top) >> 3)) >>
1);
    }
    else
    {
        pMtr->radius = ((right - left) >> 1) - (tempWidth + ((right - left) >> 3));
        pMtr->yCenter = ((bottom + top) >> 1) + ((pMtr->radius + ((right - left) >> 3)) >>
1);
    }

    // center the meter on the given dimensions
    pMtr->xCenter = (left + right) >> 1;

        #elif (METER_TYPE == MTR_QUARTER_TYPE)

    // choose the radius
    if
    (
        (right - left - tempWidth) >
            (bottom - top - (GetTextHeight(pMtr->pTitleFont) +
GetTextHeight(pMtr->hdr.pGolScheme->pFont))) -
                (GOL_EMBOSS_SIZE << 1)
    )
    {
        pMtr->radius = bottom - top - (GetTextHeight(pMtr->pTitleFont) +
GetTextHeight(pMtr->hdr.pGolScheme->pFont) + (GOL_EMBOSS_SIZE << 1));
    }
    else
    {
        pMtr->radius = right -
            left -
            (GetTextWidth(tempChar, pMtr->hdr.pGolScheme->pFont) * (SCALECHARCOUNT + 1)) -
            GOL_EMBOSS_SIZE;
    }

    pMtr->radius -= (((pMtr->radius) >> 2) + GOL_EMBOSS_SIZE);

    // center the meter on the given dimensions
    pMtr->xCenter = ((left + right) >> 1) - ((pMtr->radius + tempWidth + (pMtr->radius >>
2)) >> 1);
    pMtr->yCenter = ((top + bottom) >> 1) + ((pMtr->radius + (pMtr->radius >> 2)) >> 1);
        #endif
}

/*********************************************************************
* Function: MtrSetVal(METER *pMtr, SHORT newVal)
*
* Notes: Sets the value of the meter to newVal. If newVal is less
*        than 0, 0 is assigned. If newVal is greater than range,
*        range is assigned.
*
********************************************************************/
void MtrSetVal(METER *pMtr, SHORT newVal)
{
    if((newVal < 0) || (newVal < pMtr->minValue))
    {
        pMtr->value = pMtr->minValue;
        return;
    }

    if(newVal > pMtr->maxValue)
    {
        pMtr->value = pMtr->maxValue;
        return;
    }

    pMtr->value = newVal;
}

/*********************************************************************
* Function: MtrMsgDefault(WORD translatedMsg, void *pObj, GOL_MSG* pMsg)
*
* Notes: This the default operation to change the state of the meter.
*        Called inside GOLMsg() when GOLMsgCallback() returns a 1.
*
********************************************************************/
void MtrMsgDefault(WORD translatedMsg, void *pObj, GOL_MSG *pMsg)
{
    METER *pMtr;

    pMtr = (METER *)pObj;

    if(translatedMsg == MTR_MSG_SET)
    {
        MtrSetVal(pMtr, pMsg->param2);      // set the value
        SetState(pMtr, MTR_DRAW_UPDATE);    // update the meter
    }
}
```

```
/*********************************************************************
* Function: WORD MtrTranslateMsg(void *pObj, GOL_MSG *pMsg)
*
* Notes: Evaluates the message if the object will be affected by the
*        message or not.
*
********************************************************************/
WORD MtrTranslateMsg(void *pObj, GOL_MSG *pMsg)
{
    METER *pMtr;

    pMtr = (METER *)pObj;

    // Evaluate if the message is for the meter
    // Check if disabled first
    if(GetState(pMtr, MTR_DISABLED))
        return (OBJ_MSG_INVALID);

    if(pMsg->type == TYPE_SYSTEM)
    {
        if(pMsg->param1 == pMtr->hdr.ID)
        {
            if(pMsg->uiEvent == EVENT_SET)
            {
                return (MTR_MSG_SET);
            }
        }
    }

    return (OBJ_MSG_INVALID);
}

/*********************************************************************
* Function: WORD MtrDraw(void *pObj)
*
* Notes: This is the state machine to draw the meter.
*
********************************************************************/
WORD MtrDraw(void *pObj)
{
    typedef enum
    {
        IDLE,
        FRAME_DRAW,
        NEEDLE_DRAW,
        NEEDLE_ERASE,
        TEXT_DRAW,
        TEXT_DRAW_RUN,
        ARC_DRAW_SETUP,
        ARC_DRAW,
        SCALE_COMPUTE,
        SCALE_LABEL_DRAW,
        SCALE_DRAW,
        VALUE_ERASE,
        VALUE_DRAW,
        VALUE_DRAW_RUN,
    } MTR_DRAW_STATES;

    static MTR_DRAW_STATES state = IDLE;
    static SHORT x1, y1, x2, y2;
    static SHORT temp, j, i, angle;
    static XCHAR strVal[SCALECHARCOUNT + 1];    // add one more space here for the NULL
character
    static XCHAR tempXchar[2] = {'8',0};        // NULL is pre-defined here
    static float radian;
    static DWORD_VAL dTemp, dRes;
    METER *pMtr;

    pMtr = (METER *)pObj;

    if(IsDeviceBusy())
        return (0);
    switch(state)
    {
        case IDLE:
            if(GetState(pMtr, MTR_HIDE))
            {   // Hide the meter (remove from screen)
                SetColor(pMtr->hdr.pGolScheme->CommonBkColor);
                if(!Bar(pMtr->hdr.left, pMtr->hdr.top, pMtr->hdr.right, pMtr->hdr.bottom))
                    return (0);
                return (1);
            }

            // Check if we need to draw the whole object
            SetLineThickness(NORMAL_LINE);
            SetLineType(SOLID_LINE);
            if(GetState(pMtr, MTR_DRAW))
            {

                // set parameters to draw the frame
                GOLPanelDraw
                    (
                        pMtr->hdr.left, pMtr->hdr.top, pMtr->hdr.right, pMtr->hdr.bottom,
0, pMtr->hdr.pGolScheme->Color0,
                            pMtr->hdr.pGolScheme->EmbossLtColor,
pMtr->hdr.pGolScheme->EmbossDkColor, NULL,
                                GOL_EMBOSS_SIZE - 1
                    );
                state = FRAME_DRAW;
            }
            else
            {
                state = NEEDLE_ERASE;
                goto mtr_needle_draw_st;
            }

        case FRAME_DRAW:
            if(!GOLPanelDrawTsk())
            {
                return (0);
            }

            state = TEXT_DRAW;

        case TEXT_DRAW:

            // draw the meter title
            SetColor(pMtr->hdr.pGolScheme->TextColor1);
            SetFont(pMtr->pTitleFont);
            temp = GetTextWidth(pMtr->pText, pMtr->pTitleFont);

            // set the start location of the meter title
                #if (METER_TYPE == MTR_WHOLE_TYPE)
                    #ifdef METER_DISPLAY_VALUES_ENABLE
            MoveTo(pMtr->xCenter - (temp >> 1), pMtr->yCenter + pMtr->radius +
GetTextHeight(pMtr->pValueFont));
                    #else
            MoveTo(pMtr->xCenter - (temp >> 1), pMtr->yCenter + pMtr->radius +
GetTextHeight(pMtr->hdr.pGolScheme->pFont));
                    #endif
                #elif (METER_TYPE == MTR_HALF_TYPE)
            MoveTo(pMtr->xCenter - (temp >> 1), pMtr->yCenter + 3);

                #elif (METER_TYPE == MTR_QUARTER_TYPE)
            MoveTo
                (
                    ((pMtr->hdr.right + pMtr->hdr.left) >> 1) - (temp >> 1),
pMtr->hdr.bottom - GOL_EMBOSS_SIZE - GetTextHeight
                        (pMtr->pTitleFont)
                );
                #endif
            state = TEXT_DRAW_RUN;
        case TEXT_DRAW_RUN:

            // render the title of the meter
            if(!OutText(pMtr->pText))
                return (0);
            state = ARC_DRAW_SETUP;

        //case ARC0_DRAW:
        case ARC_DRAW_SETUP:

            // check if we need to draw the arcs
            if(!GetState(pMtr, MTR_RING))
            {

                // if meter is not RING type, for scale label colors use
                // the three colors (normal, critical and danger)
                i = DEGREE_END;
                state = SCALE_COMPUTE;
                goto mtr_scale_compute;
            }
            else
            {

                // set the arc radii: x1 smaller radius and x2 as the larger radius
                x1 = pMtr->radius + 2;
                x2 = pMtr->radius + (pMtr->radius >> 2) + 2;
                    #if (METER_TYPE == MTR_WHOLE_TYPE)
                temp = 6;
                    #elif (METER_TYPE == MTR_HALF_TYPE)
                temp = 5;
                    #elif (METER_TYPE == MTR_QUARTER_TYPE)
                temp = 3;
                    #endif
                state = ARC_DRAW;
            }

        case ARC_DRAW:

            // draw the arcs
                #if (METER_TYPE == MTR_WHOLE_TYPE)
            while(temp)
            {
                    #elif (METER_TYPE == MTR_HALF_TYPE)
                while(temp > 1)
                {
                        #elif (METER_TYPE == MTR_QUARTER_TYPE)
                    while(temp > 1)
                    {
                            #endif

                        // decide which arc will be drawn
                        switch(temp)
                        {
                            case 6:
                                SetColor(pMtr->arcColor1);
                                if(!Arc(pMtr->xCenter, pMtr->yCenter, pMtr->xCenter,
  pMtr->yCenter, x1, x2, 0x20))
                                    return (0);
                                break;

                            case 5:
                                SetColor(pMtr->arcColor2);
                                if(!Arc(pMtr->xCenter, pMtr->yCenter, pMtr->xCenter,
  pMtr->yCenter, x1, x2, 0x40))
                                    return (0);
                                break;

                            case 4:
                                SetColor(pMtr->arcColor3);
                                if(!Arc(pMtr->xCenter, pMtr->yCenter, pMtr->xCenter,
  pMtr->yCenter, x1, x2, 0x80))
                                    return (0);
                                break;

                            case 3:
                                SetColor(pMtr->arcColor4);
                                if(!Arc(pMtr->xCenter, pMtr->yCenter, pMtr->xCenter,
  pMtr->yCenter, x1, x2, 0x01))
                                    return (0);
                                break;

                            case 2:
                                SetColor(pMtr->arcColor5);
                                if(!Arc(pMtr->xCenter, pMtr->yCenter, pMtr->xCenter,
  pMtr->yCenter, x1, x2, 0x02))
                                    return (0);
                                break;

                            case 1:
                                SetColor(pMtr->arcColor6);
                                if(!Arc(pMtr->xCenter, pMtr->yCenter, pMtr->xCenter,
  pMtr->yCenter, x1, x2, 0x04))
                                    return (0);
                                break;

                            default:
                                break;
                        }

                        temp--;
                    }

                    // set the color for the scale labels
                    SetColor(pMtr->hdr.pGolScheme->Color1);
                    i = DEGREE_END;
                    state = SCALE_COMPUTE;

                case SCALE_COMPUTE:
                    mtr_scale_compute : if(i >= DEGREE_START)
                    {
                        radian = i * .0175;

                        if(!GetState(pMtr, MTR_RING))
                        {
                            if(i >= ARC1_DEGREE)
                            {
                                SetColor(pMtr->arcColor1);
                            }
                            else if(i >= ARC2_DEGREE)
                            {
                                SetColor(pMtr->arcColor2);
                            }
                            else if(i >= ARC3_DEGREE)
                            {
                                SetColor(pMtr->arcColor3);
                            }
                            else if(i >= ARC4_DEGREE)
                            {
                                SetColor(pMtr->arcColor4);
                            }
                            else if(i >= ARC5_DEGREE)
                            {
                                SetColor(pMtr->arcColor5);
                            }
                            else
                            {
                                SetColor(pMtr->arcColor6);
                            }
                        }

                        // compute for the effective radius of the scales
                        if((i % 45) == 0)
                            x2 = pMtr->radius + (pMtr->radius >> 2) + 2;
                        else
```

```
                            x2 = pMtr->radius + (pMtr->radius >> 3) + 3;

                        // compute the starting x1 and y1 position of the scales
                        // x2 here is the distance from the center to the x1, y1
                        // position. Sin and cos is used here since computation speed in
 initial
                        // drawing is not yet critical.
                        x1 = x2 * cos(radian);
                        y1 = (-1) * (x2 * sin(radian));

                        // using ratio and proportion we get the x2,y2 position
                        dTemp.Val = 0;
                        dTemp.w[1] = (pMtr->radius + 3);
                        dTemp.Val /= x2;

                        dRes.Val = dTemp.Val * x1;
                        x2 = dRes.w[1] + pMtr->xCenter; // adjusted to center
                        dRes.Val = dTemp.Val * y1;
                        y2 = dRes.w[1] + pMtr->yCenter; // adjusted to center
                        x1 += pMtr->xCenter;
                        y1 += pMtr->yCenter;            // adjust x1, y1 to the center
                        state = SCALE_DRAW;
                    }
                    else
                    {
                        state = NEEDLE_ERASE;
                        goto mtr_needle_draw_st;
                    }

                case SCALE_DRAW:
                    if(!Line(x1, y1, x2, y2))               // now draw the scales
                        return (0);

                    if((i % 45) == 0)
                    {

                        // draw the scale labels
                        // reusing radian, x2 and y2
                        // compute for the actual angle of needle to be shown in
 screen
                        radian = (DEGREE_END - DEGREE_START) - (i - (DEGREE_START));

                        // compute the values of the label to be shown per 45 degree
                        temp = (pMtr->maxValue - pMtr->minValue) * (radian / (DEGREE_END -
 DEGREE_START));

                        // adjust for the minimum or offset value
                        temp += pMtr->minValue;

                        // this implements sprintf(strVal, "%d", temp); faster
                        // note that this is just for values >= 0, while sprintf covers
 negative values.
                        j = 1;

                        // get the ones value first and account for the required decimal
 point if enabled
                        if(GetState(pMtr, MTR_ACCURACY))
                        {

                            // round off to nearest tens
                            dTemp.w[0] = (temp % RESOLUTION) / (RESOLUTION / 10);
                            if((dTemp.w[0]) > (RESOLUTION >> 1))
                                temp += (RESOLUTION - dTemp.w[0]);
                            temp /= RESOLUTION;
                        }

                        do
                        {
                            strVal[SCALECHARCOUNT - j] = (temp % 10) + '0';
                            if(((temp /= 10) == 0) || (j >= SCALECHARCOUNT))
                                break;
                            j++;
                        } while(j <= SCALECHARCOUNT);

                        // the (&strVal[SCALECHARCOUNT-j]) removes the leading zeros.
                        // if leading zeroes will be printed change
(&strVal[SCALECHARCOUNT-j])
                        // to simply strVal and remove the break statement above in the
do-while loop
                        x2 = GetTextWidth((&strVal[SCALECHARCOUNT - j]),
pMtr->hdr.pGolScheme->pFont);
                        y2 = GetTextHeight(pMtr->hdr.pGolScheme->pFont);

                        if(i == -45)
                        {
                            MoveTo(x1 + 3, y1);
                        }
                        else if(i == 0)
                        {
                            MoveTo(x1 + 3, y1 - (y2 >> 1));
                        }
                        else if(i == 45)
                        {
                            MoveTo(x1 + 3, y1 - (y2 >> 1) - 3);
                        }
                        else if(i == 90)
                        {
                            MoveTo(x1 - (x2 >> 1), y1 - (y2) - 3);
                        }
                        else if(i == 135)
                        {
                            MoveTo(x1 - (x2), y1 - (y2));
                        }
                        else if(i == 180)
                        {
                            MoveTo(x1 - (x2) - 3, y1 - (y2 >> 1));
                        }
                        else if(i == 225)
                        {
                            MoveTo(x1 - (x2 + 3), y1);
                        }

                        state = SCALE_LABEL_DRAW;
                    }
                    else
                    {
                        i -= DEGREECOUNT;
                        state = SCALE_COMPUTE;          //SCALE_LABEL_DRAW;
                        goto mtr_scale_compute;
                    }

                case SCALE_LABEL_DRAW:
                    SetFont(pMtr->hdr.pGolScheme->pFont);
                    if(!OutText(&strVal[SCALECHARCOUNT - j]))
                        return (0);
                    i -= DEGREECOUNT;
                    state = SCALE_COMPUTE;
                    goto mtr_scale_compute;

                case NEEDLE_ERASE:
                    mtr_needle_draw_st : if(GetState(pMtr, MTR_DRAW_UPDATE))
                    {

                        // to update the needle, redraw the old position with background
color
                        SetColor(pMtr->hdr.pGolScheme->Color0);
                        SetLineThickness(THICK_LINE);
                        if(!Line(pMtr->xCenter, pMtr->yCenter, pMtr->xPos, pMtr->yPos))
                            return (0);
                    }

                    state = NEEDLE_DRAW;

                case NEEDLE_DRAW:
                    if(IsDeviceBusy())
                        return (0);

                    // At this point, pMtr->value is assumed to contain the new value of
the meter.
                    // calculate the new angle:
                    // equation is still ratio and proportion of angle and values.
                    dTemp.Val = 0;
                    dTemp.w[1] = pMtr->value - pMtr->minValue;
                    dTemp.Val /= (pMtr->maxValue - pMtr->minValue);
                    dTemp.Val *= (DEGREE_END - DEGREE_START);

                    angle = DEGREE_END - (dTemp.w[1]);
                    temp = angle;

                    /* The method uses a lookup table of pre-calculated sine values. The
table
               is derived from calculating sine values from 0 degrees to 90 degrees.
               To save space, the entries are just a byte size. So 360/256 = 1.40625 degrees
               increments is used for each entry. (i.e entry 0 is zero, entry i is 1.40625,
               entry 2 is 2*1.40625,... entry n is n*1.40625.
               Get the sine of the entries yields a float value. Since we only use a
               byte for storage we can shift the values by 128 without overflowing the
               storage. Thus we need to shift the computed values by 8 bits. Shifting now
               permits us to work with integers which greatly reduces the execution time.
               With this in mind, the input angles must be translated to 0-90 range with the
               quadrant of the original angle stored to translate back the value from the
               table to the correct quadrant. Also the quadrant number will determine if
               the calculated x and y positions are to be swapped.
               In summary:
                Swap x and y when calculating points in quadrant 2 and 4
                Negate x when in quadrant 2 and 3
                Negate y when in quadrant 1 and 2
            */

                    // translate the angle to 0-90 range
                    while(temp < 0)                     // this is needed for negative
                        temp += 90;                     // for negative values
                    while(temp > 90)
                        temp -= 90;

                    // determine which quadrant the angle is located
                    // i determines if x and y are swapped (0 no swapping, 1 swapping
needed)
                    // y2 and x2 are the multiplier to negate or not the x and y values
                    if((180 < angle) && (angle <= 270))
                    {               // quadrant 3
                        i = 0;
                        y2 = 1;
                        x2 = -1;
                    }
                    else if((90 < angle) && (angle <= 180))
                    {               // quadrant 2
                        i = 1;
                        y2 = -1;
                        x2 = -1;
                    }
                    else if((0 <= angle) && (angle <= 90))
                    {               // quadrant 1
                        i = 0;
                        y2 = -1;
                        x2 = 1;
                    }
                    else if((-90 < angle) && (angle < 0))
                    {               // quadrant 4
                        i = 1;
                        y2 = 1;
                        x2 = 1;
                    }

                    // using the calculated angle we get the sine and cosine
                    // values from the look up table, then to avoid
                    // division, the inverse is used
                    x1 = Cosine(temp) * pMtr->radius;
                    y1 = Sine(temp) * pMtr->radius;

                    // calculate new positions, check if we need to reverse x and y values
                    pMtr->xPos = ((x2) * (((i == 0) ? x1 : y1) >> 8)) + pMtr->xCenter;
                    pMtr->yPos = ((y2) * (((i == 0) ? y1 : x1) >> 8)) + pMtr->yCenter;

                    // now draw the needle with the new position
                    SetColor(BRIGHTRED);
                    SetLineThickness(THICK_LINE);
                    if(!Line(pMtr->xCenter, pMtr->yCenter, pMtr->xPos, pMtr->yPos))
                        return (0);
                    SetLineThickness(NORMAL_LINE);
                        #ifdef METER_DISPLAY_VALUES_ENABLE
                    state = VALUE_ERASE;
                        #else

                    // reset the line to normal
                    SetLineThickness(NORMAL_LINE);
                    state = IDLE;
                    return (1);
                        #endif
                        #ifdef METER_DISPLAY_VALUES_ENABLE

                case VALUE_ERASE:
                    if(IsDeviceBusy())
                        return (0);

                    // reset the line to normal
                    SetLineThickness(NORMAL_LINE);

                    // display the value
                    // erase previous value first. The temp>>1 accomodates fonts with
characters that has unequal widths
                    temp = GetTextWidth(tempXchar, pMtr->pValueFont);
                    temp = temp * SCALECHARCOUNT + (temp >> 1);

                    //temp = GetTextWidth(tempXchar, pMtr->pValueFont)*SCALECHARCOUNT;
                    SetColor(pMtr->hdr.pGolScheme->Color0);

                            #if (METER_TYPE == MTR_WHOLE_TYPE)
                    if
                    (
                        !Bar
                            (
                                pMtr->xCenter -
                                (temp >> 1), pMtr->yCenter +
                                pMtr->radius, pMtr->xCenter +
                                (temp >> 1), pMtr->yCenter +
                                pMtr->radius +
                                GetTextHeight(pMtr->pValueFont)
                            )
                    ) return (0);

                            #elif (METER_TYPE == MTR_HALF_TYPE)
                    if
                    (
                        !Bar
                            (
                                pMtr->xCenter -
                                (temp >> 1), pMtr->yCenter -
                                GetTextHeight(pMtr->pValueFont), pMtr->xCenter +
                                (temp >> 1), pMtr->yCenter
                            )
                    ) return (0);

                            #elif (METER_TYPE == MTR_QUARTER_TYPE)
                    if
                    (
                        !Bar
                            (
                            pMtr->xCenter -
                            1, pMtr->yCenter -
                            GetTextHeight(pMtr->pValueFont), pMtr->xCenter +
                            temp, pMtr->yCenter +
                            1
                        )
                    ) return (0);
                        #endif
                    state = VALUE_DRAW;

                case VALUE_DRAW:
                    if(IsDeviceBusy())
                        return (0);

                    if(angle >= ARC1_DEGREE)
                    {
                        SetColor(pMtr->arcColor1);
                    }
                    else if(angle >= ARC2_DEGREE)
                    {
                        SetColor(pMtr->arcColor2);
                    }
                    else if(angle >= ARC3_DEGREE)
                    {
                        SetColor(pMtr->arcColor3);
                    }
                    else if(angle >= ARC4_DEGREE)
                    {
                        SetColor(pMtr->arcColor4);
                    }
                    else if(angle >= ARC5_DEGREE)
                    {
                        SetColor(pMtr->arcColor5);
                    }
                    else
                    {
                        SetColor(pMtr->arcColor6);
                    }

                    // display the current value
                    SetFont(pMtr->pValueFont);

                    // this implements sprintf(strVal, "%03d", pMtr->value); faster
                    // note that this is just for values >= 0, while sprintf covers
negative values.
                i = pMtr->value;
                j = 1;

                // get the ones value first and account for the required decimal point
if enabled
                if(GetState(pMtr, MTR_ACCURACY))
                {
                    strVal[SCALECHARCOUNT - j] = (((i % RESOLUTION)) / (RESOLUTION /
10)) + '0';
                    i /= RESOLUTION;
                    j++;
                    strVal[SCALECHARCOUNT - j] = '.';
                    j++;
                }

                do
                {
                    strVal[SCALECHARCOUNT - j] = (i % 10) + '0';
                    if(((i /= 10) == 0) || (j >= SCALECHARCOUNT))
                        break;
                    j++;
                } while(j <= SCALECHARCOUNT);

                temp = GetTextWidth(&strVal[SCALECHARCOUNT - j], pMtr->pValueFont);

                    #if (METER_TYPE == MTR_WHOLE_TYPE)
                MoveTo(pMtr->xCenter - (temp >> 1), pMtr->yCenter + pMtr->radius);
```

```
                                #elif (METER_TYPE == MTR_HALF_TYPE)
                        MoveTo(pMtr->xCenter - (temp >> 1), pMtr->yCenter -
GetTextHeight(pMtr->pValueFont));

                                #elif (METER_TYPE == MTR_QUARTER_TYPE)
                        MoveTo(pMtr->xCenter, pMtr->yCenter - GetTextHeight(pMtr->pValueFont));
                                #endif
                        state = VALUE_DRAW_RUN;

                    case VALUE_DRAW_RUN:
                        if(!OutText(&strVal[SCALECHARCOUNT - j]))
                            return (0);
                        state = IDLE;
                        return (1);
                            #endif //METER_DISPLAY_VALUES_ENABLE
                    }

                    return (1);
                }

                #endif // USE_METER
```

14.1.25 Meter.h

Functions

	Name	Description
	MtrCreate (see page 214)	This function creates a METER (see page 223) object with the parameters given. It automatically attaches the new object into a global linked list of objects and returns the address of the object.
	MtrDraw (see page 215)	This function renders the object on the screen using the current parameter settings. Location of the object is determined by the left, top, right and bottom parameters. The colors used are dependent on the state of the object. The font used is determined by the style scheme set. Depending on the defined settings, value of the meter will displayed or hidden. Displaying the value will require a little bit more rendering time depending on the size of the meter and font used. When rendering objects of the same type, each object must be rendered completely before the rendering of the... more (see page 215)
	MtrMsgDefault (see page 222)	This function performs the actual state change based on the translated message given. Meter (see page 210) value is set based on parameter 2 of the message given. The following state changes are supported:
	MtrSetVal (see page 216)	This function sets the value of the meter to the passed newVal. newVal is checked to be in the minValue-maxValue range inclusive. If newVal is not in the range, minValue maxValue is assigned depending on the given newVal if less than minValue or above maxValue.
	MtrTranslateMsg (see page 222)	This function evaluates the message from a user if the message will affect the object or not. The table below enumerates the translated messages for each event of the touch screen and keyboard inputs.

Macros

Name	Description
METER_DISPLAY_VALUES_ENABLE (see page 221)	This enables the display of the values.

METER_TYPE (see page 220)	This is a compile time setting to select the type if meter shape. There are three types: • MTR_WHOLE_TYPE - Meter (see page 210) drawn with 6 octants used. • MTR_HALF_TYPE - Meter (see page 210) drawn with semi circle shape. • MTR_QUARTER_TYPE - Meter (see page 210) drawn with quarter circle shape. Set only one value at a time. This is done to save code space. User can define the colors of the arcs for each type. MTR_WHOLE_TYPE will use all the arc colors (arcColor1 - arcColor6) MTR_HALF_TYPE will use arc colors (arcColor5, arcColor4, arcColor3, arcColor2) MTR_QUARTER_TYPE will use arc colors (arcColor3, arcColor2) Set the meter type in Meter.h file and... more (see page 220)
MTR_ACCURACY (see page 221)	Sets the meter accuracy to one decimal places
MTR_DISABLED (see page 212)	Bit for disabled state.
MTR_DRAW (see page 213)	Bit to indicate object must be redrawn.
MTR_DRAW_UPDATE (see page 213)	Bit to indicate an update only.
MTR_HIDE (see page 213)	Bit to indicate object must be removed from screen.
MTR_RING (see page 213)	Bit for ring type, scales are drawn over the ring
MtrDecVal (see page 217)	This macro is used to directly decrement the value.
MtrGetVal (see page 217)	This macro returns the current value of the meter. Value is always in the minValue-maxValue range inclusive.
MtrIncVal (see page 218)	This macro is used to directly increment the value.
MtrSetScaleColors (see page 218)	Scale colors can be used to highlight values of the meter. User can set these colors to define the arc colors and scale colors. This also sets the color of the meter value when displayed. Limitation is that color settings are set to the following angles: Color Boundaries Type Whole Type Half Type Quarter Arc (see page 375) 6 225 to 180 not used not used Arc (see page 375) 5 179 to 135 179 to 135 not used Arc (see page 375) 4 134 to 90 134 to 90 not used Arc (see page 375) 3 89 to 45 89 to 45 89 to 45 Arc (see page 375) 2 44 to 0 44... more (see page 218)
MtrSetTitleFont (see page 219)	This function sets the font of title.
MtrSetValueFont (see page 220)	This function sets the font of value.
RESOLUTION (see page 221)	Factor that the meter widget will divide minValue, maxValue

Structures

Name	Description
METER (see page 223)	Defines the parameters required for a meter Object. Depending on the type selected the meter is drawn with the defined shape parameters and values set on the given fields.

Description

This is file Meter.h.

Body Source

```
/*****************************************************************************
 *  Module for Microchip Graphics Library
 *  GOL Layer
 *  Meter
 *****************************************************************************
 * FileName:        Meter.h
 * Dependencies:    None
 * Processor:       PIC24F, PIC24H, dsPIC, PIC32
 * Compiler:        MPLAB C30, MPLAB C32
 * Linker:          MPLAB LINK30, MPLAB LINK32
 * Company:         Microchip Technology Incorporated
 *
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 *
```

```
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  * CLAIMS BY THIRD PARTIES (INCLUDING BUT NOT LIMITED TO ANY DEFENSE THEREOF),
  * OR OTHER SIMILAR COSTS.
  *
  * Date         Comment
  *~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
  * 11/12/07     Version 1.0 release
  * 07/31/08     Added arc colors options
  * 08/20/08     Added accuracy option for displaying values
  * 01/18/10     Fixed MtrIncVal() and MtrDecVal() macros
  *****************************************************************************/
#ifndef _METER_H
    #define _METER_H

    #include <Graphics/GOL.h>
    #include "GenericTypeDefs.h"

// Compile time Options for Meter
    #define METER_DISPLAY_VALUES_ENABLE // This enables the display of the values.

// Displaying the values will have significant
// drawing time requirement.

/*********************************************************************
* Object States Definition:
*********************************************************************/
    #define MTR_DISABLED    0x0002      // Bit for disabled state.
    #define MTR_RING        0x0004      // Bit for ring type, scales are drawn over the ring

// default is only scales drawn.
    #define MTR_ACCURACY    0x0008      // Sets the meter accuracy to one decimal places

// when displaying the values. Application must multiply
// the minValue, maxValue and values passed to the widget
// by RESOLUTION.
    #define MTR_DRAW_UPDATE 0x1000      // Bit to indicate an update only.
    #define MTR_DRAW        0x4000      // Bit to indicate object must be redrawn.
    #define MTR_HIDE        0x8000      // Bit to indicate object must be removed from
screen.

/*********************************************************************
* Used Constants
*********************************************************************/
    #define RADIAN      1144            // Radian definition. Equivalent to sine(1) * 2^16.
    #define PIIOVER2    102944          // The constant Pii divided by two (pii/2).

// Meter types
    #define MTR_WHOLE_TYPE      0
    #define MTR_HALF_TYPE       1
    #define MTR_QUARTER_TYPE    2

/*****************************************************************************
* Overview: This is a compile time setting to select the type if meter shape.
*  There are three types:
```

```
*       - MTR_WHOLE_TYPE   - Meter drawn with 6 octants used.
*       - MTR_HALF_TYPE    - Meter drawn with semi circle shape.
*       - MTR_QUARTER_TYPE - Meter drawn with quarter circle shape.
*  Set only one value at a time. This is done to save code space.
*  User can define the colors of the arcs for each type.
*  MTR_WHOLE_TYPE will use all the arc colors (arcColor1 - arcColor6)
*  MTR_HALF_TYPE will use arc colors (arcColor5, arcColor4, arcColor3, arcColor2)
*  MTR_QUARTER_TYPE will use arc colors (arcColor3, arcColor2)
*  Set the meter type in Meter.h file and arc colors using
*  MtrSetScaleColors(pMtr, arc1, arc2, arc3, arc4, arc5, arc6) macro.
*****************************************************************************/
    #define METER_TYPE  MTR_WHOLE_TYPE

//#define METER_TYPE                    MTR_HALF_TYPE              // Meter drawn with
semi circle shape.
//#define METER_TYPE                    MTR_QUARTER_TYPE           // Meter drawn with
quarter circle shape.
    #define ARC1_DEGREE 180             // defines one arc1 limit (used for determining
colors)
    #define ARC2_DEGREE 135             // defines one arc2 limit (used for determining
colors)
    #define ARC3_DEGREE 90              // defines one arc3 limit (used for determining
colors)
    #define ARC4_DEGREE 45              // defines one arc4 limit (used for determining
colors)
    #define ARC5_DEGREE 0               // defines one arc5 limit (used for determining
colors)

// These selects the other parameters of the meter that are dependent on the shape.
    #if (METER_TYPE == MTR_WHOLE_TYPE)
        #define DEGREE_START    - 45    // Defines the start angle to draw the meter.
        #define DEGREE_END      225     // Defines the end angle to draw the meter.
    #elif (METER_TYPE == MTR_HALF_TYPE)
        #define DEGREE_START    0       // Defines the start angle to draw the meter.
        #define DEGREE_END      180     // Defines the end angle to draw the meter.
    #elif (METER_TYPE == MTR_QUARTER_TYPE)
        #define DEGREE_START    0       // Defines the start angle to draw the meter.
        #define DEGREE_END      90      // Defines the end angle to draw the meter.
    #endif
    #define SCALECHARCOUNT  4           // Defines how many characters will be allocated
for the

// scale labels. Use this define in accordance to
// the maxValue-minValue. Example: if maxValue-minValue = 500, SCALECHARCOUNT
// should be 3. if maxValue-minValue = 90, SCALECHARCOUNT = 2
// You must include the decimal point if this
// feature is enabled (see MTR_ACCURACY state bit).
    #define DEGREECOUNT 9               // Defines how many degrees per scale, computed per
octant

// Example: for 5 division per octant 45/5 = 9.
// So every 9 degrees a scale is drawn
// for a 5 scale division per octant.
    #define RESOLUTION  10              // Factor that the meter widget will divide
minValue, maxValue

// and current value. Used only when MTR_ACCURACY state bit is set.

/*********************************************************************
* Overview: Defines the parameters required for a meter Object.
*           Depending on the type selected the meter is drawn with
*           the defined shape parameters and values set on the
*           given fields.
*
*********************************************************************/
typedef struct
{
    OBJ_HEADER  hdr;            // Generic header for all Objects (see OBJ_HEADER).
    XCHAR       *pText;         // The text label of the meter.
    SHORT       value;          // Current value of the meter.
    SHORT       minValue;       // minimum value the meter can display
    SHORT       maxValue;       // maximum value the meter can display (range is maxValue -
minValue)
    SHORT       xCenter;        // The x coordinate center position. This is computed
automatically.
    SHORT       yCenter;        // The y coordinate center position. This is computed
automatically.
    SHORT       radius;         // Radius of the meter, also defines the needle length.

    // This is computed automatically.
    SHORT       xPos;           // The current x position of the needle. This is computed
automatically.
    SHORT       yPos;           // The current y position of the needle. This is computed
automatically.
    WORD        arcColor6;      // Arc 6 color parameter.
    WORD        arcColor5;      // Arc 5 color parameter
    WORD        arcColor4;      // Arc 4 color parameter
    WORD        arcColor3;      // Arc 3 color parameter
    WORD        arcColor2;      // Arc 2 color parameter
    WORD        arcColor1;      // Arc 1 color parameter

    // The following three points define three fonts used in meter widget, they can be
different from the scheme font.
    // Note that the sizes of these fonts are not checked with the meter dimension. In
cases where font sizes are
    // larger than the meter dimension, some overlaps will occur.
    void        *pTitleFont;    // Pointer to the font used in the title of the meter
    void        *pValueFont;    // Pointer to the font used in the current reading (if
displayed) of the meter
} METER;

/*********************************************************************
* Function: METER  *MtrCreate(WORD ID, SHORT left, SHORT top, SHORT right,
*                             SHORT bottom, WORD state, SHORT value,
*                             SHORT minValue, SHORT maxValue,
*                             XCHAR *pText, GOL_SCHEME *pScheme)
*
* Overview: This function creates a METER object with the parameters given.
*           It automatically attaches the new object into a global linked list of
*           objects and returns the address of the object.
*
* PreCondition: none
*
* Input: ID - Unique user defined ID for the object instance.
*        left - Left most position of the object.
*        top - Top most position of the object.
*        right - Right most position of the object.
*        bottom - Bottom most position of the object.
*        state - Sets the initial state of the object.
*        value - Initial value set to the meter.
*        minValue - The minimum value the meter will display.
*        maxValue - The maximum value the meter will display.
*        pText - Pointer to the text label of the meter.
*        pScheme - Pointer to the style scheme used.
*
* Output: Returns the pointer to the object created.
*
* Example:
*   <CODE>
*   #define ID_METER 101
*
*   extern const FONT_FLASH GOLMediumFont;      // medium font
*   extern const FONT_FLASH GOLSmallFont;       // small font
*
*   GOL_SCHEME *pMeterScheme;
*   METER *pMtr;
*
*       pMeterScheme = GOLCreateScheme();
*
*       pMtr = MtrCreate(
*               ID_METER,               // assign ID
*               30, 50, 150, 180,       // set dimension
*               MTR_DRAW|MTR_RING,      // draw object after creation
*               0,                      // set initial value
```

```
 *               0, 100,                 // set minimum and maximum value
 *               (void*)&GOLMediumFont,  // set title font
 *               (void*)&GOLSmallFont,   // set value font
 *               "Speed",                // Text Label
 *               pMeterScheme);          // style scheme
 *
 *       // check if meter was created
 *       if (pMtr == NULL)
 *          return 0;
 *
 *       // Change range colors: Normal values to WHITE
 *       //                      Critical values to BLUE
 *       //                      Danger values to RED
 *       // assume that WHITE, GREEN, YELLOW and RED have been defined.
 *       MtrSetScaleColors(pMtr, WHITE, WHITE, WHITE, GREEN, YELLOW, RED);
 *
 *       // use GOLDraw() to draw the meter and all other objects you created
 *       while(!GOLDraw());
 *       // OR to draw the meter manually use this:
 *       //while(!MtrDraw(pMtr);
 *
 *   </CODE>
 *
 * Side Effects: none
 *
 ********************************************************************/
METER   *MtrCreate
        (
            WORD        ID,
            SHORT       left,
            SHORT       top,
            SHORT       right,
            SHORT       bottom,
            WORD        state,
            SHORT       value,
            SHORT       minValue,
            SHORT       maxValue,
            void        *pTitleFont,
            void        *pValueFont,
            XCHAR       *pText,
            GOL_SCHEME  *pScheme
        );

/*********************************************************************
* Function: WORD MtrTranslateMsg(void *pObj, GOL_MSG *pMsg)
*
* Overview: This function evaluates the message from a user if the
*           message will affect the object or not. The table below enumerates the
translated
*           messages for each event of the touch screen and keyboard inputs.
*
*   <TABLE>
*       Translated Message   Input Source  Events           Description
*       ##################   ############  ######           ###########
*       MTR_MSG_SET          System        EVENT_SET        If event set occurs and the
meter ID is sent in parameter 1.
*       OBJ_MSG_INVALID      Any           Any              If the message did not affect
the object.
*   </TABLE>
*
* PreCondition: none
*
* Input: pMtr  - The pointer to the object where the message will be
*                evaluated to check if the message will affect the object.
*        pMsg  - Pointer to the message struct containing the message from
*                the user interface.
*
* Output: Returns the translated message depending on the received GOL message:
*         - MTR_MSG_SET - Meter ID is given in parameter 1 for a TYPE_SYSTEM message.
*         - OBJ_MSG_INVALID - Meter is not affected.
*
* Side Effects: none
```

```
*
********************************************************************/
WORD    MtrTranslateMsg(void *pObj, GOL_MSG *pMsg);

/*********************************************************************
* Function: MtrMsgDefault(WORD translatedMsg, void *pObj, GOL_MSG* pMsg)
*
* Overview: This function performs the actual state change
*           based on the translated message given. Meter value is set
*           based on parameter 2 of the message given. The following state changes
*           are supported:
*   <TABLE>
*       Translated Message   Input Source  Set/Clear State Bit      Description
*       ##################   ############  ######                   ###########
*       MTR_MSG_SET          System        Set MTR_DRAW_UPDATE      Meter will be redrawn
to update the needle position and value displayed.
*   </TABLE>
*
* PreCondition: none
*
* Input: translatedMsg - The translated message.
*        pMtr          - The pointer to the object whose state will be modified.
*        pMsg          - The pointer to the GOL message.
*
* Output: none
*
* Side Effects: none
*
********************************************************************/
void    MtrMsgDefault(WORD translatedMsg, void *pObj, GOL_MSG *pMsg);

/*********************************************************************
* Macros:  MtrGetVal(pMtr)
*
* Overview: This macro returns the current value of the meter.
*           Value is always in the minValue-maxValue range inclusive.
*
* PreCondition: none
*
* Input: pMtr - Pointer to the object.
*
* Output: Returns current value of the meter.
*
* Side Effects: none
*
********************************************************************/
    #define MtrGetVal(pMtr) ((pMtr)->value)

/*********************************************************************
* Function: MtrSetVal(METER *pMtr, SHORT newVal)
*
* Overview: This function sets the value of the meter to the passed
*           newVal. newVal is checked to be in the minValue-maxValue
*           range inclusive. If newVal is not in the range, minValue
*           maxValue is assigned depending on the given newVal
*           if less than minValue or above maxValue.
*
* PreCondition: none
*
* Input: pMtr   - The pointer to the object.
*        newVal - New value to be set for the Meter.
*
* Output: none
*
* Side Effects: none
*
********************************************************************/
void    MtrSetVal(METER *pMtr, SHORT newVal);

/*********************************************************************
* Macros:  MtrIncVal(pMtr, deltaValue)
*
```

```
 * Overview: This macro is used to directly increment the value.
 *
 * PreCondition: none
 *
 * Input: pMtr - Pointer to the object.
 *        deltaValue - Number to be added to the current Meter value.
 *
 * Output: none
 *
 * Side Effects: none
 *
 ********************************************************************/
    #define MtrIncVal(pMtr, deltaValue)  MtrSetVal(pMtr, ((pMtr)->value + deltaValue))

 /*********************************************************************
 * Macros:  MtrDecVal(pMtr, deltaValue)
 *
 * Overview: This macro is used to directly decrement the value.
 *
 * PreCondition: none
 *
 * Input: pMtr - Pointer to the object.
 *        deltaValue - Number to be subtracted to the current Meter value.
 *
 * Output: none
 *
 * Side Effects: none
 *
 ********************************************************************/
    #define MtrDecVal(pMtr, deltaValue)  MtrSetVal(pMtr, ((pMtr)->value - deltaValue))

 /*********************************************************************
 * Macros:  MtrSetScaleColors(pMtr, arc1, arc2, arc3, arc4, arc5, arc6)
 *                               {   pMtr->arcColor6=arc6;
 *                                   pMtr->arcColor5=arc5;
 *                                   pMtr->arcColor4=arc4;
 *                                   pMtr->arcColor3=arc3;
 *                                   pMtr->arcColor2=arc2;
 *                                   pMtr->arcColor1=arc1;   }
 *
 * Overview: Scale colors can be used to highlight values of the meter.
 *           User can set these colors to define the arc colors and scale colors.
 *           This also sets the color of the meter value when displayed. Limitation is that
 *           color settings are set to the following angles:
 *           Color Boundaries        Type Whole      Type Half       Type Quarter
 *           Arc 6                   225  to 180     not used        not used
 *           Arc 5                   179  to 135     179  to 135     not used
 *           Arc 4                   134  to  90     134  to  90     not used
 *           Arc 3                    89  to  45      89  to  45     89  to  45
 *           Arc 2                    44  to   0      44  to   0     44  to   0
 *           Arc 1                   -45  to  -1     not used        not used
 *           As the meter is drawn colors are changed depending on the
 *           angle of the scale and label being drawn.
 *
 * PreCondition: The object must be created (using MtrCreate()) before
 *               a call to this macro is performed.
 *
 * Input: pMtr - Pointer to the object.
 *        arc1 - color for arc 1.
 *        arc2 - color for arc 2.
 *        arc3 - color for arc 3.
 *        arc4 - color for arc 4.
 *        arc5 - color for arc 5.
 *        arc6 - color for arc 6.
 *
 * Output: none
 *
 * Side Effects: none
 *
 ********************************************************************/
    #define MtrSetScaleColors(pMtr, arc1, arc2, arc3, arc4, arc5, arc6) \
    {                                                                   \
        pMtr->arcColor6 = arc6;                                     \
        pMtr->arcColor5 = arc5;                                     \
        pMtr->arcColor4 = arc4;                                     \
        pMtr->arcColor3 = arc3;                                     \
        pMtr->arcColor2 = arc2;                                     \
        pMtr->arcColor1 = arc1;                                     \
    }

/*********************************************************************
* Function: WORD MtrDraw(void *pObj)
*
* Overview: This function renders the object on the screen using
*           the current parameter settings. Location of the object is
*           determined by the left, top, right and bottom parameters.
*           The colors used are dependent on the state of the object.
*           The font used is determined by the style scheme set.
*
*           Depending on the defined settings, value of the meter
*           will displayed or hidden. Displaying the value will require
*           a little bit more rendering time depending on the size
*           of the meter and font used.
*
*           When rendering objects of the same type, each object
*           must be rendered completely before the rendering of the
*           next object is started. This is to avoid incomplete
*           object rendering.
*
* PreCondition: Object must be created before this function is called.
*
* Input: pMtr - Pointer to the object to be rendered.
*
* Output: Returns the status of the drawing
*         - 1 - If the rendering was completed and
*         - 0 - If the rendering is not yet finished.
*         Next call to the function will resume the
*         rendering on the pending drawing state.
*
* Example:
*   See MtrCreate() example.
*
* Side Effects: none
*
********************************************************************/
WORD MtrDraw(void *pObj);

/*********************************************************************
* Macro: MtrSetTitleFont(pMtr, pNewFont)   (((METER*)pMtr)->pTitleFont = pNewFont)
*
* Overview: This function sets the font of title.
*
* PreCondition: Font must be created before this function is called.
*
* Input: pMtr - Pointer to the object.
*       pNewFont - Pointer to the new font used for the title.
*
* Output: N/A
*
* Side Effects: none
*
********************************************************************/
    #define MtrSetTitleFont(pMtr, pNewFont) (((METER *)pMtr)->pTitleFont = pNewFont)

/*********************************************************************
* Macro: MtrSetValueFont(pMtr, pNewFont)   (((METER*)pMtr)->pValueFont = pNewFont)
*
* Overview: This function sets the font of value.
*
* PreCondition: Font must be created before this function is called.
*
* Input: pMtr - Pointer to the object.
*       pNewFont - Pointer to the new font used for the value.
*
```

```
* Output: N/A
*
* Side Effects: none
*
********************************************************************/
    #define MtrSetValueFont(pMtr, pNewFont) (((METER *)pMtr)->pValueFont = pNewFont)
#endif // _METER_H
```

14.1.26 Picture.c

This is file Picture.c.

Body Source

```
/*****************************************************************************
 *  Module for Microchip Graphics Library
 *  GOL Layer
 *  Picture
 *****************************************************************************
 * FileName:        Picture.c
 * Dependencies:    None
 * Processor:       PIC24F, PIC24H, dsPIC, PIC32
 * Compiler:        MPLAB C30 V3.00, MPLAB C32
 * Linker:          MPLAB LINK30, MPLAB LINK32
 * Company:         Microchip Technology Incorporated
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 * CLAIMS BY THIRD PARTIES (INCLUDING BUT NOT LIMITED TO ANY DEFENSE THEREOF),
 * OR OTHER SIMILAR COSTS.
 *
 * Date         Comment
 *~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
 * 11/12/07     Version 1.0 release
 * 01/19/11     Fixed bug when drawing picture from (0,0) position.
 *****************************************************************************/
#include "Graphics/Graphics.h"

#ifdef USE_PICTURE

/*********************************************************************
* Function: PICTURE  *PictCreate(WORD ID, SHORT left, SHORT top, SHORT right,
*                               SHORT bottom, WORD state, char scale, void *pBitmap,
*                               GOL_SCHEME *pScheme)
*
* Overview: creates the picture control
*
********************************************************************/
PICTURE *PictCreate
```

```
(
    WORD        ID,
    SHORT       left,
    SHORT       top,
    SHORT       right,
    SHORT       bottom,
    WORD        state,
    char        scale,
    void        *pBitmap,
    GOL_SCHEME  *pScheme
)
{
    PICTURE *pPict = NULL;

    pPict = (PICTURE *)GFX_malloc(sizeof(PICTURE));
    if(pPict == NULL)
        return (pPict);

    pPict->hdr.ID = ID;
    pPict->hdr.pNxtObj = NULL;
    pPict->hdr.type = OBJ_PICTURE;
    pPict->hdr.left = left;
    pPict->hdr.top = top;
    pPict->hdr.right = right;
    pPict->hdr.bottom = bottom;
    pPict->pBitmap = pBitmap;
    pPict->hdr.state = state;
    pPict->scale = scale;
    pPict->hdr.DrawObj = PictDraw;          // draw function
    pPict->hdr.MsgObj = PictTranslateMsg;   // message function
    pPict->hdr.MsgDefaultObj = NULL;        // default message function
    pPict->hdr.FreeObj = NULL;              // free function

    // Set the style scheme to be used
    if(pScheme == NULL)
        pPict->hdr.pGolScheme = _pDefaultGolScheme;
    else
        pPict->hdr.pGolScheme = (GOL_SCHEME *)pScheme;

    GOLAddObject((OBJ_HEADER *)pPict);

    return (pPict);
}

/*********************************************************************
* Function: WORD PictTranslateMsg(void *pObj, GOL_MSG *pMsg)
*
* Overview: translates the GOL message for the picture control
*
********************************************************************/
WORD PictTranslateMsg(void *pObj, GOL_MSG *pMsg)
{
    PICTURE *pPict;

    pPict = (PICTURE *)pObj;

    // Evaluate if the message is for the picture
    // Check if disabled first
    if(GetState(pPict, PICT_DISABLED))
        return (OBJ_MSG_INVALID);

        #ifdef USE_TOUCHSCREEN
    if(pMsg->type == TYPE_TOUCHSCREEN)
    {

        // Check if it falls in the picture area
        if
        (
            (pPict->hdr.left < pMsg->param1) &&
            (pPict->hdr.right > pMsg->param1) &&
            (pPict->hdr.top < pMsg->param2) &&
            (pPict->hdr.bottom > pMsg->param2)
        )
        {
            return (PICT_MSG_SELECTED);
        }
    }

        #endif
    return (OBJ_MSG_INVALID);
}

/*********************************************************************
* Function: WORD PictDraw(void *pObj)
*
* Output: returns the status of the drawing
*         0 - not completed
*         1 - done
*
* Overview: draws picture
*
********************************************************************/
WORD PictDraw(void *pObj)
{
    typedef enum
    {
        REMOVE,
        DRAW_IMAGE,
        DRAW_BACKGROUND1,
        DRAW_BACKGROUND2,
        DRAW_BACKGROUND3,
        DRAW_BACKGROUND4,
        DRAW_FRAME
    } PICT_DRAW_STATES;

    static PICT_DRAW_STATES state = REMOVE;
    static SHORT posleft;
    static SHORT postop;
    static SHORT posright;
    static SHORT posbottom;
    PICTURE *pPict;

    pPict = (PICTURE *)pObj;

    if(IsDeviceBusy())
        return (0);

    switch(state)
    {
        case REMOVE:
            if(GetState(pPict, PICT_HIDE))
            {
                SetColor(pPict->hdr.pGolScheme->CommonBkColor);
                if(!Bar(pPict->hdr.left, pPict->hdr.top, pPict->hdr.right,
pPict->hdr.bottom))
                    return (0);
                return (1);
            }

            posleft = (pPict->hdr.left + 1 + pPict->hdr.right - pPict->scale *
GetImageWidth(pPict->pBitmap)) >> 1;
            postop = (pPict->hdr.top + 1 + pPict->hdr.bottom - pPict->scale *
GetImageHeight(pPict->pBitmap)) >> 1;
            posright = (pPict->hdr.right + pPict->hdr.left + pPict->scale *
GetImageWidth(pPict->pBitmap)) >> 1;
            posbottom = (pPict->hdr.bottom + pPict->hdr.top + pPict->scale *
GetImageHeight(pPict->pBitmap)) >> 1;
            state = DRAW_IMAGE;

        case DRAW_IMAGE:
            if(pPict->pBitmap != NULL)
            {
                if(IsDeviceBusy())
                    return (0);
                if(!PutImage(posleft, postop, pPict->pBitmap, pPict->scale))
                    return (0);
            }

            SetColor(pPict->hdr.pGolScheme->CommonBkColor);
            state = DRAW_BACKGROUND1;

        case DRAW_BACKGROUND1:
            if(!Bar(pPict->hdr.left + 1, pPict->hdr.top + 1, pPict->hdr.right - 1, postop -
1))
                return (0);
            state = DRAW_BACKGROUND2;

        case DRAW_BACKGROUND2:
            if(!Bar(pPict->hdr.left + 1, posbottom, pPict->hdr.right - 1, pPict->hdr.bottom
- 1))
                return (0);
            state = DRAW_BACKGROUND3;

        case DRAW_BACKGROUND3:
            if(!Bar(pPict->hdr.left + 1, postop, posleft - 1, posbottom))
                return (0);
            state = DRAW_BACKGROUND4;

        case DRAW_BACKGROUND4:
            if(!Bar(posright, postop, pPict->hdr.right - 1, posbottom))
                return (0);
            state = DRAW_FRAME;

        case DRAW_FRAME:
            if(GetState(pPict, PICT_FRAME))
            {
                SetLineType(SOLID_LINE);
                SetColor(pPict->hdr.pGolScheme->TextColor0);
                if(!Rectangle(pPict->hdr.left, pPict->hdr.top, pPict->hdr.right,
pPict->hdr.bottom))
                    return (0);
            }

            state = REMOVE;
            return (1);
    }

    return (1);
}

#endif // USE_PICTURE
```

14.1.27 Picture.h

Functions

	Name	Description
	PictCreate (see page 226)	This function creates a PICTURE (see page 231) object with the parameters given. It automatically attaches the new object into a global linked list of objects and returns the address of the object.
	PictDraw (see page 227)	This function renders the object on the screen using the current parameter settings. Location of the object is determined by the left, top, right and bottom parameters. The colors used are dependent on the state of the object. When rendering objects of the same type, each object must be rendered completely before the rendering of the next object is started. This is to avoid incomplete object rendering.
	PictTranslateMsg (see page 230)	This function evaluates the message from a user if the message will affect the object or not. The table below enumerates the translated messages for each event accepted by the PICTURE (see page 231) Object.

Macros

Name	Description
PICT_DISABLED (see page 225)	Bit to indicate Picture (see page 224) is in a disabled state.
PICT_DRAW (see page 226)	Bit to indicate Picture (see page 224) will be redrawn.
PICT_FRAME (see page 226)	Bit to indicate Picture (see page 224) has a frame.
PICT_HIDE (see page 226)	Bit to indicate Picture (see page 224) must be hidden.
PictGetBitmap (see page 229)	This macro returns the pointer to the bitmap used in the object.
PictGetScale (see page 229)	This macro returns the current scale factor used to render the bitmap.
PictSetBitmap (see page 228)	This macro sets the bitmap used in the object.
PictSetScale (see page 230)	This macro sets the scale factor used to render the bitmap used in the object.

Structures

Name	Description
PICTURE (see page 231)	The structure contains data for picture control

Description

This is file Picture.h.

Body Source

```
/*****************************************************************************
 *  Module for Microchip Graphics Library
 *  GOL Layer
 *  Picture control
 *****************************************************************************
 * FileName:        Picture.h
 * Processor:       PIC24F, PIC24H, dsPIC, PIC32
 * Compiler:        MPLAB C30, MPLAB C32
 * Company:         Microchip Technology Incorporated
 *
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 * CLAIMS BY THIRD PARTIES (INCLUDING BUT NOT LIMITED TO ANY DEFENSE THEREOF),
 * OR OTHER SIMILAR COSTS.
 *
 * Date         Comment
 *~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
 * 11/12/07     Version 1.0 release
 * 03/09/11     Removed compile warnings
 *****************************************************************************/
#ifndef _PICTURE_H
    #define _PICTURE_H

    #include <Graphics/GOL.h>
    #include "GenericTypeDefs.h"
```

```
/*********************************************************************
* Object States Definition:
*********************************************************************/
    #define PICT_DISABLED   0x0002  // Bit to indicate Picture is in a disabled state.
    #define PICT_FRAME      0x0004  // Bit to indicate Picture has a frame.
    #define PICT_HIDE       0x8000  // Bit to indicate Picture must be hidden.
    #define PICT_DRAW       0x4000  // Bit to indicate Picture will be redrawn.

/*****************************************************************************
 * Overview: The structure contains data for picture control
 *****************************************************************************/
typedef struct
{
    OBJ_HEADER  hdr;        // Generic header for all Objects (see OBJ_HEADER).
    char        scale;      // Scale factor for the bitmap
    void        *pBitmap;   // Pointer to the bitmap
} PICTURE;

/*********************************************************************
* Macros:  PictGetBitmap(pPict)
*
* Overview: This macro returns the pointer to the bitmap used in the object.
*
* PreCondition: none
*
* Input: pPict - Pointer to the object
*
* Output: Returns the pointer to the bitmap used.
*
* Side Effects: none
*
********************************************************************/
    #define PictGetBitmap(pPict)            ((PICTURE*)pPict)->pBitmap

/*********************************************************************
* Macros:  PictSetBitmap(pPict,pBtMap)
*
* Overview: This macro sets the bitmap used in the object.
*
* PreCondition: none
*
* Input: pPict - Pointer to the object
*        pBtMap - Pointer to the bitmap to be used
*
* Output: none
*
* Side Effects: none
*
********************************************************************/
    #define PictSetBitmap(pPict, pBtmap)    ((PICTURE*)pPict)->pBitmap = pBtmap


/*********************************************************************
* Macros:  PictSetScale(pPict,scl)
*
* Overview: This macro sets the scale factor used to render the
*           bitmap used in the object.
*
* PreCondition: none
*
* Input: pPict - Pointer to the object
*        scl   - The scale factor that will be used to display the
*                bitmap.
*
* Output: none
*
* Side Effects: none
*
********************************************************************/
    #define PictSetScale(pPict, scl)    pPict->scale = scl

/*********************************************************************
```

```
* Macros:  PictGetScale(pPict,scl)
*
* Overview: This macro returns the current scale factor used to
*           render the bitmap.
*
* PreCondition: none
*
* Input: pPict - Pointer to the object
*
* Output: Returns the current scale factor used to display the
*         bitmap.
*
* Side Effects: none
*
********************************************************************/
    #define PictGetScale(pPict) pPict->scale

/*********************************************************************
* Function: PICTURE  *PictCreate(WORD ID, SHORT left, SHORT top, SHORT right,
*                                SHORT bottom, WORD state, char scale,
*                                void *pBitmap, GOL_SCHEME *pScheme)
*
* Overview: This function creates a PICTURE object with the parameters given.
*           It automatically attaches the new object into a global linked list of
*           objects and returns the address of the object.
*
* PreCondition: none
*
* Input: ID - Unique user defined ID for the object instance.
*        left - Left most position of the Object.
*        top - Top most position of the Object.
*        right - Right most position of the Object.
*        bottom - Bottom most position of the object.
*        radius - Radius of the rounded edge.
*        state - Sets the initial state of the object.
*        scale - Sets the scale factor used to render the bitmap.
*        pBitmap - Pointer to the bitmap that will be used.
*        pScheme - Pointer to the style scheme
*
* Output: Returns the pointer to the object created
*
* Side Effects: none
*
********************************************************************/
PICTURE * PictCreate
    (
        WORD ID, SHORT left, SHORT top, SHORT right, SHORT bottom, WORD state, char scale,
void *pBitmap, GOL_SCHEME *
        pScheme
    );

/*********************************************************************
* Function: WORD PictTranslateMsg(void *pObj, GOL_MSG *pMsg)
*
* Overview: This function evaluates the message from a user if the
*           message will affect the object or not. The table below
*           enumerates the translated messages for each event
*           accepted by the PICTURE Object.
*
*   <TABLE>
*       Translated Message   Input Source  Events
Description
*       ##################   ############  ######
###########
*       PICT_MSG_SELECTED    Touch Screen  EVENT_PRESS, EVENT_RELEASE, EVENT_MOVE   If
events occurs and the x,y position falls in the area of the picture.
*       OBJ_MSG_INVALID      Any           Any                                      If the
message did not affect the object.
*   </TABLE>
*
* PreCondition: none
*
```

```
* Input: pPict - The pointer to the object where the message will be
*                evaluated to check if the message will affect the object.
*        pMsg  - Pointer to the message struct containing the message from
*                the user interface.
*
* Output: Returns the translated message depending on the received GOL message:
*         - PICT_MSG_SELECTED – Picture is touched.
*         - OBJ_MSG_INVALID – Picture is not affected
*
* Side Effects: none
*
********************************************************************/
WORD    PictTranslateMsg(void *pObj, GOL_MSG *pMsg);

/*********************************************************************
* Function: WORD PictDraw(void *pObj)
*
* Overview: This function renders the object on the screen using
*           the current parameter settings. Location of the object is
*           determined by the left, top, right and bottom parameters.
*           The colors used are dependent on the state of the object.
*
*           When rendering objects of the same type, each object
*           must be rendered completely before the rendering of the
*           next object is started. This is to avoid incomplete
*           object rendering.
*
* PreCondition: Object must be created before this function is called.
*
* Input: pPict - Pointer to the object to be rendered.
*
* Output: Returns the status of the drawing
*         - 1 - If the rendering was completed and
*         - 0 - If the rendering is not yet finished.
*         Next call to the function will resume the
*         rendering on the pending drawing state.
*
* Side Effects: none
*
********************************************************************/
WORD PictDraw(void *pObj);
#endif // _PICTURE_H
```

14.1.28 ProgressBar.c

This is file ProgressBar.c.

Body Source

```
/*****************************************************************************
 *  Module for Microchip Graphics Library
 *  GOL Layer
 *  Progress Bar
 *****************************************************************************
 * FileName:        ProgressBar.c
 * Dependencies:    Graphics.h
 * Processor:       PIC24F, PIC24H, dsPIC, PIC32
 * Compiler:        MPLAB C30 V3.00, MPLAB C32
 * Linker:          MPLAB LINK30, MPLAB LINK32
 * Company:         Microchip Technology Incorporated
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 * OR OTHER SIMILAR COSTS.
 *
 * Author               Date        Comment
 *~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
 * Anton Alkhimenok     11/12/07    Version 1.0 release
 *****************************************************************************/
#include "Graphics/Graphics.h"

#ifdef USE_PROGRESSBAR

/*********************************************************************
* Function: void PbWordToString(WORD value, XCHAR* buffer)
*
* Input: value  - value to be converted (from 0 - 100)
*        buffer - buffer receiving string (must be at least 5 bytes)
*
* Output: none
*
* Overview: converts SHORT into string with % at the end
*
********************************************************************/
void PbWordToString(WORD value, XCHAR *buffer)
{
    WORD    result;
    BYTE    pos;

    if(value > 99)
    {
        buffer[0] = '1';
        buffer[1] = '0';
        buffer[2] = '0';
        buffer[3] = '%';
        buffer[4] = 0;
        return;
    }

    pos = 0;
    result = value / 10;
    if(result)
        buffer[pos++] = result + '0';
    result = value - 10 * result;

    buffer[pos++] = result + '0';
    buffer[pos++] = '%';
    buffer[pos++] = 0;
}

/*********************************************************************
* Function: PROGRESSBAR  *PbCreate(WORD ID, SHORT left, SHORT top, SHORT right,
*                                 SHORT bottom, WORD state, WORD pos, WORD range,
*                                 GOL_SCHEME *pScheme)
*
* Overview: creates the progress bar
*
********************************************************************/
PROGRESSBAR *PbCreate
(
```

```
    WORD        ID,
    SHORT       left,
    SHORT       top,
    SHORT       right,
    SHORT       bottom,
    WORD        state,
    WORD        pos,
    WORD        range,
    GOL_SCHEME  *pScheme
)
{
    PROGRESSBAR *pPb = NULL;

    pPb = (PROGRESSBAR *)GFX_malloc(sizeof(PROGRESSBAR));
    if(pPb == NULL)
        return (pPb);

    pPb->hdr.ID         = ID;
    pPb->hdr.pNxtObj    = NULL;
    pPb->hdr.type       = OBJ_PROGRESSBAR;
    pPb->hdr.left       = left;
    pPb->hdr.top        = top;
    pPb->hdr.right      = right;
    pPb->hdr.bottom     = bottom;
    pPb->pos            = pos;
    pPb->range          = (range == 0) ? 100 : range;
    pPb->prevPos        = 0;
    pPb->hdr.state      = state;
    pPb->hdr.DrawObj    = PbDraw;   // draw function
    pPb->hdr.MsgObj     = NULL;     // message function
    pPb->hdr.MsgDefaultObj = NULL;  // default message function
    pPb->hdr.FreeObj    = NULL;     // free function

    // Set the style scheme to be used
    if(pScheme == NULL)
        pPb->hdr.pGolScheme = _pDefaultGolScheme;
    else
        pPb->hdr.pGolScheme = (GOL_SCHEME *)pScheme;

    GOLAddObject((OBJ_HEADER *)pPb);

    return (pPb);
}

/*********************************************************************
* Function: void PbSetPos(PROGRESSBAR *pPb, SHORT position)
*
* Overview: sets the current position of the progress bar
*
********************************************************************/
void PbSetPos(PROGRESSBAR *pPb, WORD position)
{
    if(pPb->range < position)
        position = pPb->range;

    pPb->pos = position;
}

/*********************************************************************
* Function: void PbSetRange(PROGRESSBAR *pPb, WORD range)
*
* Overview: sets the range of the progress bar
*
********************************************************************/
void PbSetRange(PROGRESSBAR *pPb, WORD range)
{

    // range cannot be assigned a zero value
    if(range != 0)
        pPb->range = range;
    pPb->pos = range;
    pPb->prevPos = 0;
```

```
}

/*********************************************************************
* Function: WORD PbTranslateMsg(PROGRESSBAR *pPb, GOL_MSG *pMsg)
*
* Overview: translates the GOL message for the progress bar
*
********************************************************************/
WORD PbTranslateMsg(PROGRESSBAR *pPb, GOL_MSG *pMsg)
{

    // Evaluate if the message is for the progress bar
    // Check if disabled first
    if(GetState(pPb, PB_DISABLED))
        return (OBJ_MSG_INVALID);

        #ifdef USE_TOUCHSCREEN
    if(pMsg->type == TYPE_TOUCHSCREEN)
    {

        // Check if it falls in the progress bar border
        if
        (
            (pPb->hdr.left < pMsg->param1) &&
            (pPb->hdr.right > pMsg->param1) &&
            (pPb->hdr.top < pMsg->param2) &&
            (pPb->hdr.bottom > pMsg->param2)
        )
        {
            return (PB_MSG_SELECTED);
        }
    }

        #endif
    return (OBJ_MSG_INVALID);
}

/*********************************************************************
* Function: WORD PbDraw(void *pObj)
*
* Output: returns the status of the drawing
*         0 - not complete
*         1 - done
*
* Overview: draws progress bar
*
********************************************************************/
WORD PbDraw(void *pObj)
{
    typedef enum
    {
        REMOVE,
        BOX_DRAW,
        RUN_DRAW,
        BAR_DRAW,
        TEXT_DRAW1,
        TEXT_DRAW2,
        TEXT_DRAW3
    } PB_DRAW_STATES;

    static PB_DRAW_STATES state = REMOVE;
    static DWORD x1;
    static DWORD x2;
    static XCHAR text[5] = {'0','0','%',0};
    PROGRESSBAR *pPb;

    pPb = (PROGRESSBAR *)pObj;

    if(IsDeviceBusy())
        return (0);

    switch(state)
    {
        case REMOVE:
            if(GetState(pPb, PB_HIDE))
            {
                SetColor(pPb->hdr.pGolScheme->CommonBkColor);
                if(!Bar(pPb->hdr.left, pPb->hdr.top, pPb->hdr.right, pPb->hdr.bottom))
                    return (0);
                return (1);
            }

            state = BOX_DRAW;

        case BOX_DRAW:
            if(GetState(pPb, PB_DRAW))
            {
                GOLPanelDraw
                (
                    pPb->hdr.left,
                    pPb->hdr.top,
                    pPb->hdr.right,
                    pPb->hdr.bottom,
                    0,
                    pPb->hdr.pGolScheme->Color0,
                    pPb->hdr.pGolScheme->EmbossDkColor,
                    pPb->hdr.pGolScheme->EmbossLtColor,
                    NULL,
                    GOL_EMBOSS_SIZE
                );

                state = RUN_DRAW;

            case RUN_DRAW:
                if(!GOLPanelDrawTsk())
                    return (0);
            }

            state = BAR_DRAW;

        case BAR_DRAW:
            if(GetState(pPb, PB_VERTICAL))
            {
                x2 = ((DWORD) (pPb->range-pPb->pos)) * (pPb->hdr.bottom - pPb->hdr.top - (2
  * GOL_EMBOSS_SIZE)) / pPb->range;
                x1 = ((DWORD) (pPb->range-pPb->prevPos)) * (pPb->hdr.bottom - pPb->hdr.top
  - (2 * GOL_EMBOSS_SIZE)) / pPb->range;
                x1 += (pPb->hdr.top + GOL_EMBOSS_SIZE);
                x2 += (pPb->hdr.top + GOL_EMBOSS_SIZE);
            }
            else
            {
                x1 = ((DWORD) pPb->pos) * (pPb->hdr.right - pPb->hdr.left - (2 *
  GOL_EMBOSS_SIZE)) / pPb->range;
                x2 = ((DWORD) pPb->prevPos) * (pPb->hdr.right - pPb->hdr.left - (2 *
  GOL_EMBOSS_SIZE)) / pPb->range;
                x1 += (pPb->hdr.left + GOL_EMBOSS_SIZE);
                x2 += (pPb->hdr.left + GOL_EMBOSS_SIZE);
            }

            if(pPb->prevPos > pPb->pos)
            {
                SetColor(pPb->hdr.pGolScheme->Color0);
                if(GetState(pPb, PB_VERTICAL))
                {
                    if(!Bar(pPb->hdr.left + GOL_EMBOSS_SIZE, x1, pPb->hdr.right -
  GOL_EMBOSS_SIZE, x2))
                        return (0);
                }
                else
                {
                    if(!Bar(x1, pPb->hdr.top + GOL_EMBOSS_SIZE, x2, pPb->hdr.bottom -
  GOL_EMBOSS_SIZE))
                        return (0);
                }
            }
            else
            {
                SetColor(pPb->hdr.pGolScheme->Color1);
                if(GetState(pPb, PB_VERTICAL))
                {
                    if(!Bar(pPb->hdr.left + GOL_EMBOSS_SIZE, x2, pPb->hdr.right -
GOL_EMBOSS_SIZE, x1))
                        return (0);
                }
                else
                {
                    if(!Bar(x2, pPb->hdr.top + GOL_EMBOSS_SIZE, x1, pPb->hdr.bottom -
GOL_EMBOSS_SIZE))
                        return (0);
                }
            }

            state = TEXT_DRAW1;

        case TEXT_DRAW1:
            if(GetState(pPb, PB_VERTICAL))
            {
                SetColor(pPb->hdr.pGolScheme->Color0);
                if
                (
                    !Bar
                        (
                            pPb->hdr.left + GOL_EMBOSS_SIZE,
                            (pPb->hdr.top + pPb->hdr.bottom -
GetTextHeight(pPb->hdr.pGolScheme->pFont)) >> 1,
                            pPb->hdr.right - GOL_EMBOSS_SIZE,
                            x2
                        )
                ) return (0);
            }
            else
            {
                SetColor(pPb->hdr.pGolScheme->Color1);
                if
                (
                    !Bar
                        (
                            (pPb->hdr.left + pPb->hdr.right - GetTextWidth(text,
pPb->hdr.pGolScheme->pFont)) >> 1,
                            pPb->hdr.top + GOL_EMBOSS_SIZE,
                            x1,
                            pPb->hdr.bottom - GOL_EMBOSS_SIZE
                        )
                ) return (0);
            }

            state = TEXT_DRAW2;

        case TEXT_DRAW2:
            if(GetState(pPb, PB_VERTICAL))
            {
                SetColor(pPb->hdr.pGolScheme->Color1);
                if
                (
                    !Bar
                        (
                            pPb->hdr.left + GOL_EMBOSS_SIZE,
                            x2,
                            pPb->hdr.right - GOL_EMBOSS_SIZE,
                            (pPb->hdr.top + pPb->hdr.bottom +
GetTextHeight(pPb->hdr.pGolScheme->pFont)) >> 1
                        )
                ) return (0);
            }
            else
            {
                SetColor(pPb->hdr.pGolScheme->Color0);
                if
                (
                    !Bar
                        (
                            x1,
                            pPb->hdr.top + GOL_EMBOSS_SIZE,
                            (pPb->hdr.left + pPb->hdr.right + GetTextWidth(text,
pPb->hdr.pGolScheme->pFont)) >> 1,
                            pPb->hdr.bottom - GOL_EMBOSS_SIZE
                        )
                ) return (0);
            }

            PbWordToString((DWORD) pPb->pos * 100 / pPb->range, text);
            SetColor(pPb->hdr.pGolScheme->TextColor0);

            MoveTo
            (
                (pPb->hdr.left + pPb->hdr.right - GetTextWidth(text,
pPb->hdr.pGolScheme->pFont)) >> 1,
                (pPb->hdr.top + pPb->hdr.bottom -
GetTextHeight(pPb->hdr.pGolScheme->pFont)) >> 1
            );

            SetFont(pPb->hdr.pGolScheme->pFont);
            state = TEXT_DRAW3;

        case TEXT_DRAW3:
            if(!OutText(text))
                return (0);

            pPb->prevPos = pPb->pos;
            state = REMOVE;
            return (1);
    }

    return (1);
}

#endif // USE_PROGRESSBAR
```

14.1.29 ProgressBar.h

Functions

	Name	Description
	PbCreate (see page 234)	This function creates a PROGRESSBAR (see page 240) object with the parameters given. It automatically attaches the new object into a global linked list of objects and returns the address of the object.
	PbDraw (see page 235)	This function renders the object on the screen using the current parameter settings. Location of the object is determined by the left, top, right and bottom parameters. The colors used are dependent on the state of the object. The font used is determined by the style scheme set. When rendering objects of the same type, each object must be rendered completely before the rendering of the next object is started. This is to avoid incomplete object rendering.
	PbSetPos (see page 237)	This function sets the position of the progress bar. Position should be in the given range inclusive.
	PbSetRange (see page 236)	This function sets the range of the progress bar. Calling this function also resets the position equal to the new range value.

	PbTranslateMsg (see page 239)	This function evaluates the message from a user if the message will affect the object or not. The table below enumerates the translated messages for each event of the touch screen inputs.

Macros

Name	Description
PB_DISABLED (see page 233)	Bit to indicate Progress Bar (see page 371) is in a disabled state.
PB_DRAW (see page 233)	Bit to indicate Progress Bar (see page 371) must be redrawn.
PB_DRAW_BAR (see page 234)	Bit to indicate Progress Bar (see page 371) must be redrawn.
PB_HIDE (see page 234)	Bit to indicate Progress Bar (see page 371) must be hidden.
PB_VERTICAL (see page 234)	Bit for orientation (0 - horizontal, 1 - vertical)
PbGetPos (see page 238)	This macro returns the current progress bar position.
PbGetRange (see page 237)	This macro returns the current range of the progress bar.

Structures

Name	Description
PROGRESSBAR (see page 240)	The structure contains data for the progress bar

Description

This is file ProgressBar.h.

Body Source

```
/*****************************************************************************
 *  Module for Microchip Graphics Library
 *  GOL Layer
 *  Progress Bar
 *****************************************************************************
 * FileName:        ProgressBar.h
 * Dependencies:    None
 * Processor:       PIC24F, PIC24H, dsPIC, PIC32
 * Compiler:        MPLAB C30, MPLAB C32
 * Linker:          MPLAB LINK30 MPLAB LINK32
 * Company:         Microchip Technology Incorporated
 *
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 * CLAIMS BY THIRD PARTIES (INCLUDING BUT NOT LIMITED TO ANY DEFENSE THEREOF),
 * OR OTHER SIMILAR COSTS.
 *
 * Date         Comment
 *~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
 * 11/12/07     Version 1.0 release
 *****************************************************************************/
#ifndef _PROGRESSBAR_H
    #define _PROGRESSBAR_H
```

```
    #include <Graphics/GOL.h>
    #include "GenericTypeDefs.h"

/*********************************************************************
* Object States Definition:
*********************************************************************/
    #define PB_DISABLED 0x0002  // Bit to indicate Progress Bar is in a disabled state.
    #define PB_VERTICAL 0x0004  // Bit for orientation  (0 - horizontal, 1 - vertical)
    #define PB_HIDE     0x8000  // Bit to indicate Progress Bar must be hidden.
    #define PB_DRAW_BAR 0x2000  // Bit to indicate Progress Bar must be redrawn.
    #define PB_DRAW     0x4000  // Bit to indicate Progress Bar must be redrawn.

/*****************************************************************************
 * Overview: The structure contains data for the progress bar
 *****************************************************************************/
typedef struct
{
    OBJ_HEADER  hdr;        // Generic header for all Objects (see OBJ_HEADER).
    WORD        pos;        // Current progress position.
    WORD        prevPos;    // Previous progress position.
    WORD        range;      // Sets the range of the object.
} PROGRESSBAR;

/*********************************************************************
* Macros:  PbGetPos(pPb)
*
* Overview: This macro returns the current progress bar position.
*
* PreCondition: none
*
* Input: pPb - Pointer to the object
*
* Output: Returns the progress bar position.
*
* Example:
*   See PbSetPos() exmaple.
*
* Side Effects: none
*
********************************************************************/
    #define PbGetPos(pPb)   pPb->pos

/*********************************************************************
* Function: void PbSetPos(PROGRESSBAR *pPb, WORD position)
*
* Overview: This function sets the position of the progress bar.
*           Position should be in the given range inclusive.
*
* PreCondition: none
*
* Input: pPb - Pointer to the object
*        position - New position.
*
* Output: none
*
* Example:
*   <CODE>
*   PROGRESSBAR *pPb;
*   BYTE  direction = 1;
*
*       // this code increments and decrements the progress bar by 1
*       // assume progress bar was created and initialized before
*       while (1) {
*           if(direction) {
*               if(pPb ->pos == pPb ->range)
*                   direction = 0;
*               else
*                   PbSetPos(pPb,PbGetPos(pPb)+1);
*           } else {
*               if(pPb ->pos == 0)
*                   direction = 1;
*               else
*                   PbSetPos(pPb,PbGetPos(pPb)-1);
*           }
*       }
*   </CODE>
*
* Side Effects: none
*
********************************************************************/
void        PbSetPos(PROGRESSBAR *pPb, WORD position);

/*********************************************************************
* Function: PROGRESSBAR  *PbCreate( WORD ID, SHORT left, SHORT top,
*                                   SHORT right, SHORT bottom, WORD state,
*                                   WORD pos, WORD range, GOL_SCHEME *pScheme)
*
* Overview: This function creates a PROGRESSBAR object with the parameters
*           given. It automatically attaches the new object into a global
*           linked list of objects and returns the address of the object.
*
* PreCondition: none
*
* Input: ID - Unique user defined ID for the object instance.
*        left - Left most position of the Object.
*        top - Top most position of the Object.
*        right - Right most position of the Object.
*        bottom - Bottom most position of the Object.
*        state - Sets the initial state of the Object.
*        pos - Defines the initial position of the progress.
*        range - This specifies the maximum value of the progress
*                bar when the progress bar is at 100% position.
*        pScheme - Pointer to the style scheme used for the object.
*                  Set to NULL if default style scheme is used.
*
* Output: Returns the pointer to the object created
*
* Example:
*   <CODE>
*   PROGRESSBAR *pPBar;
*   void CreateProgressBar(){
*       pPBar = PbCreate(ID_PROGRESSBAR1,    // ID
*                        50,90,270,140,      // dimension
*                        PB_DRAW,            // Draw the object
*                        25,                 // position
*                        50,                 // set the range
*                        NULL);              // use default GOL scheme
*       while(!PbDraw(pPBar));
*   }
*   </CODE>
*
* Side Effects: none
*
********************************************************************/
PROGRESSBAR *PbCreate
            (
                WORD        ID,
                SHORT       left,
                SHORT       top,
                SHORT       right,
                SHORT       bottom,
                WORD        state,
                WORD        pos,
                WORD        range,
                GOL_SCHEME  *pScheme
            );

/*********************************************************************
* Function: WORD PbTranslateMsg(PROGRESSBAR *pPb, GOL_MSG *pMsg)
*
* Overview: This function evaluates the message from a user if the
*           message will affect the object or not. The table below
*           enumerates the translated messages for each event of
```

```
 *           the touch screen inputs.
 *
 *   <TABLE>
 *       Translated Message   Input Source  Events
Description
 *       ##################   ############  ######
###########
 *       PB_MSG_SELECTED      Touch Screen  EVENT_PRESS, EVENT_RELEASE, EVENT_MOVE   If
events occurs and the x,y position falls in the area of the progress bar.
 *       OBJ_MSG_INVALID      Any           Any                                      If the
message did not affect the object.
 *   </TABLE>
 *
 * PreCondition: none
 *
 * Input: pPb   - The pointer to the object where the message will be
 *                evaluated to check if the message will affect the object.
 *         pMsg  - Pointer to the message struct containing the message from
 *                the user interface.
 *
 * Output: Returns the translated message depending on the received GOL message:
 *         - PB_MSG_SELECTED – Progress Bar is selected.
 *         - OBJ_MSG_INVALID – Progress Bar is not affected
 *
 * Example:
 *   Usage is similar to BtnTranslateMsg() example.
 *
 * Side Effects: none
 *
********************************************************************/
WORD        PbTranslateMsg(PROGRESSBAR *pPb, GOL_MSG *pMsg);

/*********************************************************************
 * Function: WORD PbDraw(void *pObj)
 *
 * Overview: This function renders the object on the screen using
 *           the current parameter settings. Location of the object is
 *           determined by the left, top, right and bottom parameters.
 *           The colors used are dependent on the state of the object.
 *           The font used is determined by the style scheme set.
 *
 *           When rendering objects of the same type, each object
 *           must be rendered completely before the rendering of the
 *           next object is started. This is to avoid incomplete
 *           object rendering.
 *
 * PreCondition: Object must be created before this function is called.
 *
 * Input: pPb - Pointer to the object to be rendered.
 *
 * Output: Returns the status of the drawing
 *          - 1 - If the rendering was completed and
 *          - 0 - If the rendering is not yet finished.
 *          Next call to the function will resume the
 *          rendering on the pending drawing state.
 *
 * Example:
 *   See PbCreate() example.
 *
 * Side Effects: none
 *
********************************************************************/
WORD PbDraw(void *pObj);

/*********************************************************************
 * Function:  PbSetRange(PROGRESSBAR *pPb, WORD range)
 *
 * Overview: This function sets the range of the progress bar. Calling
 *           this function also resets the position equal to the new
 *           range value.
 *
 * PreCondition: none
```

```
*
* Input: pPb - Pointer to the object
*
* Output: none.
*
* Side Effects: Sets the position equal to the new range.
*
********************************************************************/
void        PbSetRange(PROGRESSBAR *pPb, WORD range);

/*********************************************************************
* Macros:  PbGetRange(pPb)
*
* Overview: This macro returns the current range of the progress bar.
*
* PreCondition: none
*
* Input: pPb - Pointer to the object
*
* Output: Returns the range value.
*
* Side Effects: none
*
********************************************************************/
    #define PbGetRange(pPb) (pPb->range)
#endif // _PROGRESSBAR_H
```

14.1.30 RoundDial.c

This is file RoundDial.c.

Body Source

```
/*****************************************************************************
 *  Module for Microchip Graphics Library
 *  GOL Layer
 *  Round Dial
 *****************************************************************************
 * FileName:        RoundDial.c
 * Dependencies:    math.h
 * Processor:       PIC24F, PIC24H, dsPIC, PIC32
 * Compiler:        MPLAB C30 Version 3.00, MPLAB C32
 * Linker:          MPLAB LINK30, MPLAB LINK32
 * Company:         Microchip Technology Incorporated
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 * OR OTHER SIMILAR COSTS.
```

```
  *
  * Date         Comment
  *~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
  * 11/12/07     Version 1.0 release
  * 12/03/09     Added Object Header for Double Buffering Support
  * 11/15/10     Fixed build error when USE_KEYBOARD is not defined
  * 04/20/11     Fixed KEYBOARD bug on object ID and GOL_MSG param1 comparison.
  *****************************************************************************/
#include "Graphics/Graphics.h"
#include <math.h>

#ifdef USE_ROUNDDIAL

/*********************************************************************
* Function: ROUNDDIAL  *RdiaCreate( WORD ID, SHORT x, SHORT y, SHORT radius,
*                       WORD state, SHORT res, SHORT value, SHORT max,
*                       GOL_SCHEME *pScheme)
*
*
* Notes: Creates a ROUNDDIAL object and adds it to the current active list.
*        If the creation is successful, the pointer to the created Object
*        is returned. If not successful, NULL is returned.
*
********************************************************************/
ROUNDDIAL *RdiaCreate
(
    WORD        ID,
    SHORT       x,
    SHORT       y,
    SHORT       radius,
    WORD        state,
    SHORT       res,
    SHORT       value,
    SHORT       max,
    GOL_SCHEME  *pScheme
)
{
    ROUNDDIAL   *pDia = NULL;

    pDia = (ROUNDDIAL *)GFX_malloc(sizeof(ROUNDDIAL));
    if(pDia == NULL)
        return (NULL);

    pDia->hdr.ID = ID;              // unique id assigned for referencing
    pDia->hdr.pNxtObj = NULL;       // initialize pointer to NULL
    pDia->hdr.type = OBJ_ROUNDDIAL; // set object type
    pDia->xCenter = x;              // x coordinate of center
    pDia->yCenter = y;              // y coordinate of center
    pDia->radius = radius;          // radius of dial
    pDia->res = res;
    pDia->value = value;
    pDia->max = max;
    pDia->hdr.state = state;        // state
    #ifdef USE_KEYBOARD
    pDia->vAngle = 0;               // initial position
    #endif
    pDia->curr_xPos = x + radius * 2 / 3;
    pDia->curr_yPos = y;
    pDia->hdr.DrawObj = RdiaDraw;               // draw function
    pDia->hdr.MsgObj = RdiaTranslateMsg;        // message function
    pDia->hdr.MsgDefaultObj = RdiaMsgDefault;   // default message function
    pDia->hdr.FreeObj = NULL;                   // free function

    pDia->hdr.left = x - radius;    // left position
    pDia->hdr.top = y - radius;     // top position
    pDia->hdr.right = x + radius;   // right position
    pDia->hdr.bottom = y + radius;  // bottom position

    // Set the color scheme to be used
    if(pScheme == NULL)
        pDia->hdr.pGolScheme = _pDefaultGolScheme;
    else
```

```
        pDia->hdr.pGolScheme = (GOL_SCHEME *)pScheme;

    GOLAddObject((OBJ_HEADER *)pDia);

    return (pDia);
}

/*********************************************************************
* Function: RdiaMsgDefault(WORD translatedMsg, void *pObj, GOL_MSG* pMsg)
*
*
* Notes: This the default operation to change the state of the dial.
*        Called inside GOLMsg() when GOLMsgCallback() returns a 1.
*
********************************************************************/
void RdiaMsgDefault(WORD translatedMsg, void *pObj, GOL_MSG *pMsg)
{
    ROUNDDIAL *pDia;

    pDia = (ROUNDDIAL *)pObj;

    switch(translatedMsg)
    {
        case RD_MSG_CLOCKWISE:      SetState(pDia, RDIA_ROT_CW | RDIA_DRAW);    // set
rotate left and redraw
            break;
        case RD_MSG_CTR_CLOCKWISE:  SetState(pDia, RDIA_ROT_CCW | RDIA_DRAW);   // set
rotate right and redraw
            break;
    }
}

/*********************************************************************
* Function: SHORT RdiaCosine( SHORT v )
*
*
* Notes: Returns the cosine of the dial position.
*
********************************************************************/
    #ifdef USE_KEYBOARD

// Dimple position table for 15 degree increments
SHORT   _cosine[RDIA_QUADRANT_POSITIONS] = { 100, 97, 87, 71, 50, 26};

/* */
SHORT RdiaCosine(SHORT v)
{
    if(v >= RDIA_QUADRANT_POSITIONS * 3)
    {
        v -= RDIA_QUADRANT_POSITIONS * 3;
        return (_cosine[RDIA_QUADRANT_POSITIONS - 1 - v]);
    }
    else if(v >= RDIA_QUADRANT_POSITIONS * 2)
    {
        v -= RDIA_QUADRANT_POSITIONS * 2;
        return (-(_cosine[v]));
    }
    else if(v >= RDIA_QUADRANT_POSITIONS)
    {
        v -= RDIA_QUADRANT_POSITIONS;
        return (-(_cosine[RDIA_QUADRANT_POSITIONS - 1 - v]));
    }
    else
    {
        return (_cosine[v]);
    }
}

/*********************************************************************
* Function: SHORT RdiaSine( SHORT v )
*
*
```

```
* Notes: Returns the sine of the dial position.
*
********************************************************************/
SHORT RdiaSine(SHORT v)
{
    if(v >= RDIA_QUADRANT_POSITIONS * 3)
    {
        v -= RDIA_QUADRANT_POSITIONS * 3;
        return (-(_cosine[v]));
    }
    else if(v >= RDIA_QUADRANT_POSITIONS * 2)
    {
        v -= RDIA_QUADRANT_POSITIONS * 2;
        return (-(_cosine[RDIA_QUADRANT_POSITIONS - 1 - v]));
    }
    else if(v >= RDIA_QUADRANT_POSITIONS)
    {
        v -= RDIA_QUADRANT_POSITIONS;
        return (_cosine[v]);
    }
    else
    {
        return (_cosine[RDIA_QUADRANT_POSITIONS - 1 - v]);
    }
}
    #endif

/*********************************************************************
* Function: WORD RdiaTranslateMsg(void *pObj, GOL_MSG *pMsg)
*
*
* Notes: Evaluates the message if the object will be affected by the
*        message or not.
*
********************************************************************/
WORD RdiaTranslateMsg(void *pObj, GOL_MSG *pMsg)
{
    ROUNDDIAL *pDia;
    WORD      messageID = OBJ_MSG_INVALID;

    pDia = (ROUNDDIAL *)pObj;

        #ifdef USE_TOUCHSCREEN

    SHORT           touchRadius, touchX, touchY;
    static SHORT    prevX = -1, prevY = -1;

    // Evaluate if the message is for the button
    // Check if disabled first
    if(GetState(pDia, RDIA_DISABLED))
        return (OBJ_MSG_INVALID);

    if((pMsg->type == TYPE_TOUCHSCREEN) && (pMsg->uiEvent == EVENT_MOVE))
    {

        // Check if it falls in the dial's face
        // to check this the x,y position must be within the circle
        // (x - xCenter)^2 + (y - yCenter)^2 = r^2  where x and y are the points
        // to test, the distance between x,y position of touch and center must be
        // greater than or equal to the radius of the dial
        if
        (
            ((pDia->xCenter - pDia->radius) < pMsg->param1) &&
            ((pDia->xCenter + pDia->radius) > pMsg->param1) &&
            ((pDia->yCenter - pDia->radius) < pMsg->param2) &&
            ((pDia->yCenter + pDia->radius) > pMsg->param2)
        )
        {

            // first get the radius of the touch point
            touchX = pMsg->param1 - pDia->xCenter;
            touchY = pMsg->param2 - pDia->yCenter;
            touchRadius = sqrt(touchX * touchX + touchY * touchY);

            if(touchRadius <= pDia->radius)
            {

                // difference of 3 is used to remove jitter caused by noise or sensitivity
of the touchscreen
                if((abs(prevX - pMsg->param1) > 3) || (abs(prevY - pMsg->param2) > 3))
                {

                    // The first MOVE event is used to record the current position only.
The second MOVE event
                    // will be used together with the previous MOVE and determine if the
movement is in the
                    // clockwise or counter clockwise direction.
                    if((prevX == -1) || (prevY == -1))
                    {
                        prevX = pMsg->param1;
                        prevY = pMsg->param2;
                        messageID = OBJ_MSG_INVALID;
                    }
                    else
                    {

                        // this makes the sampling area a ring where the max radius is the
dial radius
                        // and min radius is 5
                        if(touchRadius > 5)
                        {
                            pDia->new_xPos = (pDia->radius * 2 / 3) * (pMsg->param1 -
pDia->xCenter) / touchRadius;
                            pDia->new_yPos = (pDia->radius * 2 / 3) * (pMsg->param2 -
pDia->yCenter) / touchRadius;

                            // check if moving in clockwise direction or counter clockwise
direction

                            if((pDia->xCenter >= pMsg->param1) && (pDia->yCenter >
pMsg->param2))

                            {
                                if((prevX < pMsg->param1) && (prevY >= pMsg->param2))
                                    messageID = RD_MSG_CLOCKWISE;
                                else if((prevX >= pMsg->param1) && (prevY < pMsg->param2))
                                    messageID = RD_MSG_CTR_CLOCKWISE;
                            }

                            if((pDia->xCenter < pMsg->param1) && (pDia->yCenter >
pMsg->param2))

                            {
                                if((prevX < pMsg->param1) && (prevY <= pMsg->param2))
                                    messageID = RD_MSG_CLOCKWISE;
                                else if((prevX >= pMsg->param1) && (prevY > pMsg->param2))
                                    messageID = RD_MSG_CTR_CLOCKWISE;
                            }

                            if((pDia->xCenter < pMsg->param1) && (pDia->yCenter <=
pMsg->param2))

                            {
                                if((prevX > pMsg->param1) && (prevY <= pMsg->param2))
                                    messageID = RD_MSG_CLOCKWISE;
                                else if((prevX <= pMsg->param1) && (prevY > pMsg->param2))
                                    messageID = RD_MSG_CTR_CLOCKWISE;
                            }

                            if((pDia->xCenter >= pMsg->param1) && (pDia->yCenter <=
pMsg->param2))

                            {
                                if((prevX > pMsg->param1) && (prevY >= pMsg->param2))
                                    messageID = RD_MSG_CLOCKWISE;
                                else if((prevX <= pMsg->param1) && (prevY < pMsg->param2))
                                    messageID = RD_MSG_CTR_CLOCKWISE;
                            }
                        }
                        else
                            messageID = OBJ_MSG_INVALID;

                        prevX = pMsg->param1;
                        prevY = pMsg->param2;
                    }
                }
                else
                    messageID = OBJ_MSG_INVALID;

                // determine the movement clockwise or counter clockwise
                // this is important to update the value variable
                return (messageID);
            }
            else
            {
                prevX = -1;
                prevY = -1;
            }
        }
    }

        #endif
       #ifdef USE_KEYBOARD

    SHORT   newValue;

    // Evaluate if the message is for the Dial
    // Check if disabled first
    if(GetState(pDia, RDIA_DISABLED))
        return (OBJ_MSG_INVALID);

    if((pMsg->type == TYPE_KEYBOARD) && ((WORD)pMsg->param1 == pDia->hdr.ID) &&
(pMsg->uiEvent == EVENT_KEYSCAN))
    {
        if(pMsg->param2 == SCAN_RIGHT_PRESSED)
        {
            newValue = pDia->value + pDia->res;
            if(newValue > pDia->max)
            {
                newValue -= (pDia->max + 1);
            }

            pDia->vAngle += 1;
            messageID = RD_MSG_CLOCKWISE;
        }

        if(pMsg->param2 == SCAN_LEFT_PRESSED)
        {
            newValue = pDia->value - pDia->res;
            if(newValue < 0)
            {
                newValue += (pDia->max + 1);
            }

            pDia->vAngle -= 1;
            messageID = RD_MSG_CTR_CLOCKWISE;
        }

        if (pDia->vAngle > (RDIA_MAX_POSITIONS - 1))
            pDia->vAngle = 0;
        else if (pDia->vAngle < 0)
            pDia->vAngle = (RDIA_MAX_POSITIONS - 1);

        pDia->new_xPos = pDia->radius * 2 * RdiaCosine(pDia->vAngle) / 100 / 3;
        pDia->new_yPos = pDia->radius * 2 * RdiaSine(pDia->vAngle) / 100 / 3;
    }

        #endif
    return (messageID);
}
```

```
/*********************************************************************
* Function: WORD RdiaDraw(void *pObj)
*
*
* Notes: This is the state machine to draw the dial.
*
********************************************************************/
WORD RdiaDraw(void *pObj)
{
    typedef enum
    {
        REMOVE,
        RND_PANEL_DRAW,
        RND_PANEL_TASK,
        ERASE_POSITION,
        DRAW_POSITION
    } RDIA_DRAW_STATES;

    static RDIA_DRAW_STATES state = REMOVE;
    static SHORT dimpleRadius;
    WORD faceClr;
    ROUNDDIAL *pDia;

    pDia = (ROUNDDIAL *)pObj;

    switch(state)
    {
        case REMOVE:
            if(IsDeviceBusy())
                return (0);

            if(GetState(pDia, RDIA_HIDE))
            {   // Hide the dial (remove from screen)
                SetColor(pDia->hdr.pGolScheme->CommonBkColor);
                if
                (
                    !Bar
                        (
                            pDia->xCenter - pDia->radius,
                            pDia->yCenter - pDia->radius,
                            pDia->xCenter + pDia->radius,
                            pDia->yCenter + pDia->radius
                        )
                ) return (0);
                return (1);
            }

            dimpleRadius = (pDia->radius >> 3) + 1;

            if(GetState(pDia, RDIA_ROT_CCW | RDIA_ROT_CW))
            {
                state = ERASE_POSITION;
                goto erase_current_pos;
            }

            state = RND_PANEL_DRAW;

        case RND_PANEL_DRAW:
            if(!GetState(pDia, RDIA_DISABLED))
            {
                faceClr = pDia->hdr.pGolScheme->Color0;
            }
            else
            {
                faceClr = pDia->hdr.pGolScheme->ColorDisabled;
            }

            SetLineThickness(NORMAL_LINE);
            SetLineType(SOLID_LINE);
            GOLPanelDraw
            (
                pDia->xCenter,
                pDia->yCenter,
                pDia->xCenter,
                pDia->yCenter,
                pDia->radius,
                faceClr,
                pDia->hdr.pGolScheme->EmbossLtColor,
                pDia->hdr.pGolScheme->EmbossDkColor,
                NULL,
                GOL_EMBOSS_SIZE
            );
            state = RND_PANEL_TASK;

        case RND_PANEL_TASK:
            if(!GOLPanelDrawTsk())
            {
                return (0);
            }

            state = DRAW_POSITION;
            goto draw_current_pos;

        case ERASE_POSITION:
            erase_current_pos : SetColor(pDia->hdr.pGolScheme->Color0);
            if
            (
                !Bar
                    (
                        pDia->curr_xPos - dimpleRadius,
                        pDia->curr_yPos - dimpleRadius,
                        pDia->curr_xPos + dimpleRadius,
                        pDia->curr_yPos + dimpleRadius
                    )
            ) return (0);

            // determine if the value will increment or decrement
            if(GetState(pDia, RDIA_ROT_CW))
            {
                pDia->value = pDia->value + pDia->res;
                if(pDia->value > pDia->max)
                {
                    pDia->value -= (pDia->max + 1);
                }
            }
            else if(GetState(pDia, RDIA_ROT_CCW))
            {
                pDia->value = pDia->value - pDia->res;
                if(pDia->value < 0)
                {
                    pDia->value += (pDia->max + 1);
                }
            }

            // else do not update counter yet
            // locate the new position of the dimple
            pDia->curr_xPos = pDia->xCenter + pDia->new_xPos;
            pDia->curr_yPos = pDia->yCenter + pDia->new_yPos;

            ClrState(pDia, RDIA_ROT_CW | RDIA_ROT_CCW); // make sure this is cleared to
  avoid

            // unwanted redraw
            state = DRAW_POSITION;

        case DRAW_POSITION:
            draw_current_pos : if(IsDeviceBusy()) return (0);

            SetColor(pDia->hdr.pGolScheme->EmbossLtColor);
            SetLineThickness(NORMAL_LINE);
            SetLineType(SOLID_LINE);
            if(!Circle(pDia->curr_xPos, pDia->curr_yPos, dimpleRadius))
                return (0);
            SetColor(pDia->hdr.pGolScheme->EmbossDkColor);
            if(!FillCircle(pDia->curr_xPos, pDia->curr_yPos, dimpleRadius - 1))
                return (0);

            state = REMOVE;
            return (1);
    }

    return (1);
}

#endif // USE_ROUNDDIAL
```

14.1.31 RoundDial.h

Functions

	Name	Description
⇒	RdiaCreate (see page 141)	This function creates a ROUNDDIAL (see page 148) object with the parameters given. It automatically attaches the new object into a global linked list of objects and returns the address of the object.
⇒	RdiaDraw (see page 142)	This function renders the object on the screen using the current parameter settings. Location of the object is determined by the center (x,y) postion and the radius parameters. The colors used are dependent on the state of the object. When rendering objects of the same type, each object must be rendered completely before the rendering of the next object is started. This is to avoid incomplete object rendering.
⇒	RdiaMsgDefault (see page 146)	This function performs the actual state change based on the translated message given. The following state changes are supported:
⇒	RdiaTranslateMsg (see page 146)	This function evaluates the message from a user if the message will affect the object or not. The table below enumerates the translated messages for each event of the touch screen inputs.

Macros

Name	Description
RDIA_DISABLED (see page 140)	Bit for disabled state.
RDIA_DRAW (see page 140)	Bit to indicate object must be redrawn.
RDIA_HIDE (see page 140)	Bit to indicate object must be removed from screen.
RDIA_ROT_CCW (see page 141)	Bit for rotate counter clockwise state.
RDIA_ROT_CW (see page 141)	Bit for rotate clockwise state.
RdiaDecVal (see page 144)	Used to directly decrement the value. The delta change used is the resolution setting (res).
RdiaGetVal (see page 144)	Returns the current dial value. Value is always in the 0-max range inclusive.
RdiaIncVal (see page 143)	Used to directly increment the value. The delta change used is the resolution setting (res).
RdiaSetVal (see page 145)	Sets the value to the given new value. Value set must be in 0-max range inclusive.

Structures

Name	Description
ROUNDDIAL (see page 148)	Defines the parameters required for a dial Object. The curr_xPos, curr_yPos, new_xPos and new_yPos parameters are internally generated to aid in the redrawing of the dial. User must avoid modifying these values.

Description

This is file RoundDial.h.

Body Source

```
/*****************************************************************************
 *  Module for Microchip Graphics Library
 *  GOL Layer
 *  Round Dial
 *****************************************************************************
 * FileName:        RoundDial.h
 * Dependencies:    None
 * Processor:       PIC24F, PIC24H, dsPIC, PIC32
 * Compiler:        MPLAB C30, MPLAB C32
 * Linker:          MPLAB LINK30, MPLAB LINK32
 * Company:         Microchip Technology Incorporated
 *
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 * OR OTHER SIMILAR COSTS.
 *
 * Date             Comment
 *~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
 * 11/12/07         Version 1.0 release
 * 03/12/09         Added Object Header for Double Buffering Support
 * 11/15/10         Added new structure member for KEYBOARD support
 *****************************************************************************************/
#ifndef _ROUNDDIAL_H
    #define _ROUNDDIAL_H

    #include "GenericTypeDefs.h"
    #include "GraphicsConfig.h"
    #include "Graphics/GOL.h"
/*********************************************************************
* Object States Definition:
*********************************************************************/
    #define RDIA_DISABLED   0x0002  // Bit for disabled state.
    #define RDIA_ROT_CW     0x0004  // Bit for rotate clockwise state.
    #define RDIA_ROT_CCW    0x0008  // Bit for rotate counter clockwise state.
    #define RDIA_DRAW       0x4000  // Bit to indicate object must be redrawn.
    #define RDIA_HIDE       0x8000  // Bit to indicate object must be removed from screen.
#ifdef USE_KEYBOARD
    #define RDIA_QUADRANT_POSITIONS 6
    #define RDIA_MAX_POSITIONS      24
    extern SHORT    _cosine[RDIA_QUADRANT_POSITIONS];
    SHORT           RdiaCosine(SHORT v);
    SHORT           RdiaSine(SHORT v);
#endif

/*********************************************************************
* Overview: Defines the parameters required for a dial Object.
*           The curr_xPos, curr_yPos, new_xPos and new_yPos parameters
*           are internally generated to aid in the redrawing of the
*           dial. User must avoid modifying these values.
```

```
*
*********************************************************************/
typedef struct
{
    OBJ_HEADER      hdr;        // Generic header for all Objects (see OBJ_HEADER).
    SHORT           xCenter;        // x coordinate center position.
    SHORT           yCenter;        // y coordinate center position.
    SHORT           radius;         // Radius of the dial.
    SHORT           value;          // Initial value of the dial.
    WORD            max;            // Maximum value of variable value (maximum = 65535).

    // Minimum is always zero.
    WORD            res;            // Resolution of movement.
    SHORT           curr_xPos;      // Current x position.
    SHORT           curr_yPos;      // Current y position.
    SHORT           new_xPos;       // New x position.
    SHORT           new_yPos;       // New y position.
    #ifdef USE_KEYBOARD
    SHORT           vAngle;
    #endif
} ROUNDDIAL;

/*********************************************************************
* Function: ROUNDDIAL  *RdiaCreate( WORD ID, SHORT x, SHORT y, SHORT radius,
*                       WORD state, SHORT res, SHORT value, SHORT max,
*                       GOL_SCHEME *pScheme);
*
* Overview: This function creates a ROUNDDIAL object with the parameters given.
*           It automatically attaches the new object into a global linked list of
*           objects and returns the address of the object.
*
* PreCondition: none
*
* Input: ID - Unique user defined ID for the object instance.
*        x - Location of the center of the dial in the x coordinate.
*        y - Location of the center of the dial in the y coordinate.
*        radius - Defines the radius of the dial.
*        state - Sets the initial state of the object.
*        res - Sets the resolution of the dial when rotating clockwise or
*              counter clockwise.
*        value - Sets the initial value of the dial.
*        max - Sets the maximum value of the dial.
*        pScheme - Pointer to the style scheme used.
*
* Output: Returns the pointer to the object created.
*
* Example:
*   <CODE>
*   GOL_SCHEME *pScheme;
*   ROUNDDIAL *pDial;
*   WORD state;
*
*       pScheme = GOLCreateScheme();
*       state = RDIA_DRAW;
*
*       // creates a dial at (50,50) x,y location, with an initial value
*       // of 50, a resolution of 2 and maximum value of 100.
*       pDial = RdiaCreate(1,50,50,25,118,0, state, 2, 50, 100, pScheme);
*       // check if dial was created
*       if (pDial == NULL)
*          return 0;
*
*       return 1;
*   </CODE>
*
* Side Effects: none
*
********************************************************************/
ROUNDDIAL    *RdiaCreate
             (
                 WORD        ID,
                 SHORT       x,
                SHORT       y,
                SHORT       radius,
                WORD        state,
                SHORT       res,
                SHORT       value,
                SHORT       max,
                GOL_SCHEME  *pScheme
            );

/*********************************************************************
* Function: RdiaTranslateMsg(void *pObj, GOL_MSG *pMsg)
*
* Overview: This function evaluates the message from a user if the
*           message will affect the object or not. The table below enumerates the
translated
*           messages for each event of the touch screen inputs.
*
*   <TABLE>
*       Translated Message      Input Source  Events        Description
*       #####################   ############  ######        ###########
*       RD_MSG_CLOCKWISE        Touch Screen  EVENT_MOVE    If events occurs and the x,y
position falls in the face of the Dial and moving in the clockwise rotation.
*       RD_MSG_CTR_CLOCKWISE    Touch Screen  EVENT_MOVE    If events occurs and the x,y
position falls in the face of the Dial and moving in the counter clockwise
rotation.
*       OBJ_MSG_INVALID         Any           Any           If the message did not affect
the object.
*   </TABLE>
*
* PreCondition: none
*
* Input: pDia  - The pointer to the object where the message will be
*                evaluated to check if the message will affect the object.
*         pMsg  - Pointer to the message struct containing the message from
*                the user interface.
*
* Output: Returns the translated message depending on the received GOL message:
*         - RD_MSG_CLOCKWISE – Dial is moved in a clockwise direction.
*         - RD_MSG_CTR_CLOCKWISE – Dial is moved in a counter clockwise direction.
*         - OBJ_MSG_INVALID – Dial is not affected
*
* Example:
*   <CODE>
*   void MyGOLMsg(GOL_MSG *pMsg){
*
*       OBJ_HEADER *pCurrentObj;
*       WORD objMsg;
*
*       if(pMsg->event == EVENT_INVALID)
*           return;
*       pCurrentObj = GOLGetList();
*
*       while(pCurrentObj != NULL){
*           // Process only ROUNDDIAL
*           if(!IsObjUpdated(pCurrentObj)){
*               switch(pCurrentObj->type){
*                   case OBJ_ROUNDIAL:
*                       objMsg = RdiaTranslateMsg((ROUNDDIAL*)pCurrentObj, pMsg);
*                       if(objMsg == OBJ_MSG_INVALID)
*                           break;
*                       if(GOLMsgCallback(objMsg,pCurrentObj,pMsg))
*                           RdiaMsgDefault(objMsg,(ROUNDDIAL*)pCurrentObj);
*                       break;
*                   default: break;
*               }
*           }
*       }
*       pCurrentObj = pCurrentObj->pNxtObj;
*   }
*   </CODE>
*
* Side Effects: none
```

```
*
********************************************************************/
WORD        RdiaTranslateMsg(void *pObj, GOL_MSG *pMsg);

/*********************************************************************
* Function: RdiaMsgDefault(WORD translatedMsg, void *pObj, GOL_MSG* pMsg)
*
* Overview: This function performs the actual state change
*           based on the translated message given. The following state changes
*           are supported:
*   <TABLE>
*       Translated Message      Input Source    Set/Clear State Bit     Description
*       ##################      ############    ######                  ###########
*       RD_MSG_CLOCKWISE        Touch Screen    Set RDIA_ROT_CW,        Dial will be
redrawn with clockwise update.
*                                                Set RDIA_DRAW
*       RD_MSG_CTR_CLOCKWISE    Touch Screen    Set RDIA_ROT_CCW,       Dial will be
redrawn with counter clockwise update.
*                                                Set RDIA_DRAW
*   </TABLE>
*
* PreCondition: none
*
* Input: translatedMsg - The translated message
*        pDia          - The pointer to the object whose state will be modified
*        pMsg          - The pointer to the GOL message
*
* Output: none
*
* Example:
*   See RdiaTranslateMsg() example.
*
* Side Effects: none
*
********************************************************************/
void        RdiaMsgDefault(WORD translatedMsg, void *pObj, GOL_MSG *pMsg);

/*********************************************************************
* Macros:  RdiaGetVal(pDia)
*
* Overview: Returns the current dial value. Value is always
*           in the 0-max range inclusive.
*
* PreCondition: none
*
* Input: pDia - Pointer to the object.
*
* Output: Returns the current value of the dial.
*
* Example:
*   <CODE>
*   WORD currVal;
*   ROUNDDIAL *pDia;
*
*       // assuming pDia is initialized to an existing dial Object
*       currVal = RdiaGetVal(pDia);
*   </CODE>
*
* Side Effects: none
*
********************************************************************/
    #define RdiaGetVal(pDia)    (pDia)->value

/*********************************************************************
* Macros:  RdiaSetVal(pDia, newVal)
*
* Overview: Sets the value to the given new value. Value set must be in 0-max
*           range inclusive.
*
* PreCondition: none
*
* Input: pDia - Pointer to the object.
```

```
 *        newVal - New dial value.
 *
 * Output: none
 *
 * Example:
 *   <CODE>
 *   WORD updatedVal;
 *   ROUNDDIAL *pDia;
 *
 *       // assuming pDia is initialized to an existing dial Object
 *       // assume GetInput() is a function that retrieves source data
 *       updatedVal = GetInput();
 *       RdiaSetVal(pDia, updatedVal);
 *   </CODE>
 *
 * Side Effects: none
 *
 ********************************************************************/
    #define RdiaSetVal(pDia, newVal)    (pDia)->value = newVal

/*********************************************************************
 * Macros:  RdiaIncVal(pDia)
 *
 * Overview: Used to directly increment the value. The delta
 *           change used is the resolution setting (res).
 *
 * PreCondition: none
 *
 * Input: pDia - Pointer to the object.
 *
 * Output: none
 *
 * Example:
 *   <CODE>
 *   WORD updatedVal, prevVal;
 *   ROUNDDIAL *pDia;
 *
 *       // assuming pDia is initialized to an existing dial Object
 *       // assume GetInput() is a function that retrieves source data
 *       prevVal = RdiaGetVal(pDia);
 *       updatedVal = GetInput();
 *       if (updatedVal > prevVal)
 *           RdiaIncVal(pDia);
 *       if (updatedVal < prevVal)
 *           RdiaDecVal(pDia);
 *   </CODE>
 *
 * Side Effects: none
 *
 ********************************************************************/
    #define RdiaIncVal(pDia)    RdiaSetVal(pDia, (pDia->val + pDia->res))

/*********************************************************************
 * Macros:  RdiaDecVal(pDia)
 *
 * Overview: Used to directly decrement the value. The delta
 *           change used is the resolution setting (res).
 *
 * PreCondition: none
 *
 * Input: pDia - Pointer to the object.
 *
 * Output: none
 *
 * Example:
 *   Refer to RdiaIncVal() example.
 *
 * Side Effects: none
 *
 ********************************************************************/
    #define RdiaDecVal(pDia)    RdiaSetVal(pDia, (pDia->pos - pDia->res))
```

```
/*********************************************************************
* Function: WORD RdiaDraw(void *pObj)
*
* Overview: This function renders the object on the screen using
*           the current parameter settings. Location of the object is
*           determined by the center (x,y) postion and the radius parameters.
*           The colors used are dependent on the state of the object.
*
*           When rendering objects of the same type, each object
*           must be rendered completely before the rendering of the
*           next object is started. This is to avoid incomplete
*           object rendering.
*
* PreCondition: Object must be created before this function is called.
*
* Input: pDia - Pointer to the object
*
* Output: Returns the status of the drawing
*         - 1 - If the rendering was completed and
*         - 0 - If the rendering is not yet finished.
*
* Side Effects: none
*
********************************************************************/
WORD RdiaDraw(void *pObj);
#endif // _ROUNDDIAL_H
```

14.1.32 RadioButton.c

This is file RadioButton.c.

Body Source

```
/*****************************************************************************
 *  Module for Microchip Graphics Library
 *  GOL Layer
 *  Radio Button
 *****************************************************************************
 * FileName:        RadioButton.c
 * Dependencies:    Graphics.h
 * Processor:       PIC24F, PIC24H, dsPIC, PIC32
 * Compiler:        MPLAB C30 V3.00, MPLAB C32
 * Linker:          MPLAB LINK30, MPLAB LINK32
 * Company:         Microchip Technology Incorporated
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 * CLAIMS BY THIRD PARTIES (INCLUDING BUT NOT LIMITED TO ANY DEFENSE THEREOF),
 * OR OTHER SIMILAR COSTS.
 *
 * Date         Comment
 *~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
 * 11/12/07     Version 1.0 release
 * 04/20/11     Fixed KEYBOARD bug on object ID and GOL_MSG param1 comparison.
 *****************************************************************************/
#include "Graphics/Graphics.h"

#ifdef USE_RADIOBUTTON

// This pointer is used to create linked list of radio buttons for the group
RADIOBUTTON *_pListButtons = NULL;

/*********************************************************************
* Function: RADIOBUTTON  *RbCreate(WORD ID, SHORT left, SHORT top, SHORT right,
*                              SHORT bottom, WORD state, XCHAR *pText, GOL_SCHEME *pScheme)
*
* Overview: creates the radio button
*
********************************************************************/
RADIOBUTTON *RbCreate
(
    WORD        ID,
    SHORT       left,
    SHORT       top,
    SHORT       right,
    SHORT       bottom,
    WORD        state,
    XCHAR       *pText,
    GOL_SCHEME  *pScheme
)
{
    RADIOBUTTON *pRb = NULL;
    RADIOBUTTON *pointer;

    pRb = (RADIOBUTTON *)GFX_malloc(sizeof(RADIOBUTTON));
    if(pRb == NULL)
        return (pRb);

    pRb->hdr.ID = ID;
    pRb->hdr.pNxtObj = NULL;
    pRb->hdr.type = OBJ_RADIOBUTTON;
    pRb->hdr.left = left;
    pRb->hdr.top = top;
    pRb->hdr.right = right;
    pRb->hdr.bottom = bottom;
    pRb->pText = pText;
    pRb->pNext = NULL;                      // last radio button in the list
    pRb->hdr.state = state;
    pRb->hdr.DrawObj = RbDraw;              // draw function
    pRb->hdr.MsgObj = RbTranslateMsg;       // message function
    pRb->hdr.MsgDefaultObj = RbMsgDefault;  // default message function
    pRb->hdr.FreeObj = NULL;                // free function

    if(GetState(pRb, RB_GROUP))
    {

        // If it's first button in the group start new button's list
        _pListButtons = pRb;

        // Attach the button to the list
        pRb->pHead = (OBJ_HEADER *)_pListButtons;
    }
    else
    {

        // Attach the button to the list
        pRb->pHead = (OBJ_HEADER *)_pListButtons;
        pointer = _pListButtons;
        while(pointer->pNext != NULL)
        {
            pointer = (RADIOBUTTON *)pointer->pNext;
```

```
        }

        pointer->pNext = (OBJ_HEADER *)pRb;
    }

    // Set the style scheme to be used
    if(pScheme == NULL)
        pRb->hdr.pGolScheme = _pDefaultGolScheme;
    else
        pRb->hdr.pGolScheme = pScheme;

    // Set the text height
    pRb->textHeight = 0;
    if(pText != NULL)
    {
        pRb->textHeight = GetTextHeight(pRb->hdr.pGolScheme->pFont);
    }

    GOLAddObject((OBJ_HEADER *)pRb);

    return (pRb);
}

/*********************************************************************
* Function: void RbSetCheck(RADIOBUTTON *pRb, WORD ID)
*
* Input: pRb - the pointer to any radio button in the group
*        ID - ID of button to be checked
*
* Output: none
*
* Overview: sets radio button to checked state, and marks states of group
*           radio buttons to be redrawn
*
********************************************************************/
void RbSetCheck(RADIOBUTTON *pRb, WORD ID)
{
    RADIOBUTTON *pointer;

    pointer = (RADIOBUTTON *)pRb->pHead;

    while(pointer != NULL)
    {
        if(pointer->hdr.ID == ID)
        {
            SetState(pointer, RB_CHECKED | RB_DRAW_CHECK);  // set check and redraw
        }
        else
        {
            ClrState(pointer, RB_CHECKED);                  // reset checked
            SetState(pointer, RB_DRAW_CHECK);               // redraw
        }

        pointer = (RADIOBUTTON *)pointer->pNext;
    }
}

/*********************************************************************
* Function: WORD RbGetCheck(RADIOBUTTON *pRb)
*
* Input: pRb - the pointer to any radio button in the group
*
* Output: ID of checked button, -1 if there are no checked buttons
*
* Overview: gets ID of checked radio button
*
********************************************************************/
WORD RbGetCheck(RADIOBUTTON *pRb)
{
    RADIOBUTTON *pointer;

    pointer = (RADIOBUTTON *)pRb->pHead;
    while(pointer != NULL)
    {
        if(GetState(pointer, RB_CHECKED))
        {
            return (pointer->hdr.ID);
        }

        pointer = (RADIOBUTTON *)pointer->pNext;
    }

    return (-1);
}

/*********************************************************************
* Function: RbSetText(RADIOBUTTON *pRb, XCHAR *pText)
*
* Input: pRb - the pointer to the radio button
*        pText - pointer to the text
*
* Output: none
*
* Overview: sets text
*
********************************************************************/
void RbSetText(RADIOBUTTON *pRb, XCHAR *pText)
{
    pRb->pText = pText;
    pRb->textHeight = GetTextHeight((BYTE *)pRb->hdr.pGolScheme->pFont);
}

/*********************************************************************
* Function: RbMsgDefault(WORD translatedMsg, void *pObj, GOL_MSG* pMsg)
*
* Overview: changes the state of the radio button by default
*
********************************************************************/
void RbMsgDefault(WORD translatedMsg, void *pObj, GOL_MSG *pMsg)
{
    RADIOBUTTON *pointer;
    RADIOBUTTON *pRb;

    pRb = (RADIOBUTTON *)pObj;

        #ifdef USE_FOCUS
            #ifdef USE_TOUCHSCREEN
    if(pMsg->type == TYPE_TOUCHSCREEN)
    {
        if(!GetState(pRb, RB_FOCUSED))
        {
            GOLSetFocus((OBJ_HEADER *)pRb);
        }
    }

            #endif
        #endif
    if(translatedMsg == RB_MSG_CHECKED)
    {

        // Uncheck radio buttons in the group
        pointer = (RADIOBUTTON *)pRb->pHead;

        while(pointer != NULL)
        {
            if(GetState(pointer, RB_CHECKED))
            {
                ClrState(pointer, RB_CHECKED);      // reset check
                SetState(pointer, RB_DRAW_CHECK);   // redraw
            }

            pointer = (RADIOBUTTON *)pointer->pNext;
        }
        SetState(pRb, RB_CHECKED | RB_DRAW_CHECK);  // set check and redraw
    }
}

/*********************************************************************
* Function: WORD RbTranslateMsg(void *pObj, GOL_MSG *pMsg)
*
* Overview: translates the GOL message for the radio button
*
*********************************************************************/
WORD RbTranslateMsg(void *pObj, GOL_MSG *pMsg)
{

    RADIOBUTTON *pRb;

    pRb = (RADIOBUTTON *)pObj;

    // Evaluate if the message is for the radio button
    // Check if disabled first
    if(GetState(pRb, RB_DISABLED))
        return (OBJ_MSG_INVALID);

        #ifdef USE_TOUCHSCREEN
    if(pMsg->type == TYPE_TOUCHSCREEN)
    {
        if(pMsg->uiEvent == EVENT_PRESS)
        {

            // Check if it falls in the radio button borders
            if
            (
                (pRb->hdr.left < pMsg->param1) &&
                (pRb->hdr.right > pMsg->param1) &&
                (pRb->hdr.top < pMsg->param2) &&
                (pRb->hdr.bottom > pMsg->param2)
            )
            {
                if(!GetState(pRb, RB_CHECKED))
                    return (RB_MSG_CHECKED);
            }
        }

        return (OBJ_MSG_INVALID);
    }

        #endif
        #ifdef USE_KEYBOARD
    if(pMsg->type == TYPE_KEYBOARD)
    {
        if((WORD)pMsg->param1 == pRb->hdr.ID)
        {
            if(pMsg->uiEvent == EVENT_KEYSCAN)
            {
                if((pMsg->param2 == SCAN_SPACE_PRESSED) || (pMsg->param2 ==
SCAN_CR_PRESSED))
                {
                    if(!GetState(pRb, RB_CHECKED))
                        return (RB_MSG_CHECKED);
                }
            }
        }

        return (OBJ_MSG_INVALID);
    }

        #endif
    return (OBJ_MSG_INVALID);
}

/*********************************************************************
* Function: WORD RbDraw(void *pObj)
```

```
*
* Output: returns the status of the drawing
*         0 - not completed
*         1 - done
*
* Overview: draws radio button
*
********************************************************************/
WORD RbDraw(void *pObj)
{
    typedef enum
    {
        REMOVE,
        DRAW_BUTTON0,
        DRAW_BUTTON1,
        DRAW_TEXT,
        DRAW_TEXT_RUN,
        DRAW_CHECK,
        DRAW_CHECK_RUN,
        DRAW_FOC
    } RB_DRAW_STATES;

        #define SIN45   46341

    static RB_DRAW_STATES   state = REMOVE;
    SHORT                   checkIndent;
    static SHORT            radius;
    static SHORT            x, y;
    static DWORD_VAL        temp;

    WORD                    faceClr;
    RADIOBUTTON *pRb;

    pRb = (RADIOBUTTON *)pObj;

    if(IsDeviceBusy())
        return (0);

    switch(state)
    {
        case REMOVE:
            if(GetState(pRb, (RB_HIDE | RB_DRAW)))
            {
                SetColor(pRb->hdr.pGolScheme->CommonBkColor);
                if(!Bar(pRb->hdr.left, pRb->hdr.top, pRb->hdr.right, pRb->hdr.bottom))
                    return (0);
            }

            if(GetState(pRb, RB_HIDE))
                return (1);

            radius = ((pRb->hdr.bottom - pRb->hdr.top) >> 1) - RB_INDENT;
            x = pRb->hdr.left + ((pRb->hdr.bottom - pRb->hdr.top) >> 1) + RB_INDENT;
            y = (pRb->hdr.bottom + pRb->hdr.top) >> 1;
            temp.Val = SIN45;

            if(GetState(pRb, RB_DRAW))
            {
                state = DRAW_BUTTON0;
            }
            else
            {
                state = DRAW_CHECK;
                goto rb_draw_check;
            }

        case DRAW_BUTTON0:
            if(!GetState(pRb, RB_DISABLED))
            {
                faceClr = pRb->hdr.pGolScheme->Color0;
            }
            else
            {
                faceClr = pRb->hdr.pGolScheme->ColorDisabled;
            }

            GOLPanelDraw
            (
                x,
                y,
                x,
                y,
                radius,
                faceClr,
                pRb->hdr.pGolScheme->EmbossDkColor,
                pRb->hdr.pGolScheme->EmbossLtColor,
                NULL,
                GOL_EMBOSS_SIZE
            );
            state = DRAW_BUTTON1;

        case DRAW_BUTTON1:
            if(!GOLPanelDrawTsk())
            {
                return (0);
            }

            state = DRAW_TEXT;

        case DRAW_TEXT:
            if(pRb->pText != NULL)
            {
                SetFont(pRb->hdr.pGolScheme->pFont);

                if(GetState(pRb, RB_DISABLED))
                {
                    SetColor(pRb->hdr.pGolScheme->TextColorDisabled);
                }
                else
                {
                    SetColor(pRb->hdr.pGolScheme->TextColor0);
                }

                MoveTo
                (
                    pRb->hdr.left + pRb->hdr.bottom - pRb->hdr.top + RB_INDENT,
                    (pRb->hdr.bottom + pRb->hdr.top - pRb->textHeight) >> 1
                );

                state = DRAW_TEXT_RUN;

            case DRAW_TEXT_RUN:
                if(!OutText(pRb->pText))
                    return (0);
            }

            state = DRAW_CHECK;

    rb_draw_check:

        case DRAW_CHECK:
            if(GetState(pRb, RB_CHECKED))
            {
                if(GetState(pRb, RB_DISABLED))
                {
                    SetColor(pRb->hdr.pGolScheme->TextColorDisabled);
                }
                else
                {
                        #if (COLOR_DEPTH == 1)
                    SetColor(BLACK);
                        #else
                    SetColor(pRb->hdr.pGolScheme->TextColor0);
                        #endif
                }
            }
            else
            {
                if(GetState(pRb, RB_DISABLED))
                {
                    SetColor(pRb->hdr.pGolScheme->ColorDisabled);
                }
                else
                {
                        #if (COLOR_DEPTH == 1)
                    SetColor(WHITE);
                        #else
                    SetColor(pRb->hdr.pGolScheme->Color0);
                        #endif
                }
            }

            state = DRAW_CHECK_RUN;

        case DRAW_CHECK_RUN:
            checkIndent = (pRb->hdr.bottom - pRb->hdr.top) >> 2;
            if(!FillCircle(x, y, radius - checkIndent))
                return (0);

            state = DRAW_FOC;

        case DRAW_FOC:
            if(GetState(pRb, RB_DRAW | RB_DRAW_FOCUS))
            {
                if(IsDeviceBusy())
                    return (0);

                if(GetState(pRb, RB_FOCUSED))
                {
                    SetColor(pRb->hdr.pGolScheme->TextColor0);
                }
                else
                {
                    SetColor(pRb->hdr.pGolScheme->CommonBkColor);
                }

                SetLineType(FOCUS_LINE);
                if(!Rectangle(pRb->hdr.left, pRb->hdr.top, pRb->hdr.right, pRb->hdr.bottom))
                    return (0);
                SetLineType(SOLID_LINE);
            }

            state = REMOVE;
            return (1);
    }

    return (1);
}

#endif // USE_RADIOBUTTON
```

14.1.33 RadioButton.h

Functions

	Name	Description
	RbCreate (see page 244)	This function creates a RADIOBUTTON (see page 251) object with the parameters given. It automatically attaches the new object into a global linked list of objects and returns the address of the object.

	RbDraw (see page 245)	This function renders the object on the screen using the current parameter settings. Location of the object is determined by the left, top, right and bottom parameters. The colors used are dependent on the state of the object. The font used is determined by the style scheme set. When rendering objects of the same type, each object must be rendered completely before the rendering of the next object is started. This is to avoid incomplete object rendering.
	RbGetCheck (see page 246)	This function returns the ID of the currently checked Radio Button (see page 78) in the group.
	RbMsgDefault (see page 249)	This function performs the actual state change based on the translated message given. The following state changes are supported:
	RbSetCheck (see page 247)	This function sets the Radio Button (see page 78) with the given ID to its checked state.
	RbSetText (see page 248)	This function sets the string used for the object.
	RbTranslateMsg (see page 250)	This function evaluates the message from a user if the message will affect the object or not. The table below enumerates the translated messages for each event of the touch screen and keyboard inputs.

Macros

Name	Description
RB_CHECKED (see page 242)	Bit to indicate Radio Button (see page 78) is checked.
RB_DISABLED (see page 242)	Bit for disabled state.
RB_DRAW (see page 242)	Bit to indicate whole Radio Button (see page 78) must be redrawn.
RB_DRAW_CHECK (see page 243)	Bit to indicate check mark should be redrawn.
RB_DRAW_FOCUS (see page 243)	Bit to indicate focus must be redrawn.
RB_FOCUSED (see page 243)	Bit for focused state.
RB_GROUP (see page 243)	Bit to indicate the first Radio Button (see page 78) in the group.
RB_HIDE (see page 243)	Bit to indicate that button must be removed from screen.
RbGetText (see page 247)	This macro returns the address of the current text string used for the object.

Structures

Name	Description
RADIOBUTTON (see page 251)	the structure contains data for the Radio Button (see page 78)

Description

This is file RadioButton.h.

Body Source

```
/*****************************************************************************
 *  Module for Microchip Graphics Library
 *  GOL Layer
 *  Radio Button
 *****************************************************************************
 * FileName:        RadioButton.h
 * Dependencies:    None
 * Processor:       PIC24F, PIC24H, dsPIC, PIC32
 * Compiler:        MPLAB C30, MPLAB C32
 * Linker:          MPLAB LINK30, MPLAB LINK32
 * Company:         Microchip Technology Incorporated
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   * OR OTHER SIMILAR COSTS.
   *
   * Date         Comment
   *~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
   * 11/12/07     Version 1.0 release
   *****************************************************************************/
  #ifndef _RADIOBUTTON_H
      #define _RADIOBUTTON_H

      #include <Graphics/GOL.h>
      #include "GenericTypeDefs.h"

      #define RB_INDENT   2           // Indent for the text from title bar border

  /*********************************************************************
  * Object States Definition:
  *********************************************************************/
      #define RB_FOCUSED      0x0001  // Bit for focused state.
      #define RB_DISABLED     0x0002  // Bit for disabled state.
      #define RB_CHECKED      0x0004  // Bit to indicate Radio Button is checked.
      #define RB_GROUP        0x0008  // Bit to indicate the first Radio Button in the group.
      #define RB_HIDE         0x8000  // Bit to indicate that button must be removed from
  screen.
      #define RB_DRAW_FOCUS   0x2000  // Bit to indicate focus must be redrawn.
      #define RB_DRAW_CHECK   0x1000  // Bit to indicate check mark should be redrawn.
      #define RB_DRAW         0x4000  // Bit to indicate whole Radio Button must be redrawn.

  /*****************************************************************************
  * Overview: the structure contains data for the Radio Button
  *****************************************************************************/
  typedef struct
  {
      OBJ_HEADER  hdr;        // Generic header for all Objects (see OBJ_HEADER).
      OBJ_HEADER  *pHead;     // Pointer to the first Radio Button in the group
      OBJ_HEADER  *pNext;     // Pointer to the next Radio Button in the group
      SHORT       textHeight; // Pre-computed text height
      XCHAR       *pText;     // Pointer to the text
  } RADIOBUTTON;

  /*********************************************************************
  * Macros:  RbGetText(pRb)
  *
  * Overview: This macro returns the address of the current
  *           text string used for the object.
  *
  * PreCondition: none
  *
  * Input: pRb - Pointer to the object
  *
  * Output: Returns pointer to the text string being used.
  *
  * Side Effects: none
  *
  ********************************************************************/
      #define RbGetText(pRb)  pRb->pText

  /*********************************************************************
  * Function: RbSetText(RADIOBUTTON *pRb, XCHAR *pText)
  *
  * Overview: This function sets the string used for the object.
```

```
 *
 * PreCondition: none
 *
 * Input: pRb - The pointer to the object whose text will be modified
 *        pText - Pointer to the text that will be used
 *
 * Output: none
 *
 * Side Effects: none
 *
 ********************************************************************/
void        RbSetText(RADIOBUTTON *pRb, XCHAR *pText);

/*********************************************************************
 * Function: void RbSetCheck(RADIOBUTTON *pRb, WORD ID)
 *
 * Overview: This function sets the Radio Button with the given ID
 *           to its checked state.
 *
 * PreCondition: none
 *
 * Input: pRb - Pointer to the Radio Button in the group.
 *        ID - ID of the object to be checked.
 *
 * Output: none
 *
 * Example:
 *   See RbGetCheck() example.
 *
 * Side Effects: none
 *
 ********************************************************************/
void        RbSetCheck(RADIOBUTTON *pRb, WORD ID);

/*********************************************************************
 * Function: WORD RbGetCheck(RADIOBUTTON *pRb)
 *
 * Overview: This function returns the ID of the currently
 *           checked Radio Button in the group.
 *
 * PreCondition: none
 *
 * Input: pRb - Pointer to the Radio Button in the group.
 *
 * Output: Returns the ID of the selected button in the group.
 *         It returns -1 if there is no object checked.
 *
 * Example:
 *   <CODE>
 *   GOL_SCHEME *pScheme;
 *   RADIOBUTTON *pRb[3];
 *   SHORT ID;
 *
 *       pScheme = GOLCreateScheme();
 *       pRb[0] = RbCreate(ID_RADIOBUTTON1,             // ID
 *                         255,40,310,80,               // dimension
 *                         RB_DRAW|RB_GROUP|RB_CHECKED, // will be dislayed and
 *                                                      // focused after creation
 *                                                      // first button in the group
 *                         "RB1",                       // text
 *                         pScheme);                    // scheme used
 *
 *       pRb[1] = RbCreate(ID_RADIOBUTTON2,             // ID
 *                         255,85,310,125,              // dimension
 *                         RB_DRAW,                     // will be dislayed and
 *                                                      // checked after creation
 *                         "RB2",                       // text
 *                         pScheme);                    // scheme used
 *
 *       pRb[2] = RbCreate(ID_RADIOBUTTON3,             // ID
 *                         255,130,310,170,             // dimension
 *                         RB_DRAW,                     // will be dislayed and
 *                                                 // disabled after creation
 *                         "RB3",                  // text
 *                         pScheme);               // scheme used
 *
 *       // draw the Radio Buttons here
 *
 *       ID = RbGetCheck(pRb[2]);                  // can also use pRb[1] or
 *                                                 // pRb[0] to search the
 *                                                 // checked radio button of the
 *                                                 // group. ID here should
 *                                                 // be ID_RADIOBUTTON1
 *       if (ID == ID_RADIOBUTTON1) {
 *           // do something here then clear the check
 *           ClrState(pRb[0], RB_CHECKED);
 *           // Change the checked object. Pointer used is any of the three.
 *           // the ID used will find the correct object to be checked
 *           RbSetCheck(pRb[3], ID_RADIOBUTTON2);
 *       }
 *   </CODE>
 *
 * Side Effects: none
 *
 ********************************************************************/
WORD        RbGetCheck(RADIOBUTTON *pRb);

/*********************************************************************
 * Function: RADIOBUTTON  *RbCreate( WORD ID, SHORT left, SHORT top,
 *                                   SHORT right, SHORT bottom, WORD state,
 *                                   XCHAR *pText, GOL_SCHEME *pScheme)
 *
 * Overview: This function creates a RADIOBUTTON object with the parameters given.
 *           It automatically attaches the new object into a global linked list of
 *           objects and returns the address of the object.
 *
 * PreCondition: none
 *
 * Input: ID - Unique user defined ID for the object instance.
 *        left - Left most position of the Object.
 *        top - Top most position of the Object.
 *        right - Right most position of the Object
 *        bottom - Bottom most position of the object
 *        state - Sets the initial state of the object
 *        pText – The pointer to the text used for the Radio Button.
 *        pScheme - Pointer to the style scheme used.
 *
 * Output: Returns the pointer to the object created
 *
 * Example:
 *   <CODE>
 *   GOL_SCHEME *pScheme;
 *   RADIOBUTTON *pRb[3];
 *
 *       pScheme = GOLCreateScheme();
 *       pRb[0] = RbCreate(ID_RADIOBUTTON1,         // ID
 *                         255,40,310,80,          // dimension
 *                         RB_DRAW|RB_GROUP|RB_CHECKED,  // will be dislayed and
 *                                                 // focused after creation
 *                                                 // first button in the group
 *                         "RB1",                  // text
 *                         pScheme);               // scheme used
 *
 *       pRb[1] = RbCreate(ID_RADIOBUTTON2,         // ID
 *                         255,85,310,125,         // dimension
 *                         RB_DRAW,                // will be dislayed and
 *                                                 // checked after creation
 *                         "RB2",                  // text
 *                         pScheme);               // scheme used
 *
 *       pRb[2] = RbCreate(ID_RADIOBUTTON3,         // ID
 *                         255,130,310,170,        // dimension
 *                         RB_DRAW,                // will be dislayed and
 *                                                 // disabled after creation
 *                          "RB3",                          // text
 *                          pScheme);                       // scheme used
 *
 *        while(!RbDraw(pRb[0]));                           // draw the objects
 *        while(!RbDraw(pRb[1]));
 *        while(!RbDraw(pRb[2]));
 *    </CODE>
 *
 * Side Effects: none
 *
 ********************************************************************/
 RADIOBUTTON *RbCreate
             (
                 WORD        ID,
                 SHORT       left,
                 SHORT       top,
                 SHORT       right,
                 SHORT       bottom,
                 WORD        state,
                 XCHAR       *pText,
                 GOL_SCHEME  *pScheme
             );

/*********************************************************************
 * Function: WORD RbTranslateMsg(void *pObj, GOL_MSG *pMsg)
 *
 * Overview: This function evaluates the message from a user if
 *           the message will affect the object or not. The table
 *           below enumerates the translated messages for each event
 *           of the touch screen and keyboard inputs.
 *
 *    <TABLE>
 *        Translated Message   Input Source  Events           Description
 *        ##################   ############  ######           ###########
 *        RB_MSG_CHECKED       Touch Screen  EVENT_PRESS      If event occurs and the x,y
 position falls in the area of the Radio Button while the Radio Button is not checked.
 *                             Keyboard      EVENT_KEYSCAN    If event occurs and parameter1
 passed matches the object's ID and parameter 2 passed matches SCAN_CR_PRESSED or
 SCAN_SPACE_PRESSED while the Radio Button is not checked.
 *        OBJ_MSG_INVALID      Any           Any              If the message did not affect
 the object.
 *    </TABLE>
 *
 * PreCondition: none
 *
 * Input: pRb    - The pointer to the object where the message will be
 *                 evaluated to check if the message will affect the object.
 *         pMsg  - Pointer to the message struct containing the message from
 *                 the user interface.
 *
 * Output: Returns the translated message depending on the received GOL message:
 *         - RB_MSG_CHECKED – Radio Button is checked
 *         - OBJ_MSG_INVALID – Radio Button is not affected
 *
 * Example:
 *    Usage is similar to BtnTranslateMsg() example.
 *
 * Side Effects: none
 *
 ********************************************************************/
 WORD        RbTranslateMsg(void *pObj, GOL_MSG *pMsg);

/*********************************************************************
 * Function: RbMsgDefault(WORD translatedMsg, void *pObj, GOL_MSG* pMsg)
 *
 * Overview: This function performs the actual state change
 *           based on the translated message given. The following state changes
 *           are supported:
 *    <TABLE>
 *        Translated Message   Input Source   Set/Clear State Bit     Description
 *        ##################   ############   ######                  ###########
 *        RB_MSG_CHECKED       Touch Screen,  Set RB_DRAW,            Depending on the
```

```
current value of RB_CHECKED Check Box will be redrawn.
*                              Keyboard      Set/Clear RB_CHECKED
*   </TABLE>
*
* PreCondition: none
*
* Input: translatedMsg - The translated message
*        pRb           - The pointer to the object whose state will be modified
*        pMsg          - The pointer to the GOL message
*
* Output: none
*
* Example:
*   See BtnTranslateMsg() example.
*
* Side Effects: none
*
********************************************************************/
void        RbMsgDefault(WORD translatedMsg, void *pObj, GOL_MSG *pMsg);

/*********************************************************************
* Function: WORD RbDraw(void *pObj)
*
* Overview: This function renders the object on the screen using
*           the current parameter settings. Location of the object
*           is determined by the left, top, right and bottom
*           parameters. The colors used are dependent on the state
*           of the object. The font used is determined by the style
*           scheme set.
*
*           When rendering objects of the same type, each object must
*           be rendered completely before the rendering of the next
*           object is started. This is to avoid incomplete object
*           rendering.
*
* PreCondition: Object must be created before this function is called.
*
* Input: pB - Pointer to the object to be rendered.
*
* Output: Returns the status of the drawing
*         - 1 - If the rendering was completed and
*         - 0 - If the rendering is not yet finished.
*         Next call to the function will resume the
*         rendering on the pending drawing state.
*
* Example:
*   See RbCreate() example.
*
* Side Effects: none
*
********************************************************************/
WORD RbDraw(void *pObj);
#endif // _RADIOBUTTON_H
```

14.1.34 Slider.c

This is file Slider.c.

Body Source

```
/*****************************************************************************
 *  Module for Microchip Graphics Library
 *  GOL Layer
 *  Slider
 *****************************************************************************
 * FileName:        Slider.c
 * Dependencies:    None
 * Processor:       PIC24F, PIC24H, dsPIC, PIC32
 * Compiler:        MPLAB C30 V3.00, MPLAB C32
 * Linker:          MPLAB LINK30, MPLAB LINK32
 * Company:         Microchip Technology Incorporated
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 * CLAIMS BY THIRD PARTIES (INCLUDING BUT NOT LIMITED TO ANY DEFENSE THEREOF),
 * OR OTHER SIMILAR COSTS.
 *
 * Date         Comment
 *~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
 * 11/12/07     Version 1.0 release
 * 04/29/10     - Added OBJ_MSG_PASSIVE message to detect event on the slider
 *                but with no action.
 *              - fixed the swapped message translation in the
 *                SldTranslateMsg() when keyboard event is detected.
 * 02/23/11     Removed references to BLACK and WHITE colors. Replaced
 *              with emboss dark and light colors. These are used
 *              in rendering the thumb path.
 * 04/20/11     Fixed KEYBOARD bug on object ID and GOL_MSG param1 comparison.
 *****************************************************************************/
#include "Graphics/Graphics.h"

#ifdef USE_SLIDER

/* Internal Functions */
SHORT   SldSetThumbSize(SLIDER *pSld, SHORT high, SHORT low);
void    SldGetMinMaxPos(SLIDER *pSld, WORD *minPos, WORD *maxPos);
WORD    SldGetWidth(SLIDER *pSld);
WORD    SldGetHeight(SLIDER *pSld);

/*********************************************************************
* Function: SLIDER *SldCreate(WORD ID, SHORT left, SHORT top, SHORT right,
*                              SHORT bottom, WORD state, SHORT range,
*                              SHORT page, SHORT pos, GOL_SCHEME *pScheme)
*
* Notes: Creates a SLIDER object and adds it to the current active list.
*        If the creation is successful, the pointer to the created Object
*        is returned. If not successful, NULL is returned.
*
********************************************************************/
SLIDER *SldCreate
(
    WORD        ID,
    SHORT       left,
    SHORT       top,
    SHORT       right,
    SHORT       bottom,
    WORD        state,
    WORD        range,
    WORD        page,
    WORD        pos,
    GOL_SCHEME  *pScheme
```

```
)
{
    SLIDER  *pSld = NULL;

    pSld = (SLIDER *)GFX_malloc(sizeof(SLIDER));
    if(pSld == NULL)
        return (pSld);

    pSld->hdr.ID        = ID;                             // unique id assigned for
referencing
    pSld->hdr.pNxtObj   = NULL;
    pSld->hdr.type      = OBJ_SLIDER;                     // set object type
    pSld->hdr.left      = left;                           // left and right should be equal
when oriented vertically
    pSld->hdr.top       = top;                            // top and bottom should be equal
when oriented horizontally
    pSld->hdr.right     = right;
    pSld->hdr.bottom    = bottom;
    pSld->hdr.state     = state;
    pSld->hdr.DrawObj      = SldDraw;                     // draw function
    pSld->hdr.MsgObj         = SldTranslateMsg;           // message function
    pSld->hdr.MsgDefaultObj  = SldMsgDefault;             // default message function
    pSld->hdr.FreeObj  = NULL;                            // default free function

    // Parameters in the user defined range system (pos, page and range)
    pSld->range = range;                              // range of the slider movement (always
measured from 0 to range)

    // 0 refers to pSld->minPos and
    // range refers to pSld->maxpos where: minPos and maxPos are
    // the coordinate equivalent of 0 and range value
    pSld->page = page;                                // set the resolution
    pSld->pos = pos;                                  // set the initial position

    // calculate the thumb width and height
    pSld->thWidth = SldGetWidth(pSld);
    pSld->thHeight = SldGetHeight(pSld);

    // Set the color scheme to be used
    if(pScheme == NULL)
        pSld->hdr.pGolScheme = _pDefaultGolScheme;  // use default scheme
    else
        pSld->hdr.pGolScheme = (GOL_SCHEME *)pScheme;   // user defined scheme
    GOLAddObject((OBJ_HEADER *)pSld);                     // add the new object to the
current list
    return (pSld);
}

/*********************************************************************
* Function: SHORT SldSetThumbSize(SLIDER *pSld, SHORT high, SHORT low)
*
* Notes: An INTERNAL function used to compute for the width or
*        height of the thumb. This function is created to save
*        code size. This function is called only to dynamically
*        compute for the thumb size. Used only when slider is
*        type Scrollbar. Parameter are defined as:
*        pSld - pointer to the object
*        high - higher value to be used
*        low  - lower value to be used
*
********************************************************************/
SHORT SldSetThumbSize(SLIDER *pSld, SHORT high, SHORT low)
{
    WORD    temp;

    temp = (pSld->range / pSld->page);
    temp = (high - low) / temp;

    // when size is less than half of emboss size, set the
    // size to half the emboss size. This is to make sure
    // thumb will always have a size.
    if(temp < (GOL_EMBOSS_SIZE << 1))
```

```
        temp = (GOL_EMBOSS_SIZE << 1);

    return (SHORT) temp;
}

/*********************************************************************
* Function: WORD SldGetWidth(SLIDER *pSld)
*
* Notes: An INTERNAL function that computes for the width
*        of the thumb. This function is created to save
*        code size. This function is called only to dynamically
*        compute for the thumb size.
*
********************************************************************/
WORD SldGetWidth(SLIDER *pSld)
{
    WORD    temp;

    /*
        Calculating the width is dependent on the mode type.
        If type Scrollbar, width is dependent on the ratio of the
        page/range = width/max-min (see SetThumbSize())
        if type is Slider, width is dependent on height*3/8

        When horizontal width is dynamic, height is contant.

    */
    if(GetState(pSld, SLD_VERTICAL))
    {
        temp = pSld->hdr.right - pSld->hdr.left;
        if(GetState(pSld, SLD_SCROLLBAR))
        {
            temp = temp - (GOL_EMBOSS_SIZE << 1);
        }
        else
        {
            temp = temp - (GOL_EMBOSS_SIZE << 1) - 2;
        }
    }
    else
    {
        if(GetState(pSld, SLD_SCROLLBAR))
        {
            temp = SldSetThumbSize(pSld, pSld->hdr.right, pSld->hdr.left);
        }
        else
        {
            temp = (((pSld->hdr.bottom - pSld->hdr.top) - (GOL_EMBOSS_SIZE << 1) - 2) * 3)
>> 3;
        }
    }

    // to avoid calculations of dividing by two, we store half the width value
    return (temp >> 1);
}

/*********************************************************************
* Function: WORD SldGetHeight(SLIDER *pSld)
*
* Notes: An INTERNAL function that computes for the height
*        of the thumb. This function is created to save
*        code size. This function is called only to dynamically
*        compute for the thumb size.
*
********************************************************************/
WORD SldGetHeight(SLIDER *pSld)
{
    WORD    temp;

    /*
        Calculating the height is dependent on the mode type.
        If type Scrollbar, width is dependent on the ratio of the
        page/range = width/max-min (see SetThumbSize())
        if type is Slider, width is dependent on width*3/8

        When vertical height is dynamic, width is contant.
    */
    if(GetState(pSld, SLD_VERTICAL))
    {
        if(GetState(pSld, SLD_SCROLLBAR))
        {
            temp = SldSetThumbSize(pSld, pSld->hdr.bottom, pSld->hdr.top);
        }
        else
        {
            temp = (((pSld->hdr.right - pSld->hdr.left) - (GOL_EMBOSS_SIZE << 1) - 2) * 3)
>> 3;
        }
    }
    else
    {
        temp = pSld->hdr.bottom - pSld->hdr.top;
        if(GetState(pSld, SLD_SCROLLBAR))
        {
            temp = temp - (GOL_EMBOSS_SIZE << 1);
        }
        else
        {
            temp = temp - (GOL_EMBOSS_SIZE << 1) - 2;
        }
    }

    // to avoid calculations of dividing by two, we store half the height value
    return (temp >> 1);
}

/*********************************************************************
* Function: void SldGetMinMaxPos(SLIDER *pSld, WORD *min, WORD *max)
*
* Notes:  An INTERNAL function that computes for the minimum
*         and maximum pixel position in the screen. This function is
*         created to save code size. Used to define the minimum
*         & maximum position of the thumb when sliding. Parameters
*         used are defined as:
*         pSld - pointer to the object
*         min  - pointer to the minimum variable
*         max  - pointer to the maximum variable
*
********************************************************************/
void SldGetMinMaxPos(SLIDER *pSld, WORD *min, WORD *max)
{
    WORD    temp;

    // calculate maximum and minimum position
    if(GetState(pSld, SLD_VERTICAL))
    {
        temp = pSld->thHeight + GOL_EMBOSS_SIZE;
        *min = pSld->hdr.top + temp;
        *max = pSld->hdr.bottom - temp;
    }
    else
    {
        temp = pSld->thWidth + GOL_EMBOSS_SIZE;
        *min = pSld->hdr.left + temp;
        *max = pSld->hdr.right - temp;
    }

    // for aestetics.
    if(!GetState(pSld, SLD_SCROLLBAR))
    {
        *min = *min + 2;
        *max = *max - 2;
    }
}
```

```
/*********************************************************************
* Function: void SldSetRange(SLIDER *pSld, SHORT newRange)
*
* Notes:  Sets the new range value of the slider or scrollbar.
*         Object must be redrawn after this function is called to
*         reflect the changes to the object.
*
********************************************************************/
void SldSetRange(SLIDER *pSld, SHORT newRange)
{
    WORD        newPos;
    DWORD_VAL   dTemp;

    // this checks for limits of the range (minimum is 2)
    if(newRange <= 2)
        newRange = 2;

    if((WORD) newRange > (WORD) 0x7FFF)
        newRange = 0x7FFF;

    dTemp.Val = newRange * pSld->pos;
    dTemp.Val = dTemp.Val / pSld->range;

    // get new range
    newPos = dTemp.w[0];

    // set the new range
    pSld->range = newRange;

    // now check the page, adjust when necessary
    // page maximum limit is range/2, minimum is 1
    if(pSld->page > ((pSld->range) >> 1))
    {
        if(!((pSld->range) >> 1))
            pSld->page = 1;
        else
            pSld->page = (pSld->range) >> 1;
    }

    // calculate new thumb width and height
    pSld->thWidth = SldGetWidth(pSld);
    pSld->thHeight = SldGetHeight(pSld);
    SldSetPos(pSld, newPos);
}

/*********************************************************************
* Function: void SldSetPage(SLIDER *pSld, WORD newPage)
*
* Notes: Sets the new page value of the slider or scrollbar.
*        The page maximum limit is range/2, minimum is 1
*
********************************************************************/
void SldSetPage(SLIDER *pSld, WORD newPage)
{
    if(newPage < 1)
        newPage = 1;
    else if(newPage > ((pSld->range) >> 1))
        newPage = (pSld->range) >> 1;
    pSld->page = newPage;

    // calculate new thumb width and height
    pSld->thWidth = SldGetWidth(pSld);
    pSld->thHeight = SldGetHeight(pSld);
}

/*********************************************************************
* Function: SldSetPos(SLIDER *pSld, SHORT newPos)
*
* Notes: Sets the thumb to the new position. Checking is first
*        preformed if the new position is within the range (0 to range)
*        of the slider. Object must be redrawn after this function is called to
*        reflect the changes to the object.
*
********************************************************************/
void SldSetPos(SLIDER *pSld, SHORT newPos)
{
    WORD        minPos, maxPos, relPos;
    DWORD_VAL   dTemp;

    // get minimum and maximum positions
    SldGetMinMaxPos(pSld, &minPos, &maxPos);
    dTemp.Val = 0;

        #ifndef SLD_INVERT_VERTICAL

    // check if the new value is still in range
    if(newPos <= 0)
    {
        pSld->pos = 0;                                  // set to zero in range domain
        if(GetState(pSld, SLD_VERTICAL))
        {                                               // min and max in vertical is
inverted
            pSld->currPos = maxPos;                     // minimum position is the bottom
position in
        }                                               // coordinate domain
        else
            pSld->currPos = minPos;                     // minimum is left most position in
coordinate domain
    }
    else if(newPos >= pSld->range)
    {
        pSld->pos = pSld->range;                        // set to maximum value in range
domain
        if(GetState(pSld, SLD_VERTICAL))
        {                                               // min and max in vertical is
inverted
            pSld->currPos = minPos;                     // maximum position is the top
position in
        }                                               // coordinate domain
        else
            pSld->currPos = maxPos;                     // maximum is right most position
in coordinate domain
    }
    else
    {
        pSld->pos = newPos;                             // get new position in range domain
        dTemp.w[1] = newPos;
        dTemp.Val = dTemp.Val / pSld->range;
        dTemp.Val = (maxPos - minPos) * dTemp.Val;

        // set current position in coordinate domain
        relPos = dTemp.w[1] + minPos;

        if(GetState(pSld, SLD_VERTICAL))
        {                                               // test if we need to transform min
and max position
            pSld->currPos = maxPos - (relPos - minPos); // min and max position is swapped
in coordinate domain
        }
        else
            pSld->currPos = relPos;                     // use position
    }

        #else

    // check if the new value is still in range
    if(newPos <= 0)
    {
        pSld->pos = 0;              // set to zero in range domain
        pSld->currPos = minPos;     // set to minimum in coordinate domain
    }
    else if(newPos >= pSld->range)
    {
        pSld->pos = pSld->range;    // set to maximum value in range domain
        pSld->currPos = maxPos;     // set to minimum in coordinate domain
    }
    else
    {
        pSld->pos = newPos;         // get new position in range domain
        dTemp.w[1] = newPos;
        dTemp.Val = dTemp.Val / pSld->range;
        dTemp.Val = (maxPos - minPos) * dTemp.Val;

        // set current position in coordinate domain
        pSld->currPos = dTemp.w[1] + minPos;
    }

        #endif // ifndef SLD_INVERT_VERTICAL
}

/*********************************************************************
* Function: void SldMsgDefault(WORD translatedMsg, void *pObj,
*                              GOL_MSG* pMsg)
*
* Notes: This the default operation to change the state of the button.
*        Called inside GOLMsg() when GOLMsgCallback() returns a 1.
*
********************************************************************/
void SldMsgDefault(WORD translatedMsg, void *pObj, GOL_MSG *pMsg)
{
    SLIDER *pSld;

    pSld = (SLIDER *)pObj;

        #ifdef USE_TOUCHSCREEN

    WORD        newPos, minPos, maxPos;
    DWORD_VAL   dTemp;

            #ifdef USE_FOCUS
    if(pMsg->type == TYPE_TOUCHSCREEN)
    {
        if(!GetState(pSld, SLD_FOCUSED))
        {
            GOLSetFocus((OBJ_HEADER *)pSld);
        }
    }

            #endif // USE_FOCUS

    // if message was passive do not do anything
    if (translatedMsg == OBJ_MSG_PASSIVE)
        return;

    // get the min and max positions
    SldGetMinMaxPos(pSld, &minPos, &maxPos);

    if(pMsg->type == TYPE_TOUCHSCREEN)
    {
        if((translatedMsg == SLD_MSG_DEC) || (translatedMsg == SLD_MSG_INC))
        {

            // newPos in this context is used in the coordinate domain
            if(!GetState(pSld, SLD_VERTICAL))
            {                               // check if Horizontal or Vertical orientation
                if(pMsg->param1 <= minPos)
                {                           // Horizontal orientation: test x position
                    newPos = minPos;        // beyond minimum, use min position
                }
                else if(pMsg->param1 >= maxPos)
                {
                    newPos = maxPos;        // beyond maximum, use max position
                }
                else
                {
                    newPos = pMsg->param1;  // within range: use x position given
                }
            }
            else
            {
                if(pMsg->param2 <= minPos)
                {                           // Vertical orientation: test y position
                    newPos = minPos;        // beyond minimum, use min position
                }
                else if(pMsg->param2 >= maxPos)
                {
                    newPos = maxPos;        // beyond maximum, use max position
                }
                else
                {
                    newPos = pMsg->param2;  // within range: use y position given
                }
            }

            if(newPos != pSld->currPos)
            {                               // check if we need to redraw thumb
                // yes redraw is needed, translate newPos into range domain
                // first get new position in range domain
                dTemp.Val = (DWORD) (newPos - minPos) * (DWORD) pSld->range;
                dTemp.Val = dTemp.Val / (maxPos - minPos);
                newPos = dTemp.w[0];

                        #ifndef SLD_INVERT_VERTICAL
                if(GetState(pSld, SLD_VERTICAL))
                {                           // check if we need to swap min and max in
vertical
                    newPos = pSld->range - newPos;  // min and max is swapped in vertical
orientation
                }

                        #endif
                SldSetPos(pSld, newPos);            // set to new position
                SetState(pSld, SLD_DRAW_THUMB);     // redraw the thumb only
            }
            else
                return;
        }
        else
            return;
    }

        #endif // USE_TOUCHSCREEN
        #ifdef USE_KEYBOARD
    if(pMsg->type == TYPE_KEYBOARD)
    {                           // for keyboard
        if(translatedMsg == SLD_MSG_INC)
        {
            SldIncPos(pSld);    // increment is requested
        }
        else
        {
            SldDecPos(pSld);    // decrement is requested
        }

        SetState(pSld, SLD_DRAW_THUMB); // redraw the thumb only
    }

        #endif // USE_KEYBOARD
}

/*********************************************************************
* Function: WORD SldTranslateMsg(void *pObj, GOL_MSG *pMsg)
*
* Notes: Evaluates the message if the object will be affected by the
*        message or not.
*
********************************************************************/
```

```
WORD SldTranslateMsg(void *pObj, GOL_MSG *pMsg)
{

    SLIDER *pSld;

    pSld = (SLIDER *)pObj;

    // Evaluate if the message is for the slider
    // Check if disabled first
    if(GetState(pSld, SLD_DISABLED))
        return (OBJ_MSG_INVALID);

        #ifdef USE_TOUCHSCREEN
    if(pMsg->type == TYPE_TOUCHSCREEN)
    {

        // Check if it falls to the left or right of the center of the thumb's face
        if((pMsg->uiEvent == EVENT_PRESS) || (pMsg->uiEvent == EVENT_MOVE))
        {
            if
            (
                (pSld->hdr.left < pMsg->param1) &&
                (pSld->hdr.right > pMsg->param1) &&
                (pSld->hdr.top < pMsg->param2) &&
                (pSld->hdr.bottom > pMsg->param2)
            )
            {
                if(GetState(pSld, SLD_VERTICAL))
                {
                    if(pSld->currPos < pMsg->param2)
                        return (SLD_MSG_INC);
                    else
                        return (SLD_MSG_DEC);
                }
                else
                {
                    if(pSld->currPos < pMsg->param1)
                        return (SLD_MSG_INC);
                    else
                        return (SLD_MSG_DEC);
                }
            }
        }   // end of if((pMsg->uiEvent == EVENT_PRESS) || (pMsg->uiEvent == EVENT_MOVE))

        // when the event is release emit OBJ_MSG_PASSIVE this can be used to
        // detect that the release event happened on the slider.
        if(pMsg->uiEvent == EVENT_RELEASE)
            return OBJ_MSG_PASSIVE;

        return (OBJ_MSG_INVALID);
    }       // end of if(pMsg->type == TYPE_TOUCHSCREEN
        #endif
        #ifdef USE_KEYBOARD
    if(pMsg->type == TYPE_KEYBOARD)
    {
        if((WORD)pMsg->param1 == pSld->hdr.ID)
        {
            if(pMsg->uiEvent == EVENT_KEYSCAN)
            {
                if((pMsg->param2 == SCAN_RIGHT_PRESSED) || (pMsg->param2 ==
SCAN_UP_PRESSED))
                {
                    return (SLD_MSG_INC);
                }

                if((pMsg->param2 == SCAN_LEFT_PRESSED) || (pMsg->param2 ==
SCAN_DOWN_PRESSED))
                {
                    return (SLD_MSG_DEC);
                }
            }
        }
    }

        #endif
    return (OBJ_MSG_INVALID);
}

/*********************************************************************
* Function: WORD SldDraw(void *pObj)
*
* Notes: This is the state machine to draw the slider or scrollbar.
*
*********************************************************************/
WORD SldDraw(void *pObj)
{
    typedef enum
    {
        SLD_STATE_IDLE,
        SLD_STATE_PANEL,
        SLD_STATE_THUMBPATH1,
        SLD_STATE_THUMBPATH2,
        SLD_STATE_CLEARTHUMB,
        SLD_STATE_REDRAWPATH1,
        SLD_STATE_REDRAWPATH2,
        SLD_STATE_THUMB,
        SLD_STATE_THUMBPANEL,
        SLD_STATE_FOCUS
    } SLD_DRAW_STATES;

    static WORD colorTemp = 0;

    static SLD_DRAW_STATES state = SLD_STATE_IDLE;
    static WORD left, top, right, bottom;
    static WORD midPoint, thWidth, thHeight;
    static WORD minPos, maxPos;
    SLIDER *pSld;

    pSld = (SLIDER *)pObj;

    if(IsDeviceBusy())
        return (0);

    switch(state)
    {
        case SLD_STATE_IDLE:
            if(GetState(pSld, SLD_HIDE))
            {
                SetColor(pSld->hdr.pGolScheme->CommonBkColor);      // set to common BK
Color
                if(!Bar(pSld->hdr.left, pSld->hdr.top, pSld->hdr.right, pSld->hdr.bottom))
                    return (0);
                return (1);
            }

            if(!GetState(pSld, SLD_DISABLED))
            {
                colorTemp = pSld->hdr.pGolScheme->Color0;           // select enabled color
            }
            else
            {
                colorTemp = pSld->hdr.pGolScheme->ColorDisabled;    // select disabled color
            }

            SldGetMinMaxPos(pSld, &minPos, &maxPos);

            midPoint = GetState(pSld, SLD_VERTICAL) ? (pSld->hdr.left + pSld->hdr.right) >>
1 : (pSld->hdr.top + pSld->hdr.bottom) >> 1;

            // calculate the thumb width and height Actually gets the half value
            // (see calculation of width and height) SldGetWidth() and SldGetHeight()
            thWidth = pSld->thWidth;                                // gets half the width
            thHeight = pSld->thHeight;                              // gets half the height
            SetLineThickness(NORMAL_LINE);
            SetLineType(SOLID_LINE);
            if(GetState(pSld, SLD_DRAW))
            {   // draw the panel for the slider
                // modify the color setting if scroll bar mode or slider mode
                GOLPanelDraw
                (
                    pSld->hdr.left,
                    pSld->hdr.top,
                    pSld->hdr.right,
                    pSld->hdr.bottom,
                    0,
                    colorTemp,
                    (GetState(pSld, SLD_SCROLLBAR)) ? pSld->hdr.pGolScheme->EmbossDkColor :
  pSld->hdr.pGolScheme->EmbossLtColor,
                    (GetState(pSld, SLD_SCROLLBAR)) ? pSld->hdr.pGolScheme->EmbossLtColor :
  pSld->hdr.pGolScheme->EmbossDkColor,
                    NULL,
                    GOL_EMBOSS_SIZE
                );

                // initialize current and previous position
                SldSetPos(pSld, pSld->pos);
                pSld->prevPos = pSld->currPos;

                state = SLD_STATE_PANEL;
            }
            else
            {   // we do not need to draw the whole object
                state = SLD_STATE_CLEARTHUMB;   // go to thumb drawing
                goto sld_state_clearthumb;
            }

        case SLD_STATE_PANEL:
            if(!GOLPanelDrawTsk())              // draw the panel of the slider
                return (0);
            if(GetState(pSld, SLD_SCROLLBAR))
            {                                   // check if slider or scroll bar
                state = SLD_STATE_THUMB;        // scrollbar: go directly to thumb drawing
                goto sld_state_thumb;           // thumb path is not drawn in scrollbar
            }
            else
            {
                state = SLD_STATE_THUMBPATH1;   // slider: draw thumb path next
            }

        case SLD_STATE_THUMBPATH1:
            SetColor(pSld->hdr.pGolScheme->EmbossDkColor);
            if(!GetState(pSld, SLD_VERTICAL))
            {
                if(!Line(minPos, midPoint, maxPos, midPoint))
                    return (0);
            }
            else
            {
                if(!Line(midPoint, minPos, midPoint, maxPos))
                    return (0);
            }

            state = SLD_STATE_THUMBPATH2;

        case SLD_STATE_THUMBPATH2:
            SetColor(pSld->hdr.pGolScheme->EmbossLtColor);
            if(!GetState(pSld, SLD_VERTICAL))
            {
                if(!Line(minPos, midPoint + 1, maxPos, midPoint + 1))
                    return (0);
            }
            else
            {
                if(!Line(midPoint + 1, minPos, midPoint + 1, maxPos))
                    return (0);
            }
            if(GetState(pSld, SLD_DRAW))
            {                               // if drawing the whole slider
                state = SLD_STATE_THUMB;    // go straight to drawing the thumb
                goto sld_state_thumb;
            }
            else
                // if just drawing the thumb
                state = SLD_STATE_CLEARTHUMB;   // go to state to remove current position

        case SLD_STATE_CLEARTHUMB:              // this removes the current thumb
            sld_state_clearthumb : if(IsDeviceBusy()) return (0);

            if(!GetState(pSld, SLD_DRAW_THUMB))
            {                               // SLD_DRAW_THUMB is only set when
                state = SLD_STATE_FOCUS;    // object type is SLIDER
                goto sld_state_focus;
            }

            SetColor(colorTemp);

            // Remove the current thumb by drawing a bar with background color
            if(!GetState(pSld, SLD_VERTICAL))
            {
                if(!Bar(pSld->prevPos - thWidth, midPoint - thHeight, pSld->prevPos +
  thWidth, midPoint + thHeight))
                    return (0);
            }
            else
            {
                if(!Bar(midPoint - thWidth, pSld->prevPos - thHeight, midPoint + thWidth,
  pSld->prevPos + thHeight))
                    return (0);
            }

            if(!GetState(pSld, SLD_SCROLLBAR))
            {                               // check if slider or scroll bar
                state = SLD_STATE_REDRAWPATH1;
            }
            else
            {
                state = SLD_STATE_THUMB;    // go directly to thumb drawing
                goto sld_state_thumb;       // thumb path is not drawn in scrollbar
            }

        case SLD_STATE_REDRAWPATH1:         // redraws the lines that it covered
            SetColor(pSld->hdr.pGolScheme->EmbossDkColor);

            // Check if the redraw area exceeds the actual dimension. This will
            // adjust the redrawing area to just within the parameters
            if(!GetState(pSld, SLD_VERTICAL))
            {
                if(minPos + thWidth > pSld->prevPos)
                    left = minPos;
                else
                    left = pSld->prevPos - thWidth;

                if(maxPos - thWidth < pSld->prevPos)
                    right = maxPos;
                else
                    right = pSld->prevPos + thWidth;

                if(!Line(left, midPoint, right, midPoint))
                    return (0);
            }
            else
            {
                if(minPos + thHeight > pSld->prevPos)
                    top = minPos;
                else
                    top = pSld->prevPos - thHeight;
                if(maxPos - thHeight < pSld->prevPos)
                    bottom = maxPos;
                else
                    bottom = pSld->prevPos + thHeight;

                if(!Line(midPoint, top, midPoint, bottom))
                    return (0);
            }

            state = SLD_STATE_REDRAWPATH2;

        case SLD_STATE_REDRAWPATH2:
            SetColor(pSld->hdr.pGolScheme->EmbossLtColor);
            if(!GetState(pSld, SLD_VERTICAL))
            {
                if(!Line(left, midPoint + 1, right, midPoint + 1))
                    return (0);
            }
            else
            {
                if(!Line(midPoint + 1, top, midPoint + 1, bottom))
                    return (0);
            }

            state = SLD_STATE_THUMB;

        case SLD_STATE_THUMB:
            sld_state_thumb : if(IsDeviceBusy()) return (0);
            if(!GetState(pSld, SLD_VERTICAL))
            {                               // Draw the slider thumb based on the
                // current position
                left = pSld->currPos - thWidth;
                top = midPoint - thHeight;
                right = pSld->currPos + thWidth;
                bottom = midPoint + thHeight;
            }
            else
            {
                left = midPoint - thWidth;
                top = pSld->currPos - thHeight;
                right = midPoint + thWidth;
                bottom = pSld->currPos + thHeight;
            }

            GOLPanelDraw
            (
                left,
                top,
                right,
                bottom,
                0,                          // set the parameters of the thumb
                colorTemp,
                pSld->hdr.pGolScheme->EmbossLtColor,
                pSld->hdr.pGolScheme->EmbossDkColor,
                NULL,
                (GOL_EMBOSS_SIZE - 1) ? GOL_EMBOSS_SIZE - 1 : 1
            );

            state = SLD_STATE_THUMBPANEL;

        case SLD_STATE_THUMBPANEL:
            if(!GOLPanelDrawTsk())          // draw the panel of the thumb
                return (0);

            pSld->prevPos = pSld->currPos;  // record the current position as previous
            if(GetState(pSld, SLD_SCROLLBAR))
            {                               // check if scroll bar focus is not used
                state = SLD_STATE_IDLE;     // go back to idle state
                return (1);
            }

            if(!GetState(pSld, SLD_DRAW_FOCUS))
            {
                state = SLD_STATE_IDLE;
                return (1);
            }

            state = SLD_STATE_FOCUS;

        case SLD_STATE_FOCUS:
            sld_state_focus : if(!GetState(pSld, SLD_SCROLLBAR))
            {                               // do not draw focus when in scroll bar mode
                SetLineType(FOCUS_LINE);
                if(GetState(pSld, SLD_FOCUSED))
                {
                    SetColor(pSld->hdr.pGolScheme->TextColor0); // draw the focus box
                }
                else
                {
                    SetColor(colorTemp);                        // remove the focus box,
colorTemp
                }

                if
                (
                    !Rectangle
                        (
                            pSld->hdr.left + GOL_EMBOSS_SIZE,
                            pSld->hdr.top + GOL_EMBOSS_SIZE,
                            pSld->hdr.right - GOL_EMBOSS_SIZE,
                            pSld->hdr.bottom - GOL_EMBOSS_SIZE
                        )
                ) return (0);

                SetLineType(SOLID_LINE);                        // reset line type
            }

            state = SLD_STATE_IDLE;                             // set state to idle
            return (1); // return as done
    }

    return (1);
}

#endif // USE_SLIDER
```

14.1.35 Slider.h

Functions

	Name	Description
	SldCreate (see page 255)	This function creates a SLIDER (see page 266) object with the parameters given. Depending on the SLD_SCROLLBAR (see page 255) state bit slider or scrollbar mode is set. If SLD_SCROLLBAR (see page 255) is set, mode is scrollbar; if not set mode is slider. It automatically attaches the new object into a global linked list of objects and returns the address of the object.
	SldDraw (see page 257)	This function renders the object on the screen using the current parameter settings. Location of the object is determined by the left, top, right and bottom parameters. The colors used are dependent on the state of the object. When rendering objects of the same type, each object must be rendered completely before the rendering of the next object is started. This is to avoid incomplete object rendering.
	SldMsgDefault (see page 264)	This function performs the actual state change based on the translated message given. The following state changes are supported:

	SldSetPage (see page 258)	This sets the page size of the object. Page size defines the delta change of the thumb position when incremented via SldIncPos (see page 262)() or decremented via SldDecPos (see page 263)(). Page size minimum value is 1. Maximum value is range/2.
	SldSetPos (see page 259)	This function sets the position of the slider thumb. Value should be in the set range inclusive. Object must be redrawn to reflect the change.
	SldSetRange (see page 261)	This sets the range of the thumb. If this field is changed Object must be completely redrawn to reflect the change.
	SldTranslateMsg (see page 265)	This function evaluates the message from a user if the message will affect the object or not. The table below enumerates the translated messages for each event of the touch screen and keyboard inputs.

Macros

Name	Description
SLD_DISABLED (see page 253)	Bit for disabled state
SLD_DRAW (see page 254)	Bit to indicate whole slider must be redrawn
SLD_DRAW_FOCUS (see page 254)	Bit to indicate that only the focus will be redrawn
SLD_DRAW_THUMB (see page 254)	Bit to indicate that only thumb area must be redrawn
SLD_FOCUSED (see page 254)	Bit for focus state
SLD_HIDE (see page 254)	Bit to remove object from screen
SLD_SCROLLBAR (see page 255)	Bit for type usage (0 - Slider (see page 251), 1 - ScrollBar)
SLD_VERTICAL (see page 255)	Bit for orientation (0 - horizontal, 1 - vertical)
SldDecPos (see page 263)	This macro decrement the slider position by the delta change (page) value set. Object must be redrawn after this function is called to reflect the changes to the object.
SldGetPage (see page 258)	Returns returns the current slider thumb position. Value is always in the 1 to range/2 inclusive.
SldGetPos (see page 260)	Returns returns the current position of the slider thumb.
SldGetRange (see page 261)	Returns the current slider page. Value is always in the 1-range/2 inclusive for both slider and scrollbar type.
SldIncPos (see page 262)	This macro increment the slider position by the delta change (page) value set. Object must be redrawn after this function is called to reflect the changes to the object.

Structures

Name	Description
SLIDER (see page 266)	Defines the parameters required for a slider/scrollbar Object. Depending on the SLD_SCROLLBAR (see page 255) state bit slider or scrollbar mode is set. If SLD_SCROLLBAR (see page 255) is set, mode is scrollbar; if not set mode is slider. For scrollbar mode, focus rectangle is not drawn.

Description

This is file Slider.h.

Body Source

```
/*****************************************************************************
 *  Module for Microchip Graphics Library
 *  GOL Layer
 *  Slider
 *****************************************************************************
 * FileName:        Slider.h
 * Dependencies:    none
 * Processor:       PIC24F, PIC24H, dsPIC, PIC32
 * Compiler:        MPLAB C30, MPLAB C32
 * Linker:          MPLAB LINK30, MPLAB LINK32
 * Company:         Microchip Technology Incorporated
 *
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 * COST OF PROCUREMENT OF SUBSTITUTE GOODS, TECHNOLOGY, SERVICES, OR ANY
 * CLAIMS BY THIRD PARTIES (INCLUDING BUT NOT LIMITED TO ANY DEFENSE THEREOF),
 * OR OTHER SIMILAR COSTS.
 *
 * Date        Comment
 *~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
 * 11/12/07    Version 1.0 release
 * 08/12/10    Added casting to pointers in macros.
 *****************************************************************************/
#ifndef _SLIDER_H
    #define _SLIDER_H

    #include <Graphics/GOL.h>
    #include "GenericTypeDefs.h"

/*********************************************************************
* Object States Definition:
*********************************************************************/
    #define SLD_FOCUSED     0x0001  // Bit for focus state
    #define SLD_DISABLED    0x0002  // Bit for disabled state
    #define SLD_VERTICAL    0x0004  // Bit for orientation  (0 - horizontal, 1 - vertical)
    #define SLD_SCROLLBAR   0x0010  // Bit for type usage (0 - Slider, 1 - ScrollBar)
    #define SLD_DRAW_THUMB  0x1000  // Bit to indicate that only thumb area must be redrawn
    #define SLD_DRAW_FOCUS  0x2000  // Bit to indicate that only the focus will be redrawn
    #define SLD_DRAW        0x4000  // Bit to indicate whole slider must be redrawn
    #define SLD_HIDE        0x8000  // Bit to remove object from screen

/*********************************************************************
* Overview: Defines the parameters required for a slider/scrollbar Object.
*           Depending on the SLD_SCROLLBAR state bit slider or scrollbar mode
*           is set. If SLD_SCROLLBAR is set, mode is scrollbar; if not set
*           mode is slider. For scrollbar mode, focus rectangle is not drawn.
*
*********************************************************************/
typedef struct
{
    OBJ_HEADER  hdr;        // Generic header for all Objects (see OBJ_HEADER).
    WORD        currPos;    // Position of the slider relative to minimum.
    WORD        prevPos;    // Previous position of the slider relative to minimum.
    WORD        range;      // User defined range of the slider. Minimum value at 0 and
maximum at 0x7FFF.
    WORD        pos;        // Position of the slider in range domain.
    WORD        page;       // User specified resolution to incrementally change the
position

    // in range domain.
    WORD        thWidth;    // Thumb width. This is computed internally.

    // User must not change this value.
    WORD        thHeight;   // Thumb width. This is computed internally.
    // User must not change this value.
} SLIDER;

/*********************************************************************
```

```
* Function:  SldSetRange(SLIDER *pSld, SHORT newRange)
*
* Overview: This sets the range of the thumb. If this field is changed
*           Object must be completely redrawn to reflect the change.
*
* PreCondition: none
*
* Input: pSld - Pointer to the object.
*        newRange - Value of the new range used.
*
* Output: None.
*
* Example:
*   <CODE>
*   SLIDER *pSld;
*
*       SldSetRange(pSld, 100);
*       // to completely redraw the object when GOLDraw() is executed.
*       SetState(pSld, SLD_DRAW);
*
*   </CODE>
*
* Side Effects: Position of the thumb may change when redrawn.
*
*********************************************************************/
void    SldSetRange(SLIDER *pSld, SHORT newRange);

/*********************************************************************
* Function: void SldSetPage(SLIDER *pSld, WORD newPage)
*
* Overview: This sets the page size of the object. Page size defines
*           the delta change of the thumb position when incremented
*           via SldIncPos() or decremented via SldDecPos(). Page size
*           minimum value is 1. Maximum value is range/2.
*
* PreCondition: none
*
* Input: pSld - Pointer to the object.
*        newPage - Value of the new page used.
*
* Output: None.
*
* Example:
*   See SldIncPos() example.
*
* Side Effects: Position of the thumb may change when redrawn.
*
*********************************************************************/
void    SldSetPage(SLIDER *pSld, WORD newPage);

/*********************************************************************
* Macros:  SldGetRange(pSld)
*
* Overview: Returns the current slider page. Value is always
*           in the 1-range/2 inclusive for both slider and
*           scrollbar type.
*
* PreCondition: none
*
* Input: pSld - Pointer to the object.
*
* Output: Returns the current value of the slider range.
*
* Example:
*   <CODE>
*   WORD range;
*   SLIDER *pSld;
*
*       range = SldGetRange(pSld);
*   </CODE>
*
* Side Effects: none
```

```
*
********************************************************************/
    #define SldGetRange(pSld)   (((SLIDER*)pSld)->range)

/*********************************************************************
* Macros:  SldGetPage(pSld)
*
* Overview: Returns returns the current slider thumb position.
*           Value is always in the 1 to range/2 inclusive.
*
* PreCondition: none
*
* Input: pSld - Pointer to the object.
*
* Output: Returns the current value of the slider page.
*
* Example:
*   <CODE>
*   WORD page;
*   SLIDER *pSld;
*
*       page = SldGetPage(pSld);
*   </CODE>
*
* Side Effects: none
*
********************************************************************/
    #define SldGetPage(pSld)    (((SLIDER*)pSld)->page)

/*********************************************************************
* Macros:  SldGetPos(pSld)
*
* Overview: Returns returns the current position of the slider thumb.
*
* PreCondition: none
*
* Input: pSld - Pointer to the object.
*
* Output: Returns the current position of the slider's thumb.
*
* Example:
*   <CODE>
*   #define MAXVALUE 100;
*
*   SLIDER *pSlider;
*   DWORD ctr = 0;
*
*       // create slider here and initialize parameters
*       SetState(pSlider, SLD_DRAW);
*       SldDraw(pSlider);
*
*       while("some condition") {
*           SldSetPos(pSlider, ctr);
*           SetState(pSlider, SLD_DRAW_THUMB);
*           SldDraw(pSlider);
*           // update ctr here
*           ctr = "some source of value";
*       }
*
*       if (SldGetPos(pSlider) > (MAXVALUE – 1))
*          return 0;
*       else
*           "do something else"
*   </CODE>
*
* Side Effects: none
*
********************************************************************/
    #define SldGetPos(pSld) (((SLIDER*)pSld)->pos)

/*********************************************************************
* Function:  SldSetPos(SLIDER *pSld, SHORT newPos)
```

```
*
* Overview: This function sets the position of the slider thumb.
*           Value should be in the set range inclusive. Object must
*           be redrawn to reflect the change.
*
* PreCondition: none
*
* Input: pSld - Pointer to the object.
*        newPos - The new position of the slider's thumb.
*
* Output: none
*
* Example:
*   <CODE>
*   SLIDER *pSlider;
*   DWORD ctr = 0;
*
*       // create slider here and initialize parameters
*       SetState(pSlider, SLD_DRAW);
*       SldDraw(pSlider);
*
*       while("some condition") {
*           SldSetPos(pSlider, ctr);
*           SetState(pSlider, SLD_DRAW_THUMB);
*           SldDraw(pSlider);
*           // update ctr here
*           ctr = "some source of value";
*       }
*   </CODE>
*
* Side Effects: none
*
********************************************************************/
void    SldSetPos(SLIDER *pSld, SHORT newPos);

/*********************************************************************
* Macros:  SldIncPos(pSld)
*
* Overview: This macro increment the slider position by the delta
*           change (page) value set. Object must be redrawn after
*           this function is called to reflect the changes to the object.
*
* PreCondition: none
*
* Input: pSld - Pointer to the object.
*
* Output: none
*
* Example:
*   <CODE>
*   void ControlSpeed(SLIDER* pSld, int setSpeed, int curSpeed)
*   {
*       SldSetPage(pSld, 1);                    // set page size to 1
*       if (setSpeed < curSpeed) {
*           while(SldGetPos(pSld) < SetSpeed)
*               SldIncPos(pSld);                // increment by 1
*       }
*       else if (setSpeed > curSpeed) {
*           while(SldGetPos(pSld) > SetSpeed)
*               SldDecPos(pSld);                // decrement by 1
*       }
*   }
*   </CODE>
*
* Side Effects: none
*
********************************************************************/
    #define
SldIncPos(pSld)                                                            \
    SldSetPos

\
    (

\
        pSld,

\
        (((DWORD) pSld->pos + (DWORD) ((SLIDER*)pSld)->page) <= (DWORD)
((SLIDER*)pSld)->range) ?  \
                        (((SLIDER*)pSld)->pos + ((SLIDER*)pSld)->page) :
((SLIDER*)pSld)->range    \
    )

/*********************************************************************
* Macros:  SldDecPos(pSld)
*
* Overview: This macro decrement the slider position by the delta
*           change (page) value set. Object must be redrawn after
*           this function is called to reflect the changes to the object.
*
* PreCondition: none
*
* Input: pSld - Pointer to the object.
*
* Output: none
*
* Example:
*   See SldIncPos() example.
*
* Side Effects: none
*
********************************************************************/
    #define
SldDecPos(pSld)                                                                          \
    SldSetPos

\
    (

\
        pSld,

\
        (((LONG) ((SLIDER*)pSld)->pos - (LONG) ((SLIDER*)pSld)->page) >= 0)
?                       \
                        (((SLIDER*)pSld)->pos - ((SLIDER*)pSld)->page) :
0                         \
    )

/*********************************************************************
* Function: SLIDER *SldCreate(WORD ID, SHORT left, SHORT top, SHORT right,
*                             SHORT bottom, WORD state, SHORT range,
*                             SHORT page, SHORT pos, GOL_SCHEME *pScheme);
*
* Overview: This function creates a SLIDER object with the parameters given.
*           Depending on the SLD_SCROLLBAR state bit slider or scrollbar mode
*           is set. If SLD_SCROLLBAR is set, mode is scrollbar; if not set
*           mode is slider. It automatically attaches the new object into a
*           global linked list of objects and returns the address of the object.
*
* PreCondition: none
*
* Input: ID - Unique user defined ID for the object instance.
*        left - Left most position of the Object.
*        top - Top most position of the Object.
*        right - Right most position of the Object.
*        bottom - Bottom most position of the Object.
*        state - This defines the initial state of the Object.
*        range - This specifies the maximum value of the slider when the
*                thumb is on the rightmost position for a horizontal orientation
*                and bottom most position for the vertical orientation. Minimum
*                value is always at zero.
*        page - This is the incremental change of the slider when user action
*              requests to move the slider thumb. This value is added or
*              subtracted to the current position of the thumb.
*        pos - This defines the initial position of the thumb.
*        pScheme - The pointer to the style scheme used for the Object.
*                  Set to NULL if default style scheme is used.
*
* Output: Returns the pointer to the object created.
*
* Example:
*   <CODE>
*   GOL_SCHEME *pScheme;
*   SLIDER *slider[3];
*   WORD state;
*
*       pScheme = GOLCreateScheme();
*
*       // create a slider with
*       //       range = [0 – 50000]
*       //       delta = 500
*       //       initial position = 25000
*       state = SLD_DRAW;
*       slider[0] = SldCreate(  5,
*                               150, 145, 285, 181,
*                               state,
*                               50000, 500, 25000,
*                               pScheme);
*       if (slider[0] == NULL)
*           return 0;
*
*       // create a scrollbar with
*       //       range = [0 – 100]
*       //       delta = 20
*       //       initial position = 0
*
*       state = SLD_DRAW|SLD_SCROLLBAR;
*       slider[1] = SldCreate(  6,
*                               150, 190, 285, 220,
*                               state,
*                               100, 20, 0,
*                               pScheme);
*       if (slider[1] == NULL)
*           return 0;
*
*       // create a vertical slider with
*       //       range = [0 – 30]
*       //       delta = 2
*       //       initial position = 20
*
*       state = SLD_DRAW|SLD_VERTICAL;
*       slider[2] = SldCreate(  7,
*                               120, 145, 140, 220,
*                               state,
*                               30, 2, 20,
*                               pScheme);
*       if (slider[2] == NULL)
*           return 0;
*
*       // draw the sliders
*       while(!sldDraw(slider[0]);      // draw the horizontal slider
*       while(!sldDraw(slider[1]);      // draw the horizontal scroll bar
*       while(!sldDraw(slider[2]);      // draw the vertical slider
*       return 1;
*   </CODE>
*
* Side Effects: none
*
********************************************************************/
SLIDER  *SldCreate
        (
            WORD        ID,
            SHORT       left,
            SHORT       top,
            SHORT       right,
            SHORT       bottom,
            WORD        state,
            WORD        range,
            WORD        page,
            WORD        pos,
            GOL_SCHEME  *pScheme
        );

/*********************************************************************
* Function: void SldMsgDefault(WORD translatedMsg, void *pObj, GOL_MSG* pMsg)
*
* Overview: This function performs the actual state change
*           based on the translated message given. The following state changes
*           are supported:
*   <TABLE>
*       Translated Message   Input Source     Set/Clear State Bit   Description
*       ##################   ############     ######                ###########
*       SLD_MSG_INC          Touch Screen,    Set SLD_DRAW_THUMB    Slider will be redrawn
with thumb in the incremented position.
*                             Keyboard
*       SLD_MSG_DEC          Touch Screen,    Set SLD_DRAW_THUMB    Slider will be redrawn
with thumb in the decremented position.
*                             Keyboard
*   </TABLE>
*
* PreCondition: none
*
* Input: translatedMsg - The translated message.
*         pSld          - The pointer to the object whose state will be modified.
*         pMsg          - The pointer to the GOL message.
*
* Output: none
*
* Example:
*   Usage is similar to BtnTranslateMsg() example.
*
* Side Effects: none
*
********************************************************************/
void    SldMsgDefault(WORD translatedMsg, void *pObj, GOL_MSG *pMsg);

/*********************************************************************
* Function: WORD SldTranslateMsg(void *pObj, GOL_MSG *pMsg)
*
* Overview: This function evaluates the message from a user if the
*           message will affect the object or not. The table below
*           enumerates the translated messages for each event of the
*           touch screen and keyboard inputs.
*
*   <TABLE>
*       Translated Message   Input Source  Events                        Description
*       ##################   ############  ######                        ###########
*       SLD_MSG_INC          Touch Screen  EVENT_PRESS, EVENT_MOVE      If events occurs
and the x,y position falls in the area of the slider and the slider position is to the LEFT
of the x,y position for a horizontal slider or BELOW the x,y position for a vertical slider.
*                            Keyboard      EVENT_KEYSCAN                If event occurs and
parameter1 passed matches the object’s ID and parameter 2 passed matches SCAN_UP_PRESSED or
SCAN_LEFT_PRESSED.
*       SLD_MSG_DEC          Touch Screen  EVENT_PRESS, EVENT_MOVE      If events occurs
and the x,y position falls in the area of the slider and the slider position is to the
RIGHT of the x,y position for a horizontal slider or ABOVE the x,y position for a vertical
slider.
*                            Keyboard      EVENT_KEYSCAN                If event occurs and
parameter1 passed matches the object’s ID and parameter 2 passed matches SCAN_DOWN_PRESSED
or SCAN_RIGHT_PRESSED.
*       OBJ_MSG_PASSIVE      Touch Screen  EVENT_RELEASE                If events occurs
and the x,y position falls in the area of the slider.
*       OBJ_MSG_INVALID      Any           Any                          If the message did
not affect the object.
*   </TABLE>
*
```

```
* PreCondition: none
*
* Input: pSld  - The pointer to the object where the message will be
*                evaluated to check if the message will affect the object.
*        pMsg  - Pointer to the message struct containing the message from
*                the user interface.
*
* Output: Returns the translated message depending on the received GOL message:
*          - SLD_MSG_INC – Increment slider position
*          - SLD_MSG_DEC – Decrement slider position
*          - OBJ_MSG_PASSIVE – Slider is not affected
*          - OBJ_MSG_INVALID – Slider is not affected
*
* Example:
*   Usage is similar to BtnTranslateMsg() example.
*
* Side Effects: none
*
********************************************************************/
WORD    SldTranslateMsg(void *pObj, GOL_MSG *pMsg);

/*********************************************************************
* Function: WORD SldDraw(void *pObj)
*
* Overview: This function renders the object on the screen using
*           the current parameter settings. Location of the object is
*           determined by the left, top, right and bottom parameters.
*           The colors used are dependent on the state of the object.
*
*           When rendering objects of the same type, each object
*           must be rendered completely before the rendering of the
*           next object is started. This is to avoid incomplete
*           object rendering.
*
* PreCondition: Object must be created before this function is called.
*
* Input: pSld - Pointer to the object to be rendered.
*
* Output: Returns the status of the drawing
*          - 1 - If the rendering was completed and
*          - 0 - If the rendering is not yet finished.
*          Next call to the function will resume the
*          rendering on the pending drawing state.
*
* Example:
*   See SldCreate() example.
*
* Side Effects: none
*
********************************************************************/
WORD SldDraw(void *pObj);
#endif //_SLIDER_H
```

14.1.36 StaticText.c

This is file StaticText.c.

Body Source

```
/*****************************************************************************
 *  Module for Microchip Graphics Library
 *  GOL Layer
 *  Static Text
 *****************************************************************************
 * FileName:        StaticText.c
 * Dependencies:    None
 * Processor:       PIC24F, PIC24H, dsPIC, PIC32
 * Compiler:        MPLAB C30 V3.00, MPLAB C32
 * Linker:          MPLAB LINK30, MPLAB LINK32
 * Company:         Microchip Technology Incorporated
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 * COST OF PROCUREMENT OF SUBSTITUTE GOODS, TECHNOLOGY, SERVICES, OR ANY
 * CLAIMS BY THIRD PARTIES (INCLUDING BUT NOT LIMITED TO ANY DEFENSE THEREOF),
 * OR OTHER SIMILAR COSTS.
 *
 * Author               Date        Comment
 *~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
 * PAT                  11/12/07    Version 1.0 release
 * PAT                  11/12/07    Fixed clipping enabling location
*****************************************************************************/
#include "Graphics/Graphics.h"

#ifdef USE_STATICTEXT

/*********************************************************************
* Function: STATICTEXT  *StCreate(WORD ID, SHORT left, SHORT top, SHORT right, SHORT
bottom,
*                                  WORD state , XCHAR *pText, GOL_SCHEME *pScheme)
*
* Notes: Creates a STATICTEXT object and adds it to the current active list.
*        If the creation is successful, the pointer to the created Object
*        is returned. If not successful, NULL is returned.
*
********************************************************************/
STATICTEXT *StCreate
(
    WORD        ID,
    SHORT       left,
    SHORT       top,
    SHORT       right,
    SHORT       bottom,
    WORD        state,
    XCHAR       *pText,
    GOL_SCHEME  *pScheme
)
{
    STATICTEXT  *pSt = NULL;

    pSt = (STATICTEXT *)GFX_malloc(sizeof(STATICTEXT));
    if(pSt == NULL)
        return (pSt);

    pSt->hdr.ID = ID;                // unique id assigned for referencing
    pSt->hdr.pNxtObj = NULL;         // initialize pointer to NULL
    pSt->hdr.type = OBJ_STATICTEXT;  // set object type
    pSt->hdr.left = left;            // left,top corner
    pSt->hdr.top = top;
    pSt->hdr.right = right;          // right buttom corner
    pSt->hdr.bottom = bottom;
    pSt->pText = pText;              // location of the text
```

```
    pSt->hdr.state = state;
    pSt->hdr.DrawObj = StDraw;          // draw function
    pSt->hdr.MsgObj = StTranslateMsg;   // message function
    pSt->hdr.MsgDefaultObj = NULL;      // default message function
    pSt->hdr.FreeObj = NULL;            // free function

    // Set the color scheme to be used
    if(pScheme == NULL)
        pSt->hdr.pGolScheme = _pDefaultGolScheme;
    else
        pSt->hdr.pGolScheme = (GOL_SCHEME *)pScheme;

    pSt->textHeight = 0;
    if(pSt->pText != NULL)
    {

        // Set the text height
        pSt->textHeight = GetTextHeight(pSt->hdr.pGolScheme->pFont);
    }

    GOLAddObject((OBJ_HEADER *)pSt);
    return (pSt);
}

/*********************************************************************
* Function: StSetText(STATICTEXT *pSt, XCHAR *pText)
*
* Notes: Sets the string that will be used.
*
********************************************************************/
void StSetText(STATICTEXT *pSt, XCHAR *pText)
{
    pSt->pText = pText;
    pSt->textHeight = GetTextHeight(pSt->hdr.pGolScheme->pFont);
}

/*********************************************************************
* Function: WORD StTranslateMsg(void *pObj, GOL_MSG *pMsg)
*
* Notes: Evaluates the message if the object will be affected by the
*        message or not.
*
********************************************************************/
WORD StTranslateMsg(void *pObj, GOL_MSG *pMsg)
{

    STATICTEXT *pSt;

    pSt = (STATICTEXT *)pObj;


    // Evaluate if the message is for the static text
    // Check if disabled first
    if(GetState(pSt, ST_DISABLED))
        return (OBJ_MSG_INVALID);

        #ifdef USE_TOUCHSCREEN
    if(pMsg->type == TYPE_TOUCHSCREEN)
    {

        // Check if it falls in static text control borders
        if
        (
            (pSt->hdr.left < pMsg->param1) &&
            (pSt->hdr.right > pMsg->param1) &&
            (pSt->hdr.top < pMsg->param2) &&
            (pSt->hdr.bottom > pMsg->param2)
        )
        {
            return (ST_MSG_SELECTED);
        }
    }
```

```
        #endif
    return (OBJ_MSG_INVALID);
}

/*********************************************************************
* Function: WORD StDraw(void *pObj)
*
* Notes: This is the state machine to draw the static text.
*
********************************************************************/
WORD StDraw(void *pObj)
{
    typedef enum
    {
        ST_STATE_IDLE,
        ST_STATE_CLEANAREA,
        ST_STATE_INIT,
        ST_STATE_SETALIGN,
        ST_STATE_DRAWTEXT
    } ST_DRAW_STATES;

    static ST_DRAW_STATES state = ST_STATE_IDLE;
    static SHORT charCtr = 0, lineCtr = 0;
    static XCHAR *pCurLine = NULL;
    SHORT textWidth;
    XCHAR ch = 0;
    STATICTEXT *pSt;

    pSt = (STATICTEXT *)pObj;

    if(IsDeviceBusy())
        return (0);

    switch(state)
    {
        case ST_STATE_IDLE:
            SetClip(CLIP_DISABLE);

            if(GetState(pSt, ST_HIDE))
            {
                SetColor(pSt->hdr.pGolScheme->CommonBkColor);
                if(!Bar(pSt->hdr.left, pSt->hdr.top, pSt->hdr.right, pSt->hdr.bottom))
                    return (0);

                // State is still IDLE STATE so no need to set
                return (1);
            }

            if(GetState(pSt, ST_DRAW))
            {
                // show frame if specified to be shown
                SetLineType(SOLID_LINE);
                SetLineThickness(NORMAL_LINE);

                if(GetState(pSt, ST_FRAME))
                {

                    if(!GetState(pSt, ST_DISABLED))
                    {

                        // show enabled color
                        SetColor(pSt->hdr.pGolScheme->Color1);
                        if(!Rectangle(pSt->hdr.left, pSt->hdr.top, pSt->hdr.right,
pSt->hdr.bottom))

                            return (0);
                    }
                    else
                    {

                        // show disabled color
                        SetColor(pSt->hdr.pGolScheme->ColorDisabled);
                        if(!Rectangle(pSt->hdr.left, pSt->hdr.top, pSt->hdr.right,
pSt->hdr.bottom))
                            return (0);
                    }
                }
                else
                {
                    // show enabled color
                    SetColor(pSt->hdr.pGolScheme->CommonBkColor);
                    if(!Rectangle(pSt->hdr.left, pSt->hdr.top, pSt->hdr.right,
pSt->hdr.bottom))
                        return (0);

                }
            }

            state = ST_STATE_CLEANAREA;

        case ST_STATE_CLEANAREA:

            // clean area where text will be placed.
            SetColor(pSt->hdr.pGolScheme->CommonBkColor);
            if(!Bar(pSt->hdr.left + 1, pSt->hdr.top + 1, pSt->hdr.right - 1,
pSt->hdr.bottom - 1))
                return (0);

            // set clipping area, text will only appear inside the static text area.
            SetClip(CLIP_ENABLE);
            SetClipRgn(pSt->hdr.left + ST_INDENT, pSt->hdr.top, pSt->hdr.right - ST_INDENT,
pSt->hdr.bottom);
            state = ST_STATE_INIT;

        case ST_STATE_INIT:
            if(IsDeviceBusy())
                return (0);

            // set the text color
            if(!GetState(pSt, ST_DISABLED))
            {
                SetColor(pSt->hdr.pGolScheme->TextColor0);
            }
            else
            {
                SetColor(pSt->hdr.pGolScheme->TextColorDisabled);
            }

            // use the font specified in the object
            SetFont(pSt->hdr.pGolScheme->pFont);
            pCurLine = pSt->pText;                  // get first line of text
            state = ST_STATE_SETALIGN;              // go to drawing of text

        case ST_STATE_SETALIGN:
            st_state_alignment : if(!charCtr)
            {

                // set position of the next character (based on alignment and next
character)
                textWidth = GetTextWidth(pCurLine, pSt->hdr.pGolScheme->pFont);

                // Display text with center alignment
                if(GetState(pSt, (ST_CENTER_ALIGN)))
                {
                    MoveTo((pSt->hdr.left + pSt->hdr.right - textWidth) >> 1, pSt->hdr.top
+ (lineCtr * pSt->textHeight));
                }

                // Display text with right alignment
                else if(GetState(pSt, (ST_RIGHT_ALIGN)))
                {
                    MoveTo((pSt->hdr.right - textWidth - ST_INDENT), pSt->hdr.top +
(lineCtr * pSt->textHeight));
                }
                // Display text with left alignment
                else
                {
                    MoveTo(pSt->hdr.left + ST_INDENT, pSt->hdr.top + (lineCtr *
pSt->textHeight));
                }
            }

            state = ST_STATE_DRAWTEXT;

        case ST_STATE_DRAWTEXT:
            ch = *(pCurLine + charCtr);

            // output one character at time until a newline character or a NULL character
is sampled
            while((0x0000 != ch) && (0x000A != ch))
            {
                if(!OutChar(ch))
                    return (0);                 // render the character
                charCtr++;                      // update to next character
                ch = *(pCurLine + charCtr);
            }

            // pCurText is updated for the next line
            if(ch == 0x000A)
            {                                   // new line character
                pCurLine = pCurLine + charCtr + 1;  // go to first char of next line
                lineCtr++;                      // update line counter
                charCtr = 0;                    // reset char counter
                goto st_state_alignment;        // continue to next line
            }

            // end of text string is reached no more lines to display
            else
            {
                pCurLine = NULL;                // reset static variables
                lineCtr = 0;
                charCtr = 0;
                SetClip(CLIP_DISABLE);          // remove clipping
                state = ST_STATE_IDLE;          // go back to IDLE state
                return (1);
            }
    }

    return (1);
}

#endif // USE_STATICTEXT
```

14.1.37 StaticText.h

Functions

	Name	Description
⇒◆	StCreate (see page 269)	This function creates a STATICTEXT (see page 273) object with the parameters given. It automatically attaches the new object into a global linked list of objects and returns the address of the object.
⇒◆	StDraw (see page 270)	This function renders the object on the screen using the current parameter settings. Location of the object is determined by the left, top, right and bottom parameters. The colors used are dependent on the state of the object. The font used is determined by the style scheme set. When rendering objects of the same type, each object must be rendered completely before the rendering of the next object is started. This is to avoid incomplete object rendering.
⇒◆	StSetText (see page 272)	This function sets the string that will be used for the object.

	StTranslateMsg (see page 272)	This function evaluates the message from a user if the message will affect the object or not. The table below enumerates the translated messages for each event of the touch screen and keyboard inputs.

Macros

Name	Description
ST_CENTER_ALIGN (see page 268)	Bit to indicate text is center aligned.
ST_DISABLED (see page 268)	Bit for disabled state.
ST_DRAW (see page 268)	Bit to indicate static text must be redrawn.
ST_FRAME (see page 269)	Bit to indicate frame is displayed.
ST_HIDE (see page 269)	Bit to remove object from screen.
ST_RIGHT_ALIGN (see page 269)	Bit to indicate text is left aligned.
ST_UPDATE (see page 269)	Bit to indicate that text area only is redrawn.
StGetText (see page 271)	This macro returns the address of the current text string used for the object.

Structures

Name	Description
STATICTEXT (see page 273)	Defines the parameters required for a Static Text Object.

Description

This is file StaticText.h.

Body Source

```
/*****************************************************************************
 *  Module for Microchip Graphics Library
 *  GOL Layer
 *  Static text
 *****************************************************************************
 * FileName:        StaticText.h
 * Dependencies:    None
 * Processor:       PIC24F, PIC24H, dsPIC, PIC32
 * Compiler:        MPLAB C30, MPLAB C32
 * Linker:          MPLAB LINK30, MPLAB LINK32
 * Company:         Microchip Technology Incorporated
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 * CLAIMS BY THIRD PARTIES (INCLUDING BUT NOT LIMITED TO ANY DEFENSE THEREOF),
 * OR OTHER SIMILAR COSTS.
 *
 * Date         Comment
 *~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
 * 11/12/07     Version 1.0 release
 *****************************************************************************/
#ifndef _STATICTEXT_H
```

```
    #define _STATICTEXT_H

    #include <Graphics/GOL.h>
    #include "GenericTypeDefs.h"

/*********************************************************************
* Object States Definition:
*********************************************************************/
    #define ST_DISABLED     0x0002  // Bit for disabled state.
    #define ST_RIGHT_ALIGN  0x0004  // Bit to indicate text is left aligned.
    #define ST_CENTER_ALIGN 0x0008  // Bit to indicate text is center aligned.
    #define ST_FRAME        0x0010  // Bit to indicate frame is displayed.
    #define ST_UPDATE       0x2000  // Bit to indicate that text area only is redrawn.
    #define ST_DRAW         0x4000  // Bit to indicate static text must be redrawn.
    #define ST_HIDE         0x8000  // Bit to remove object from screen.

/* Indent constant for the text used in the frame. */
    #define ST_INDENT   0x02        // Text indent constant.

/*********************************************************************
* Overview: Defines the parameters required for a Static Text Object.
*
*********************************************************************/
typedef struct
{
    OBJ_HEADER  hdr;        // Generic header for all Objects (see OBJ_HEADER).
    SHORT       textHeight; // Pre-computed text height.
    XCHAR       *pText;     // The pointer to text used.
} STATICTEXT;

/*********************************************************************
* Macros:  StGetText(pSt)
*
* Overview: This macro returns the address of the current
*           text string used for the object.
*
* PreCondition: none
*
* Input: pSt - Pointer to the object.
*
* Output: Returns the pointer to the text string used.
*
* Side Effects: none
*
********************************************************************/
    #define StGetText(pSt)  pSt->pText

/*********************************************************************
* Function: StSetText(STATICTEXT *pSt, XCHAR *pText)
*
* Overview: This function sets the string that will be used for the object.
*
* PreCondition: none
*
* Input: pSt - The pointer to the object whose text string will be modified.
*        pText - The pointer to the string that will be used.
*
* Output: none
*
* Side Effects: none
*
********************************************************************/
void        StSetText(STATICTEXT *pSt, XCHAR *pText);

/*********************************************************************
* Function: STATICTEXT  *StCreate(WORD ID, SHORT left, SHORT top, SHORT right, SHORT
bottom,
*                                 WORD state , XCHAR *pText, GOL_SCHEME *pScheme)
*
* Overview: This function creates a STATICTEXT object with the
*           parameters given. It automatically attaches the new
*           object into a global linked list of objects and returns
```

```
 *           the address of the object.
 *
 * PreCondition: none
 *
 * Input: ID - Unique user defined ID for the object instance.
 *        left - Left most position of the object.
 *        top - Top most position of the object.
 *        right - Right most position of the object.
 *        bottom - Bottom most position of the object.
 *        state - Sets the initial state of the object.
 *        pText - Pointer to the text used in the static text.
 *        pScheme - Pointer to the style scheme. Set to NULL if
 *                  default style scheme is used.
 *
 * Output: Returns the pointer to the object created.
 *
 * Example:
 *   <CODE>
 *   GOL_SCHEME *pScheme;
 *   STATICTEXT *pSt;
 *
 *       pScheme = GOLCreateScheme();
 *       state = ST_DRAW | ST_FRAME | ST_CENTER_ALIGN;
 *       StCreate(ID_STATICTEXT1,          // ID
 *                30,80,235,160,           // dimension
 *                state,                   // has frame and center aligned
 *                "Static Text\n Example", // text
 *                pScheme);                // use given scheme
 *
 *       while(!StDraw(pSt));              // draw the object
 *   </CODE>
 *
 * Side Effects: none
 *
 ********************************************************************/
STATICTEXT  *StCreate
            (
                WORD        ID,
                SHORT       left,
                SHORT       top,
                SHORT       right,
                SHORT       bottom,
                WORD        state,
                XCHAR       *pText,
                GOL_SCHEME  *pScheme
            );

/*********************************************************************
 * Function: WORD StTranslateMsg(void *pObj, GOL_MSG *pMsg)
 *
 * Overview: This function evaluates the message from a user if the
 *           message will affect the object or not. The table below
 *           enumerates the translated messages for each event of the
 *           touch screen and keyboard inputs.
 *
 *   <TABLE>
 *       Translated Message   Input Source  Events                        Description
 *       ##################   ############  ######                        ###########
 *       ST_MSG_SELECTED      Touch Screen  EVENT_PRESS, EVENT_RELEASE   If events occurs
and the x,y position falls in the area of the static text.
 *       OBJ_MSG_INVALID      Any           Any                           If the message did
not affect the object.
 *   </TABLE>
 *
 * PreCondition: none
 *
 * Input: pSt   - The pointer to the object where the message will be
 *                evaluated to check if the message will affect the object.
 *        pMsg  - Pointer to the message struct containing the message from
 *                the user interface.
 *
 * Output: Returns the translated message depending on the received GOL message:
```

```
*         - ST_MSG_SELECTED – Static Text is selected
*         - OBJ_MSG_INVALID – Static Text is not affected
*
* Example:
*   Usage is similar to BtnTranslateMsg() example.
*
* Side Effects: none
*
********************************************************************/
WORD        StTranslateMsg(void *pObj, GOL_MSG *pMsg);

/*********************************************************************
* Function: WORD StDraw(void *pObj)
*
* Overview: This function renders the object on the screen using
*           the current parameter settings. Location of the object
*           is determined by the left, top, right and bottom
*           parameters. The colors used are dependent on the state
*           of the object. The font used is determined by the style
*           scheme set.
*
*           When rendering objects of the same type, each object must
*           be rendered completely before the rendering of the next
*           object is started. This is to avoid incomplete object rendering.
*
* PreCondition: Object must be created before this function is called.
*
* Input: pSt - Pointer to the object to be rendered.
*
* Output: Returns the status of the drawing
*         - 1 - If the rendering was completed and
*         - 0 - If the rendering is not yet finished.
*         Next call to the function will resume the
*         rendering on the pending drawing state.
*
* Example:
*   See StCreate() Example.
*
* Side Effects: none
*
********************************************************************/
WORD StDraw(void *pObj);
#endif // _STATICTEXT_H
```

14.1.38 TextEntry.c

This is file TextEntry.c.

Body Source

```
/*****************************************************************************
 *  Module for Microchip Graphics Library
 *  GOL Layer
 *  TextEntry
 *****************************************************************************
 * FileName:        Textentry.c
 * Dependencies:    Textentry.h
 * Processor:       PIC24F, PIC24H, dsPIC, PIC32
 * Compiler:        MPLAB C30 Version 3.00, C32
 * Linker:          MPLAB LINK30, LINK32
 * Company:         Microchip Technology Incorporated
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  * OR OTHER SIMILAR COSTS.
  *
  * Author               Date        Comment
  *~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
  * Harold Serrano       10/24/08    ...
  * PAT                  07/01/09    Updated for 2D accelerated primitive support.
  * PAT                  04/15/10    Corrected TeSetBuffer() issue on string max size.
  *****************************************************************************/
#include "Graphics/Graphics.h"

#ifdef USE_TEXTENTRY

/*********************************************************************
* Function: TEXTENTRY *TeCreate(WORD ID, SHORT left, SHORT top, SHORT right, SHORT bottom,
WORD state
*                    SHORT horizontalKeys, SHORT verticalKeys, XCHAR *pText[],
*                    void *pBuffer, WORD bufferLength, void *pDisplayFont,
*                    GOL_SCHEME *pScheme)
*
*
* Notes:
*
********************************************************************/
TEXTENTRY *TeCreate
(
    WORD        ID,
    SHORT       left,
    SHORT       top,
    SHORT       right,
    SHORT       bottom,
    WORD        state,
    SHORT       horizontalKeys,
    SHORT       verticalKeys,
    XCHAR       *pText[],
    void        *pBuffer,
    WORD        bufferLength,
    void        *pDisplayFont,
    GOL_SCHEME  *pScheme
)
{
    TEXTENTRY   *pTe = NULL;                    //Text entry
    pTe = (TEXTENTRY *)GFX_malloc(sizeof(TEXTENTRY));
    if(pTe == NULL)
        return (NULL);

    pTe->hdr.ID = ID;
    pTe->hdr.pNxtObj = NULL;
    pTe->hdr.type = OBJ_TEXTENTRY;              // set object type
    pTe->hdr.left = left;                       // left parameter of the text-entry
    pTe->hdr.top = top;                         // top parameter of the text-entry
    pTe->hdr.right = right;                     // right parameter of the text-entry
    pTe->hdr.bottom = bottom;                   // bottom parameter of the text-entry
    pTe->hdr.state = state;                     // State of the Text-Entry
    pTe->horizontalKeys = horizontalKeys;       // number of horizontal keys
    pTe->verticalKeys = verticalKeys;           // number of vertical keys
    pTe->CurrentLength = 0;                     // current length of text
```

```
    pTe->pHeadOfList = NULL;
    TeSetBuffer(pTe, pBuffer, bufferLength);    // set the text to be displayed buffer
length is also initialized in this call
    pTe->pActiveKey = NULL;
    pTe->hdr.DrawObj = TeDraw;                  // draw function
    pTe->hdr.MsgObj = TeTranslateMsg;           // message function
    pTe->hdr.MsgDefaultObj = TeMsgDefault;      // default message function
    pTe->hdr.FreeObj = TeDelKeyMembers;         // free function

    // Set the color scheme to be used
    if(pScheme == NULL)
        pTe->hdr.pGolScheme = _pDefaultGolScheme;
    else
        pTe->hdr.pGolScheme = (GOL_SCHEME *)pScheme;

    // Set the font to be used
    if(pDisplayFont == NULL)
        pTe->pDisplayFont = (void *) &GOLFontDefault;
    else
        pTe->pDisplayFont = pDisplayFont;

    //check if either values of horizontal keys and vertical keys are equal to zero
    if((pTe->horizontalKeys != 0) || (pTe->verticalKeys != 0))
    {

        //create the key members, return null if not successful
        if(TeCreateKeyMembers(pTe, pText) == 0)
        {
            GFX_free(pTe);
            return (NULL);
        }
    }

    //Add this new widget object to the GOL list
    GOLAddObject((OBJ_HEADER *)pTe);
    return (pTe);
}   //end TeCreate()

/*********************************************************************
* Function: WORD TeDraw(void *pObj)
*
* Notes: This function draws the keys with their appropriate text
*
********************************************************************/
WORD TeDraw(void *pObj)
{
    static WORD         faceClr, embossLtClr, embossDkClr, xText, yText;
    static XCHAR        XcharTmp;
    static KEYMEMBER    *pKeyTemp = NULL;

    static WORD         CountOfKeys = 0;
    static WORD         counter = 0;
    static XCHAR        hideChar[2] = {0x2A, 0x00};

    typedef enum
    {
        TE_START,
        TE_HIDE_WIDGET,
        TE_DRAW_PANEL,
        TE_INIT_DRAW_EDITBOX,
        TE_DRAW_EDITBOX,
        TE_DRAW_KEY_INIT,
        TE_DRAW_KEY_SET_PANEL,
        TE_DRAW_KEY_DRAW_PANEL,
        TE_DRAW_KEY_TEXT,
        TE_DRAW_KEY_UPDATE,
        TE_UPDATE_STRING_INIT,
        TE_UPDATE_STRING,
        TE_WAIT_ERASE_EBOX_AREA,
        TE_UPDATE_CHARACTERS,
    } TE_DRAW_STATES;
    static TE_DRAW_STATES state = TE_START;
    TEXTENTRY *pTe;

    pTe = (TEXTENTRY *)pObj;

    if(IsDeviceBusy())
        return (0);

    switch(state)
    {
        case TE_START:
            if(IsDeviceBusy())
                return (0);

            if(GetState(pTe, TE_HIDE))
            {
                SetColor(pTe->hdr.pGolScheme->CommonBkColor);
                Bar(pTe->hdr.left, pTe->hdr.top, pTe->hdr.right, pTe->hdr.bottom);
                state = TE_HIDE_WIDGET;
                goto te_hide_widget;
            }
            else
            {
                if(GetState(pTe, TE_DRAW))
                {

                    /************DRAW THE WIDGET PANEL*****************************/
                    GOLPanelDraw
                    (
                        pTe->hdr.left,
                        pTe->hdr.top,
                        pTe->hdr.right,
                        pTe->hdr.bottom,
                        0,
                        pTe->hdr.pGolScheme->Color0,        //face color of panel
                        pTe->hdr.pGolScheme->EmbossDkColor, //emboss dark color
                        pTe->hdr.pGolScheme->EmbossLtColor, //emboss light color
                        NULL,
                        GOL_EMBOSS_SIZE
                    );
                    state = TE_DRAW_PANEL;
                    goto te_draw_panel;
                }

                // update the keys (if TE_UPDATE_TEXT is also set it will also be redrawn)
                // at the states after the keys are updated
                else if(GetState(pTe, TE_UPDATE_KEY))
                {
                    state = TE_DRAW_KEY_INIT;
                    goto te_draw_key_init_st;
                }

                // check if updating only the text displayed
                else if(GetState(pTe, TE_UPDATE_TEXT))
                {
                    state = TE_UPDATE_STRING_INIT;
                    goto te_update_string_init_st;
                }
            }

        /*hide the widget*/
        case TE_HIDE_WIDGET:
            te_hide_widget : if(IsDeviceBusy()) return (0);
            state = TE_START;
            return (1);

        /*Draw the widget of the Text-Entry*/
        case TE_DRAW_PANEL:
            te_draw_panel : if(!GOLPanelDrawTsk()) return (0);
            state = TE_INIT_DRAW_EDITBOX;

        case TE_INIT_DRAW_EDITBOX:
            //Draw the editbox
            GOLPanelDraw
            (
            pTe->hdr.left,
            pTe->hdr.top,
            pTe->hdr.right,
            pTe->hdr.top + GetTextHeight(pTe->pDisplayFont) + (GOL_EMBOSS_SIZE << 1),
            0,
            pTe->hdr.pGolScheme->Color1; ,
        pTe->hdr.pGolScheme->EmbossDkColor,
        pTe->hdr.pGolScheme->EmbossLtColor,
        NULL,
        GOL_EMBOSS_SIZE
            );

            state = TE_DRAW_EDITBOX;

        case TE_DRAW_EDITBOX:
            if(!GOLPanelDrawTsk())
                return (0);
            state = TE_DRAW_KEY_INIT;

        /* ******************************************************************** */

        /*                  Update the keys                                     */

        /* ******************************************************************** */
        case TE_DRAW_KEY_INIT:
            te_draw_key_init_st : embossLtClr = pTe->hdr.pGolScheme->EmbossLtColor;
            embossDkClr = pTe->hdr.pGolScheme->EmbossDkColor;
            faceClr = pTe->hdr.pGolScheme->Color0;

            // if the active key update flag is set, only one needs to be redrawn
            if((GetState(pTe, TE_DRAW) != TE_DRAW) && (pTe->pActiveKey->update == TRUE))
            {
                CountOfKeys = (pTe->horizontalKeys * pTe->verticalKeys) -
                1;
                pKeyTemp = pTe->pActiveKey;
            }
            else
            {
                CountOfKeys = 0;
                pKeyTemp = pTe->pHeadOfList;
            }

            state = TE_DRAW_KEY_SET_PANEL;

        case TE_DRAW_KEY_SET_PANEL:
            te_draw_key_set_panel_st : if(CountOfKeys < (pTe->horizontalKeys *
pTe->verticalKeys))
            {

                // check if we need to draw the panel
                if(GetState(pTe, TE_DRAW) != TE_DRAW)
                {
                    if(pKeyTemp->update == TRUE)
                    {

                        // set the colors needed
                        if(GetState(pTe, TE_KEY_PRESSED))
                        {
                            embossLtClr = pTe->hdr.pGolScheme->EmbossDkColor;
                            embossDkClr = pTe->hdr.pGolScheme->EmbossLtColor;
                            faceClr = pTe->hdr.pGolScheme->Color1;
                        }
                        else
                        {
                            embossLtClr = pTe->hdr.pGolScheme->EmbossLtColor;
                            embossDkClr = pTe->hdr.pGolScheme->EmbossDkColor;
                            faceClr = pTe->hdr.pGolScheme->Color0;
                        }
                    }
                    else
                    {
                        state = TE_DRAW_KEY_UPDATE;
                        goto te_draw_key_update_st;
                    }
                }

                if(GetState(pTe, TE_DISABLED) == TE_DISABLED)
                {
                    faceClr = SetColor(pTe->hdr.pGolScheme->ColorDisabled);
                }

                // set up the panel
                GOLPanelDraw
                (
                    pKeyTemp->left,
                    pKeyTemp->top,
                    pKeyTemp->right,
                    pKeyTemp->bottom,
                    0,
                    faceClr,
                    embossLtClr,
                    embossDkClr,
                    NULL,
                    GOL_EMBOSS_SIZE
                );

                state = TE_DRAW_KEY_DRAW_PANEL;
            }
            else
            {
                state = TE_UPDATE_STRING_INIT;
                goto te_update_string_init_st;
            }

        case TE_DRAW_KEY_DRAW_PANEL:
            if(!GOLPanelDrawTsk())
                return (0);

            // reset the update flag since the key panel is already redrawn
            pKeyTemp->update = FALSE;

            //set the text coordinates of the drawn key
            xText = ((pKeyTemp->left) + (pKeyTemp->right) - (pKeyTemp->textWidth)) >>
            1;
            yText = ((pKeyTemp->bottom) + (pKeyTemp->top) - (pKeyTemp->textHeight)) >>
            1;

            //set color of text
            // if the object is disabled, draw the disabled colors
            if(GetState(pTe, TE_DISABLED) == TE_DISABLED)
            {
                SetColor(pTe->hdr.pGolScheme->TextColorDisabled);
            }
            else
            {
                if((GetState(pTe, TE_DRAW) != TE_DRAW) && (GetState(pTe, TE_KEY_PRESSED))
 == TE_KEY_PRESSED)
                {
                    SetColor(pTe->hdr.pGolScheme->TextColor1);
                }
                else
                {
                    SetColor(pTe->hdr.pGolScheme->TextColor0);
                }
            }

            //output the text
            MoveTo(xText, yText);

            // set the font to be used
            SetFont(pTe->hdr.pGolScheme->pFont);

            state = TE_DRAW_KEY_TEXT;

        case TE_DRAW_KEY_TEXT:
            if(!OutText(pKeyTemp->pKeyName))
                return (0);
            state = TE_DRAW_KEY_UPDATE;

        case TE_DRAW_KEY_UPDATE:
            te_draw_key_update_st :

            // update loop variables
            CountOfKeys++;
            pKeyTemp = pKeyTemp->pNextKey;

            state = TE_DRAW_KEY_SET_PANEL;
            goto te_draw_key_set_panel_st;

        /* ********************************************************************* */

        /*                  Update the displayed string                          */

        /* ********************************************************************* */
        case TE_UPDATE_STRING_INIT:
            te_update_string_init_st :

            // check if there are characters to remove
            if(pTe->pActiveKey != NULL)
            {
                if(pTe->pActiveKey->command == TE_DELETE_COM)
                {
                    if(pTe->CurrentLength == 0)
                    {
                        state = TE_START;
                        return (1);
                    }
                }
            }
            else
            {

                // check if text indeed needs to be updated
                if(pTe->CurrentLength == pTe->outputLenMax)
                {
                    state = TE_START;
                    return (1);
                }
            }

            //set the clipping region
            SetClipRgn
            (
                pTe->hdr.left + GOL_EMBOSS_SIZE,
                pTe->hdr.top + GOL_EMBOSS_SIZE,
                pTe->hdr.right - GOL_EMBOSS_SIZE,
                pTe->hdr.top + GOL_EMBOSS_SIZE + GetTextHeight(pTe->pDisplayFont)
            );

            SetClip(1);     //set the clipping
            if(GetState(pTe, TE_DRAW))
            {

                // update only the displayed text
                // position the string rendering on the right position
                if(GetState(pTe, TE_ECHO_HIDE))
                {

                    // fill the area with '*' character so we use the width of this
  character
                    MoveTo
                    (
                        pTe->hdr.right - 4 - GOL_EMBOSS_SIZE - (GetTextWidth(hideChar,
pTe->pDisplayFont) * pTe->CurrentLength),
                        pTe->hdr.top + GOL_EMBOSS_SIZE
                    );
                }
                else
                {
                    MoveTo
                    (
                        pTe->hdr.right - 4 - GOL_EMBOSS_SIZE - GetTextWidth(pTe->pTeOutput,
pTe->pDisplayFont),
                        pTe->hdr.top + GOL_EMBOSS_SIZE
                    );
                }
            }
            else if(GetState(pTe, TE_UPDATE_TEXT))
            {

                // erase the current text by drawing a bar over the edit box area
                SetColor(pTe->hdr.pGolScheme->Color1);
                Bar
                (
                    pTe->hdr.left + GOL_EMBOSS_SIZE,
                    pTe->hdr.top + GOL_EMBOSS_SIZE,
                    pTe->hdr.right - GOL_EMBOSS_SIZE,
                    pTe->hdr.top + GOL_EMBOSS_SIZE + GetTextHeight(pTe->pDisplayFont)
                );

                // we have to make sure we finish the Bar() first before we continue.
                state = TE_WAIT_ERASE_EBOX_AREA;
                goto te_wait_erase_ebox_area;
            }
            else
            {
                SetClip(0); //reset the clipping
                state = TE_START;
                return (1);
            }

            counter = 0;
            state = TE_UPDATE_STRING;
            goto te_update_string;

        case TE_WAIT_ERASE_EBOX_AREA:
            te_wait_erase_ebox_area : if(IsDeviceBusy()) return (0);

            // check if the command given is delete a character
            if(pTe->pActiveKey->command == TE_DELETE_COM)
            {
                *(pTe->pTeOutput + (--pTe->CurrentLength)) = 0;
            }

            // position the cursor to the start of string rendering
            // notice that we need to remove the characters first before we position the
cursor when
            // deleting characters
            if(GetState(pTe, TE_ECHO_HIDE))
            {

                // fill the area with '*' character so we use the width of this character
                MoveTo
                (
                    pTe->hdr.right - 4 - GOL_EMBOSS_SIZE - (GetTextWidth(hideChar,
pTe->pDisplayFont) * (pTe->CurrentLength)),
                    pTe->hdr.top + GOL_EMBOSS_SIZE
                );
            }
            else
            {
                MoveTo
                (
                    pTe->hdr.right - 4 - GOL_EMBOSS_SIZE - GetTextWidth(pTe->pTeOutput,
pTe->pDisplayFont),
                    pTe->hdr.top + GOL_EMBOSS_SIZE
                );
            }

            counter = 0;
            state = TE_UPDATE_STRING;

        case TE_UPDATE_STRING:
            te_update_string :

            //output the text
            SetColor(pTe->hdr.pGolScheme->TextColor1);
            SetFont(pTe->pDisplayFont);

            // this is manually doing the OutText() function but with the capability to
replace the
            // characters to the * character when hide echo is
enabled.
            XcharTmp = *((pTe->pTeOutput) + counter);
            if(XcharTmp < (XCHAR)15)
            {

                // update is done time to return to start and exit with success
                SetClip(0); //reset the clipping
                state = TE_START;
                return (1);
            }
            else
            {
                if(GetState(pTe, TE_ECHO_HIDE))
                    OutChar(0x2A);
                else
                    OutChar(XcharTmp);
                state = TE_UPDATE_CHARACTERS;
            }

        case TE_UPDATE_CHARACTERS:
            if(IsDeviceBusy()) return (0);
            counter++;
            state = TE_UPDATE_STRING;
            goto te_update_string;
    }                       //end switch

    return (1);
}                           //end TeDraw()

/*********************************************************************
* Function: TeTranslateMsg(void *pObj, GOL_MSG *pMsg)
*
* Notes: Function to check which key was pressed/released
*
********************************************************************/
WORD TeTranslateMsg(void *pObj, GOL_MSG *pMsg)
{
    SHORT       NumberOfKeys, param1, param2;
    KEYMEMBER   *pKeyTemp = NULL;
    TEXTENTRY *pTe;

    pTe = (TEXTENTRY *)pObj;

    // Check if disabled first
    if(GetState(pTe, TE_DISABLED))
        return (OBJ_MSG_INVALID);

        #ifdef USE_TOUCHSCREEN

    //find the total number of keys
    NumberOfKeys = (pTe->horizontalKeys) *
    (pTe->verticalKeys);
    param1 = pMsg->param1;
    param2 = pMsg->param2;
    if((pMsg->type == TYPE_TOUCHSCREEN))
    {

        // Check if it falls in the panel of the TextEntry
        if
        (
            (pTe->hdr.left < pMsg->param1) &&
            (pTe->hdr.right > pMsg->param1) &&
            (pTe->hdr.top + (GetTextHeight(pTe->pDisplayFont) + (GOL_EMBOSS_SIZE << 1)) <
pMsg->param2) &&
            (pTe->hdr.bottom > pMsg->param2)
        )
        {

            /* If it fell inside the TextEntry panel, go through the link list and check
which one was pressed
               At this point the touch screen event is either EVENT_MOVE or EVENT_PRESS.
            */

            //point to the head of the link list
            pKeyTemp = pTe->pHeadOfList;

            while(pKeyTemp != NULL)
            {
                if
                (
                    (pKeyTemp->left < param1) &&
                    (pKeyTemp->right > param1) &&
                    (pKeyTemp->top < param2) &&
                    (pKeyTemp->bottom > param2)
                )
                {
                    if(pMsg->uiEvent == EVENT_RELEASE)
                    {
                        pTe->pActiveKey = pKeyTemp;
                        pKeyTemp->update = TRUE;

                        if(pTe->pActiveKey->state == TE_KEY_PRESSED)
                        {
                            if(pKeyTemp->command == 0)
                                return (TE_MSG_ADD_CHAR);

                            //command for a TE_DELETE_COM key
                            if(pKeyTemp->command == TE_DELETE_COM)
                                return (TE_MSG_DELETE);

                            //command for a TE_SPACE_COM key 0x20
                            if(pKeyTemp->command == TE_SPACE_COM)
                                return (TE_MSG_SPACE);

                            //command for a TE_ENTER_COM key
                            if(pKeyTemp->command == TE_ENTER_COM)
                                return (TE_MSG_ENTER);
                        }

                        // this is a catch all backup
                        return (TE_MSG_RELEASED);
                    }
                    else
                    {

                        // to shift the press to another key make sure that there are no
other

                        // keys currently pressed. If there is one it must be released
first.

                        // check if there are previously pressed keys
                        if(GetState(pTe, TE_KEY_PRESSED))
                        {

                            // there is a key being pressed.
                            if(pKeyTemp->index != pTe->pActiveKey->index)
```

```
                                {

                                    // release the currently pressed key first
                                    pTe->pActiveKey->update = TRUE;
                                    return (TE_MSG_RELEASED);
                                }
                            }
                            else
                            {

                                // check if the active key is not pressed
                                // if not, set to press since the current touch event
                                // is either move or press
                                // check if there is an active key already set
                                // if none, set the current key as active and return a pressed
mesage
                                if(pTe->pActiveKey == NULL)
                                {
                                    pTe->pActiveKey = pKeyTemp;
                                    pKeyTemp->update = TRUE;
                                    return (TE_MSG_PRESSED);
                                }

                                if(pTe->pActiveKey->state != TE_KEY_PRESSED)
                                {
                                    pTe->pActiveKey = pKeyTemp;
                                    pKeyTemp->update = TRUE;
                                    return (TE_MSG_PRESSED);
                                }
                                else
                                {
                                    return (OBJ_MSG_INVALID);
                                }
                            }
                        }
                    }
                    else
                    {

                        // if the key is in the pressed state and current touch is not here
                        // then it has to be redrawn
                        if(pKeyTemp->state == TE_KEY_PRESSED)
                        {
                            pTe->pActiveKey = pKeyTemp;
                            pKeyTemp->update = TRUE;
                            return (TE_MSG_RELEASED);
                        }
                    }

                    //access the next link list
                    pKeyTemp = pKeyTemp->pNextKey;
                }   //end while
            }
            else
            {
                if((pMsg->uiEvent == EVENT_MOVE) && (GetState(pTe, TE_KEY_PRESSED)))
                {
                    pTe->pActiveKey->update = TRUE;
                    return (TE_MSG_RELEASED);
                }
            }
        }

        return (OBJ_MSG_INVALID);
            #endif // USE_TOUCHSCREEN
}                   //end TeTranslateMsg()

/*********************************************************************
* Function: TeMsgDefault(WORD translatedMsg, void *pObj, GOL_MSG* pMsg)
*
*
* Notes: This the default operation to change the state of the key.
*        Called inside GOLMsg() when GOLMsgCallback() returns a 1.
*
*********************************************************************/
void TeMsgDefault(WORD translatedMsg, void *pObj, GOL_MSG *pMsg)
{
        TEXTENTRY *pTe;

        pTe = (TEXTENTRY *)pObj;

        switch(translatedMsg)
        {
            case TE_MSG_DELETE:
                SetState(pTe, TE_UPDATE_KEY | TE_UPDATE_TEXT);
                break;

            case TE_MSG_SPACE:
                TeSpaceChar(pTe);
                SetState(pTe, TE_UPDATE_KEY | TE_UPDATE_TEXT);
                break;

            case TE_MSG_ENTER:
                SetState(pTe, TE_UPDATE_KEY);
                break;

            case TE_MSG_ADD_CHAR:
                TeAddChar(pTe);
                SetState(pTe, TE_UPDATE_KEY | TE_UPDATE_TEXT);
                break;

            case TE_MSG_PRESSED:
                (pTe->pActiveKey)->state = TE_KEY_PRESSED;
                SetState(pTe, TE_KEY_PRESSED | TE_UPDATE_KEY);
                return;

            case TE_MSG_RELEASED:
                (pTe->pActiveKey)->state = 0;
                ClrState(pTe, TE_KEY_PRESSED);  // reset pressed
                SetState(pTe, TE_UPDATE_KEY);   // redraw
                return;
        }

        if(pTe->pActiveKey != NULL)
            (pTe->pActiveKey)->state = 0;
        ClrState(pTe, TE_KEY_PRESSED);
}

/*********************************************************************
* Function: void TeClearBuffer(TEXTENTRY *pTe)
*
* Notes: This function will clear the edibox and the buffer.
*        You must set the drawing state bit TE_UPDATE_TEXT
*        to update the TEXTENTRY on the screen.
*
*********************************************************************/
void TeClearBuffer(TEXTENTRY *pTe)
{
        WORD    i;

        //clear the buffer
        for(i = 0; i < (pTe->outputLenMax); i++)
        {
            *(pTe->pTeOutput + i) = 0;
        }

        pTe->CurrentLength = 0;
}

/*********************************************************************
* Function: void TeSetBuffer(TEXTENTRY *pTe, XCHAR *pText, WORD size)
*
* Notes: This function will replace the currently used buffer.
*        MaxSize defines the length of the buffer. Buffer must be
*        a NULL terminated string.
*
*********************************************************************/
void TeSetBuffer(TEXTENTRY *pTe, XCHAR *pText, WORD MaxSize)
{
        WORD    count = 0;
        XCHAR   *pTemp;

        pTemp = pText;

        while(*pTemp != 0)
        {
            if(count >= MaxSize)
                break;
            *pTemp++;
            count++;
        }

        // terminate the string
        *pTemp = 0;

        pTe->CurrentLength = count;
        pTe->outputLenMax = MaxSize-1;
        pTe->pTeOutput = pText;
}

/*********************************************************************
* Function: BOOL TeIsKeyPressed(TEXTENTRY *pTe,WORD index)
*
* Notes: This function will check if the key was pressed. If no
*        key was pressed it will return FALSE.
*
*********************************************************************/
BOOL TeIsKeyPressed(TEXTENTRY *pTe, WORD index)
{
        KEYMEMBER   *pTemp;

        pTemp = pTe->pHeadOfList;

        //search the key using the given index
        while(index != pTemp->index)
        {

            // catch all check
            if(pTemp == NULL)
                return (FALSE);
            pTemp = pTemp->pNextKey;
        }

        if(pTemp->state == TE_KEY_PRESSED)
        {
            return (TRUE);
        }
        else
        {
            return (FALSE);
        }
}

/*********************************************************************
* Function: BOOL TeSetKeyCommand(TEXTENTRY *pTe,WORD index,WORD command)
*
* Notes: This function will assign a command to a particular key.
*        Returns TRUE if sucessful and FALSE if not.
*
*********************************************************************/
BOOL TeSetKeyCommand(TEXTENTRY *pTe, WORD index, WORD command)
{
        KEYMEMBER   *pTemp;

        pTemp = pTe->pHeadOfList;
        //search the key using the given index
        while(index != pTemp->index)
        {

            // catch all check
            if(pTemp == NULL)
                return (FALSE);
            pTemp = pTemp->pNextKey;
        }

        pTemp->command = command;
        return (TRUE);
}

/*********************************************************************
* Function: TeGetKeyCommand(pTe, index)
*
* Notes: This function will return the currently used command by a key
*        with the given index.
*
********************************************************************/
WORD TeGetKeyCommand(TEXTENTRY *pTe, WORD index)
{
        KEYMEMBER   *pTemp;

        pTemp = pTe->pHeadOfList;

        //search the key using the given index
        while(index != pTemp->index)
        {

            // catch all check
            if(pTemp == NULL)
                return (0);
            pTemp = pTemp->pNextKey;
        }

        return (pTemp->command);
}

/*********************************************************************
* Function: BOOL TeSetKeyText(TEXTENTRY *pTe,WORD index, XCHAR *pText)
*
* Notes: This function will set the string associated with the key
*        with the new string pText. The key to be modified is determined
*        by the index. Returns TRUE if sucessful and FALSE if not.
*
********************************************************************/
BOOL TeSetKeyText(TEXTENTRY *pTe, WORD index, XCHAR *pText)
{
        KEYMEMBER   *pTemp;

        pTemp = pTe->pHeadOfList;

        //search the key using the given index
        while(index != pTemp->index)
        {
            // catch all check
            if(pTemp == NULL)
                return (FALSE);
            pTemp = pTemp->pNextKey;
        }

        // Set the the text
        pTemp->pKeyName = pText;

        return (TRUE);
}


/*********************************************************************
* Function: KEYMEMBER *TeCreateKeyMembers(TEXTENTRY *pTe,XCHAR *pText[])
```

```
*
* Notes: This function will create the members of the list
*
********************************************************************/
KEYMEMBER *TeCreateKeyMembers(TEXTENTRY *pTe, XCHAR *pText[])
{
    SHORT       NumberOfKeys, width, height;
    SHORT       keyTop, keyLeft;
    WORD        rowcount, colcount;
    WORD        index = 0;

    KEYMEMBER   *pKl = NULL;    //link list
    KEYMEMBER   *pTail = NULL;

    // determine starting positions of the keys
    keyTop = pTe->hdr.top +
    GetTextHeight(pTe->pDisplayFont) +
    (GOL_EMBOSS_SIZE << 1);
    keyLeft = pTe->hdr.left;    // + GOL_EMBOSS_SIZE;

    //calculate the total number of keys, and width and height of each key
    NumberOfKeys = pTe->horizontalKeys *
    pTe->verticalKeys;
    width = (pTe->hdr.right - keyLeft + 1) / pTe->horizontalKeys;
    height = (pTe->hdr.bottom - keyTop + 1) / pTe->verticalKeys;

    /*create the list and calculate the coordinates of each bottom, and the
textwidth/textheight of each font*/

    //Add a list for each key
    for(colcount = 0; colcount < pTe->verticalKeys; colcount++)
    {
        for(rowcount = 0; rowcount < pTe->horizontalKeys; rowcount++)
        {

            //get storage for new entry
            pKl = (KEYMEMBER *)GFX_malloc(sizeof(KEYMEMBER));
            if(pKl == NULL)
                return (NULL);
            if(pTe->pHeadOfList == NULL)
                pTe->pHeadOfList = pKl;
            if(pTail == NULL)
            {
                pTail = pKl;
            }
            else
            {
                pTail->pNextKey = pKl;
                pTail = pTail->pNextKey;
            }

            //set the index for the new list
            pKl->index = index;

            // set update flag to off
            pKl->update = FALSE;

            //calculate the x-y coordinate for each key
            pKl->left   = keyLeft + (rowcount * width);
            pKl->top    = keyTop  + (colcount * height);
            pKl->right  = keyLeft + ((rowcount + 1) * width);
            pKl->bottom = keyTop  + ((colcount + 1) * height);

            //Add the text to the list and increase the index
            pKl->pKeyName = pText[index++];

            //set the COMMAND to NULL for all keys
            pKl->command = 0;

            //calculate the textwidth, textheight
            pKl->textWidth = 0;
            pKl->textHeight = 0;
            if(pKl->pKeyName != NULL)
            {

                // Calculate the text width & height
                pKl->textWidth = GetTextWidth(pKl->pKeyName, pTe->hdr.pGolScheme->pFont);
                pKl->textHeight = GetTextHeight(pTe->hdr.pGolScheme->pFont);
            }                   //end if
        }                       //end for
    }                           //end for

    pTail->pNextKey = NULL;

    return (pKl);
}

/*********************************************************************
* Function: void TeDelKeyMembers(void *pObj)
*
* Notes: This function will delete the members of the list
********************************************************************/
void TeDelKeyMembers(void *pObj)
{
    KEYMEMBER   *pCurItem;
    KEYMEMBER   *pItem;
    TEXTENTRY *pTe;

    pTe = (TEXTENTRY *)pObj;

    pCurItem = pTe->pHeadOfList;

    while(pCurItem != NULL)
    {
        pItem = pCurItem;
        pCurItem = pCurItem->pNextKey;
        GFX_free(pItem);
    }

    pTe->pHeadOfList = NULL;
}

/*********************************************************************
* Function: void TeSpaceChar(TEXTENTRY *pTe)
*
* Notes: This function will add a space to the buffer/editbox
********************************************************************/
void TeSpaceChar(TEXTENTRY *pTe)
{

    //first determine if the array has not overflown
    if((pTe->CurrentLength) < pTe->outputLenMax)
    {
        *(pTe->pTeOutput + (pTe->CurrentLength)) = 0x20;
        *(pTe->pTeOutput + (pTe->CurrentLength) + 1) = 0;
    }   //end if
    (pTe->CurrentLength)++;
}

/*********************************************************************
* Function: void TeAddChar(TEXTENTRY *pTe)
*
* Notes: This function will add a character to the buffer/editbox
********************************************************************/
void TeAddChar(TEXTENTRY *pTe)
{
    XCHAR   *pPoint;

    //first determine if the array has not overflown
    if((pTe->CurrentLength) < pTe->outputLenMax)
    {
        pPoint = (pTe->pActiveKey)->pKeyName;
        while(*(pPoint) != 0)
        {
            *(pTe->pTeOutput + (pTe->CurrentLength)) = *(pPoint)++;
        }
    }   //end if
    else
    {

        // it is full ignore the added key
        return;
    }

    (pTe->CurrentLength)++;
    // add the string terminator
    *(pTe->pTeOutput + pTe->CurrentLength) = 0;
}

#endif // USE_TEXTENTRY
```

14.1.39 TextEntry.h

Functions

	Name	Description
	TeAddChar (see page 284)	This function will insert a character to the end of the buffer. The character inserted is dependent on the currently pressed key. Drawing states TE_UPDATE_TEXT (see page 278) or TE_DRAW (see page 277) must be set to see the effect of this insertion.
	TeClearBuffer (see page 282)	This function will clear the data in the display. You must set the drawing state bit TE_UPDATE_TEXT (see page 278) to update the TEXTENTRY (see page 290) on the screen.
	TeCreate (see page 279)	This function creates a TEXTENTRY (see page 290) object with the parameters given. It automatically attaches the new object into a global linked list of objects and returns the address of the object.
	TeCreateKeyMembers (see page 284)	This function will create the list of KEYMEMBERS that holds the information on each key. The number of keys is determined by the equation (verticalKeys*horizontalKeys). The object creates the information holder for each key automatically and assigns each entry in the *pText[] array with the first entry automatically assigned to the key with an index of 1. The number of entries to *pText[] must be equal or greater than (verticalKeys*horizontalKeys). The last key is assigned with an index of (verticalKeys*horizontalKeys)-1. No checking is performed on the length of *pText[] entries to match (verticalKeys*horizontalKeys).
	TeDelKeyMembers (see page 286)	This function will delete the KEYMEMBER (see page 291) list assigned to the object from memory. Pointer to the KEYMEMBER (see page 291) list is then initialized to NULL.
	TeDraw (see page 280)	This function renders the object on the screen using the current parameter settings. Location of the object is determined by the left, top, right and bottom parameters. The colors used are dependent on the state of the object. This widget will draw the keys using the function GOLPanelDraw (see page 322)(). The number of keys will depend on the horizontal and vertical parameters given (horizontalKeys*verticakKeys).
	TeGetKeyCommand (see page 282)	This function will return the currently used command by a key with the given index.
	TeIsKeyPressed (see page 285)	This function will test if a key given by its index in the TextEntry object has been pressed.
	TeMsgDefault (see page 287)	This function performs the actual state change based on the translated message given. The following state changes are supported:

◆	TeSetBuffer (see page 281)	This function sets the buffer used to display text. If the buffer is initialized with a string, the string must be a null terminated string. If the string length is greater than MaxSize, string will be truncated to MaxSize. pText must point to a valid memory location with size equal to MaxSize+1. The +1 is used for the string terminator.
◆	TeSetKeyCommand (see page 283)	This function will assign a command (TE_DELETE_COM (see page 278), TE_SPACE_COM (see page 279) or TE_ENTER_COM (see page 278)) to a key with the given index.
◆	TeSetKeyText (see page 287)	This function will set the test assigned to a key with the given index.
◆	TeSpaceChar (see page 286)	This function will insert a space character to the end of the buffer. Drawing states TE_UPDATE_TEXT (see page 278) or TE_DRAW (see page 277) must be set to see the effect of this insertion.
◆	TeTranslateMsg (see page 289)	This function evaluates the message from a user if the message will affect the object or not. If the message is valid, the keys in the Text Entry object will be scanned to detect which key was pressed. If True, the corresponding text will be displayed, the 'text' will also be stored in the TeOutput parameter of the object.

Macros

Name	Description
TE_DELETE_COM (see page 278)	This macro is used to assign a "delete" command on a key.
TE_DISABLED (see page 277)	Bit for disabled state.
TE_DRAW (see page 277)	Bit to indicate object must be redrawn.
TE_ECHO_HIDE (see page 277)	Bit to hide the entered characters and instead echo "*" characters to the display.
TE_ENTER_COM (see page 278)	This macro is used to assign an "enter" (carriage return) command on a key.
TE_HIDE (see page 277)	Bit to indicate object must be removed from screen.
TE_KEY_PRESSED (see page 276)	Bit for press state of one of the keys.
TE_SPACE_COM (see page 279)	This macro is used to assign an insert "space" command on a key.
TE_UPDATE_KEY (see page 277)	Bit to indicate redraw of a key is needed.
TE_UPDATE_TEXT (see page 278)	Bit to indicate redraw of the text displayed is needed.
TeGetBuffer (see page 281)	This macro will return the currently used buffer in the TextEntry object.

Structures

Name	Description
KEYMEMBER (see page 291)	Defines the parameters and the strings assigned for each key.
TEXTENTRY (see page 290)	Defines the parameters required for a TextEntry Object.

Description

This is file TextEntry.h.

Body Source

```
/*****************************************************************************
 *  Module for Microchip Graphics Library
 *  GOL Layer
 *  TextEntry
 *****************************************************************************
 * FileName:        TextEntry.h
 * Dependencies:    None
 * Processor:       PIC24F, PIC24H, dsPIC, PIC32
 * Compiler:        MPLAB C30, MPLAB C32
 * Linker:          MPLAB LINK30, MPLAB LINK32
 * Company:         Microchip Technology Incorporated
 *
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 * CLAIMS BY THIRD PARTIES (INCLUDING BUT NOT LIMITED TO ANY DEFENSE THEREOF),
 * OR OTHER SIMILAR COSTS.
 *
 * Date         Comment
 *~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
 * 10/24/08     ...
 *****************************************************************************/
#ifndef _TEXTENTRY_H
    #define _TEXTENTRY_H

    #include <Graphics/GOL.h>
    #include "GenericTypeDefs.h"

/*********************************************************************
* Object States Definition:
*********************************************************************/
    #define TE_KEY_PRESSED  0x0004  // Bit for press state of one of the keys.
    #define TE_DISABLED     0x0002  // Bit for disabled state.
    #define TE_ECHO_HIDE    0x0008  // Bit to hide the entered characters and instead echo
"*" characters to the display.
    #define TE_DRAW         0x4000  // Bit to indicate object must be redrawn.
    #define TE_HIDE         0x8000  // Bit to indicate object must be removed from screen.
    #define TE_UPDATE_KEY   0x2000  // Bit to indicate redraw of a key is needed.
    #define TE_UPDATE_TEXT  0x1000  // Bit to indicate redraw of the text displayed is
needed.

/*********************************************************************
* Optional COMMANDS assigned to keys
*********************************************************************/
    #define TE_DELETE_COM   0x01    // This macro is used to assign a "delete" command on a
key.
    #define TE_SPACE_COM    0x02    // This macro is used to assign an insert "space"
command on a key.
    #define TE_ENTER_COM    0x03    // This macro is used to assign an "enter" (carriage
return) command on a key.

// User can use this command to customize application code in the message

// callback function. Use the returned translated TE_MSG_ENTER to detect the key

// pressed was assigned the enter command. Refer to TeTranslateMsg() for details.

/*********************************************************************
* Overview: Defines the parameters and the strings assigned for each key.
*********************************************************************/
typedef struct
{
    SHORT   left;       // Left position of the key
    SHORT   top;        // Top position of the key
    SHORT   right;      // Right position of the key
    SHORT   bottom;     // Bottom position of the key
    SHORT   index;      // Index of the key in the list
    WORD    state;      // State of the key. Either Pressed (TE_KEY_PRESSED) or Released (0)
    BOOL    update;     // flag to indicate key is to be redrawn with the current state
    WORD    command;    // Command of the key. Either TE_DELETE_COM, TE_SPACE_COM or
TE_ENTER_COM.
```

```
    XCHAR   *pKeyName;  // Pointer to the custom text assigned to the key. This is
displayed over the face of the key.
    SHORT   textWidth;  // Computed text width, done at creation. Used to predict size and
position of text on the key face.
    SHORT   textHeight; // Computed text height, done at creation. Used to predict size and
position of text on the key face.
    void    *pNextKey;  // Pointer to the next key parameters.
} KEYMEMBER;

/*********************************************************************
* Overview: Defines the parameters required for a TextEntry Object.
*********************************************************************/
typedef struct
{
    OBJ_HEADER  hdr;            // Generic header for all objects (see OBJ_HEADER).
    SHORT       horizontalKeys; // Number of horizontal keys
    SHORT       verticalKeys;   // Number of vertical keys
    XCHAR       *pTeOutput;     // Pointer to the buffer assigned by the user which holds
the text shown in the editbox.

    // User creates and manages the buffer. Buffer can also be managed using the APIs
provided
    // to add a character, delete the last character or clear the buffer.
    WORD        CurrentLength;  // Current length of the string in the buffer. The maximum
value of this is equal to outputLenMax.

    // TextEntry object will update this parameter when adding, removing characters or
clearing the buffer
    // and switching buffers.
    WORD        outputLenMax;   // Maximum expected length of output buffer pTeOutput
    KEYMEMBER   *pActiveKey;    // Pointer to the active key KEYMEMBER. This is only used
by the Widget. User must not change

    // the value of this parameter directly.
    KEYMEMBER   *pHeadOfList;   // Pointer to head of the list
    void        *pDisplayFont;  // Pointer to the font used in displaying the text.
} TEXTENTRY;

/*********************************************************************
* Function: TEXTENTRY *TeCreate(WORD ID, SHORT left, SHORT top,
*                    SHORT right, SHORT bottom, WORD state,
*                    SHORT horizontalKeys, SHORT verticalKeys, XCHAR *pText[],
*                    void *pBuffer, WORD bufferLength,void *pDisplayFont,
*                    GOL_SCHEME *pScheme)
*
* Overview: This function creates a TEXTENTRY object with the parameters given.
*           It automatically attaches the new object into a global linked list of
*           objects and returns the address of the object.
*
*
* PreCondition: If the object will use customized keys, the structure CUSTOMEKEYS must be
*               populated before calling this function.
*
* Input:  ID -      Unique user defined ID for the object instance
*         left-     Left most position of the object.
*         top -     Top most position of the object.
*         right -   Right most position of the object.
*         bottom -  Bottom most position of the object.
*         state          - state of the widget.
*         horizontalKeys - Number of horizontal keys
*         verticalKeys   - Number of vertical keys
*         pText          - array of pointer to the custom "text" assigned by the user.
*         bufferLength   - length of the buffer assigned by the user.
*         pDisplayFont   - pointer to the font image to be used on the editbox
*         pScheme- Pointer to the style scheme used.
*
* Output Returns the pointer to the object created.
*
* Side Effects: none.
*
*********************************************************************/
TEXTENTRY   *TeCreate
```

```
            (
                WORD        ID,
                SHORT       left,
                SHORT       top,
                SHORT       right,
                SHORT       bottom,
                WORD        state,
                SHORT       horizontalKeys,
                SHORT       verticalKeys,
                XCHAR       *pText[],
                void        *pBuffer,
                WORD        bufferLength,
                void        *pDisplayFont,
                GOL_SCHEME  *pScheme
            );

/*********************************************************************
* Function: WORD TeDraw(void *pObj)
*
* Overview: This function renders the object on the screen using
*           the current parameter settings. Location of the object is
*           determined by the left, top, right and bottom parameters.
*           The colors used are dependent on the state of the object.
*
*           This widget will draw the keys using the function
*           GOLPanelDraw(). The number of keys will depend on the horizontal
*           and vertical parameters given (horizontalKeys*verticakKeys).
*
* PreCondition: Object must be created before this function is called.
*
* Input: pTe- Pointer to the object to be rendered.
*
* Output: Returns the status of the drawing
*          - 1 - If the rendering was completed and
*          - 0 - If the rendering is not yet finished.
*          Next call to the function will resume the
*          rendering on the pending drawing state.
*
* Side Effects: none.
*
********************************************************************/
WORD TeDraw(void *pObj);

/*********************************************************************
* Function:  WORD TeTranslateMsg(void *pObj, GOL_MSG *pMsg)
*
* Overview: This function evaluates the message from a user if the
*           message will affect the object or not. If the message
*           is valid, the keys in the Text Entry object will be
*           scanned to detect which key was pressed. If True, the
*           corresponding text will be displayed, the ‘text’ will
*           also be stored in the TeOutput parameter of the object.
*
*   <TABLE>
*       Translated Message   Input Source  Events                        Description
*       ##################   ############  ######                        ###########
*       TE_MSG_PRESS         Touch Screen  EVENT_PRESS, EVENT_MOVE      If the event occurs
and the x,y position falls in the face of one of the keys of the object while the key is
unpressed.
*       TE_MSG_RELEASED      Touch Screen  EVENT_MOVE                    If the event occurs
and the x,y position falls outside the face of one of the keys of the object while the key
is pressed.
*       TE_MSG_RELEASED      Touch Screen  EVENT_RELEASE                 If the event occurs
and the x,y position falls does not falls inside any of the faces of the keys of the
object.
*       TE_MSG_ADD_CHAR      Touch Screen  EVENT_RELEASE, EVENT_MOVE    If the event occurs
and the x,y position falls in the face of one of the keys of the object while the key is
unpressed and the key is associated with no commands.
*       TE_MSG_DELETE        Touch Screen  EVENT_RELEASE, EVENT_MOVE    If the event occurs
and the x,y position falls in the face of one of the keys of the object while the key is
unpressed and the key is associated with delete command.
*       TE_MSG_SPACE         Touch Screen  EVENT_RELEASE, EVENT_MOVE    If the event occurs
```

```
and the x,y position falls in the face of one of the keys of the object while the key is
unpressed and the key is associated with space command.
*       TE_MSG_ENTER         Touch Screen  EVENT_RELEASE, EVENT_MOVE    If the event occurs
and the x,y position falls in the face of one of the keys of the object while the key is
unpressed and the key is associated with enter command.
*       OBJ_MSG_INVALID      Any           Any                          If the message did
not affect the object.
*   </TABLE>
*
* PreCondition: none
*
* Input:    pTe-    The pointer to the object where the message will be
*                   evaluated to check if the message will affect the object.
*           pMsg-   Pointer to the message struct containing the message from
*                   the user interface.
*
* Output: Returns the translated message depending on the received GOL message:
*         - TE_MSG_PRESS – A key is pressed
*         - TE_MSG_RELEASED - A key was released (generic for keys with no commands or
characters assigned)
*         - TE_MSG_ADD_CHAR – A key was released with character assigned
*         - TE_MSG_DELETE – A key was released with delete command assigned
*         - TE_MSG_SPACE - A key was released with space command assigned
*         - TE_MSG_ENTER - A key was released with enter command assigned
*         - OBJ_MSG_INVALID – Text Entry is not affected
*
* Side Effects: none.
*
********************************************************************/
WORD        TeTranslateMsg(void *pObj, GOL_MSG *pMsg);

/*********************************************************************
* Function: TeMsgDefault(WORD translatedMsg, void *pObj, GOL_MSG* pMsg)
*
* Overview: This function performs the actual state change
*           based on the translated message given. The following state changes
*           are supported:
*   <TABLE>
*       Translated Message   Input Source   Set/Clear State Bit     Description
*       ##################   ############   ######                  ###########
*       TE_MSG_ADD_CHAR      Touch Screen,  Set TE_UPDATE_TEXT,     Add a character in the
buffer and update the text displayed.
*                                               TE_UPDATE_KEY,
*                                           Clear TE_KEY_PRESSED
*       TE_MSG_SPACE         Touch Screen,  Set TE_UPDATE_TEXT,     Insert a space
character in the buffer and update the text displayed.
*                                               TE_UPDATE_KEY,
*                                           Clear TE_KEY_PRESSED
*       TE_MSG_DELETE        Touch Screen,  Set TE_UPDATE_TEXT,     Delete the most recent
character in the buffer and update the text displayed.
*                                               TE_UPDATE_KEY,
*                                           Clear TE_KEY_PRESSED
*       TE_MSG_ENTER         Touch Screen,  Set TE_UPDATE_TEXT,     User can define the use
of this event in the message callback. Object will just update the key.
*                                               TE_UPDATE_KEY,
*                                           Clear TE_KEY_PRESSED
*       TE_MSG_RELEASED      Touch Screen,  Clear TE_KEY_PRESSED    A Key in the object
will be redrawn in the unpressed state.
*                                           Set Te_UPDATE_KEY
*       TE_MSG_PRESSED       Touch Screen,  Set TE_KEY_PRESSED      A Key in the object
will be redrawn in the pressed state.
*                                               TE_UPDATE_KEY
*
*   </TABLE>
*
* PreCondition: none
*
* Input: translatedMsg - The translated message.
*          pTe           - The pointer to the object whose state will be modified.
*          pMsg          - The pointer to the GOL message.
*
* Output: none
```

```
*
* Example:
*   See BtnTranslateMsg() example.
*
* Side Effects: none
*
********************************************************************/
void        TeMsgDefault(WORD translatedMsg, void *pObj, GOL_MSG *pMsg);

/*********************************************************************
* Function: void TeSetBuffer(TEXTENTRY *pTe, XCHAR *pText, WORD MaxSize)
*
* Overview: This function sets the buffer used to display text. If the
*           buffer is initialized with a string, the string must be
*           a null terminated string. If the string length is greater
*           than MaxSize, string will be truncated to MaxSize.
*           pText must point to a valid memory location with size equal
*           to MaxSize+1. The +1 is used for the string terminator.
*
*
* PreCondition: none
*
* Input:    pTe- pointer to the object
*           pText- pointer to the new text buffer to be displayed
*           maxSize - maximum length of the new buffer to be used.
* Output:  none.
*
* Side Effects: none.
*
********************************************************************/
void        TeSetBuffer(TEXTENTRY *pTe, XCHAR *pText, WORD MaxSize);

/*********************************************************************
* Macro: TeGetBuffer(pTe)
*
* Overview: This macro will return the currently used buffer in the
*           TextEntry object.
*
* PreCondition: none
*
* Input:    pTe- pointer to the object
*
* Output:  It will return a pointer to the buffer used.
*
* Side Effects: none.
*
********************************************************************/
    #define TeGetBuffer(pTe)    (((TEXTENTRY *)pTe)->pTeOutput)

/*********************************************************************
* Function: void TeClearBuffer (TEXTENTRY *pTe)
*
* Overview: This function will clear the data in the display. You must
*           set the drawing state bit TE_UPDATE_TEXT
*           to update the TEXTENTRY on the screen.
*
* PreCondition: none
*
* Input:    pTe- pointer to the object
*
* Output:  none
*
* Side Effects: none.
*
********************************************************************/
void        TeClearBuffer(TEXTENTRY *pTe);

/*********************************************************************
* Function: BOOL TeIsKeyPressed(TEXTENTRY *pTe, WORD index)
*
* Overview: This function will test if a key given by its index
*           in the TextEntry object has been pressed.
```

```
 *
 * PreCondition: none
 *
 * Input:    pTe- pointer to the object
 *           index- index to the key in the link list
 * Output:   Returns a TRUE if the key is pressed. FALSE if key
 *           is not pressed or the given index does not exist in
 *           the list.
 *
 * Side Effects: none.
 *
 ********************************************************************/
 BOOL        TeIsKeyPressed(TEXTENTRY *pTe, WORD index);

 /*********************************************************************
 * Function: void TeSetKeyCommand(TEXTENTRY *pTe,WORD index,WORD command)
 *
 * Overview: This function will assign a command (TE_DELETE_COM, TE_SPACE_COM
 *           or TE_ENTER_COM) to a key with the given index.
 *
 * PreCondition: none
 *
 * Input:    pTe  -      pointer to the object
 *           index  -    index to the key in the link list
 *           command-    command assigned for the key
 *
 * Output:   Returns TRUE if successful and FALSE if not.
 *
 * Side Effects: none.
 *
 ********************************************************************/
 BOOL        TeSetKeyCommand(TEXTENTRY *pTe, WORD index, WORD command);

 /*********************************************************************
 * Function: TeGetKeyCommand(pTe, index)
 *
 * Overview: This function will return the currently used command by a key
 *           with the given index.
 *
 * PreCondition: none
 *
 * Input:    pTe- pointer to the object
 *           index- index to the key in the link list
 *
 * Output:  It will return the command ID currently set for the key. If the
 *          given index is not in the list the function returns zero.
 *          0x00 - no command is assigned or the index given does not exist.
 *          0x01 - TE_DELETE_COM
 *          0x02 - TE_SPACE_COM
 *          0x03 - TE_ENTER_COM
 *
 * Side Effects: none.
 *
 ********************************************************************/
 WORD        TeGetKeyCommand(TEXTENTRY *pTe, WORD index);

 /*********************************************************************
 * Function: TeSetKeyText(TEXTENTRY *pTe, WORD index, XCHAR *pText)
 *
 * Overview: This function will set the test assigned to a key with
 *           the given index.
 *
 * PreCondition: none
 *
 * Input:    pTe  -      pointer to the object
 *           index  -    index to the key in the link list
 *           pText -     pointer to the new string to be used
 *
 * Output:   Returns TRUE if successful and FALSE if not.
 *
 * Side Effects: none.
 *
```

```
********************************************************************/
BOOL TeSetKeyText(TEXTENTRY *pTe, WORD index, XCHAR *pText);

/*********************************************************************
* Function: KEYMEMBER *TeCreateKeyMembers(TEXTENTRY *pTe,XCHAR *pText[])
*
* Overview: This function will create the list of KEYMEMBERS that holds the
*           information on each key. The number of keys is determined by the
*           equation (verticalKeys*horizontalKeys). The object creates the information
*           holder for each key automatically and assigns each entry in the *pText[]
*           array with the first entry automatically assigned to the key with an
*           index of 1. The number of entries to *pText[] must be equal or greater
*           than (verticalKeys*horizontalKeys). The last key is assigned with an index
*           of (verticalKeys*horizontalKeys)-1. No checking is performed on the
*           length of *pText[] entries to match (verticalKeys*horizontalKeys).
*
* PreCondition: none
*
* Input:    pTe  -      pointer to the object
*           pText -     pointer to the text defined by the user
*
* Output: Returns the pointer to the newly created KEYMEMBER list. A NULL is returned
*         if the list is not created succesfully.
*
* Side Effects: none.
*
********************************************************************/
KEYMEMBER   *TeCreateKeyMembers(TEXTENTRY *pTe, XCHAR *pText[]);

/*********************************************************************
* Function: void TeDelKeyMembers(void *pObj)
*
* Overview: This function will delete the KEYMEMBER list assigned to
*           the object from memory. Pointer to the KEYMEMBER list is
*           then initialized to NULL.
*
* PreCondition: none
*
* Input:    pTe  -  pointer to the object
*
* Output:  none.
*
* Side Effects: none.
*
********************************************************************/
void        TeDelKeyMembers(void *pObj);

/*********************************************************************
* Function: void TeSpaceChar(TEXTENTRY *pTe)
*
* Overview: This function will insert a space character to the end of
*           the buffer. Drawing states TE_UPDATE_TEXT or TE_DRAW must
*           be set to see the effect of this insertion.
*
* PreCondition: none
*
* Input:    pTe  -  pointer to the object
*
* Output:  none.
*
* Side Effects: none.
*
********************************************************************/
void        TeSpaceChar(TEXTENTRY *pTe);

/*********************************************************************
* Function: void TeAddChar(TEXTENTRY *pTe)
*
* Overview: This function will insert a character to the end of
*           the buffer. The character inserted is dependent on the
*           currently pressed key. Drawing states TE_UPDATE_TEXT or
*           TE_DRAW must be set to see the effect of this insertion.
```

```
*
* PreCondition: none
*
* Input:    pTe  -  pointer to the object
*
* Output:
*
* Side Effects: none.
*
********************************************************************/
void        TeAddChar(TEXTENTRY *pTe);
#endif // _TEXTENTRY_H
```

14.1.40 GraphicsConfig.h

Macros

Name	Description
COLOR_DEPTH (see page 48)	Specifies the color depth used in the application defined in GraphicsConfig.h.
GFX_free (see page 48)	When using Operating Systems (OS), define the OS specific malloc() and free() functions for compatibility with the OS based systems. Define these in GraphicsConfig.h
GFX_malloc (see page 48)	When using Operating Systems (OS), define the OS specific malloc() and free() functions for compatibility with the OS based systems. Define these in GraphicsConfig.h
USE_ALPHABLEND (see page 40)	To enable support for Alpha Blending. Use this feature only if the display driver used can support alpha blending. Define this in GraphicsConfig.h
USE_ANALOGCLOCK (see page 32)	Enable Analog Clock Object.
USE_BITMAP_EXTERNAL (see page 47)	Similar to Font data bitmaps can also be placed in two locations. One is in FLASH memory and the other is from external memory. Definining one or both enables the support for bitmaps located in internal flash and external memory. Define this in GraphicsConfig.h • USE_BITMAP_FLASH - Images located in internal flash memory. • USE_BITMAP_EXTERNAL (see page 47) - Images located in external memory (including external memory mapped to EDS)..
USE_BITMAP_FLASH (see page 46)	Similar to Font data bitmaps can also be placed in two locations. One is in FLASH memory and the other is from external memory. Definining one or both enables the support for bitmaps located in internal flash and external memory. Define this in GraphicsConfig.h • USE_BITMAP_FLASH - Images located in internal flash memory. • USE_BITMAP_EXTERNAL (see page 47) - Images located in external memory (including external memory mapped to EDS)..
USE_BUTTON (see page 32)	Enable Button (see page 78) Object.
USE_BUTTON_MULTI_LINE (see page 33)	Enable Multi-Line (see page 366) Button (see page 78) Object
USE_CHECKBOX (see page 33)	Enable Checkbox (see page 130) Object.
USE_COMP_IPU (see page 41)	To enable support for DEFLATE compressed images for PutImage (see page 383)(). When this macro is enabled, the PutImage (see page 383)() function will be able to process images generated by the Graphics Resource Converter (GRC) that are compressed using the DEFLATE algorithm. PutImage (see page 383)() will need the IPU module of the Microchip Graphics Module to decompress. Enable this feature only when the driver features the IPU module (example: PIC24FJ2456DA210). Define this in GraphicsConfig.h
USE_COMP_RLE (see page 41)	To enable support for RLE compressed images for PutImage (see page 383)(). When this macro is enabled, the PutImage (see page 383)() function will be able to process images generated by the Graphics Resource Converter (GRC) that are RLE compressed. Define this in GraphicsConfig.h

USE_CUSTOM (see page 36)	Enable Custom Control Object (an example to create customized Object).
USE_DIGITALMETER (see page 33)	Enable DigitalMeter Object.
USE_DOUBLE_BUFFERING (see page 41)	To enable support for double buffering. Use this feature only if the display driver used can support double buffering. Define this in GraphicsConfig.h
USE_EDITBOX (see page 33)	Enable Edit Box Object.
USE_FOCUS (see page 31)	Keyboard control on some objects can be used by enabling the GOL (see page 64) Focus (USE_FOCUS)support. Define this in GraphicsConfig.h
USE_FONT_EXTERNAL (see page 46)	Font data can be placed in two locations. One is in FLASH memory and the other is from external memory. Definining one or both enables the support for fonts located in internal flash and external memory. Define this in GraphicsConfig.h • USE_FONT_FLASH - Font in internal flash memory support. • USE_FONT_EXTERNAL (see page 46) - Font in external memory support (including external memory mapped to EDS).
USE_FONT_FLASH (see page 45)	Font data can be placed in two locations. One is in FLASH memory and the other is from external memory. Definining one or both enables the support for fonts located in internal flash and external memory. Define this in GraphicsConfig.h • USE_FONT_FLASH - Font in internal flash memory support. • USE_FONT_EXTERNAL (see page 46) - Font in external memory support (including external memory mapped to EDS).
USE_GOL (see page 36)	Enable Graphics Object Layer.
USE_GRADIENT (see page 38)	To enable support for Gradient bars and bevel primitives. Define this in GraphicsConfig.h.
USE_GROUPBOX (see page 34)	Enable Group Box Object.
USE_KEYBOARD (see page 30)	Input devices used defines the messages that Objects will process. The following definitions indicate the usage of the different input device: • USE_TOUCHSCREEN - enables the touch screen support. • USE_KEYBOARD (see page 30) - enables the key board support. Define in GraphicsConfig.h
USE_LISTBOX (see page 34)	Enable List Box Object.
USE_METER (see page 34)	Enable Meter (see page 210) Object.
USE_MULTIBYTECHAR (see page 37)	To enable support for unicode fonts, USE_MULTIBYTECHAR must be defined. This sets the XCHAR (see page 361) definition (0-2^16 range). See XCHAR (see page 361) for details. Define this in GraphicsConfig.h
USE_NONBLOCKING_CONFIG (see page 45)	Blocking and Non-Blocking configuration selection. To enable non-blocking configuration USE_NONBLOCKING_CONFIG must be defined. If this is not defined, blocking configuration is assumed. Define this in GraphicsConfig.h
USE_PALETTE (see page 48)	Using Palettes, different colors can be used with the same bit depth. Define this in GraphicsConfig.h
USE_PALETTE_EXTERNAL (see page 48)	Palettes can also be specified to reside in external memory similar to fonts and images. Use this when the palette is located in external memory. Define this in GraphicsConfig.h
USE_PICTURE (see page 34)	Enable Picture (see page 224) Object.
USE_PROGRESSBAR (see page 34)	Enable Progress Bar (see page 371) Object.
USE_RADIOBUTTON (see page 35)	Enable Radio Button (see page 78) Object.
USE_ROUNDDIAL (see page 35)	Enable Dial (see page 138) Object.
USE_SLIDER (see page 35)	Enable Slider (see page 251) or Scroll (see page 439) Bar (see page 371) Object.
USE_STATICTEXT (see page 35)	Enable Static Text Object.
USE_TEXTENTRY (see page 36)	Enable TextEntry Object.

USE_TOUCHSCREEN (see page 31)	Input devices used defines the messages that Objects will process. The following definitions indicate the usage of the different input device: • USE_TOUCHSCREEN - enables the touch screen support. • USE_KEYBOARD (see page 30) - enables the key board support. Define in GraphicsConfig.h
USE_TRANSPARENT_COLOR (see page 39)	To enable support for transparent color in PutImage (see page 383)(). Enabling this macro enables the use of a transparent color (set by TransparentColorEnable (see page 401)()) in rendering images by PutImage (see page 383)(). When a pixel in the image matches the transparent color set, the pixel is not rendered to the screen. This is useful in rendering rounded icons or images to the screen with a complex background. Define this in GraphicsConfig.h
USE_UNSIGNED_XCHAR (see page 38)	To enable support for unsigned characters data type for fonts, USE_UNSIGNED_XCHAR must be defined. This sets the XCHAR (see page 361) definition (0-255 range). See XCHAR (see page 361) for details. Define this in GraphicsConfig.h
USE_WINDOW (see page 36)	Enable Window (see page 292) Object.

Description

This is file GraphicsConfig.h.

Body Source

```
/*********************************************************************
 * Module for Microchip Graphics Library
 * This file contains compile time options for the Graphics Library.
 *********************************************************************
 * FileName:        GraphicsConfig.h
 * Dependencies:    none
 * Processor:       PIC24F, PIC24H, dsPIC, PIC32
 * Compiler:        C30 V3.00/C32
 * Company:         Microchip Technology, Inc.
 *
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 * CLAIMS BY THIRD PARTIES (INCLUDING BUT NOT LIMITED TO ANY DEFENSE THEREOF),
 * OR OTHER SIMILAR COSTS.
 *
 * Author                   Date            Comment
 *~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
 * Anton Alkhimenok         10/28/2007      Initial Version
 * Pradeep Budagutta        10/28/2007      Display related defines
 *                                          moved to DisplayConfig.h
 ********************************************************************/
#ifndef _GRAPHICSCONFIG_H
    #define _GRAPHICSCONFIG_H
```

```
/////////////////// COMPILE OPTIONS AND DEFAULTS ///////////////////

/*********************************************************************
* Overview: Blocking and Non-Blocking configuration selection. To
*           enable non-blocking configuration USE_NONBLOCKING_CONFIG
*           must be defined. If this is not defined, blocking
*           configuration is assumed. Define this in GraphicsConfig.h
*
********************************************************************/
#define USE_NONBLOCKING_CONFIG

/*********************************************************************
* Overview: Using Palettes, different colors can be used with the same
*           bit depth. Define this in GraphicsConfig.h
*
********************************************************************/
#define USE_PALETTE

/*********************************************************************
* Overview: Palettes can also be specified to reside in external memory
*           similar to fonts and images. Use this when the palette is
*           located in external memory. Define this in GraphicsConfig.h
*
********************************************************************/
#define USE_PALETTE_EXTERNAL

/*********************************************************************
* Overview: Keyboard control on some objects can be used by enabling
*           the GOL Focus (USE_FOCUS)support. Define this in GraphicsConfig.h
*
*********************************************************************/
#define USE_FOCUS

/*********************************************************************
* Overview: Input devices used defines the messages that Objects will
*           process. The following definitions indicate the usage of
*           the different input device:
*           - USE_TOUCHSCREEN - enables the touch screen support.
*           - USE_KEYBOARD - enables the key board support.
*           Define in GraphicsConfig.h
*
*********************************************************************/
#define USE_TOUCHSCREEN
#define USE_KEYBOARD // <COPY USE_TOUCHSCREEN>

/*********************************************************************
* Overview: To save program memory, unused Widgets or Objects can be
*           removed at compile time. Define in GraphicsConfig.h
*
*********************************************************************/
#define USE_GOL                   // Enable Graphics Object Layer.
#define USE_BUTTON                // Enable Button Object.
#define USE_BUTTON_MULTI_LINE     // Enable Multi-Line Button Object
#define USE_WINDOW                // Enable Window Object.
#define USE_CHECKBOX              // Enable Checkbox Object.
#define USE_RADIOBUTTON           // Enable Radio Button Object.
#define USE_EDITBOX               // Enable Edit Box Object.
#define USE_LISTBOX               // Enable List Box Object.
#define USE_SLIDER                // Enable Slider or Scroll Bar Object.
#define USE_PROGRESSBAR           // Enable Progress Bar Object.
#define USE_STATICTEXT            // Enable Static Text Object.
#define USE_PICTURE               // Enable Picture Object.
#define USE_GROUPBOX              // Enable Group Box Object.
#define USE_ROUNDDIAL             // Enable Dial Object.
#define USE_METER                 // Enable Meter Object.
#define USE_DIGITALMETER          // Enable DigitalMeter Object.
#define USE_TEXTENTRY             // Enable TextEntry Object.
#define USE_CUSTOM                // Enable Custom Control Object (an example to create
customized Object).
#define USE_ANALOGCLOCK           // Enable Analog Clock Object.

/*********************************************************************
```

```
* Overview: To enable support for unicode fonts, USE_MULTIBYTECHAR
*           must be defined. This sets the XCHAR definition
*           (0-2^16 range). See XCHAR for details. Define this in GraphicsConfig.h
*
********************************************************************/
    #define USE_MULTIBYTECHAR

/*********************************************************************
* Overview: To enable support for unsigned characters data type for
*           fonts, USE_UNSIGNED_XCHAR must be defined. This sets the
*           XCHAR definition (0-255 range). See XCHAR for details.
*           Define this in GraphicsConfig.h
*
********************************************************************/
    #define USE_UNSIGNED_XCHAR

/*********************************************************************
* Overview: Font data can be placed in two locations. One is in
*           FLASH memory and the other is from external memory.
*           Definining one or both enables the support for fonts located
*           in internal flash and external memory. Define this in GraphicsConfig.h
*    - USE_FONT_FLASH - Font in internal flash memory support.
*    - USE_FONT_EXTERNAL - Font in external memory support (including external memory mapped
to EDS).
*
********************************************************************/
    #define USE_FONT_FLASH
    #define USE_FONT_EXTERNAL       // <COPY USE_FONT_FLASH>

/*********************************************************************
* Overview: Similar to Font data bitmaps can also be placed in
*           two locations. One is in FLASH memory and the other is
*           from external memory.
*           Definining one or both enables the support for bitmaps located
*           in internal flash and external memory. Define this in GraphicsConfig.h
*    - USE_BITMAP_FLASH - Images located in internal flash memory.
*    - USE_BITMAP_EXTERNAL - Images located in external memory (including external memory
mapped to EDS)..
*
********************************************************************/
    #define USE_BITMAP_FLASH
    #define USE_BITMAP_EXTERNAL     // <COPY USE_BITMAP_FLASH>


/*********************************************************************
* Overview: When using Operating Systems (OS), define the OS specific
*           malloc() and free() functions for compatibility with the
*           OS based systems. Define these in GraphicsConfig.h
*
********************************************************************/
    #define GFX_malloc(size)        malloc(size)
    #define GFX_free(pObj)          free(pObj)      // <COPY GFX_malloc>

/*********************************************************************
* Overview: Specifies the color depth used in the application defined
*           in GraphicsConfig.h.
*
********************************************************************/
    #define COLOR_DEPTH             16

/*********************************************************************
* Overview: To enable support for Gradient bars and bevel primitives.
*           Define this in GraphicsConfig.h.
*
********************************************************************/
    #define USE_GRADIENT

/*********************************************************************
* Overview: To enable support for Alpha Blending. Use this feature only
*           if the display driver used can support alpha blending.
*           Define this in GraphicsConfig.h
*
```

```
*********************************************************************/
    #define USE_ALPHABLEND

/*********************************************************************
* Overview: Declare this macro to enable application layer to override
*           the Graphics Library supplied default GOL Scheme.
*           When this is defined, the application code must define
*           GOL_SCHEME GOLSchemeDefault structure and initialize its
*           structure members to the user desired initial values.
*           Each call to GOLCreateScheme() will use the user defined
*           style scheme initialization. Define this in GraphicsConfig.h
*
*********************************************************************/
    #define GFX_SCHEMEDEFAULT

/*********************************************************************
* Overview: To enable support for transparent color in PutImage().
*           Enabling this macro enables the use of a transparent color
*           (set by TransparentColorEnable()) in rendering images by
*           PutImage(). When a pixel in the image matches the transparent
*           color set, the pixel is not rendered to the screen.
*           This is useful in rendering rounded icons or images to the
*           screen with a complex background. Define this in GraphicsConfig.h
*
*********************************************************************/
    #define USE_TRANSPARENT_COLOR

/*********************************************************************
* Overview: To enable support for double buffering. Use this feature only
*           if the display driver used can support double buffering.
*           Define this in GraphicsConfig.h
*
*********************************************************************/
    #define USE_DOUBLE_BUFFERING

/*********************************************************************
* Overview: To enable support for DEFLATE compressed images for PutImage().
*           When this macro is enabled, the PutImage() function will
*           be able to process images generated by the Graphics Resource
*           Converter (GRC) that are compressed using the DEFLATE algorithm.
*           PutImage() will need the IPU module of the Microchip Graphics
*           Module to decompress. Enable this feature only when the driver
*           features the IPU module (example: PIC24FJ2456DA210).
*           Define this in GraphicsConfig.h
*
*********************************************************************/
    #define USE_COMP_IPU

/*********************************************************************
* Overview: To enable support for RLE compressed images for PutImage().
*           When this macro is enabled, the PutImage() function will
*           be able to process images generated by the Graphics Resource
*           Converter (GRC) that are RLE compressed. Define this in GraphicsConfig.h
*
*********************************************************************/
    #define USE_COMP_RLE


#endif // _GRAPHICSCONFIG_H
```

14.1.41 Window.c

This is file Window.c.

Body Source

```
/*****************************************************************************
```

```
 *  Module for Microchip Graphics Library
 *  GOL Layer
 *  Window
 *****************************************************************************
 * FileName:        Window.c
 * Dependencies:    Graphics.h
 * Processor:       PIC24F, PIC24H, dsPIC, PIC32
 * Compiler:        MPLAB C30 V3.00, MPLAB C32
 * Linker:          MPLAB LINK30, MPLAB LINK32
 * Company:         Microchip Technology Incorporated
 *
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 * OR OTHER SIMILAR COSTS.
 *
 * Author               Date        Comment
 *~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
 * Anton Alkhimenok     11/12/07    Version 1.0 release
 *****************************************************************************/
#include "Graphics/Graphics.h"

#ifdef USE_WINDOW

/*********************************************************************
* Function: WINDOW  *WndCreate(WORD ID, SHORT left, SHORT top, SHORT right,
*                              SHORT bottom, WORD state, XCHAR *pText, void* pBitmap,
*                              GOL_SCHEME *pScheme)
*
* Overview: creates the window
*
********************************************************************/
WINDOW *WndCreate
(
    WORD        ID,
    SHORT       left,
    SHORT       top,
    SHORT       right,
    SHORT       bottom,
    WORD        state,
    void        *pBitmap,
    XCHAR       *pText,
    GOL_SCHEME  *pScheme
)
{
    WINDOW  *pW;

    pW = (WINDOW *)GFX_malloc(sizeof(WINDOW));
    if(pW == NULL)
        return (pW);

    pW->hdr.ID = ID;
    pW->hdr.pNxtObj = NULL;
```

```
    pW->hdr.type = OBJ_WINDOW;
    pW->hdr.left = left;
    pW->hdr.top = top;
    pW->hdr.right = right;
    pW->hdr.bottom = bottom;
    pW->pBitmap = pBitmap;
    pW->pText = pText;
    pW->hdr.state = state;
    pW->hdr.DrawObj = WndDraw;           // draw function
    pW->hdr.MsgObj = WndTranslateMsg;    // message function
    pW->hdr.MsgDefaultObj = NULL;        // default message function
    pW->hdr.FreeObj = NULL;              // free function

    // Set the style scheme to be used
    if(pScheme == NULL)
        pW->hdr.pGolScheme = _pDefaultGolScheme;
    else
        pW->hdr.pGolScheme = pScheme;

    pW->textHeight = 0;
    if(pText != NULL)
    {
        pW->textHeight = GetTextHeight(pW->hdr.pGolScheme->pFont);
    }

    GOLAddObject((OBJ_HEADER *)pW);

    return (pW);
}

/*********************************************************************
* Function: WndSetText(WINDOW *pW, XCHAR *pText)
*
* Overview: sets text
*
********************************************************************/
void WndSetText(WINDOW *pW, XCHAR *pText)
{
    pW->pText = pText;
    pW->textHeight = GetTextHeight(pW->hdr.pGolScheme->pFont);
}

/*********************************************************************
* Function: WORD WndTranslateMsg(void *pObj, GOL_MSG *pMsg)
*
* Overview: translates the GOL message for the window
*
********************************************************************/
WORD WndTranslateMsg(void *pObj, GOL_MSG *pMsg)
{
    WINDOW *pW;

    pW = (WINDOW *)pObj;

    // Evaluate if the message is for the window
    // Check if disabled first
    if(GetState(pW, WND_DISABLED))
        return (OBJ_MSG_INVALID);

        #ifdef USE_TOUCHSCREEN
    if(pMsg->type == TYPE_TOUCHSCREEN)
    {

        // Check if it falls in the title bar area
        if
        (
            (pW->hdr.left < pMsg->param1) &&
            (pW->hdr.right > pMsg->param1) &&
            (pW->hdr.top < pMsg->param2) &&
            (pW->hdr.top + WND_TITLE_HEIGHT + GOL_EMBOSS_SIZE > pMsg->param2)
        )
        {
            return (WND_MSG_TITLE);
        }

        // Check if it falls in the client area
        if
        (
            (pW->hdr.left + GOL_EMBOSS_SIZE < pMsg->param1) &&
            (pW->hdr.right - GOL_EMBOSS_SIZE > pMsg->param1) &&
            (pW->hdr.top + WND_TITLE_HEIGHT + GOL_EMBOSS_SIZE < pMsg->param2) &&
            (pW->hdr.bottom - GOL_EMBOSS_SIZE > pMsg->param2)
        )
        {
            return (WND_MSG_CLIENT);
        }
    }

        #endif
    return (OBJ_MSG_INVALID);
}

/*********************************************************************
* Function: WORD WndDraw(void *pObj)
*
* Overview: draws window
*
********************************************************************/
WORD WndDraw(void *pObj)
{
    typedef enum
    {
        WND_REMOVE,
        WND_TITLE_BAR_DRAW,
        WND_TITLE_BAR_BITMAP,
        WND_TITLE_BAR_TEXT,
        WND_TITLE_BAR_TEXT_DRAW,
        WND_CLIENT,
        WND_CLIENT_DRAW
    } WND_DRAW_STATES;

    SHORT temp;
    WINDOW *pW;
    static WND_DRAW_STATES state = WND_REMOVE;

    pW = (WINDOW *)pObj;

    while(1)
    {
        if(IsDeviceBusy())
            return (0);

        switch(state)
        {
            case WND_REMOVE:
                if(GetState(pW, WND_HIDE))
                {
                    SetColor(pW->hdr.pGolScheme->CommonBkColor);
                    if(!Bar(pW->hdr.left, pW->hdr.top, pW->hdr.right, pW->hdr.bottom))
                    {
                        return (0);
                    }

                    return (1);
                }

                if(GetState(pW, WND_DRAW_CLIENT))
                {
                    state = WND_CLIENT;
                    break;

                case WND_CLIENT:
                    SetLineThickness(NORMAL_LINE);
                    SetLineType(SOLID_LINE);
                    GOLPanelDraw
                    (
                        pW->hdr.left,
                        pW->hdr.top,
                        pW->hdr.right,
                        pW->hdr.bottom,
                        0,
                        pW->hdr.pGolScheme->CommonBkColor,
                        pW->hdr.pGolScheme->EmbossLtColor,
                        pW->hdr.pGolScheme->EmbossDkColor,
                        NULL,
                        GOL_EMBOSS_SIZE
                    );

                    state = WND_CLIENT_DRAW;

                case WND_CLIENT_DRAW:
                    if(!GOLPanelDrawTsk())
                        return (0);
                }

                state = WND_TITLE_BAR_DRAW;
                break;

            case WND_TITLE_BAR_DRAW:
                if(!GetState(pW, WND_DISABLED))
                {
                    if(GetState(pW, WND_FOCUSED))
                    {
                        SetColor(pW->hdr.pGolScheme->Color1);
                    }
                    else
                    {
                        SetColor(pW->hdr.pGolScheme->Color0);
                    }
                }
                else
                {
                    SetColor(pW->hdr.pGolScheme->ColorDisabled);
                }

                if
                (
                    !Bar
                        (
                            pW->hdr.left + GOL_EMBOSS_SIZE,
                            pW->hdr.top + GOL_EMBOSS_SIZE,
                            pW->hdr.right - GOL_EMBOSS_SIZE,
                            pW->hdr.top + GOL_EMBOSS_SIZE + WND_TITLE_HEIGHT
                        )
                )
                {
                    return (0);
                }

                state = WND_TITLE_BAR_BITMAP;

                break;

            case WND_TITLE_BAR_BITMAP:
                if(pW->pBitmap != NULL)
                {
                    if
                    (
                        !PutImage
                            (
                                pW->hdr.left + GOL_EMBOSS_SIZE,
                                pW->hdr.top + GOL_EMBOSS_SIZE + ((WND_TITLE_HEIGHT -
  GetImageHeight(pW->pBitmap)) >> 1),
                                pW->pBitmap,
                                IMAGE_NORMAL
                            )
                    )
                    {
                        return (0);
                    }
                }

                if(pW->pText != NULL)
                {
                    state = WND_TITLE_BAR_TEXT;
                    break;

                case WND_TITLE_BAR_TEXT:
                    SetFont(pW->hdr.pGolScheme->pFont);

                    if(!GetState(pW, WND_DISABLED))
                    {
                        if(GetState(pW, WND_FOCUSED))
                        {
                            SetColor(pW->hdr.pGolScheme->TextColor1);
                        }
                        else
                        {
                            SetColor(pW->hdr.pGolScheme->TextColor0);
                        }
                    }
                    else
                    {
                        SetColor(pW->hdr.pGolScheme->TextColorDisabled);
                    }

                    temp = pW->hdr.left + GOL_EMBOSS_SIZE + WND_INDENT;

                    if(pW->pBitmap != NULL)
                    {
                        temp += GetImageWidth(pW->pBitmap);
                    }

                    if(GetState(pW, WND_TITLECENTER))
                    {
                        temp = (temp + (pW->hdr.right - GetTextWidth(pW->pText,
pW->hdr.pGolScheme->pFont))) >> 1;
                    }

                    MoveTo(temp, pW->hdr.top + GOL_EMBOSS_SIZE + ((WND_TITLE_HEIGHT -
pW->textHeight) >> 1));

                    state = WND_TITLE_BAR_TEXT_DRAW;

                case WND_TITLE_BAR_TEXT_DRAW:
                    if(!OutText(pW->pText))
                        return (0);
                }

                state = WND_REMOVE;
                return (1);
        }   //end of switch
    }       //end of while
}

#endif // USE_WINDOW
```

14.1.42 Window.h

Functions

	Name	Description
	WndCreate (see page 295)	This function creates a WINDOW (see page 299) object with the parameters given. It automatically attaches the new object into a global linked list of objects and returns the address of the object.
	WndDraw (see page 296)	This function renders the object on the screen using the current parameter settings. Location of the object is determined by the left, top, right and bottom parameters. The colors used are dependent on the state of the object. The font used is determined by the style scheme set. When rendering objects of the same type, each object must be rendered completely before the rendering of the next object is started. This is to avoid incomplete object rendering.
	WndSetText (see page 297)	This function sets the string used for the title bar.
	WndTranslateMsg (see page 298)	This function evaluates the message from a user if the message will affect the object or not. The table below enumerates the translated messages for each event of the touch screen inputs.

Macros

Name	Description
WND_DISABLED (see page 293)	Bit for disabled state
WND_DRAW (see page 294)	Bits to indicate whole window must be redrawn
WND_DRAW_CLIENT (see page 294)	Bit to indicate client area must be redrawn
WND_DRAW_TITLE (see page 294)	Bit to indicate title area must be redrawn
WND_FOCUSED (see page 294)	Bit for focus state
WND_HIDE (see page 294)	Bit to indicate window must be removed from screen
WND_TITLECENTER (see page 295)	Bit to center the text on the Title Area
WndGetText (see page 297)	This macro returns the address of the current text string used for the title bar.

Structures

Name	Description
WINDOW (see page 299)	The structure contains data for the window

Description

This is file Window.h.

Body Source

```
/*****************************************************************************
 *  Module for Microchip Graphics Library
 *  GOL Layer
 *  Window
 *****************************************************************************
 * FileName:        Window.h
 * Dependencies:    None
 * Processor:       PIC24F, PIC24H, dsPIC, PIC32
 * Compiler:        MPLAB C30, MPLAB C32
 * Linker:          MPLAB LINK30, MPLAB LINK32
 * Company:         Microchip Technology Incorporated
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```

```
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  * CLAIMS BY THIRD PARTIES (INCLUDING BUT NOT LIMITED TO ANY DEFENSE THEREOF),
  * OR OTHER SIMILAR COSTS.
  *
  * Date         Comment
  *~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
  * 11/12/07     Version 1.0 release
  *****************************************************************************/
#ifndef _WINDOW_H
    #define _WINDOW_H

    #include <Graphics/GOL.h>
    #include "GenericTypeDefs.h"

// Indent for the title bar text from the left side of bitmap or title bar emboss
    #define WND_INDENT  2

// Height of the title bar
    #define WND_TITLE_HEIGHT    35

/*********************************************************************
* Object States Definition:
*********************************************************************/
    #define WND_FOCUSED     0x0001  // Bit for focus state
    #define WND_DISABLED    0x0002  // Bit for disabled state
    #define WND_TITLECENTER 0x0004  // Bit to center the text on the Title Area
    #define WND_HIDE        0x8000  // Bit to indicate window must be removed from screen
    #define WND_DRAW_CLIENT 0x4000  // Bit to indicate client area must be redrawn
    #define WND_DRAW_TITLE  0x2000  // Bit to indicate title area must be redrawn
    #define WND_DRAW        0x6000  // Bits to indicate whole window must be redrawn

/*****************************************************************************
 * Overview: The structure contains data for the window
 *****************************************************************************/
typedef struct
{
    OBJ_HEADER  hdr;        // Generic header for all Objects (see OBJ_HEADER).
    SHORT       textHeight; // Pre-computed text height
    XCHAR       *pText;     // Pointer to the title text
    void        *pBitmap;   // Pointer to the bitmap for the title bar
} WINDOW;

/*********************************************************************
* Function: WINDOW  *WndCreate(WORD ID, SHORT left, SHORT top, SHORT right,
*                              SHORT bottom, WORD state,  void* pBitmap, XCHAR* pText,
*                              GOL_SCHEME *pScheme)
*
* Overview: This function creates a WINDOW object with the parameters
*           given. It automatically attaches the new object into a
*           global linked list of objects and returns the address
*           of the object.
*
* PreCondition: none
*
* Input: ID - Unique user defined ID for the object instance.
*        left - Left most position of the Object.
*        top - Top most position of the Object.
```

```
*        right - Right most position of the Object.
*        bottom - Bottom most position of the object.
*        state - Sets the initial state of the object.
*        pBitmap - Pointer to the bitmap used in the title bar.
*        pText - Pointer to the text used as a title of the window.
*        pScheme - Pointer to the style scheme used.
*
* Output: Returns the pointer to the object created
*
* Example:
*   <CODE>
*   WINDOW *pWindow;
*       pWindow  = WndCreate(ID_WINDOW1,                // ID
*                     0,0,GetMaxX(),GetMaxY(),   // whole screen dimension
*                     WND_DRAW,                  // set state to draw all
*                     (char*)myIcon,             // icon
*                     "Place Title Here.",       // text
*                     NULL);                     // use default GOL scheme
*
*       if (pWindow == NULL)
*           return 0;
*       WndDraw(pWindow);
*       return 1;
*   </CODE>
*
* Side Effects: none
*
********************************************************************/
WINDOW  *WndCreate
        (
            WORD        ID,
            SHORT       left,
            SHORT       top,
            SHORT       right,
            SHORT       bottom,
            WORD        state,
            void        *pBitmap,
            XCHAR       *pText,
            GOL_SCHEME  *pScheme
        );

/*********************************************************************
* Macros:  WndGetText(pW)
*
* Overview: This macro returns the address of the current
*           text string used for the title bar.
*
* PreCondition: none
*
* Input: pW - Pointer to the object
*
* Output: Returns pointer to the text string being used.
*
* Example:
*   <CODE>
*   WINDOW *pWindow;
*   XCHAR textUsed = "USE THIS!";
*
*       if (WndGetText(pWindow) == NULL)
*           WndSetText(&textUsed);
*   </CODE>
*
* Side Effects: none
*
********************************************************************/
    #define WndGetText(pW)  pW->pText

/*********************************************************************
* Function: WndSetText(WINDOW *pW, XCHAR *pText)
*
* Overview: This function sets the string used for the title bar.
*
```

```
* PreCondition: none
*
* Input: pW - The pointer to the object whose text will be modified
*        pText - Pointer to the text that will be used
*
* Output: none
*
* Example:
*  See WndGetText() example.
*
* Side Effects: none
*
********************************************************************/
void    WndSetText(WINDOW *pW, XCHAR *pText);

/*********************************************************************
* Function: WORD WndTranslateMsg(void *pObj, GOL_MSG *pMsg)
*
* Overview: This function evaluates the message from a user if
*           the message will affect the object or not. The table
*           below enumerates the translated messages for each
*           event of the touch screen inputs.
*
*   <TABLE>
*       Translated Message   Input Source  Events
Description
*       ##################   ############  ######
###########
*       WND_MSG_TITLE        Touch Screen  EVENT_PRESS, EVENT_RELEASE, EVENT_MOVE   If
events occurs and the x,y position falls in the TITLE area of the window
*       WND_MSG_CLIENT       Touch Screen  EVENT_PRESS, EVENT_RELEASE, EVENT_MOVE   If
events occurs and the x,y position falls in the CLIENT area of the window
*       OBJ_MSG_INVALID      Any           Any                                      If the
message did not affect the object.
*   </TABLE>
*
* PreCondition: none
*
* Input: pW    - The pointer to the object where the message will be
*                evaluated to check if the message will affect the object.
*        pMsg  - Pointer to the message struct containing the message from
*                the user interface.
*
* Output: Returns the translated message depending on the received GOL message:
*       - WND_MSG_TITLE – Title area is selected
*       - WND_MSG_CLIENT – Client area is selected
*       - OBJ_MSG_INVALID – Window is not affected
*
* Example:
*   Usage is similar to BtnTranslateMsg() example.
*
* Side Effects: none
*
********************************************************************/
WORD    WndTranslateMsg(void *pObj, GOL_MSG *pMsg);

/*********************************************************************
* Function: WORD WndDraw(void *pObj)
*
* Overview: This function renders the object on the screen
*           using the current parameter settings. Location of
*           the object is determined by the left, top, right
*           and bottom parameters. The colors used are dependent
*           on the state of the object. The font used is
*           determined by the style scheme set.
*
*           When rendering objects of the same type, each object
*           must be rendered completely before the rendering of the
*           next object is started. This is to avoid incomplete
*           object rendering.
*
* PreCondition: Object must be created before this function is called.
```

```
*
* Input: pW - Pointer to the object to be rendered.
*
* Output: Returns the status of the drawing
*         - 1 - If the rendering was completed and
*         - 0 - If the rendering is not yet finished.
*         Next call to the function will resume the
*         rendering on the pending drawing state.
*
* Example:
*   See WndCreate() example.
*
* Side Effects: none
*
*******************************************************************/
WORD WndDraw(void *pObj);
#endif // _WINDOW_H
```

14.2 Primitive Layer

Files

Name	Description
Primitive.c (see page 960)	This is file Primitive.c.
Primitive.h (see page 1028)	This is file Primitive.h.

Description

Lists all files describing the Primitive Layer.

14.2.1 Primitive.c

This is file Primitive.c.

Body Source

```
/*****************************************************************************
 *  Module for Microchip Graphics Library
 *  Graphic Primitives Layer
 *****************************************************************************
 * FileName:        Primitive.c
 * Processor:       PIC24, dsPIC, PIC32
 * Compiler:        MPLAB C30, MPLAB C32
 * Company:         Microchip Technology Incorporated
 *
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```

```
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   * CLAIMS BY THIRD PARTIES (INCLUDING BUT NOT LIMITED TO ANY DEFENSE THEREOF),
   * OR OTHER SIMILAR COSTS.
   *
   * Date         Comment
   *~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
   * 11/12/07     Version 1.0 release
   * 05/11/10     Added dynamic Arc() where start and end
   *                                angle can be specified.
   * 03/04/11     - Removed SetColor(WHITE) in InitGraph(). Default color
   *                after InitGraph() is not 0 (BLACK in most displays).
   *              - removed USE_DRV_XX checks, replaced them with
   *                weak attributes.
   * 05/13/11     Add Transparent Color support in PutImage() and PutImageRLE()
   *              functions defined in this layer.
   * 05/20/11     Added GetCirclePoint() commonly used in Widgets.
   *
   ******************************************************************************/
  #include "HardwareProfile.h"              // needed to provide values for GetMaxX() and
  GetMaxY() macros
  #include "Graphics/DisplayDriver.h"
  #include "Graphics/Primitive.h"
  #include "Compiler.h"

  ////////////////////// LOCAL FUNCTIONS PROTOTYPES ////////////////////////////
  #ifdef USE_BITMAP_FLASH
      void    PutImage1BPP(SHORT left, SHORT top, FLASH_BYTE *image, BYTE stretch);
      void    PutImage4BPP(SHORT left, SHORT top, FLASH_BYTE *image, BYTE stretch);
      void    PutImage8BPP(SHORT left, SHORT top, FLASH_BYTE *image, BYTE stretch);
      void    PutImage16BPP(SHORT left, SHORT top, FLASH_BYTE *image, BYTE stretch);

  #ifdef USE_COMP_RLE
      void    PutImageRLE4BPP(SHORT left, SHORT top, FLASH_BYTE *image, BYTE stretch);
      void    PutImageRLE8BPP(SHORT left, SHORT top, FLASH_BYTE *image, BYTE stretch);
  #endif
  #endif

  #ifdef USE_BITMAP_EXTERNAL
      void    PutImage1BPPExt(SHORT left, SHORT top, void *image, BYTE stretch);
      void    PutImage4BPPExt(SHORT left, SHORT top, void *image, BYTE stretch);
      void    PutImage8BPPExt(SHORT left, SHORT top, void *image, BYTE stretch);
      void    PutImage16BPPExt(SHORT left, SHORT top, void *image, BYTE stretch);

  #ifdef USE_COMP_RLE
      void    PutImageRLE4BPPExt(SHORT left, SHORT top, void *image, BYTE stretch);
      void    PutImageRLE8BPPExt(SHORT left, SHORT top, void *image, BYTE stretch);
  #endif
  #endif

  // Current line type
  SHORT   _lineType;

  // Current line thickness
  BYTE    _lineThickness;

  // Font orientation
  BYTE    _fontOrientation;

  // Current cursor x-coordinates
  SHORT   _cursorX;

  // Current cursor y-coordinates
  SHORT   _cursorY;

  // Pointer to the current font
  void    *_font;

  #ifdef USE_PALETTE
  void    *_palette;
  #endif
```

```
// First and last characters in the font
WORD    _fontFirstChar; // First character in the font table.
WORD    _fontLastChar;  // Last character in the font table.

// Installed font height
SHORT   _fontHeight;

// bevel drawing type (0 = full bevel, 0xF0 - top bevel only, 0x0F - bottom bevel only
BYTE _bevelDrawType;


#define COSINETABLEENTRIES  90
// Cosine table used to calculate angles when rendering circular objects and  arcs
// Make cosine values * 256 instead of 100 for easier math later
const SHORT   _CosineTable[COSINETABLEENTRIES+1] __attribute__((aligned(2))) =
                        {
                            256, 256, 256, 256, 255, 255, 255, 254, 254, 253,
                            252, 251, 250, 249, 248, 247, 246, 245, 243, 242,
                            241, 239, 237, 236, 234, 232, 230, 228, 226, 224,
                            222, 219, 217, 215, 212, 210, 207, 204, 202, 199,
                            196, 193, 190, 187, 184, 181, 178, 175, 171, 168,
                            165, 161, 158, 154, 150, 147, 143, 139, 136, 132,
                            128, 124, 120, 116, 112, 108, 104, 100, 96,  92,
                            88,  83,  79,  75,  71,  66,  62,  58,  53,  49,
                            44,  40,  36,  31,  27,  22,  18,  13,  9,   4,
                            0
                        };

/*********************************************************************
* Function: WORD Bar(SHORT left, SHORT top, SHORT right, SHORT bottom)
*
* PreCondition: none
*

* Input: left,top - top left corner coordinates,
*        right,bottom - bottom right corner coordinates
*
* Output: For NON-Blocking configuration:
*         - Returns 0 when device is busy and the shape is not yet completely drawn.
*         - Returns 1 when the shape is completely drawn.
*         For Blocking configuration:
*         - Always return 1.
*
* Side Effects: none
*
* Overview: draws rectangle filled with current color
*
* Note: none
*
********************************************************************/
WORD __attribute__((weak)) Bar(SHORT left, SHORT top, SHORT right, SHORT bottom)
{
    SHORT   x, y;

        #ifndef USE_NONBLOCKING_CONFIG
    while(IsDeviceBusy() != 0) Nop();

    /* Ready */
        #else
    if(IsDeviceBusy() != 0)
        return (0);
        #endif
    for(y = top; y < bottom + 1; y++)
        for(x = left; x < right + 1; x++)
            PutPixel(x, y);

    return (1);
}

/*********************************************************************
* Function: WORD Line(SHORT x1, SHORT y1, SHORT x2, SHORT y2)
```

```
*
* PreCondition: none
*
* Input: x1,y1 - starting coordinates, x2,y2 - ending coordinates
*
* Output: For NON-Blocking configuration:
*         - Returns 0 when device is busy and the shape is not yet completely drawn.
*         - Returns 1 when the shape is completely drawn.
*         For Blocking configuration:
*         - Always return 1.
*
* Side Effects: none
*
* Overview: draws line
*
* Note: none
*
********************************************************************/
WORD __attribute__((weak)) Line(SHORT x1, SHORT y1, SHORT x2, SHORT y2)
{
    SHORT   deltaX, deltaY;
    SHORT   error, stepErrorLT, stepErrorGE;
    SHORT   stepX, stepY;
    SHORT   steep;
    SHORT   temp;
    SHORT   style, type;

        #ifndef USE_NONBLOCKING_CONFIG
    while(IsDeviceBusy() != 0) Nop();

    /* Ready */
        #else
    if(IsDeviceBusy() != 0)
        return (0);
        #endif

    // Move cursor
    MoveTo(x2, y2);

    if(x1 == x2)
    {
        if(y1 > y2)
        {
            temp = y1;
            y1 = y2;
            y2 = temp;
        }

        style = 0;
        type = 1;
        for(temp = y1; temp < y2 + 1; temp++)
        {
            if((++style) == _lineType)
            {
                type ^= 1;
                style = 0;
            }

            if(type)
            {
                PutPixel(x1, temp);
                if(_lineThickness)
                {
                    PutPixel(x1 + 1, temp);
                    PutPixel(x1 - 1, temp);
                }
            }
        }

        return (1);
    }
    if(y1 == y2)
    {
        if(x1 > x2)
        {
            temp = x1;
            x1 = x2;
            x2 = temp;
        }

        style = 0;
        type = 1;
        for(temp = x1; temp < x2 + 1; temp++)
        {
            if((++style) == _lineType)
            {
                type ^= 1;
                style = 0;
            }

            if(type)
            {
                PutPixel(temp, y1);
                if(_lineThickness)
                {
                    PutPixel(temp, y1 + 1);
                    PutPixel(temp, y1 - 1);
                }
            }
        }

        return (1);
    }

    stepX = 0;
    deltaX = x2 - x1;
    if(deltaX < 0)
    {
        deltaX = -deltaX;
        --stepX;
    }
    else
    {
        ++stepX;
    }

    stepY = 0;
    deltaY = y2 - y1;
    if(deltaY < 0)
    {
        deltaY = -deltaY;
        --stepY;
    }
    else
    {
        ++stepY;
    }

    steep = 0;
    if(deltaX < deltaY)
    {
        ++steep;
        temp = deltaX;
        deltaX = deltaY;
        deltaY = temp;
        temp = x1;
        x1 = y1;
        y1 = temp;
        temp = stepX;
        stepX = stepY;
        stepY = temp;
        PutPixel(y1, x1);
    }
    else
    {
        PutPixel(x1, y1);
    }

    // If the current error greater or equal zero
    stepErrorGE = deltaX << 1;

    // If the current error less than zero
    stepErrorLT = deltaY << 1;

    // Error for the first pixel
    error = stepErrorLT - deltaX;

    style = 0;
    type = 1;

    while(--deltaX >= 0)
    {
        if(error >= 0)
        {
            y1 += stepY;
            error -= stepErrorGE;
        }

        x1 += stepX;
        error += stepErrorLT;

        if((++style) == _lineType)
        {
            type ^= 1;
            style = 0;
        }

        if(type)
        {
            if(steep)
            {
                PutPixel(y1, x1);
                if(_lineThickness)
                {
                    PutPixel(y1 + 1, x1);
                    PutPixel(y1 - 1, x1);
                }
            }
            else
            {
                PutPixel(x1, y1);
                if(_lineThickness)
                {
                    PutPixel(x1, y1 + 1);
                    PutPixel(x1, y1 - 1);
                }
            }
        }
    }   // end of while

    return (1);
}

/*********************************************************************
* Function: void ClearDevice(void)
*
* PreCondition: none
*
* Input: none
*
* Output: none
*
* Side Effects: none
*
* Overview: clears screen with current color and sets cursor to 0,0
```

```
*
* Note: none
*
********************************************************************/
void __attribute__((weak)) ClearDevice(void)
{
    while(Bar(0, 0, GetMaxX(), GetMaxY()) == 0);
    MoveTo(0, 0);
}

/*********************************************************************
* Function:  void InitGraph(void)
*
* PreCondition: none
*
* Input: none
*
* Output: none
*
* Side Effects: none
*
* Overview: initializes LCD controller,
*           sets cursor position to upper left corner,
*           sets active and visual pages to page 0,
*           clears active page with BLACK,
*           sets color to WHITE,
*           disables clipping
*
* Note: none
*
********************************************************************/
void InitGraph(void)
{

    // Current line type
    SetLineType(SOLID_LINE);

    // Current line thickness
    SetLineThickness(NORMAL_LINE);

    // Current cursor coordinates to 0,0
    MoveTo(0, 0);

    // Reset device
    ResetDevice();

    // Set color to BLACK
    SetColor(0);

    // set the transparent color check to be disabled
#ifdef USE_TRANSPARENT_COLOR
    TransparentColorDisable();
#endif

    // Clear screen
    ClearDevice();

    // Disable clipping
    SetClip(CLIP_DISABLE);

    // Set font orientation
    SetFontOrientation(ORIENT_HOR);

    // set Bevel drawing
    SetBevelDrawType(DRAWFULLBEVEL);
}

/*********************************************************************
* Function: WORD Arc(SHORT xL, SHORT yT, SHORT xR, SHORT yB, SHORT r1, SHORT r2, BYTE
octant);
*
* PreCondition: none
```

```
*
* Input: xL, yT - location of the upper left center in the x,y coordinate
*        xR, yB - location of the lower right left center in the x,y coordinate
*        r1, r2 - the two concentric circle radii, r1 as the radius
*                 of the smaller circle and and r2 as the radius of the
*                 larger circle.
*        octant - bitmask of the octant that will be drawn.
*                 Moving in a clockwise direction from x = 0, y = +radius
*                 bit0 : first octant   bit4 : fifth octant
*                 bit1 : second octant  bit5 : sixth octant
*                 bit2 : third octant   bit6 : seventh octant
*                 bit3 : fourth octant  bit7 : eigth octant
*
* Output: For NON-Blocking configuration:
*         - Returns 0 when device is busy and the shape is not yet completely drawn.
*         - Returns 1 when the shape is completely drawn.
*         For Blocking configuration:
*         - Always return 1.
*
* Side Effects: none
*
* Overview: Draws the octant arc of a beveled figure with given centers, radii
*           and octant mask. When r1 is zero and r2 has some value, a filled
*           circle is drawn; when the radii have values, an arc of
*           thickness (r2-r1) is drawn; when octant = 0xFF, a full ring
*           is drawn. When r1 and r2 are zero, a rectangular object is drawn, where
*           xL, yT specifies the left top corner; xR, yB specifies the right bottom
*           corner.
*
* Note: none
*
********************************************************************/
WORD __attribute__((weak)) Arc(SHORT xL, SHORT yT, SHORT xR, SHORT yB, SHORT r1, SHORT r2,
BYTE octant)
{

    // this is using a variant of the Midpoint (Bresenham's) Algorithm
    #ifndef USE_NONBLOCKING_CONFIG

    SHORT       y1Limit, y2Limit;
    SHORT       x1, x2, y1, y2;
    SHORT       err1, err2;
    SHORT       x1Cur, y1Cur, y1New;
    SHORT       x2Cur, y2Cur, y2New;
    DWORD_VAL   temp;

    temp.Val = SIN45 * r1;
    y1Limit = temp.w[1];
    temp.Val = SIN45 * r2;
    y2Limit = temp.w[1];

    temp.Val = (DWORD) (ONEP25 - ((LONG) r1 << 16));
    err1 = (SHORT) (temp.w[1]);

    temp.Val = (DWORD) (ONEP25 - ((LONG) r2 << 16));
    err2 = (SHORT) (temp.w[1]);

    x1 = r1;
    x2 = r2;
    y1 = 0;
    y2 = 0;

    x1Cur = x1;
    y1Cur = y1;
    y1New = y1;
    x2Cur = x2;
    y2Cur = y2;
    y2New = y2;

    while(y2 <= y2Limit)
    {   // just watch for y2 limit since outer circle
        // will have greater value.
        // Drawing of the rounded panel is done only when there is a change in the
        // x direction. Bars are drawn to be efficient.
        // detect changes in the x position. Every change will mean a bar will be drawn
        // to cover the previous area. y1New records the last position of y before the
        // change in x position.
        // y1New & y2New records the last y positions, must remember this to
        // draw the correct bars (non-overlapping).
        y1New = y1;
        y2New = y2;

        if(y1 <= y1Limit)
        {
            if(err1 > 0)
            {
                x1--;
                err1 += 5;
                err1 += (y1 - x1) << 1;
            }
            else
            {
                err1 += 3;
                err1 += y1 << 1;
            }

            y1++;
        }
        else
        {
            y1++;
            if(x1 < y1)
                x1 = y1;
        }

        if(err2 > 0)
        {
            x2--;
            err2 += 5;
            err2 += (y2 - x2) << 1;
        }
        else
        {
            err2 += 3;
            err2 += y2 << 1;
        }

        y2++;

        if((x1Cur != x1) || (x2Cur != x2))
        {
            if(octant & 0x01)
            {
                Bar(xR + y2Cur, yT - x2Cur, xR + y1New, yT - x1Cur);    // 1st octant
            }

            if(octant & 0x02)
            {
                Bar(xR + x1Cur, yT - y1New, xR + x2Cur, yT - y2Cur);    // 2nd octant
            }

            if(octant & 0x04)
            {
                Bar(xR + x1Cur, yB + y1Cur, xR + x2Cur, yB + y2New);    // 3rd octant
            }

            if(octant & 0x08)
            {
                Bar(xR + y1Cur, yB + x1Cur, xR + y2New, yB + x2Cur);    // 4th octant
            }

            if(octant & 0x10)
            {
                Bar(xL - y1New, yB + x1Cur, xL - y2Cur, yB + x2Cur);    // 5th octant
            }

            if(octant & 0x20)
            {
                Bar(xL - x2Cur, yB + y2Cur, xL - x1Cur, yB + y1New);    // 6th octant
            }

            if(octant & 0x40)
            {
                Bar(xL - x2Cur, yT - y2New, xL - x1Cur, yT - y1Cur);    // 7th octant
            }

            if(octant & 0x80)
            {
                Bar(xL - y2New, yT - x2Cur, xL - y1Cur, yT - x1Cur);    // 8th octant
            }

            // update current values
            x1Cur = x1;
            y1Cur = y1;
            x2Cur = x2;
            y2Cur = y2;
        }
    }                           // end of while loop

    // draw the width and height
    if((xR - xL) || (yB - yT))
    {

        // draw right
        if(octant & 0x02)
        {
            Bar(xR + r1, yT, xR + r2, (yB + yT) >> 1);
        }

        if(octant & 0x04)
        {
            Bar(xR + r1, ((yB + yT) >> 1), xR + r2, yB);
        }

        // draw bottom
        if(octant & 0x10)
        {
            Bar(xL, yB + r1, ((xR + xL) >> 1), yB + r2);
        }

        if(octant & 0x08)
        {
            Bar(((xR + xL) >> 1), yB + r1, xR, yB + r2);
        }

        if(xR - xL)
        {

            // draw top
            if(octant & 0x80)
            {
                Bar(xL, yT - r2, ((xR + xL) >> 1), yT - r1);
            }

            if(octant & 0x01)
            {
                Bar(((xR + xL) >> 1), yT - r2, xR, yT - r1);
            }
        }

        if(yT - yB)
        {

            // draw left
            if(octant & 0x40)
            {
                Bar(xL - r2, yT, xL - r1, ((yB + yT) >> 1));
            }

            if(octant & 0x20)
            {
                Bar(xL - r2, ((yB + yT) >> 1), xL - r1, yB);
            }
        }
    }

    return (1);
    #else

    typedef enum
    {
        BEGIN,
        QUAD11,
        BARRIGHT1,
        QUAD12,
        BARRIGHT2,
        QUAD21,
        BARLEFT1,
        QUAD22,
        BARLEFT2,
        QUAD31,
        BARTOP1,
        QUAD32,
        BARTOP2,
        QUAD41,
        BARBOTTOM1,
        QUAD42,
        BARBOTTOM2,
        CHECK,
    } OCTANTARC_STATES;

    DWORD_VAL temp;

    //  LONG temp1;
    static SHORT y1Limit, y2Limit;
    static SHORT x1, x2, y1, y2;
    static SHORT err1, err2;
    static SHORT x1Cur, y1Cur, y1New;
    static SHORT x2Cur, y2Cur, y2New;
    static OCTANTARC_STATES state = BEGIN;

    while(1)
    {
        if(IsDeviceBusy())
            return (0);
        switch(state)
        {
            case BEGIN:
                temp.Val = SIN45 * r1;
                y1Limit = temp.w[1];
                temp.Val = SIN45 * r2;
                y2Limit = temp.w[1];

                temp.Val = (DWORD) (ONEP25 - ((LONG) r1 << 16));
                err1 = (SHORT) (temp.w[1]);

                temp.Val = (DWORD) (ONEP25 - ((LONG) r2 << 16));
                err2 = (SHORT) (temp.w[1]);

                x1 = r1;
                x2 = r2;
                y1 = 0;
                y2 = 0;

                x1Cur = x1;
                y1Cur = y1;
                y1New = y1;
                x2Cur = x2;
                y2Cur = y2;
                y2New = y2;
                state = CHECK;

            case CHECK:
                arc_check_state : if(y2 > y2Limit)
                {
                    state = BARRIGHT1;
                    goto arc_draw_width_height_state;
                }

                // y1New & y2New records the last y positions
                y1New = y1;
                y2New = y2;

                if(y1 <= y1Limit)
                {
                    if(err1 > 0)
                    {
                        x1--;
                        err1 += 5;
                        err1 += (y1 - x1) << 1;
                    }
                    else
                    {
                        err1 += 3;
                        err1 += y1 << 1;
                    }

                    y1++;
                }
                else
                {
                    y1++;
                    if(x1 < y1)
                        x1 = y1;
                }

                if(err2 > 0)
                {
                    x2--;
                    err2 += 5;
                    err2 += (y2 - x2) << 1;
                }
                else
                {
                    err2 += 3;
                    err2 += y2 << 1;
                }

                y2++;

                state = QUAD11;
                break;

            case QUAD11:
                if((x1Cur != x1) || (x2Cur != x2))
                {

                    // 1st octant
                    if(octant & 0x01)
                    {
                        if(Bar(xR + y2Cur, yT - x2Cur, xR + y1New, yT - x1Cur) == 0)
                            return (0);
                    }
                }
                else
                {
                    state = CHECK;
                    goto arc_check_state;
                }
```

```
                state = QUAD12;
                break;

            case QUAD12:

                // 2nd octant
                if(octant & 0x02)
                {
                    if(Bar(xR + x1Cur, yT - y1New, xR + x2Cur, yT - y2Cur) == 0)
                        return (0);
                }

                state = QUAD21;
                break;

            case QUAD21:

                // 3rd octant
                if(octant & 0x04)
                {
                    if(Bar(xR + x1Cur, yB + y1Cur, xR + x2Cur, yB + y2New) == 0)
                        return (0);
                }

                state = QUAD22;
                break;

            case QUAD22:

                // 4th octant
                if(octant & 0x08)
                {
                    if(Bar(xR + y1Cur, yB + x1Cur, xR + y2New, yB + x2Cur) == 0)
                        return (0);
                }

                state = QUAD31;
                break;

            case QUAD31:

                // 5th octant
                if(octant & 0x10)
                {
                    if(Bar(xL - y1New, yB + x1Cur, xL - y2Cur, yB + x2Cur) == 0)
                        return (0);
                }

                state = QUAD32;
                break;

            case QUAD32:

                // 6th octant
                if(octant & 0x20)
                {
                    if(Bar(xL - x2Cur, yB + y2Cur, xL - x1Cur, yB + y1New) == 0)
                        return (0);
                }

                state = QUAD41;
                break;

            case QUAD41:

                // 7th octant
                if(octant & 0x40)
                {
                    if(Bar(xL - x2Cur, yT - y2New, xL - x1Cur, yT - y1Cur) == 0)
                        return (0);
                }
                state = QUAD42;
                break;

            case QUAD42:

                // 8th octant
                if(octant & 0x80)
                {
                    if(Bar(xL - y2New, yT - x2Cur, xL - y1Cur, yT - x1Cur) == 0)
                        return (0);
                }

                // update current values
                x1Cur = x1;
                y1Cur = y1;
                x2Cur = x2;
                y2Cur = y2;
                state = CHECK;
                break;

            case BARRIGHT1:     // draw upper right
                arc_draw_width_height_state : if((xR - xL) || (yB - yT))
                {

                    // draw right
                    if(octant & 0x02)
                    {
                        if(Bar(xR + r1, yT, xR + r2, (yB + yT) >> 1) == 0)
                            return (0);
                    }
                }
                else
                {
                    state = BEGIN;
                    return (1);
                }

                state = BARRIGHT2;
                break;

            case BARRIGHT2:     // draw lower right
                if(octant & 0x04)
                {
                    if(Bar(xR + r1, ((yB + yT) >> 1), xR + r2, yB) == 0)
                        return (0);
                }

                state = BARBOTTOM1;
                break;

            case BARBOTTOM1:    // draw left bottom
                // draw bottom
                if(octant & 0x10)
                {
                    if(Bar(xL, yB + r1, ((xR + xL) >> 1), yB + r2) == 0)
                        return (0);
                }

                state = BARBOTTOM2;
                break;

            case BARBOTTOM2:    // draw right bottom
                if(octant & 0x08)
                {
                    if(Bar(((xR + xL) >> 1), yB + r1, xR, yB + r2) == 0)
                        return (0);
                }

                state = BARTOP1;
                break;

            case BARTOP1:       // draw left top
```

```
                if(xR - xL)
                {

                    // draw top
                    if(octant & 0x80)
                    {
                        if(Bar(xL, yT - r2, ((xR + xL) >> 1), yT - r1) == 0)
                            return (0);
                    }

                    state = BARTOP2;
                }
                else
                    state = BARLEFT1;   // no width go directly to height bar
                break;

            case BARTOP2:               // draw right top
                if(octant & 0x01)
                {
                    if(Bar(((xR + xL) >> 1), yT - r2, xR, yT - r1) == 0)
                        return (0);
                }

                state = BARLEFT1;
                break;

            case BARLEFT1:              // draw upper left
                if(yT - yB)
                {

                    // draw left
                    if(octant & 0x40)
                    {
                        if(Bar(xL - r2, yT, xL - r1, ((yB + yT) >> 1)) == 0)
                            return (0);
                    }

                    state = BARLEFT2;
                }
                else
                {
                    state = BEGIN;      // no height go back to BEGIN
                    return (1);
                }

                break;

            case BARLEFT2:              // draw lower left
                if(octant & 0x20)
                {
                    if(Bar(xL - r2, ((yB + yT) >> 1), xL - r1, yB) == 0)
                        return (0);
                }

                state = BEGIN;
                return (1);
        }                               // end of switch
    }   // end of while
    #endif // USE_NONBLOCKING_CONFIG
}

/*********************************************************************
* Function: WORD Bevel(SHORT x1, SHORT y1, SHORT x2, SHORT y2, SHORT rad)
*
* PreCondition: None
*
* Input: x1, y1 - coordinate position of the upper left center of the
*                 circle that draws the rounded corners,
*        x2, y2 - coordinate position of the lower right center of the
*                 circle that draws the rounded corners,
*        rad - defines the redius of the circle,
*
```

```
* Output: For NON-Blocking configuration:
*         - Returns 0 when device is busy and the shape is not yet completely drawn.
*         - Returns 1 when the shape is completely drawn.
*         For Blocking configuration:
*         - Always return 1.
*
* Overview: Draws a beveled figure on the screen.
*           For a pure circular object x1 = x2 and y1 = y2.
*           For a rectangular object radius = 0.
*
* Note: none
*
********************************************************************/
WORD __attribute__((weak)) Bevel(SHORT x1, SHORT y1, SHORT x2, SHORT y2, SHORT rad)
{
    SHORT       style, type, xLimit, xPos, yPos, error;
    DWORD_VAL   temp;

    #ifndef USE_NONBLOCKING_CONFIG
    while(IsDeviceBusy() != 0) Nop();

    /* Ready */
    #else
    if(IsDeviceBusy() != 0)
        return (0);
    #endif
    temp.Val = SIN45 * rad;
    xLimit = temp.w[1] + 1;
    temp.Val = (DWORD) (ONEP25 - ((LONG) rad << 16));
    error = (SHORT) (temp.w[1]);
    yPos = rad;

    style = 0;
    type = 1;

    if(rad)
    {
        for(xPos = 0; xPos <= xLimit; xPos++)
        {
            if((++style) == _lineType)
            {
                type ^= 1;
                style = 0;
            }

            if(type)
            {
                PutPixel(x2 + xPos, y1 - yPos);         // 1st quadrant
                PutPixel(x2 + yPos, y1 - xPos);
                PutPixel(x2 + xPos, y2 + yPos);         // 2nd quadrant
                PutPixel(x2 + yPos, y2 + xPos);
                PutPixel(x1 - xPos, y2 + yPos);         // 3rd quadrant
                PutPixel(x1 - yPos, y2 + xPos);
                PutPixel(x1 - yPos, y1 - xPos);         // 4th quadrant
                PutPixel(x1 - xPos, y1 - yPos);

                if(_lineThickness)
                {
                    PutPixel(x2 + xPos, y1 - yPos - 1); // 1st quadrant
                    PutPixel(x2 + xPos, y1 - yPos + 1);
                    PutPixel(x2 + yPos + 1, y1 - xPos);
                    PutPixel(x2 + yPos - 1, y1 - xPos);
                    PutPixel(x2 + xPos, y2 + yPos - 1); // 2nd quadrant
                    PutPixel(x2 + xPos, y2 + yPos + 1);
                    PutPixel(x2 + yPos + 1, y2 + xPos);
                    PutPixel(x2 + yPos - 1, y2 + xPos);
                    PutPixel(x1 - xPos, y2 + yPos - 1); // 3rd quadrant
                    PutPixel(x1 - xPos, y2 + yPos + 1);
                    PutPixel(x1 - yPos + 1, y2 + xPos);
                    PutPixel(x1 - yPos - 1, y2 + xPos);
                    PutPixel(x1 - yPos + 1, y1 - xPos); // 4th quadrant
                    PutPixel(x1 - yPos - 1, y1 - xPos);
                    PutPixel(x1 - xPos, y1 - yPos + 1);
                    PutPixel(x1 - xPos, y1 - yPos - 1);
                }
            }

            if(error > 0)
            {
                yPos--;
                error += 5 + ((xPos - yPos) << 1);
            }
            else
                error += 3 + (xPos << 1);
        }
    }
    // Must use lines here since this can also be used to draw focus of round buttons
    if(x2 - x1)
    {
        while(!Line(x1, y1 - rad, x2, y1 - rad));

        // draw top
    }

    if(y2 - y1)
    {
        while(!Line(x1 - rad, y1, x1 - rad, y2));

        // draw left
    }

    if((x2 - x1) || (y2 - y1))
    {
        while(!Line(x2 + rad, y1, x2 + rad, y2));

        // draw right
        while(!Line(x1, y2 + rad, x2, y2 + rad));

        // draw bottom
    }

    return (1);
}

/*********************************************************************
* Function: WORD FillBevel(SHORT x1, SHORT y1, SHORT x2, SHORT y2, SHORT rad)
*
* PreCondition: None
*
* Input: x1, y1 - coordinate position of the upper left center of the
*                 circle that draws the rounded corners,
*        x2, y2 - coordinate position of the lower right center of the
*                 circle that draws the rounded corners,
*        rad - defines the redius of the circle,
*
* Output: For NON-Blocking configuration:
*         - Returns 0 when device is busy and the shape is not yet completely drawn.
*         - Returns 1 when the shape is completely drawn.
*         For Blocking configuration:
*         - Always return 1.
*
* Overview: Draws a filled beveled figure on the screen.
*           For a filled circular object x1 = x2 and y1 = y2.
*           For a filled rectangular object radius = 0.
*
* Note: none
*
********************************************************************/
WORD FillBevel(SHORT x1, SHORT y1, SHORT x2, SHORT y2, SHORT rad)
{
    #ifndef USE_NONBLOCKING_CONFIG

    SHORT       yLimit, xPos, yPos, err;
    SHORT       xCur, yCur, yNew;
    DWORD_VAL   temp;

    // note that octants here is defined as:
    // from yPos=-radius, xPos=0 in the clockwise direction octant 1 to 8 are labeled
    // assumes an origin at 0,0. Quadrants are defined in the same manner
    if(rad)
    {
        temp.Val = SIN45 * rad;
        yLimit = temp.w[1];
        temp.Val = (DWORD) (ONEP25 - ((LONG) rad << 16));
        err = (SHORT) (temp.w[1]);
        xPos = rad;
        yPos = 0;

        xCur = xPos;
        yCur = yPos;
        yNew = yPos;

        while(yPos <= yLimit)
        {

            // Drawing of the rounded panel is done only when there is a change in the
            // x direction. Bars are drawn to be efficient.
            // detect changes in the x position. Every change will mean a bar will be drawn
            // to cover the previous area. y1New records the last position of y before the
            // change in x position.
            // y1New records the last y position
            yNew = yPos;

            if(err > 0)
            {
                xPos--;
                err += 5 + ((yPos - xPos) << 1);
            }
            else
                err += 3 + (yPos << 1);
            yPos++;

            if(xCur != xPos)
            {
                if (_bevelDrawType & DRAWBOTTOMBEVEL)
                {
                    // 6th octant to 3rd octant
                    Bar(x1 - xCur, y2 + yCur, x2 + xCur, y2 + yNew);

                    // 5th octant to 4th octant
                    Bar(x1 - yNew, y2 + xPos, x2 + yNew, y2 + xCur);
                }

                if (_bevelDrawType & DRAWTOPBEVEL)
                {
                    // 8th octant to 1st octant
                    Bar(x1 - yNew, y1 - xCur, x2 + yNew, y1 - xPos);

                    // 7th octant to 2nd octant
                    Bar(x1 - xCur, y1 - yNew, x2 + xCur, y1 - yCur);
                }
                // update current values
                xCur = xPos;
                yCur = yPos;
            }
        }
    }

    // this covers both filled rounded object and filled rectangle.
    if((x2 - x1) || (y2 - y1))
    {
        if (_bevelDrawType == DRAWFULLBEVEL)
            Bar(x1 - rad, y1, x2 + rad, y2);
        else if (_bevelDrawType == DRAWTOPBEVEL)
            Bar(x1 - rad, y1, x2 + rad, y1+((y2-y1)>>1));
        else
```

```
            Bar(x1 - rad, y1+((y2-y1)>>1), x2 + rad, y2);
    }

    return (1);
    #else

    typedef enum
    {
        BEGIN,
        CHECK,
        Q8TOQ1,
        Q7TOQ2,
        Q6TOQ3,
        Q5TOQ4,
        WAITFORDONE,
        FACE
    } FILLCIRCLE_STATES;

    DWORD_VAL temp;
    static LONG err;
    static SHORT yLimit, xPos, yPos;
    static SHORT xCur, yCur, yNew;

    static FILLCIRCLE_STATES state = BEGIN;

    while(1)
    {
        if(IsDeviceBusy())
            return (0);
        switch(state)
        {
            case BEGIN:
                if(!rad)
                {   // no radius object is a filled rectangle
                    state = FACE;
                    break;
                }

                // compute variables
                temp.Val = SIN45 * rad;
                yLimit = temp.w[1];
                temp.Val = (DWORD) (ONEP25 - ((LONG) rad << 16));
                err = (SHORT) (temp.w[1]);
                xPos = rad;
                yPos = 0;
                xCur = xPos;
                yCur = yPos;
                yNew = yPos;
                state = CHECK;

            case CHECK:
                bevel_fill_check : if(yPos > yLimit)
                {
                    state = FACE;
                    break;
                }

                // y1New records the last y position
                yNew = yPos;

                // calculate the next value of x and y
                if(err > 0)
                {
                    xPos--;
                    err += 5 + ((yPos - xPos) << 1);
                }
                else
                    err += 3 + (yPos << 1);
                yPos++;
                state = Q6TOQ3;

            case Q6TOQ3:
                if(xCur != xPos)
                {

                    // 6th octant to 3rd octant
                    if (_bevelDrawType & DRAWBOTTOMBEVEL)
                    {
                        if(Bar(x1 - xCur, y2 + yCur, x2 + xCur, y2 + yNew) == 0)
                            return (0);
                    }
                    state = Q5TOQ4;
                    break;
                }

                state = CHECK;
                goto bevel_fill_check;

            case Q5TOQ4:

                if (_bevelDrawType & DRAWBOTTOMBEVEL)
                {
                    // 5th octant to 4th octant
                    if(Bar(x1 - yNew, y2 + xPos, x2 + yNew, y2 + xCur) == 0)
                        return (0);
                }
                state = Q8TOQ1;
                break;

            case Q8TOQ1:

                // 8th octant to 1st octant
                if (_bevelDrawType & DRAWTOPBEVEL)
                {
                    if(Bar(x1 - yNew, y1 - xCur, x2 + yNew, y1 - xPos) == 0)
                        return (0);
                }
                state = Q7TOQ2;
                break;

            case Q7TOQ2:

                // 7th octant to 2nd octant
                if (_bevelDrawType & DRAWTOPBEVEL)
                {
                    if(Bar(x1 - xCur, y1 - yNew, x2 + xCur, y1 - yCur) == 0)
                        return (0);
                }
                // update current values
                xCur = xPos;
                yCur = yPos;
                state = CHECK;
                break;



            case FACE:
                if((x2 - x1) || (y2 - y1))
                {
                    if (_bevelDrawType == DRAWFULLBEVEL)
                    {
                        if(Bar(x1 - rad, y1, x2 + rad, y2) == 0)
                            return (0);
                    }
                    else if (_bevelDrawType == DRAWTOPBEVEL)
                    {
                        if(Bar(x1 - rad, y1, x2 + rad, y1+((y2-y1)>>1)) == 0)
                            return (0);
                    }
                    else
                    {
                        if(Bar(x1 - rad, y1+((y2-y1)>>1), x2 + rad, y2) == 0)
                            return (0);
                    }
                    state = WAITFORDONE;
                }
                else
                {
                    state = BEGIN;
                    return (1);
                }

            case WAITFORDONE:
                if(IsDeviceBusy())
                    return (0);
                state = BEGIN;
                return (1);
        }           // end of switch
    }               // end of while
    #endif // end of USE_NONBLOCKING_CONFIG
}

/*********************************************************************
* Function: WORD DrawPoly(SHORT numPoints, SHORT* polyPoints)
*
* PreCondition: none
*
* Input: numPoints - points number, polyPoints - pointer to points array
*
* Output: For NON-Blocking configuration:
*         - Returns 0 when device is busy and the shape is not yet completely drawn.
*         - Returns 1 when the shape is completely drawn.
*         For Blocking configuration:
*         - Always return 1.
*
* Side Effects: none
*
* Overview: draws line polygon
*
* Note: none
*
********************************************************************/
WORD __attribute__((weak)) DrawPoly(SHORT numPoints, SHORT *polyPoints)
{
    #ifndef USE_NONBLOCKING_CONFIG

    SHORT   counter;
    SHORT   sx, sy, ex, ey;

        #ifndef USE_NONBLOCKING_CONFIG
    while(IsDeviceBusy() != 0) Nop();

    /* Ready */
        #else
    if(IsDeviceBusy() != 0)
        return (0);
        #endif
    sx = *polyPoints++;
    sy = *polyPoints++;
    for(counter = 0; counter < numPoints - 1; counter++)
    {
        ex = *polyPoints++;
        ey = *polyPoints++;
        while(Line(sx, sy, ex, ey) == 0);
        sx = ex;
        sy = ey;
    }

    #else

    typedef enum
    {
        POLY_BEGIN,
        POLY_DRAWING,
    } DRAWPOLY_STATES;
    static DRAWPOLY_STATES state = POLY_BEGIN;
    static SHORT counter;
    SHORT sx, sy, ex, ey;
    while(1)
    {
        if(IsDeviceBusy())
            return (0);
        switch(state)
        {
            case POLY_BEGIN:
                counter = 1;
                state = POLY_DRAWING;

            case POLY_DRAWING:
                if(counter == 0 || counter >= numPoints)
                {
                    state = POLY_BEGIN;
                    break;
                }

                while(counter < numPoints)
                {
                    sx = polyPoints[(counter - 1) * 2];
                    sy = polyPoints[(counter * 2) - 1];
                    ex = polyPoints[counter * 2];
                    ey = polyPoints[counter * 2 + 1];
                    if(Line(sx, sy, ex, ey) == 0)
                    {
                        return (0);
                    }

                    counter++;
                }

                state = POLY_BEGIN;
                return (1);
        }
    }
    #endif
    return (1);
}

/*********************************************************************
* Function: void SetFont(void* font)
*
* PreCondition: none
*
* Input: pointer to the font image
*
* Output: none
*
* Side Effects: none
*
* Overview: defines current font
*
* Note: none
*
********************************************************************/
void __attribute__((weak)) SetFont(void *font)
{
    FONT_HEADER *pHeader;

        #ifdef USE_FONT_EXTERNAL
    FONT_HEADER header;
        #endif
    _font = font;
    switch(*((SHORT *)font))
    {
                #ifdef USE_FONT_FLASH

        case FLASH:
            pHeader = (FONT_HEADER *) ((FONT_FLASH *)font)->address;
            break;

                #endif // USE_FONT_FLASH
                #ifdef USE_FONT_EXTERNAL

        case EXTERNAL:
            pHeader = &header;
            ExternalMemoryCallback(font, 0, sizeof(FONT_HEADER), pHeader);
            break;

                #endif // USE_FONT_EXTERNAL

        default:
            return;
    }

    _fontFirstChar = pHeader->firstChar;
    _fontLastChar = pHeader->lastChar;
    _fontHeight = pHeader->height;
}

/*********************************************************************
* Function: WORD OutChar(XCHAR ch)
*
* PreCondition: none
*
* Input: character code
*
* Output: For NON-Blocking configuration:
*         - Returns 0 when device is busy and the character is not yet completely drawn.
*         - Returns 1 when the character is completely drawn.
*         For Blocking configuration:
*         - Always return 1.
*
* Side Effects: none
*
* Overview: outputs a character
*
* Note: none
*
********************************************************************/
WORD __attribute__((weak)) OutChar(XCHAR ch)
{
        #ifdef USE_FONT_FLASH
    GLYPH_ENTRY *pChTable = NULL;
        #endif
    BYTE        *pChImage = NULL;

        #ifdef USE_FONT_EXTERNAL
    GLYPH_ENTRY chTable;
    BYTE        chImage[EXTERNAL_FONT_BUFFER_SIZE];
    WORD        imageSize;
    DWORD_VAL   glyphOffset;
        #endif
    SHORT       chWidth = 0;
    SHORT       xCnt, yCnt, x = 0, y;
    BYTE        temp = 0, mask;

        #ifndef USE_NONBLOCKING_CONFIG
    while(IsDeviceBusy() != 0) Nop();

    /* Ready */
        #else
    if(IsDeviceBusy() != 0)
        return (0);
        #endif
    if((XCHAR)ch < (XCHAR)_fontFirstChar)
        return (-1);
    if((XCHAR)ch > (XCHAR)_fontLastChar)
        return (-1);
    switch(*((SHORT *)_font))
    {
                #ifdef USE_FONT_FLASH

        case FLASH:
            pChTable = (GLYPH_ENTRY *) (((FONT_FLASH *)_font)->address +
  sizeof(FONT_HEADER)) + ((XCHAR)ch - (XCHAR)_fontFirstChar);

            pChImage = (BYTE *) (((FONT_FLASH *)_font)->address +
  ((DWORD)(pChTable->offsetMSB) << 8) + pChTable->offsetLSB);

            chWidth = pChTable->width;

            break;
                #endif
                #ifdef USE_FONT_EXTERNAL

        case EXTERNAL:

            // get glyph entry
            ExternalMemoryCallback
            (
                _font,
                sizeof(FONT_HEADER) + ((XCHAR)ch - (XCHAR)_fontFirstChar) *
  sizeof(GLYPH_ENTRY),
                sizeof(GLYPH_ENTRY),
                &chTable
            );

            chWidth = chTable.width;

            // width of glyph in bytes
            imageSize = 0;
            if(chWidth & 0x0007)
                imageSize = 1;
            imageSize += (chWidth >> 3);

            // glyph image size
            imageSize *= _fontHeight;

            // get glyph image
            glyphOffset.w[1] = (chTable.offsetMSB >> 8);
            glyphOffset.w[0] = (chTable.offsetMSB << 8) + (chTable.offsetLSB);

            ExternalMemoryCallback(_font, glyphOffset.Val, imageSize, &chImage);
            pChImage = (BYTE *) &chImage;

            break;
                #endif

        default:
            break;
    }

    if(_fontOrientation == ORIENT_HOR)
    {
        y = GetY();
        for(yCnt = 0; yCnt < _fontHeight; yCnt++)
        {
            x = GetX();
            mask = 0;
            for(xCnt = 0; xCnt < chWidth; xCnt++)
            {
                if(mask == 0)
                {
                    temp = *pChImage++;
                    mask = 0x01;
                }

                if(temp & mask)
                {
                    PutPixel(x, y);
                }

                x++;
                mask <<= 1;
            }

            y++;
        }

        // move cursor
        _cursorX = x;
    }
    else
    {
        y = GetX();
        for(yCnt = 0; yCnt < _fontHeight; yCnt++)
        {
            x = GetY();
            mask = 0;
            for(xCnt = 0; xCnt < chWidth; xCnt++)
            {
                if(mask == 0)
                {
                    temp = *pChImage++;
                    mask = 0x01;
                }

                if(temp & mask)
                {
                    PutPixel(y, x);
                }

                x--;
                mask <<= 1;
            }

            y++;
        }

        // move cursor
        _cursorY = x;
    }

    return (1);
}

/*********************************************************************
* Function: WORD OutText(XCHAR* textString)
*
* PreCondition: none
*
* Input: textString - pointer to text string
*
* Output: non-zero if drawing done (used for NON-BLOCKING configuration)
*
* Side Effects: none
*
* Overview: outputs text from current position
*
* Note: none
*
********************************************************************/
WORD __attribute__((weak)) OutText(XCHAR *textString)
{
    #ifndef USE_NONBLOCKING_CONFIG

    XCHAR   ch;
    while((XCHAR)15 < (XCHAR)(ch = *textString++))
        while(OutChar(ch) == 0);
    return (1);

    #else
    XCHAR       ch;
    static WORD counter = 0;

    while((XCHAR)(ch = *(textString + counter)) > (XCHAR)15)
    {
        if(OutChar(ch) == 0)
            return (0);
        counter++;
    }

    counter = 0;
    return (1);
    #endif
}

/*********************************************************************
* Function: WORD OutTextXY(SHORT x, SHORT y, XCHAR* textString)
*
* PreCondition: none
*
* Input: x,y - starting coordinates, textString - pointer to text string
*
* Output: non-zero if drawing done (used for NON-BLOCKING configuration)
*
* Side Effects: none
*
* Overview: outputs text from x,y position
*
* Note: none
*
********************************************************************/
WORD __attribute__((weak)) OutTextXY(SHORT x, SHORT y, XCHAR *textString)
{
    #ifndef USE_NONBLOCKING_CONFIG
    MoveTo(x, y);
    OutText(textString);
    return (1);

    #else

    static BYTE start = 1;

    if(start)
    {
        MoveTo(x, y);
        start = 0;
    }

    if(OutText(textString) == 0)
    {
        return (0);
    }
    else
    {
        start = 1;
        return (1);
    }

    #endif
}

/*********************************************************************
* Function: SHORT GetTextWidth(XCHAR* textString, void* font)
*
* PreCondition: none
*
* Input: textString - pointer to the text string,
*        font - pointer to the font
*
* Output: text width in pixels
*
```

```
* Side Effects: none
*
* Overview: returns text width for the font
*
* Note: none
*
********************************************************************/
SHORT __attribute__((weak)) GetTextWidth(XCHAR *textString, void *font)
{
        #if defined (USE_FONT_RAM) || defined (USE_FONT_FLASH)
    GLYPH_ENTRY *pChTable;
    FONT_HEADER *pHeader;
        #endif
        #ifdef USE_FONT_EXTERNAL
    GLYPH_ENTRY chTable;
    FONT_HEADER header;
        #endif

        #if defined (USE_FONT_RAM) || defined (USE_FONT_FLASH) || defined
(USE_FONT_EXTERNAL)
    SHORT       textWidth;
    XCHAR       ch;
    XCHAR       fontFirstChar;
    XCHAR       fontLastChar;
        #endif

    switch(*((SHORT *)font))
    {
                #ifdef USE_FONT_RAM

        case RAM:
            pHeader = (FONT_HEADER *) ((FONT_RAM *)font)->address;
            fontFirstChar = pHeader->firstChar;
            fontLastChar = pHeader->lastChar;
            pChTable = (GLYPH_ENTRY *) (pHeader + 1);
            textWidth = 0;
            while((unsigned XCHAR)15 < (unsigned XCHAR)(ch = *textString++))
            {
                if((unsigned XCHAR)ch < (unsigned XCHAR)fontFirstChar)
                    continue;
                if((unsigned XCHAR)ch > (unsigned XCHAR)fontLastChar)
                    continue;
                textWidth += (pChTable + ((unsigned XCHAR)ch - (unsigned
XCHAR)fontFirstChar))->width;
            }

            return (textWidth);
                #endif

                #ifdef USE_FONT_FLASH

        case FLASH:
            pHeader = (FONT_HEADER *) ((FONT_FLASH *)font)->address;
            fontFirstChar = pHeader->firstChar;
            fontLastChar = pHeader->lastChar;
            pChTable = (GLYPH_ENTRY *) (pHeader + 1);
            textWidth = 0;
            while((XCHAR)15 < (XCHAR)(ch = *textString++))
            {
                if((XCHAR)ch < (XCHAR)fontFirstChar)
                    continue;
                if((XCHAR)ch > (XCHAR)fontLastChar)
                    continue;
                textWidth += (pChTable + ((XCHAR)ch - (XCHAR)fontFirstChar))->width;
            }

            return (textWidth);
                #endif
                #ifdef USE_FONT_EXTERNAL

        case EXTERNAL:
            ExternalMemoryCallback(font, 0, sizeof(FONT_HEADER), &header);
            fontFirstChar = header.firstChar;
            fontLastChar = header.lastChar;
            textWidth = 0;
            while((XCHAR)15 < (XCHAR)(ch = *textString++))
            {
                if((XCHAR)ch < (XCHAR)fontFirstChar)
                    continue;
                if((XCHAR)ch > (XCHAR)fontLastChar)
                    continue;
                ExternalMemoryCallback
                (
                    font,
                    sizeof(FONT_HEADER) + sizeof(GLYPH_ENTRY) * ((XCHAR)ch -
(XCHAR)fontFirstChar),
                    sizeof(GLYPH_ENTRY),
                    &chTable
                );
                textWidth += chTable.width;
            }

            return (textWidth);
                #endif

        default:
            return (0);
    }
}

/*********************************************************************
* Function: SHORT GetTextHeight(void* font)
*
* PreCondition: none
*
* Input: pointer to the font
*
* Output: character height in pixels
*
* Side Effects: none
*
* Overview: returns characters height for the font
*
* Note: none
*
********************************************************************/
SHORT __attribute__((weak)) GetTextHeight(void *font)
{
        #ifdef USE_FONT_EXTERNAL

    char    height;
        #endif
    switch(*((SHORT *)font))
    {
                #ifdef USE_FONT_RAM
        case RAM:
            return ((FONT_HEADER *) ((FONT_RAM *)font)->address)->height;
                #endif

                #ifdef USE_FONT_FLASH
        case FLASH:
            return ((FONT_HEADER *) ((FONT_FLASH *)font)->address)->height;
                #endif

                #ifdef USE_FONT_EXTERNAL
        case EXTERNAL:
            ExternalMemoryCallback(font, sizeof(FONT_HEADER) - 2, 1, &height);
            return (height);
                #endif

        default:
            return (0);
    }
}
```

```
/*********************************************************************
* Function: SHORT GetImageWidth(void* image)
*
* PreCondition: none
*
* Input: image - image pointer
*
* Output: none
*
* Side Effects: none
*
* Overview: returns image width
*
* Note: none
*
********************************************************************/
SHORT __attribute__((weak)) GetImageWidth(void *image)
{
    #ifdef USE_BITMAP_EXTERNAL

    SHORT   width;
    #endif
    switch(*((SHORT *)image))
    {
            #ifdef USE_BITMAP_FLASH

        case FLASH:
            return (*((FLASH_WORD *) ((IMAGE_FLASH *)image)->address + 2));
            #endif
            #ifdef USE_BITMAP_EXTERNAL

        case EXTERNAL:
            ExternalMemoryCallback(image, 4, 2, &width);
            return (width);
            #endif

        default:
            return (0);
    }
}

/*********************************************************************
* Function: SHORT GetImageHeight(void* image)
*
* PreCondition: none
*
* Input: image - image pointer
*
* Output: none
*
* Side Effects: none
*
* Overview: returns image height
*
* Note: none
*
********************************************************************/
SHORT __attribute__((weak)) GetImageHeight(void *image)
{
    #ifdef USE_BITMAP_EXTERNAL

    SHORT   height;
    #endif
    switch(*((SHORT *)image))
    {
            #ifdef USE_BITMAP_FLASH

        case FLASH:
            return (*((FLASH_WORD *) ((IMAGE_FLASH *)image)->address + 1));
            #endif
            #ifdef USE_BITMAP_EXTERNAL
        case EXTERNAL:
            ExternalMemoryCallback(image, 2, 2, &height);
            return (height);
            #endif


        default:
            return (0);
    }
}

    #ifdef USE_BITMAP_FLASH

/*********************************************************************
* Function: void PutImage1BPP(SHORT left, SHORT top, FLASH_BYTE* image, BYTE stretch)
*
* PreCondition: none
*
* Input: left,top - left top image corner,
*        image - image pointer,
*        stretch - image stretch factor
*
* Output: none
*
* Side Effects: none
*
* Overview: outputs monochrome image starting from left,top coordinates
*
* Note: image must be located in flash
*
********************************************************************/
void __attribute__((weak)) PutImage1BPP(SHORT left, SHORT top, FLASH_BYTE *image, BYTE
stretch)
{
    register FLASH_BYTE *flashAddress;
    BYTE                temp = 0;
    WORD                sizeX, sizeY;
    WORD                x, y;
    WORD                xc, yc;
    WORD                pallete[2];
    BYTE                mask;

    // Move pointer to size information
    flashAddress = image + 2;

    // Read image size
    sizeY = *((FLASH_WORD *)flashAddress);
    flashAddress += 2;
    sizeX = *((FLASH_WORD *)flashAddress);
    flashAddress += 2;
    pallete[0] = *((FLASH_WORD *)flashAddress);
    flashAddress += 2;
    pallete[1] = *((FLASH_WORD *)flashAddress);
    flashAddress += 2;

    yc = top;

    // Note: For speed the code for loops are repeated. A small code size increase for
performance
    if (stretch == IMAGE_NORMAL)
    {
        for(y = 0; y < sizeY; y++)
        {
            xc = left;
            mask = 0;
            for(x = 0; x < sizeX; x++)
            {

                // Read 8 pixels from flash
                if(mask == 0)
                {
                    temp = *flashAddress++;
                    mask = 0x80;
                }

                // Set color
                if(mask & temp)
                {
                // Set color
                    #ifdef USE_PALETTE
                        SetColor(1);
                    #else
                        SetColor(pallete[1]);
                    #endif
                }
                else
                {
                    // Set color
                    #ifdef USE_PALETTE
                        SetColor(0);
                    #else
                        SetColor(pallete[0]);
                    #endif
                }

                #ifdef USE_TRANSPARENT_COLOR
                    if (!((GetTransparentColor() == GetColor()) &&
(GetTransparentColorStatus() == TRANSPARENT_COLOR_ENABLE)))
                #endif
                        // Write pixel(s) to screen
                        PutPixel(xc, yc);
                    // adjust to next location
                    xc++;
                    // Shift to the next pixel
                    mask >>= 1;
            }
            yc++;
        }
    }
    else
    {
        for(y = 0; y < sizeY; y++)
        {
            xc = left;
            mask = 0;

            for(x = 0; x < sizeX; x++)
            {

                // Read 8 pixels from flash
                if(mask == 0)
                {
                    temp = *flashAddress++;
                    mask = 0x80;
                }

                    // Set color
                if(mask & temp)
                {
                    // Set color
                    #ifdef USE_PALETTE
                        SetColor(1);
                    #else
                        SetColor(pallete[1]);
                    #endif
                }
                else
                {
                    // Set color
                    #ifdef USE_PALETTE
                        SetColor(0);
                    #else
                        SetColor(pallete[0]);
                    #endif
                }
                #ifdef USE_TRANSPARENT_COLOR
                    if (!((GetTransparentColor() == GetColor()) &&
(GetTransparentColorStatus() == TRANSPARENT_COLOR_ENABLE)))
                #endif
                    {
                        // Write pixel(s) to screen, basically writes a tile of 4x4 pixels
to the screen
                        PutPixel(xc,   yc);
                        PutPixel(xc,   yc+1);
                        PutPixel(xc+1, yc);
                        PutPixel(xc+1, yc+1);
                    }
                    xc += 2;
                // Shift to the next pixel
                mask >>= 1;
            }
            yc+=2;
        }
    }

}

/*********************************************************************
* Function: void PutImage4BPP(SHORT left, SHORT top, FLASH_BYTE* image, BYTE stretch)
*
* PreCondition: none
*
* Input: left,top - left top image corner, image - image pointer,
*        stretch - image stretch factor
*
* Output: none
*
* Side Effects: none
*
* Overview: outputs 16 color image starting from left,top coordinates
*
* Note: image must be located in flash
*
********************************************************************/
        #if (COLOR_DEPTH >= 4)

/* */
void __attribute__((weak)) PutImage4BPP(SHORT left, SHORT top, FLASH_BYTE *image, BYTE
stretch)
{
    register FLASH_BYTE *flashAddress;
    WORD                sizeX, sizeY;
    register WORD       x, y;
    WORD                xc, yc;
    BYTE                temp = 0;
    WORD                pallete[16];
    WORD                counter;

    // Move pointer to size information
    flashAddress = image + 2;

    // Read image size
    sizeY = *((FLASH_WORD *)flashAddress);
    flashAddress += 2;
    sizeX = *((FLASH_WORD *)flashAddress);
    flashAddress += 2;

    // Read pallete
    for(counter = 0; counter < 16; counter++)
    {
        pallete[counter] = *((FLASH_WORD *)flashAddress);
        flashAddress += 2;
    }

    yc = top;
    // Note: For speed the code for loops are repeated. A small code size increase for
performance
    if (stretch == IMAGE_NORMAL)
    {
        for(y = 0; y < sizeY; y++)
        {
            xc = left;
            for(x = 0; x < sizeX; x++)
            {

                // Read 2 pixels from flash
                if(x & 0x0001)
                {

                // second pixel in byte
                // Set color
                #ifdef USE_PALETTE
                    SetColor(temp >> 4);
                #else
                    SetColor(pallete[temp >> 4]);
                #endif
                }
                else
                {
                    temp = *flashAddress++;

                // first pixel in byte
                // Set color
                #ifdef USE_PALETTE
                    SetColor(temp & 0x0f);
                #else
                    SetColor(pallete[temp & 0x0f]);
                #endif
                }

                #ifdef USE_TRANSPARENT_COLOR
                    if (!((GetTransparentColor() == GetColor()) &&
(GetTransparentColorStatus() == TRANSPARENT_COLOR_ENABLE)))
                #endif
                        // Write pixel(s) to screen
                        PutPixel(xc, yc);
                    xc++;
            }
            yc++;
        }
    }
    else
    {
        for(y = 0; y < sizeY; y++)
        {
            xc = left;
            for(x = 0; x < sizeX; x++)
            {

               if(x & 0x0001)
               {

                // second pixel in byte
                // Set color
                #ifdef USE_PALETTE
                    SetColor(temp >> 4);
                #else
                    SetColor(pallete[temp >> 4]);
                #endif
                }
                else
                {
                    temp = *flashAddress++;

                // first pixel in byte
                // Set color
                #ifdef USE_PALETTE
                    SetColor(temp & 0x0f);
                #else
                    SetColor(pallete[temp & 0x0f]);
                #endif
                }

                #ifdef USE_TRANSPARENT_COLOR
                    if (!((GetTransparentColor() == GetColor()) &&
(GetTransparentColorStatus() == TRANSPARENT_COLOR_ENABLE)))
                #endif
                    {
                        // Write pixel(s) to screen, basically writes a tile of 4x4 pixels
to the screen
                        PutPixel(xc,   yc);
                        PutPixel(xc,   yc+1);
                        PutPixel(xc+1, yc);
                        PutPixel(xc+1, yc+1);
                    }
                    xc += 2;
            }
            yc+=2;
        }
    }
}
        #endif // #if (COLOR_DEPTH >= 4)

/*********************************************************************
* Function: void PutImage8BPP(SHORT left, SHORT top, FLASH_BYTE* image, BYTE stretch)
*
* PreCondition: none
*
* Input: left,top - left top image corner, image - image pointer,
*        stretch - image stretch factor
*
* Output: none
*
* Side Effects: none
*
* Overview: outputs 256 color image starting from left,top coordinates
*
* Note: image must be located in flash
*
********************************************************************/
        #if (COLOR_DEPTH >= 8)

/* */
void __attribute__((weak)) PutImage8BPP(SHORT left, SHORT top, FLASH_BYTE *image, BYTE
stretch)
{
    register FLASH_BYTE *flashAddress;
    WORD                sizeX, sizeY;
    WORD                x, y;
    WORD                xc, yc;
    BYTE                temp;
    WORD                pallete[256];
    WORD                counter;

    // Move pointer to size information
    flashAddress = image + 2;

    // Read image size
    sizeY = *((FLASH_WORD *)flashAddress);
    flashAddress += 2;
    sizeX = *((FLASH_WORD *)flashAddress);
    flashAddress += 2;

    // Read pallete
    for(counter = 0; counter < 256; counter++)
    {
        pallete[counter] = *((FLASH_WORD *)flashAddress);
        flashAddress += 2;
    }

    yc = top;

    // Note: For speed the code for loops are repeated. A small code size increase for
performance
    if (stretch == IMAGE_NORMAL)
    {
        for(y = 0; y < sizeY; y++)
        {
            xc = left;
            for(x = 0; x < sizeX; x++)
            {
                temp = *flashAddress++;

                // Set color
                #ifdef USE_PALETTE
                    SetColor(temp);
                #else
                    SetColor(pallete[temp]);
                #endif

                #ifdef USE_TRANSPARENT_COLOR
                    if (!((GetTransparentColor() == GetColor()) &&
(GetTransparentColorStatus() == TRANSPARENT_COLOR_ENABLE)))
                #endif
                        // Write pixel(s) to screen
                        PutPixel(xc, yc);
                    xc++;
            }
            yc++;
        }
    }
    else
    {
        for(y = 0; y < sizeY; y++)
        {
            xc = left;
            for(x = 0; x < sizeX; x++)
            {
                temp = *flashAddress++;

                // Set color
                #ifdef USE_PALETTE
                    SetColor(temp);
                #else
                    SetColor(pallete[temp]);
                #endif

                #ifdef USE_TRANSPARENT_COLOR
                    if (!((GetTransparentColor() == GetColor()) &&
(GetTransparentColorStatus() == TRANSPARENT_COLOR_ENABLE)))
                #endif
                    {
                        // Write pixel(s) to screen, basically writes a tile of 4x4 pixels
to the screen
                        PutPixel(xc,   yc);
                        PutPixel(xc,   yc+1);
                        PutPixel(xc+1, yc);
                        PutPixel(xc+1, yc+1);
                    }
                    xc += 2;
            }
            yc+=2;
        }
    }

}
        #endif // #if (COLOR_DEPTH >= 8)

/*********************************************************************
* Function: void PutImage16BPP(SHORT left, SHORT top, FLASH_BYTE* image, BYTE stretch)
```

```
*
* PreCondition: none
*
* Input: left,top - left top image corner, image - image pointer,
*        stretch - image stretch factor
*
* Output: none
*
* Side Effects: none
*
* Overview: outputs hicolor image starting from left,top coordinates
*
* Note: image must be located in flash
*
********************************************************************/
        #if (COLOR_DEPTH == 16)

/* */
void __attribute__((weak)) PutImage16BPP(SHORT left, SHORT top, FLASH_BYTE *image, BYTE
stretch)
{
    register FLASH_WORD *flashAddress;
    WORD                sizeX, sizeY;
    register WORD       x, y;
    WORD                xc, yc;
    WORD                temp;

    // Move pointer to size information
    flashAddress = (FLASH_WORD *)image + 1;

    // Read image size
    sizeY = *flashAddress;
    flashAddress++;
    sizeX = *flashAddress;
    flashAddress++;

    yc = top;

    // Note: For speed the code for loops are repeated. A small code size increase for
performance
    if (stretch == IMAGE_NORMAL)
    {
        for(y = 0; y < sizeY; y++)
        {
            xc = left;
            for(x = 0; x < sizeX; x++)
            {
                temp = *flashAddress++;
                SetColor(temp);

                #ifdef USE_TRANSPARENT_COLOR
                    if (!((GetTransparentColor() == GetColor()) &&
(GetTransparentColorStatus() == TRANSPARENT_COLOR_ENABLE)))
                #endif
                        // Write pixel(s) to screen
                        PutPixel(xc, yc);
                    xc++;
            }
            yc++;
        }
    }
    else
    {
        for(y = 0; y < sizeY; y++)
        {
            xc = left;
            for(x = 0; x < sizeX; x++)
            {
                temp = *flashAddress++;
                SetColor(temp);

                #ifdef USE_TRANSPARENT_COLOR
```

```
                    if (!((GetTransparentColor() == GetColor()) &&
(GetTransparentColorStatus() == TRANSPARENT_COLOR_ENABLE)))
                #endif
                    {
                        // Write pixel(s) to screen, basically writes a tile of 4x4 pixels
to the screen
                        PutPixel(xc,   yc);
                        PutPixel(xc,   yc+1);
                        PutPixel(xc+1, yc);
                        PutPixel(xc+1, yc+1);
                    }
                    xc += 2;
            }
            yc+=2;
        }
    }

}

        #endif //#if (COLOR_DEPTH == 16)
    #endif // #ifdef USE_BITMAP_FLASH

    #ifdef USE_BITMAP_EXTERNAL

/*********************************************************************
* Function: void PutImage1BPPExt(SHORT left, SHORT top, void* image, BYTE stretch)
*
* PreCondition: none
*
* Input: left,top - left top image corner, image - image pointer,
*        stretch - image stretch factor
*
* Output: none
*
* Side Effects: none
*
* Overview: outputs monochrome image starting from left,top coordinates
*
* Note: image must be located in external memory
*
********************************************************************/
void __attribute__((weak)) PutImage1BPPExt(SHORT left, SHORT top, void *image, BYTE stretch)
{
    register DWORD  memOffset;
    BITMAP_HEADER   bmp;
    WORD            pallete[2];
    BYTE            lineBuffer[((GetMaxX() + 1) / 8) + 1];
    BYTE            *pData;
    SHORT           byteWidth;

    BYTE            temp = 0;
    BYTE            mask;
    WORD            sizeX, sizeY;
    WORD            x, y;
    WORD            xc, yc;

    // Get image header
    ExternalMemoryCallback(image, 0, sizeof(BITMAP_HEADER), &bmp);

    // Get pallete (2 entries)
    ExternalMemoryCallback(image, sizeof(BITMAP_HEADER), 2 * sizeof(WORD), pallete);

    // Set offset to the image data
    memOffset = sizeof(BITMAP_HEADER) + 2 * sizeof(WORD);

    // Line width in bytes
    byteWidth = bmp.width >> 3;
    if(bmp.width & 0x0007)
        byteWidth++;

    // Get size
    sizeX = bmp.width;
    sizeY = bmp.height;

    yc = top;

    // Note: For speed the code for loops are repeated. A small code size increase for
performance
    if (stretch == IMAGE_NORMAL)
    {
        for(y = 0; y < sizeY; y++)
        {
            // Get line
            ExternalMemoryCallback(image, memOffset, byteWidth, lineBuffer);
            memOffset += byteWidth;

            pData = lineBuffer;
            mask = 0;

            xc = left;
            for(x = 0; x < sizeX; x++)
            {

                    // Read 8 pixels from flash
                    if(mask == 0)
                    {
                        temp = *pData++;
                        mask = 0x80;
                    }

                    // Set color
                    if(mask & temp)
                    {
                        // Set color
                        #ifdef USE_PALETTE
                            SetColor(1);
                        #else
                            SetColor(pallete[1]);
                        #endif
                    }
                    else
                    {
                        // Set color
                        #ifdef USE_PALETTE
                            SetColor(0);
                        #else
                            SetColor(pallete[0]);
                        #endif
                    }


                #ifdef USE_TRANSPARENT_COLOR
                    if (!((GetTransparentColor() == GetColor()) &&
(GetTransparentColorStatus() == TRANSPARENT_COLOR_ENABLE)))
                #endif
                        // Write pixel(s) to screen
                        PutPixel(xc, yc);
                    xc++;
                // Shift to the next pixel
                mask >>= 1;
            }
            yc++;
        }
    }
    else
    {
        for(y = 0; y < sizeY; y++)
        {
            // Get line
            ExternalMemoryCallback(image, memOffset, byteWidth, lineBuffer);
            memOffset += byteWidth;

            pData = lineBuffer;
            mask = 0;
            xc = left;
            for(x = 0; x < sizeX; x++)
            {

                      // Read 8 pixels from flash
                    if(mask == 0)
                    {
                        temp = *pData++;
                        mask = 0x80;
                    }

                    // Set color
                    if(mask & temp)
                    {
                        // Set color
                        #ifdef USE_PALETTE
                            SetColor(1);
                        #else
                            SetColor(pallete[1]);
                        #endif
                    }
                    else
                    {
                        // Set color
                        #ifdef USE_PALETTE
                            SetColor(0);
                        #else
                            SetColor(pallete[0]);
                        #endif
                    }


                #ifdef USE_TRANSPARENT_COLOR
                    if (!((GetTransparentColor() == GetColor()) &&
(GetTransparentColorStatus() == TRANSPARENT_COLOR_ENABLE)))
                #endif
                    {
                        // Write pixel(s) to screen, basically writes a tile of 4x4 pixels
to the screen
                        PutPixel(xc,   yc);
                        PutPixel(xc,   yc+1);
                        PutPixel(xc+1, yc);
                        PutPixel(xc+1, yc+1);
                    }
                    xc += 2;
                // Shift to the next pixel
                mask >>= 1;

            }
            yc+=2;
        }
    }

}

/*********************************************************************
* Function: void PutImage4BPPExt(SHORT left, SHORT top, void* image, BYTE stretch)
*
* PreCondition: none
*
* Input: left,top - left top image corner, image - image pointer,
*        stretch - image stretch factor
*
* Output: none
*
* Side Effects: none
*
* Overview: outputs monochrome image starting from left,top coordinates
*
* Note: image must be located in external memory
*
```

```
*********************************************************************/
        #if (COLOR_DEPTH >= 4)

/* */
void __attribute__((weak)) PutImage4BPPExt(SHORT left, SHORT top, void *image, BYTE stretch)
{
    register DWORD  memOffset;
    BITMAP_HEADER   bmp;
    WORD            pallete[16];
    BYTE            lineBuffer[((GetMaxX() + 1) / 2) + 1];
    BYTE            *pData;
    SHORT           byteWidth;

    BYTE            temp = 0;
    WORD            sizeX, sizeY;
    WORD            x, y;
    WORD            xc, yc;

    // Get image header
    ExternalMemoryCallback(image, 0, sizeof(BITMAP_HEADER), &bmp);

    // Get pallete (16 entries)
    ExternalMemoryCallback(image, sizeof(BITMAP_HEADER), 16 * sizeof(WORD), pallete);

    // Set offset to the image data
    memOffset = sizeof(BITMAP_HEADER) + 16 * sizeof(WORD);

    // Line width in bytes
    byteWidth = bmp.width >> 1;
    if(bmp.width & 0x0001)
        byteWidth++;

    // Get size
    sizeX = bmp.width;
    sizeY = bmp.height;

    yc = top;

    // Note: For speed the code for loops are repeated. A small code size increase for
performance
    if (stretch == IMAGE_NORMAL)
    {
        for(y = 0; y < sizeY; y++)
        {
            // Get line
            ExternalMemoryCallback(image, memOffset, byteWidth, lineBuffer);
            memOffset += byteWidth;

            pData = lineBuffer;

            xc = left;
            for(x = 0; x < sizeX; x++)
            {

                // Read 2 pixels from flash
                if(x & 0x0001)
                {

                    // second pixel in byte
                    // Set color
                    #ifdef USE_PALETTE
                        SetColor(temp >> 4);
                    #else
                        SetColor(pallete[temp >> 4]);
                    #endif
                }
                else
                {
                    temp = *pData++;

                    // first pixel in byte
                    // Set color
                    #ifdef USE_PALETTE
                        SetColor(temp & 0x0f);
                    #else
                        SetColor(pallete[temp & 0x0f]);
                    #endif
                }

                #ifdef USE_TRANSPARENT_COLOR
                    if (!((GetTransparentColor() == GetColor()) &&
(GetTransparentColorStatus() == TRANSPARENT_COLOR_ENABLE)))
                #endif
                        // Write pixel(s) to screen
                        PutPixel(xc, yc);
                    xc++;
            }
            yc++;
        }
    }
    else
    {
        for(y = 0; y < sizeY; y++)
        {
            // Get line
            ExternalMemoryCallback(image, memOffset, byteWidth, lineBuffer);
            memOffset += byteWidth;

            pData = lineBuffer;

            xc = left;
            for(x = 0; x < sizeX; x++)
            {

                // Read 2 pixels from flash
                if(x & 0x0001)
                {

                    // second pixel in byte
                    // Set color
                    #ifdef USE_PALETTE
                        SetColor(temp >> 4);
                    #else
                        SetColor(pallete[temp >> 4]);
                    #endif
                }
                else
                {
                    temp = *pData++;

                    // first pixel in byte
                    // Set color
                    #ifdef USE_PALETTE
                        SetColor(temp & 0x0f);
                    #else
                        SetColor(pallete[temp & 0x0f]);
                    #endif
                }

                #ifdef USE_TRANSPARENT_COLOR
                    if (!((GetTransparentColor() == GetColor()) &&
(GetTransparentColorStatus() == TRANSPARENT_COLOR_ENABLE)))
                #endif
                    {
                        // Write pixel(s) to screen, basically writes a tile of 4x4 pixels
to the screen
                        PutPixel(xc,   yc);
                        PutPixel(xc,   yc+1);
                        PutPixel(xc+1, yc);
                        PutPixel(xc+1, yc+1);
                    }
                    xc += 2;
            }
            yc+=2;
        }
    }
}

        #endif

/*********************************************************************
* Function: void PutImage8BPPExt(SHORT left, SHORT top, void* image, BYTE stretch)
*
* PreCondition: none
*
* Input: left,top - left top image corner, image - image pointer,
*        stretch - image stretch factor
*
* Output: none
*
* Side Effects: none
*
* Overview: outputs monochrome image starting from left,top coordinates
*
* Note: image must be located in external memory
*
********************************************************************/
        #if (COLOR_DEPTH >= 8)

/* */
void __attribute__((weak)) PutImage8BPPExt(SHORT left, SHORT top, void *image, BYTE stretch)
{
    register DWORD  memOffset;
    BITMAP_HEADER   bmp;
    WORD            pallete[256];
    BYTE            lineBuffer[(GetMaxX() + 1)];
    BYTE            *pData;

    BYTE            temp;
    WORD            sizeX, sizeY;
    WORD            x, y;
    WORD            xc, yc;

    // Get image header
    ExternalMemoryCallback(image, 0, sizeof(BITMAP_HEADER), &bmp);

    // Get pallete (256 entries)
    ExternalMemoryCallback(image, sizeof(BITMAP_HEADER), 256 * sizeof(WORD), pallete);

    // Set offset to the image data
    memOffset = sizeof(BITMAP_HEADER) + 256 * sizeof(WORD);

    // Get size
    sizeX = bmp.width;
    sizeY = bmp.height;

    yc = top;

    // Note: For speed the code for loops are repeated. A small code size increase for
performance
    if (stretch == IMAGE_NORMAL)
    {
        for(y = 0; y < sizeY; y++)
        {
            // Get line
            ExternalMemoryCallback(image, memOffset, sizeX, lineBuffer);
            memOffset += sizeX;

            pData = lineBuffer;

            xc = left;
            for(x = 0; x < sizeX; x++)
            {
                temp = *pData++;

                // Set color
                #ifdef USE_PALETTE
                    SetColor(temp);
                #else
                    SetColor(pallete[temp]);
                #endif

                #ifdef USE_TRANSPARENT_COLOR
                    if (!((GetTransparentColor() == GetColor()) &&
(GetTransparentColorStatus() == TRANSPARENT_COLOR_ENABLE)))
                #endif
                        // Write pixel(s) to screen
                        PutPixel(xc, yc);
                    xc++;
            }
            yc++;
        }
    }
    else
    {
        for(y = 0; y < sizeY; y++)
        {
            // Get line
            ExternalMemoryCallback(image, memOffset, sizeX, lineBuffer);
            memOffset += sizeX;

            pData = lineBuffer;

            xc = left;
            for(x = 0; x < sizeX; x++)
            {
                temp = *pData++;

                // Set color
                #ifdef USE_PALETTE
                    SetColor(temp);
                #else
                    SetColor(pallete[temp]);
                #endif

                #ifdef USE_TRANSPARENT_COLOR
                    if (!((GetTransparentColor() == GetColor()) &&
(GetTransparentColorStatus() == TRANSPARENT_COLOR_ENABLE)))
                #endif
                    {
                        // Write pixel(s) to screen, basically writes a tile of 4x4 pixels
to the screen
                        PutPixel(xc,   yc);
                        PutPixel(xc,   yc+1);
                        PutPixel(xc+1, yc);
                        PutPixel(xc+1, yc+1);
                    }
                    xc += 2;
            }
            yc+=2;
        }
    }

}

        #endif

/*********************************************************************
* Function: void PutImage16BPPExt(SHORT left, SHORT top, void* image, BYTE stretch)
*
* PreCondition: none
*
* Input: left,top - left top image corner, image - image pointer,
*        stretch - image stretch factor
*
* Output: none
*
* Side Effects: none
```

```
*
* Overview: outputs monochrome image starting from left,top coordinates
*
* Note: image must be located in external memory
*
********************************************************************/
        #if (COLOR_DEPTH == 16)

/* */
void __attribute__((weak)) PutImage16BPPExt(SHORT left, SHORT top, void *image, BYTE
stretch)
{
    register DWORD  memOffset;
    BITMAP_HEADER   bmp;
    WORD            lineBuffer[(GetMaxX() + 1)];
    WORD            *pData;
    WORD            byteWidth;

    WORD            temp;
    WORD            sizeX, sizeY;
    WORD            x, y;
    WORD            xc, yc;

    // Get image header
    ExternalMemoryCallback(image, 0, sizeof(BITMAP_HEADER), &bmp);

    // Set offset to the image data
    memOffset = sizeof(BITMAP_HEADER);

    // Get size
    sizeX = bmp.width;
    sizeY = bmp.height;

    byteWidth = sizeX << 1;

    yc = top;

    // Note: For speed the code for loops are repeated. A small code size increase for
performance
    if (stretch == IMAGE_NORMAL)
    {
        for(y = 0; y < sizeY; y++)
        {
            // Get line
            ExternalMemoryCallback(image, memOffset, byteWidth, lineBuffer);
            memOffset += byteWidth;

            pData = lineBuffer;

            xc = left;
            for(x = 0; x < sizeX; x++)
                {
                temp = *pData++;
                SetColor(temp);

                #ifdef USE_TRANSPARENT_COLOR
                    if (!((GetTransparentColor() == GetColor()) &&
(GetTransparentColorStatus() == TRANSPARENT_COLOR_ENABLE)))
                #endif
                        // Write pixel(s) to screen
                        PutPixel(xc, yc);
                    xc++;
            }
            yc++;
        }
    }
    else
    {
        for(y = 0; y < sizeY; y++)
        {
            // Get line
            ExternalMemoryCallback(image, memOffset, byteWidth, lineBuffer);
```

```
              memOffset += byteWidth;

              pData = lineBuffer;

              xc = left;
              for(x = 0; x < sizeX; x++)
                  {
                  temp = *pData++;
                  SetColor(temp);

                  #ifdef USE_TRANSPARENT_COLOR
                      if (!((GetTransparentColor() == GetColor()) &&
(GetTransparentColorStatus() == TRANSPARENT_COLOR_ENABLE)))
                  #endif
                      {
                          // Write pixel(s) to screen, basically writes a tile of 4x4 pixels
to the screen
                          PutPixel(xc,   yc);
                          PutPixel(xc,   yc+1);
                          PutPixel(xc+1, yc);
                          PutPixel(xc+1, yc+1);
                      }
                      xc += 2;
              }
              yc+=2;
          }
      }
}

        #endif
    #endif

/*********************************************************************
* Function: WORD PutImage(SHORT left, SHORT top, void* image, BYTE stretch)
*
* PreCondition: none
*
* Input: left,top - left top image corner,
*        image - image pointer,
*        stretch - image stretch factor
*
* Output: For NON-Blocking configuration:
*         - Returns 0 when device is busy and the image is not yet completely drawn.
*         - Returns 1 when the image is completely drawn.
*         For Blocking configuration:
*         - Always return 1.
*
* Side Effects: none
*
* Overview: outputs image starting from left,top coordinates
*
* Note: image must be located in flash
*
********************************************************************/
WORD __attribute__((weak)) PutImage(SHORT left, SHORT top, void *image, BYTE stretch)
{
    FLASH_BYTE  *flashAddress;
    BYTE        colorDepth;
    WORD        colorTemp;
    WORD        resType;

#if defined(USE_COMP_RLE)
    GFX_IMAGE_HEADER *pimghdr = (GFX_IMAGE_HEADER *)image;
#endif

#ifndef USE_NONBLOCKING_CONFIG
    while(IsDeviceBusy() != 0) Nop();

    /* Ready */
#else
    if(IsDeviceBusy() != 0)
        return (0);
```

```
 #endif

     // Save current color
     colorTemp = GetColor();
     resType = *((WORD *)image);


     switch(resType & (GFX_MEM_MASK | GFX_COMP_MASK))
     {

                 #ifdef USE_COMP_RLE
                 #ifdef USE_BITMAP_FLASH
         case (FLASH | COMP_RLE):

             // Image address
             flashAddress = pimghdr->LOCATION.progByteAddress;
             // Read color depth
             colorDepth = pimghdr->colorDepth;

             // Draw picture
             switch(colorDepth)
             {
                     #if (COLOR_DEPTH >= 4)
                 case 4:
                     PutImageRLE4BPP(left, top, flashAddress, stretch); break;
                     #endif

                     #if (COLOR_DEPTH >= 8)
                 case 8:
                     PutImageRLE8BPP(left, top, flashAddress, stretch); break;
                     #endif

                     default:    break;
             }
             break;
                 #endif //#ifdef USE_BITMAP_FLASH

                 #ifdef USE_BITMAP_EXTERNAL
         case (EXTERNAL | COMP_RLE):

             // Get color depth
             ExternalMemoryCallback(image, 1, 1, &colorDepth);

             // Draw picture
             switch(colorDepth)
             {
                     #if (COLOR_DEPTH >= 4)
                 case 4:
                     PutImageRLE4BPPExt(left, top, image, stretch); break;
                     #endif

                     #if (COLOR_DEPTH >= 8)
                 case 8:
                     PutImageRLE8BPPExt(left, top, image, stretch); break;
                     #endif

                 default:    break;
             }
             break;
                 #endif //#ifdef USE_BITMAP_EXTERNAL
                 #endif // #ifdef USE_COMP_RLE

                 #ifdef USE_BITMAP_FLASH

         case (FLASH | COMP_NONE):

             // Image address
             flashAddress = ((IMAGE_FLASH *)image)->address;

             // Read color depth
             colorDepth = *(flashAddress + 1);
```

```
            // Draw picture
            switch(colorDepth)
            {
                case 1:
                    PutImage1BPP(left, top, flashAddress, stretch); break;

                    #if (COLOR_DEPTH >= 4)
                case 4:
                    PutImage4BPP(left, top, flashAddress, stretch); break;
                    #endif

                    #if (COLOR_DEPTH >= 8)
                case 8:
                    PutImage8BPP(left, top, flashAddress, stretch); break;
                    #endif

                    #if (COLOR_DEPTH == 16)
                case 16:
                    PutImage16BPP(left, top, flashAddress, stretch); break;
                    #endif

                default:    break;

            }

            break;
                #endif // #ifdef USE_BITMAP_FLASH

                #ifdef USE_BITMAP_EXTERNAL

        case (EXTERNAL | COMP_NONE):

            // Get color depth
            ExternalMemoryCallback(image, 1, 1, &colorDepth);

            // Draw picture
            switch(colorDepth)
            {
                case 1:
                    PutImage1BPPExt(left, top, image, stretch); break;

                    #if (COLOR_DEPTH >= 4)
                case 4:
                    PutImage4BPPExt(left, top, image, stretch); break;
                    #endif

                    #if (COLOR_DEPTH >= 8)
                case 8:
                    PutImage8BPPExt(left, top, image, stretch); break;
                    #endif

                    #if (COLOR_DEPTH == 16)
                case 16:
                    PutImage16BPPExt(left, top, image, stretch); break;
                    #endif

                default:    break;
            }

            break;
                #endif //#ifdef USE_BITMAP_EXTERNAL

                #if defined (GFX_USE_DISPLAY_CONTROLLER_MCHP_DA210)
                #ifdef USE_COMP_IPU
        case (FLASH | COMP_IPU):
        case (EXTERNAL | COMP_IPU):
        case (EDS_EPMP | COMP_IPU):
                #endif // #ifdef USE_COMP_IPU
        case (EDS_EPMP | COMP_NONE):

            // this requires special processing of images in Extended Data Space
            // call the driver specific function to perform the processing
            PutImageDrv(left, top, image, stretch);
            break;

                #endif //#if defined (__PIC24FJ256DA210__)

        default:
            break;
    }

    // Restore current color
    SetColor(colorTemp);
    return (1);
}

/*********************************************************************
* Function:  SHORT GetSineCosine(SHORT v, WORD type)
*
* PreCondition: none
*
* Input: v - the angle used to calculate the sine or cosine value.
*            The angle must be in the range of -360 to 360 degrees.
*        type - sets if the angle calculation is for a sine or cosine
*               - GETSINE (0) - get the value of sine(v).
*               - GETCOSINE (1) - return the value of cosine(v).
*
* Output: Returns the sine or cosine of the angle given.
*
* Side Effects: none
*
* Overview: This calculates the sine or cosine value of the given angle.
*
* Note: none
*
********************************************************************/
SHORT GetSineCosine(SHORT v, WORD type)
{
    // if angle is neg, convert to pos equivalent
    if (v < 0)
        v += 360;
    //v /= DEGREECOUNT;                 // convert into ticks from degrees, tick = 3 deg

    if(v >= COSINETABLEENTRIES * 3)
    {
        v -= COSINETABLEENTRIES * 3;
        return ((type == GETSINE) ? -(_CosineTable[v]) : (_CosineTable[COSINETABLEENTRIES -
v]));
    }
    else if(v >= COSINETABLEENTRIES * 2)
    {
        v -= COSINETABLEENTRIES * 2;
        return ((type == GETSINE) ? -(_CosineTable[(COSINETABLEENTRIES - v)]) :
-(_CosineTable[v]));
    }
    else if(v >= COSINETABLEENTRIES)
    {
        v -= COSINETABLEENTRIES;
        return ((type == GETSINE) ? (_CosineTable[v]) : -(_CosineTable[COSINETABLEENTRIES -
v]));
    }
    else
    {
        return ((type == GETSINE) ? (_CosineTable[COSINETABLEENTRIES - v]) :
(_CosineTable[v]));
    }


}

/*********************************************************************
* Function:  WORD DrawArc(SHORT cx, SHORT cy, SHORT r1, SHORT r2, SHORT startAngle, SHORT
endAngle)
*
```

```
* PreCondition: none
*
* Input: cx - the location of the center of the arc in the x direction.
*        cy - the location of the center of the arc in the y direction.
*        r1 - the smaller radius of the arc.
*        r2 - the larger radius of the arc.
*        startAngle - start angle of the arc.
*        endAngle - end angle of the arc.
*
* Output: Returns 1 if the rendering is done, 0 if not yet done.
*
* Side Effects: none
*
* Overview: This renders an arc with from startAngle to endAngle with the thickness
*           of r2-r1. The function returns 1 when the arc is rendered successfuly
*           and returns a 0 when it is not yet finished. The next call to the
*           function will continue the rendering.
*
* Note: none
*
********************************************************************/
WORD __attribute__((weak)) DrawArc(SHORT cx, SHORT cy, SHORT r1, SHORT r2, SHORT
startAngle, SHORT endAngle)
{

    SHORT i;
    SHORT x1,y1,x2,y2;

    for (i=startAngle; i <= endAngle; i++)
    {
        // get inner arc x,y position
        y1 = (r1*Sine(i))/256;
        x1 = (r1*Cosine(i))/256;

        // get outer arc x,y position
        if (r1 != r2)
        {
            y2 = (r2*Sine(i))/256;
            x2 = (r2*Cosine(i))/256;

            // check if we need to double the line to cover all pixels
            if ((x1 == x2) || (y1 == y2))
            {
                SetLineThickness(NORMAL_LINE);
            }
            else
            {
                SetLineThickness(THICK_LINE);
            }
            // draw the lines to fill the arc
            while(!Line(cx+x1, cy+y1, cx+x2, cy+y2));
        }
        else
        {
            PutPixel(cx+x1, cy+y1);
        }

    }
    return 1;
}


#ifdef USE_GRADIENT
#define WAIT_UNTIL_FINISH(x)    while(!x)

#if (COLOR_DEPTH == 24)
#define GetRed(color)       (((color) & 0xFF0000) >> 16)
#define GetGreen(color)     (((color) & 0x00FF00) >> 8)
#define GetBlue(color)      ((color) & 0x0000FF)
#else
#define GetRed(color)       (((color) & 0xF800) >> 8)
#define GetGreen(color)     (((color) & 0x07E0) >> 3)
```

```
#define GetBlue(color)      (((color) & 0x001F) << 3)
#endif

WORD BarGradient(SHORT left, SHORT top, SHORT right, SHORT bottom, GFX_COLOR color1,
GFX_COLOR color2, DWORD length, BYTE direction)
{

    WORD startRed, startBlue, startGreen;
    WORD endRed, endBlue, endGreen;

    long rdiff=0,gdiff=0,bdiff=0;
    short i,steps;

    SetColor(color2);

    // if length is 100, why waste the bar call?
    switch(direction)
    {
    case GRAD_UP:
        length = length * (bottom - top);
        length /= 100;
        steps = length;
        WAIT_UNTIL_FINISH(Bar(left,top,right,bottom-steps));
        break;

    case GRAD_DOWN:
        length = length * (bottom - top);
        length /= 100;
        steps = length;
        WAIT_UNTIL_FINISH(Bar(left,top+steps,right,bottom));
        break;

    case GRAD_RIGHT:
        length = length * (right - left);
        length /= 100;
        steps = length;
        WAIT_UNTIL_FINISH(Bar(left+steps,top,right,bottom));
        break;

    case GRAD_LEFT:
        length = length * (right - left);
        length /= 100;
        steps = length;
        WAIT_UNTIL_FINISH(Bar(left,top,right-steps,bottom));
        break;

    case GRAD_DOUBLE_VER:
        steps = (right - left) >> 1;
        break;

    case GRAD_DOUBLE_HOR:
        steps = (bottom - top) >> 1;
        break;

    default:
        return 1;
    }

    startRed    = GetRed(color1);
    startGreen  = GetGreen(color1);
    startBlue   = GetBlue(color1);

    endRed      = GetRed(color2);
    endGreen    = GetGreen(color2);
    endBlue     = GetBlue(color2);

    ///////////////////////////////////

    //Find the step size for the red portion//
    rdiff = ((long)endRed - (long)startRed) << 8;
    rdiff /= steps;
    //Find the step size for the green portion//
    gdiff = ((long)endGreen - (long)startGreen) << 8;
    gdiff /= steps;

    //Find the step size for the blue portion//
    bdiff = ((long)endBlue - (long)startBlue) << 8;
    bdiff /= steps;

    short barSize = 1;
    color1 = RGBConvert(startRed, startGreen, startBlue);

    // PERCENTAGE BASED CODE
    for(i=0; i < steps; i++)
    {
        //Calculate the starting RGB values
        endRed      = startRed + ((rdiff*i) >> 8);
        endGreen    = startGreen + ((gdiff*i) >> 8);
        endBlue     = startBlue + ((bdiff*i) >> 8);

        color2 = RGBConvert(endRed, endGreen, endBlue);

        if(color2 == color1)
        {
            barSize++;
            continue;
        }

        SetColor(color2);
        color1 = color2;

        switch(direction)           //This switch statement draws the gradient depending on
  direction chosen
        {
        case GRAD_DOWN:
            WAIT_UNTIL_FINISH(Bar(left, top, right, top + barSize));
            top += barSize;
        break;

        case GRAD_UP:
            WAIT_UNTIL_FINISH(Bar(left,bottom - barSize,right,bottom));
            bottom -= barSize;
        break;

        case GRAD_RIGHT:
            WAIT_UNTIL_FINISH(Bar(left, top, left + barSize, bottom));
            left += barSize;
        break;

        case GRAD_LEFT:
            WAIT_UNTIL_FINISH(Bar(right - barSize, top, right, bottom));
            right -= barSize;
        break;

        case GRAD_DOUBLE_VER:
            WAIT_UNTIL_FINISH(Bar(right - barSize, top, right, bottom));
            right -= barSize;
            WAIT_UNTIL_FINISH(Bar(left, top, left + barSize, bottom));
            left += barSize;
        break;

        case GRAD_DOUBLE_HOR:
            WAIT_UNTIL_FINISH(Bar(left, bottom - barSize, right, bottom));
            bottom -= barSize;
            WAIT_UNTIL_FINISH(Bar(left, top, right, top + barSize));
            top += barSize;
        break;

        default:
            break;
        }

        barSize = 1;
    }

    if(barSize > 1)
    {

        SetColor(RGBConvert(endRed, endGreen, endBlue));

        switch(direction)          //This switch statement draws the gradient depending on
direction chosen
        {
        case GRAD_DOWN:
            WAIT_UNTIL_FINISH(Bar(left, top, right, top + barSize));
        break;

        case GRAD_UP:
            WAIT_UNTIL_FINISH(Bar(left,bottom - barSize,right,bottom));
        break;

        case GRAD_RIGHT:
            WAIT_UNTIL_FINISH(Bar(left, top, left + barSize, bottom));
        break;

        case GRAD_LEFT:
            WAIT_UNTIL_FINISH(Bar(right - barSize, top, right, bottom));
        break;

        case GRAD_DOUBLE_VER:
            WAIT_UNTIL_FINISH(Bar(right - barSize, top, right, bottom));
            WAIT_UNTIL_FINISH(Bar(left, top, left + barSize, bottom));
        break;

        case GRAD_DOUBLE_HOR:
            WAIT_UNTIL_FINISH(Bar(left, bottom - barSize, right, bottom));
            WAIT_UNTIL_FINISH(Bar(left, top, right, top + barSize));
        break;

        default:
            break;
        }

    }
    return 1;
}

WORD BevelGradient(SHORT left, SHORT top, SHORT right, SHORT bottom, SHORT rad, GFX_COLOR
color1, GFX_COLOR color2, DWORD length, BYTE direction)
{
    WORD i;
    WORD sred,sblue,sgreen;
    WORD ered,eblue,egreen;
    GFX_COLOR EndColor;
    long rdiff=0,gdiff=0,bdiff=0;
    short steps;
    EndColor = color2;

    switch(direction)     //This switch statement calculates the amount of transitions
needed
    {
    case GRAD_UP:
    case GRAD_DOWN:
        length = length * (bottom - top +(rad << 1));
        length /= 100;
        steps = length;
        break;

    case GRAD_RIGHT:
    case GRAD_LEFT:
        length = length * (right - left +(rad << 1));
        length /= 100;
        steps = length;
        break;
    case GRAD_DOUBLE_VER:
        steps = (right - left +(rad << 1)) >> 1;
        break;

    case GRAD_DOUBLE_HOR:
        steps = (bottom - top +(rad << 1)) >> 1;
        break;

    default:
        return (1);
    }

    //Calculate the starting RGB values
    sred    = GetRed(color1);
    sgreen  = GetGreen(color1);
    sblue   = GetBlue(color1);

    ered    = GetRed(color2);
    egreen  = GetGreen(color2);
    eblue   = GetBlue(color2);

    ///////////////////////////////////

    //Find the step size for the red portion//
    rdiff = ((long)ered - (long)sred) << 8;
    rdiff /= steps;

    //Find the step size for the green portion//
    gdiff = ((long)egreen - (long)sgreen) << 8;
    gdiff /= steps;

    //Find the step size for the blue portion//
    bdiff = ((long)eblue - (long)sblue) << 8;
    bdiff /= steps;

    typedef enum
    {
        BEGIN,
        CHECK,
        Q8TOQ1,
        Q7TOQ2,
        Q6TOQ3,
        Q5TOQ4,
        WAITFORDONE,
        FACE
    } FILLCIRCLE_STATES;

    DWORD_VAL temp;
    static LONG err;
    static SHORT yLimit, xPos, yPos;
    static SHORT xCur, yCur, yNew;

    static FILLCIRCLE_STATES state = BEGIN;

    while(1)
    {
        if(IsDeviceBusy())
            return (0);
        switch(state)
        {
            case BEGIN:
                if(!rad)
                {   // no radius object is a filled rectangle
                    state = FACE;
                    break;
                }

                // compute variables
                temp.Val = SIN45 * rad;
                yLimit = temp.w[1];
                temp.Val = (DWORD) (ONEP25 - ((LONG) rad << 16));
                err = (SHORT) (temp.w[1]);
                xPos = rad;
                yPos = 0;
                xCur = xPos;
                yCur = yPos;
                yNew = yPos;
                state = CHECK;

            case CHECK:
                bevel_fill_check : if(yPos > yLimit)
                {
                    state = FACE;
                    break;
                }

                // New records the last y position
                yNew = yPos;

                // calculate the next value of x and y
                if(err > 0)
                {
                    xPos--;
                    err += 5 + ((yPos - xPos) << 1);
                }
                else
                    err += 3 + (yPos << 1);
                yPos++;
                state = Q6TOQ3;

            case Q6TOQ3:
                if(xCur != xPos)
                {

                    // 6th octant to 3rd octant
                    //if (_bevelDrawType & DRAWBOTTOMBEVEL)
                    {
                        if(direction == GRAD_DOUBLE_VER || direction == GRAD_DOUBLE_HOR)
                            i = (top - yCur) - top + rad;
                        else
                            i = (bottom + yCur) - top + rad;

                        ered = sred + ((rdiff*i) >> 8);
                        egreen = sgreen + ((gdiff*i) >> 8);
                        eblue = sblue + ((bdiff*i) >> 8);

                        color2 = RGBConvert(ered,egreen,eblue);

                        SetColor(color2);

                        switch(direction)    //Direction matter because different portions
  of the circle are drawn
                        {
                           case GRAD_LEFT:
                               if(i>length) SetColor(EndColor);
                               if(Bar(left - yNew, top - xCur, left - yCur, bottom + xCur)
  == 0) return (0);
                                break;

                           case GRAD_RIGHT:
                           case GRAD_DOUBLE_VER:
                                if(i>length)
                                    SetColor(EndColor);

                                if(Bar(right + yCur, top - xCur, right + yNew, bottom +
  xCur) == 0)
                                    return (0);
                                break;

                           case GRAD_UP:
                                if(i>length)
                                    SetColor(EndColor);

                                if(Bar(left - xCur, top - yNew, right + xCur, top - yCur)
== 0)
                                    return (0);
                                break;

                           case GRAD_DOWN:
                           case GRAD_DOUBLE_HOR:
                                if(i>length)
                                    SetColor(EndColor);
                                if(Bar(left - xCur, bottom + yCur, right + xCur, bottom +
yNew) == 0)
                                    return (0);

                           default:
                               break;
                        }

                    }
                    state = Q5TOQ4;
                    break;
                }

                state = CHECK;
                goto bevel_fill_check;

            case Q5TOQ4:

                //if (_bevelDrawType & DRAWBOTTOMBEVEL)
                {
                    if(direction == GRAD_DOUBLE_VER || direction == GRAD_DOUBLE_HOR)
                    i = top + xPos - top + rad;
                    else

                    // 5th octant to 4th octant
                    i = (bottom + xPos) - top + rad ;

                    //Calculate the starting RGB values
                    ered = sred + ((rdiff*i) >> 8);
                    egreen = sgreen + ((gdiff*i) >> 8);
                    eblue = sblue + ((bdiff*i) >> 8);

                    color2 = RGBConvert(ered,egreen,eblue);
                    SetColor(color2);

                    switch(direction)    //Direction matter because different portions of
the circle are drawn
                    {
                       case GRAD_LEFT:
                           if(i>length)
                               SetColor(EndColor);
                           if(Bar(left - xCur, top - yNew, left - xPos, bottom + yNew) ==
0)
                               return (0);
                            break;

                       case GRAD_RIGHT:
                       case GRAD_DOUBLE_VER:
                           if(i>length)
                               SetColor(EndColor);
                           if(Bar(right + xPos, top - yNew, right + xCur, bottom + yNew) ==
0)
                               return (0);
                            break;

                       case GRAD_UP:
                            if(i>length)
                                SetColor(EndColor);
                            if(Bar(left - yNew, top - xCur, right + yNew, top - xPos) == 0)
                                return (0);
                            break;

                       case GRAD_DOWN:
                       case GRAD_DOUBLE_HOR:
                            if(i>length)
                                SetColor(EndColor);
                            if(Bar(left - yNew, bottom + xPos, right + yNew, bottom + xCur)
  == 0)
                                return (0);
                        default:
                            break;
                    }

                }
                state = Q8TOQ1;
                break;

            case Q8TOQ1:

                // 8th octant to 1st octant
                //if (_bevelDrawType & DRAWTOPBEVEL)
                {
                    i = (top - xCur) - top + rad;

                    //Calculate the starting RGB values
                    ered = sred + ((rdiff*i) >> 8);
                    egreen = sgreen + ((gdiff*i) >> 8);
                    eblue = sblue + ((bdiff*i) >> 8);

                    color2 = RGBConvert(ered,egreen,eblue);
                    SetColor(color2);

                    switch(direction)    //Direction matter because different portions of
  the circle are drawn
                    {
                       case GRAD_LEFT:
                           if(i>length)
                               SetColor(EndColor);
                           if(Bar(right + xPos, top - yNew, right + xCur, bottom + yNew) ==
  0)
                               return (0);
                            break;

                       case GRAD_RIGHT:
                       case GRAD_DOUBLE_VER:
                           if(i>length)
                               SetColor(EndColor);
                           if(Bar(left - xCur, top - yNew, left - xPos, bottom + yNew) ==
  0)
                               return (0);
                            break;

                       case GRAD_UP:
                            if(i>length)
                                SetColor(EndColor);
                            if(Bar(left - yNew, bottom + xPos, right + yNew, bottom + xCur)
  == 0)
                                return (0);
                            break;

                       case GRAD_DOWN:
                       case GRAD_DOUBLE_HOR:
                            if(i>length)
                                SetColor(EndColor);
                            if(Bar(left - yNew, top - xCur, right + yNew, top - xPos) == 0)
                                return (0);
                            break;

                       default:
                           break;
                    }

                }
                state = Q7TOQ2;
                break;
            case Q7TOQ2:

                // 7th octant to 2nd octant
                //if (_bevelDrawType & DRAWTOPBEVEL)
                {
                    i = (top - yNew) - top + rad;

                    //Calculate the starting RGB values
                    ered = sred + ((rdiff*i) >> 8);
                    egreen = sgreen + ((gdiff*i) >> 8);
                    eblue = sblue + ((bdiff*i) >> 8);

                    color2 = RGBConvert(ered,egreen,eblue);

                    SetColor(color2);

                    switch(direction)    //Direction matter because different portions of
 the circle are drawn
                    {
                       case GRAD_LEFT:
                           if(i>length)
                               SetColor(EndColor);
                           if(Bar(right + yCur, top - xCur, right + yNew, bottom + xCur) ==
0)

                               return (0);
                            break;

                       case GRAD_RIGHT:
                       case GRAD_DOUBLE_VER:
                           if(i>length)
                               SetColor(EndColor);
                           if(Bar(left - yNew, top - xCur, left - yCur, bottom + xCur) ==
0)

                               return (0);
                            break;

                       case GRAD_UP:
                            if(i>length)
                                SetColor(EndColor);
                            if(Bar(left - xCur, bottom + yCur, right + xCur, bottom + yNew)
== 0)

                                return (0);
                            break;

                       case GRAD_DOWN:
                       case GRAD_DOUBLE_HOR:
                            if(i>length)
                                SetColor(EndColor);
                            if(Bar(left - xCur, top - yNew, right + xCur, top - yCur) == 0)
                                return (0);
                            break;

                       default:
                           break;
                    }

                }
                // update current values
                xCur = xPos;
                yCur = yPos;
                state = CHECK;
                break;



            case FACE:
                if((right - left) || (bottom - top))
                {
                i = (top) - top + rad;
                //Calculate the starting RGB values
                ered = sred + ((rdiff*i) >> 8);
                egreen = sgreen + ((gdiff*i) >> 8);
                eblue = sblue + ((bdiff*i) >> 8);

                color1 = RGBConvert(ered,egreen,eblue);

                if(i>length)
                    color1 = EndColor;

                i = (bottom) - top + rad;
                //Calculate the ending RGB values
                ered = sred + ((rdiff*i) >> 8);
                egreen = sgreen + ((gdiff*i) >> 8);
                eblue = sblue + ((bdiff*i) >> 8);

                color2 = RGBConvert(ered,egreen,eblue);

                if(i>length)
                    color2 = EndColor;

                length -= rad;   //Subtract the radius from the length needed for
gradient

                if(direction == GRAD_UP || direction == GRAD_DOWN || direction ==
GRAD_DOUBLE_HOR)
                {
                   if(length>= bottom-top)
                   {
                       length = 100;
                   }
                   else
                   {
                       length *= 100;
                       length /= (bottom -top);
                   }
                   BarGradient(left-rad, top, right+rad,
bottom,color1,color2,length,direction);
                }
                else
                {
                  if(length>=right-left)
                  {
                      length = 100;
                  }
                  else
                  {
                       length *= 100;
                       length /= (right - left);
                  }
                   BarGradient(left, top-rad, right,
bottom+rad,color1,color2,length,direction);
                }

                    state = WAITFORDONE;
                }
                else
                {
                    state = BEGIN;
                    return (1);
                }

            case WAITFORDONE:
                if(IsDeviceBusy())
                    return (0);
                state = BEGIN;
                return (1);
        }           // end of switch
    }               // end of while

}
#endif


#ifdef USE_COMP_RLE
```

```
    #ifdef USE_BITMAP_FLASH

        #if (COLOR_DEPTH >= 8)
/*********************************************************************
* Function: WORD DecodeRLE8(FLASH_BYTE *flashAddress, BYTE *pixelrow, WORD size)
*
* PreCondition: tempFlashAddress should point to the beginning of a RLE compressed block
*
* Input: flashAddress - Address of the beginning of a RLE compressed block
*        pixelrow - Pointer to an array where the decoded row must be stored
*        size - Size of the decoded data in bytes
*
* Output: Number of source bytes traversed
*
* Side Effects: none
*
* Overview: Decodes the data
*
********************************************************************/
WORD DecodeRLE8(FLASH_BYTE *flashAddress, BYTE *pixel_row, WORD size)
{
    WORD sourceOffset = 0;
    WORD decodeSize = 0;

    while(decodeSize < size)
    {
        BYTE code = *flashAddress++;
        BYTE value = *flashAddress++;
        sourceOffset += 2;

        if(code > 0)
        {
            decodeSize += code;

            if(decodeSize > size) //To avoid writing oustide the array bounds
            {
                code -= (decodeSize - size);
            }

            while(code)
            {
                *pixel_row++ = value;
                code--;
            }
        }
        else
        {
            decodeSize += value;
            sourceOffset += value;

            if(decodeSize > size) //To avoid writing oustide the array bounds
            {
                value -= (decodeSize - size);
            }

            while(value)
            {
                *pixel_row++ = *flashAddress++;
                value--;
            }
        }
    }
    return (sourceOffset);
}

/*********************************************************************
* Function: void PutImageRLE8BPP(SHORT left, SHORT top, FLASH_BYTE* image, BYTE stretch)
*
* PreCondition: none
*
* Input: left,top - left top image corner, image - image pointer,
*         stretch - Should be NORMAL when RLE is used
*
* Output: none
*
* Side Effects: none
*
* Overview: outputs the image starting from left,top coordinates
*
* Note: image must be located in internal memory
*
********************************************************************/
void PutImageRLE8BPP(SHORT left, SHORT top, FLASH_BYTE *image, BYTE stretch)
{
    register FLASH_BYTE *flashAddress;
    register FLASH_BYTE *tempFlashAddress;
    WORD                sizeX, sizeY;
    WORD                x, y;
    WORD                xc, yc;
    BYTE                temp;
    BYTE                stretchX, stretchY;
    GFX_COLOR           pallete[256];
    WORD                counter;
    BYTE                pixelrow[GetMaxX() + 1];
    WORD                offset;
    BYTE                *pixelAddress;

    // Move pointer to size information
    flashAddress = image + 2;

    // Read image size
    sizeY = *((FLASH_WORD *)flashAddress);
    flashAddress += 2;
    sizeX = *((FLASH_WORD *)flashAddress);
    flashAddress += 2;

    #if COLOR_DEPTH == 24
    flashAddress += 2;      // pad word for alignment
    #endif

    // Read pallete
    for(counter = 0; counter < 256; counter++)
    {
        #if COLOR_DEPTH == 16
        pallete[counter] = *((FLASH_WORD *)flashAddress);
        flashAddress += 2;
        #endif

        #if COLOR_DEPTH == 24
        pallete[counter] = *((FLASH_DWORD *)flashAddress);
        flashAddress += 4;
        #endif
    }

    yc = top;
    tempFlashAddress = flashAddress;
    for(y = 0; y < sizeY; y++)
    {
        offset = DecodeRLE8(tempFlashAddress, pixelrow, sizeX);
        tempFlashAddress += offset;

        for(stretchY = 0; stretchY < stretch; stretchY++)
        {
            pixelAddress = pixelrow;
            xc = left;
            for(x = 0; x < sizeX; x++)
            {

                // Read pixels from flash
                temp = *pixelAddress;
                pixelAddress++;

                // Set color
            #ifdef USE_PALETTE
                SetColor(temp);
            #else
                SetColor(pallete[temp]);
            #endif

                // Write pixel to screen
                for(stretchX = 0; stretchX < stretch; stretchX++)
                {
                    #ifdef USE_TRANSPARENT_COLOR
                        if (!((GetTransparentColor() == GetColor()) &&
(GetTransparentColorStatus() == TRANSPARENT_COLOR_ENABLE)))
                    #endif
                            PutPixel(xc, yc);
                        xc++;
                }
            }

            yc++;
        }
    }
}
        #endif //#if (COLOR_DEPTH >= 8)

        #if (COLOR_DEPTH >= 4)

/*********************************************************************
* Function: WORD DecodeRLE4(FLASH_BYTE *flashAddress, BYTE *pixelrow, WORD size)
*
* PreCondition: tempFlashAddress should point to the beginning of a RLE compressed block
*
* Input: flashAddress - Address of the beginning of a RLE compressed block
*        pixelrow - Pointer to an array where the decoded row must be stored
*        size - Size of the decoded data in bytes
*
* Output: Number of source bytes traversed
*
* Side Effects: none
*
* Overview: Decodes the data
*
********************************************************************/
WORD DecodeRLE4(FLASH_BYTE *flashAddress, BYTE *pixel_row, WORD size)
{
    WORD sourceOffset = 0;
    WORD decodeSize = 0;

    while(decodeSize < size)
    {
        BYTE code = *flashAddress++;
        BYTE value = *flashAddress++;
        BYTE counter;

        sourceOffset += 2;

        if(code > 0)
        {
            decodeSize += code;

            if(decodeSize > size) //To avoid writing oustide the array bounds
            {
                code -= (decodeSize - size);
            }

            for(counter = 0; counter < code; counter++)
            {
                if(counter & 0x01)
                {
                    *pixel_row++ = (value >> 4) & 0x0F;
                }
                else
                {
                    *pixel_row++ = (value) & 0x0F;
                }
            }
        }
        else
        {
            decodeSize += value;
            sourceOffset += (value + 1) >> 1;

            if(decodeSize > size) //To avoid writing oustide the array bounds
            {
                value -= (decodeSize - size);
            }

            for(counter = 0; counter < value; counter++)
            {
                if(counter & 0x01)
                {
                    *pixel_row++ = (*flashAddress >> 4) & 0x0F;
                    flashAddress++;
                }
                else
                {
                    *pixel_row++ = (*flashAddress) & 0x0F;
                }
            }
        }
    }

    return (sourceOffset);
}

/*********************************************************************
* Function: void PutImageRLE4BPP(SHORT left, SHORT top, FLASH_BYTE* image, BYTE stretch)
*
* PreCondition: none
*
* Input: left,top - left top image corner, image - image pointer,
*        stretch - Should be NORMAL when RLE is used
*
* Output: none
*
* Side Effects: none
*
* Overview: outputs the image starting from left,top coordinates
*
* Note: image must be located in internal memory
*
********************************************************************/
void PutImageRLE4BPP(SHORT left, SHORT top, FLASH_BYTE *image, BYTE stretch)
{
    register FLASH_BYTE *flashAddress;
    register FLASH_BYTE *tempFlashAddress;
    WORD                sizeX, sizeY;
    register WORD       x, y;
    WORD                xc, yc;
    BYTE                temp = 0;
    register BYTE       stretchX, stretchY;
    GFX_COLOR           pallete[16];
    WORD                counter;
    BYTE                pixelrow[GetMaxX() + 1];
    WORD                offset;
    BYTE                *pixelAddress;

    // Move pointer to size information
    flashAddress = image + 2;

    // Read image size
    sizeY = *((FLASH_WORD *)flashAddress);
    flashAddress += 2;
    sizeX = *((FLASH_WORD *)flashAddress);
    flashAddress += 2;
    #if COLOR_DEPTH == 24
    flashAddress += 2;          // pad for alignment
    #endif

    // Read pallete
    for(counter = 0; counter < 16; counter++)
    {
        #if COLOR_DEPTH == 16
        pallete[counter] = *((FLASH_WORD *)flashAddress);
        flashAddress += 2;
        #endif

        #if COLOR_DEPTH == 24
        pallete[counter] = *((FLASH_DWORD *)flashAddress);
        flashAddress += 4;
        #endif
    }

    yc = top;
    tempFlashAddress = flashAddress;
    for(y = 0; y < sizeY; y++)
    {
        offset = DecodeRLE4(tempFlashAddress, pixelrow, sizeX);
        tempFlashAddress += offset;

        for(stretchY = 0; stretchY < stretch; stretchY++)
        {
            pixelAddress = pixelrow;
            xc = left;
            for(x = 0; x < sizeX; x++)
            {
                temp = *pixelAddress;
                pixelAddress++;

                #ifdef USE_PALETTE
                    SetColor(temp);
                #else
                    SetColor(pallete[temp]);
                #endif

                // Write pixel to screen
                for(stretchX = 0; stretchX < stretch; stretchX++)
                {
                    #ifdef USE_TRANSPARENT_COLOR
                        if (!((GetTransparentColor() == GetColor()) &&
  (GetTransparentColorStatus() == TRANSPARENT_COLOR_ENABLE)))
                    #endif
                            PutPixel(xc, yc);
                        xc++;
                }
            }

            yc++;
        }
    }
}
        #endif //#if (COLOR_DEPTH >= 4)

    #endif //    #ifdef USE_BITMAP_FLASH

    #ifdef USE_BITMAP_EXTERNAL

        #if (COLOR_DEPTH >= 8)

/*********************************************************************
 * Function: WORD DecodeRLE8Ext(void *image, DWORD  memAddress, BYTE *pixelrow, WORD size)
 *
 * PreCondition: tempFlashAddress should point to the beginning of a RLE compressed block
 *
 * Input: image - External memory image pointer
 *        memAddress - Address of the beginning of a RLE compressed block
*        pixelrow - Pointer to an array where the decoded row must be stored
*        size - Size of the decoded data in bytes
*
* Output: Number of source bytes traversed
*
* Side Effects: none
*
* Overview: Decodes the data from the external flash
*
********************************************************************/
WORD DecodeRLE8Ext(void *image, DWORD memAddress, BYTE *pixel_row, WORD size)
{
    WORD sourceOffset = 0;
    WORD decodeSize = 0;

    while(decodeSize < size)
    {
        BYTE code, value;

        ExternalMemoryCallback(image, memAddress, sizeof(BYTE), &code);
        memAddress++;
        ExternalMemoryCallback(image, memAddress, sizeof(BYTE), &value);
        memAddress++;

        sourceOffset += 2;

        if(code > 0)
        {
            decodeSize += code;

            if(decodeSize > size) //To avoid writing oustide the array bounds
            {
                code -= (decodeSize - size);
            }

            while(code)
            {
                *pixel_row++ = value;
                code--;
            }
        }
        else
        {
            decodeSize += value;
            sourceOffset += value;

            if(decodeSize > size) //To avoid writing oustide the array bounds
            {
                value -= (decodeSize - size);
            }

            ExternalMemoryCallback(image, memAddress, value * sizeof(BYTE), pixel_row);
            pixel_row += value;
            memAddress += value;
        }
    }
    return (sourceOffset);
}

/*********************************************************************
* Function: void PutImageRLE8BPPExt(SHORT left, SHORT top, void* image, BYTE stretch)
*
* PreCondition: none
*
* Input: left,top - left top image corner, image - image pointer,
*        stretch - image stretch factor
*
* Output: none
*
* Side Effects: none
*
* Overview: outputs monochrome image starting from left,top coordinates
```

```
*
* Note: image must be located in external memory
*
********************************************************************/
void PutImageRLE8BPPExt(SHORT left, SHORT top, void *image, BYTE stretch)
{
    register DWORD  memOffset;
    BITMAP_HEADER   bmp;
    WORD            pallete[256];
    BYTE            pixelrow[(GetMaxX() + 1)];
    BYTE            *pixelAddress;

    BYTE            temp;
    WORD            sizeX, sizeY;
    WORD            x, y;
    WORD            xc, yc;
    BYTE            stretchX, stretchY;
    WORD            offset;

    // Get image header
    ExternalMemoryCallback(image, 0, sizeof(BITMAP_HEADER), &bmp);

    // Get pallete (256 entries)
    ExternalMemoryCallback(image, sizeof(BITMAP_HEADER), 256 * sizeof(WORD), pallete);

    // Set offset to the image data
    memOffset = sizeof(BITMAP_HEADER) + 256 * sizeof(WORD);

    // Get size
    sizeX = bmp.width;
    sizeY = bmp.height;

    yc = top;
    for(y = 0; y < sizeY; y++)
    {
        offset = DecodeRLE8Ext(image, memOffset, pixelrow, sizeX);
        memOffset += offset;

        for(stretchY = 0; stretchY < stretch; stretchY++)
        {
            pixelAddress = pixelrow;
            xc = left;
            for(x = 0; x < sizeX; x++)
            {

                // Read pixels from flash
                temp = *pixelAddress;
                pixelAddress++;

                // Set color
            #ifdef USE_PALETTE
                SetColor(temp);
            #else
                SetColor(pallete[temp]);
            #endif

                // Write pixel to screen
                for(stretchX = 0; stretchX < stretch; stretchX++)
                {
                    #ifdef USE_TRANSPARENT_COLOR
                        if (!((GetTransparentColor() == GetColor()) &&
(GetTransparentColorStatus() == TRANSPARENT_COLOR_ENABLE)))
                    #endif
                            PutPixel(xc, yc);
                        xc++;
                }
            }

            yc++;
        }
    }
}
```

```
        #endif //#if (COLOR_DEPTH >= 8)

        #if (COLOR_DEPTH >= 4)

/*********************************************************************
* Function: WORD DecodeRLE4Ext(void *image, DWORD memAddress, BYTE *pixelrow, WORD size)
*
* PreCondition: tempFlashAddress should point to the beginning of a RLE compressed block
*
* Input: image - External memory image pointer
*        memAddress - Address of the beginning of a RLE compressed block
*        pixelrow - Pointer to an array where the decoded row must be stored
*        size - Size of the decoded data in bytes
*
* Output: Number of source bytes traversed
*
* Side Effects: none
*
* Overview: Decodes the data
*
********************************************************************/
WORD DecodeRLE4Ext(void *image, DWORD memAddress, BYTE *pixel_row, WORD size)
{
    WORD sourceOffset = 0;
    WORD decodeSize = 0;

    while(decodeSize < size)
    {
        BYTE code, value;
        BYTE counter, temp;

        ExternalMemoryCallback(image, memAddress, sizeof(BYTE), &code);
        memAddress++;
        ExternalMemoryCallback(image, memAddress, sizeof(BYTE), &value);
        memAddress++;

        sourceOffset += 2;

        if(code > 0)
        {
            decodeSize += code;

            if(decodeSize > size) //To avoid writing oustide the array bounds
            {
                code -= (decodeSize - size);
            }

            for(counter = 0; counter < code; counter++)
            {
                if(counter & 0x01)
                {
                    *pixel_row++ = (value >> 4) & 0x0F;
                }
                else
                {
                    *pixel_row++ = (value) & 0x0F;
                }
            }
        }
        else
        {
            decodeSize += value;
            sourceOffset += (value + 1) >> 1;

            if(decodeSize > size) //To avoid writing oustide the array bounds
            {
                value -= (decodeSize - size);
            }

            for(counter = 0; counter < value; counter++)
            {
                if(counter & 0x01)
                {
                    *pixel_row++ = (temp >> 4) & 0x0F;
                    memAddress++;
                }
                else
                {
                    ExternalMemoryCallback(image, memAddress, sizeof(BYTE), &temp);
                    *pixel_row++ = temp & 0x0F;
                }
            }
        }
    }

    return (sourceOffset);
}

/*********************************************************************
* Function: void PutImageRLE4BPPExt(SHORT left, SHORT top, void* image, BYTE stretch)
*
* PreCondition: none
*
* Input: left,top - left top image corner, image - image pointer,
*        stretch - image stretch factor
*
* Output: none
*
* Side Effects: none
*
* Overview: outputs monochrome image starting from left,top coordinates
*
* Note: image must be located in external memory
*
********************************************************************/
void PutImageRLE4BPPExt(SHORT left, SHORT top, void *image, BYTE stretch)
{
    register DWORD  memOffset;
    BITMAP_HEADER   bmp;
    WORD            pallete[16];
    BYTE            pixelrow[(GetMaxX() + 1)];
    BYTE            *pixelAddress;

    BYTE            temp;
    WORD            sizeX, sizeY;
    WORD            x, y;
    WORD            xc, yc;
    BYTE            stretchX, stretchY;
    WORD            offset;

    // Get image header
    ExternalMemoryCallback(image, 0, sizeof(BITMAP_HEADER), &bmp);

    // Get pallete (16 entries)
    ExternalMemoryCallback(image, sizeof(BITMAP_HEADER), 16 * sizeof(WORD), pallete);

    // Set offset to the image data
    memOffset = sizeof(BITMAP_HEADER) + 16 * sizeof(WORD);

    // Get size
    sizeX = bmp.width;
    sizeY = bmp.height;

    yc = top;
    for(y = 0; y < sizeY; y++)
    {
        offset = DecodeRLE4Ext(image, memOffset, pixelrow, sizeX);
        memOffset += offset;

        for(stretchY = 0; stretchY < stretch; stretchY++)
        {
            pixelAddress = pixelrow;
            xc = left;
            for(x = 0; x < sizeX; x++)
            {

                // Read pixels from flash
                temp = *pixelAddress;
                pixelAddress++;

                // Set color
            #ifdef USE_PALETTE
                SetColor(temp);
            #else
                SetColor(pallete[temp]);
            #endif

                // Write pixel to screen
                for(stretchX = 0; stretchX < stretch; stretchX++)
                {
                    #ifdef USE_TRANSPARENT_COLOR
                        if (!((GetTransparentColor() == GetColor()) &&
(GetTransparentColorStatus() == TRANSPARENT_COLOR_ENABLE)))
                    #endif
                            PutPixel(xc, yc);
                        xc++;
                }
            }

            yc++;
        }
    }
}
        #endif //#if (COLOR_DEPTH >= 4)

    #endif //#ifdef USE_BITMAP_EXTERNAL

#endif //#ifdef USE_COMP_RLE

void GetCirclePoint(SHORT radius, SHORT angle, SHORT *x, SHORT *y)
{
    DWORD   rad;
    SHORT   ang;
    SHORT   temp;

    ang = angle % 45;
    if((angle / 45) & 0x01)
        ang = 45 - ang;

    rad = radius;
    // there is a shift by 8 bits here since this function assumes a shift on the
calculations for accuracy
    // and to avoid long and complex multiplications.
    rad *= ((DWORD) GetSineCosine(ang, GETCOSINE) << 8);

    *x = ((DWORD_VAL) rad).w[1];
    rad = radius;
    rad *= ((DWORD) GetSineCosine(ang, GETSINE) << 8);

    *y = ((DWORD_VAL) rad).w[1];

    if(((angle > 45) && (angle < 135)) || ((angle > 225) && (angle < 315)))
    {
        temp = *x;
        *x = *y;
        *y = temp;
    }

    if((angle > 90) && (angle < 270))
    {
        *x = -*x;
    }

    if((angle > 180) && (angle < 360))
    {
        *y = -*y;
        }
    }
```

14.2.2 Primitive.h

Enumerations

Name	Description
GFX_GRADIENT_TYPE (see page 364)	Enumeration for gradient type
GFX_RESOURCE (see page 388)	Memory type enumeration to determine the source of data. Used in interpreting bitmap and font from different memory sources.

Functions

	Name	Description
	AlphaBlendWindow (see page 420)	This alphablends a foreground and a background stored in frames to a destination window. The function uses windows insides frames. Each window shares the same width and height parameters.
	Arc (see page 375)	Draws the octant arc of the beveled figure with the given centers, radii and octant mask. When octant = 0xFF and the following are true: 1. xL = xR, yT = yB , r1 = 0 and r2 = z, a filled circle is drawn with a radius of z. 2. radii have values (where r1 < r2), a full ring with thickness of (r2-r1) is drawn. 3. xL != xR, yT != yB , r1 = 0 and r2 = 0 (where xR > xL and yB > yT) a rectangle is drawn. xL, yT specifies the left top corner and xR,... more (see page 375)
	Bar (see page 371)	This function draws a bar given the left, top and right, bottom corners with the current color.
	BarGradient (see page 362)	This renders a bar onto the screen, but instead of one color a gradient is drawn depending on the direction (GFX_GRADIENT_TYPE (see page 364)), length, and colors chosen
	Bevel (see page 377)	Draws a beveled figure on the screen. When x1 = x2 and y1 = y2, a circular object is drawn. When x1 < x2 and y1 < y2 and rad (radius) = 0, a rectangular object is drawn.
	BevelGradient (see page 363)	This renders a gradient on the screen. It works the same as the fillbevel function, except a gradient out of color1 and color2 is drawn depending on the direction (GFX_GRADIENT_TYPE (see page 364)).
	ClearDevice (see page 387)	This function clears the screen with the current color and sets the graphic cursor position to (0, 0). Clipping is NOT supported by ClearDevice().
	DrawPoly (see page 372)	This function draws a polygon with the current line type using the given number of points. The polygon points are stored in an array arranged in the following order:
	FillBevel (see page 378)	Draws a filled beveled figure on the screen. For a filled circular object x1 = x2 and y1 = y2. For a filled rectangular object radius = 0.
	GetImageHeight (see page 383)	This function returns the image height.
	GetImageWidth (see page 384)	This function returns the image width.
	GetTextHeight (see page 360)	This macro returns the height of the specified font. All characters in a given font table have a constant height.
	GetTextWidth (see page 360)	This function returns the width of the specified string for the specified font. The string must be terminated by a line feed or zero.
	GFXGetPageOriginAddress (see page 421)	This function calculates the address of a certain 0,0 location of a page in memory

◆	GFXGetPageXYAddress (↗ see page 422)	This function calculates the address of a certain x,y location in memory
◆	InitGraph (↗ see page 388)	This function initializes the display controller, sets the line type to SOLID_LINE (↗ see page 369), sets the screen to all BLACK (↗ see page 409), sets the current drawing color to WHITE (↗ see page 415), sets the graphic cursor position to upper left corner of the screen, sets active and visual pages to page #0, clears the active page and disables clipping. This function should be called before using the Graphics Primitive Layer.
◆	Line (↗ see page 366)	This function draws a line with the current line type from the start point to the end point.
◆	OutChar (↗ see page 357)	This function outputs a character from the current graphic cursor position. OutChar() uses the current active font set with SetFont (↗ see page 356)().
◆	OutText (↗ see page 358)	This function outputs a string of characters starting at the current graphic cursor position. The string must be terminated by a line feed or zero. For Non-Blocking configuration, OutText() may return control to the program due to display device busy status. When this happens zero is returned and OutText() must be called again to continue the outputting of the string. For Blocking configuration, this function always returns a 1. OutText() uses the current active font set with SetFont (↗ see page 356)().
◆	OutTextXY (↗ see page 359)	This function outputs a string of characters starting at the given x, y position. The string must be terminated by a line feed or zero. For Non-Blocking configuration, OutTextXY() may return control to the program due to display device busy status. When this happens zero is returned and OutTextXY() must be called again to continue the outputting of the string. For Blocking configuration, this function always returns a 1. OutTextXY() uses the current active font set with SetFont (↗ see page 356)().
◆	PutImage (↗ see page 383)	This function outputs image starting from left,top coordinates.
◆	SetFont (↗ see page 356)	This function sets the current font used in OutTextXY (↗ see page 359)(), OutText (↗ see page 358)() and OutChar (↗ see page 357)() functions.

Macros

Name	Description
Circle (↗ see page 374)	This macro draws a circle with the given center and radius.
DASHED_LINE (↗ see page 369)	Dashed Line (↗ see page 366) Style
DOTTED_LINE (↗ see page 370)	Dotted Line (↗ see page 366) Style
EXTERNAL_FONT_BUFFER_SIZE (↗ see page 386)	This defines the size of the buffer used by font functions to retrieve font data from the external memory. The buffer size can be increased to accommodate large font sizes. The user must be aware of the expected glyph sizes of the characters stored in the font table.
FillCircle (↗ see page 374)	This macro draws a filled circle. Uses the FillBevel (↗ see page 378)() function.
GetFontOrientation (↗ see page 356)	This macro returns font orientation (0 == horizontal, 1 == vertical).
GetX (↗ see page 380)	This macro returns the current graphic cursor x-coordinate.
GetY (↗ see page 381)	This macro returns the current graphic cursor y-coordinate.
IMAGE_NORMAL (↗ see page 385)	Normal image stretch code
IMAGE_X2 (↗ see page 385)	Stretched image stretch code
LineRel (↗ see page 367)	This macro draws a line with the current line type from the current graphic cursor position to the position defined by displacement.
LineTo (↗ see page 367)	This macro draws a line with the current line type from the current graphic cursor position to the given x, y position.
MoveRel (↗ see page 381)	This macro moves the graphic cursor relative to the current location. The given dX and dY displacement can be positive or negative numbers.
MoveTo (↗ see page 382)	This macro moves the graphic cursor to new x,y position.
NORMAL_LINE (↗ see page 370)	Normal Line (↗ see page 366) (thickness is 1 pixel)
Rectangle (↗ see page 372)	This macro draws a rectangle with the given left, top and right, bottom corners. Current line type is used.
SetBevelDrawType (↗ see page 379)	This macro sets the fill bevel type to be drawn.

SetFontOrientation (see page 357)	This macro sets font orientation vertical or horizontal.
SetLineThickness (see page 368)	This macro sets sets line thickness to 1 pixel or 3 pixels.
SetLineType (see page 368)	This macro sets the line type to draw.
SOLID_LINE (see page 369)	Solid Line (see page 366) Style
THICK_LINE (see page 370)	Thick Line (see page 366) (thickness is 3 pixels)
XCHAR (see page 361)	This macro sets the data type for the Fonts. There are three types • #define XCHAR unsigned short // use multibyte characters (0-2^16 range) • #define XCHAR unsigned char // use unsigned char (0-255 range) • #define XCHAR char // use signed char (0-127 range)

Structures

Name	Description
BITMAP_HEADER (see page 384)	Structure describing the bitmap header.
FONT_FLASH (see page 355)	Structure for font stored in FLASH memory.
FONT_HEADER (see page 355)	Structure describing the font header.
GFX_EXTDATA (see page 391)	This structure is used to describe external memory.
GFX_GRADIENT_STYLE (see page 365)	This structure is used to describe the gradient style.
GFX_IMAGE_HEADER (see page 389)	Structure for images stored in various system memory (Flash, External Memory (SPI, Parallel Flash, or memory in EPMP).
IMAGE_FLASH (see page 390)	Structure for images stored in FLASH memory.
IMAGE_RAM (see page 390)	Structure for images stored in RAM memory.

Types

Name	Description
FONT_EXTERNAL (see page 356)	Structure for font stored in EXTERNAL memory space. (example: External SPI or parallel Flash, EDS_EPMP)
IMAGE_EXTERNAL (see page 391)	Structure for images stored in EXTERNAL memory space. (example: External SPI or parallel Flash, EDS_EPMP)

Description

This is file Primitive.h.

Body Source

```
/*****************************************************************************
 *  Module for Microchip Graphics Library
 *  Graphic Primitives Layer
 *****************************************************************************
 * FileName:        Primitive.h
 * Processor:       PIC24F, PIC24H, dsPIC, PIC32
 * Compiler:        MPLAB C30, MPLAB C32
 * Company:         Microchip Technology Incorporated
 *
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  * OR OTHER SIMILAR COSTS.
  *
  * Date        Comment
  *~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
  * 11/12/07    Version 1.0 release
  * 18/05/09    Version 1.1 - All Primitive functions have
  *                           return value(To support 2d-Acceleration)
  * 05/12/10    Added sine and cosine functions.
  * 08/20/10    Modified TYPE_MEMORY enum for more types
  *             and changed the enumeration to GFX_RESOURCE. Also removed
  *             unused types.
  *             Added new structure GFX_IMAGE_HEADER.
  *             Deprecated the following (renamed):
  *                TYPE_MEMORY
  *                EXTDATA
  *                BITMAP_FLASH
  *                BITMAP_RAM
  *                BITMAP_EXTERNAL
  * 03/09/11    Removed USE_DRV_xxx.
  * 04/01/11    Added GetSineCosine().
  *****************************************************************************/
#ifndef _PRIMITIVE_H
    #define _PRIMITIVE_H

#include "GenericTypeDefs.h"
#include "GraphicsConfig.h"
#include "gfxcolors.h"
/*********************************************************************
* Overview: Primitive lines are drawn using line type and line thickness.
*           There are 3 line styles and 2 types of line thickness.
*
*********************************************************************/

// Solid Line Style
    #define SOLID_LINE  0

// Dotted Line Style
    #define DOTTED_LINE 1

// Dashed Line Style
    #define DASHED_LINE 4

// Normal Line (thickness is 1 pixel)
    #define NORMAL_LINE 0

// Thick Line (thickness is 3 pixels)
    #define THICK_LINE  1

/*********************************************************************
* Overview: Drawing bitmaps will have two modes, normal rendering
*           and stretched rendering. Stretched rendering effectively
*           doubles the image size in the horizontal and vertical
*           direction.
*
*********************************************************************/

// Normal image stretch code
    #define IMAGE_NORMAL    1

// Stretched image stretch code
    #define IMAGE_X2    2

// Current line style
extern SHORT    _lineType;

// Current line thickness
```

```
extern BYTE     _lineThickness;

// constants used for circle/arc computation
    #define SIN45       46341   // sin(45) * 2^16)
    #define ONEP25      81920   // 1.25 * 2^16
// constants used to get sine(v) and cosine(v)
    #define GETSINE     0x00
    #define GETCOSINE   0x01

// Current cursor coordinates
extern SHORT    _cursorX;
extern SHORT    _cursorY;

// Font orientation
extern BYTE     _fontOrientation;

    #define ORIENT_HOR  0
    #define ORIENT_VER  1

/*********************************************************************
* Overview: This macro sets the data type for the Fonts.
*           There are three types
*           - #define XCHAR   unsigned short        // use multibyte characters (0-2^16
range)
*           - #define XCHAR   unsigned char     // use unsigned char (0-255 range)
*           - #define XCHAR   char              // use signed char (0-127 range)
*
********************************************************************/
    #if defined (USE_MULTIBYTECHAR)
        #define XCHAR   unsigned short
    #elif defined (USE_UNSIGNED_XCHAR)
        #define XCHAR   unsigned char
    #else
        #define XCHAR   char
    #endif

// bevel drawing type (0 = full bevel, 0xF0 - top bevel only, 0x0F - bottom bevel only
extern BYTE _bevelDrawType;

    #define DRAWFULLBEVEL   0xFF
    #define DRAWTOPBEVEL    0xF0
    #define DRAWBOTTOMBEVEL 0x0F

    #ifdef __PIC32MX__
        // Flash data with 32bit pointers
        #define FLASH_BYTE  const BYTE
        #define FLASH_WORD  const WORD
        #define FLASH_DWORD const DWORD
    #else
        // Flash data with 24bit pointers
        #define FLASH_BYTE  char __prog__
        #define FLASH_WORD  short int __prog__
        #define FLASH_DWORD unsigned long __prog__
    #endif

/*********************************************************************
* Overview: Memory type enumeration to determine the source of data.
*           Used in interpreting bitmap and font from different
*           memory sources.
*
********************************************************************/
typedef enum
{
    FLASH         = 0x0000, // internal flash
    EXTERNAL      = 0x0001, // external memory
    FLASH_JPEG    = 0x0002, // internal flash
    EXTERNAL_JPEG = 0x0003, // external memory
    RAM           = 0x0004, // RAM
    EDS_EPMP      = 0x0005, // memory in EPMP, base addresses are
                            // are set in the hardware profile

    IMAGE_MBITMAP = 0x0000, // data resource is type Microchip bitmap
    IMAGE_JPEG    = 0x0100, // data resource is type JPEG

    COMP_NONE     = 0x0000, // no compression
    COMP_RLE      = 0x1000, // compressed with RLE
    COMP_IPU      = 0x2000, // compressed with DEFLATE (for IPU)
} GFX_RESOURCE;

#define GFX_COMP_MASK   0xF000
#define GFX_MEM_MASK    0x000F

/*********************************************************************
* Overview: This structure is used to describe external memory.
*
*********************************************************************/
typedef struct
{
    GFX_RESOURCE type;       // must be EXTERNAL or EDS_EPMP
    WORD         ID;         // memory ID, user defined value to differentiate
                             // between graphics resources of the same type
                             //   When using EDS_EPMP the following ID values are
                             //   reserved and used by the Microchip display driver
                             //   0 - reserved (do not use)
                             //   1 - reserved for base address of EPMP CS1
                             //   2 - reserved for base address of EPMP CS2
    DWORD        address;    // Data image address (user data, bitmap or font)
} GFX_EXTDATA;

/* &&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&& */
//                         STRUCTURES FOR IMAGES
/* &&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&& */

/*********************************************************************
* Overview: Structure describing the bitmap header.
*
*********************************************************************/
typedef struct
{
    BYTE    compression;     // Compression setting
    BYTE    colorDepth;      // Color depth used
    SHORT   height;          // Image height
    SHORT   width;           // Image width
} BITMAP_HEADER;

/*********************************************************************
* Overview: Structure for images stored in FLASH memory.
*
*********************************************************************/
typedef struct
{
    GFX_RESOURCE  type;      // must be FLASH
    FLASH_BYTE    *address;  // image address in FLASH
} IMAGE_FLASH;

/*********************************************************************
* Overview: Structure for images stored in RAM memory.
*
*********************************************************************/
typedef struct
{
    GFX_RESOURCE  type;      // must be RAM
    DWORD         *address;  // image address in RAM
} IMAGE_RAM;

/*********************************************************************
* Overview: Structure for images stored in EXTERNAL memory space.
*           (example: External SPI or parallel Flash, EDS_EPMP)
*
*********************************************************************/
typedef GFX_EXTDATA IMAGE_EXTERNAL;

/* &&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&& */
//                         STRUCTURES FOR FONTS
```

```
/* &&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&& */

/*********************************************************************
* Overview: Structure describing the font header.
*
*********************************************************************/
typedef struct
{
    BYTE fontID;              // User assigned value
    BYTE res1        : 4;     // Reserved for future use (must be set to 0).
    BYTE orientation : 2;     // Orientation of the character glyphs (0,90,180,270 degrees)
                              //   00 - Normal
                              //   01 - Characters rotated 270 degrees clockwise
                              //   10 - Characters rotated 180 degrees
                              //   11 - Characters rotated 90 degrees clockwise
    BYTE res2        : 2;     // Reserved for future use (must be set to 0).
    WORD firstChar;           // Character code of first character (e.g. 32).
    WORD lastChar;            // Character code of last character in font (e.g. 3006).
    BYTE height;              // Font characters height in pixels.
    BYTE reserved;            // Reserved for future use (must be set to 0).
} FONT_HEADER;

/*********************************************************************
* Overview: Structure describing the glyph entry.
*
*********************************************************************/
typedef struct
{
    BYTE    width;            // width of the glyph
    BYTE    offsetLSB;        // Least Significant Byte of the glyph location offset
    WORD    offsetMSB;        // Most Significant (2) Bytes of the glyph location offset
} GLYPH_ENTRY;

/*********************************************************************
* Overview: Structure for font stored in FLASH memory.
*
*********************************************************************/
typedef struct
{
    GFX_RESOURCE  type;       // must be FLASH
    const char    *address;   // font image address in FLASH
} FONT_FLASH;

/*********************************************************************
* Overview: Structure for font stored in RAM memory.
*
*********************************************************************/
typedef struct
{
    GFX_RESOURCE  type;       // must be RAM
    char          *address;   // font image address in RAM
} FONT_RAM;

/*********************************************************************
* Overview: Structure for font stored in EXTERNAL memory space.
*           (example: External SPI or parallel Flash, EDS_EPMP)
*
*********************************************************************/
typedef GFX_EXTDATA FONT_EXTERNAL;

/*********************************************************************
* Overview: Structure for images stored in various system memory
*           (Flash, External Memory (SPI, Parallel Flash,
*           or memory in EPMP).
*
*********************************************************************/
typedef struct
{
    GFX_RESOURCE     type;              // Graphics resource type, determines the type and
location of data
    WORD             ID;                // memory ID, user defined value to differentiate
                                        // between graphics resources of the same type
                                        //   When using EDS_EPMP the following ID values are
                                        //   reserved and used by the Microchip display
driver
                                        //   0 - reserved (do not use)
                                        //   1 - reserved for base address of EPMP CS1
                                        //   2 - reserved for base address of EPMP CS2
    union
    {
        DWORD        extAddress;        // generic address
        FLASH_BYTE   *progByteAddress;  // for addresses in program section
        FLASH_WORD   *progWordAddress;  // for addresses in program section
        const char   *constAddress;     // for addresses in FLASH
        char         *ramAddress;       // for addresses in RAM
#if defined(__PIC24F__)
        __eds__ char *edsAddress;       // for addresses in EDS
#endif
    } LOCATION;

    WORD             width;             // width of the image
    WORD             height;            // height of the image
    DWORD            param1;            // size of the IPU compressed data
    DWORD            param2;            // size of the IPU decompressed data
    WORD             colorDepth;        // color depth of the image
} GFX_IMAGE_HEADER;

/* &&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&& */
//                           DEPRECATED TYPES and VARIABLES
/* &&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&& */
typedef GFX_RESOURCE TYPE_MEMORY     __attribute__ ((deprecated));
typedef GFX_EXTDATA  EXTDATA         __attribute__ ((deprecated));
typedef IMAGE_FLASH  BITMAP_FLASH    __attribute__ ((deprecated));
typedef IMAGE_RAM    BITMAP_RAM      __attribute__ ((deprecated));
typedef GFX_EXTDATA  BITMAP_EXTERNAL __attribute__ ((deprecated));

/*********************************************************************
* Overview: This defines the size of the buffer used by font functions
*           to retrieve font data from the external memory. The buffer
*           size can be increased to accommodate large font sizes.
*           The user must be aware of the expected glyph sizes of the
*           characters stored in the font table.
*
********************************************************************/
    #define EXTERNAL_FONT_BUFFER_SIZE   600

// Pointer to the current font image
extern void     *_font;

// First and last characters in the font
extern WORD     _fontFirstChar;
extern WORD     _fontLastChar;

// Installed font height
extern SHORT    _fontHeight;

/*********************************************************************
* Function: WORD Arc(SHORT xL, SHORT yT, SHORT xR, SHORT yB,
*                    SHORT r1, SHORT r2, BYTE octant)
*
* Overview: Draws the octant arc of the beveled figure with the given centers,
*           radii and octant mask.
*           When octant = 0xFF and the following are true:
*           1. xL = xR, yT = yB , r1 = 0 and r2 = z, a filled circle is drawn with a radius
of z.
*           2. radii have values (where r1 < r2), a full ring with thickness of (r2-r1) is
drawn.
*           3. xL != xR, yT != yB , r1 = 0 and r2 = 0 (where xR > xL and yB > yT) a
rectangle is
*              drawn. xL, yT specifies the left top corner and xR, yB specifies the right
bottom corner.
*           When octant != 0xFF the figure drawn is the subsection of the 8 section figure
where
*           each non-zero bit of the octant value specifies the octants that will be drawn.
```

```
*
* Description:
*          <img name="Arc.jpg" />
*
* PreCondition: none
*
* Input: xL - x location of the upper left center in the x,y coordinate.
*        yT - y location of the upper left center in the x,y coordinate.
*        xR - x location of the lower right center in the x,y coordinate.
*        yB - y location of the lower right center in the x,y coordinate.
*        r1 - The smaller radius of the two concentric cicles that defines the thickness
*             of the object.
*        r2 - The larger of radius the two concentric circles that defines the thickness
*             of the object.
*        octant - Bitmask of the octant that will be drawn.
*                 Moving in a clockwise direction from x = 0, y = +radius
*                 - bit0 : first octant
*                 - bit1 : second octant
*                 - bit2 : third octant
*                 - bit3 : fourth octant
*                 - bit4 : fifth octant
*                 - bit5 : sixth octant
*                 - bit6 : seventh octant
*                 - bit7 : eight octant
*
* Output: Returns the rendering status.
*         1 - If the rendering was completed and
*         0 - If the rendering is not yet finished.
*
* Side Effects: none
*
********************************************************************/
WORD            Arc(SHORT xL, SHORT yT, SHORT xR, SHORT yB, SHORT r1, SHORT r2, BYTE
octant);

/*********************************************************************
* Function:  void InitGraph(void)
*
* Overview: This function initializes the display controller, sets
*           the line type to SOLID_LINE, sets the screen to all BLACK,
*           sets the current drawing color to WHITE, sets the graphic
*           cursor position to upper left corner of the screen, sets
*           active and visual pages to page #0, clears the active page
*           and disables clipping. This function should be called before
*           using the Graphics Primitive Layer.
*
* PreCondition: none
*
* Input: none
*
* Output: none
*
* Side Effects: none
*
********************************************************************/
void            InitGraph(void);

/*********************************************************************
* Macros:  GetX()
*
* Overview: This macro returns the current graphic cursor x-coordinate.
*
* PreCondition: none
*
* Input: none
*
* Output: none
*
* Side Effects: none
*
********************************************************************/
    #define GetX()  _cursorX
```

```
/*********************************************************************
* Macros:  GetX()
*
* Overview: This macro returns the current graphic cursor y-coordinate.
*
* PreCondition: none
*
* Input: none
*
* Output: none
*
* Side Effects: none
*
********************************************************************/
    #define GetY()  _cursorY

/*********************************************************************
* Macros:  MoveTo(x,y)
*
* Overview: This macro moves the graphic cursor to new x,y position.
*
* PreCondition: none
*
* Input: x - Specifies the new x position of the graphic cursor.
*        y - Specifies the new y position of the graphic cursor.
*
* Output: none
*
* Side Effects: none
*
********************************************************************/
    #define MoveTo(x, y) \
    _cursorX = x;        \
    _cursorY = y;

/*********************************************************************
* Macros:  MoveRel(dX,dY)
*
* Overview: This macro moves the graphic cursor relative to the
*           current location. The given dX and dY displacement can
*           be positive or negative numbers.
*
* PreCondition: none
*
* Input: dX - Specifies the displacement of the graphic cursor for
*             the horizontal direction.
*        dY - Specifies the displacement of the graphic cursor for
*             the vertical direction.
*
* Output: none
*
* Side Effects: none
*
********************************************************************/
    #define MoveRel(dX, dY) \
    _cursorX += dX;         \
    _cursorY += dY;

/*********************************************************************
* Macro: SetFontOrientation(orient)
*
* Overview: This macro sets font orientation vertical or horizontal.
*
* PreCondition: none
*
* Input: orient - should be non-zero if the font orientation is vertical
*
* Output: none
*
********************************************************************/
    #define SetFontOrientation(orient)  _fontOrientation = orient;
```

```
/*********************************************************************
* Macro: GetFontOrientation()
*
* Overview: This macro returns font orientation (0 == horizontal, 1 == vertical).
*
* PreCondition: none
*
* Input: none
*
* Output: font orientation (0 == horizontal, 1 == vertical)
*
********************************************************************/
    #define GetFontOrientation()    _fontOrientation

/*********************************************************************
* Function: WORD OutChar(XCHAR ch)
*
* Overview: This function outputs a character from the current graphic
*           cursor position. OutChar() uses the current active font
*           set with SetFont().
*
* PreCondition: none
*
* Input: ch - The character code to be displayed.
*
* Output: For NON-Blocking configuration:
*         - Returns 0 when device is busy and the character is not yet completely drawn.
*         - Returns 1 when the character is completely drawn.
*         For Blocking configuration:
*         - Always return 1.
*
*
* Side Effects: After the function is completed, the graphic cursor
*               position is moved in the horizontal direction by the
*               character width. Vertical position of the graphic cursor
*               is not changed.
*
********************************************************************/
WORD    OutChar(XCHAR ch);

/*********************************************************************
* Function: WORD OutText(XCHAR* textString)
*
* Overview: This function outputs a string of characters starting
*           at the current graphic cursor position. The string must
*           be terminated by a line feed or zero. For Non-Blocking
*           configuration, OutText() may return control to the program
*           due to display device busy status. When this happens zero
*           is returned and OutText() must be called again to continue
*           the outputting of the string. For Blocking configuration,
*           this function always returns a 1. OutText() uses the current
*           active font set with SetFont().
*
*
* Input: textString - Pointer to the string to be displayed.
*
* Output: For NON-Blocking configuration:
*         - Returns 0 when string is not yet outputted completely.
*         - Returns 1 when string is outputted completely.
*         For Blocking configuration:
*         - Always return 1.
*
* Side Effects: Current horizontal graphic cursor position will be moved
*               to the end of the text. The vertical graphic cursor
*               position will not be changed.
*
********************************************************************/
WORD    OutText(XCHAR *textString);

/*********************************************************************
* Function: WORD OutTextXY(SHORT x, SHORT y, XCHAR* textString)
```

```
*
* Overview: This function outputs a string of characters starting
*           at the given x, y position. The string must be terminated
*           by a line feed or zero. For Non-Blocking configuration,
*           OutTextXY() may return control to the program due to
*           display device busy status. When this happens zero is
*           returned and OutTextXY() must be called again to continue
*           the outputting of the string. For Blocking configuration,
*           this function always returns a 1. OutTextXY() uses the
*           current active font set with SetFont().
*
* Input: x - Defines the x starting position of the string.
*        y - Defines the y starting position of the string.
*        textString - Pointer to the string to be displayed.
*
* Output: For NON-Blocking configuration:
*          - Returns 0 when string is not yet outputted completely.
*          - Returns 1 when string is outputted completely.
*         For Blocking configuration:
*          - Always return 1.
*
* Example:
*   <CODE>
*   void PlaceText(void)
*   {
*       SHORT width, height;
*       static const XCHAR text[] = "Touch screen to continue";
*
*       SetColor(BRIGHTRED);                // set color
*       SetFont(pMyFont);                   // set font to my font
*
*       // get string width & height
*       width = GetTextWidth(text, pMyFont);
*       height = GetTextHeight(pMyFont);
*
*       // place string in the middle of the screen
*       OutTextXY(  (GetMaxX() - width) >> 1, \
*       (GetMaxY() – height) >> 1, \
*       (char*)text);
*   }
*   </CODE>
*
* Side Effects: Current horizontal graphic cursor position will be
*               moved to the end of the text. The vertical graphic
*               cursor position will not be changed.
*
********************************************************************/
WORD    OutTextXY(SHORT x, SHORT y, XCHAR *textString);

/*********************************************************************
* Function: SHORT GetTextHeight(void* font)
*
* Overview: This macro returns the height of the specified font.
*           All characters in a given font table have a constant
*           height.
*
* Input: font - Pointer to the font image.
*
* Output: Returns the font height.
*
* Example:
*   See OutTextXY() example.
*
* Side Effects: none
*
********************************************************************/
SHORT   GetTextHeight(void *font);

/*********************************************************************
* Function: SHORT GetTextWidth(XCHAR* textString, void* font)
*
* Overview: This function returns the width of the specified string
*           for the specified font. The string must be terminated
*           by a line feed or zero.
*
* Input: textString - Pointer to the string.
*        font - Pointer to the font image.
*
* Output: Returns the string width in the specified font.
*
* Example:
*   See OutTextXY() example.
*
* Side Effects: none
*
********************************************************************/
SHORT   GetTextWidth(XCHAR *textString, void *font);

/*********************************************************************
* Function: void SetFont(void* font)
*
* Overview: This function sets the current font used in OutTextXY(),
*           OutText() and OutChar() functions.
*
* Input: font - Pointer to the new font image to be used.
*
* Output: none
*
* Example:
*   See OutTextXY() example.
*
* Side Effects: none
*
********************************************************************/
void    SetFont(void *font);

/*********************************************************************
* Macros: SetLineType(lnType)
*
* Overview: This macro sets the line type to draw.
*
* Input: lnType - The type of line to be used.
*           Supported line types:
*               - SOLID_LINE
*               - DOTTED_LINE
*               - DASHED_LINE
*
* Output: none
*
* Side Effects: none
*
********************************************************************/
    #define SetLineType(lnType) _lineType = lnType;

/*********************************************************************
* Macros: SetLineThickness(lnThickness)
*
* Overview: This macro sets sets line thickness to 1 pixel or 3 pixels.
*
* Input: lnThickness - Line thickness code (0 - 1 pixel; 1 - 3 pixels)
*
* Output: none
*
* Side Effects: none
*
********************************************************************/
    #define SetLineThickness(lnThickness)   _lineThickness = lnThickness;

/*********************************************************************
* Function: WORD Line(SHORT x1, SHORT y1, SHORT x2, SHORT y2)
*
* Overview: This function draws a line with the current line type
*           from the start point to the end point.
*
```

```
* Input: x1 - x coordinate of the start point.
*        y1 - y coordinate of the start point.
*        x2 - x coordinate of the end point.
*        y2 - y coordinate of the end point.
*
* Output: For NON-Blocking configuration:
*         - Returns 0 when device is busy and the shape is not yet completely drawn.
*         - Returns 1 when the shape is completely drawn.
*         For Blocking configuration:
*         - Always return 1.
*
*
* Side Effects: The graphic cursor position is moved to the end
*               point of the line.
*
********************************************************************/
WORD Line(SHORT x1, SHORT y1, SHORT x2, SHORT y2);

/*********************************************************************
* Macros: LineRel(dX, dY)
*
* Overview: This macro draws a line with the current line type from
*           the current graphic cursor position to the position defined
*           by displacement.
*
* Input: dX - Displacement from the current x position.
*        dY - Displacement from the current y position.
*
* Output: For NON-Blocking configuration:
*         - Returns 0 when device is busy and the shape is not yet completely drawn.
*         - Returns 1 when the shape is completely drawn.
*         For Blocking configuration:
*         - Always return 1.
*
* Side Effects: The graphic cursor position is moved to the end
*               point of the line.
*
********************************************************************/
    #define LineRel(dX, dY) Line(GetX(), GetY(), GetX() + dX, GetY() + dY)

/*********************************************************************
* Macros: LineTo(x,y)
*
* Overview: This macro draws a line with the current line type from
*           the current graphic cursor position to the given x, y position.
*
* Input: x - End point x position.
*        y - End point y poisiton.
*
* Output: For NON-Blocking configuration:
*         - Returns 0 when device is busy and the shape is not yet completely drawn.
*         - Returns 1 when the shape is completely drawn.
*         For Blocking configuration:
*         - Always return 1.
*
* Side Effects: The graphic cursor position is moved to the end
*               point of the line.
*
********************************************************************/
    #define LineTo(x, y)    Line(_cursorX, _cursorY, x, y)

/*********************************************************************
* Macro: Circle(x, y, radius)
*
* Overview: This macro draws a circle with the given center and radius.
*
* Input: x - Center x position.
*        y - Center y position.
*        radius - the radius of the circle.
*
* Output: For NON-Blocking configuration:
*         - Returns 0 when device is busy and the shape is not yet completely drawn.
*         - Returns 1 when the shape is completely drawn.
*         For Blocking configuration:
*         - Always return 1.
*
* Side Effects: none
*
********************************************************************/
    #define Circle(x, y, radius)    Bevel(x, y, x, y, radius)

/*********************************************************************
* Macro: SetBevelDrawType(type)
*
* Overview: This macro sets the fill bevel type to be drawn.
*
* Input: type - is set using the following.
*        - DRAWFULLBEVEL to draw the full shape
*        - DRAWTOPBEVEL to draw the upper half portion
*        - DRAWBOTTOMBEVEL to draw the lower half portion
*
* Output: none
*
* Side Effects: none
*
********************************************************************/
    #define SetBevelDrawType(type)      (_bevelDrawType = type)

/*********************************************************************
* Function: WORD Bevel(SHORT x1, SHORT y1, SHORT x2, SHORT y2, SHORT rad)
*
* Overview: Draws a beveled figure on the screen.
*           When x1 = x2 and y1 = y2, a circular object is drawn.
*           When x1 < x2 and y1 < y2 and rad (radius) = 0, a rectangular
*           object is drawn.
*
* Description:
*        <img name="Bevel.jpg" />
*
* Input: x1 - x coordinate position of the upper left center of the circle that
*             draws the rounded corners.
*        y1 - y coordinate position of the upper left center of the circle that
*             draws the rounded corners.
*        x2 - x coordinate position of the lower right center of the circle that
*             draws the rounded corners.
*        y2 - y coordinate position of the lower right center of the circle that
*             draws the rounded corners.
*        rad - defines the redius of the circle, that draws the rounded corners.
*
* Output: For NON-Blocking configuration:
*         - Returns 0 when device is busy and the shape is not yet completely drawn.
*         - Returns 1 when the shape is completely drawn.
*         For Blocking configuration:
*         - Always return 1.
*
*
* Side Effects: none
*
********************************************************************/
WORD    Bevel(SHORT x1, SHORT y1, SHORT x2, SHORT y2, SHORT rad);

/*********************************************************************
* Function: WORD FillBevel(SHORT x1, SHORT y1, SHORT x2, SHORT y2, SHORT rad)
*
* Overview: Draws a filled beveled figure on the screen.
*           For a filled circular object x1 = x2 and y1 = y2.
*           For a filled rectangular object radius = 0.
*
* Description:
*        <img name="FillBevel.jpg" />
*
* Input: x1 - x coordinate position of the upper left center of the circle that
*             draws the rounded corners.
*        y1 - y coordinate position of the upper left center of the circle that
*             draws the rounded corners.
*        x2 - x coordinate position of the lower right center of the circle that
*             draws the rounded corners.
*        y2 - y coordinate position of the lower right center of the circle that
*             draws the rounded corners.
*        rad - defines the redius of the circle, that draws the rounded corners.
*
* Output: For NON-Blocking configuration:
*          - Returns 0 when device is busy and the shape is not yet completely drawn.
*          - Returns 1 when the shape is completely drawn.
*          For Blocking configuration:
*          - Always return 1.
*
* Side Effects: none
*
********************************************************************/
WORD    FillBevel(SHORT x1, SHORT y1, SHORT x2, SHORT y2, SHORT rad);

/*********************************************************************
* Macro: FillCircle(SHORT x1, SHORT y1, SHORT rad)
*
* Overview: This macro draws a filled circle. Uses the FillBevel() function.
*
* Input: x1 - x coordinate position of the center of the circle.
*        y1 - y coordinate position of the center of the circle.
*        rad - defines the redius of the circle.
*
* Output: For NON-Blocking configuration:
*          - Returns 0 when device is busy and the shape is not yet completely drawn.
*          - Returns 1 when the shape is completely drawn.
*          For Blocking configuration:
*          - Always return 1.
*
* Side Effects: none
*
********************************************************************/
    #define FillCircle(x1, y1, rad) FillBevel(x1, y1, x1, y1, rad)

/*********************************************************************
* Macro: Rectangle(left, top, right, bottom)
*
* Overview: This macro draws a rectangle with the given left,
*           top and right, bottom corners. Current line type is used.
*
* Input: left - x position of the left top corner.
*        top - y position of the left top corner.
*        right - x position of the right bottom corner.
*        bottom - y position of the right bottom corner.
*
* Output: For NON-Blocking configuration:
*          - Returns 0 when device is busy and the shape is not yet completely drawn.
*          - Returns 1 when the shape is completely drawn.
*          For Blocking configuration:
*          - Always return 1.
*
* Side Effects: none
*
********************************************************************/
    #define Rectangle(left, top, right, bottom) Bevel(left, top, right, bottom, 0)

/*********************************************************************
* Function: WORD DrawPoly(SHORT numPoints, SHORT* polyPoints)
*
* Overview: This function draws a polygon with the current line
*           type using the given number of points. The polygon points
*           are stored in an array arranged in the following order:
*    <PRE>
*            SHORT polyPoints[numPoints] = {x0, y0, x1, y1, x2, y2 … xn, yn};
*            Where n = numPoints - 1
*    </PRE>
*
* Input: numPoints - Defines the number of points in the polygon.
*        polyPoints - Pointer to the array of polygon points.
*
* Output: For NON-Blocking configuration:
*          - Returns 0 when device is busy and the shape is not yet completely drawn.
*          - Returns 1 when the shape is completely drawn.
*          For Blocking configuration:
*          - Always return 1.
*
*
* Side Effects: none
*
********************************************************************/
WORD    DrawPoly(SHORT numPoints, SHORT *polyPoints);

/*********************************************************************
* Function: WORD Bar(SHORT left, SHORT top, SHORT right, SHORT bottom)
*
* Overview: This function draws a bar given the left, top and right,
*           bottom corners with the current color.
*
* Input: left - x position of the left top corner.
*        top - y position of the left top corner.
*        right - x position of the right bottom corner.
*        bottom - y position of the right bottom corner.
*
* Output: For NON-Blocking configuration:
*          - Returns 0 when device is busy and the shape is not yet completely drawn.
*          - Returns 1 when the shape is completely drawn.
*          For Blocking configuration:
*          - Always return 1.
*
*
* Side Effects: none
*
********************************************************************/
WORD Bar(SHORT left, SHORT top, SHORT right, SHORT bottom);

/*********************************************************************
* Function: void ClearDevice(void)
*
* Overview: This function clears the screen with the current color
*           and sets the graphic cursor position to (0, 0).
*           Clipping is NOT supported by ClearDevice().
*
* Input: none
*
* Output: none
*
* Example:
*   <CODE>
*   void ClearScreen(void)
*   {
*       SetColor(WHITE);        // set color to WHITE
*       ClearDevice();          // set screen to all WHITE
*   }
*   </CODE>
*
* Side Effects: none
*
********************************************************************/
void    ClearDevice(void);

/*********************************************************************
* Function: WORD PutImage(SHORT left, SHORT top, void* bitmap, BYTE stretch)
*
* Overview: This function outputs image starting from left,top coordinates.
*
* Input: left - x coordinate position of the left top corner.
*        top - y coordinate position of the left top corner.
*        bitmap - pointer to the bitmap.
*        stretch - The image stretch factor.
*
```

```
* Output: For NON-Blocking configuration:
*         - Returns 0 when device is busy and the image is not yet completely drawn.
*         - Returns 1 when the image is completely drawn.
*         For Blocking configuration:
*         - Always return 1.
*
*
* Side Effects: none
*
********************************************************************/
WORD    PutImage(SHORT left, SHORT top, void *bitmap, BYTE stretch);

/*********************************************************************
* Function: SHORT GetImageWidth(void* bitmap)
*
* Overview: This function returns the image width.
*
* Input: bitmap - Pointer to the bitmap.
*
* Output: Returns the image width in pixels.
*
* Side Effects: none
*
********************************************************************/
SHORT   GetImageWidth(void *bitmap);

/*********************************************************************
* Function: SHORT GetImageHeight(void* bitmap)
*
* Overview: This function returns the image height.
*
* Input: bitmap - Pointer to the bitmap.
*
* Output: Returns the image height in pixels.
*
* Side Effects: none
*
********************************************************************/
SHORT   GetImageHeight(void *bitmap);

/*********************************************************************
* Function: WORD ExternalMemoryCallback(GFX_EXTDATA* memory, LONG offset, WORD nCount,
void* buffer)
*
* Overview: This function must be implemented in the application.
*           The library will call this function each time when
*           the external memory data will be required. The application
*           must copy requested bytes quantity into the buffer provided.
*           Data start address in external memory is a sum of the address
*           in GFX_EXTDATA structure and offset.
*
* Input:  memory - Pointer to the external memory bitmap or font structures
*                  (FONT_EXTERNAL or BITMAP_EXTERNAL).
*         offset - Data offset.
*         nCount - Number of bytes to be transferred into the buffer.
*         buffer - Pointer to the buffer.
*
* Output: Returns the number of bytes were transferred.
*
* Example:
*   <CODE>
*   // If there are several memories in the system they can be selected by IDs.
*   // In this example, ID for memory device used is assumed to be 0.
*   #define X_MEMORY 0
*
*   WORD ExternalMemoryCallback(GFX_EXTDATA* memory, LONG offset, WORD nCount, void*
buffer) {
*       int i;
*       long address;
*
*       // Address of the requested data is a start address of the object referred by
GFX_EXTDATA structure plus offset
*       address = memory->address+offset;
*
*       if(memory->ID == X_MEMORY){
*           // MemoryXReadByte() is some function implemented to access external memory.
*           // Implementation will be specific to the memory used. In this example
*           // it reads byte each time it is called.
*           i = 0;
*           while (i < nCount) {
*               (BYTE*)buffer = MemoryXReadByte(address++);
*               i++;
*           }
*      }
*      // return the actual number of bytes retrieved
*      return (i);
*  }
*  </CODE>
*
* Side Effects: none
*
********************************************************************/
WORD    ExternalMemoryCallback(GFX_EXTDATA *memory, LONG offset, WORD nCount, void *buffer);

/*********************************************************************
* Function:  SHORT GetSineCosine(SHORT v, WORD type)
*
* PreCondition: none
*
* Input: v - the angle used to retrieve the sine or cosine value.
*            The angle must be in the range of -360 to 360 degrees.
*        type - sets if the angle calculation is for a sine or cosine
*               - GETSINE (0) - get the value of sine(v).
*               - GETCOSINE (1) - return the value of cosine(v).
*
* Output: Returns the sine or cosine of the angle given.
*
* Side Effects: none
*
* Overview: Using a lookup table, the sine or cosine values of the given angle
*           is returned.
*
* Note: none
*
********************************************************************/
SHORT GetSineCosine(SHORT v, WORD type);

/*********************************************************************
* Function:  SHORT Sine(SHORT v)
*
* PreCondition: none
*
* Input: v - the angle used to calculate the sine value.
*            The angle must be in the range of -360 to 360 degrees.
*
* Output: Returns the sine of the given angle.
*
* Side Effects: none
*
* Overview: This calculates the sine value of the given angle.
*
* Note: none
*
********************************************************************/
#define Sine(v)     GetSineCosine(v, GETSINE)

/*********************************************************************
* Function:  SHORT Cosine(SHORT v)
*
* PreCondition: none
*
* Input: v - the angle used to calculate the cosine value.
*            The angle must be in the range of -360 to 360 degrees.
*
```

```
* Output: Returns the cosine of the given angle.
*
* Side Effects: none
*
* Overview: This calculates the cosine value of the given angle.
*
* Note: none
*
********************************************************************/
#define Cosine(v)       GetSineCosine(v, GETCOSINE)


/*********************************************************************
* Function:  WORD DrawArc(SHORT cx, SHORT cy, SHORT r1, SHORT r2, SHORT startAngle, SHORT
endAngle)
*
* Overview: This renders an arc with from startAngle to endAngle with the thickness
*           of r2-r1. The function returns 1 when the arc is rendered successfuly
*           and returns a 0 when it is not yet finished. The next call to the
*           function will continue the rendering.
*
* PreCondition: none
*
* Input: cx - the location of the center of the arc in the x direction.
*        cy - the location of the center of the arc in the y direction.
*        r1 - the smaller radius of the arc.
*        r2 - the larger radius of the arc.
*        startAngle - start angle of the arc.
*        endAngle - end angle of the arc.
*
* Output: Returns 1 if the rendering is done, 0 if not yet done.
*
* Side Effects: none
*
* Note: none
*
********************************************************************/
WORD DrawArc(SHORT cx, SHORT cy, SHORT r1, SHORT r2, SHORT startAngle, SHORT endAngle);

void GetCirclePoint(SHORT radius, SHORT angle, SHORT *x, SHORT *y);

#ifdef USE_GRADIENT

/*********************************************************************
* Function:  WORD BarGradient(SHORT left, SHORT top, SHORT right, SHORT bottom,
*                         GFX_COLOR color1, GFX_COLOR color2, DWORD length,
*                         BYTE direction);
*
* Overview: This renders a bar onto the screen, but instead of one color a gradient is drawn
* depending on the direction (GFX_GRADIENT_TYPE), length, and colors chosen
*
* Description:
*        <img name="BarGradient.jpg" />
*
* PreCondition: none
*
* Input: left - x position of the left top corner.
*        top - y position of the left top corner.
*        right - x position of the right bottom corner.
*        bottom - y position of the right bottom corner.
*        color1 - start color for the gradient
*        color2 - end color for the gradient
*        length - From 0-100%. How much of a gradient is wanted
*        direction - Gradient Direction
*
* Output: Returns 1 if the rendering is done, 0 if not yet done.
*
* Example:
*   <CODE>
*   // draw a full screen gradient background
*   // with color transitioning from BRIGHTRED to
*   // BLACK in the upward direction.
```

```
*
*   GFX_GRADIENT_STYLE  gradScheme;
*
*   gradScheme.gradientType         = GRAD_UP;
*   gradScheme.gradientStartColor   = BRIGHTRED;
*   gradScheme.gradientEndColor     = BLACK;
*
*    BarGradient(0,                                     //left position
*                0,                                     //top position
*                GetMaxX(),                             //right position
*                GetMaxY(),                             //bottom position
*                0,                                     // no radius, since full screen
*                gradScheme.gradientStartColor,
*                gradScheme.gradientEndColor,
*                50,                                    // at the halfway point (50%)
of the rectangular area
*                                                       // defined by the first 4
parameters (full screen),
*                                                       // the color becomes BLACK and
BLACK color is used until
*                                                       // the rectangle defined is
filled up
*                gradScheme.gradientType);              // gradient direction is
bottom->top
*   </CODE>
*
* Side Effects: none
*
* Note: none
*
********************************************************************/
WORD        BarGradient(SHORT left, SHORT top, SHORT right, SHORT bottom, GFX_COLOR color1,
GFX_COLOR color2, DWORD length, BYTE direction);

/*********************************************************************
* Function:  BevelGradient(SHORT left, SHORT top, SHORT right, SHORT bottom,
*                          SHORT rad, GFX_COLOR color1, GFX_COLOR color2,
*                          DWORD length, BYTE direction);
*
* Overview: This renders a gradient on the screen. It works the same as the fillbevel
function,
* except a gradient out of color1 and color2 is drawn depending on the direction
(GFX_GRADIENT_TYPE).
*
* Description:
*         <img name="BevelGradient.jpg" />
*
* PreCondition: none
*
* Input: left - x coordinate position of the upper left center of the circle that
*              draws the rounded corners.
*         top - y coordinate position of the upper left center of the circle that
*              draws the rounded corners.
*         right - x coordinate position of the lower right center of the circle that
*              draws the rounded corners.
*         bottom - y coordinate position of the lower right center of the circle that
*              draws the rounded corners.
*         rad - defines the redius of the circle, that draws the rounded corners. When
*               rad = 0, the object drawn is a rectangular gradient.
*         color1 - start color for the gradient
*         color2 - end color for the gradient
*         length - From 0-100%. How much of a gradient is wanted
*         direction - Gradient Direction
*
* Output: Returns 1 if the rendering is done, 0 if not yet done.
*
* Side Effects: none
*
* Note: none
*
********************************************************************/
WORD        BevelGradient(SHORT left, SHORT top, SHORT right, SHORT bottom, SHORT rad,
GFX_COLOR color1, GFX_COLOR color2, DWORD length, BYTE direction);

/*********************************************************************
* Overview: Enumeration for gradient type
*********************************************************************/
typedef enum
{
       GRAD_NONE=0,                      // No Gradients to be drawn
       GRAD_DOWN,                        // gradient changes in the vertical direction
       GRAD_RIGHT,                       // gradient change in the horizontal direction
       GRAD_UP,                          // gradient changes in the vertical direction
       GRAD_LEFT,                        // gradient change in the horizontal direction
       GRAD_DOUBLE_VER,                  // two gradient transitions in the vertical
direction
       GRAD_DOUBLE_HOR,                  // two gradient transitions in the horizontal
direction

} GFX_GRADIENT_TYPE;

/*********************************************************************
* Overview: This structure is used to describe the gradient style.
*
*********************************************************************/
typedef struct
{

GFX_GRADIENT_TYPE  gradientType;         // selected the gradient type
DWORD              gradientStartColor;   // sets the starting color of gradient transition
DWORD              gradientEndColor;     // sets the ending color of gradient transition
DWORD              gradientLength;       // defines the length of the gradient transition in
pixels

} GFX_GRADIENT_STYLE;
#endif

#ifdef USE_ALPHABLEND
extern SHORT _GFXForegroundPage;         // foreground page (or buffer) used in alpha
blending
extern SHORT _GFXBackgroundPage;         // background page (or buffer)  used in alpha
blending
extern SHORT _GFXDestinationPage;        // destination page (or buffer)  used in alpha
blending


/*********************************************************************
* Function: void AlphaBlendWindow(DWORD foregroundWindowAddr, DWORD backgroundWindowAddr,
*                      DWORD destinationWindowAddr,
*                      WORD  width, WORD height,
*                      BYTE  alphaPercentage)
* PreCondition: none
*
* Input:  foregroundWindowAddr -  the starting address of the foreground window
*       backgroundWindowAddr -  the starting address of the background window
*       destinationWindowAddr - the starting address of the destination window
*       width - the width of the alpha blend window
*         height - the height of the alpha blend window
*         alphaPercentage - the amount of transparency to give the foreground Window
*
*
* Output: none
*
* Side Effects: none
*
* Overview: This alphablends a foreground and a background stored in frames to a
destination window. The function
* uses windows insides frames. Each window shares the same width and height parameters.
*
* Note: none
********************************************************************/
extern void AlphaBlendWindow(DWORD foregroundWindowAddr, DWORD backgroundWindowAddr,
                      DWORD destinationWindowAddr,
                      WORD  width, WORD height,
                        BYTE  alphaPercentage);

/*********************************************************************
* Function: DWORD GFXGetPageXYAddress(SHORT pageNumber, WORD x, WORD y)
* PreCondition: none
*
* Input:  pageNumber - the page number
*         x - the x (horizontal) offset from 0,0 of the pagenumber
*         y - the y (vertical) offset from the 0,0 of the pagenumber
*
* Output: The address of an XY position of a certain page in memory
*
* Side Effects: none
*
* Overview: This function calculates the address of a certain x,y location in
* memory
*
* Note: none
********************************************************************/
extern DWORD GFXGetPageXYAddress(SHORT pageNumber, WORD x, WORD y);

/*********************************************************************
* Function: DWORD GFXGetPageOriginAddress(SHORT pageNumber)
* PreCondition: none
*
* Input:  pageNumber - the page number
*
* Output: The address of the start of a certain page in memory
*
* Side Effects: none
*
* Overview: This function calculates the address of a certain 0,0 location of a
* page in memory
*
* Note: none
********************************************************************/
extern DWORD GFXGetPageOriginAddress(SHORT pageNumber);

#endif


#endif // _PRIMITIVE_H
```

14.3 Device Driver Layer

Files

Name	Description
drvTFT001.c (see page 1051)	This is file drvTFT001.c.
drvTFT001.h (see page 1077)	This is file drvTFT001.h.
HIT1270.c (see page 1080)	This is file HIT1270.c.
HIT1270.h (see page 1095)	This is file HIT1270.h.
HX8347.c (see page 1097)	This is file HX8347.c.
HX8347.h (see page 1115)	This is file HX8347.h.
SH1101A_SSD1303.c (see page 1116)	This is file SH1101A_SSD1303.c.
SH1101A_SSD1303.h (see page 1124)	This is file SH1101A_SSD1303.h.
SSD1339.c (see page 1126)	This is file SSD1339.c.
SSD1339.h (see page 1142)	This is file SSD1339.h.
SSD1926.c (see page 1144)	This is file SSD1926.c.
SSD1926.h (see page 1188)	This is file SSD1926.h.
TCON_HX8238.c (see page 1207)	This is file TCON_HX8238.c.

TCON_SSD1289.c (see page 1212)	This is file TCON_SSD1289.c.
TCON_HX8257.c (see page 1218)	This is file TCON_HX8257.c.
CustomDisplayDriver.c (see page 1222)	This is file CustomDisplayDriver.c.
UC1610.c (see page 1224)	This is file UC1610.c.
UC1610.h (see page 1236)	This is file UC1610.h.
TCON_Custom.c (see page 1238)	This is file TCON_Custom.c.

Description

Lists all Device Driver files currently included in the library that can be used in the Device Driver Layer.

14.3.1 drvTFT001.c

This is file drvTFT001.c.

Body Source

```
/*****************************************************************************
 *  Module for Microchip Graphics Library
 *  LCD controller driver
 *  LG LGDP4531
 *  Renesas R61505
 *  Renesas R61580
 *  Samsung S6D0129
 *  Samsung S6D0139
 *  Orise Tech. SPFD5408
 *  Ilitek ILI9320
 *****************************************************************************
 * FileName:        drvTFT001.c
 * Processor:       PIC24, PIC32
 * Compiler:        MPLAB C30, MPLAB C32
 * Company:         Microchip Technology Incorporated
 *
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 *
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 * INDIRECT, PUNITIVE OR CONSEQUENTIAL DAMAGES, LOST PROFITS OR LOST DATA,
 * COST OF PROCUREMENT OF SUBSTITUTE GOODS, TECHNOLOGY, SERVICES, OR ANY
 * CLAIMS BY THIRD PARTIES (INCLUDING BUT NOT LIMITED TO ANY DEFENSE THEREOF),
 * OR OTHER SIMILAR COSTS.
 *
 * Date         Comment
 *~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
 * 11/12/07     Version 1.0 release
 * 01/30/08     combined version for landscape and portrait
 * 01/30/08     PIC32 support
 * 06/25/09     dsPIC & PIC24H support
 * 06/26/09     16-bit PMP support
 * 03/11/11     - Modified dependencies
```

```
 *              - changes for Graphics Library Version 3.00
 *****************************************************************************/
//#include "Graphics/Graphics.h"

#include "HardwareProfile.h"

#if defined (GFX_USE_DISPLAY_CONTROLLER_S6D0129)  || defined
(GFX_USE_DISPLAY_CONTROLLER_S6D0139) || \
    defined (GFX_USE_DISPLAY_CONTROLLER_LGDP4531) || defined
(GFX_USE_DISPLAY_CONTROLLER_R61505)  || \
    defined (GFX_USE_DISPLAY_CONTROLLER_SPFD5408) || defined
(GFX_USE_DISPLAY_CONTROLLER_ILI9320) || \
    defined (GFX_USE_DISPLAY_CONTROLLER_R61580)

#include "Compiler.h"
#include "TimeDelay.h"
#include "Graphics/DisplayDriver.h"
#include "Graphics/drvTFT001.h"
#include "Graphics/Primitive.h"

#ifdef USE_GFX_PMP
    #include "Graphics/gfxpmp.h"
#elif USE_GFX_EPMP
    #include "Graphics/gfxepmp.h"
#endif

// Unsupported Graphics Library Features
#ifdef USE_TRANSPARENT_COLOR
    #warning "This driver does not support the transparent feature on PutImage(). Build
will use the PutImage() functions defined in the Primitive.c"
#endif

// Color
GFX_COLOR   _color;
#ifdef USE_TRANSPARENT_COLOR
GFX_COLOR   _colorTransparent;
SHORT       _colorTransparentEnable;
#endif

// Clipping region control
SHORT       _clipRgn;

// Clipping region borders
SHORT       _clipLeft;
SHORT       _clipTop;
SHORT       _clipRight;
SHORT       _clipBottom;

////////////////////// LOCAL FUNCTIONS PROTOTYPES ////////////////////////////
#ifndef USE_TRANSPARENT_COLOR
void        PutImage1BPP(SHORT left, SHORT top, FLASH_BYTE *image, BYTE stretch);
void        PutImage4BPP(SHORT left, SHORT top, FLASH_BYTE *image, BYTE stretch);
void        PutImage8BPP(SHORT left, SHORT top, FLASH_BYTE *image, BYTE stretch);
void        PutImage16BPP(SHORT left, SHORT top, FLASH_BYTE *image, BYTE stretch);

void        PutImage1BPPExt(SHORT left, SHORT top, void *image, BYTE stretch);
void        PutImage4BPPExt(SHORT left, SHORT top, void *image, BYTE stretch);
void        PutImage8BPPExt(SHORT left, SHORT top, void *image, BYTE stretch);
void        PutImage16BPPExt(SHORT left, SHORT top, void *image, BYTE stretch);
#endif

/*********************************************************************
* Macro:  WritePixel(color)
*
* PreCondition: none
*
* Input: color
*
* Output: none
*
* Side Effects: none
*
```

```
* Overview: writes pixel at the current address
*
* Note: chip select should be enabled
*
********************************************************************/
#ifdef USE_16BIT_PMP
#define WritePixel(color)   DeviceWrite(color)
#else
#define WritePixel(color)   { DeviceWrite(((WORD_VAL)color).v[1]);
DeviceWrite(((WORD_VAL)color).v[0]);}
#endif

/*********************************************************************
* Macros:  SetAddress(addr)
*
* Overview: Writes address pointer.
*
* PreCondition: none
*
* Input: add0 -  32-bit address.
*
* Output: none
*
* Side Effects: none
*
********************************************************************/
#ifdef USE_16BIT_PMP
#define SetAddress(addr)                    \
    {                                       \
    DisplaySetCommand();                    \
    DeviceWrite(0x0020);                    \
    DisplaySetData();                       \
    DeviceWrite((WORD) addr & 0x00ff);      \
    DisplaySetCommand();                    \
    DeviceWrite(0x0021);                    \
    DisplaySetData();                       \
    DeviceWrite((WORD) ((DWORD) addr >> 8));\
    DisplaySetCommand();                    \
    DeviceWrite(0x0022);                    \
    DisplaySetData();                       \
    }
#else
#define SetAddress(addr)                    \
    {\
    DisplaySetCommand();                    \
    DeviceWrite(0);                         \
    DeviceWrite(0x20);                      \
    DisplaySetData();                       \
    DeviceWrite(0);                         \
    DeviceWrite(((DWORD_VAL) (DWORD) addr).v[0]);\
    DisplaySetCommand();                    \
    DeviceWrite(0);                         \
    DeviceWrite(0x21);                      \
    DisplaySetData();                       \
    DeviceWrite(((DWORD_VAL) (DWORD) addr).v[2]);\
    DeviceWrite(((DWORD_VAL) (DWORD) addr).v[1]);\
    DisplaySetCommand();                    \
    DeviceWrite(0);                         \
    DeviceWrite(0x22);                      \
    DisplaySetData();                       \
    }
#endif

/*********************************************************************
* Function:  void  SetReg(WORD index, WORD value)
*
* PreCondition: none
*
* Input: index - register number
*        value - value to be set
*
* Output: none
```

```
*
* Side Effects: none
*
* Overview: sets graphics controller register
*
* Note: none
*
********************************************************************/
void SetReg(WORD index, WORD value)
{
#ifdef USE_16BIT_PMP
    DisplayEnable();
    DisplaySetCommand();
    DeviceWrite(index);
    DisplaySetData();
    DeviceWrite(value);
    DisplayDisable();
#else
    DisplayEnable();
    DisplaySetCommand();
    DeviceWrite(((WORD_VAL)index).v[1]);
    DeviceWrite(((WORD_VAL)index).v[0]);
    DisplaySetData();
    DeviceWrite(((WORD_VAL)value).v[1]);
    DeviceWrite(((WORD_VAL)value).v[0]);
    DisplayDisable();
#endif
}

/*********************************************************************
* Function:  void DisplayBrightness(WORD level)
*
* PreCondition: none
*
* Input: level - Brightness level. Valid values are 0 to 100.
*           - 0: brightness level is zero or display is turned off
*           - 1: brightness level is maximum
*
* Output: none
*
* Side Effects: none
*
* Overview: Sets the brightness of the display.
*
* Note: none
*
********************************************************************/
void DisplayBrightness(WORD level)
{
    // If the brightness can be controlled (for example through PWM)
    // add code that will control the PWM here.

    if (level > 0)
    {
        DisplayBacklightOn();
    }
    else if (level == 0)
    {
        DisplayBacklightOff();
    }

}

/*********************************************************************
* Function:  void ResetDevice()
*
* PreCondition: none
*
* Input: none
*
* Output: none
*
```

```
 * Side Effects: none
 *
 * Overview: resets LCD, initializes PMP
 *
 * Note: none
 *
 ********************************************************************/
void ResetDevice(void)
{
    // Set FLASH CS pin as output
    DisplayFlashConfig();

    // Initialize the device
    DriverInterfaceInit();

    DelayMs(5);

    // Power on LCD
    DisplayPowerOn();
    DisplayPowerConfig();

    DelayMs(2);

    #if defined (GFX_USE_DISPLAY_CONTROLLER_LGDP4531)

    /////////////////////////////////////////////////////////
    // Synchronization after reset
    DisplayEnable();
    DeviceWrite(0);
    DeviceWrite(0);
    DisplayDisable();

    // Setup display
    SetReg(0x0010, 0x0628);
    SetReg(0x0012, 0x0006);
    SetReg(0x0013, 0x0A32);
    SetReg(0x0011, 0x0040);
    SetReg(0x0015, 0x0050);
    SetReg(0x0012, 0x0016);
    DelayMs(15);
    SetReg(0x0010, 0x5660);
    DelayMs(15);
    SetReg(0x0013, 0x2A4E);
    SetReg(0x0001, 0x0100);
    SetReg(0x0002, 0x0300);

        #if (DISP_ORIENTATION == 0)
    SetReg(0x0003, 0x1030);
        #else
    SetReg(0x0003, 0x1038);
        #endif
    SetReg(0x0008, 0x0202);
    SetReg(0x000A, 0x0000);
    SetReg(0x0030, 0x0000);
    SetReg(0x0031, 0x0402);
    SetReg(0x0032, 0x0106);
    SetReg(0x0033, 0x0700);
    SetReg(0x0034, 0x0104);
    SetReg(0x0035, 0x0301);
    SetReg(0x0036, 0x0707);
    SetReg(0x0037, 0x0305);
    SetReg(0x0038, 0x0208);
    SetReg(0x0039, 0x0F0B);
    DelayMs(15);
    SetReg(0x0041, 0x0002);
    SetReg(0x0060, 0x2700);
    SetReg(0x0061, 0x0001);
    SetReg(0x0090, 0x0119);
    SetReg(0x0092, 0x010A);
    SetReg(0x0093, 0x0004);
    SetReg(0x00A0, 0x0100);
    SetReg(0x0007, 0x0001);
```

```
DelayMs(15);
SetReg(0x0007, 0x0021);
DelayMs(15);
SetReg(0x0007, 0x0023);
DelayMs(15);
SetReg(0x0007, 0x0033);
DelayMs(15);
SetReg(0x0007, 0x0133);
DelayMs(15);
SetReg(0x00A0, 0x0000);
DelayMs(20);

/////////////////////////////////////////////////////////
#elif defined (GFX_USE_DISPLAY_CONTROLLER_R61505)

// Setup display
SetReg(0x0000, 0x0000);
SetReg(0x0007, 0x0001);
DelayMs(5);
SetReg(0x0017, 0x0001);
DelayMs(5);
SetReg(0x0010, 0x17b0);
SetReg(0x0011, 0x0007);
SetReg(0x0012, 0x011a);
SetReg(0x0013, 0x0f00);
SetReg(0x0015, 0x0000);
SetReg(0x0029, 0x0009);
SetReg(0x00fd, 0x0000);
DelayMs(5);
SetReg(0x0012, 0x013a);
DelayMs(50);
SetReg(0x0001, 0x0100);
SetReg(0x0002, 0x0700);

    #if (DISP_ORIENTATION == 0)
SetReg(0x0003, 0x1030);
    #else
SetReg(0x0003, 0x1038);
    #endif
SetReg(0x0008, 0x0808);
SetReg(0x0009, 0x0000);
SetReg(0x000a, 0x0000);
SetReg(0x000c, 0x0000);
SetReg(0x000d, 0x0000);
SetReg(0x0030, 0x0000);
SetReg(0x0031, 0x0000);
SetReg(0x0032, 0x0000);
SetReg(0x0033, 0x0000);
SetReg(0x0034, 0x0000);
SetReg(0x0035, 0x0000);
SetReg(0x0036, 0x0000);
SetReg(0x0037, 0x0707);
SetReg(0x0038, 0x0707);
SetReg(0x0039, 0x0707);
SetReg(0x003a, 0x0303);
SetReg(0x003b, 0x0303);
SetReg(0x003c, 0x0707);
SetReg(0x003d, 0x0808);
SetReg(0x0050, 0x0000);
SetReg(0x0051, 0x00ef);
SetReg(0x0052, 0x0000);
SetReg(0x0053, 0x013f);
SetReg(0x0060, 0x2700);
SetReg(0x0061, 0x0001);
SetReg(0x006a, 0x0000);
SetReg(0x0090, 0x0010);
SetReg(0x0092, 0x0000);
SetReg(0x0093, 0x0000);
SetReg(0x0007, 0x0021);
DelayMs(1);
SetReg(0x0007, 0x0061);
DelayMs(50);
```

```
    SetReg(0x0007, 0x0173);
    SetReg(0x0020, 0x0000);
    SetReg(0x0021, 0x0000);
    SetReg(0x0022, 0x0000);
    SetReg(0x0030, 0x0707);
    SetReg(0x0031, 0x0407);
    SetReg(0x0032, 0x0203);
    SetReg(0x0033, 0x0303);
    SetReg(0x0034, 0x0303);
    SetReg(0x0035, 0x0202);
    SetReg(0x0036, 0x001f);
    SetReg(0x0037, 0x0707);
    SetReg(0x0038, 0x0407);
    SetReg(0x0039, 0x0203);
    SetReg(0x003a, 0x0303);
    SetReg(0x003b, 0x0303);
    SetReg(0x003c, 0x0202);
    SetReg(0x003d, 0x001f);
    SetReg(0x0020, 0x0000);
    SetReg(0x0021, 0x0000);

    /////////////////////////////////////////////////////////
    #elif defined (GFX_USE_DISPLAY_CONTROLLER_S6D0129) || defined
(GFX_USE_DISPLAY_CONTROLLER_S6D0139)

    // Setup display
    SetReg(0x0000, 0x0001);
    SetReg(0x0011, 0x1a00);
    SetReg(0x0014, 0x2020);
    SetReg(0x0010, 0x0900);
    SetReg(0x0013, 0x0040);
    SetReg(0x0013, 0x0060);
    SetReg(0x0013, 0x0070);
    SetReg(0x0011, 0x1a04);
    SetReg(0x0010, 0x2f00);
    SetReg(0x0001, 0x0127);
    SetReg(0x0002, 0x0700);

        #if (DISP_ORIENTATION == 0)
    SetReg(0x0003, 0x1030);
        #else
    SetReg(0x0003, 0x1038);
        #endif
    SetReg(0x0007, 0x0000);
    SetReg(0x0008, 0x0808);
    SetReg(0x0009, 0x0000);
    SetReg(0x000b, 0x0000);
    SetReg(0x000c, 0x0000);
    SetReg(0x0040, 0x0000);
    SetReg(0x0041, 0x0000);
    SetReg(0x0042, 0x013f);
    SetReg(0x0043, 0x0000);
    SetReg(0x0044, 0x00ef);
    SetReg(0x0045, 0x0000);
    SetReg(0x0046, 0xef00);
    SetReg(0x0047, 0x013f);
    SetReg(0x0048, 0x0000);
    SetReg(0x0007, 0x0014);
    SetReg(0x0007, 0x0016);
    SetReg(0x0007, 0x0017);
    SetReg(0x0020, 0x0000);
    SetReg(0x0021, 0x0000);
    SetReg(0x0022, 0x0000);

    /////////////////////////////////////////////////////////
    #elif defined (GFX_USE_DISPLAY_CONTROLLER_SPFD5408)

    // Setup display
    SetReg(0x0000, 0x0000);
    SetReg(0x0001, 0x0000);
    SetReg(0x0002, 0x0700);
        #if (DISP_ORIENTATION == 0)
    SetReg(0x0003, 0x1010);
        #else
    SetReg(0x0003, 0x1028);
        #endif
    SetReg(0x0004, 0x0000);
    SetReg(0x0008, 0x0207);
    SetReg(0x0009, 0x0000);
    SetReg(0x000a, 0x0000);
    SetReg(0x000c, 0x0000);
    SetReg(0x000d, 0x0000);
    SetReg(0x000f, 0x0000);
    SetReg(0x0007, 0x0101);
    SetReg(0x0010, 0x12b0);
    SetReg(0x0011, 0x0007);
    SetReg(0x0017, 0x0001);
    SetReg(0x0012, 0x01bb);
    SetReg(0x0013, 0x1300);
    SetReg(0x0029, 0x0010);

    SetReg(0x0030, 0x0100);
    SetReg(0x0031, 0x0c19);
    SetReg(0x0032, 0x111e);
    SetReg(0x0033, 0x3819);
    SetReg(0x0034, 0x350b);
    SetReg(0x0035, 0x0e08);
    SetReg(0x0036, 0x0d07);
    SetReg(0x0037, 0x0318);
    SetReg(0x0038, 0x0705);
    SetReg(0x0039, 0x0303);
    SetReg(0x003a, 0x0905);
    SetReg(0x003b, 0x0801);
    SetReg(0x003c, 0x030e);
    SetReg(0x003d, 0x050d);
    SetReg(0x003e, 0x0106);
    SetReg(0x003f, 0x0408);

    SetReg(0x0050, 0x0000);
    SetReg(0x0051, 0x00ef);
    SetReg(0x0052, 0x0000);
    SetReg(0x0053, 0x013f);
    SetReg(0x0060, 0xa700);
    SetReg(0x0061, 0x0001);
    SetReg(0x006a, 0x0000);
    SetReg(0x0080, 0x0000);
    SetReg(0x0081, 0x0000);
    SetReg(0x0082, 0x0000);
    SetReg(0x0083, 0x0000);
    SetReg(0x0084, 0x0000);
    SetReg(0x0085, 0x0000);
    SetReg(0x0090, 0x0010);
    SetReg(0x0092, 0x0000);
    SetReg(0x0093, 0x0103);
    SetReg(0x0095, 0x0110);
    SetReg(0x0097, 0x0000);
    SetReg(0x0098, 0x0000);
    SetReg(0x00f0, 0x5408);
    SetReg(0x00f3, 0x0010);
    SetReg(0x00f4, 0x001f);
    SetReg(0x00f0, 0x0000);
    SetReg(0x0007, 0x0133);

    /////////////////////////////////////////////////////////
    #elif defined (GFX_USE_DISPLAY_CONTROLLER_ILI9320)
    SetReg(0x0000, 0x0001); //start Int. osc
    DelayMs(15);
    SetReg(0x0001, 0x0100); //Set SS bit (shift direction of outputs is from S720 to S1)
    SetReg(0x0002, 0x0700); //select  the line inversion
        #if (DISP_ORIENTATION == 0)
    SetReg(0x0003, 0x1030); //Entry mode(Horizontal : increment,Vertical : increment, AM=0)
        #else
    SetReg(0x0003, 0x1038); //Entry mode(Horizontal : increment,Vertical : increment, AM=1)
```

```
        #endif
    SetReg(0x0004, 0x0000); //Resize control(No resizing)
    SetReg(0x0008, 0x0202); //front and back porch 2 lines
    SetReg(0x0009, 0x0000); //select normal scan
    SetReg(0x000A, 0x0000); //display control 4
    SetReg(0x000C, 0x0000); //system interface(2 transfer /pixel), internal sys clock,
    SetReg(0x000D, 0x0000); //Frame marker position
    SetReg(0x000F, 0x0000); //selects clk, enable and sync signal polarity,
    SetReg(0x0010, 0x0000); //
    SetReg(0x0011, 0x0000); //power control 2 reference voltages = 1:1,
    SetReg(0x0012, 0x0000); //power control 3 VRH
    SetReg(0x0013, 0x0000); //power control 4 VCOM amplitude
    DelayMs(20);
    SetReg(0x0010, 0x17B0); //power control 1 BT,AP
    SetReg(0x0011, 0x0137); //power control 2 DC,VC
    DelayMs(50);
    SetReg(0x0012, 0x0139); //power control 3 VRH
    DelayMs(50);
    SetReg(0x0013, 0x1d00); //power control 4 vcom amplitude
    SetReg(0x0029, 0x0011); //power control 7 VCOMH
    DelayMs(50);
    SetReg(0x0030, 0x0007);
    SetReg(0x0031, 0x0403);
    SetReg(0x0032, 0x0404);
    SetReg(0x0035, 0x0002);
    SetReg(0x0036, 0x0707);
    SetReg(0x0037, 0x0606);
    SetReg(0x0038, 0x0106);
    SetReg(0x0039, 0x0007);
    SetReg(0x003c, 0x0700);
    SetReg(0x003d, 0x0707);
    SetReg(0x0020, 0x0000); //starting Horizontal GRAM Address
    SetReg(0x0021, 0x0000); //starting Vertical GRAM Address
    SetReg(0x0050, 0x0000); //Horizontal GRAM Start Position
    SetReg(0x0051, 0x00EF); //Horizontal GRAM end Position
    SetReg(0x0052, 0x0000); //Vertical GRAM Start Position
    SetReg(0x0053, 0x013F); //Vertical GRAM end Position
    SetReg(0x0060, 0x2700); //starts scanning from G1, and 320 drive lines
    SetReg(0x0061, 0x0001); //fixed base display
    SetReg(0x006a, 0x0000); //no scroll
    SetReg(0x0090, 0x0010); //set Clocks/Line =16, Internal Operation Clock
Frequency=fosc/1,
    SetReg(0x0092, 0x0000); //set gate output non-overlap period=0
    SetReg(0x0093, 0x0003); //set Source Output Position=3
    SetReg(0x0095, 0x0110); //RGB interface(Clocks per line period=16 clocks)
    SetReg(0x0097, 0x0110); //set Gate Non-overlap Period 0 locksc
    SetReg(0x0098, 0x0110); //
    SetReg(0x0007, 0x0173); //display On
    ////////////////////////////////////////////////////////
    #elif defined (GFX_USE_DISPLAY_CONTROLLER_R61580)

    // Synchronization after reset
    DelayMs(2);
    SetReg(0x0000, 0x0000);
    SetReg(0x0000, 0x0000);
    SetReg(0x0000, 0x0000);
    SetReg(0x0000, 0x0000);

    // Setup display
    SetReg(0x00A4, 0x0001); // CALB=1
    DelayMs(2);
    SetReg(0x0060, 0xA700); // Driver Output Control
    SetReg(0x0008, 0x0808); // Display Control BP=8, FP=8
    SetReg(0x0030, 0x0111); // y control
    SetReg(0x0031, 0x2410); // y control
    SetReg(0x0032, 0x0501); // y control
    SetReg(0x0033, 0x050C); // y control
    SetReg(0x0034, 0x2211); // y control
    SetReg(0x0035, 0x0C05); // y control
    SetReg(0x0036, 0x2105); // y control
    SetReg(0x0037, 0x1004); // y control
    SetReg(0x0038, 0x1101); // y control
    SetReg(0x0039, 0x1122); // y control
    SetReg(0x0090, 0x0019); // 80Hz
    SetReg(0x0010, 0x0530); // Power Control
    SetReg(0x0011, 0x0237);
    SetReg(0x0012, 0x01BF);
    SetReg(0x0013, 0x1300);
    DelayMs(100);

    SetReg(0x0001, 0x0100);
    SetReg(0x0002, 0x0200);
        #if (DISP_ORIENTATION == 0)
    SetReg(0x0003, 0x1030);
        #else
    SetReg(0x0003, 0x1038);
        #endif
    SetReg(0x0009, 0x0001);
    SetReg(0x000A, 0x0008);
    SetReg(0x000C, 0x0001);
    SetReg(0x000D, 0xD000);
    SetReg(0x000E, 0x0030);
    SetReg(0x000F, 0x0000);
    SetReg(0x0020, 0x0000);
    SetReg(0x0021, 0x0000);
    SetReg(0x0029, 0x0077);
    SetReg(0x0050, 0x0000);
    SetReg(0x0051, 0xD0EF);
    SetReg(0x0052, 0x0000);
    SetReg(0x0053, 0x013F);
    SetReg(0x0061, 0x0001);
    SetReg(0x006A, 0x0000);
    SetReg(0x0080, 0x0000);
    SetReg(0x0081, 0x0000);
    SetReg(0x0082, 0x005F);
    SetReg(0x0093, 0x0701);
    SetReg(0x0007, 0x0100);
    SetReg(0x0022, 0x0000);
    #else
        #error Graphics controller is not supported.
    #endif
    DelayMs(20);
}

#ifdef USE_TRANSPARENT_COLOR
/*********************************************************************
* Function:  void TransparentColorEnable(GFX_COLOR color)
*
* Overview: Sets current transparent color.
*
* PreCondition: none
*
* Input: color - Color value chosen.
*
* Output: none
*
* Side Effects: none
*
********************************************************************/
void TransparentColorEnable(GFX_COLOR color)
{
    _colorTransparent = color;
    _colorTransparentEnable = TRANSPARENT_COLOR_ENABLE;

}
#endif

/*********************************************************************
* Function: void PutPixel(SHORT x, SHORT y)
*
* PreCondition: none
*
* Input: x,y - pixel coordinates
*
```

```
* Output: none
*
* Side Effects: none
*
* Overview: puts pixel
*
* Note: none
*
********************************************************************/
void PutPixel(SHORT x, SHORT y)
{
    DWORD   address;
    if(_clipRgn)
    {
        if(x < _clipLeft)
            return;
        if(x > _clipRight)
            return;
        if(y < _clipTop)
            return;
        if(y > _clipBottom)
            return;
    }

    #if (DISP_ORIENTATION == 0)
    address = (long)LINE_MEM_PITCH * y + x;

    #else
    y = GetMaxY() - y;
    address = (long)LINE_MEM_PITCH * x + y;
    #endif
    DisplayEnable();
    SetAddress(address);
    WritePixel(_color);
    DisplayDisable();
}

/*********************************************************************
* Function: WORD GetPixel(SHORT x, SHORT y)
*
* PreCondition: none
*
* Input: x,y - pixel coordinates
*
* Output: pixel color
*
* Side Effects: none
*
* Overview: returns pixel color at x,y position
*
* Note: none
*
********************************************************************/
#ifndef __PIC24FJ256GB210__
#ifdef USE_16BIT_PMP

/* */
WORD GetPixel(SHORT x, SHORT y)
{
    DWORD   address;
    WORD    result;
        #if (DISP_ORIENTATION == 0)
    address = (long)LINE_MEM_PITCH * y + x;
        #else
    y = GetMaxY() - y;
    address = (long)LINE_MEM_PITCH * x + y;
        #endif
    DisplayEnable();

    SetAddress(address);

    // Temporary change wait cycles for reading (250ns = 4 cycles)
```

```
        #if defined(__C30__)
    PMMODEbits.WAITM = 4;
        #elif defined(__PIC32MX__)
    PMMODEbits.WAITM = 8;
        #else
            #error Need wait states for the device
        #endif
    DisplaySetData();

    // First RD cycle to move data from GRAM to Read Data Latch
    result = PMDIN1;

    while(PMMODEbits.BUSY);

    // Second RD cycle to get data from Read Data Latch
    result = PMDIN1;

    while(PMMODEbits.BUSY);

    // Disable LCD
    DisplayDisable();

    // Disable PMP
    PMCONbits.PMPEN = 1;

    // Read result
    result = PMDIN1;

    // Restore wait cycles for writing (60ns)
        #if defined(__dsPIC33F__) || defined(__PIC24H__)
    PMMODEbits.WAITM = 2;
        #else
    PMMODEbits.WAITM = 1;
        #endif

    // Enable PMP
    PMCONbits.PMPEN = 1;

    return (result);
}

#else

/* */
WORD GetPixel(SHORT x, SHORT y)
{
    DWORD       address;
    WORD_VAL    result;

        #if (DISP_ORIENTATION == 0)
    address = (long)LINE_MEM_PITCH * y + x;
        #else
    y = GetMaxY() - y;
    address = (long)LINE_MEM_PITCH * x + y;
        #endif
    DisplayEnable();

    SetAddress(address);

    // Temporary change wait cycles for reading (250ns = 4 cycles)
        #if defined(__C30__)
    PMMODEbits.WAITM = 4;
        #elif defined(__PIC32MX__)
    PMMODEbits.WAITM = 8;
        #else
            #error Need wait states for the device
        #endif
    DisplaySetData();

    // First RD cycle to move data from GRAM to Read Data Latch
    result.v[1] = PMDIN1;
    while(PMMODEbits.BUSY);

        #if defined(GFX_USE_DISPLAY_CONTROLLER_ILI9320)
    DelayForSync();
        #endif

    // Second RD cycle to move data from GRAM to Read Data Latch
    result.v[1] = PMDIN1;

    while(PMMODEbits.BUSY);
        #if defined (GFX_USE_DISPLAY_CONTROLLER_ILI9320)
    DelayForSync();
        #endif

    // First RD cycle to get data from Read Data Latch
    // Read previous dummy value
    result.v[1] = PMDIN1;

    while(PMMODEbits.BUSY);
        #if defined (GFX_USE_DISPLAY_CONTROLLER_ILI9320)
    DelayForSync();
        #endif

    // Second RD cycle to get data from Read Data Latch
    // Read MSB
    result.v[1] = PMDIN1;

    while(PMMODEbits.BUSY);
        #if defined (GFX_USE_DISPLAY_CONTROLLER_ILI9320)
    DelayForSync();
        #endif

    // Disable LCD
    DisplayDisable();

    // Disable PMP
    PMCONbits.PMPEN = 1;

    // Read LSB
    result.v[0] = PMDIN1;
        #if defined (GFX_USE_DISPLAY_CONTROLLER_ILI9320)
    DelayForSync();
        #endif

    // Restore wait cycles for writing (60ns)
        #if defined(__dsPIC33F__) || defined(__PIC24H__)
    PMMODEbits.WAITM = 2;
        #else
    PMMODEbits.WAITM = 1;
        #endif

    // Enable PMP
    PMCONbits.PMPEN = 1;

    return (result.Val);
}

#endif
#endif

/*********************************************************************
* Function: WORD Bar(SHORT left, SHORT top, SHORT right, SHORT bottom)
*
* PreCondition: none
*
* Input: left,top - top left corner coordinates,
*        right,bottom - bottom right corner coordinates
*
* Output: For NON-Blocking configuration:
*         - Returns 0 when device is busy and the shape is not yet completely drawn.
*         - Returns 1 when the shape is completely drawn.
*         For Blocking configuration:
```

```
*         - Always return 1.
*
* Side Effects: none
*
* Overview: draws rectangle filled with current color
*
* Note: none
*
********************************************************************/
WORD Bar(SHORT left, SHORT top, SHORT right, SHORT bottom)
{
    DWORD           address;
    register SHORT  x, y;

    #ifndef USE_NONBLOCKING_CONFIG
    while(IsDeviceBusy() != 0);

    /* Ready */
    #else
    if(IsDeviceBusy() != 0)
        return (0);
    #endif
    if(_clipRgn)
    {
        if(left < _clipLeft)
            left = _clipLeft;
        if(right > _clipRight)
            right = _clipRight;
        if(top < _clipTop)
            top = _clipTop;
        if(bottom > _clipBottom)
            bottom = _clipBottom;
    }

    #if (DISP_ORIENTATION == 0)
    address = (DWORD) LINE_MEM_PITCH * top + left;

    DisplayEnable();
    for(y = top; y < bottom + 1; y++)
    {
        SetAddress(address);
        for(x = left; x < right + 1; x++)
        {
            WritePixel(_color);
        }

        address += LINE_MEM_PITCH;
    }

    DisplayDisable();

    #else
    top = GetMaxY() - top;
    bottom = GetMaxY() - bottom;
    address = (DWORD) LINE_MEM_PITCH * left + top;

    DisplayEnable();
    for(y = bottom; y < top + 1; y++)
    {
        SetAddress(address);
        for(x = left; x < right + 1; x++)
        {
            WritePixel(_color);
        }

        address -= 1;
    }

    DisplayDisable();
    #endif
    return (1);
}
```

```
/*********************************************************************
* Function: void ClearDevice(void)
*
* PreCondition: none
*
* Input: none
*
* Output: none
*
* Side Effects: none
*
* Overview: clears screen with current color
*
* Note: none
*
********************************************************************/
void ClearDevice(void)
{
    DWORD   counter;

    DisplayEnable();
    SetAddress(0);
    for(counter = 0; counter < (DWORD) (GetMaxX() + 1) * (GetMaxY() + 1); counter++)
    {
        WritePixel(_color);
    }

    DisplayDisable();
}

#ifndef USE_TRANSPARENT_COLOR

    #ifdef USE_BITMAP_FLASH

/*********************************************************************
* Function: void PutImage1BPP(SHORT left, SHORT top, FLASH_BYTE* image, BYTE stretch)
*
* PreCondition: none
*
* Input: left,top - left top image corner,
*        image - image pointer,
*        stretch - image stretch factor
*
* Output: none
*
* Side Effects: none
*
* Overview: outputs monochrome image starting from left,top coordinates
*
* Note: image must be located in flash
*
********************************************************************/
void PutImage1BPP(SHORT left, SHORT top, FLASH_BYTE *image, BYTE stretch)
{
    register DWORD      address;
    register FLASH_BYTE *flashAddress;
    register FLASH_BYTE *tempFlashAddress;
    BYTE                temp = 0;
    WORD                sizeX, sizeY;
    WORD                x, y;
    BYTE                stretchX, stretchY;
    WORD                pallete[2];
    BYTE                mask;

    #if (DISP_ORIENTATION == 90)
        top = GetMaxY() - top;
    #endif

    // Move pointer to size information
    flashAddress = image + 2;
    // Set start address
    #if (DISP_ORIENTATION == 0)
        address = (long)LINE_MEM_PITCH * top + left;
    #else
        address = (long)LINE_MEM_PITCH * left + top;
    #endif

    // Read image size
    sizeY = *((FLASH_WORD *)flashAddress);
    flashAddress += 2;
    sizeX = *((FLASH_WORD *)flashAddress);
    flashAddress += 2;
    pallete[0] = *((FLASH_WORD *)flashAddress);
    flashAddress += 2;
    pallete[1] = *((FLASH_WORD *)flashAddress);
    flashAddress += 2;

    DisplayEnable();
    for(y = 0; y < sizeY; y++)
    {
        tempFlashAddress = flashAddress;
        for(stretchY = 0; stretchY < stretch; stretchY++)
        {
            flashAddress = tempFlashAddress;
            SetAddress(address);
            mask = 0;
            for(x = 0; x < sizeX; x++)
            {

                // Read 8 pixels from flash
                if(mask == 0)
                {
                    temp = *flashAddress;
                    flashAddress++;
                    mask = 0x80;
                }

                // Set color
                if(mask & temp)
                {
                    SetColor(pallete[1]);
                }
                else
                {
                    SetColor(pallete[0]);
                }

                // Write pixel to screen
                for(stretchX = 0; stretchX < stretch; stretchX++)
                {
                    WritePixel(_color);
                }

                // Shift to the next pixel
                mask >>= 1;
            }

            #if (DISP_ORIENTATION == 0)
                address += LINE_MEM_PITCH;
            #else
                address -= 1;
            #endif
        }
    }

    DisplayDisable();
}

/*********************************************************************
* Function: void PutImage4BPP(SHORT left, SHORT top, FLASH_BYTE* image, BYTE stretch)
*
* PreCondition: none
```

```
*
* Input: left,top - left top image corner, image - image pointer,
*        stretch - image stretch factor
*
* Output: none
*
* Side Effects: none
*
* Overview: outputs 16 color image starting from left,top coordinates
*
* Note: image must be located in flash
*
*********************************************************************/
void PutImage4BPP(SHORT left, SHORT top, FLASH_BYTE *image, BYTE stretch)
{
    register DWORD      address;
    register FLASH_BYTE *flashAddress;
    register FLASH_BYTE *tempFlashAddress;
    WORD                sizeX, sizeY;
    register WORD       x, y;
    BYTE                temp = 0;
    register BYTE       stretchX, stretchY;
    WORD                pallete[16];
    WORD                counter;

    #if (DISP_ORIENTATION == 90)
        top = GetMaxY() - top;
    #endif

    // Move pointer to size information
    flashAddress = image + 2;

    // Set start address
    #if (DISP_ORIENTATION == 0)
        address = (long)LINE_MEM_PITCH * top + left;
    #else
        address = (long)LINE_MEM_PITCH * left + top;
    #endif

    // Read image size
    sizeY = *((FLASH_WORD *)flashAddress);
    flashAddress += 2;
    sizeX = *((FLASH_WORD *)flashAddress);
    flashAddress += 2;

    // Read pallete
    for(counter = 0; counter < 16; counter++)
    {
        pallete[counter] = *((FLASH_WORD *)flashAddress);
        flashAddress += 2;
    }

    DisplayEnable();
    for(y = 0; y < sizeY; y++)
    {
        tempFlashAddress = flashAddress;
        for(stretchY = 0; stretchY < stretch; stretchY++)
        {
            flashAddress = tempFlashAddress;
            SetAddress(address);
            for(x = 0; x < sizeX; x++)
            {

                // Read 2 pixels from flash
                if(x & 0x0001)
                {

                    // second pixel in byte
                    SetColor(pallete[temp >> 4]);
                }
                else
                {
                    temp = *flashAddress;
                    flashAddress++;

                    // first pixel in byte
                    SetColor(pallete[temp & 0x0f]);
                }

                // Write pixel to screen
                for(stretchX = 0; stretchX < stretch; stretchX++)
                {
                    WritePixel(_color);
                }

                // Shift to the next pixel
                //temp >>= 4;
            }

            #if (DISP_ORIENTATION == 0)
                address += LINE_MEM_PITCH;
            #else
                address -= 1;
            #endif
        }
    }

    DisplayDisable();
}

/*********************************************************************
* Function: void PutImage8BPP(SHORT left, SHORT top, FLASH_BYTE* image, BYTE stretch)
*
* PreCondition: none
*
* Input: left,top - left top image corner, image - image pointer,
*        stretch - image stretch factor
*
* Output: none
*
* Side Effects: none
*
* Overview: outputs 256 color image starting from left,top coordinates
*
* Note: image must be located in flash
*
********************************************************************/
void PutImage8BPP(SHORT left, SHORT top, FLASH_BYTE *image, BYTE stretch)
{
    register DWORD      address;
    register FLASH_BYTE *flashAddress;
    register FLASH_BYTE *tempFlashAddress;
    WORD                sizeX, sizeY;
    WORD                x, y;
    BYTE                temp;
    BYTE                stretchX, stretchY;
    WORD                pallete[256];
    WORD                counter;

    #if (DISP_ORIENTATION == 90)
        top = GetMaxY() - top;
    #endif

    // Move pointer to size information
    flashAddress = image + 2;

    // Set start address
            #if (DISP_ORIENTATION == 0)
    address = (long)LINE_MEM_PITCH * top + left;
            #else
    address = (long)LINE_MEM_PITCH * left + top;
            #endif

    // Read image size
    sizeY = *((FLASH_WORD *)flashAddress);
    flashAddress += 2;
    sizeX = *((FLASH_WORD *)flashAddress);
    flashAddress += 2;

    // Read pallete
    for(counter = 0; counter < 256; counter++)
    {
        pallete[counter] = *((FLASH_WORD *)flashAddress);
        flashAddress += 2;
    }

    DisplayEnable();
    for(y = 0; y < sizeY; y++)
    {
        tempFlashAddress = flashAddress;
        for(stretchY = 0; stretchY < stretch; stretchY++)
        {
            flashAddress = tempFlashAddress;
            SetAddress(address);
            for(x = 0; x < sizeX; x++)
            {

                // Read pixels from flash
                temp = *flashAddress;
                flashAddress++;

                // Set color
                SetColor(pallete[temp]);

                // Write pixel to screen
                for(stretchX = 0; stretchX < stretch; stretchX++)
                {
                    WritePixel(_color);
                }
            }

                    #if (DISP_ORIENTATION == 0)
            address += LINE_MEM_PITCH;
                    #else
            address -= 1;
                    #endif
        }
    }

    DisplayDisable();
}

/*********************************************************************
* Function: void PutImage16BPP(SHORT left, SHORT top, FLASH_BYTE* image, BYTE stretch)
*
* PreCondition: none
*
* Input: left,top - left top image corner, image - image pointer,
*        stretch - image stretch factor
*
* Output: none
*
* Side Effects: none
*
* Overview: outputs hicolor image starting from left,top coordinates
*
* Note: image must be located in flash
*
********************************************************************/
void PutImage16BPP(SHORT left, SHORT top, FLASH_BYTE *image, BYTE stretch)
{
    register DWORD      address;
    register FLASH_WORD *flashAddress;
    register FLASH_WORD *tempFlashAddress;
    WORD                sizeX, sizeY;
    register WORD       x, y;
    WORD                temp;
    register BYTE       stretchX, stretchY;

    #if (DISP_ORIENTATION == 90)
        top = GetMaxY() - top;
    #endif

    // Move pointer to size information
    flashAddress = (FLASH_WORD *)image + 1;

    // Set start address
    #if (DISP_ORIENTATION == 0)
        address = (long)LINE_MEM_PITCH * top + left;
    #else
        address = (long)LINE_MEM_PITCH * left + top;
    #endif

    // Read image size
    sizeY = *flashAddress;
    flashAddress++;
    sizeX = *flashAddress;
    flashAddress++;

    DisplayEnable();
    for(y = 0; y < sizeY; y++)
    {
        tempFlashAddress = flashAddress;
        for(stretchY = 0; stretchY < stretch; stretchY++)
        {
            flashAddress = tempFlashAddress;
            SetAddress(address);
            for(x = 0; x < sizeX; x++)
            {

                // Read pixels from flash
                temp = *flashAddress;
                flashAddress++;

                // Set color
                SetColor(temp);

                // Write pixel to screen
                for(stretchX = 0; stretchX < stretch; stretchX++)
                {
                    WritePixel(_color);
                }
            }

            #if (DISP_ORIENTATION == 0)
                address += LINE_MEM_PITCH;
            #else
                address -= 1;
            #endif
        }
    }

    DisplayDisable();
}

    #endif // USE_BITMAP_FLASH
    #ifdef USE_BITMAP_EXTERNAL

/*********************************************************************
* Function: void PutImage1BPPExt(SHORT left, SHORT top, void* image, BYTE stretch)
*
* PreCondition: none
*
* Input: left,top - left top image corner, image - image pointer,
*        stretch - image stretch factor
*
* Output: none
*
```

```
 * Side Effects: none
 *
 * Overview: outputs monochrome image starting from left,top coordinates
 *
 * Note: image must be located in external memory
 *
 *********************************************************************/
void PutImage1BPPExt(SHORT left, SHORT top, void *image, BYTE stretch)
{
    register DWORD  address;
    register DWORD  memOffset;
    BITMAP_HEADER   bmp;
    WORD            pallete[2];
    BYTE            lineBuffer[((GetMaxX() + 1) / 8) + 1];
    BYTE            *pData;
    SHORT           byteWidth;

    BYTE            temp = 0;
    BYTE            mask;
    WORD            sizeX, sizeY;
    WORD            x, y;
    BYTE            stretchX, stretchY;


    #if (DISP_ORIENTATION == 90)
        top = GetMaxY() - top;
    #endif

    // Set start address
    #if (DISP_ORIENTATION == 0)
        address = (long)LINE_MEM_PITCH * top + left;
    #else
        address = (long)LINE_MEM_PITCH * left + top;
    #endif

    // Get image header
    ExternalMemoryCallback(image, 0, sizeof(BITMAP_HEADER), &bmp);

    // Get pallete (2 entries)
    ExternalMemoryCallback(image, sizeof(BITMAP_HEADER), 2 * sizeof(WORD), pallete);

    // Set offset to the image data
    memOffset = sizeof(BITMAP_HEADER) + 2 * sizeof(WORD);

    // Line width in bytes
    byteWidth = bmp.width >> 3;
    if(bmp.width & 0x0007)
        byteWidth++;

    // Get size
    sizeX = bmp.width;
    sizeY = bmp.height;

    for(y = 0; y < sizeY; y++)
    {

        // Get line
        ExternalMemoryCallback(image, memOffset, byteWidth, lineBuffer);
        memOffset += byteWidth;
        DisplayEnable();
        for(stretchY = 0; stretchY < stretch; stretchY++)
        {
            pData = lineBuffer;
            SetAddress(address);
            mask = 0;
            for(x = 0; x < sizeX; x++)
            {

                // Read 8 pixels from flash
                if(mask == 0)
                {
                    temp = *pData++;
                    mask = 0x80;
                }

                // Set color
                if(mask & temp)
                {
                    SetColor(pallete[1]);
                }
                else
                {
                    SetColor(pallete[0]);
                }

                // Write pixel to screen
                for(stretchX = 0; stretchX < stretch; stretchX++)
                {
                    WritePixel(_color);
                }

                // Shift to the next pixel
                mask >>= 1;
            }

            #if (DISP_ORIENTATION == 0)
                address += LINE_MEM_PITCH;
            #else
                address -= 1;
            #endif
        }

        DisplayDisable();
    }
}

/*********************************************************************
* Function: void PutImage4BPPExt(SHORT left, SHORT top, void* image, BYTE stretch)
*
* PreCondition: none
*
* Input: left,top - left top image corner, image - image pointer,
*        stretch - image stretch factor
*
* Output: none
*
* Side Effects: none
*
* Overview: outputs monochrome image starting from left,top coordinates
*
* Note: image must be located in external memory
*
********************************************************************/
void PutImage4BPPExt(SHORT left, SHORT top, void *image, BYTE stretch)
{
    register DWORD  address;
    register DWORD  memOffset;
    BITMAP_HEADER   bmp;
    WORD            pallete[16];
    BYTE            lineBuffer[((GetMaxX() + 1) / 2) + 1];
    BYTE            *pData;
    SHORT           byteWidth;

    BYTE            temp = 0;
    WORD            sizeX, sizeY;
    WORD            x, y;
    BYTE            stretchX, stretchY;

    #if (DISP_ORIENTATION == 90)
        top = GetMaxY() - top;
    #endif

    // Set start address
    #if (DISP_ORIENTATION == 0)
```

```
            address = (long)LINE_MEM_PITCH * top + left;
        #else
            address = (long)LINE_MEM_PITCH * left + top;
        #endif

        // Get image header
        ExternalMemoryCallback(image, 0, sizeof(BITMAP_HEADER), &bmp);

        // Get pallete (16 entries)
        ExternalMemoryCallback(image, sizeof(BITMAP_HEADER), 16 * sizeof(WORD), pallete);

        // Set offset to the image data
        memOffset = sizeof(BITMAP_HEADER) + 16 * sizeof(WORD);

        // Line width in bytes
        byteWidth = bmp.width >> 1;
        if(bmp.width & 0x0001)
            byteWidth++;

        // Get size
        sizeX = bmp.width;
        sizeY = bmp.height;

        for(y = 0; y < sizeY; y++)
        {

            // Get line
            ExternalMemoryCallback(image, memOffset, byteWidth, lineBuffer);
            memOffset += byteWidth;
            DisplayEnable();
            for(stretchY = 0; stretchY < stretch; stretchY++)
            {
                pData = lineBuffer;
                SetAddress(address);

                for(x = 0; x < sizeX; x++)
                {

                    // Read 2 pixels from flash
                    if(x & 0x0001)
                    {

                        // second pixel in byte
                        SetColor(pallete[temp >> 4]);
                    }
                    else
                    {
                        temp = *pData++;

                        // first pixel in byte
                        SetColor(pallete[temp & 0x0f]);
                    }

                    // Write pixel to screen
                    for(stretchX = 0; stretchX < stretch; stretchX++)
                    {
                        WritePixel(_color);
                    }
                }

                #if (DISP_ORIENTATION == 0)
                    address += LINE_MEM_PITCH;
                #else
                    address -= 1;
                #endif
            }

            DisplayDisable();
        }
    }

  /*********************************************************************
```

```
* Function: void PutImage8BPPExt(SHORT left, SHORT top, void* image, BYTE stretch)
*
* PreCondition: none
*
* Input: left,top - left top image corner, image - image pointer,
*        stretch - image stretch factor
*
* Output: none
*
* Side Effects: none
*
* Overview: outputs monochrome image starting from left,top coordinates
*
* Note: image must be located in external memory
*
********************************************************************/
void PutImage8BPPExt(SHORT left, SHORT top, void *image, BYTE stretch)
{
    register DWORD  address;
    register DWORD  memOffset;
    BITMAP_HEADER   bmp;
    WORD            pallete[256];
    BYTE            lineBuffer[(GetMaxX() + 1)];
    BYTE            *pData;

    BYTE            temp;
    WORD            sizeX, sizeY;
    WORD            x, y;
    BYTE            stretchX, stretchY;

    #if (DISP_ORIENTATION == 90)
        top = GetMaxY() - top;
    #endif

    // Set start address
    #if (DISP_ORIENTATION == 0)
        address = (long)LINE_MEM_PITCH * top + left;
    #else
        address = (long)LINE_MEM_PITCH * left + top;
    #endif

    // Get image header
    ExternalMemoryCallback(image, 0, sizeof(BITMAP_HEADER), &bmp);

    // Get pallete (256 entries)
    ExternalMemoryCallback(image, sizeof(BITMAP_HEADER), 256 * sizeof(WORD), pallete);

    // Set offset to the image data
    memOffset = sizeof(BITMAP_HEADER) + 256 * sizeof(WORD);

    // Get size
    sizeX = bmp.width;
    sizeY = bmp.height;

    for(y = 0; y < sizeY; y++)
    {

        // Get line
        ExternalMemoryCallback(image, memOffset, sizeX, lineBuffer);
        memOffset += sizeX;
        DisplayEnable();
        for(stretchY = 0; stretchY < stretch; stretchY++)
        {
            pData = lineBuffer;
            SetAddress(address);

            for(x = 0; x < sizeX; x++)
            {
                temp = *pData++;
                SetColor(pallete[temp]);

                // Write pixel to screen
                for(stretchX = 0; stretchX < stretch; stretchX++)
                {
                    WritePixel(_color);
                }
            }

            #if (DISP_ORIENTATION == 0)
                address += LINE_MEM_PITCH;
            #else
                address -= 1;
            #endif
        }

        DisplayDisable();
    }
}

/*********************************************************************
* Function: void PutImage16BPPExt(SHORT left, SHORT top, void* image, BYTE stretch)
*
* PreCondition: none
*
* Input: left,top - left top image corner, image - image pointer,
*        stretch - image stretch factor
*
* Output: none
*
* Side Effects: none
*
* Overview: outputs monochrome image starting from left,top coordinates
*
* Note: image must be located in external memory
*
********************************************************************/
void PutImage16BPPExt(SHORT left, SHORT top, void *image, BYTE stretch)
{
    register DWORD  address;
    register DWORD  memOffset;
    BITMAP_HEADER   bmp;
    WORD            lineBuffer[(GetMaxX() + 1)];
    WORD            *pData;
    WORD            byteWidth;

    WORD            temp;
    WORD            sizeX, sizeY;
    WORD            x, y;
    BYTE            stretchX, stretchY;

    #if (DISP_ORIENTATION == 90)
        top = GetMaxY() - top;
    #endif

    // Set start address
    #if (DISP_ORIENTATION == 0)
        address = (long)LINE_MEM_PITCH * top + left;
    #else
        address = (long)LINE_MEM_PITCH * left + top;
    #endif

    // Get image header
    ExternalMemoryCallback(image, 0, sizeof(BITMAP_HEADER), &bmp);

    // Set offset to the image data
    memOffset = sizeof(BITMAP_HEADER);

    // Get size
    sizeX = bmp.width;
    sizeY = bmp.height;

    byteWidth = sizeX << 1;

    for(y = 0; y < sizeY; y++)
    {
        // Get line
        ExternalMemoryCallback(image, memOffset, byteWidth, lineBuffer);
        memOffset += byteWidth;
        DisplayEnable();
        for(stretchY = 0; stretchY < stretch; stretchY++)
        {
            pData = lineBuffer;
            SetAddress(address);

            for(x = 0; x < sizeX; x++)
            {
                temp = *pData++;
                SetColor(temp);

                // Write pixel to screen
                for(stretchX = 0; stretchX < stretch; stretchX++)
                {
                    WritePixel(_color);
                }
            }

            #if (DISP_ORIENTATION == 0)
                address += LINE_MEM_PITCH;
            #else
                address -= 1;
            #endif
        }

        DisplayDisable();
    }
}

    #endif //USE_BITMAP_EXTERNAL
#endif // #ifndef USE_TRANSPARENT_COLOR


/*********************************************************************
* Function: SetClipRgn(left, top, right, bottom)
*
* Overview: Sets clipping region.
*
* PreCondition: none
*
* Input: left - Defines the left clipping region border.
*        top - Defines the top clipping region border.
*        right - Defines the right clipping region border.
*        bottom - Defines the bottom clipping region border.
*
* Output: none
*
* Side Effects: none
*
********************************************************************/
void SetClipRgn(SHORT left, SHORT top, SHORT right, SHORT bottom)
{
    _clipLeft=left;
    _clipTop=top;
    _clipRight=right;
    _clipBottom=bottom;

}

/*********************************************************************
* Function: SetClip(control)
*
* Overview: Enables/disables clipping.
*
* PreCondition: none
*
* Input: control - Enables or disables the clipping.
*           - 0: Disable clipping
*           - 1: Enable clipping
*
* Output: none
*
* Side Effects: none
*
********************************************************************/
void SetClip(BYTE control)
{
    _clipRgn=control;
}

/*********************************************************************
* Function: IsDeviceBusy()
*
* Overview: Returns non-zero if LCD controller is busy
*           (previous drawing operation is not completed).
*
* PreCondition: none
*
* Input: none
*
* Output: Busy status.
*
* Side Effects: none
*
********************************************************************/
WORD IsDeviceBusy(void)
{
    return (0);
}

#endif // #if defined (GFX_USE_DISPLAY_CONTROLLER_S6D0129)  || defined
(GFX_USE_DISPLAY_CONTROLLER_S6D0139) ||  ...
```

14.3.2 drvTFT001.h

This is file drvTFT001.h.

Body Source

```
/*****************************************************************************
 *  Module for Microchip Graphics Library
 *  LCD controller driver
 *  LG LGDP4531
 *  Renesas R61505
 *  Renesas R61580
 *  Samsung S6D0129
 *  Samsung S6D0139
 *  Orise Tech. SPFD5408
 *  Ilitek ILI9320
 *****************************************************************************
 * FileName:        drvTFT001.h
 * Processor:       PIC24, PIC32
 * Compiler:        MPLAB C30, MPLAB C32
 * Company:         Microchip Technology Incorporated
 *
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 *
 * Date         Comment
 *~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
 * 01/29/08
 * 01/31/08     combined portrait and landscape, PIC32 support
 * 06/26/09     16-bit PMP support
 * 03/11/11     Changes for Graphics Library Version 3.00
 *****************************************************************************/
#ifndef _DRVTFT001_H
    #define _DRVTFT001_H

    #include "HardwareProfile.h"
    #include "GraphicsConfig.h"
    #include "GenericTypeDefs.h"

/*********************************************************************
* Error Checking
*********************************************************************/
    #ifndef DISP_HOR_RESOLUTION
        #error DISP_HOR_RESOLUTION must be defined in HardwareProfile.h
    #endif
    #ifndef DISP_VER_RESOLUTION
        #error DISP_VER_RESOLUTION must be defined in HardwareProfile.h
    #endif
    #ifndef DISP_ORIENTATION
        #error DISP_ORIENTATION must be defined in HardwareProfile.h
    #endif
    #ifndef COLOR_DEPTH
        #error COLOR_DEPTH must be defined in GraphicsConfig.h
    #endif

/*********************************************************************
* Overview: Horizontal and vertical screen size.
*********************************************************************/
    #if (DISP_HOR_RESOLUTION != 240)
        #error This driver doesn't supports this resolution. Horisontal resolution must be
240 pixels.
    #endif
    #if (DISP_VER_RESOLUTION != 320)
        #error This driver doesn't supports this resolution. Vertical resolution must be
320 pixels.
    #endif

/*********************************************************************
* Overview: Display orientation.
*********************************************************************/
    #if (DISP_ORIENTATION != 0) && (DISP_ORIENTATION != 90)
        #error This driver doesn't support this orientation.
    #endif

/*********************************************************************
* Overview: Color depth.
*********************************************************************/
    #if (COLOR_DEPTH != 16)
        #error This driver support 16 BPP color depth only.
    #endif

/*********************************************************************
```

```
* Function:  void SetReg(WORD index, WORD value);
*
* PreCondition: none
*
* Input: index - register number
*        value - data to be written to the register
*
* Output: none
*
* Side Effects: none
*
* Overview: Writes the given value to the register defined by index.
*
* Note: none
*
********************************************************************/
void            SetReg(WORD index, WORD value);

/*********************************************************************
* Function:  void DisplayBrightness(WORD level)
*
* PreCondition: none
*
* Input: level - Brightness level. Valid values are 0 to 100.
*           - 0: brightness level is zero or display is turned off
*           - 1: brightness level is maximum
*
* Output: none
*
* Side Effects: none
*
* Overview: Sets the brightness of the display.
*
* Note: none
*
********************************************************************/
void            DisplayBrightness(WORD level);


// Memory pitch for line
    #define LINE_MEM_PITCH  0x100

/*********************************************************************
* Function:  void ResetDevice()
*
* Overview: Initializes LCD module.
*
* PreCondition: none
*
* Input: none
*
* Output: none
*
* Side Effects: none
*
********************************************************************/
void    ResetDevice(void);

/*********************************************************************
* Macros: SetPalette(colorNum, color)
*
* Overview:  Sets palette register.
*
* PreCondition: none
*
* Input: colorNum - Register number.
*        color - Color.
*
* Output: none
*
* Side Effects: none
*
```

```
********************************************************************/
    #define SetPalette(colorNum, color)

#endif // _DRVTFT001_H
```

14.3.3 HIT1270.c

This is file HIT1270.c.

Body Source

```
/*****************************************************************************
 *  Module for Microchip Graphics Library
 *  Densitron HIT1270 controller driver
 *  Landscape orientation
 *****************************************************************************
 * FileName:        HIT1270.c
 * Dependencies:    Graphics.h
 * Processor:       PIC24
 * Compiler:        MPLAB C30
 * Linker:          MPLAB LINK30
 * Company:         Microchip Technology Incorporated
 *
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 * OR OTHER SIMILAR COSTS.
 *
 * Date             Comment
 *~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
 * 11/12/07         Version 1.0 release
 * 04/12/11         Support for Graphics Library Version 3.00
  *****************************************************************************/
#include "HardwareProfile.h"

#if defined(GFX_USE_DISPLAY_CONTROLLER_HIT1270)

#include "Compiler.h"
#include "GenericTypeDefs.h"
#include "TimeDelay.h"
#include "Graphics/DisplayDriver.h"
#include "Graphics/HIT1270.h"
#include "Graphics/Primitive.h"


#if defined (USE_GFX_PMP)
    #include "Graphics/gfxpmp.h"
#elif defined (USE_GFX_EPMP)
    #include "Graphics/gfxepmp.h"
```

```
#endif

// Unsupported Graphics Library Features
#ifdef USE_TRANSPARENT_COLOR
    #warning "This driver does not support the transparent feature on PutImage(). Build
will use the PutImage() functions defined in the Primitive.c"
#endif

#define SETCOLOR_LOWBYTE(color) (((WORD_VAL) color).v[0] & 0x1c)
#define SETCOLOR_HIBYTE(color)  (((WORD_VAL) color).v[1] & 0x73)

// Color
GFX_COLOR   _color;
#ifdef USE_TRANSPARENT_COLOR
GFX_COLOR   _colorTransparent;
SHORT       _colorTransparentEnable;
#endif

// Clipping region control
SHORT       _clipRgn;

// Clipping region borders
SHORT       _clipLeft;
SHORT       _clipTop;
SHORT       _clipRight;
SHORT       _clipBottom;

////////////////////// LOCAL FUNCTIONS PROTOTYPES ////////////////////////////
#ifndef USE_TRANSPARENT_COLOR
void        PutImage1BPP(SHORT left, SHORT top, FLASH_BYTE *image, BYTE stretch);
void        PutImage4BPP(SHORT left, SHORT top, FLASH_BYTE *image, BYTE stretch);
void        PutImage8BPP(SHORT left, SHORT top, FLASH_BYTE *image, BYTE stretch);
void        PutImage16BPP(SHORT left, SHORT top, FLASH_BYTE *image, BYTE stretch);

void        PutImage1BPPExt(SHORT left, SHORT top, void *image, BYTE stretch);
void        PutImage4BPPExt(SHORT left, SHORT top, void *image, BYTE stretch);
void        PutImage8BPPExt(SHORT left, SHORT top, void *image, BYTE stretch);
void        PutImage16BPPExt(SHORT left, SHORT top, void *image, BYTE stretch);
#endif

/*********************************************************************
* Function:  SetAddress(addr2,addr1,addr0)
*
* PreCondition: none
*
* Input: addr0,addr1,addr2 - address bytes
*
* Output: none
*
* Side Effects: none
*
* Overview: writes S6D0129 address pointer
*
* Note: none
*
********************************************************************/
inline void SetAddress(DWORD address)
{
    DisplaySetCommand();
    DeviceWrite(SET_DATA_POINTER);
    DisplaySetData();
    DeviceWrite(((DWORD_VAL)address).v[0]);
    DeviceWrite(((DWORD_VAL)address).v[1]);
    DeviceWrite(((DWORD_VAL)address).v[2]);
}

/*********************************************************************
* Function:  void ResetDevice()
*
* PreCondition: none
*
* Input: none
```

```
*
* Output: none
*
* Side Effects: none
*
* Overview: resets LCD, initializes PMP
*
* Note: none
*
********************************************************************/
void ResetDevice(void)
{
    WORD counter;

    // Initialize the device
    DriverInterfaceInit();

    // Enable LCD
    DisplayEnable();

    DelayMs(10);

    // Clear text layer
    SetAddress(0);
    for(counter = 0; counter < 0x4b0; counter++)
    {
        DeviceWrite(0x07);
        DeviceWrite(0x07);
    }

    // Disable LCD
    DisplayDisable();

    DelayMs(20);
}

#ifdef USE_TRANSPARENT_COLOR
/*********************************************************************
* Function:  void TransparentColorEnable(GFX_COLOR color)
*
* Overview: Sets current transparent color.
*
* PreCondition: none
*
* Input: color - Color value chosen.
*
* Output: none
*
* Side Effects: none
*
********************************************************************/
void TransparentColorEnable(GFX_COLOR color)
{
    _colorTransparent = color;
    _colorTransparentEnable = TRANSPARENT_COLOR_ENABLE;

}
#endif

/*********************************************************************
* Function: void PutPixel(SHORT x, SHORT y)
*
* PreCondition: none
*
* Input: x,y - pixel coordinates
*
* Output: none
*
* Side Effects: none
*
* Overview: puts pixel
*
```

```
* Note: none
*
********************************************************************/
void PutPixel(SHORT x, SHORT y)
{
    DWORD   address;
    if(_clipRgn)
    {
        if(x < _clipLeft)
            return;
        if(x > _clipRight)
            return;
        if(y < _clipTop)
            return;
        if(y > _clipBottom)
            return;
    }

    DisplayEnable();
    address = BUF_MEM_OFFSET + (long)LINE_MEM_PITCH * y + x;
    SetAddress(address);
    DeviceWrite(SETCOLOR_LOWBYTE(_color));
    DeviceWrite(SETCOLOR_HIBYTE(_color));
    DisplayDisable();
}

/*********************************************************************
* Function: SetClipRgn(left, top, right, bottom)
*
* Overview: Sets clipping region.
*
* PreCondition: none
*
* Input: left - Defines the left clipping region border.
*        top - Defines the top clipping region border.
*        right - Defines the right clipping region border.
*        bottom - Defines the bottom clipping region border.
*
* Output: none
*
* Side Effects: none
*
********************************************************************/
void SetClipRgn(SHORT left, SHORT top, SHORT right, SHORT bottom)
{
    _clipLeft=left;
    _clipTop=top;
    _clipRight=right;
    _clipBottom=bottom;

}

/*********************************************************************
* Function: SetClip(control)
*
* Overview: Enables/disables clipping.
*
* PreCondition: none
*
* Input: control - Enables or disables the clipping.
*           - 0: Disable clipping
*           - 1: Enable clipping
*
* Output: none
*
* Side Effects: none
*
********************************************************************/
void SetClip(BYTE control)
{
    _clipRgn=control;
}
```

```
/*********************************************************************
* Function: IsDeviceBusy()
*
* Overview: Returns non-zero if LCD controller is busy
*           (previous drawing operation is not completed).
*
* PreCondition: none
*
* Input: none
*
* Output: Busy status.
*
* Side Effects: none
*
********************************************************************/
WORD IsDeviceBusy(void)
{
    return (0);
}

/*********************************************************************
* Function: WORD Bar(SHORT left, SHORT top, SHORT right, SHORT bottom)
*
* PreCondition: none
*
* Input: left,top - top left corner coordinates,
*        right,bottom - bottom right corner coordinates
*
* Output: For NON-Blocking configuration:
*         - Returns 0 when device is busy and the shape is not yet completely drawn.
*         - Returns 1 when the shape is completely drawn.
*         For Blocking configuration:
*         - Always return 1.
*
* Side Effects: none
*
* Overview: draws rectangle filled with current color
*
* Note: none
*
********************************************************************/
WORD Bar(SHORT left, SHORT top, SHORT right, SHORT bottom)
{
    DWORD       address;
    register SHORT  x, y;

    #ifndef USE_NONBLOCKING_CONFIG
    while(IsDeviceBusy() != 0);

    /* Ready */
    #else
    if(IsDeviceBusy() != 0)
        return (0);
    #endif
    if(_clipRgn)
    {
        if(left < _clipLeft)
            left = _clipLeft;
        if(right > _clipRight)
            right = _clipRight;
        if(top < _clipTop)
            top = _clipTop;
        if(bottom > _clipBottom)
            bottom = _clipBottom;
    }

    address = BUF_MEM_OFFSET + (DWORD) LINE_MEM_PITCH * top + left;

    DisplayEnable();

    for(y = top; y < bottom + 1; y++)
    {
        SetAddress(address);
        for(x = left; x < right + 1; x++)
        {
            DeviceWrite(SETCOLOR_HIBYTE(_color));
            DeviceWrite(SETCOLOR_LOWBYTE(_color));
        }

        address += LINE_MEM_PITCH;
    }

    DisplayDisable();
    return (1);
}

/*********************************************************************
* Function: void ClearDevice(void)
*
* PreCondition: none
*
* Input: none
*
* Output: none
*
* Side Effects: none
*
* Overview: clears screen with current color
*
* Note: none
*
********************************************************************/
void ClearDevice(void)
{
    DWORD   counter;

    DisplayEnable();
    SetAddress(0x018000);
    for(counter = 0; counter < (DWORD) (GetMaxX() + 1) * (GetMaxY() + 1); counter++)
    {
        DeviceWrite(SETCOLOR_HIBYTE(_color));
        DeviceWrite(SETCOLOR_LOWBYTE(_color));
    }

    DisplayDisable();
    MoveTo(0, 0);
}

#ifndef USE_TRANSPARENT_COLOR

#ifdef USE_BITMAP_FLASH

/*********************************************************************
* Function: void PutImage1BPP(SHORT left, SHORT top, FLASH_BYTE* image, BYTE stretch)
*
* PreCondition: none
*
* Input: left,top - left top image corner, image - image pointer,
*        stretch - image stretch factor
*
* Output: none
*
* Side Effects: none
*
* Overview: outputs monochrome image starting from left,top coordinates
*
* Note: image must be located in flash
*
********************************************************************/
void PutImage1BPP(SHORT left, SHORT top, FLASH_BYTE *image, BYTE stretch)
{
    register FLASH_BYTE *flashAddress;
    register FLASH_BYTE *tempFlashAddress;
    register DWORD  address;
    BYTE                temp;
    register WORD       sizeX, sizeY;
    WORD                x, y;
    register BYTE       stretchX, stretchY;
    WORD                pallete[2];
    BYTE                mask;

    // Move pointer to size information
    flashAddress = image + 2;

    // Set start address
    address = BUF_MEM_OFFSET + (long)LINE_MEM_PITCH * top + left;

    // Read image size
    sizeY = *((FLASH_WORD *)flashAddress);
    flashAddress += 2;
    sizeX = *((FLASH_WORD *)flashAddress);
    flashAddress += 2;
    pallete[0] = *((FLASH_WORD *)flashAddress);
    flashAddress += 2;
    pallete[1] = *((FLASH_WORD *)flashAddress);
    flashAddress += 2;

    for(y = 0; y < sizeY; y++)
    {
        tempFlashAddress = flashAddress;
        DisplayEnable();
        for(stretchY = 0; stretchY < stretch; stretchY++)
        {
            flashAddress = tempFlashAddress;
            SetAddress(address);
            mask = 0;
            for(x = 0; x < sizeX; x++)
            {

                // Read 8 pixels from flash
                if(mask == 0)
                {
                    temp = *flashAddress;
                    flashAddress++;
                    mask = 0x80;
                }

                // Set color
                if(mask & temp)
                {
                    SetColor(pallete[1]);
                }
                else
                {
                    SetColor(pallete[0]);
                }

                // Write pixel to screen
                for(stretchX = 0; stretchX < stretch; stretchX++)
                {
                    DeviceWrite(SETCOLOR_HIBYTE(_color));
                    DeviceWrite(SETCOLOR_LOWBYTE(_color));
                }

                // Shift to the next pixel
                mask >>= 1;
            }

            address += LINE_MEM_PITCH;
        }
    }

    DisplayDisable();
}
```

```
/*********************************************************************
* Function: void PutImage4BPP(SHORT left, SHORT top, FLASH_BYTE* image, BYTE stretch)
*
* PreCondition: none
*
* Input: left,top - left top image corner, image - image pointer,
*        stretch - image stretch factor
*
* Output: none
*
* Side Effects: none
*
* Overview: outputs 16 color image starting from left,top coordinates
*
* Note: image must be located in flash
*
********************************************************************/
void PutImage4BPP(SHORT left, SHORT top, FLASH_BYTE *image, BYTE stretch)
{
    register DWORD  address;
    register FLASH_BYTE *flashAddress;
    register FLASH_BYTE *tempFlashAddress;
    WORD                sizeX, sizeY;
    register WORD       x, y;
    BYTE                temp;
    register BYTE       stretchX, stretchY;
    WORD                pallete[16];
    WORD                counter;

    // Move pointer to size information
    flashAddress = image + 2;

    // Set start address
    address = BUF_MEM_OFFSET + (long)LINE_MEM_PITCH * top + left;

    // Read image size
    sizeY = *((FLASH_WORD *)flashAddress);
    flashAddress += 2;
    sizeX = *((FLASH_WORD *)flashAddress);
    flashAddress += 2;

    // Read pallete
    for(counter = 0; counter < 16; counter++)
    {
        pallete[counter] = *((FLASH_WORD *)flashAddress);
        flashAddress += 2;
    }


    for(y = 0; y < sizeY; y++)
    {
        tempFlashAddress = flashAddress;
        for(stretchY = 0; stretchY < stretch; stretchY++)
        {
            DisplayEnable();
            flashAddress = tempFlashAddress;
            SetAddress(address);
            for(x = 0; x < sizeX; x++)
            {

                // Read 2 pixels from flash
                if((x & 0x0001) == 0)
                {
                    temp = *flashAddress;
                    flashAddress++;
                }

                // Set color
                SetColor(pallete[temp & 0x0f]);

                // Write pixel to screen
                for(stretchX = 0; stretchX < stretch; stretchX++)
                {
                    DeviceWrite(SETCOLOR_HIBYTE(_color));
                    DeviceWrite(SETCOLOR_LOWBYTE(_color));
                }

                // Shift to the next pixel
                temp >>= 4;
            }

            address += LINE_MEM_PITCH;
            DisplayDisable();
        }
    }


}

/*********************************************************************
* Function: void PutImage8BPP(SHORT left, SHORT top, FLASH_BYTE* image, BYTE stretch)
*
* PreCondition: none
*
* Input: left,top - left top image corner, image - image pointer,
*        stretch - image stretch factor
*
* Output: none
*
* Side Effects: none
*
* Overview: outputs 256 color image starting from left,top coordinates
*
* Note: image must be located in flash
*
********************************************************************/
void PutImage8BPP(SHORT left, SHORT top, FLASH_BYTE *image, BYTE stretch)
{
    register DWORD  address;
    register FLASH_BYTE *flashAddress;
    register FLASH_BYTE *tempFlashAddress;
    WORD                sizeX, sizeY;
    register WORD       x, y;
    BYTE                temp;
    register BYTE       stretchX, stretchY;
    WORD                pallete[256];
    WORD                counter;

    // Move pointer to size information
    flashAddress = image + 2;

    // Set start address
    address = BUF_MEM_OFFSET + (long)LINE_MEM_PITCH * top + left;

    // Read image size
    sizeY = *((FLASH_WORD *)flashAddress);
    flashAddress += 2;
    sizeX = *((FLASH_WORD *)flashAddress);
    flashAddress += 2;

    // Read pallete
    for(counter = 0; counter < 256; counter++)
    {
        pallete[counter] = *((FLASH_WORD *)flashAddress);
        flashAddress += 2;
    }

    DisplayEnable();
    for(y = 0; y < sizeY; y++)
    {
        tempFlashAddress = flashAddress;
        for(stretchY = 0; stretchY < stretch; stretchY++)
        {
            flashAddress = tempFlashAddress;
            SetAddress(address);
            for(x = 0; x < sizeX; x++)
            {

                // Read pixels from flash
                temp = *flashAddress;
                flashAddress++;

                // Set color
                SetColor(pallete[temp]);

                // Write pixel to screen
                for(stretchX = 0; stretchX < stretch; stretchX++)
                {
                    DeviceWrite(SETCOLOR_HIBYTE(_color));
                    DeviceWrite(SETCOLOR_LOWBYTE(_color));

                }
            }

            address += LINE_MEM_PITCH;
        }
    }

    DisplayDisable();
}

/*********************************************************************
* Function: void PutImage16BPP(SHORT left, SHORT top, FLASH_BYTE* image, BYTE stretch)
*
* PreCondition: none
*
* Input: left,top - left top image corner, image - image pointer,
*        stretch - image stretch factor
*
* Output: none
*
* Side Effects: none
*
* Overview: outputs hicolor image starting from left,top coordinates
*
* Note: image must be located in flash
*
********************************************************************/
void PutImage16BPP(SHORT left, SHORT top, FLASH_BYTE *image, BYTE stretch)
{
    register DWORD      address;
    register FLASH_WORD *flashAddress;
    register FLASH_WORD *tempFlashAddress;
    WORD                sizeX, sizeY;
    register WORD       x, y;
    WORD                temp;
    register BYTE       stretchX, stretchY;

    // Move pointer to size information
    flashAddress = (FLASH_WORD *)image + 1;

    // Set start address
    address = BUF_MEM_OFFSET + (long)LINE_MEM_PITCH * top + left;

    // Read image size
    sizeY = *flashAddress;
    flashAddress++;
    sizeX = *flashAddress;
    flashAddress++;

    DisplayEnable();
    for(y = 0; y < sizeY; y++)
    {
        tempFlashAddress = flashAddress;
        for(stretchY = 0; stretchY < stretch; stretchY++)
        {
            flashAddress = tempFlashAddress;
            SetAddress(address);
            for(x = 0; x < sizeX; x++)
            {

                // Read pixels from flash
                temp = *flashAddress;
                flashAddress++;

                // Set color
                SetColor(temp);

                // Write pixel to screen
                for(stretchX = 0; stretchX < stretch; stretchX++)
                {
                    DeviceWrite(SETCOLOR_HIBYTE(_color));
                    DeviceWrite(SETCOLOR_LOWBYTE(_color));
                }
            }

            address += LINE_MEM_PITCH;
        }
    }

    DisplayDisable();
}

#endif //USE_BITMAP_FLASH
#ifdef USE_BITMAP_EXTERNAL

/*********************************************************************
* Function: void PutImage1BPPExt(SHORT left, SHORT top, void* image, BYTE stretch)
*
* PreCondition: none
*
* Input: left,top - left top image corner, image - image pointer,
*        stretch - image stretch factor
*
* Output: none
*
* Side Effects: none
*
* Overview: outputs monochrome image starting from left,top coordinates
*
* Note: image must be located in flash
*
********************************************************************/
void PutImage1BPPExt(SHORT left, SHORT top, void *image, BYTE stretch)
{
    register DWORD      address;
    register DWORD      memOffset;
    BITMAP_HEADER       bmp;
    WORD                pallete[2];
    BYTE                lineBuffer[320 / 8];
    BYTE                *pData;
    SHORT               byteWidth;

    BYTE                temp;
    BYTE                mask;
    WORD                sizeX, sizeY;
    WORD                x, y;
    BYTE                stretchX, stretchY;

    // Set start address
    address = BUF_MEM_OFFSET + (long)LINE_MEM_PITCH * top + left;

    // Get image header
    ExternalMemoryCallback(image, 0, sizeof(BITMAP_HEADER), &bmp);

    // Get pallete (2 entries)
    ExternalMemoryCallback(image, sizeof(BITMAP_HEADER), 2 * sizeof(WORD), pallete);
    // Set offset to the image data
    memOffset = sizeof(BITMAP_HEADER) + 2 * sizeof(WORD);

    // Line width in bytes
    byteWidth = bmp.width >> 3;
    if(bmp.width & 0x0007)
        byteWidth++;

    // Get size
    sizeX = bmp.width;
    sizeY = bmp.height;

    DisplayEnable();
    for(y = 0; y < sizeY; y++)
    {

        // Get line
        ExternalMemoryCallback(image, memOffset, byteWidth, lineBuffer);
        memOffset += byteWidth;

        for(stretchY = 0; stretchY < stretch; stretchY++)
        {
            pData = lineBuffer;
            SetAddress(address);
            mask = 0;
            for(x = 0; x < sizeX; x++)
            {

                // Read 8 pixels from flash
                if(mask == 0)
                {
                    temp = *pData++;
                    mask = 0x80;
                }

                // Set color
                if(mask & temp)
                {
                    SetColor(pallete[1]);
                }
                else
                {
                    SetColor(pallete[0]);
                }

                // Write pixel to screen
                for(stretchX = 0; stretchX < stretch; stretchX++)
                {
                    DeviceWrite(SETCOLOR_HIBYTE(_color));
                    DeviceWrite(SETCOLOR_LOWBYTE(_color));
                }

                // Shift to the next pixel
                mask >>= 1;
            }

            address += LINE_MEM_PITCH;
        }
    }

    DisplayDisable();
}

/*********************************************************************
* Function: void PutImage4BPPExt(SHORT left, SHORT top, void* image, BYTE stretch)
*
* PreCondition: none
*
* Input: left,top - left top image corner, image - image pointer,
*        stretch - image stretch factor
*
* Output: none
```

```
*
* Side Effects: none
*
* Overview: outputs monochrome image starting from left,top coordinates
*
* Note: image must be located in flash
*
********************************************************************/
void PutImage4BPPExt(SHORT left, SHORT top, void *image, BYTE stretch)
{
    register DWORD      address;
    register DWORD      memOffset;
    BITMAP_HEADER       bmp;
    WORD                pallete[16];
    BYTE                lineBuffer[320 / 2];
    BYTE                *pData;
    SHORT               byteWidth;

    BYTE                temp;
    WORD                sizeX, sizeY;
    WORD                x, y;
    BYTE                stretchX, stretchY;

    // Set start address
    address = BUF_MEM_OFFSET + (long)LINE_MEM_PITCH * top + left;

    // Get image header
    ExternalMemoryCallback(image, 0, sizeof(BITMAP_HEADER), &bmp);

    // Get pallete (16 entries)
    ExternalMemoryCallback(image, sizeof(BITMAP_HEADER), 16 * sizeof(WORD), pallete);

    // Set offset to the image data
    memOffset = sizeof(BITMAP_HEADER) + 16 * sizeof(WORD);

    // Line width in bytes
    byteWidth = bmp.width >> 1;
    if(bmp.width & 0x0001)
        byteWidth++;

    // Get size
    sizeX = bmp.width;
    sizeY = bmp.height;

    for(y = 0; y < sizeY; y++)
    {

        // Get line
        ExternalMemoryCallback(image, memOffset, byteWidth, lineBuffer);
        memOffset += byteWidth;
        DisplayEnable();
        for(stretchY = 0; stretchY < stretch; stretchY++)
        {
            pData = lineBuffer;
            SetAddress(address);

            for(x = 0; x < sizeX; x++)
            {

                // Read 2 pixels from flash
                if(x & 0x0001)
                {

                    // second pixel in byte
                    SetColor(pallete[temp & 0x0f]);
                }
                else
                {
                    temp = *pData++;

                    // first pixel in byte
                    SetColor(pallete[temp >> 4]);
                }

                // Write pixel to screen
                for(stretchX = 0; stretchX < stretch; stretchX++)
                {
                    DeviceWrite(SETCOLOR_HIBYTE(_color));
                    DeviceWrite(SETCOLOR_LOWBYTE(_color));
                }
            }

            address += LINE_MEM_PITCH;
        }

        DisplayDisable();
    }
}

/*********************************************************************
* Function: void PutImage8BPPExt(SHORT left, SHORT top, void* image, BYTE stretch)
*
* PreCondition: none
*
* Input: left,top - left top image corner, image - image pointer,
*        stretch - image stretch factor
*
* Output: none
*
* Side Effects: none
*
* Overview: outputs monochrome image starting from left,top coordinates
*
* Note: image must be located in flash
*
********************************************************************/
void PutImage8BPPExt(SHORT left, SHORT top, void *image, BYTE stretch)
{
    register DWORD      address;
    register DWORD      memOffset;
    BITMAP_HEADER       bmp;
    WORD                pallete[256];
    BYTE                lineBuffer[320];
    BYTE                *pData;

    BYTE                temp;
    WORD                sizeX, sizeY;
    WORD                x, y;
    BYTE                stretchX, stretchY;

    // Set start address
    address = BUF_MEM_OFFSET + (long)LINE_MEM_PITCH * top + left;

    // Get image header
    ExternalMemoryCallback(image, 0, sizeof(BITMAP_HEADER), &bmp);

    // Get pallete (256 entries)
    ExternalMemoryCallback(image, sizeof(BITMAP_HEADER), 256 * sizeof(WORD), pallete);

    // Set offset to the image data
    memOffset = sizeof(BITMAP_HEADER) + 256 * sizeof(WORD);

    // Get size
    sizeX = bmp.width;
    sizeY = bmp.height;

    for(y = 0; y < sizeY; y++)
    {

        // Get line
        ExternalMemoryCallback(image, memOffset, sizeX, lineBuffer);
        memOffset += sizeX;

        DisplayEnable();
        for(stretchY = 0; stretchY < stretch; stretchY++)
        {
            pData = lineBuffer;
            SetAddress(address);

            for(x = 0; x < sizeX; x++)
            {
                temp = *pData++;
                SetColor(pallete[temp]);

                // Write pixel to screen
                for(stretchX = 0; stretchX < stretch; stretchX++)
                {
                    DeviceWrite(SETCOLOR_HIBYTE(_color));
                    DeviceWrite(SETCOLOR_LOWBYTE(_color));
                }
            }

            address += LINE_MEM_PITCH;
        }

        DisplayDisable();
    }
}

/*********************************************************************
* Function: void PutImage8BPPExt(SHORT left, SHORT top, void* image, BYTE stretch)
*
* PreCondition: none
*
* Input: left,top - left top image corner, image - image pointer,
*        stretch - image stretch factor
*
* Output: none
*
* Side Effects: none
*
* Overview: outputs monochrome image starting from left,top coordinates
*
* Note: image must be located in flash
*
********************************************************************/
void PutImage16BPPExt(SHORT left, SHORT top, void *image, BYTE stretch)
{
    register DWORD  address;
    register DWORD      memOffset;
    BITMAP_HEADER       bmp;
    WORD                lineBuffer[320];
    WORD                *pData;
    WORD                byteWidth;

    WORD                temp;
    WORD                sizeX, sizeY;
    WORD                x, y;
    BYTE                stretchX, stretchY;

    // Set start address
    address = BUF_MEM_OFFSET + (long)LINE_MEM_PITCH * top + left;

    // Get image header
    ExternalMemoryCallback(image, 0, sizeof(BITMAP_HEADER), &bmp);

    // Set offset to the image data
    memOffset = sizeof(BITMAP_HEADER);

    // Get size
    sizeX = bmp.width;
    sizeY = bmp.height;

    byteWidth = sizeX << 1;
```

```
      for(y = 0; y < sizeY; y++)
      {

          // Get line
          ExternalMemoryCallback(image, memOffset, byteWidth, lineBuffer);
          memOffset += byteWidth;

          DisplayEnable();

          for(stretchY = 0; stretchY < stretch; stretchY++)
          {
              pData = lineBuffer;
              SetAddress(address);

              for(x = 0; x < sizeX; x++)
              {
                  temp = *pData++;
                  SetColor(temp);

                  // Write pixel to screen
                  for(stretchX = 0; stretchX < stretch; stretchX++)
                  {
                      DeviceWrite(SETCOLOR_HIBYTE(_color));
                      DeviceWrite(SETCOLOR_LOWBYTE(_color));
                  }
              }

              address += LINE_MEM_PITCH;
          }

          DisplayDisable();
      }
  }

  #endif //USE_BITMAP_EXTERNAL

  #endif //#ifndef USE_TRANSPARENT_COLOR

  #endif //GFX_USE_DISPLAY_CONTROLLER_HIT1270
```

14.3.4 HIT1270.h

This is file HIT1270.h.

Body Source

```
/*****************************************************************************
 *  Module for Microchip Graphics Library
 *  Densitron HIT1270 LCD controller driver
 *  Landscape orientation only
 *****************************************************************************
 * FileName:        HIT1270.h
 * Dependencies:    p24Fxxxx.h
 * Processor:       PIC24
 * Compiler:        MPLAB C30
 * Linker:          MPLAB LINK30
 * Company:         Microchip Technology Incorporated
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  * OR OTHER SIMILAR COSTS.
  *
  * Date         Comment
  *~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
  * 11/12/07     Version 1.0 release
  * 04/12/11     Support for Graphics Library Version 3.00
  *****************************************************************************/
#ifndef _HIT1270L_H
    #define _HIT1270L_H

    #include "HardwareProfile.h"
    #include "GraphicsConfig.h"
    #include "GenericTypeDefs.h"

    #ifdef USE_16BIT_PMP
        #error This driver doesn't support 16-bit PMP (USE_8BIT_PMP instead in
HardwareProfile.h)
    #endif
    #ifndef DISP_HOR_RESOLUTION
        #error DISP_HOR_RESOLUTION must be defined in HardwareProfile.h
    #endif
    #ifndef DISP_VER_RESOLUTION
        #error DISP_VER_RESOLUTION must be defined in HardwareProfile.h
    #endif
    #ifndef COLOR_DEPTH
        #error COLOR_DEPTH must be defined in GraphicsConfig.h
    #endif
    #ifndef DISP_ORIENTATION
        #error DISP_ORIENTATION must be defined in HardwareProfile.h
    #endif

// Horizontal and vertical screen size
    #if (DISP_HOR_RESOLUTION != 320)
        #error This driver doesn't supports this resolution. Horisontal resolution must be
320 pixels.
    #endif
    #if (DISP_VER_RESOLUTION > 234)
        #error This driver doesn't supports this resolution. Vertical resolution must be
234 pixels or less.
    #endif

// Display orientation
    #if (DISP_ORIENTATION != 0)
        #error This driver doesn't support this orientation.
    #endif

// Color depth
    #if (COLOR_DEPTH != 16)
        #error This driver doesn't support this color depth. It should be 16.
    #endif

// Memory pitch for line
    #define LINE_MEM_PITCH  320

// Video buffer offset
    #define BUF_MEM_OFFSET  (DWORD) 0x18000

// HIT1270 commands
    #define SET_DATA_POINTER    0x50
```

```
    #define SRAM_WRITE          0x51
    #define STAMP_ICON          0x52
    #define FILL_BLOCK          0x53

    #define FLASH_WRITE         0x60
    #define FLASH_READ          0x61


/*********************************************************************
* Macros: SetPalette(colorNum, color)
*
* PreCondition: none
*
* Input: colorNum - register number, color - color
*
* Output: none
*
* Side Effects: none
*
* Overview:  sets palette register
*
* Note: S6D0129 has no palette
*
********************************************************************/
    #define SetPalette(colorNum, color)

#endif // HIT1270L.h
```

14.3.5 HX8347.c

This is file HX8347.c.

Body Source

```
/*****************************************************************************
 *  Module for Microchip Graphics Library
 *  HIMAX HX8347 controller driver
 *****************************************************************************
 * FileName:        HX8347.c
 * Dependencies:    Graphics.h
 * Processor:       PIC24, PIC32
 * Compiler:        MPLAB C30, MPLAB C32
 * Linker:          MPLAB LINK30, MPLAB LINK32
 * Company:         Microchip Technology Incorporated
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 * OR OTHER SIMILAR COSTS.
 *
 * Date         Comment
 *~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
 * 05/26/09     ...
 * 04/12/11     Graphics Library Version 3.00 Support
 *****************************************************************************/
#include "HardwareProfile.h"

#if defined (GFX_USE_DISPLAY_CONTROLLER_HX8347A) || defined
(GFX_USE_DISPLAY_CONTROLLER_HX8347D)

#include "Compiler.h"
#include "TimeDelay.h"
#include "Graphics/DisplayDriver.h"
#include "Graphics/HX8347.h"
#include "Graphics/Primitive.h"

#if defined (USE_GFX_PMP)
    #include "Graphics/gfxpmp.h"
#elif defined (USE_GFX_EPMP)
    #include "Graphics/gfxepmp.h"
#endif

// Unsupported Graphics Library Features
#ifdef USE_TRANSPARENT_COLOR
    #warning "This driver does not support the transparent feature on PutImage(). Build
will use the PutImage() functions defined in the Primitive.c"
#endif

// Color
GFX_COLOR   _color;
#ifdef USE_TRANSPARENT_COLOR
GFX_COLOR   _colorTransparent;
SHORT       _colorTransparentEnable;
#endif

// Clipping region control
SHORT   _clipRgn;

// Clipping region borders
SHORT   _clipLeft;
SHORT   _clipTop;
SHORT   _clipRight;
SHORT   _clipBottom;

////////////////////// LOCAL FUNCTIONS PROTOTYPES ////////////////////////////
void    SetReg(BYTE index, BYTE value);
#ifndef USE_TRANSPARENT_COLOR
void    PutImage1BPP(SHORT left, SHORT top, FLASH_BYTE *image, BYTE stretch);
void    PutImage4BPP(SHORT left, SHORT top, FLASH_BYTE *image, BYTE stretch);
void    PutImage8BPP(SHORT left, SHORT top, FLASH_BYTE *image, BYTE stretch);
void    PutImage16BPP(SHORT left, SHORT top, FLASH_BYTE *image, BYTE stretch);

void    PutImage1BPPExt(SHORT left, SHORT top, void *image, BYTE stretch);
void    PutImage4BPPExt(SHORT left, SHORT top, void *image, BYTE stretch);
void    PutImage8BPPExt(SHORT left, SHORT top, void *image, BYTE stretch);
void    PutImage16BPPExt(SHORT left, SHORT top, void *image, BYTE stretch);
#endif

/*********************************************************************
* Macros:  WritePixel(data)
*
* Overview: Writes data
*
* PreCondition: none
*
* Input: data
*
* Output: none
*
* Side Effects: none
*
```

```
********************************************************************/

#ifdef USE_16BIT_PMP
#define WritePixel(data)  DeviceWrite(data)
#else
#define WritePixel(data) \
    DisplaySetData(); \
    DeviceWrite(((WORD_VAL)data).v[1]);\
    DeviceWrite(((WORD_VAL)data).v[0]);
#endif

/*********************************************************************
* Function:  void SetAddress(SHORT x, SHORT y)
*
* Overview: Writes address pointer.
*
* PreCondition: none
*
* Input: x - horizontal position
*        y - vertical position
*
* Output: none
*
* Side Effects: none
*
********************************************************************/
inline void SetAddress(SHORT x, SHORT y)
{
    DisplaySetCommand();
    DeviceWrite(0x02);
    DisplaySetData();
    DeviceWrite(((WORD_VAL) (WORD) x).v[1]);
    DisplaySetCommand();
    DeviceWrite(0x03);
    DisplaySetData();
    DeviceWrite(((WORD_VAL) (WORD) x).v[0]);
    DisplaySetCommand();
    DeviceWrite(0x06);
    DisplaySetData();
    DeviceWrite(((WORD_VAL) (WORD) y).v[1]);
    DisplaySetCommand();
    DeviceWrite(0x07);
    DisplaySetData();
    DeviceWrite(((WORD_VAL) (WORD) y).v[0]);
    DisplaySetCommand();
    DeviceWrite(0x22);
}

/*********************************************************************
* Function:  void  SetReg(BYTE index, BYTE value)
*
* PreCondition: none
*
* Input: index - register number
*        value - value to be set
*
* Output: none
*
* Side Effects: none
*
* Overview: sets graphics controller register
*
* Note: none
*
********************************************************************/
void SetReg(BYTE index, BYTE value)
{
    DisplayEnable();
    DisplaySetCommand();
    DeviceWrite(index);
    DisplaySetData();
    DeviceWrite(value);
    DisplayDisable();
}

/*********************************************************************
* Function:  void ResetDevice()
*
* PreCondition: none
*
* Input: none
*
* Output: none
*
* Side Effects: none
*
* Overview: resets LCD, initializes PMP
*
* Note: none
*
********************************************************************/
void ResetDevice(void)
{
    // Initialize the device
    DriverInterfaceInit();
    DelayMs(1);             // Delay to let controller ready for next SetReg command

#if defined (GFX_USE_DISPLAY_CONTROLLER_HX8347A)
    // Gamma for CMO 2.8
    SetReg(0x46, 0x95);     //
    SetReg(0x47, 0x51);     //
    SetReg(0x48, 0x00);     //
    SetReg(0x49, 0x36);     //
    SetReg(0x4A, 0x11);     //
    SetReg(0x4B, 0x66);     //
    SetReg(0x4C, 0x14);     //
    SetReg(0x4D, 0x77);     //
    SetReg(0x4E, 0x13);     //
    SetReg(0x4F, 0x4C);     //
    SetReg(0x50, 0x46);     //
    SetReg(0x51, 0x46);     //

    // Display
    SetReg(0x90, 0x7F);     // SAP=0111 1111
    SetReg(0x01, 0x06);     // IDMON=0, INVON=1, NORON=1, PTLON=0
    #if (DISP_ORIENTATION == 0)
    SetReg(0x16, 0xC8);     // MY=1, MX=1, MV=0, BGR=1
    #else
    SetReg(0x16, 0xA8);     // MY=1, MX=0, MV=1, BGR=1
    #endif
    SetReg(0x23, 0x95);     // N_DC=1001 0101
    SetReg(0x24, 0x95);     // P_DC=1001 0101
    SetReg(0x25, 0xFF);     // I_DC=1111 1111
    SetReg(0x27, 0x06);     // N_BP=0000 0110
    SetReg(0x28, 0x06);     // N_FP=0000 0110
    SetReg(0x29, 0x06);     // P_BP=0000 0110
    SetReg(0x2A, 0x06);     // P_FP=0000 0110
    SetReg(0x2C, 0x06);     // I_BP=0000 0110
    SetReg(0x2D, 0x06);     // I_FP=0000 0110
    SetReg(0x3A, 0x01);     // N_RTN=0000, N_NW=001
    SetReg(0x3B, 0x01);     // P_RTN=0000, P_NW=001
    SetReg(0x3C, 0xF0);     // I_RTN=1111, I_NW=000
    SetReg(0x3D, 0x00);     // DIV=00
    DelayMs(20);

    SetReg(0x10, 0xA6);     // SS=0,GS=0 CSEL=110

    // Power Supply Setting
    SetReg(0x19, 0x49);     // OSCADJ=10 0000, OSD_EN=1 //60Hz
    SetReg(0x93, 0x0C);     // RADJ=1100,
    DelayMs(10);

    SetReg(0x20, 0x40);     // BT=0100
    SetReg(0x1D, 0x07);     // VC1=111
```

```
        SetReg(0x1E, 0x00);      // VC3=000
        SetReg(0x1F, 0x04);      // VRH=0100          4.12V
        SetReg(0x44, 0x4D);      // VCM=101 0000    3.21V
        SetReg(0x45, 0x11);      // VDV=1 0001           -1.19V
        DelayMs(10);

        SetReg(0x1C, 0x04);      // AP=100
        DelayMs(20);
        SetReg(0x43, 0x80);      //set VCOMG=1
        DelayMs(5);
        SetReg(0x1B, 0x18);      // GASENB=0, PON=1, DK=1, XDK=0, DDVDH_TRI=0, STB=0
        DelayMs(40);

        SetReg(0x1B, 0x10);      // GASENB=0, PON=1, DK=0, XDK=0, DDVDH_TRI=0, STB=0
        DelayMs(40);

        // Display ON Setting
        SetReg(0x26, 0x04);      // GON=0, DTE=0, D=01
        DelayMs(40);
        SetReg(0x26, 0x24);      // GON=1, DTE=0, D=01
        SetReg(0x26, 0x2C);      // GON=1, DTE=0, D=11
        DelayMs(40);

        SetReg(0x26, 0x3C);      // GON=1, DTE=1, D=11
        SetReg(0x35, 0x38);      // EQS=38h
        SetReg(0x36, 0x78);      // EQP=78h
        SetReg(0x3E, 0x38);      // SON=38h
        SetReg(0x40, 0x0F);      // GDON=0Fh
        SetReg(0x41, 0xF0);      // GDOFF

        // Set spulse & rpulse
        SetReg(0x57, 0x02);      // Test mode='1'
        SetReg(0x56, 0x84);      // set Rpulse='1000',spulse='0100'
        SetReg(0x57, 0x00);      // Test mode= '0'
        #if (DISP_ORIENTATION == 0)
        SetReg(0x04, 0x00);
        SetReg(0x05, 0xEF);
        SetReg(0x08, 0x01);
        SetReg(0x09, 0x3F);
        #else
        SetReg(0x04, 0x01);
        SetReg(0x05, 0x3F);
        SetReg(0x08, 0x00);
        SetReg(0x09, 0xEF);
        #endif
        DelayMs(20);

    #elif defined (GFX_USE_DISPLAY_CONTROLLER_HX8347D)

        // Driving ability setting
        SetReg(0xEA,0x00);    // PTBA[15:8]
        SetReg(0xEB,0x20);    // PTBA[7:0]
        SetReg(0xEC,0x0C);    // STBA[15:8]
        SetReg(0xED,0xC4);    // STBA[7:0]
        SetReg(0xE8,0x40);    // OPON[7:0]
        SetReg(0xE9,0x38);    // OPON1[7:0]
        SetReg(0xF1,0x01);    // OTPS1B
        SetReg(0xF2,0x10);    // GEN
        SetReg(0x27,0xA3);    //

        // Gamma 2.8 setting
        SetReg(0x40,0x00);    //
        SetReg(0x41,0x00);    //
        SetReg(0x42,0x01);    //
        SetReg(0x43,0x13);    //
        SetReg(0x44,0x10);    //
        SetReg(0x45,0x26);    //
        SetReg(0x46,0x08);    //
        SetReg(0x47,0x51);    //
        SetReg(0x48,0x02);    //
        SetReg(0x49,0x12);    //
        SetReg(0x4A,0x18);    //
        SetReg(0x4B,0x19);   //
        SetReg(0x4C,0x14);   //

        SetReg(0x50,0x19);   //
        SetReg(0x51,0x2F);   //
        SetReg(0x52,0x2C);   //
        SetReg(0x53,0x3E);   //
        SetReg(0x54,0x3F);   //
        SetReg(0x55,0x3F);   //
        SetReg(0x56,0x2E);   //
        SetReg(0x57,0x77);   //
        SetReg(0x58,0x0B);   //
        SetReg(0x59,0x06);   //
        SetReg(0x5A,0x07);   //
        SetReg(0x5B,0x0D);   //
        SetReg(0x5C,0x1D);   //
        SetReg(0x5D,0xCC);   //

        // Window setting
    #if (DISP_ORIENTATION == 0)
        SetReg(0x04,0x00);
        SetReg(0x05,0xEF);
        SetReg(0x08,0x01);
        SetReg(0x09,0x3F);
    #else
        SetReg(0x04,0x01);
        SetReg(0x05,0x3F);
        SetReg(0x08,0x00);
        SetReg(0x09,0xEF);
    #endif

        // Display Setting
        //SetReg(0x01,0x06);   // IDMON=0, INVON=1, NORON=1, PTLON=0

    #if (DISP_ORIENTATION == 0)
        SetReg(0x16,0x08);   // MY=0, MX=0, MV=0, BGR=1
    #else
        SetReg(0x16,0x68);   // MY=0, MX=1, MV=1, BGR=1
    #endif


        // Power Voltage Setting
        SetReg(0x1B,0x1B);   // VRH = 4.65
        SetReg(0x1A,0x01);   // BT
        SetReg(0x24,0x2F);   // VMH
        SetReg(0x25,0x57);   // VML

        // Vcom offset
        SetReg(0x23,0x8D);   // FLICKER ADJUST

        // Power ON Setting
        SetReg(0x18,0x36);   //
        SetReg(0x19,0x01);   //
        SetReg(0x01,0x00);   //
        SetReg(0x1F,0x88);   //
        DelayMs(5);
        SetReg(0x1F,0x80);   //
        DelayMs(5);
        SetReg(0x1F,0x90);   //
        DelayMs(5);
        SetReg(0x1F,0xD0);   //
        DelayMs(5);

        // 65K Color Selection
        SetReg(0x17,0x05);   //

        // Set Panel
        SetReg(0x36,0x00);   //

        // Display ON Setting
        SetReg(0x28,0x38);   //
        DelayMs( 40);
        SetReg(0x28,0x3C);   //
    #endif

    }

    #ifdef USE_TRANSPARENT_COLOR
    /*********************************************************************
    * Function:  void TransparentColorEnable(GFX_COLOR color)
    *
    * Overview: Sets current transparent color.
    *
    * PreCondition: none
    *
    * Input: color - Color value chosen.
    *
    * Output: none
    *
    * Side Effects: none
    *
    ********************************************************************/
    void TransparentColorEnable(GFX_COLOR color)
    {
        _colorTransparent = color;
        _colorTransparentEnable = TRANSPARENT_COLOR_ENABLE;

    }
    #endif

    /*********************************************************************
    * Function: void PutPixel(SHORT x, SHORT y)
    *
    * PreCondition: none
    *
    * Input: x,y - pixel coordinates
    *
    * Output: none
    *
    * Side Effects: none
    *
    * Overview: puts pixel
    *
    * Note: none
    *
    ********************************************************************/
    void PutPixel(SHORT x, SHORT y)
    {
        if(_clipRgn)
        {
            if(x < _clipLeft)
                return;
            if(x > _clipRight)
                return;
            if(y < _clipTop)
                return;
            if(y > _clipBottom)
                return;
        }

        DisplayEnable();
        SetAddress(x, y);
        WritePixel(_color);
        DisplayDisable();
    }

    /*********************************************************************
    * Function: SetClipRgn(left, top, right, bottom)
    *
    * Overview: Sets clipping region.
    *
    * PreCondition: none
    *
    * Input: left - Defines the left clipping region border.
    *        top - Defines the top clipping region border.
    *        right - Defines the right clipping region border.
    *        bottom - Defines the bottom clipping region border.
    *
    * Output: none
    *
    * Side Effects: none
    *
    ********************************************************************/
    void SetClipRgn(SHORT left, SHORT top, SHORT right, SHORT bottom)
    {
        _clipLeft=left;
        _clipTop=top;
        _clipRight=right;
        _clipBottom=bottom;

    }

    /*********************************************************************
    * Function: SetClip(control)
    *
    * Overview: Enables/disables clipping.
    *
    * PreCondition: none
    *
    * Input: control - Enables or disables the clipping.
    *           - 0: Disable clipping
    *           - 1: Enable clipping
    *
    * Output: none
    *
    * Side Effects: none
    *
    ********************************************************************/
    void SetClip(BYTE control)
    {
        _clipRgn=control;
    }

    /*********************************************************************
    * Function: IsDeviceBusy()
    *
    * Overview: Returns non-zero if LCD controller is busy
    *           (previous drawing operation is not completed).
    *
    * PreCondition: none
    *
    * Input: none
    *
    * Output: Busy status.
    *
    * Side Effects: none
    *
    ********************************************************************/
    WORD IsDeviceBusy(void)
    {
        return (0);
    }

    /*********************************************************************
    * Function: WORD Bar(SHORT left, SHORT top, SHORT right, SHORT bottom)
    *
    * PreCondition: none
    *
    * Input: left,top - top left corner coordinates,
    *        right,bottom - bottom right corner coordinates
    *
    * Output: none
    *
    * Side Effects: none
    *
    * Overview: draws rectangle filled with current color
```

```
*
* Note: none
*
********************************************************************/
WORD Bar(SHORT left, SHORT top, SHORT right, SHORT bottom)
{
    register SHORT  x, y;

    #ifndef USE_NONBLOCKING_CONFIG
    while(IsDeviceBusy() != 0);

    /* Ready */
    #else
    if(IsDeviceBusy() != 0)
        return (0);
    #endif
    if(_clipRgn)
    {
        if(left < _clipLeft)
            left = _clipLeft;
        if(right > _clipRight)
            right = _clipRight;
        if(top < _clipTop)
            top = _clipTop;
        if(bottom > _clipBottom)
            bottom = _clipBottom;
    }

    DisplayEnable();
    for(y = top; y < bottom + 1; y++)
    {
        SetAddress(left, y);
        for(x = left; x < right + 1; x++)
        {
            WritePixel(_color);
        }
    }

    DisplayDisable();
    return (1);
}

/*********************************************************************
* Function: void ClearDevice(void)
*
* PreCondition: none
*
* Input: none
*
* Output: none
*
* Side Effects: none
*
* Overview: clears screen with current color
*
* Note: none
*
********************************************************************/
void ClearDevice(void)
{
    DWORD   counter;

    DisplayEnable();
    SetAddress(0, 0);
    for(counter = 0; counter < (DWORD) (GetMaxX() + 1) * (GetMaxY() + 1); counter++)
    {
        WritePixel(_color);
    }

    DisplayDisable();
}
```

```
#ifndef USE_TRANSPARENT_COLOR

    #ifdef USE_BITMAP_FLASH

/*********************************************************************
* Function: void PutImage1BPP(SHORT left, SHORT top, FLASH_BYTE* image, BYTE stretch)
*
* PreCondition: none
*
* Input: left,top - left top image corner,
*        image - image pointer,
*        stretch - image stretch factor
*
* Output: none
*
* Side Effects: none
*
* Overview: outputs monochrome image starting from left,top coordinates
*
* Note: image must be located in flash
*
********************************************************************/
void PutImage1BPP(SHORT left, SHORT top, FLASH_BYTE *image, BYTE stretch)
{
    register FLASH_BYTE *flashAddress;
    register FLASH_BYTE *tempFlashAddress;
    BYTE                temp = 0;
    WORD                sizeX, sizeY;
    WORD                x, y;
    BYTE                stretchX, stretchY;
    WORD                pallete[2];
    BYTE                mask;

    // Move pointer to size information
    flashAddress = image + 2;

    // Read image size
    sizeY = *((FLASH_WORD *)flashAddress);
    flashAddress += 2;
    sizeX = *((FLASH_WORD *)flashAddress);
    flashAddress += 2;
    pallete[0] = *((FLASH_WORD *)flashAddress);
    flashAddress += 2;
    pallete[1] = *((FLASH_WORD *)flashAddress);
    flashAddress += 2;

    DisplayEnable();
    for(y = 0; y < sizeY; y++)
    {
        tempFlashAddress = flashAddress;
        for(stretchY = 0; stretchY < stretch; stretchY++)
        {
            flashAddress = tempFlashAddress;
            SetAddress((WORD) left, (WORD) top);
            mask = 0;
            for(x = 0; x < sizeX; x++)
            {

                // Read 8 pixels from flash
                if(mask == 0)
                {
                    temp = *flashAddress;
                    flashAddress++;
                    mask = 0x80;
                }

                // Set color
                if(mask & temp)
                {
                    SetColor(pallete[1]);
                }
                else
```

```
                  {
                      SetColor(pallete[0]);
                  }

                  // Write pixel to screen
                  for(stretchX = 0; stretchX < stretch; stretchX++)
                  {
                      WritePixel(_color);
                  }

                  // Shift to the next pixel
                  mask >>= 1;
              }

              top++;
          }
      }

      DisplayDisable();
  }

  /*********************************************************************
  * Function: void PutImage4BPP(SHORT left, SHORT top, FLASH_BYTE* image, BYTE stretch)
  *
  * PreCondition: none
  *
  * Input: left,top - left top image corner, image - image pointer,
  *        stretch - image stretch factor
  *
  * Output: none
  *
  * Side Effects: none
  *
  * Overview: outputs 16 color image starting from left,top coordinates
  *
  * Note: image must be located in flash
  *
  ********************************************************************/
  void PutImage4BPP(SHORT left, SHORT top, FLASH_BYTE *image, BYTE stretch)
  {
      register FLASH_BYTE *flashAddress;
      register FLASH_BYTE *tempFlashAddress;
      WORD                sizeX, sizeY;
      register WORD       x, y;
      BYTE                temp = 0;
      register BYTE       stretchX, stretchY;
      WORD                pallete[16];
      WORD                counter;

      // Move pointer to size information
      flashAddress = image + 2;

      // Read image size
      sizeY = *((FLASH_WORD *)flashAddress);
      flashAddress += 2;
      sizeX = *((FLASH_WORD *)flashAddress);
      flashAddress += 2;

      // Read pallete
      for(counter = 0; counter < 16; counter++)
      {
          pallete[counter] = *((FLASH_WORD *)flashAddress);
          flashAddress += 2;
      }

      DisplayEnable();
      for(y = 0; y < sizeY; y++)
      {
          tempFlashAddress = flashAddress;
          for(stretchY = 0; stretchY < stretch; stretchY++)
          {
              flashAddress = tempFlashAddress;
```

```
            SetAddress(left, top);
            for(x = 0; x < sizeX; x++)
            {

                // Read 2 pixels from flash
                if(x & 0x0001)
                {

                    // second pixel in byte
                    SetColor(pallete[temp >> 4]);
                }
                else
                {
                    temp = *flashAddress;
                    flashAddress++;

                    // first pixel in byte
                    SetColor(pallete[temp & 0x0f]);
                }

                // Write pixel to screen
                for(stretchX = 0; stretchX < stretch; stretchX++)
                {
                    WritePixel(_color);
                }
            }

            top++;
        }
    }

    DisplayDisable();
}

/*********************************************************************
* Function: void PutImage8BPP(SHORT left, SHORT top, FLASH_BYTE* image, BYTE stretch)
*
* PreCondition: none
*
* Input: left,top - left top image corner, image - image pointer,
*        stretch - image stretch factor
*
* Output: none
*
* Side Effects: none
*
* Overview: outputs 256 color image starting from left,top coordinates
*
* Note: image must be located in flash
*
********************************************************************/
void PutImage8BPP(SHORT left, SHORT top, FLASH_BYTE *image, BYTE stretch)
{
    register FLASH_BYTE *flashAddress;
    register FLASH_BYTE *tempFlashAddress;
    WORD                sizeX, sizeY;
    WORD                x, y;
    BYTE                temp;
    BYTE                stretchX, stretchY;
    WORD                pallete[256];
    WORD                counter;

    // Move pointer to size information
    flashAddress = image + 2;

    // Read image size
    sizeY = *((FLASH_WORD *)flashAddress);
    flashAddress += 2;
    sizeX = *((FLASH_WORD *)flashAddress);
    flashAddress += 2;

    // Read pallete
    for(counter = 0; counter < 256; counter++)
    {
        pallete[counter] = *((FLASH_WORD *)flashAddress);
        flashAddress += 2;
    }

    DisplayEnable();
    for(y = 0; y < sizeY; y++)
    {
        tempFlashAddress = flashAddress;
        for(stretchY = 0; stretchY < stretch; stretchY++)
        {
            flashAddress = tempFlashAddress;
            SetAddress(left, top);
            for(x = 0; x < sizeX; x++)
            {

                // Read pixels from flash
                temp = *flashAddress;
                flashAddress++;

                // Set color
                SetColor(pallete[temp]);

                // Write pixel to screen
                for(stretchX = 0; stretchX < stretch; stretchX++)
                {
                    WritePixel(_color);
                }
            }

            top++;
        }
    }

    DisplayDisable();
}

/*********************************************************************
* Function: void PutImage16BPP(SHORT left, SHORT top, FLASH_BYTE* image, BYTE stretch)
*
* PreCondition: none
*
* Input: left,top - left top image corner, image - image pointer,
*        stretch - image stretch factor
*
* Output: none
*
* Side Effects: none
*
* Overview: outputs hicolor image starting from left,top coordinates
*
* Note: image must be located in flash
*
********************************************************************/
void PutImage16BPP(SHORT left, SHORT top, FLASH_BYTE *image, BYTE stretch)
{
    register FLASH_WORD *flashAddress;
    register FLASH_WORD *tempFlashAddress;
    WORD                sizeX, sizeY;
    register WORD       x, y;
    WORD                temp;
    register BYTE       stretchX, stretchY;

    // Move pointer to size information
    flashAddress = (FLASH_WORD *)image + 1;

    // Read image size
    sizeY = *flashAddress;
    flashAddress++;
    sizeX = *flashAddress;
    flashAddress++;
    DisplayEnable();
    for(y = 0; y < sizeY; y++)
    {
        tempFlashAddress = flashAddress;
        for(stretchY = 0; stretchY < stretch; stretchY++)
        {
            flashAddress = tempFlashAddress;
            SetAddress(left, top);
            for(x = 0; x < sizeX; x++)
            {

                // Read pixels from flash
                temp = *flashAddress;
                flashAddress++;

                // Set color
                SetColor(temp);

                // Write pixel to screen
                for(stretchX = 0; stretchX < stretch; stretchX++)
                {
                    WritePixel(_color);
                }
            }

            top++;
        }
    }

    DisplayDisable();
}

    #endif // USE_BITMAP_FLASH
    #ifdef USE_BITMAP_EXTERNAL

/*********************************************************************
* Function: void PutImage1BPPExt(SHORT left, SHORT top, void* image, BYTE stretch)
*
* PreCondition: none
*
* Input: left,top - left top image corner, image - image pointer,
*        stretch - image stretch factor
*
* Output: none
*
* Side Effects: none
*
* Overview: outputs monochrome image starting from left,top coordinates
*
* Note: image must be located in external memory
*
********************************************************************/
void PutImage1BPPExt(SHORT left, SHORT top, void *image, BYTE stretch)
{
    register DWORD  memOffset;
    BITMAP_HEADER   bmp;
    WORD            pallete[2];
    BYTE            lineBuffer[((GetMaxX() + 1) / 8) + 1];
    BYTE            *pData;
    SHORT           byteWidth;

    BYTE            temp;
    BYTE            mask;
    WORD            sizeX, sizeY;
    WORD            x, y;
    BYTE            stretchX, stretchY;

    // Get image header
    ExternalMemoryCallback(image, 0, sizeof(BITMAP_HEADER), &bmp);

    // Get pallete (2 entries)
    ExternalMemoryCallback(image, sizeof(BITMAP_HEADER), 2 * sizeof(WORD), pallete);

    // Set offset to the image data
    memOffset = sizeof(BITMAP_HEADER) + 2 * sizeof(WORD);

    // Line width in bytes
    byteWidth = bmp.width >> 3;
    if(bmp.width & 0x0007)
        byteWidth++;

    // Get size
    sizeX = bmp.width;
    sizeY = bmp.height;

    for(y = 0; y < sizeY; y++)
    {

        // Get line
        ExternalMemoryCallback(image, memOffset, byteWidth, lineBuffer);
        memOffset += byteWidth;
        DisplayEnable();
        for(stretchY = 0; stretchY < stretch; stretchY++)
        {
            pData = lineBuffer;
            SetAddress(left, top);
            mask = 0;
            for(x = 0; x < sizeX; x++)
            {

                // Read 8 pixels from flash
                if(mask == 0)
                {
                    temp = *pData++;
                    mask = 0x80;
                }

                // Set color
                if(mask & temp)
                {
                    SetColor(pallete[1]);
                }
                else
                {
                    SetColor(pallete[0]);
                }

                // Write pixel to screen
                for(stretchX = 0; stretchX < stretch; stretchX++)
                {
                    WritePixel(_color);
                }

                // Shift to the next pixel
                mask >>= 1;
            }

            top++;
        }

        DisplayDisable();
    }
}

/*********************************************************************
* Function: void PutImage4BPPExt(SHORT left, SHORT top, void* image, BYTE stretch)
*
* PreCondition: none
*
* Input: left,top - left top image corner, image - image pointer,
*        stretch - image stretch factor
*
* Output: none
```

```
*
* Side Effects: none
*
* Overview: outputs monochrome image starting from left,top coordinates
*
* Note: image must be located in external memory
*
*********************************************************************/
void PutImage4BPPExt(SHORT left, SHORT top, void *image, BYTE stretch)
{
    register DWORD  memOffset;
    BITMAP_HEADER   bmp;
    WORD            pallete[16];
    BYTE            lineBuffer[((GetMaxX() + 1) / 2) + 1];
    BYTE            *pData;
    SHORT           byteWidth;

    BYTE            temp;
    WORD            sizeX, sizeY;
    WORD            x, y;
    BYTE            stretchX, stretchY;

    // Get image header
    ExternalMemoryCallback(image, 0, sizeof(BITMAP_HEADER), &bmp);

    // Get pallete (16 entries)
    ExternalMemoryCallback(image, sizeof(BITMAP_HEADER), 16 * sizeof(WORD), pallete);

    // Set offset to the image data
    memOffset = sizeof(BITMAP_HEADER) + 16 * sizeof(WORD);

    // Line width in bytes
    byteWidth = bmp.width >> 1;
    if(bmp.width & 0x0001)
        byteWidth++;

    // Get size
    sizeX = bmp.width;
    sizeY = bmp.height;

    for(y = 0; y < sizeY; y++)
    {

        // Get line
        ExternalMemoryCallback(image, memOffset, byteWidth, lineBuffer);
        memOffset += byteWidth;
        DisplayEnable();
        for(stretchY = 0; stretchY < stretch; stretchY++)
        {
            pData = lineBuffer;
            SetAddress(left, top);

            for(x = 0; x < sizeX; x++)
            {

                // Read 2 pixels from flash
                if(x & 0x0001)
                {

                    // second pixel in byte
                    SetColor(pallete[temp >> 4]);
                }
                else
                {
                    temp = *pData++;

                    // first pixel in byte
                    SetColor(pallete[temp & 0x0f]);
                }

                // Write pixel to screen
                for(stretchX = 0; stretchX < stretch; stretchX++)
                {
                    WritePixel(_color);
                }
            }

            top++;
        }

        DisplayDisable();
    }
}

/*********************************************************************
* Function: void PutImage8BPPExt(SHORT left, SHORT top, void* image, BYTE stretch)
*
* PreCondition: none
*
* Input: left,top - left top image corner, image - image pointer,
*        stretch - image stretch factor
*
* Output: none
*
* Side Effects: none
*
* Overview: outputs monochrome image starting from left,top coordinates
*
* Note: image must be located in external memory
*
********************************************************************/
void PutImage8BPPExt(SHORT left, SHORT top, void *image, BYTE stretch)
{
    register DWORD  memOffset;
    BITMAP_HEADER   bmp;
    WORD            pallete[256];
    BYTE            lineBuffer[(GetMaxX() + 1)];
    BYTE            *pData;

    BYTE            temp;
    WORD            sizeX, sizeY;
    WORD            x, y;
    BYTE            stretchX, stretchY;

    // Get image header
    ExternalMemoryCallback(image, 0, sizeof(BITMAP_HEADER), &bmp);

    // Get pallete (256 entries)
    ExternalMemoryCallback(image, sizeof(BITMAP_HEADER), 256 * sizeof(WORD), pallete);

    // Set offset to the image data
    memOffset = sizeof(BITMAP_HEADER) + 256 * sizeof(WORD);

    // Get size
    sizeX = bmp.width;
    sizeY = bmp.height;

    for(y = 0; y < sizeY; y++)
    {

        // Get line
        ExternalMemoryCallback(image, memOffset, sizeX, lineBuffer);
        memOffset += sizeX;
        DisplayEnable();
        for(stretchY = 0; stretchY < stretch; stretchY++)
        {
            pData = lineBuffer;
            SetAddress(left, top);

            for(x = 0; x < sizeX; x++)
            {
                temp = *pData++;
                SetColor(pallete[temp]);
                // Write pixel to screen
                for(stretchX = 0; stretchX < stretch; stretchX++)
                {
                    WritePixel(_color);
                }
            }

            top++;
        }

        DisplayDisable();
    }
}

/*********************************************************************
* Function: void PutImage16BPPExt(SHORT left, SHORT top, void* image, BYTE stretch)
*
* PreCondition: none
*
* Input: left,top - left top image corner, image - image pointer,
*        stretch - image stretch factor
*
* Output: none
*
* Side Effects: none
*
* Overview: outputs monochrome image starting from left,top coordinates
*
* Note: image must be located in external memory
*
********************************************************************/
void PutImage16BPPExt(SHORT left, SHORT top, void *image, BYTE stretch)
{
    register DWORD  memOffset;
    BITMAP_HEADER   bmp;
    WORD            lineBuffer[(GetMaxX() + 1)];
    WORD            *pData;
    WORD            byteWidth;

    WORD            temp;
    WORD            sizeX, sizeY;
    WORD            x, y;
    BYTE            stretchX, stretchY;

    // Get image header
    ExternalMemoryCallback(image, 0, sizeof(BITMAP_HEADER), &bmp);

    // Set offset to the image data
    memOffset = sizeof(BITMAP_HEADER);

    // Get size
    sizeX = bmp.width;
    sizeY = bmp.height;

    byteWidth = sizeX << 1;

    for(y = 0; y < sizeY; y++)
    {

        // Get line
        ExternalMemoryCallback(image, memOffset, byteWidth, lineBuffer);
        memOffset += byteWidth;
        DisplayEnable();
        for(stretchY = 0; stretchY < stretch; stretchY++)
        {
            pData = lineBuffer;
            SetAddress(left, top);

            for(x = 0; x < sizeX; x++)
            {
                temp = *pData++;
                SetColor(temp);
                // Write pixel to screen
                for(stretchX = 0; stretchX < stretch; stretchX++)
                {
                    WritePixel(_color);
                }
            }

            top++;
        }

        DisplayDisable();
    }
}

    #endif //USE_BITMAP_EXTERNAL
#endif //#ifndef USE_TRANSPARENT_COLOR

#endif // USE_DRV_PUTIMAGE
```

14.3.6 HX8347.h

This is file HX8347.h.

Body Source

```
/*****************************************************************************
 *  Module for Microchip Graphics Library
 *  HIMAX HX8347 LCD controllers driver
 *****************************************************************************
 * FileName:        HX8347.h
 * Dependencies:    p24Fxxxx.h or plib.h
 * Processor:       PIC24, PIC32
 * Compiler:        MPLAB C30, MPLAB C32
 * Linker:          MPLAB LINK30, MPLAB LINK32
 * Company:         Microchip Technology Incorporated
 *
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 * COST OF PROCUREMENT OF SUBSTITUTE GOODS, TECHNOLOGY, SERVICES, OR ANY
 * CLAIMS BY THIRD PARTIES (INCLUDING BUT NOT LIMITED TO ANY DEFENSE THEREOF),
 * OR OTHER SIMILAR COSTS.
 *
 * Date         Comment
 *~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
 * 05/26/09     ...
 * 04/12/11     Graphics Library Version 3.00 Support
 *****************************************************************************/
#ifndef _HX8347_H
    #define _HX8347_H
```

```
    #include "HardwareProfile.h"
    #include "GraphicsConfig.h"
    #include "GenericTypeDefs.h"

    #ifndef DISP_HOR_RESOLUTION
        #error DISP_HOR_RESOLUTION must be defined in HardwareProfile.h
    #endif
    #ifndef DISP_VER_RESOLUTION
        #error DISP_VER_RESOLUTION must be defined in HardwareProfile.h
    #endif
    #ifndef COLOR_DEPTH
        #error COLOR_DEPTH must be defined in GraphicsConfig.h
    #endif
    #ifndef DISP_ORIENTATION
        #error DISP_ORIENTATION must be defined in HardwareProfile.h
    #endif

/*********************************************************************
* Overview: Horizontal and vertical screen size.
*********************************************************************/
    #if (DISP_HOR_RESOLUTION != 240)
        #error This driver doesn't supports this resolution. Horisontal resolution must be
240 pixels.
    #endif
    #if (DISP_VER_RESOLUTION != 320)
        #error This driver doesn't supports this resolution. Vertical resolution must be
320 pixels.
    #endif

/*********************************************************************
* Overview: Display orientation.
*********************************************************************/
    #if (DISP_ORIENTATION != 0) && (DISP_ORIENTATION != 90)
        #error This driver doesn't support this orientation.
    #endif

/*********************************************************************
* Overview: Color depth.
*********************************************************************/
    #if (COLOR_DEPTH != 16)
        #error This driver doesn't support this color depth. It should be 16.
    #endif

/*********************************************************************
* Macros: SetPalette(colorNum, color)
*
* Overview:  Sets palette register.
*
* PreCondition: none
*
* Input: colorNum - Register number.
*        color - Color.
*
* Output: none
*
* Side Effects: none
*
********************************************************************/
    #define SetPalette(colorNum, color)


#endif // _HX8347_H
```

14.3.7 SH1101A_SSD1303.c

This is file SH1101A_SSD1303.c.

Body Source

```
/*****************************************************************************
 *  Module for Microchip Graphics Library
 *  Sino Wealth Microelectronic SH1101A OLED controller driver
 *  Solomon Systech SSD1303 LCD controller driver
  *****************************************************************************
 * FileName:        SH1101A_SSD1303.c
 * Processor:       PIC24
 * Compiler:        MPLAB C30
 * Company:         Microchip Technology Incorporated
 *
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 *
 * Date         Comment
 *~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
 * 03/10/07     Original
 * 12/20/07     Ported to PIC24 Kit
 * 03/26/10     Fixed error on PutPixel() timing (PMP timing).
 * 03/22/11     - Modified for Graphics Library Version 3.00
 *              - Replace color data type from WORD_VAL to GFX_COLOR
 *              - Replace DeviceInit() to DriverInterfaceInit()
 *****************************************************************************/
#include "HardwareProfile.h"

#if defined(USE_GFX_DISPLAY_CONTROLLER_SH1101A)

#include "Compiler.h"
#include "TimeDelay.h"
#include "Graphics/DisplayDriver.h"
#include "Graphics/SH1101A_SSD1303.h"
#include "Graphics/gfxtcon.h"
#include "Graphics/Primitive.h"

#if defined (USE_GFX_PMP)
    #include "Graphics/gfxpmp.h"
#elif defined (USE_GFX_PMP)
    #include "Graphics/gfxepmp.h"
#endif

// Color
GFX_COLOR   _color;
#ifdef USE_TRANSPARENT_COLOR
GFX_COLOR   _colorTransparent;
SHORT       _colorTransparentEnable;
#endif

// Clipping region control
SHORT   _clipRgn;
```

```
// Clipping region borders
SHORT   _clipLeft;
SHORT   _clipTop;
SHORT   _clipRight;
SHORT   _clipBottom;


/*********************************************************************
* Macros:  SetAddress(lowerAddr,higherAddr)
*
* Overview: Sets the page and the lower and higher address pointer
*           of the display buffer. All parameters should be pre-calculated.
*
* PreCondition: none
*
* Input: page - Page value for the address.
*        lowerAddr - Lower column address.
*        higherAddr - Higher column address.
*
* Output: none
*
* Side Effects: none
*
********************************************************************/
#define SetAddress(page, lowerAddr, higherAddr) \
    DisplaySetCommand(); \
    DeviceWrite(page); \
    DeviceWrite(lowerAddr); \
    DeviceWrite(higherAddr); \
    DisplaySetData();


/*********************************************************************
* Function:  void ResetDevice()
*
* PreCondition: none
*
* Input: none
*
* Output: none
*
* Side Effects: none
*
* Overview: resets LCD, initializes PMP
*
* Note: none
*
********************************************************************/
void ResetDevice(void)
{
    // Initialize the device
    DriverInterfaceInit();

    DisplayEnable();
    DisplaySetCommand();

    #if (DISPLAY_CONTROLLER == SH1101A)

    // Setup Display
    DeviceWrite(0xAE);             // turn off the display (AF=ON, AE=OFF)
    DeviceWrite(0xDB);             // set  VCOMH
    DeviceWrite(0x23);
    DeviceWrite(0xD9);             // set  VP
    DeviceWrite(0x22);

    // Re-map
    DeviceWrite(0xA1);             // [A0]:column address 0 is map to SEG0

    // [A1]:column address 131 is map to SEG0
    // COM Output Scan Direction
    DeviceWrite(0xC8);             // C0 is COM0 to COMn, C8 is COMn to COM0
    // COM Pins Hardware Configuration
    DeviceWrite(0xDA);              // set pins hardware configuration
    DeviceWrite(0x12);

    // Multiplex Ratio
    DeviceWrite(0xA8);              // set multiplex ratio
    DeviceWrite(0x3F);              // set to 64 mux

    // Display Clock Divide
    DeviceWrite(0xD5);              // set display clock divide
    DeviceWrite(0xA0);              // set to 100Hz

    // Contrast Control Register
    DeviceWrite(0x81);              // Set contrast control
    DeviceWrite(0x60);              // display 0 ~ 127; 2C

    // Display Offset
    DeviceWrite(0xD3);              // set display offset
    DeviceWrite(0x00);              // no offset

    //Normal or Inverse Display
    DeviceWrite(0xA6);              // Normal display
    DeviceWrite(0xAD);              // Set DC-DC
    DeviceWrite(0x8B);              // 8B=ON, 8A=OFF

    // Display ON/OFF
    DeviceWrite(0xAF);              // AF=ON, AE=OFF
    DelayMs(150);

    // Entire Display ON/OFF
    DeviceWrite(0xA4);              // A4=ON

    // Display Start Line
    DeviceWrite(0x40);              // Set display start line

    // Lower Column Address
    DeviceWrite(0x00 + OFFSET);     // Set lower column address

    // Higher Column Address
    DeviceWrite(0x10);              // Set higher column address
    DelayMs(1);
    #elif (DISPLAY_CONTROLLER == SSD1303)

    // Setup Display
    DeviceWrite(0xAE);              // turn off the display (AF=ON, AE=OFF)
    DeviceWrite(0xDB);              // set  VCOMH
    DeviceWrite(0x23);
    DeviceWrite(0xD9);              // set  VP
    DeviceWrite(0x22);
    DeviceWrite(0xAD);              // Set DC-DC
    DeviceWrite(0x8B);              // 8B=ON, 8A=OFF
    DelayMs(1);

    // Display ON/OFF
    DeviceWrite(0xAF);              // AF=ON, AE=OFF

    // Init OLED display using SSD1303 driver
    // Display Clock Divide
    DeviceWrite(0xD5);              // set display clock divide
    DeviceWrite(0xA0);              // set to 100Hz

    // Display Offset
    DeviceWrite(0xD3);              // set display offset
    DeviceWrite(0x00);              // no offset

    // Multiplex Ratio
    DeviceWrite(0xA8);              // set multiplex ratio
    DeviceWrite(0x3F);              // set to 64 mux

    // Display Start Line
    DeviceWrite(0x40);              // Set display start line
    // Re-map
    DeviceWrite(0xA0);              // [A0]:column address 0 is map to SEG0

    // [A1]:column address 131 is map to SEG0
    // COM Output Scan Direction
    DeviceWrite(0xC8);              // C0 is COM0 to COMn, C8 is COMn to COM0

    // COM Pins Hardware Configuration
    DeviceWrite(0xDA);              // set pins hardware configuration
    DeviceWrite(0x12);

    // Contrast Control Register
    DeviceWrite(0x81);              // Set contrast control
    DeviceWrite(0x60);              // display 0 ~ 127; 2C

    // Entire Display ON/OFF
    DeviceWrite(0xA4);              // A4=ON

    //Normal or Inverse Display
    DeviceWrite(0xA6);              // Normal display

#ifdef DISABLE_DC_DC_CONVERTER
    DeviceWrite(0x8A);
#else
    DeviceWrite(0x8B);              // 8B=ON, 8A=OFF
#endif

    // Lower Column Address
    DeviceWrite(0x00 + OFFSET);     // Set lower column address

    // Higher Column Address
    DeviceWrite(0x10);              // Set higher column address
    DelayMs(1);
    #else
        #error The controller is not supported.
    #endif
    DisplayDisable();
    DisplaySetData();
}

#ifdef USE_TRANSPARENT_COLOR
/*********************************************************************
* Function:  void TransparentColorEnable(GFX_COLOR color)
*
* Overview: Sets current transparent color.
*
* PreCondition: none
*
* Input: color - Color value chosen.
*
* Output: none
*
* Side Effects: none
*
********************************************************************/
void TransparentColorEnable(GFX_COLOR color)
{
    _colorTransparent = color;
    _colorTransparentEnable = TRANSPARENT_COLOR_ENABLE;

}
#endif

/*********************************************************************
* Function: void PutPixel(SHORT x, SHORT y)
*
* PreCondition: none
*
* Input: x,y - pixel coordinates
*
* Output: none
```

```
*
* Side Effects: none
*
* Overview: puts pixel
*
* Note: none
*
********************************************************************/
void PutPixel(SHORT x, SHORT y)
{
    BYTE    page, add, lAddr, hAddr;
    BYTE    mask, display;

    // check if point is in clipping region
    if(_clipRgn)
    {
        if(x < _clipLeft)
            return;
        if(x > _clipRight)
            return;
        if(y < _clipTop)
            return;
        if(y > _clipBottom)
            return;
    }

    // Assign a page address
    if(y < 8)
        page = 0xB0;
    else if(y < 16)
        page = 0xB1;
    else if(y < 24)
        page = 0xB2;
    else if(y < 32)
        page = 0xB3;
    else if(y < 40)
        page = 0xB4;
    else if(y < 48)
        page = 0xB5;
    else if(y < 56)
        page = 0xB6;
    else
        page = 0xB7;

    add = x + OFFSET;
    lAddr = 0x0F & add;             // Low address
    hAddr = 0x10 | (add >> 4);      // High address

    // Calculate mask from rows basically do a y%8 and remainder is bit position
    add = y >> 3;                   // Divide by 8
    add <<= 3;                      // Multiply by 8
    add = y - add;                  // Calculate bit position
    mask = 1 << add;                // Left shift 1 by bit position
    DisplayEnable();

    SetAddress(page, lAddr, hAddr); // Set the address (sets the page,


    // lower and higher column address pointers)
    display = SingleDeviceRead();   // Read to initiate Read transaction on PMP and dummy
read
                                    // (requirement for data synchronization in the
controller)
    display = SingleDeviceRead();   // Read again as a requirement for data synchronization
in the display controller
    display = SingleDeviceRead();   // Read actual data from from display buffer

    if(_color > 0)                  // If non-zero for pixel on
        display |= mask;            // or in mask
    else
        // If 0 for pixel off
        display &= ~mask;           // and with inverted mask
    SetAddress(page, lAddr, hAddr); // Set the address (sets the page,

    // lower and higher column address pointers)
    DeviceWrite(display);             // restore the byte with manipulated bit
    DisplayDisable();
}

/*********************************************************************
* Function: BYTE GetPixel(SHORT x, SHORT y)
*
* PreCondition: none
*
* Input: x,y - pixel coordinates
*
* Output: pixel color
*
* Side Effects: none
*
* Overview: return pixel color at x,y position
*
* Note: none
*
********************************************************************/
BYTE GetPixel(SHORT x, SHORT y)
{
    BYTE    page, add, lAddr, hAddr;
    BYTE    mask, temp, display;

    // check if point is in clipping region
    if(_clipRgn)
    {
        if(x < _clipLeft)
            return (0);
        if(x > _clipRight)
            return (0);
        if(y < _clipTop)
            return (0);
        if(y > _clipBottom)
            return (0);
    }

    // Assign a page address
    if(y < 8)
        page = 0xB0;
    else if(y < 16)
        page = 0xB1;
    else if(y < 24)
        page = 0xB2;
    else if(y < 32)
        page = 0xB3;
    else if(y < 40)
        page = 0xB4;
    else if(y < 48)
        page = 0xB5;
    else if(y < 56)
        page = 0xB6;
    else
        page = 0xB7;

    add = x + OFFSET;
    lAddr = 0x0F & add;             // Low address
    hAddr = 0x10 | (add >> 4);      // High address

    // Calculate mask from rows basically do a y%8 and remainder is bit position
    temp = y >> 3;                  // Divide by 8
    temp <<= 3;                     // Multiply by 8
    temp = y - temp;                // Calculate bit position
    mask = 1 << temp;               // Left shift 1 by bit position
    DisplayEnable();

    SetAddress(page, lAddr, hAddr); // Set the address (sets the page,
    // lower and higher column address pointers)
    display = SingleDeviceRead();   // Read to initiate Read transaction on PMP
                                    // Dummy Read (requirement for data synchronization in
the controller)
    display = DeviceRead();         // Read data from display buffer
    DisplayDisable();

    return (display & mask);        // mask all other bits and return the result
}

/*********************************************************************
* Function: SetClipRgn(left, top, right, bottom)
*
* Overview: Sets clipping region.
*
* PreCondition: none
*
* Input: left - Defines the left clipping region border.
*        top - Defines the top clipping region border.
*        right - Defines the right clipping region border.
*        bottom - Defines the bottom clipping region border.
*
* Output: none
*
* Side Effects: none
*
********************************************************************/
void SetClipRgn(SHORT left, SHORT top, SHORT right, SHORT bottom)
{
    _clipLeft=left;
    _clipTop=top;
    _clipRight=right;
    _clipBottom=bottom;

}

/*********************************************************************
* Function: SetClip(control)
*
* Overview: Enables/disables clipping.
*
* PreCondition: none
*
* Input: control - Enables or disables the clipping.
*           - 0: Disable clipping
*           - 1: Enable clipping
*
* Output: none
*
* Side Effects: none
*
********************************************************************/
void SetClip(BYTE control)
{
    _clipRgn=control;
}

/*********************************************************************
* Function: IsDeviceBusy()
*
* Overview: Returns non-zero if LCD controller is busy
*           (previous drawing operation is not completed).
*
* PreCondition: none
*
* Input: none
*
* Output: Busy status.
*
* Side Effects: none
*
********************************************************************/
```

```
WORD IsDeviceBusy(void)
{
    return (0);
}

/*********************************************************************
* Function: void ClearDevice(void)
*
* PreCondition: none
*
* Input: none
*
* Output: none
*
* Side Effects: none
*
* Overview: clears screen with current color
*
* Note: none
*
********************************************************************/
void ClearDevice(void)
{
    BYTE    i, j;
    DisplayEnable();
    for(i = 0xB0; i < 0xB8; i++)
    {       // Go through all 8 pages
        SetAddress(i, 0x00, 0x10);
        for(j = 0; j < 132; j++)
        {   // Write to all 132 bytes
            DeviceWrite(_color);
        }
    }

    DisplayDisable();
}


#endif // #if defined(USE_GFX_DISPLAY_CONTROLLER_SH1101A)
```

14.3.8 SH1101A_SSD1303.h

Macros

Name	Description
SetPalette (see page 416)	Sets palette register.

Description

This is file SH1101A_SSD1303.h.

Body Source

```
/*****************************************************************************
 *  Module for Microchip Graphics Library
 *  Sino Wealth Microelectronic SH1101A OLED controller driver
 *  Solomon Systech SSD1303 LCD controller driver
  *****************************************************************************
 * FileName:        SH1101A_SSD1303.h
 * Dependencies:    p24Fxxxx.h
 * Processor:       PIC24
 * Compiler:        MPLAB C30
 * Linker:          MPLAB LINK30
 * Company:         Microchip Technology Incorporated
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 * CLAIMS BY THIRD PARTIES (INCLUDING BUT NOT LIMITED TO ANY DEFENSE THEREOF),
 * OR OTHER SIMILAR COSTS.
 *
 * Date         Comment
 *~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
 * 03/10/07     Original
 * 12/20/07     Ported to PIC24 Kit
 * 03/22/11     Modified for Graphics Library Version 3.00
 *****************************************************************************/
#ifndef _SH1101A_SSD1303_OLED_H
    #define _SH1101A_SSD1303_OLED_H

    #include "HardwareProfile.h"
    #include "GenericTypeDefs.h"
    #include "GraphicsConfig.h"

#if defined (USE_GFX_PMP)
    #include "Graphics/gfxpmp.h"
#elif defined (USE_GFX_PMP)
    #include "Graphics/gfxepmp.h"
#endif

    #ifdef USE_16BIT_PMP
        #error This driver doesn't support 16-bit PMP (remove USE_16BIT_PMP option from
HardwareProfile.h)
    #endif
    #ifndef DISP_HOR_RESOLUTION
        #error DISP_HOR_RESOLUTION must be defined in HardwareProfile.h
    #endif
    #ifndef DISP_VER_RESOLUTION
        #error DISP_VER_RESOLUTION must be defined in HardwareProfile.h
    #endif
    #ifndef COLOR_DEPTH
        #error COLOR_DEPTH must be defined in GraphicsConfig.h
    #endif
    #ifndef DISP_ORIENTATION
        #error DISP_ORIENTATION must be defined in HardwareProfile.h
    #endif

/*********************************************************************
* Overview: Horizontal and vertical screen size.
*********************************************************************/
    #if (DISP_HOR_RESOLUTION != 128)
        #error This driver doesn't supports this resolution. Horisontal resolution must be
128 pixels.
    #endif
    #if (DISP_VER_RESOLUTION != 64)
        #error This driver doesn't supports this resolution. Vertical resolution must be 64
pixels.
    #endif

/*********************************************************************
* Overview: Display orientation.
```

```
*********************************************************************/
    #if (DISP_ORIENTATION != 0)
        #error This driver doesn't support this orientation.
    #endif

/*********************************************************************
* Overview: Defines the display offset in x direction. Dependent on the display
* used and how it is connected.
*********************************************************************/
    #define OFFSET  2

/*********************************************************************
* Overview: Clipping region control codes to be used with SetClip(...)
*           function.
*********************************************************************/
    #define CLIP_DISABLE    0   // Disables clipping.
    #define CLIP_ENABLE     1   // Enables clipping.

/*********************************************************************
* Overview: Screen Saver parameters.
*           - SSON - Means that screen saver will be enabled when
*                    ScreenSaver(SSON) function is called with SSON as
*                    parameter.
*           - SSOFF - Means that screen saver will be disbled when
*                    ScreenSaver(SSOFF) function is called with SSOFF as
*                    parameter.
*
*********************************************************************/
    #define SSON    1           // screen saver is turned on
    #define SSOFF   0           // screen saver is turned off

    // Memory pitch for line
    #define LINE_MEM_PITCH  0x100

/*********************************************************************
* Macros: SetPalette(colorNum, color)
*
* Overview:  Sets palette register.
*
* PreCondition: none
*
* Input: colorNum - Register number.
*        color - Color.
*
* Output: none
*
* Side Effects: none
*
********************************************************************/
    #define SetPalette(colorNum, color)

#endif // _SH1101A_SSD1303_OLED_H
```

14.3.9 SSD1339.c

This is file SSD1339.c.

Body Source

```
/*****************************************************************************
 *  Module for Microchip Graphics Library
 *  Solomon Systech SSD1339 OLED display controller driver
  *****************************************************************************
 * FileName:        SSD1339.c
 * Dependencies:    Graphics.h
 * Processor:       PIC24
 * Compiler:        MPLAB C30
 * Linker:          MPLAB LINK30
 * Company:         Microchip Technology Incorporated
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 * OR OTHER SIMILAR COSTS.
 *
 * Date         Comment
 *~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
 * 11/12/07     Version 1.0 release
 * 04/11/11     - Modified for Graphics Library Version 3.00
 *              - Replace color data type from WORD_VAL to GFX_COLOR
 *              - Replace DeviceInit() to DriverInterfaceInit()
 *****************************************************************************/
#include "HardwareProfile.h"

#if defined(GFX_USE_DISPLAY_CONTROLLER_SSD1339)

#include "Compiler.h"
#include "GenericTypeDefs.h"
#include "Graphics/DisplayDriver.h"
#include "Graphics/SSD1339.h"
#include "Graphics/Primitive.h"

#if defined (USE_GFX_PMP)
    #include "Graphics/gfxpmp.h"
#elif defined (USE_GFX_PMP)
    #include "Graphics/gfxepmp.h"
#endif

// Unsupported Graphics Library Features
#ifdef USE_TRANSPARENT_COLOR
    #warning "This driver does not support the transparent feature on PutImage(). Build
will use the PutImage() functions defined in the Primitive.c"
#endif

// Color
GFX_COLOR    _color;
#ifdef USE_TRANSPARENT_COLOR
GFX_COLOR   _colorTransparent;
SHORT       _colorTransparentEnable;
#endif

// Clipping region control
SHORT       _clipRgn;

// Clipping region borders
SHORT       _clipLeft;
SHORT       _clipTop;
SHORT       _clipRight;
SHORT       _clipBottom;

////////////////////// LOCAL FUNCTIONS PROTOTYPES ////////////////////////////
```

```
#ifndef USE_TRANSPARENT_COLOR
void        PutImage1BPP(SHORT left, SHORT top, FLASH_BYTE *image, BYTE stretch);
void        PutImage4BPP(SHORT left, SHORT top, FLASH_BYTE *image, BYTE stretch);
void        PutImage8BPP(SHORT left, SHORT top, FLASH_BYTE *image, BYTE stretch);
void        PutImage16BPP(SHORT left, SHORT top, FLASH_BYTE *image, BYTE stretch);

void        PutImage1BPPExt(SHORT left, SHORT top, void *image, BYTE stretch);
void        PutImage4BPPExt(SHORT left, SHORT top, void *image, BYTE stretch);
void        PutImage8BPPExt(SHORT left, SHORT top, void *image, BYTE stretch);
void        PutImage16BPPExt(SHORT left, SHORT top, void *image, BYTE stretch);
#endif

/*********************************************************************
* Macros:  SetAddress(x, y)
*
* PreCondition: none
*
* Input: x,y - start x,y position
*
* Output: none
*
* Side Effects: none
*
* Overview: sets pointer to to write/read operations
*
* Note: none
*
********************************************************************/
#define SetAddress(x, y) \
    DisplaySetCommand(); \
    DeviceWrite(CMD_COL); \
    DisplaySetData(); \
    DeviceWrite(x); \
    DisplaySetCommand(); \
    DeviceWrite(CMD_ROW); \
    DisplaySetData(); \
    DeviceWrite(y);

/*********************************************************************
* Function:  void ResetDevice()
*
* PreCondition: none
*
* Input: none
*
* Output: none
*
* Side Effects: none
*
* Overview: resets LCD, initializes PMP
*
* Note: none
*
********************************************************************/
void ResetDevice(void)
{
    // Initialize device
    DriverInterfaceInit();

    // Enable LCD
    DisplayEnable();

    // Setup display
    DisplaySetCommand();
    DeviceWrite(CMD_DISPON);
    DeviceWrite(CMD_MODE);
    DisplaySetData();
    DeviceWrite(0x74);
    DisplaySetCommand();
    DeviceWrite(CMD_SRTLINE);
    DisplaySetData();
    DeviceWrite(128);
    // Disable LCD
    DisplayDisable();
}

#ifdef USE_TRANSPARENT_COLOR
/*********************************************************************
* Function:  void TransparentColorEnable(GFX_COLOR color)
*
* Overview: Sets current transparent color.
*
* PreCondition: none
*
* Input: color - Color value chosen.
*
* Output: none
*
* Side Effects: none
*
********************************************************************/
void TransparentColorEnable(GFX_COLOR color)
{
    _colorTransparent = color;
    _colorTransparentEnable = TRANSPARENT_COLOR_ENABLE;

}
#endif

/*********************************************************************
* Function: void PutPixel(SHORT x, SHORT y)
*
* PreCondition: none
*
* Input: x,y - pixel coordinates
*
* Output: none
*
* Side Effects: none
*
* Overview: puts pixel
*
* Note: none
*
********************************************************************/
void PutPixel(SHORT x, SHORT y)
{
    if(_clipRgn)
    {
        if(x < _clipLeft)
            return;
        if(x > _clipRight)
            return;
        if(y < _clipTop)
            return;
        if(y > _clipBottom)
            return;
    }

    DisplayEnable();
    SetAddress(x, y);
    DisplaySetCommand();
    DeviceWrite(CMD_WRITE);
    DisplaySetData();
    DeviceWrite(((WORD_VAL)_color).v[1]);
    DeviceWrite(((WORD_VAL)_color).v[0]);
    DisplayDisable();
}

/*********************************************************************
* Function: WORD GetPixel(SHORT x, SHORT y)
*
* PreCondition: none
```

```
*
* Input: x,y - pixel coordinates
*
* Output: pixel color
*
* Side Effects: none
*
* Overview: return pixel color at x,y position
*
* Note: none
*
********************************************************************/
WORD GetPixel(SHORT x, SHORT y)
{
    WORD_VAL    result;

    DisplayEnable();

    SetAddress(x, y);

    DisplaySetCommand();
    DeviceWrite(CMD_READ);
    DisplaySetData();

    result.v[0] = DeviceRead();
    result.v[1] = DeviceRead();

    DisplayDisable();

    return (result.Val);
}

/*********************************************************************
* Function: WORD Bar(SHORT left, SHORT top, SHORT right, SHORT bottom)
*
* PreCondition: none
*
* Input: left,top - top left corner coordinates,
*        right,bottom - bottom right corner coordinates
*
* Output: For NON-Blocking configuration:
*         - Returns 0 when device is busy and the shape is not yet completely drawn.
*         - Returns 1 when the shape is completely drawn.
*         For Blocking configuration:
*         - Always return 1.
*
* Side Effects: none
*
* Overview: draws rectangle filled with current color
*
* Note: none
*
********************************************************************/
WORD Bar(SHORT left, SHORT top, SHORT right, SHORT bottom)
{
    SHORT   x, y;

    #ifndef USE_NONBLOCKING_CONFIG
    while(IsDeviceBusy() != 0);

    /* Ready */
    #else
    if(IsDeviceBusy() != 0)
        return (0);
    #endif
    if(_clipRgn)
    {
        if(left < _clipLeft)
            left = _clipLeft;
        if(right > _clipRight)
            right = _clipRight;
        if(top < _clipTop)
```

```
            top = _clipTop;
        if(bottom > _clipBottom)
            bottom = _clipBottom;
    }

    DisplayEnable();

    for(y = top; y < bottom + 1; y++)
    {
        SetAddress(left, top);
        DisplaySetCommand();
        DeviceWrite(CMD_WRITE);
        DisplaySetData();
        for(x = left; x < right + 1; x++)
        {
            DeviceWrite(((WORD_VAL)_color).v[1]);
            DeviceWrite(((WORD_VAL)_color).v[0]);
        }
    }

    DisplayDisable();
    return (1);
}

/*********************************************************************
* Function: SetClipRgn(left, top, right, bottom)
*
* Overview: Sets clipping region.
*
* PreCondition: none
*
* Input: left - Defines the left clipping region border.
*        top - Defines the top clipping region border.
*        right - Defines the right clipping region border.
*        bottom - Defines the bottom clipping region border.
*
* Output: none
*
* Side Effects: none
*
********************************************************************/
void SetClipRgn(SHORT left, SHORT top, SHORT right, SHORT bottom)
{
    _clipLeft=left;
    _clipTop=top;
    _clipRight=right;
    _clipBottom=bottom;

}

/*********************************************************************
* Function: SetClip(control)
*
* Overview: Enables/disables clipping.
*
* PreCondition: none
*
* Input: control - Enables or disables the clipping.
*           - 0: Disable clipping
*           - 1: Enable clipping
*
* Output: none
*
* Side Effects: none
*
********************************************************************/
void SetClip(BYTE control)
{
    _clipRgn=control;
}

/*********************************************************************
```

```
* Function: IsDeviceBusy()
*
* Overview: Returns non-zero if LCD controller is busy
*           (previous drawing operation is not completed).
*
* PreCondition: none
*
* Input: none
*
* Output: Busy status.
*
* Side Effects: none
*
********************************************************************/
WORD IsDeviceBusy(void)
{
    return (0);
}

/*********************************************************************
* Function: void ClearDevice(void)
*
* PreCondition: none
*
* Input: none
*
* Output: none
*
* Side Effects: none
*
* Overview: clears screen with current color
*
* Note: none
*
********************************************************************/
void ClearDevice(void)
{
    DWORD   counter;

    DisplayEnable();
    SetAddress(0, 0);
    DisplaySetCommand();
    DeviceWrite(CMD_WRITE);
    DisplaySetData();
    for(counter = 0; counter < (DWORD) (GetMaxX() + 1) * (GetMaxY() + 1); counter++)
    {
        DeviceWrite(((WORD_VAL)_color).v[1]);
        DeviceWrite(((WORD_VAL)_color).v[0]);
    }

    DisplayDisable();
}

#ifndef USE_TRANSPARENT_COLOR

#ifdef USE_BITMAP_FLASH

/*********************************************************************
* Function: void PutImage1BPP(SHORT left, SHORT top, FLASH_BYTE* image, BYTE stretch)
*
* PreCondition: none
*
* Input: left,top - left top image corner, image - image pointer,
*        stretch - image stretch factor
*
* Output: none
*
* Side Effects: none
*
* Overview: outputs monochrome image starting from left,top coordinates
*
* Note: image must be located in flash
```

```
*
********************************************************************/
void PutImage1BPP(SHORT left, SHORT top, FLASH_BYTE *image, BYTE stretch)
{
    register FLASH_BYTE *flashAddress;
    register FLASH_BYTE *tempFlashAddress;
    BYTE                temp;
    WORD                sizeX, sizeY;
    WORD                x, y;
    BYTE                stretchX, stretchY;
    WORD                pallete[2];
    BYTE                mask;

    // Move pointer to size information
    flashAddress = image + 2;

    // Read image size
    sizeY = *((FLASH_WORD *)flashAddress);
    flashAddress += 2;
    sizeX = *((FLASH_WORD *)flashAddress);
    flashAddress += 2;
    pallete[0] = *((FLASH_WORD *)flashAddress);
    flashAddress += 2;
    pallete[1] = *((FLASH_WORD *)flashAddress);
    flashAddress += 2;

    DisplayEnable();
    for(y = 0; y < sizeY; y++)
    {
        tempFlashAddress = flashAddress;
        for(stretchY = 0; stretchY < stretch; stretchY++)
        {
            flashAddress = tempFlashAddress;
            SetAddress(left, top + y);
            DisplaySetCommand();
            DeviceWrite(CMD_WRITE);
            DisplaySetData();
            mask = 0;
            for(x = 0; x < sizeX; x++)
            {

                // Read 8 pixels from flash
                if(mask == 0)
                {
                    temp = *flashAddress;
                    flashAddress++;
                    mask = 0x80;
                }

                // Set color
                if(mask & temp)
                {
                    SetColor(pallete[1]);
                }
                else
                {
                    SetColor(pallete[0]);
                }

                // Write pixel to screen
                for(stretchX = 0; stretchX < stretch; stretchX++)
                {
                    DeviceWrite(((WORD_VAL)_color).v[1]);
                    DeviceWrite(((WORD_VAL)_color).v[0]);
                }

                // Shift to the next pixel
                mask >>= 1;
            }
        }
    }
    DisplayDisable();
}

/*********************************************************************
* Function: void PutImage4BPP(SHORT left, SHORT top, FLASH_BYTE* image, BYTE stretch)
*
* PreCondition: none
*
* Input: left,top - left top image corner, image - image pointer,
*        stretch - image stretch factor
*
* Output: none
*
* Side Effects: none
*
* Overview: outputs 16 color image starting from left,top coordinates
*
* Note: image must be located in flash
*
********************************************************************/
void PutImage4BPP(SHORT left, SHORT top, FLASH_BYTE *image, BYTE stretch)
{
    register FLASH_BYTE *flashAddress;
    register FLASH_BYTE *tempFlashAddress;
    WORD                sizeX, sizeY;
    register WORD       x, y;
    BYTE                temp;
    register BYTE       stretchX, stretchY;
    WORD                pallete[16];
    WORD                counter;

    // Move pointer to size information
    flashAddress = image + 2;

    // Read image size
    sizeY = *((FLASH_WORD *)flashAddress);
    flashAddress += 2;
    sizeX = *((FLASH_WORD *)flashAddress);
    flashAddress += 2;

    // Read pallete
    for(counter = 0; counter < 16; counter++)
    {
        pallete[counter] = *((FLASH_WORD *)flashAddress);
        flashAddress += 2;
    }

    DisplayEnable();
    for(y = 0; y < sizeY; y++)
    {
        tempFlashAddress = flashAddress;
        for(stretchY = 0; stretchY < stretch; stretchY++)
        {
            flashAddress = tempFlashAddress;
            SetAddress(left, top + y);
            DisplaySetCommand();
            DeviceWrite(CMD_WRITE);
            DisplaySetData();
            for(x = 0; x < sizeX; x++)
            {

                // Read 2 pixels from flash
                if((x & 0x0001) == 0)
                {

                    // Set color
                    SetColor(pallete[temp >> 4]);
                }
                else
                {
                    temp = *flashAddress;
                    flashAddress++;
                    // Set color
                    SetColor(pallete[temp & 0x0f]);
                }

                // Write pixel to screen
                for(stretchX = 0; stretchX < stretch; stretchX++)
                {
                    DeviceWrite(((WORD_VAL)_color).v[1]);
                    DeviceWrite(((WORD_VAL)_color).v[0]);
                }

                // Shift to the next pixel
                temp >>= 4;
            }
        }
    }

    DisplayDisable();
}

/*********************************************************************
* Function: void PutImage8BPP(SHORT left, SHORT top, FLASH_BYTE* image, BYTE stretch)
*
* PreCondition: none
*
* Input: left,top - left top image corner, image - image pointer,
*        stretch - image stretch factor
*
* Output: none
*
* Side Effects: none
*
* Overview: outputs 256 color image starting from left,top coordinates
*
* Note: image must be located in flash
*
********************************************************************/
void PutImage8BPP(SHORT left, SHORT top, FLASH_BYTE *image, BYTE stretch)
{
    register FLASH_BYTE *flashAddress;
    register FLASH_BYTE *tempFlashAddress;
    WORD                sizeX, sizeY;
    WORD                x, y;
    BYTE                temp;
    BYTE                stretchX, stretchY;
    WORD                pallete[256];
    WORD                counter;

    // Move pointer to size information
    flashAddress = image + 2;

    // Read image size
    sizeY = *((FLASH_WORD *)flashAddress);
    flashAddress += 2;
    sizeX = *((FLASH_WORD *)flashAddress);
    flashAddress += 2;

    // Read pallete
    for(counter = 0; counter < 256; counter++)
    {
        pallete[counter] = *((FLASH_WORD *)flashAddress);
        flashAddress += 2;
    }

    DisplayEnable();
    for(y = 0; y < sizeY; y++)
    {
        tempFlashAddress = flashAddress;
        for(stretchY = 0; stretchY < stretch; stretchY++)
        {
            flashAddress = tempFlashAddress;
            SetAddress(left, top + y);
            DisplaySetCommand();
            DeviceWrite(CMD_WRITE);
            DisplaySetData();
            for(x = 0; x < sizeX; x++)
            {

                // Read pixels from flash
                temp = *flashAddress;
                flashAddress++;

                // Set color
                SetColor(pallete[temp]);

                // Write pixel to screen
                for(stretchX = 0; stretchX < stretch; stretchX++)
                {
                    DeviceWrite(((WORD_VAL)_color).v[1]);
                    DeviceWrite(((WORD_VAL)_color).v[0]);
                }
            }
        }
    }

    DisplayDisable();
}

/*********************************************************************
* Function: void PutImage16BPP(SHORT left, SHORT top, FLASH_BYTE* image, BYTE stretch)
*
* PreCondition: none
*
* Input: left,top - left top image corner, image - image pointer,
*        stretch - image stretch factor
*
* Output: none
*
* Side Effects: none
*
* Overview: outputs hicolor image starting from left,top coordinates
*
* Note: image must be located in flash
*
********************************************************************/
void PutImage16BPP(SHORT left, SHORT top, FLASH_BYTE *image, BYTE stretch)
{
    register FLASH_WORD *flashAddress;
    register FLASH_WORD *tempFlashAddress;
    WORD                sizeX, sizeY;
    register WORD       x, y;
    WORD                temp;
    register BYTE       stretchX, stretchY;

    // Move pointer to size information
    flashAddress = (FLASH_WORD *)image + 1;

    // Read image size
    sizeY = *flashAddress;
    flashAddress++;
    sizeX = *flashAddress;
    flashAddress++;

    DisplayEnable();
    for(y = 0; y < sizeY; y++)
    {
        tempFlashAddress = flashAddress;
        for(stretchY = 0; stretchY < stretch; stretchY++)
        {
            flashAddress = tempFlashAddress;
            SetAddress(left, top + y);
            DisplaySetCommand();
            DeviceWrite(CMD_WRITE);
            DisplaySetData();
            for(x = 0; x < sizeX; x++)
            {

                // Read pixels from flash
                temp = *flashAddress;
                flashAddress++;

                // Set color
                SetColor(temp);

                // Write pixel to screen
                for(stretchX = 0; stretchX < stretch; stretchX++)
                {
                    DeviceWrite(((WORD_VAL)_color).v[1]);
                    DeviceWrite(((WORD_VAL)_color).v[0]);
                }
            }
        }
    }

    DisplayDisable();
}

#endif //USE_BITMAP_FLASH
#ifdef USE_BITMAP_EXTERNAL

/*********************************************************************
* Function: void PutImage1BPPExt(SHORT left, SHORT top, void* image, BYTE stretch)
*
* PreCondition: none
*
* Input: left,top - left top image corner, image - image pointer,
*        stretch - image stretch factor
*
* Output: none
*
* Side Effects: none
*
* Overview: outputs monochrome image starting from left,top coordinates
*
* Note: image must be located in flash
*
********************************************************************/
void PutImage1BPPExt(SHORT left, SHORT top, void *image, BYTE stretch)
{
    register DWORD  memOffset;
    BITMAP_HEADER   bmp;
    WORD            pallete[2];
    BYTE            lineBuffer[((GetMaxX() + 1) / 8) + 1];
    BYTE            *pData;
    SHORT           byteWidth;

    BYTE            temp;
    BYTE            mask;
    WORD            sizeX, sizeY;
    WORD            x, y;
    BYTE            stretchX, stretchY;

    // Get image header
    ExternalMemoryCallback(image, 0, sizeof(BITMAP_HEADER), &bmp);

    // Get pallete (2 entries)
    ExternalMemoryCallback(image, sizeof(BITMAP_HEADER), 2 * sizeof(WORD), pallete);

    // Set offset to the image data
    memOffset = sizeof(BITMAP_HEADER) + 2 * sizeof(WORD);

    // Line width in bytes
    byteWidth = bmp.width >> 3;
    if(bmp.width & 0x0007)
        byteWidth++;
    // Get size
    sizeX = bmp.width;
    sizeY = bmp.height;

    for(y = 0; y < sizeY; y++)
    {

        // Get line
        ExternalMemoryCallback(image, memOffset, byteWidth, lineBuffer);
        memOffset += byteWidth;
        DisplayEnable();
        for(stretchY = 0; stretchY < stretch; stretchY++)
        {
            pData = lineBuffer;
            SetAddress(left, top + y);
            DisplaySetCommand();
            DeviceWrite(CMD_WRITE);
            DisplaySetData();
            mask = 0;
            for(x = 0; x < sizeX; x++)
            {

                // Read 8 pixels from flash
                if(mask == 0)
                {
                    temp = *pData++;
                    mask = 0x80;
                }

                // Set color
                if(mask & temp)
                {
                    SetColor(pallete[1]);
                }
                else
                {
                    SetColor(pallete[0]);
                }

                // Write pixel to screen
                for(stretchX = 0; stretchX < stretch; stretchX++)
                {
                    DeviceWrite(((WORD_VAL)_color).v[1]);
                    DeviceWrite(((WORD_VAL)_color).v[0]);
                }

                // Shift to the next pixel
                mask >>= 1;
            }
        }

        DisplayDisable();
    }
}

/*********************************************************************
* Function: void PutImage4BPPExt(SHORT left, SHORT top, void* image, BYTE stretch)
*
* PreCondition: none
*
* Input: left,top - left top image corner, image - image pointer,
*        stretch - image stretch factor
*
* Output: none
*
* Side Effects: none
*
* Overview: outputs monochrome image starting from left,top coordinates
*
* Note: image must be located in flash
*
```

```
*******************************************************************/
void PutImage4BPPExt(SHORT left, SHORT top, void *image, BYTE stretch)
{
    register DWORD  memOffset;
    BITMAP_HEADER   bmp;
    WORD            pallete[16];
    BYTE            lineBuffer[((GetMaxX() + 1) / 2) + 1];
    BYTE            *pData;
    SHORT           byteWidth;

    BYTE            temp;
    WORD            sizeX, sizeY;
    WORD            x, y;
    BYTE            stretchX, stretchY;

    // Get image header
    ExternalMemoryCallback(image, 0, sizeof(BITMAP_HEADER), &bmp);

    // Get pallete (16 entries)
    ExternalMemoryCallback(image, sizeof(BITMAP_HEADER), 16 * sizeof(WORD), pallete);

    // Set offset to the image data
    memOffset = sizeof(BITMAP_HEADER) + 16 * sizeof(WORD);

    // Line width in bytes
    byteWidth = bmp.width >> 1;
    if(bmp.width & 0x0001)
        byteWidth++;

    // Get size
    sizeX = bmp.width;
    sizeY = bmp.height;

    for(y = 0; y < sizeY; y++)
    {

        // Get line
        ExternalMemoryCallback(image, memOffset, byteWidth, lineBuffer);
        memOffset += byteWidth;
        DisplayEnable();
        for(stretchY = 0; stretchY < stretch; stretchY++)
        {
            pData = lineBuffer;
            SetAddress(left, top + y);
            DisplaySetCommand();
            DeviceWrite(CMD_WRITE);
            DisplaySetData();
            for(x = 0; x < sizeX; x++)
            {

                // Read 2 pixels from flash
                if(x & 0x0001)
                {

                    // second pixel in byte
                    SetColor(pallete[temp >> 4]);
                }
                else
                {
                    temp = *pData++;

                    // first pixel in byte
                    SetColor(pallete[temp & 0x0f]);
                }

                // Set color
                SetColor(pallete[temp & 0x0f]);

                // Write pixel to screen
                for(stretchX = 0; stretchX < stretch; stretchX++)
                {
                    DeviceWrite(((WORD_VAL)_color).v[1]);
                    DeviceWrite(((WORD_VAL)_color).v[0]);
                }

                // Shift to the next pixel
                temp >>= 4;
            }
        }

        DisplayDisable();
    }
}

/*********************************************************************
* Function: void PutImage8BPPExt(SHORT left, SHORT top, void* image, BYTE stretch)
*
* PreCondition: none
*
* Input: left,top - left top image corner, image - image pointer,
*        stretch - image stretch factor
*
* Output: none
*
* Side Effects: none
*
* Overview: outputs monochrome image starting from left,top coordinates
*
* Note: image must be located in flash
*
********************************************************************/
void PutImage8BPPExt(SHORT left, SHORT top, void *image, BYTE stretch)
{
    register DWORD  memOffset;
    BITMAP_HEADER   bmp;
    WORD            pallete[256];
    BYTE            lineBuffer[(GetMaxX() + 1)];
    BYTE            *pData;

    BYTE            temp;
    WORD            sizeX, sizeY;
    WORD            x, y;
    BYTE            stretchX, stretchY;

    // Get image header
    ExternalMemoryCallback(image, 0, sizeof(BITMAP_HEADER), &bmp);

    // Get pallete (256 entries)
    ExternalMemoryCallback(image, sizeof(BITMAP_HEADER), 256 * sizeof(WORD), pallete);

    // Set offset to the image data
    memOffset = sizeof(BITMAP_HEADER) + 256 * sizeof(WORD);

    // Get size
    sizeX = bmp.width;
    sizeY = bmp.height;

    for(y = 0; y < sizeY; y++)
    {

        // Get line
        ExternalMemoryCallback(image, memOffset, sizeX, lineBuffer);
        memOffset += sizeX;
        DisplayEnable();
        for(stretchY = 0; stretchY < stretch; stretchY++)
        {
            pData = lineBuffer;
            SetAddress(left, top + y);
            DisplaySetCommand();
            DeviceWrite(CMD_WRITE);
            DisplaySetData();
            for(x = 0; x < sizeX; x++)
            {
                // Read pixels from flash
                temp = *pData++;

                // Set color
                SetColor(pallete[temp]);

                // Write pixel to screen
                for(stretchX = 0; stretchX < stretch; stretchX++)
                {
                    DeviceWrite(((WORD_VAL)_color).v[1]);
                    DeviceWrite(((WORD_VAL)_color).v[0]);
                }
            }
        }

        DisplayDisable();
    }
}

/*********************************************************************
* Function: void PutImage16BPPExt(SHORT left, SHORT top, void* image, BYTE stretch)
*
* PreCondition: none
*
* Input: left,top - left top image corner, image - image pointer,
*        stretch - image stretch factor
*
* Output: none
*
* Side Effects: none
*
* Overview: outputs monochrome image starting from left,top coordinates
*
* Note: image must be located in flash
*
********************************************************************/
void PutImage16BPPExt(SHORT left, SHORT top, void *image, BYTE stretch)
{
    register DWORD  memOffset;
    BITMAP_HEADER   bmp;
    WORD            lineBuffer[(GetMaxX() + 1)];
    WORD            *pData;
    WORD            byteWidth;

    WORD            temp;
    WORD            sizeX, sizeY;
    WORD            x, y;
    BYTE            stretchX, stretchY;

    // Get image header
    ExternalMemoryCallback(image, 0, sizeof(BITMAP_HEADER), &bmp);

    // Set offset to the image data
    memOffset = sizeof(BITMAP_HEADER);

    // Get size
    sizeX = bmp.width;
    sizeY = bmp.height;

    byteWidth = sizeX << 1;

    for(y = 0; y < sizeY; y++)
    {

        // Get line
        ExternalMemoryCallback(image, memOffset, byteWidth, lineBuffer);
        memOffset += byteWidth;
        DisplayEnable();
        for(stretchY = 0; stretchY < stretch; stretchY++)
        {
            pData = lineBuffer;
            SetAddress(left, top + y);
```

```
                DisplaySetCommand();
                DeviceWrite(CMD_WRITE);
                DisplaySetData();
                for(x = 0; x < sizeX; x++)
                {

                    // Read pixels from flash
                    temp = *pData++;

                    // Set color
                    SetColor(temp);

                    // Write pixel to screen
                    for(stretchX = 0; stretchX < stretch; stretchX++)
                    {
                        DeviceWrite(((WORD_VAL)_color).v[1]);
                        DeviceWrite(((WORD_VAL)_color).v[0]);
                    }
                }
            }

            DisplayDisable();
        }
    }

#endif // USE_BITMAP_EXTERNAL
#endif //#ifndef USE_TRANSPARENT_COLOR
#endif //if defined(GFX_USE_DISPLAY_CONTROLLER_SSD1339)
```

14.3.10 SSD1339.h

This is file SSD1339.h.

Body Source

```
/*****************************************************************************
 *  Module for Microchip Graphics Library
 *  Solomon Systech. SSD1339 OLED display controller driver
 *****************************************************************************
 * FileName:        SSD1339.h
 * Dependencies:    p24Fxxxx.h
 * Processor:       PIC24
 * Compiler:        MPLAB C30
 * Linker:          MPLAB LINK30
 * Company:         Microchip Technology Incorporated
 *
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 * INDIRECT, PUNITIVE OR CONSEQUENTIAL DAMAGES, LOST PROFITS OR LOST DATA,
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```

```
  * CLAIMS BY THIRD PARTIES (INCLUDING BUT NOT LIMITED TO ANY DEFENSE THEREOF),
  * OR OTHER SIMILAR COSTS.
  *
  * Date         Comment
  *~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
  * 11/12/07     Version 1.0 release
  * 04/11/11     - Modified for Graphics Library Version 3.00
  *****************************************************************************/
#ifndef _SSD1339_H
    #define _SSD1339_H

    #include "HardwareProfile.h"
    #include "GenericTypeDefs.h"
    #include "GraphicsConfig.h"

#if defined (USE_GFX_PMP)
    #include "Graphics/gfxpmp.h"
#elif defined (USE_GFX_PMP)
    #include "Graphics/gfxepmp.h"
#endif

    #ifdef USE_16BIT_PMP
        #error This driver doesn't support 16-bit PMP (remove USE_16BIT_PMP option from
HardwareProfile.h)
    #endif
    #ifndef DISP_HOR_RESOLUTION
        #error DISP_HOR_RESOLUTION must be defined in HardwareProfile.h
    #endif
    #ifndef DISP_VER_RESOLUTION
        #error DISP_VER_RESOLUTION must be defined in HardwareProfile.h
    #endif
    #ifndef COLOR_DEPTH
        #error COLOR_DEPTH must be defined in GraphicsConfig.h
    #endif
    #ifndef DISP_ORIENTATION
        #error DISP_ORIENTATION must be defined in HardwareProfile.h
    #endif

/*********************************************************************
* Overview: Horizontal and vertical screen size.
*********************************************************************/
    #if (DISP_HOR_RESOLUTION != 128)
        #error This driver doesn't supports this resolution. Horisontal resolution must be
128 pixels.
    #endif
    #if (DISP_VER_RESOLUTION != 128)
        #error This driver doesn't supports this resolution. Vertical resolution must be
128 pixels.
    #endif

/*********************************************************************
* Overview: Display orientation.
*********************************************************************/
    #if (DISP_ORIENTATION != 0)
        #error This driver doesn't support this orientation.
    #endif

/*********************************************************************
* Overview: Color depth.
*********************************************************************/
    #if (COLOR_DEPTH != 16)
        #error This driver doesn't support this color depth. It should be 16.
    #endif

// Clipping region control codes
    #define CLIP_DISABLE    0
    #define CLIP_ENABLE     1

// Display commands
    #define CMD_COL         0x15
    #define CMD_ROW         0x75
    #define CMD_WRITE       0x5C
```

```
    #define CMD_READ        0x5D
    #define CMD_MODE        0xA0
    #define CMD_SRTLINE     0xA1
    #define CMD_DISPON      0xAF
    #define CMD_DISPOFF     0xAE
    #define CMD_FILLMODE    0x92
    #define CMD_RECT        0x84


/*********************************************************************
* Macros: SetPalette(colorNum, color)
*
* PreCondition: none
*
* Input: colorNum - register number, color - color
*
* Output: none
*
* Side Effects: none
*
* Overview:  sets palette register
*
* Note: SSD1339 has no palette
*
********************************************************************/
    #define SetPalette(colorNum, color)


#endif // _SSD1339_H
```

14.3.11 SSD1926.c

This is file SSD1926.c.

Body Source

```
/*****************************************************************************
 *  Module for Microchip Graphics Library
 *  Solomon Systech. SSD1926 LCD controller driver
 *  to be used with GFX 3 PICtail board
 *****************************************************************************
 * FileName:        SSD1926.c
 * Processor:       PIC24, PIC32
 * Compiler:        MPLAB C30, MPLAB C32
 * Company:         Microchip Technology Incorporated
 *
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 *
 * Date         Comment
 *~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
 * 08/27/08
 * 06/25/09     dsPIC & PIC24H support
 * 07/30/09     Added Palette Support
 * 02/05/10     Fixed GetPixel() bug
 * 03/03/10     Fixed Circle() bug
 * 03/26/10     Fixed Line2D() bug
 * 07/28/10     Add USE_DRV_PUTIMAGE label to PutImage() related functions
 *              to fix build error when driver PutImage() is not used.
 * 01/27/11     Fixed Bar() bug when clipping region is enabled.
 * 02/11/11     Added backlight enabling after display controller and
 *              Timing Controller (TCON) initialization.
 * 02/14/11     - Removed USE_DRV_xxxx switches. This is not needed anymore
 *                since Primitive Layer implements weak attributes on
 *                Primitive Routines that can be implemented in hardware.
 *              - Removed Circle Function implementation (SSD1926 bug)
 *              - Replace color data type from WORD_VAL to GFX_COLOR
 *              - Replace DeviceInit() to DriverInterfaceInit()
 *              - Optimized PutImageXBPP() & PutImageXBPPExt() for performance.
 *              - Added transparent color feature in PutImageXBPP() and
 *                PutImageXBPPExt().
 *              - Added DisplayBrightness() to control the backlight.
 *              - Added GFX_LCD_TYPE to select type of display
 *****************************************************************************/
#include "HardwareProfile.h"

#if defined(GFX_USE_DISPLAY_CONTROLLER_SSD1926)

#include "Compiler.h"
#include "TimeDelay.h"
#include "Graphics/DisplayDriver.h"
#include "Graphics/SSD1926.h"
#include "Graphics/gfxtcon.h"
#include "Graphics/Primitive.h"


#if defined (USE_GFX_PMP)
    #include "Graphics/gfxpmp.h"
#elif defined (USE_GFX_EPMP)
    #include "Graphics/gfxepmp.h"
#endif

// Color
GFX_COLOR   _color;
#ifdef USE_TRANSPARENT_COLOR
GFX_COLOR   _colorTransparent;
SHORT       _colorTransparentEnable;
#endif

// Clipping region control
SHORT       _clipRgn;

// Clipping region borders
SHORT       _clipLeft;
SHORT       _clipTop;
SHORT       _clipRight;
SHORT       _clipBottom;

#define RED8(color16)   (BYTE) ((color16 & 0xF800) >> 8)
#define GREEN8(color16) (BYTE) ((color16 & 0x07E0) >> 3)
#define BLUE8(color16)  (BYTE) ((color16 & 0x001F) << 3)

////////////////////// LOCAL FUNCTIONS PROTOTYPES ////////////////////////////
void        SetAddress(DWORD address);
BYTE        GetReg(WORD index);

void        PutImage1BPP(SHORT left, SHORT top, FLASH_BYTE *bitmap, BYTE stretch);
void        PutImage4BPP(SHORT left, SHORT top, FLASH_BYTE *bitmap, BYTE stretch);
void        PutImage8BPP(SHORT left, SHORT top, FLASH_BYTE *bitmap, BYTE stretch);
```

```
void        PutImage16BPP(SHORT left, SHORT top, FLASH_BYTE *bitmap, BYTE stretch);

void        PutImage1BPPExt(SHORT left, SHORT top, void *image, BYTE stretch);
void        PutImage4BPPExt(SHORT left, SHORT top, void *image, BYTE stretch);
void        PutImage8BPPExt(SHORT left, SHORT top, void *image, BYTE stretch);
void        PutImage16BPPExt(SHORT left, SHORT top, void *image, BYTE stretch);

#ifdef USE_PALETTE
extern void *_palette;
static BYTE PaletteBpp = 16;
extern BYTE blPaletteChangeError;
extern void *pPendingPalette;
extern WORD PendingStartEntry;
extern WORD PendingLength;
#endif

/*********************************************************************
* Macro:  WritePixel(color)
*
* PreCondition: none
*
* Input: color
*
* Output: none
*
* Side Effects: none
*
* Overview: writes pixel at the current address
*
* Note: chip select should be enabled
*
********************************************************************/
#ifdef USE_16BIT_PMP
#define WritePixel(color)   DeviceWrite(color)
#else
#ifdef USE_PALETTE
#define WritePixel(color)   DeviceWrite(color)
#else
#define WritePixel(color)   { DeviceWrite(((WORD_VAL)color).v[1]);
DeviceWrite(((WORD_VAL)color).v[0]);}
#endif
#endif

/*********************************************************************
* Function:  void SetAddress(DWORD address)
*
* PreCondition: none
*
* Input: address - address
*
* Output: none
*
* Side Effects: none
*
* Overview: sets the address for read/write operations
*
* Note: chip select should be enabled
*
********************************************************************/
void SetAddress(DWORD address)
{
    #ifdef USE_16BIT_PMP
    WORD_VAL    temp;

    DisplaySetCommand(); // set RS line to low for command

    temp.v[0] = ((DWORD_VAL) address).v[1];
    temp.v[1] = ((DWORD_VAL) address).v[2] | 0x80;
    DeviceWrite(temp.Val);
    temp.v[0] = 0x01;
    temp.v[1] = ((DWORD_VAL) address).v[0];
    DeviceWrite(temp.Val);
    DisplaySetData();    // set RS line to high for data

    #else

    DisplaySetCommand(); // set RS line to low for command

    DeviceWrite(((DWORD_VAL) address).v[2] | 0x80);
    DeviceWrite(((DWORD_VAL) address).v[1]);
    DeviceWrite(((DWORD_VAL) address).v[0]);

    DisplaySetData();    // set RS line to high for data

    #endif
}

/*********************************************************************
* Function:  void  SetReg(WORD index, BYTE value)
*
* PreCondition: none
*
* Input: index - register number
*        value - value to be set
*
* Output: none
*
* Side Effects: none
*
* Overview: sets graphics controller register (byte access)
*
* Note: none
*
********************************************************************/
void SetReg(WORD index, BYTE value)
{
    #ifdef USE_16BIT_PMP

    DisplaySetCommand(); // set RS line to low for command
    DisplayEnable();     // enable SSD1926

    DeviceWrite(((WORD_VAL) index).v[1]);
    DeviceWrite(index << 8);

    DisplaySetData();    // set RS line to high for data

    if(index & 0x0001)
        DeviceWrite(value);
    else
        DeviceWrite(value << 8);

    DisplayDisable();   // disable SSD1926

    #else

    DisplaySetCommand(); // set RS line to low for command
    DisplayEnable();     // enable SSD1926

    DeviceWrite(0x00);    // register access
    DeviceWrite(((WORD_VAL) index).v[1]);
    DeviceWrite(((WORD_VAL) index).v[0]);

    DisplaySetData();    // set RS line to high for data
    DeviceWrite(value);

    DisplayDisable();   // disable SSD1926
    #endif
}

/*********************************************************************
* Function:  BYTE GetReg(WORD index)
*
* PreCondition: none
```

```
*
* Input: index - register number
*
* Output: none
*
* Side Effects: none
*
* Overview: returns graphics controller register value (byte access)
*
* Note: none
*
********************************************************************/
BYTE GetReg(WORD index)
{
#ifdef USE_16BIT_PMP

    WORD    value;

    DisplaySetCommand(); // set RS line to low for command
    DisplayEnable();     // enable SSD1926

    DeviceWrite(((WORD_VAL) index).v[1]);
    DeviceWrite(index << 8);

    DisplaySetData();    // set RS line to high for data

    value = DeviceRead();
    value = DeviceRead();

    DisplayDisable();   // disable SSD1926

    if(index & 0x0001)
        value &= 0x00ff;
    else
        value = (value >> 8) & 0x00ff;

#else
    BYTE   value;

    DisplaySetCommand(); // set RS line to low for command
    DisplayEnable();     // enable SSD1926

    DeviceWrite(0x00);    // register access
    DeviceWrite(((WORD_VAL) index).v[1]);
    DeviceWrite(((WORD_VAL) index).v[0]);

    DisplaySetData();    // set RS line to high for data

    value = DeviceRead();
    value = DeviceRead();

    DisplayDisable();   // disable SSD1926
#endif

    return (value);
}

/*********************************************************************
* Function:  void DisplayBrightness(WORD level)
*
* PreCondition: none
*
* Input: level - Brightness level. Valid values are 0 to 100.
*           -   0: brightness level is zero or display is turned off
*           - 100: brightness level is maximum
*
* Output: none
*
* Side Effects: none
*
* Overview: Sets the brightness of the display.
*
```

```
* Note: none
*
********************************************************************/
void DisplayBrightness(WORD level)
{
    // If the brightness can be controlled (for example through PWM)
    // add code that will control the PWM here.

    if (level > 0)
    {
        DisplayBacklightOn();
    }
    else if (level == 0)
    {
        DisplayBacklightOff();
    }

}

/*********************************************************************
* Function:  void ResetDevice()
*
* PreCondition: none
*
* Input: none
*
* Output: none
*
* Side Effects: none
*
* Overview: resets LCD, initializes PMP
*
* Note: none
*
********************************************************************/
void ResetDevice(void)
{
    /*
        This is the reset routine of the display controller.
        ResetDevice() recommended sequence:
        1. Initialize the interface to the controller  - DriverInterfaceInit()
        2. Initialize the registers of the controller make the enabling of
           the display control last. In other words, the sync signals
           are enabled only after all the registers that needs to be set
           for the synchronization control are initialized.
        3. Before, the display is turned on, initialize the display buffer
           to a single color so you will not see a snowy image on the screen.
           This is done here using:
              SetColor(0);
              ClearDevice();
           where 0 is the black color.
        4. Enable the display controller refresh of the screen
           This is done here using:
              SetReg(REG_POWER_SAVE_CONFIG, 0x00);    //  wake up
        5. Initialize the Timing Controller (TCON) if needed.
        6. Enable the Backlight

        Most display panels will have the power-up sequence:
        1. Enable Analog Power Supply
        2. Enable Digital Power Supply - to start synchronization signals
        3. Enable Backlight - to show the contents of the display buffer
        For power-down, the reverse is followed.

    */

    /////////////////////////////////////////////////////////////////////
    // Initialize the device
    /////////////////////////////////////////////////////////////////////
    DriverInterfaceInit();

    // give time for the controller to power up
    DelayMs(250);
    /////////////////////////////////////////////////////////////////////
    // PLL SETUP
    // Crystal frequency x M / N = 80 MHz
    // for 4 MHz crystal:
    /////////////////////////////////////////////////////////////////////
    SetReg(REG_PLL_CONFIG_0, 0x0a);         // set N = 10
    SetReg(REG_PLL_CONFIG_1, 0xc8);         // set M = 200
    SetReg(REG_PLL_CONFIG_2, 0xae);         // must be programmed to 0xAE
    SetReg(REG_PLL_CONFIG_0, 0x8a);         // enable PLL

    /////////////////////////////////////////////////////////////////////
    // VIDEO BUFFER MEMORY CLOCK SETUP
    // Memory frequency = PLL frequency / (MCLK + 1)
    /////////////////////////////////////////////////////////////////////
    SetReg(REG_MEMCLK_CONFIG, 0x00);        // set MCLK = 0 (80 MHz)

    /////////////////////////////////////////////////////////////////////

    // PIXEL OUTPUT CLOCK SETUP (LCD_SHIFT SIGNAL)
    // Pixel clock = Memory frequency * (PCLK + 1) / 0x100000
    /////////////////////////////////////////////////////////////////////
    SetReg(REG_PCLK_FREQ_RATIO_0, 0x00);    // set PCLK = 0x020000
    SetReg(REG_PCLK_FREQ_RATIO_1, 0x00);    // Pixel clock = 10 MHz
    SetReg(REG_PCLK_FREQ_RATIO_2, 0x02);

    /////////////////////////////////////////////////////////////////////
    // Panel Configuration (reg 10h)
    // TFT display with 18 bit or 24-bit RGB parallel interface.
    /////////////////////////////////////////////////////////////////////
    BYTE panelType  = 0;
    BYTE panelWidth = 0;

    #if (DISP_DATA_WIDTH == 18)
        panelWidth |= 0x20;
    #elif (DISP_DATA_WIDTH == 24)
        panelWidth |= 0x30;
    #else
       #error "Define DISP_DATA_WIDTH in HardwareProfile.h (valid values: 18, 24)"
    #endif

    #if (GFX_LCD_TYPE == GFX_LCD_TFT)
        panelType |= 0x41;
    #elif (GFX_LCD_TYPE == GFX_LCD_CSTN)
        panelType |= 0x40;
    #elif (GFX_LCD_TYPE == GFX_LCD_MSTN)
        panelType |= 0x00;
    #else
       #error "Define GFX_LCD_TYPE in HardwareProfile.h (valid values: GFX_LCD_TFT,
GFX_LCD_CSTN, GFX_LCD_MSTN)"
    #endif

    SetReg(REG_PANEL_TYPE, panelType|panelWidth);

    /////////////////////////////////////////////////////////////////////
    // Horizontal total HT (reg 12h)
    /////////////////////////////////////////////////////////////////////
    #define HT  (DISP_HOR_PULSE_WIDTH + DISP_HOR_BACK_PORCH + DISP_HOR_FRONT_PORCH +
DISP_HOR_RESOLUTION)
    SetReg(REG_HORIZ_TOTAL_0, HT / 8);
    SetReg(REG_HORIZ_TOTAL_1, HT % 8);

    /////////////////////////////////////////////////////////////////////
    // Horizontal display period HDP (reg 14h)
    /////////////////////////////////////////////////////////////////////
    SetReg(REG_HDP, DISP_HOR_RESOLUTION / 8 - 1);

    /////////////////////////////////////////////////////////////////////
    // Horizontal display period start HDPS (regs 16h, 17h)
    /////////////////////////////////////////////////////////////////////
    #define HDPS (DISP_HOR_PULSE_WIDTH + DISP_HOR_BACK_PORCH)
    SetReg(REG_HDP_START_POS0, HDPS & 0x00FF);
    SetReg(REG_HDP_START_POS1, (HDPS >> 8) & 0x00FF);

    /////////////////////////////////////////////////////////////////////
    // Horizontal syncronization pulse width HPW (reg 20h)
    /////////////////////////////////////////////////////////////////////
    SetReg(REG_HSYNC_PULSE_WIDTH, DISP_HOR_PULSE_WIDTH - 1);

    /////////////////////////////////////////////////////////////////////
    // Vertical total VT (regs 18h, 19h)
    /////////////////////////////////////////////////////////////////////
    #define VT  (DISP_VER_PULSE_WIDTH + DISP_VER_BACK_PORCH + DISP_VER_FRONT_PORCH +
DISP_VER_RESOLUTION)
    SetReg(REG_VERT_TOTAL0, VT & 0x00FF);
    SetReg(REG_VERT_TOTAL1, (VT >> 8) & 0x00FF);

    /////////////////////////////////////////////////////////////////////
    // Vertical display period VDP (regs 1ch, 1dh)
    /////////////////////////////////////////////////////////////////////
    #define VDP (DISP_VER_RESOLUTION - 1)
    SetReg(REG_VDP0, VDP & 0x00FF);
    SetReg(REG_VDP1, (VDP >> 8) & 0x00FF);

    /////////////////////////////////////////////////////////////////////
    // Vertical display period start VDPS (regs 1eh, 1fh)
    /////////////////////////////////////////////////////////////////////
    #define VDPS  (DISP_VER_PULSE_WIDTH + DISP_VER_BACK_PORCH)
    SetReg(REG_VDP_START_POS0, VDPS & 0x00FF);
    SetReg(REG_VDP_START_POS1, (VDPS >> 8) & 0x00FF);

    /////////////////////////////////////////////////////////////////////
    // Vertical syncronization pulse width VPW (reg 24h)
    /////////////////////////////////////////////////////////////////////
    SetReg(REG_VSYNC_PULSE_WIDTH, DISP_VER_PULSE_WIDTH - 1);

    /////////////////////////////////////////////////////////////////////
    // PALETTE INIT
    #ifdef USE_PALETTE
    PaletteInit();
    #endif

    /////////////////////////////////////////////////////////////////////
    // ROTATION MODE
    #if (DISP_ORIENTATION == 0)
        #define WIN_START_ADDR  0ul
        #define ROTATION        0

    #elif (DISP_ORIENTATION == 90)
        #ifndef USE_PALETTE
            #define WIN_START_ADDR  ((((DWORD) GetMaxX() + 1) >> 1) - 1)
        #else
            #define WIN_START_ADDR  (((((DWORD) GetMaxX() + 1) * PaletteBpp) >> 5) - 1)
        #endif
        #define ROTATION    1

    #elif (DISP_ORIENTATION == 180)
        #ifndef USE_PALETTE
            #define WIN_START_ADDR  (((((DWORD) GetMaxX() + 1) * (GetMaxY() + 1)) >> 1) - 1)
        #else
            #define WIN_START_ADDR  (((((DWORD) GetMaxX() + 1) * (GetMaxY() + 1) *
PaletteBpp) >> 5) - 1)
        #endif
        #define ROTATION    2

    #elif (DISP_ORIENTATION == 270)
        #ifndef USE_PALETTE
            #define WIN_START_ADDR  ((((DWORD) GetMaxX() + 1) * GetMaxY()) >> 1)
        #else
            #define WIN_START_ADDR  ((((DWORD) GetMaxX() + 1) * GetMaxY() * PaletteBpp) >>
5)
        #endif
        #define ROTATION    3
    #endif
    /////////////////////////////////////////////////////////////////////
    // Special Effects Register (reg 71h)
    /////////////////////////////////////////////////////////////////////
    #ifndef USE_PALETTE
    SetReg(REG_SPECIAL_EFFECTS, 0x40 | ROTATION);
    #else
    SetReg(REG_SPECIAL_EFFECTS, 0x00 | ROTATION);
    #endif

    /////////////////////////////////////////////////////////////////////
    // Main Window Display Start Address (regs 74h, 75h, 76h)
    /////////////////////////////////////////////////////////////////////
    SetReg(REG_MAIN_WIN_DISP_START_ADDR0, WIN_START_ADDR & 0x00FF);
    SetReg(REG_MAIN_WIN_DISP_START_ADDR1, (WIN_START_ADDR >> 8) & 0x00FF);
    SetReg(REG_MAIN_WIN_DISP_START_ADDR2, (WIN_START_ADDR >> 16) & 0x00FF);

    /////////////////////////////////////////////////////////////////////
    // Main Window Display Offset (regs 78h, 79h)
    /////////////////////////////////////////////////////////////////////
    #ifndef USE_PALETTE
        #define WIN_OFFSET  ((GetMaxX() + 1) >> 1)
    #else
        #define WIN_OFFSET  (((GetMaxX() + 1) * PaletteBpp) >> 5)
    #endif
    SetReg(REG_MAIN_WIN_ADDR_OFFSET0, WIN_OFFSET & 0x00FF);
    SetReg(REG_MAIN_WIN_ADDR_OFFSET1, (WIN_OFFSET >> 8) & 0x00FF);

    /////////////////////////////////////////////////////////////////////
    // Display Mode Register (reg 70h)
    /////////////////////////////////////////////////////////////////////
    SetReg(REG_DISPLAY_MODE, 0x04);         // 16 BPP, enable RAM content to screen

    /////////////////////////////////////////////////////////////////////
    // RGB Settings Register (reg 1a4h)
    /////////////////////////////////////////////////////////////////////
    SetReg(REG_RGB_SETTING, 0xc0);          // RGB format

    /////////////////////////////////////////////////////////////////////
    // LSHIFT Polarity Register (reg 38h)
    /////////////////////////////////////////////////////////////////////
    #ifdef DISP_INV_LSHIFT
    SetReg(REG_LSHIFT_POLARITY, 0x01);      // 1 means falling trigger
    #endif

    /////////////////////////////////////////////////////////////////////
    // Clear the display buffer with all zeros so the display will not
    // show garbage data when initially powered up
    /////////////////////////////////////////////////////////////////////
    SetColor(0);
    ClearDevice();

    /////////////////////////////////////////////////////////////////////
    // Power Saving Configuration Register (reg a0h)
    /////////////////////////////////////////////////////////////////////
    SetReg(REG_POWER_SAVE_CONFIG, 0x00);    //  wake up

    // check until the controller is really awake
    while(GetReg(REG_POWER_SAVE_CONFIG) == 0x00);

    /////////////////////////////////////////////////////////////////////
    // LCD Power Control Register (reg adh)
    // If LCD_POWER is connected to the glass DISPON or RESET
    /////////////////////////////////////////////////////////////////////
    SetReg(REG_GPIO_STATUS_CONTROL1, 0x80); // release the glass from reset

    /////////////////////////////////////////////////////////////////////
    // Panel TCON Programming - set up the TCON first before turning
    // on the display.
    /////////////////////////////////////////////////////////////////////
#ifdef USE_TCON_MODULE
    GfxTconInit();
```

```
#endif
    /////////////////////////////////////////////////////////////////////
    // Turn on the backlight
    /////////////////////////////////////////////////////////////////////
    DisplayBacklightOn();

}

/*********************************************************************
* Function: void PutPixel(SHORT x, SHORT y)
*
* PreCondition: none
*
* Input: x,y - pixel coordinates
*
* Output: none
*
* Side Effects: none
*
* Overview: puts pixel
*
* Note: none
*
********************************************************************/
void PutPixel(SHORT x, SHORT y)
{
    DWORD   address;

    if(_clipRgn)
    {
        if(x < _clipLeft)
            return;
        if(x > _clipRight)
            return;
        if(y < _clipTop)
            return;
        if(y > _clipBottom)
            return;
    }

    #ifndef USE_PALETTE
    address = (((DWORD) (GetMaxX() + 1)) * y + x) << 1;
    #else
    address = ((((DWORD) (GetMaxX() + 1)) * y + x) * PaletteBpp) >> 3;
    #endif
    DisplayEnable();      // enable SSD1926
    SetAddress(address);
    WritePixel(_color);
    DisplayDisable();    // disable SSD1926
}

/*********************************************************************
* Function: WORD GetPixel(SHORT x, SHORT y)
*
* PreCondition: none
*
* Input: x,y - pixel coordinates
*
* Output: pixel color
*
* Side Effects: none
*
* Overview: returns pixel color at x,y position
*
* Note: none
*
********************************************************************/
WORD GetPixel(SHORT x, SHORT y)
{
    DWORD   address;

    address = (((DWORD) (GetMaxX() + 1)) * y + x) << 1;
    #ifdef USE_16BIT_PMP

    WORD    value;

    DisplayEnable();

    SetAddress(address);
    value = DeviceRead();
    value = DeviceRead();

    DisplayDisable();

    return (value);
    #else

    WORD_VAL    value;

    DisplayEnable();

    SetAddress(address);

    #if defined(USE_GFX_PMP)
        // this first two reads are a dummy reads
        value.Val = SingleDeviceRead();
        value.Val = SingleDeviceRead();
        // these are the reads that will get the actual pixel data
        value.v[1] = SingleDeviceRead();
        value.v[0] = SingleDeviceRead();
    #endif

    #if defined(USE_GFX_EPMP)
        value.Val = DeviceRead();
        value.v[1] = DeviceRead();
        value.v[0] = DeviceRead();
    #endif
    DisplayDisable();

    return (value.Val);
    #endif
}

#ifdef USE_TRANSPARENT_COLOR
/*********************************************************************
* Function:  void TransparentColorEnable(GFX_COLOR color)
*
* Overview: Sets current transparent color.
*
* PreCondition: none
*
* Input: color - Color value chosen.
*
* Output: none
*
* Side Effects: none
*
********************************************************************/
void TransparentColorEnable(GFX_COLOR color)
{
    _colorTransparent = color;
    _colorTransparentEnable = TRANSPARENT_COLOR_ENABLE;

}
#endif

#ifndef USE_PALETTE
    // "In SSD1926 2D-Acceleration is not supported in Palette mode. Use Line function of
Primitive layer"

/*********************************************************************
* Function: WORD Line2D(SHORT x1, SHORT y1, SHORT x2, SHORT y2)
*
```

```
 * PreCondition: none
 *
 * Input: x1,y1 - starting coordinates, x2,y2 - ending coordinates
 *
 * Output: For NON-Blocking configuration:
 *         - Returns 0 when device is busy and the shape is not yet completely drawn.
 *         - Returns 1 when the shape is completely drawn.
 *         For Blocking configuration:
 *         - Always return 1.
 *
 * Side Effects: none
 *
 * Overview: draws solid line
 *
 * Note: none
 *
 ********************************************************************/
 static WORD Line2D(SHORT x1, SHORT y1, SHORT x2, SHORT y2)
 {
         #ifndef USE_NONBLOCKING_CONFIG
     while(IsDeviceBusy() != 0);

     /* Ready */
         #else
     if(IsDeviceBusy() != 0)
         return (0);
         #endif

     /* Line Boundaries */
     SetReg(REG_2D_1e4, x1 & 0xFF);
     SetReg(REG_2D_1e5, (x1 >> 8) & 0xFF);
     SetReg(REG_2D_1e8, y1 & 0xFF);
     SetReg(REG_2D_1e9, (y1 >> 8) & 0xFF);
     SetReg(REG_2D_1ec, x2 & 0xFF);
     SetReg(REG_2D_1ed, (x2 >> 8) & 0xFF);
     SetReg(REG_2D_1f0, y2 & 0xFF);
     SetReg(REG_2D_1f1, (y2 >> 8) & 0xFF);

     /* Source & Destination Window Start Addresses */
     SetReg(REG_2D_1d4, 0);
     SetReg(REG_2D_1d5, 0);
     SetReg(REG_2D_1d6, 0);
     SetReg(REG_2D_1f4, 0);
     SetReg(REG_2D_1f5, 0);
     SetReg(REG_2D_1f6, 0);

     /* Display width */
     SetReg(REG_2D_1f8, (GetMaxX() + 1) & 0xFF);
     SetReg(REG_2D_1f9, ((GetMaxX() + 1) >> 8) & 0xFF);

     /* Display 2d width */
     SetReg(REG_2D_1d8, (GetMaxY() + 1) & 0xFF);
     SetReg(REG_2D_1d9, ((GetMaxY() + 1) >> 8) & 0xFF);

     /* Set Color */
     SetReg(REG_2D_1fe, RED8(_color));
     SetReg(REG_2D_1fd, GREEN8(_color));
     SetReg(REG_2D_1fc, BLUE8(_color));

     /* 16bpp */
     SetReg(REG_2D_1dd, 0x00);

     /* Line command */
     SetReg(REG_2D_1d1, 0x01);

     /* Draw2d command */
     SetReg(REG_2D_1d2, 0x01);

         #ifndef USE_NONBLOCKING_CONFIG
     while(IsDeviceBusy() != 0);

     /* Ready */
```

```
        #endif
    return (1);
}

/*********************************************************************
* Function: WORD Line(SHORT x1, SHORT y1, SHORT x2, SHORT y2)
*
* PreCondition: none
*
* Input: x1,y1 - starting coordinates, x2,y2 - ending coordinates
*
* Output: For NON-Blocking configuration:
*         - Returns 0 when device is busy and the shape is not yet completely drawn.
*         - Returns 1 when the shape is completely drawn.
*         For Blocking configuration:
*         - Always return 1.
*
* Side Effects: none
*
* Overview: draws line
*
* Note: none
*
********************************************************************/
WORD Line(SHORT x1, SHORT y1, SHORT x2, SHORT y2)
{

    SHORT   deltaX, deltaY;
    SHORT   error, stepErrorLT, stepErrorGE;
    SHORT   stepX, stepY;
    SHORT   steep;
    SHORT   temp;
    SHORT   style, type;

    stepX = 0;
    deltaX = x2 - x1;
    if(deltaX < 0)
    {
        deltaX = -deltaX;
        --stepX;
    }
    else
    {
        ++stepX;
    }

    stepY = 0;
    deltaY = y2 - y1;
    if(deltaY < 0)
    {
        deltaY = -deltaY;
        --stepY;
    }
    else
    {
        ++stepY;
    }

    steep = 0;
    if(deltaX < deltaY)
    {
        ++steep;
    }

        #ifndef USE_NONBLOCKING_CONFIG
    while(IsDeviceBusy() != 0);

    /* Ready */
        #else
    if(IsDeviceBusy() != 0)
        return (0);
        #endif
    if(_lineType == 0)
    {
        if(!Line2D(x1, y1, x2, y2))
            return (0);
        if(_lineThickness)
        {
            if(steep)
            {
                while(!Line2D(x1 + 1, y1, x2 + 1, y2));
                while(!Line2D(x1 - 1, y1, x2 - 1, y2));
            }
            else
            {
                while(!Line2D(x1, y1 + 1, x2, y2 + 1));
                while(!Line2D(x1, y1 - 1, x2, y2 - 1));
            }
        }

        // Move cursor
        MoveTo(x2, y2);
        return (1);
    }

    // Move cursor
    MoveTo(x2, y2);

    if(x1 == x2)
    {
        if(y1 > y2)
        {
            temp = y1;
            y1 = y2;
            y2 = temp;
        }

        style = 0;
        type = 1;
        for(temp = y1; temp < y2 + 1; temp++)
        {
            if((++style) == _lineType)
            {
                type ^= 1;
                style = 0;
            }

            if(type)
            {
                PutPixel(x1, temp);
                if(_lineThickness)
                {
                    PutPixel(x1 + 1, temp);
                    PutPixel(x1 - 1, temp);
                }
            }
        }

        return (1);
    }

    if(y1 == y2)
    {
        if(x1 > x2)
        {
            temp = x1;
            x1 = x2;
            x2 = temp;
        }

        style = 0;
        type = 1;
        for(temp = x1; temp < x2 + 1; temp++)
        {
            if((++style) == _lineType)
            {
                type ^= 1;
                style = 0;
            }

            if(type)
            {
                PutPixel(temp, y1);
                if(_lineThickness)
                {
                    PutPixel(temp, y1 + 1);
                    PutPixel(temp, y1 - 1);
                }
            }
        }

        return (1);
    }

    if(deltaX < deltaY)
    {
        temp = deltaX;
        deltaX = deltaY;
        deltaY = temp;
        temp = x1;
        x1 = y1;
        y1 = temp;
        temp = stepX;
        stepX = stepY;
        stepY = temp;
        PutPixel(y1, x1);
    }
    else
    {
        PutPixel(x1, y1);
    }

    // If the current error greater or equal zero
    stepErrorGE = deltaX << 1;

    // If the current error less than zero
    stepErrorLT = deltaY << 1;

    // Error for the first pixel
    error = stepErrorLT - deltaX;

    style = 0;
    type = 1;

    while(--deltaX >= 0)
    {
        if(error >= 0)
        {
            y1 += stepY;
            error -= stepErrorGE;
        }

        x1 += stepX;
        error += stepErrorLT;

        if((++style) == _lineType)
        {
            type ^= 1;
            style = 0;
        }

        if(type)
        {
            if(steep)
            {
                PutPixel(y1, x1);
                if(_lineThickness)
                {
                    PutPixel(y1 + 1, x1);
                    PutPixel(y1 - 1, x1);
                }
            }
            else
            {
                PutPixel(x1, y1);
                if(_lineThickness)
                {
                    PutPixel(x1, y1 + 1);
                    PutPixel(x1, y1 - 1);
                }
            }
        }
    }   // end of while

    return (1);
}

#endif // #ifndef USE_PALETTE

/*********************************************************************
* Function: WORD Bar(SHORT left, SHORT top, SHORT right, SHORT bottom)
*
* PreCondition: none
*
* Input: left,top - top left corner coordinates,
*        right,bottom - bottom right corner coordinates
*
* Output: For NON-Blocking configuration:
*         - Returns 0 when device is busy and the shape is not yet completely drawn.
*         - Returns 1 when the shape is completely drawn.
*         For Blocking configuration:
*         - Always return 1.
*
* Side Effects: none
*
* Overview: draws rectangle filled with current color
*
* Note: none
*
********************************************************************/
WORD Bar(SHORT left, SHORT top, SHORT right, SHORT bottom)
{
        #ifdef USE_PALETTE

    DWORD           address;
    register SHORT  x, y;

    if(_clipRgn)
    {
        left   = (left   < _clipLeft)   ? _clipLeft   : ((left   > _clipRight)  ?
_clipRight  : left);
        right  = (right  > _clipRight)  ? _clipRight  : ((right  < _clipLeft)   ?
_clipLeft   : right);
        top    = (top    < _clipTop)    ? _clipTop    : ((top    > _clipBottom) ?
_clipBottom : top);
        bottom = (bottom > _clipBottom) ? _clipBottom : ((bottom < _clipTop)    ?
_clipTop    : bottom);
    }

            #ifndef USE_PALETTE
    address = ((DWORD) (GetMaxX() + 1) * top + left) << 1;
            #else
    address = (((DWORD) (GetMaxX() + 1) * top + left) * PaletteBpp) >> 3;
            #endif
    DisplayEnable();
    for(y = top; y < bottom + 1; y++)
    {
        SetAddress(address);
        for(x = left; x < right + 1; x++)
        {
            WritePixel(_color);
        }

                #ifndef USE_PALETTE
        address += (GetMaxX() + 1) << 1;
                #else
        address += ((GetMaxX() + 1) * PaletteBpp) >> 3;
                #endif
    }

    DisplayDisable();
    return (1);

        #else

    DWORD   address;
    SHORT   width, height;

            #ifndef USE_NONBLOCKING_CONFIG
    while(IsDeviceBusy() != 0);

    /* Ready */
            #else
    if(IsDeviceBusy() != 0)
        return (0);
            #endif
    if(left > right)
    {
        return (1); /* Don't draw but return 1 */
    }

    if(top > bottom)
    {
        return (1); /* Don't draw but return 1 */
    }

    if(_clipRgn)
    {
        left   = (left   < _clipLeft)   ? _clipLeft   : ((left   > _clipRight)  ?
_clipRight  : left);
        right  = (right  > _clipRight)  ? _clipRight  : ((right  < _clipLeft)   ?
_clipLeft   : right);
        top    = (top    < _clipTop)    ? _clipTop    : ((top    > _clipBottom) ?
_clipBottom : top);
        bottom = (bottom > _clipBottom) ? _clipBottom : ((bottom < _clipTop)    ?
_clipTop    : bottom);
    }

    width = right - left + 1;
    height = bottom - top + 1;

    address = top * (GetMaxX() + (DWORD) 1) + left;

    PutPixel(left, top);

    /* Source, Destination & Brush Window Start Addresses */
    SetReg(REG_2D_1d4, address & 0xFF);
    SetReg(REG_2D_1d5, (address >> 8) & 0xFF);
    SetReg(REG_2D_1d6, (address >> 16) & 0xFF);
    SetReg(REG_2D_1f4, address & 0xFF);
    SetReg(REG_2D_1f5, (address >> 8) & 0xFF);
    SetReg(REG_2D_1f6, (address >> 16) & 0xFF);
    SetReg(REG_2D_204, address & 0xFF);
    SetReg(REG_2D_205, (address >> 8) & 0xFF);
    SetReg(REG_2D_206, (address >> 16) & 0xFF);

    /* Source & Destination Window Width */
    SetReg(REG_2D_1ec, width & 0xFF);
    SetReg(REG_2D_1ed, (width >> 8) & 0xFF);
    SetReg(REG_2D_1e4, width & 0xFF);
    SetReg(REG_2D_1e5, (width >> 8) & 0xFF);

    /* Source & Destination Window Height */
    SetReg(REG_2D_1f0, height & 0xFF);
    SetReg(REG_2D_1f1, (height >> 8) & 0xFF);
    SetReg(REG_2D_1e8, height & 0xFF);
    SetReg(REG_2D_1e9, (height >> 8) & 0xFF);

    /* Brush width */
    SetReg(REG_2D_214, 1);
    SetReg(REG_2D_215, 0);

    /* Brush height */
    SetReg(REG_2D_218, 1);
    SetReg(REG_2D_219, 0);

    /* Display width */
    SetReg(REG_2D_1f8, (GetMaxX() + 1) & 0xFF);
    SetReg(REG_2D_1f9, ((GetMaxX() + 1) >> 8) & 0xFF);

    /* Display 2d width */
    SetReg(REG_2D_1d8, (GetMaxX() + 1) & 0xFF);
    SetReg(REG_2D_1d9, ((GetMaxX() + 1) >> 8) & 0xFF);

    /* ROP3 Command */
    SetReg(REG_2D_1fc, 0xF0);

    /* 16bpp */
    SetReg(REG_2D_1dd, 0x00);

    /* ROP command */
    SetReg(REG_2D_1d1, 0x09);

    /* Draw2d command */
    SetReg(REG_2D_1d2, 0x01);

            #ifndef USE_NONBLOCKING_CONFIG
    while(IsDeviceBusy() != 0);

    /* Ready */
            #endif
    return (1);
        #endif
}

/*********************************************************************
* Function: void ClearDevice(void)
*
* PreCondition: none
*
* Input: none
*
* Output: none
*
* Side Effects: none
*
* Overview: clears screen with current color
*
* Note: none
*
********************************************************************/
void ClearDevice(void)
{
        #ifdef USE_PALETTE

    DWORD   counter;

    DisplayEnable();
    SetAddress(0);
    SetAddress(0);
    for(counter = 0; counter < (DWORD) (GetMaxX() + 1) * (GetMaxY() + 1); counter++)
    {
        WritePixel(_color);
    }

    DisplayDisable();

        #else
    while(GetReg(REG_2D_220) == 0);
    while(!Bar(0, 0, GetMaxX(), GetMaxY()));
    while(GetReg(REG_2D_220) == 0);

    /* Ready */
        #endif
}


#ifdef USE_BITMAP_FLASH
/*********************************************************************
* Function: void PutImage1BPP(SHORT left, SHORT top, FLASH_BYTE* image, BYTE stretch)
*
* PreCondition: none
*
* Input: left,top - left top image corner,
*        image - image pointer,
*        stretch - image stretch factor
*
* Output: none
*
* Side Effects: none
*
* Overview: outputs monochrome image starting from left,top coordinates
*
* Note: image must be located in flash
*
********************************************************************/
void PutImage1BPP(SHORT left, SHORT top, FLASH_BYTE *image, BYTE stretch)
{
    register DWORD      address;
    register FLASH_BYTE *flashAddress;
    register FLASH_BYTE *tempFlashAddress;
    BYTE                temp = 0, stretchY, mask;
    WORD                sizeX, sizeY;
    WORD                x, y;
    WORD                pallete[2];

    // Move pointer to size information
    flashAddress = image + 2;

    // Set start address
        #ifndef USE_PALETTE
    address = ((DWORD) (GetMaxX() + 1) * top + left) << 1;
        #else
    address = (((DWORD) (GetMaxX() + 1) * top + left) * PaletteBpp) >> 3;
        #endif

    // Read image size
    sizeY = *((FLASH_WORD *)flashAddress);
    flashAddress += 2;
    sizeX = *((FLASH_WORD *)flashAddress);
    flashAddress += 2;
    pallete[0] = *((FLASH_WORD *)flashAddress);
    flashAddress += 2;
    pallete[1] = *((FLASH_WORD *)flashAddress);
    flashAddress += 2;

    DisplayEnable();      // enable SSD1926

   // Note: For speed the code for loops are repeated. A small code size increase for
performance

    if (stretch == IMAGE_NORMAL)
    {
        for(y = 0; y < sizeY; y++)
        {
            SetAddress(address);
            mask = 0;
            for(x = 0; x < sizeX; x++)
            {

                // Read 8 pixels from flash
                if(mask == 0)
                {
                    temp = *flashAddress;
                    flashAddress++;
                    mask = 0x80;
                }

                // Set color
                if(mask & temp)
                {
                    #ifdef USE_PALETTE
                    if(IsPaletteEnabled())
                    {
                        #ifdef USE_TRANSPARENT_COLOR
                        if ((GetTransparentColor() == 1) && (GetTransparentColorStatus() ==
  TRANSPARENT_COLOR_ENABLE))
                            DeviceReadWord();
                        else
                        #endif
                            WritePixel(1);
                    }
                    else
                    #endif
                    {
                        #ifdef USE_TRANSPARENT_COLOR
                        if ((GetTransparentColor() == pallete[1]) &&
  (GetTransparentColorStatus() == TRANSPARENT_COLOR_ENABLE))
                            DeviceReadWord();
                        else
                        #endif
                            WritePixel(pallete[1]);
                    }
                }
                else
                {
                    #ifdef USE_PALETTE
                    if(IsPaletteEnabled())
                    {
                        #ifdef USE_TRANSPARENT_COLOR
                        if ((GetTransparentColor() == 0) && (GetTransparentColorStatus() ==
  TRANSPARENT_COLOR_ENABLE))
                            DeviceReadWord();
                        else
                        #endif
                            WritePixel(0);
                    }
                    else
                    #endif
                    {
                        #ifdef USE_TRANSPARENT_COLOR
                        if ((GetTransparentColor() == pallete[0]) &&
  (GetTransparentColorStatus() == TRANSPARENT_COLOR_ENABLE))
                            DeviceReadWord();
                        else
                        #endif
                            WritePixel(pallete[0]);
                    }
                }
                // shift to the next pixel
                mask >>= 1;
            }

            #ifndef USE_PALETTE
                address += (GetMaxX() + 1) << 1;
            #else
```

```
                address += ((GetMaxX() + 1) * PaletteBpp) >> 3;
            #endif
        }
    }
    else
    {
        for(y = 0; y < sizeY; y++)
        {
            tempFlashAddress = flashAddress;
            for(stretchY = 0; stretchY < stretch; stretchY++)
            {
                flashAddress = tempFlashAddress;
                SetAddress(address);
                mask = 0;
                for(x = 0; x < sizeX; x++)
                {
                    // Read 8 pixels from flash
                    if(mask == 0)
                    {
                        temp = *flashAddress;
                        flashAddress++;
                        mask = 0x80;
                    }

                    // Set color
                    if(mask & temp)
                    {
                        #ifdef USE_PALETTE
                        if(IsPaletteEnabled())
                        {
                            #ifdef USE_TRANSPARENT_COLOR
                            if ((GetTransparentColor() == 1) &&
  (GetTransparentColorStatus() == TRANSPARENT_COLOR_ENABLE))
                            {
                                DeviceReadWord();
                                DeviceReadWord();
                            }
                            else
                            #endif
                            {
                                WritePixel(1);
                                WritePixel(1);
                            }

                        }
                        else
                        #endif
                        {
                            #ifdef USE_TRANSPARENT_COLOR
                            if ((GetTransparentColor() == pallete[1]) &&
  (GetTransparentColorStatus() == TRANSPARENT_COLOR_ENABLE))
                            {
                                DeviceReadWord();
                                DeviceReadWord();
                            }
                            else
                            #endif
                            {
                                WritePixel(pallete[1]);
                                WritePixel(pallete[1]);
                            }
                        }
                    }
                    else
                    {
                        #ifdef USE_PALETTE
                        if(IsPaletteEnabled())
                        {
                            #ifdef USE_TRANSPARENT_COLOR
                            if ((GetTransparentColor() == 0) &&
  (GetTransparentColorStatus() == TRANSPARENT_COLOR_ENABLE))
                            {
                                DeviceReadWord();
                                DeviceReadWord();
                            }
                            else
                            #endif
                            {
                                WritePixel(0);
                                WritePixel(0);
                            }
                        }
                        else
                        #endif
                        {
                            #ifdef USE_TRANSPARENT_COLOR
                            if ((GetTransparentColor() == pallete[0]) &&
(GetTransparentColorStatus() == TRANSPARENT_COLOR_ENABLE))
                            {
                                DeviceReadWord();
                                DeviceReadWord();
                            }
                            else
                            #endif
                            {
                                WritePixel(pallete[0]);
                                WritePixel(pallete[0]);
                            }
                        }
                    }
                    // shift to the next pixel
                    mask >>= 1;
                }
                #ifndef USE_PALETTE
                    address += (GetMaxX() + 1) << 1;
                #else
                    address += ((GetMaxX() + 1) * PaletteBpp) >> 3;
                #endif
            }
        }
   }
    DisplayDisable();
}

/*********************************************************************
* Function: void PutImage4BPP(SHORT left, SHORT top, FLASH_BYTE* image, BYTE stretch)
*
* PreCondition: none
*
* Input: left,top - left top image corner, image - image pointer,
*        stretch - image stretch factor
*
* Output: none
*
* Side Effects: none
*
* Overview: outputs 16 color image starting from left,top coordinates
*
* Note: image must be located in flash
*
********************************************************************/
void PutImage4BPP(SHORT left, SHORT top, FLASH_BYTE *image, BYTE stretch)
{
    register DWORD      address;
    register FLASH_BYTE *flashAddress;
    register FLASH_BYTE *tempFlashAddress;
    BYTE                temp = 0, stretchY;
    WORD                sizeX, sizeY;
    WORD                x, y;
    WORD                pallete[16];
    WORD                counter;

    // Move pointer to size information
    flashAddress = image + 2;
    // Set start address
        #ifndef USE_PALETTE
    address = ((DWORD) (GetMaxX() + 1) * top + left) << 1;
        #else
    address = (((DWORD) (GetMaxX() + 1) * top + left) * PaletteBpp) >> 3;
        #endif

    // Read image size
    sizeY = *((FLASH_WORD *)flashAddress);
    flashAddress += 2;
    sizeX = *((FLASH_WORD *)flashAddress);
    flashAddress += 2;

    // Read pallete
    for(counter = 0; counter < 16; counter++)
    {
        pallete[counter] = *((FLASH_WORD *)flashAddress);
        flashAddress += 2;
    }

    DisplayEnable();      // enable SSD1926

   // Note: For speed the code for loops are repeated. A small code size increase for
performance

    if (stretch == IMAGE_NORMAL)
    {
        for(y = 0; y < sizeY; y++)
        {
            SetAddress(address);
            for(x = 0; x < sizeX; x++)
            {
                // Read 2 pixels from flash
                if(x & 0x0001)
                {

                    // second pixel in byte
                    #ifdef USE_PALETTE
                    if(IsPaletteEnabled())
                    {
                        #ifdef USE_TRANSPARENT_COLOR
                        if ((GetTransparentColor() == (temp >> 4)) &&
(GetTransparentColorStatus() == TRANSPARENT_COLOR_ENABLE))
                        {
                            DeviceReadWord();
                        }
                        else
                        #endif
                            WritePixel(temp >> 4);
                    }
                    else
                    #endif
                    {
                        #ifdef USE_TRANSPARENT_COLOR
                        if ((GetTransparentColor() == pallete[temp >> 4]) &&
(GetTransparentColorStatus() == TRANSPARENT_COLOR_ENABLE))
                        {
                            DeviceReadWord();
                        }
                        else
                        #endif
                            WritePixel(pallete[temp >> 4]);
                    }
                }
                else
                {
                    temp = *flashAddress++;

                    // first pixel in byte
                    #ifdef USE_PALETTE
                    if(IsPaletteEnabled())
```

```
                      {
                          #ifdef USE_TRANSPARENT_COLOR
                          if ((GetTransparentColor() == (temp & 0x0f)) &&
 (GetTransparentColorStatus() == TRANSPARENT_COLOR_ENABLE))
                          {
                              DeviceReadWord();
                          }
                          else
                          #endif
                              WritePixel(temp & 0x0f);
                      }
                      else
                      #endif
                      {
                          #ifdef USE_TRANSPARENT_COLOR
                          if ((GetTransparentColor() == pallete[temp & 0x0f]) &&
 (GetTransparentColorStatus() == TRANSPARENT_COLOR_ENABLE))
                          {
                              DeviceReadWord();
                          }
                          else
                          #endif
                              WritePixel(pallete[temp & 0x0f]);
                      }
                  }
              }
              #ifndef USE_PALETTE
                  address += (GetMaxX() + 1) << 1;
              #else
                  address += ((GetMaxX() + 1) * PaletteBpp) >> 3;
              #endif
          }
     }
     else
     {
          for(y = 0; y < sizeY; y++)
          {
              tempFlashAddress = flashAddress;
              for(stretchY = 0; stretchY < stretch; stretchY++)
              {
                  flashAddress = tempFlashAddress;
                  SetAddress(address);

                  for(x = 0; x < sizeX; x++)
                  {
                      // Read 2 pixels from flash
                      if(x & 0x0001)
                      {

                          // second pixel in byte
                          #ifdef USE_PALETTE
                          if(IsPaletteEnabled())
                          {
                              #ifdef USE_TRANSPARENT_COLOR
                              if ((GetTransparentColor() == (temp >> 4)) &&
 (GetTransparentColorStatus() == TRANSPARENT_COLOR_ENABLE))
                              {
                                  DeviceReadWord();
                                  DeviceReadWord();
                              }
                              else
                              #endif
                              {
                                  WritePixel(temp >> 4);
                                  WritePixel(temp >> 4);
                              }
                          }
                          else
                          #endif
                          {
                              #ifdef USE_TRANSPARENT_COLOR
                              if ((GetTransparentColor() == pallete[temp >> 4]) &&
  (GetTransparentColorStatus() == TRANSPARENT_COLOR_ENABLE))
                              {
                                  DeviceReadWord();
                                  DeviceReadWord();
                              }
                              else
                              #endif
                              {
                                  WritePixel(pallete[temp >> 4]);
                                  WritePixel(pallete[temp >> 4]);
                              }
                          }
                      }
                      else
                      {
                          temp = *flashAddress++;

                          // first pixel in byte
                          #ifdef USE_PALETTE
                          if(IsPaletteEnabled())
                          {
                              #ifdef USE_TRANSPARENT_COLOR
                              if ((GetTransparentColor() == (temp & 0x0f)) &&
  (GetTransparentColorStatus() == TRANSPARENT_COLOR_ENABLE))
                              {
                                  DeviceReadWord();
                                  DeviceReadWord();
                              }
                              else
                              #endif
                              {
                                  WritePixel(temp & 0x0f);
                                  WritePixel(temp & 0x0f);
                              }
                          }
                          else
                          #endif
                          {
                              #ifdef USE_TRANSPARENT_COLOR
                              if ((GetTransparentColor() == pallete[temp & 0x0f]) &&
  (GetTransparentColorStatus() == TRANSPARENT_COLOR_ENABLE))
                              {
                                  DeviceReadWord();
                                  DeviceReadWord();
                             }
                              else
                              #endif
                              {
                                  WritePixel(pallete[temp & 0x0f]);
                                  WritePixel(pallete[temp & 0x0f]);
                              }
                          }
                      }
                  }
                  #ifndef USE_PALETTE
                      address += (GetMaxX() + 1) << 1;
                  #else
                      address += ((GetMaxX() + 1) * PaletteBpp) >> 3;
                  #endif
              }
          }
     }

      DisplayDisable();
  }

  /*********************************************************************
  * Function: void PutImage8BPP(SHORT left, SHORT top, FLASH_BYTE* image, BYTE stretch)
  *
  * PreCondition: none
  *
  * Input: left,top - left top image corner, image - image pointer,
  *        stretch - image stretch factor
  *
  * Output: none
  *
  * Side Effects: none
  *
  * Overview: outputs 256 color image starting from left,top coordinates
  *
  * Note: image must be located in flash
  *
  ********************************************************************/
  void PutImage8BPP(SHORT left, SHORT top, FLASH_BYTE *image, BYTE stretch)
  {
      register DWORD      address;
      register FLASH_BYTE *flashAddress;
      register FLASH_BYTE *tempFlashAddress;
      BYTE                temp, stretchY;
      WORD                sizeX, sizeY;
      WORD                x, y;
      WORD                pallete[256];
      WORD                counter;

      // Move pointer to size information
      flashAddress = image + 2;

      // Set start address
          #ifndef USE_PALETTE
      address = ((DWORD) (GetMaxX() + 1) * top + left) << 1;
          #else
      address = (((DWORD) (GetMaxX() + 1) * top + left) * PaletteBpp) >> 3;
          #endif

      // Read image size
      sizeY = *((FLASH_WORD *)flashAddress);
      flashAddress += 2;
      sizeX = *((FLASH_WORD *)flashAddress);
      flashAddress += 2;

      // Read pallete
      for(counter = 0; counter < 256; counter++)
      {
          pallete[counter] = *((FLASH_WORD *)flashAddress);
          flashAddress += 2;
      }

      DisplayEnable();      // enable SSD1926

      // Note: For speed the code for loops are repeated. A small code size increase for
  performance

      if (stretch == IMAGE_NORMAL)
      {
          for(y = 0; y < sizeY; y++)
          {
              SetAddress(address);
              for(x = 0; x < sizeX; x++)
              {
                  temp = *flashAddress;
                  flashAddress++;

                  // Write pixel to screen
                  #ifdef USE_PALETTE
                  if(IsPaletteEnabled())
                  {
                      #ifdef USE_TRANSPARENT_COLOR
                      if ((GetTransparentColor() == temp) && (GetTransparentColorStatus() ==
  TRANSPARENT_COLOR_ENABLE))
                      {
                          DeviceReadWord();
                      }
                      else
                      #endif
```

```
                        WritePixel(temp);
                    }
                    else
                    #endif
                    {
                        #ifdef USE_TRANSPARENT_COLOR
                        if ((GetTransparentColor() == pallete[temp]) &&
 (GetTransparentColorStatus() == TRANSPARENT_COLOR_ENABLE))
                        {
                            DeviceReadWord();
                        }
                        else
                        #endif
                            WritePixel(pallete[temp]);
                    }

                }
                #ifndef USE_PALETTE
                    address += (GetMaxX() + 1) << 1;
                #else
                    address += ((GetMaxX() + 1) * PaletteBpp) >> 3;
                #endif
            }
        }
        else
        {
            for(y = 0; y < sizeY; y++)
            {
                tempFlashAddress = flashAddress;
                for(stretchY = 0; stretchY < stretch; stretchY++)
                {
                    flashAddress = tempFlashAddress;
                    SetAddress(address);

                    for(x = 0; x < sizeX; x++)
                    {
                        temp = *flashAddress;
                        flashAddress++;

                       // Write pixel to screen
                        #ifdef USE_PALETTE
                        if(IsPaletteEnabled())
                        {
                            #ifdef USE_TRANSPARENT_COLOR
                            if ((GetTransparentColor() == temp) && (GetTransparentColorStatus()
 == TRANSPARENT_COLOR_ENABLE))
                            {
                                DeviceReadWord();
                                DeviceReadWord();
                            }
                            else
                            #endif
                            {
                                WritePixel(temp);
                                WritePixel(temp);
                            }
                        }
                        else
                        #endif
                        {
                            #ifdef USE_TRANSPARENT_COLOR
                            if ((GetTransparentColor() == pallete[temp]) &&
 (GetTransparentColorStatus() == TRANSPARENT_COLOR_ENABLE))
                            {
                                DeviceReadWord();
                                DeviceReadWord();
                            }
                            else
                            #endif
                            {
                                WritePixel(pallete[temp]);
                                WritePixel(pallete[temp]);
                            }
                        }

                    }
                    #ifndef USE_PALETTE
                        address += (GetMaxX() + 1) << 1;
                    #else
                        address += ((GetMaxX() + 1) * PaletteBpp) >> 3;
                    #endif
                }
            }
       }

       DisplayDisable();
    }

    /*********************************************************************
    * Function: void PutImage16BPP(SHORT left, SHORT top, FLASH_BYTE* image, BYTE stretch)
    *
    * PreCondition: none
    *
    * Input: left,top - left top image corner, image - image pointer,
    *        stretch - image stretch factor
    *
    * Output: none
    *
    * Side Effects: none
    *
    * Overview: outputs hicolor image starting from left,top coordinates
    *
    * Note: image must be located in flash
    *
    ********************************************************************/
    void PutImage16BPP(SHORT left, SHORT top, FLASH_BYTE *image, BYTE stretch)
    {
        register DWORD      address;
        register FLASH_WORD *flashAddress;
        register FLASH_WORD *tempFlashAddress;
        WORD                temp, stretchY;
        WORD                sizeX, sizeY;
        WORD                x, y;

        // Move pointer to size information
        flashAddress = (FLASH_WORD *)image + 1;

        // Set start address
            #ifndef USE_PALETTE
        address = ((DWORD) (GetMaxX() + 1) * top + left) << 1;
            #else
        address = (((DWORD) (GetMaxX() + 1) * top + left) * PaletteBpp) >> 3;
            #endif

        // Read image size
        sizeY = *flashAddress;
        flashAddress++;
        sizeX = *flashAddress;
        flashAddress++;

        DisplayEnable();      // enable SSD1926

        // Note: For speed the code for loops are repeated. A small code size increase for
    performance

        if (stretch == IMAGE_NORMAL)
        {
            for(y = 0; y < sizeY; y++)
            {
                SetAddress(address);
                for(x = 0; x < sizeX; x++)
                {
                    temp = *flashAddress;
                    flashAddress++;
                    // Write pixel to screen
                    #ifdef USE_PALETTE
                    if(IsPaletteEnabled())
                    {
                        #ifdef USE_TRANSPARENT_COLOR
                        if ((GetTransparentColor() == temp) && (GetTransparentColorStatus() ==
    TRANSPARENT_COLOR_ENABLE))
                        {
                            DeviceReadWord();
                        }
                        else
                        #endif
                            WritePixel(0); /* Paint first value of Palette instead of junk */
                    }
                    else
                    #endif
                    {
                        #ifdef USE_TRANSPARENT_COLOR
                        if ((GetTransparentColor() == temp) && (GetTransparentColorStatus() ==
    TRANSPARENT_COLOR_ENABLE))
                        {
                            DeviceReadWord();
                        }
                        else
                        #endif
                            WritePixel(temp);
                    }

                }
                #ifndef USE_PALETTE
                    address += (GetMaxX() + 1) << 1;
                #else
                    address += ((GetMaxX() + 1) * PaletteBpp) >> 3;
                #endif
            }
       }
       else
       {
            for(y = 0; y < sizeY; y++)
            {
                tempFlashAddress = flashAddress;
                for(stretchY = 0; stretchY < stretch; stretchY++)
                {
                    flashAddress = tempFlashAddress;
                    SetAddress(address);

                    for(x = 0; x < sizeX; x++)
                    {
                        temp = *flashAddress;
                        flashAddress++;

                        #ifdef USE_PALETTE
                        if(IsPaletteEnabled())
                        {
                            #ifdef USE_TRANSPARENT_COLOR
                            if ((GetTransparentColor() == temp) && (GetTransparentColorStatus()
    == TRANSPARENT_COLOR_ENABLE))
                            {
                                DeviceReadWord();
                                DeviceReadWord();
                            }
                            else
                            #endif
                            {
                                WritePixel(0); /* Paint first value of Palette instead of junk
    */
                                WritePixel(0);
                            }
                        }
                        else
                        #endif
```

```
                        {
                            #ifdef USE_TRANSPARENT_COLOR
                            if ((GetTransparentColor() == temp) && (GetTransparentColorStatus()
== TRANSPARENT_COLOR_ENABLE))
                            {
                                DeviceReadWord();
                                DeviceReadWord();
                            }
                            else
                            #endif
                            {
                                WritePixel(temp);
                                WritePixel(temp);
                            }
                        }
                    }
                    #ifndef USE_PALETTE
                        address += (GetMaxX() + 1) << 1;
                    #else
                        address += ((GetMaxX() + 1) * PaletteBpp) >> 3;
                    #endif
                }
            }
        }

    DisplayDisable();
}

#endif
#ifdef USE_BITMAP_EXTERNAL

/*********************************************************************
* Function: void PutImage1BPPExt(SHORT left, SHORT top, void* image, BYTE stretch)
*
* PreCondition: none
*
* Input: left,top - left top image corner, image - image pointer,
*        stretch - image stretch factor
*
* Output: none
*
* Side Effects: none
*
* Overview: outputs monochrome image starting from left,top coordinates
*
* Note: image must be located in external memory
*
********************************************************************/
void PutImage1BPPExt(SHORT left, SHORT top, void *image, BYTE stretch)
{
    register DWORD  address;
    register DWORD  memOffset;
    BITMAP_HEADER   bmp;
    WORD            pallete[2];
    BYTE            lineBuffer[((GetMaxX() + 1) / 8) + 1];
    BYTE            *pData;
    SHORT           byteWidth;

    BYTE            temp = 0, stretchY;
    BYTE            mask;
    WORD            sizeX, sizeY;
    WORD            x, y;

    // Set start address
        #ifndef USE_PALETTE
    address = ((DWORD) (GetMaxX() + 1) * top + left) << 1;
        #else
    address = (((DWORD) (GetMaxX() + 1) * top + left) * PaletteBpp) >> 3;
        #endif

    // Get image header
    ExternalMemoryCallback(image, 0, sizeof(BITMAP_HEADER), &bmp);
    // Get pallete (2 entries)
    ExternalMemoryCallback(image, sizeof(BITMAP_HEADER), 2 * sizeof(WORD), pallete);

    // Set offset to the image data
    memOffset = sizeof(BITMAP_HEADER) + 2 * sizeof(WORD);

    // Line width in bytes
    byteWidth = bmp.width >> 3;
    if(bmp.width & 0x0007)
        byteWidth++;

    // Get size
    sizeX = bmp.width;
    sizeY = bmp.height;

    // Note: For speed the code for loops are repeated. A small code size increase for
performance

    if (stretch == IMAGE_NORMAL)
    {
        for(y = 0; y < sizeY; y++)
        {

            // Get line
            ExternalMemoryCallback(image, memOffset, byteWidth, lineBuffer);
            memOffset += byteWidth;
            DisplayEnable();      // enable SSD1926

            pData = lineBuffer;
            SetAddress(address);
            mask = 0;
            for(x = 0; x < sizeX; x++)
            {

                // Read 8 pixels from flash
                if(mask == 0)
                {
                    temp = *pData++;
                    mask = 0x80;
                }

                // Set color
                if(mask & temp)
                {
                    #ifdef USE_PALETTE
                    if(IsPaletteEnabled())
                    {
                        #ifdef USE_TRANSPARENT_COLOR
                        if ((GetTransparentColor() == 1) && (GetTransparentColorStatus() ==
TRANSPARENT_COLOR_ENABLE))
                            DeviceReadWord();
                        else
                        #endif
                            WritePixel(1);
                    }
                    else
                    #endif
                    {
                        #ifdef USE_TRANSPARENT_COLOR
                        if ((GetTransparentColor() == pallete[1]) &&
(GetTransparentColorStatus() == TRANSPARENT_COLOR_ENABLE))
                            DeviceReadWord();
                        else
                        #endif
                            WritePixel(pallete[1]);
                    }
                }
                else
                {
                    #ifdef USE_PALETTE
                    if(IsPaletteEnabled())
                    {
                        #ifdef USE_TRANSPARENT_COLOR
                        if ((GetTransparentColor() == 0) && (GetTransparentColorStatus() ==
TRANSPARENT_COLOR_ENABLE))
                            DeviceReadWord();
                        else
                        #endif
                            WritePixel(0);
                    }
                    else
                    #endif
                    {
                        #ifdef USE_TRANSPARENT_COLOR
                        if ((GetTransparentColor() == pallete[0]) &&
(GetTransparentColorStatus() == TRANSPARENT_COLOR_ENABLE))
                            DeviceReadWord();
                        else
                        #endif
                            WritePixel(pallete[0]);
                    }
                }

                // Shift to the next pixel
                mask >>= 1;
            }

            address += (GetMaxX() + 1) << 1;
            DisplayDisable();
        }
   }
   else
   {
        for(y = 0; y < sizeY; y++)
        {
            // Get line
            ExternalMemoryCallback(image, memOffset, byteWidth, lineBuffer);
            memOffset += byteWidth;
            DisplayEnable();      // enable SSD1926
            for(stretchY = 0; stretchY < stretch; stretchY++)
            {
                pData = lineBuffer;
                SetAddress(address);
                mask = 0;
                for(x = 0; x < sizeX; x++)
                {

                    // Read 8 pixels from flash
                    if(mask == 0)
                    {
                        temp = *pData++;
                        mask = 0x80;
                    }

                    // Set color
                    if(mask & temp)
                    {
                        #ifdef USE_PALETTE
                        if(IsPaletteEnabled())
                        {
                            #ifdef USE_TRANSPARENT_COLOR
                            if ((GetTransparentColor() == 1) &&
(GetTransparentColorStatus() == TRANSPARENT_COLOR_ENABLE))
                            {
                                DeviceReadWord();
                                DeviceReadWord();
                            }
                            else
                            #endif
                            {
                                WritePixel(1);
                                WritePixel(1);
                            }
                        }
                        else
                        #endif
                        {
                            #ifdef USE_TRANSPARENT_COLOR
                            if ((GetTransparentColor() == pallete[1]) &&
(GetTransparentColorStatus() == TRANSPARENT_COLOR_ENABLE))
                            {
                                DeviceReadWord();
                                DeviceReadWord();
                            }
                            else
                            #endif
                            {
                                WritePixel(pallete[1]);
                                WritePixel(pallete[1]);
                            }
                        }
                    }
                    else
                    {
                        #ifdef USE_PALETTE
                        if(IsPaletteEnabled())
                        {
                            #ifdef USE_TRANSPARENT_COLOR
                            if ((GetTransparentColor() == 0) &&
(GetTransparentColorStatus() == TRANSPARENT_COLOR_ENABLE))
                            {
                                DeviceReadWord();
                                DeviceReadWord();
                            }
                            else
                            #endif
                            {
                                WritePixel(0);
                                WritePixel(0);
                            }
                        }
                        else
                        #endif
                        {
                            #ifdef USE_TRANSPARENT_COLOR
                            if ((GetTransparentColor() == pallete[0]) &&
(GetTransparentColorStatus() == TRANSPARENT_COLOR_ENABLE))
                            {
                                DeviceReadWord();
                                DeviceReadWord();
                            }
                            else
                            #endif
                            {
                                WritePixel(pallete[0]);
                                WritePixel(pallete[0]);
                            }
                        }
                    }

                    // Shift to the next pixel
                    mask >>= 1;
                }
                address += (GetMaxX() + 1) << 1;
            }
            DisplayDisable();
        }
    }
}

/*********************************************************************
* Function: void PutImage4BPPExt(SHORT left, SHORT top, void* image, BYTE stretch)
*
* PreCondition: none
*
```

```
* Input: left,top - left top image corner, image - image pointer,
*        stretch - image stretch factor
*
* Output: none
*
* Side Effects: none
*
* Overview: outputs monochrome image starting from left,top coordinates
*
* Note: image must be located in external memory
*
********************************************************************/
void PutImage4BPPExt(SHORT left, SHORT top, void *image, BYTE stretch)
{
    register DWORD  address;
    register DWORD  memOffset;
    BITMAP_HEADER   bmp;
    WORD            pallete[16];
    BYTE            lineBuffer[((GetMaxX() + 1) / 2) + 1];
    BYTE            *pData;
    SHORT           byteWidth;

    BYTE            temp = 0, stretchY;
    WORD            sizeX, sizeY;
    WORD            x, y;

    // Set start address
        #ifndef USE_PALETTE
    address = ((DWORD) (GetMaxX() + 1) * top + left) << 1;
        #else
    address = (((DWORD) (GetMaxX() + 1) * top + left) * PaletteBpp) >> 3;
        #endif

    // Get image header
    ExternalMemoryCallback(image, 0, sizeof(BITMAP_HEADER), &bmp);

    // Get pallete (16 entries)
    ExternalMemoryCallback(image, sizeof(BITMAP_HEADER), 16 * sizeof(WORD), pallete);

    // Set offset to the image data
    memOffset = sizeof(BITMAP_HEADER) + 16 * sizeof(WORD);

    // Line width in bytes
    byteWidth = bmp.width >> 1;
    if(bmp.width & 0x0001)
        byteWidth++;

    // Get size
    sizeX = bmp.width;
    sizeY = bmp.height;

    // Note: For speed the code for loops are repeated. A small code size increase for
performance

    if (stretch == IMAGE_NORMAL)
    {
        for(y = 0; y < sizeY; y++)
        {

            // Get line
            ExternalMemoryCallback(image, memOffset, byteWidth, lineBuffer);
            memOffset += byteWidth;
            DisplayEnable();      // enable SSD1926

            pData = lineBuffer;
            SetAddress(address);

            for(x = 0; x < sizeX; x++)
            {
                // Read 2 pixels from flash
                if(x & 0x0001)
                {
                    // second pixel in byte
                    #ifdef USE_PALETTE
                    if(IsPaletteEnabled())
                    {
                        #ifdef USE_TRANSPARENT_COLOR
                        if ((GetTransparentColor() == (temp >> 4)) &&
(GetTransparentColorStatus() == TRANSPARENT_COLOR_ENABLE))
                            DeviceReadWord();
                        else
                        #endif
                            WritePixel(temp >> 4);
                    }
                    else
                    #endif
                    {
                        #ifdef USE_TRANSPARENT_COLOR
                        if ((GetTransparentColor() == pallete[temp >> 4]) &&
(GetTransparentColorStatus() == TRANSPARENT_COLOR_ENABLE))
                            DeviceReadWord();
                        else
                        #endif
                            WritePixel(pallete[temp >> 4]);
                    }
                }
                else
                {
                    temp = *pData++;

                    // first pixel in byte
                    #ifdef USE_PALETTE
                    if(IsPaletteEnabled())
                    {
                        #ifdef USE_TRANSPARENT_COLOR
                        if ((GetTransparentColor() == (temp & 0x0f)) &&
(GetTransparentColorStatus() == TRANSPARENT_COLOR_ENABLE))
                            DeviceReadWord();
                        else
                        #endif
                            WritePixel(temp & 0x0f);
                    }
                    else
                    #endif
                    {
                        #ifdef USE_TRANSPARENT_COLOR
                        if ((GetTransparentColor() == pallete[temp & 0x0f]) &&
(GetTransparentColorStatus() == TRANSPARENT_COLOR_ENABLE))
                            DeviceReadWord();
                        else
                        #endif
                            WritePixel(pallete[temp & 0x0f]);
                    }
                }
            }

            address += (GetMaxX() + 1) << 1;
            DisplayDisable();
        }
    }
    else
    {
        for(y = 0; y < sizeY; y++)
        {
            // Get line
            ExternalMemoryCallback(image, memOffset, byteWidth, lineBuffer);
            memOffset += byteWidth;
            DisplayEnable();      // enable SSD1926
            for(stretchY = 0; stretchY < stretch; stretchY++)
            {
                pData = lineBuffer;
                SetAddress(address);

                for(x = 0; x < sizeX; x++)
```

```
                  {

                      // Read 2 pixels from flash
                      if(x & 0x0001)
                      {
                          // second pixel in byte
                          #ifdef USE_PALETTE
                          if(IsPaletteEnabled())
                          {
                              #ifdef USE_TRANSPARENT_COLOR
                              if ((GetTransparentColor() == (temp >> 4)) &&
  (GetTransparentColorStatus() == TRANSPARENT_COLOR_ENABLE))
                              {
                                  DeviceReadWord();
                                  DeviceReadWord();
                              }
                              else
                              #endif
                              {
                                  WritePixel(temp >> 4);
                                  WritePixel(temp >> 4);
                              }
                          }
                          else
                          #endif
                          {
                              #ifdef USE_TRANSPARENT_COLOR
                              if ((GetTransparentColor() == pallete[temp >> 4]) &&
  (GetTransparentColorStatus() == TRANSPARENT_COLOR_ENABLE))
                              {
                                  DeviceReadWord();
                                  DeviceReadWord();
                              }
                              else
                              #endif
                              {
                                  WritePixel(pallete[temp >> 4]);
                                  WritePixel(pallete[temp >> 4]);
                              }
                          }
                      }
                      else
                      {
                          temp = *pData++;

                          // first pixel in byte
                          #ifdef USE_PALETTE
                          if(IsPaletteEnabled())
                          {
                              #ifdef USE_TRANSPARENT_COLOR
                              if ((GetTransparentColor() == (temp & 0x0f)) &&
  (GetTransparentColorStatus() == TRANSPARENT_COLOR_ENABLE))
                              {
                                  DeviceReadWord();
                                  DeviceReadWord();
                              }
                              else
                              #endif
                              {
                                  WritePixel(temp & 0x0f);
                                  WritePixel(temp & 0x0f);
                              }
                          }
                          else
                          #endif
                          {
                              #ifdef USE_TRANSPARENT_COLOR
                              if ((GetTransparentColor() == pallete[temp & 0x0f]) &&
  (GetTransparentColorStatus() == TRANSPARENT_COLOR_ENABLE))
                              {
                                  DeviceReadWord();
                                  DeviceReadWord();
```

```
                            }
                            else
                            #endif
                            {
                                WritePixel(pallete[temp & 0x0f]);
                                WritePixel(pallete[temp & 0x0f]);
                            }
                        }
                    }
                }
                address += (GetMaxX() + 1) << 1;
            }
            DisplayDisable();
        }
    }
}

/*********************************************************************
* Function: void PutImage8BPPExt(SHORT left, SHORT top, void* image, BYTE stretch)
*
* PreCondition: none
*
* Input: left,top - left top image corner, image - image pointer,
*        stretch - image stretch factor
*
* Output: none
*
* Side Effects: none
*
* Overview: outputs monochrome image starting from left,top coordinates
*
* Note: image must be located in external memory
*
********************************************************************/
void PutImage8BPPExt(SHORT left, SHORT top, void *image, BYTE stretch)
{
    register DWORD  address;
    register DWORD  memOffset;
    BITMAP_HEADER   bmp;
    WORD            pallete[256];
    BYTE            lineBuffer[(GetMaxX() + 1)];
    BYTE            *pData;

    BYTE            temp, stretchY;
    WORD            sizeX, sizeY;
    WORD            x, y;

    // Set start address
        #ifndef USE_PALETTE
    address = ((DWORD) (GetMaxX() + 1) * top + left) << 1;
        #else
    address = (((DWORD) (GetMaxX() + 1) * top + left) * PaletteBpp) >> 3;
        #endif

    // Get image header
    ExternalMemoryCallback(image, 0, sizeof(BITMAP_HEADER), &bmp);

    // Get pallete (256 entries)
    ExternalMemoryCallback(image, sizeof(BITMAP_HEADER), 256 * sizeof(WORD), pallete);

    // Set offset to the image data
    memOffset = sizeof(BITMAP_HEADER) + 256 * sizeof(WORD);

    // Get size
    sizeX = bmp.width;
    sizeY = bmp.height;

    // Note: For speed the code for loops are repeated. A small code size increase for
performance

    if (stretch == IMAGE_NORMAL)
    {
        for(y = 0; y < sizeY; y++)
        {

            // Get line
            ExternalMemoryCallback(image, memOffset, sizeX, lineBuffer);
            memOffset += sizeX;
            DisplayEnable();      // enable SSD1926

            pData = lineBuffer;
            SetAddress(address);

            for(x = 0; x < sizeX; x++)
            {
                temp = *pData++;

                #ifdef USE_PALETTE
                if(IsPaletteEnabled())
                {
                    #ifdef USE_TRANSPARENT_COLOR
                    if ((GetTransparentColor() == temp) && (GetTransparentColorStatus() ==
  TRANSPARENT_COLOR_ENABLE))
                        DeviceReadWord();
                    else
                    #endif
                        WritePixel(temp);
                }
                else
                #endif
                {
                    #ifdef USE_TRANSPARENT_COLOR
                    if ((GetTransparentColor() == pallete[temp]) &&
  (GetTransparentColorStatus() == TRANSPARENT_COLOR_ENABLE))
                        DeviceReadWord();
                    else
                    #endif
                        WritePixel(pallete[temp]);
                }
            }

            address += (GetMaxX() + 1) << 1;
            DisplayDisable();
        }
    }
    else
    {
        for(y = 0; y < sizeY; y++)
        {
            // Get line
            ExternalMemoryCallback(image, memOffset, sizeX, lineBuffer);
            memOffset += sizeX;
            DisplayEnable();      // enable SSD1926
            for(stretchY = 0; stretchY < stretch; stretchY++)
            {
                pData = lineBuffer;
                SetAddress(address);

                for(x = 0; x < sizeX; x++)
                {
                    temp = *pData++;

                    #ifdef USE_PALETTE
                    if(IsPaletteEnabled())
                    {
                        #ifdef USE_TRANSPARENT_COLOR
                        if ((GetTransparentColor() == temp) && (GetTransparentColorStatus()
  == TRANSPARENT_COLOR_ENABLE))
                        {
                            DeviceReadWord();
                            DeviceReadWord();
                        }
                        else
                        #endif
                        {
                            WritePixel(temp);
                            WritePixel(temp);
                        }
                    }
                    else
                    #endif
                    {
                        #ifdef USE_TRANSPARENT_COLOR
                        if ((GetTransparentColor() == pallete[temp]) &&
(GetTransparentColorStatus() == TRANSPARENT_COLOR_ENABLE))
                        {
                            DeviceReadWord();
                            DeviceReadWord();
                        }
                        else
                        #endif
                        {
                            WritePixel(pallete[temp]);
                            WritePixel(pallete[temp]);
                        }
                    }

                }
                address += (GetMaxX() + 1) << 1;
            }
            DisplayDisable();
        }
    }
}

/*********************************************************************
* Function: void PutImage16BPPExt(SHORT left, SHORT top, void* image, BYTE stretch)
*
* PreCondition: none
*
* Input: left,top - left top image corner, image - image pointer,
*        stretch - image stretch factor
*
* Output: none
*
* Side Effects: none
*
* Overview: outputs monochrome image starting from left,top coordinates
*
* Note: image must be located in external memory
*
********************************************************************/
void PutImage16BPPExt(SHORT left, SHORT top, void *image, BYTE stretch)
{
    register DWORD  address;
    register DWORD  memOffset;
    BITMAP_HEADER   bmp;
    WORD            lineBuffer[(GetMaxX() + 1)];
    WORD            *pData;
    WORD            byteWidth;

    WORD            temp, stretchY;
    WORD            sizeX, sizeY;
    WORD            x, y;

    // Set start address
        #ifndef USE_PALETTE
    address = ((DWORD) (GetMaxX() + 1) * top + left) << 1;
        #else
    address = (((DWORD) (GetMaxX() + 1) * top + left) * PaletteBpp) >> 3;
        #endif

    // Get image header
    ExternalMemoryCallback(image, 0, sizeof(BITMAP_HEADER), &bmp);

    // Set offset to the image data
    memOffset = sizeof(BITMAP_HEADER);

    // Get size
    sizeX = bmp.width;
    sizeY = bmp.height;

    byteWidth = sizeX << 1;

    // Note: For speed the code for loops are repeated. A small code size increase for
performance

    if (stretch == IMAGE_NORMAL)
    {
        for(y = 0; y < sizeY; y++)
        {

            // Get line
            ExternalMemoryCallback(image, memOffset, byteWidth, lineBuffer);
            memOffset += byteWidth;
            DisplayEnable();      // enable SSD1926

            pData = lineBuffer;
            SetAddress(address);

            for(x = 0; x < sizeX; x++)
            {
                temp = *pData++;

                // Write pixel to screen
                    #ifdef USE_TRANSPARENT_COLOR
                    if ((GetTransparentColor() == temp) && (GetTransparentColorStatus() ==
TRANSPARENT_COLOR_ENABLE))
                        DeviceReadWord();
                    else
                    #endif
                        WritePixel(temp);

            }

            address += (GetMaxX() + 1) << 1;
            DisplayDisable();
        }
   }
   else
   {
        for(y = 0; y < sizeY; y++)
        {
            // Get line
            ExternalMemoryCallback(image, memOffset, byteWidth, lineBuffer);
            memOffset += byteWidth;
            DisplayEnable();      // enable SSD1926
            for(stretchY = 0; stretchY < stretch; stretchY++)
            {
                pData = lineBuffer;
                SetAddress(address);

                for(x = 0; x < sizeX; x++)
                {
                    temp = *pData++;

                    #ifdef USE_TRANSPARENT_COLOR
                    if ((GetTransparentColor() == temp) && (GetTransparentColorStatus() ==
TRANSPARENT_COLOR_ENABLE))
                    {
                        DeviceReadWord();
                        DeviceReadWord();
                    }
                    else
                    #endif
                    {
                        WritePixel(temp);
                        WritePixel(temp);
                    }
                }
                address += (GetMaxX() + 1) << 1;
            }
            DisplayDisable();
        }
    }
}
#endif

/*********************************************************************
* Function: SetClipRgn(left, top, right, bottom)
*
* Overview: Sets clipping region.
*
* PreCondition: none
*
* Input: left - Defines the left clipping region border.
*        top - Defines the top clipping region border.
*        right - Defines the right clipping region border.
*        bottom - Defines the bottom clipping region border.
*
* Output: none
*
* Side Effects: none
*
********************************************************************/
void SetClipRgn(SHORT left, SHORT top, SHORT right, SHORT bottom)
{
    _clipLeft=left;
    _clipTop=top;
    _clipRight=right;
    _clipBottom=bottom;

}

/*********************************************************************
* Function: SetClip(control)
*
* Overview: Enables/disables clipping.
*
* PreCondition: none
*
* Input: control - Enables or disables the clipping.
*           - 0: Disable clipping
*           - 1: Enable clipping
*
* Output: none
*
* Side Effects: none
*
********************************************************************/
void SetClip(BYTE control)
{
    _clipRgn=control;
}

/*********************************************************************
* Function: IsDeviceBusy()
*
* Overview: Returns non-zero if LCD controller is busy
*           (previous drawing operation is not completed).
*
* PreCondition: none
*
* Input: none
*
* Output: Busy status.
*
* Side Effects: none
*
********************************************************************/
```

```
WORD IsDeviceBusy(void)
{
    return ((GetReg(REG_2D_220) & 0x01) == 0);
}

#ifdef USE_PALETTE

/*********************************************************************
* Function: void PaletteInit(void)
*
* Overview: Initializes the CLUT.
*
* PreCondition: none
*
* Input: none
*
* Output: none
*
* Side Effects: Drawing mode will change to support palettes
*
********************************************************************/
void PaletteInit(void)
{
    PaletteBpp = 16;
    blPaletteChangeError = 0;
    pPendingPalette = NULL;
    PendingStartEntry = 0;
    PendingLength = 0;
}

/*********************************************************************
* Function: BYTE SetPaletteBpp(BYTE bpp)
*
* Overview: Sets the CLUT's number of valid entries.
*
* PreCondition: PaletteInit() must be called before.
*
* Input: bpp -> Bits per pixel
*
* Output: Status: Zero -> Success, Non-zero -> Error.
*
* Side Effects: Drawing mode will change to support palettes
*
********************************************************************/
BYTE SetPaletteBpp(BYTE bpp)
{
    switch(bpp)
    {
        /*case 1: SetReg(REG_DISPLAY_MODE,0x00);
                break;

        case 2: SetReg(REG_DISPLAY_MODE,0x01);
                break;

        case 4: SetReg(REG_DISPLAY_MODE,0x02);
                break;*/
        case 8:     SetReg(REG_DISPLAY_MODE, 0x03); break;
        case 16:    SetReg(REG_DISPLAY_MODE, 0x04); break;
        default:    SetReg(REG_DISPLAY_MODE, 0x04); PaletteBpp = 16; return (-1);
    }

    PaletteBpp = bpp;

    /////////////////////////////////////////////////////////////////////
    // ROTATION MODE
        /////////////////////////////////////////////////////////////////////
        #if (DISP_ORIENTATION == 0)
            #define WIN_START_ADDR  0ul
            #define ROTATION        0

        #elif (DISP_ORIENTATION == 90)
            #ifndef USE_PALETTE
```

```
                #define WIN_START_ADDR  ((((DWORD) GetMaxX() + 1) >> 1) - 1)
            #else
                #define WIN_START_ADDR  (((((DWORD) GetMaxX() + 1) * PaletteBpp) >> 5) - 1)
            #endif
            #define ROTATION    1

        #elif (DISP_ORIENTATION == 180)
            #ifndef USE_PALETTE
                #define WIN_START_ADDR  (((((DWORD) GetMaxX() + 1) * (GetMaxY() + 1)) >> 1)
- 1)
            #else
                #define WIN_START_ADDR  (((((DWORD) GetMaxX() + 1) * (GetMaxY() + 1) *
PaletteBpp) >> 5) - 1)
            #endif
            #define ROTATION    2

        #elif (DISP_ORIENTATION == 270)
            #ifndef USE_PALETTE
                #define WIN_START_ADDR  ((((DWORD) GetMaxX() + 1) * GetMaxY()) >> 1)
            #else
                #define WIN_START_ADDR  ((((DWORD) GetMaxX() + 1) * GetMaxY() * PaletteBpp)
>> 5)
            #endif
            #define ROTATION    3
        #endif

    ///////////////////////////////////////////////////////////////////////
    // Special Effects Register (reg 71h)
    ///////////////////////////////////////////////////////////////////////
        #ifndef USE_PALETTE
    SetReg(REG_SPECIAL_EFFECTS, 0x40 | ROTATION);
        #else
    SetReg(REG_SPECIAL_EFFECTS, 0x00 | ROTATION);
        #endif

    ///////////////////////////////////////////////////////////////////////
    // Main Window Display Start Address (regs 74h, 75h, 76h)
    ///////////////////////////////////////////////////////////////////////
    SetReg(REG_MAIN_WIN_DISP_START_ADDR0, WIN_START_ADDR & 0x00FF);
    SetReg(REG_MAIN_WIN_DISP_START_ADDR1, (WIN_START_ADDR >> 8) & 0x00FF);
    SetReg(REG_MAIN_WIN_DISP_START_ADDR2, (WIN_START_ADDR >> 16) & 0x00FF);

    ///////////////////////////////////////////////////////////////////////
    // Main Window Display Offset (regs 78h, 79h)
    ///////////////////////////////////////////////////////////////////////
        #ifndef USE_PALETTE
            #define WIN_OFFSET  ((GetMaxX() + 1) >> 1)
        #else
            #define WIN_OFFSET  (((GetMaxX() + 1) * PaletteBpp) >> 5)
        #endif
    SetReg(REG_MAIN_WIN_ADDR_OFFSET0, WIN_OFFSET & 0x00FF);
    SetReg(REG_MAIN_WIN_ADDR_OFFSET1, (WIN_OFFSET >> 8) & 0x00FF);

    return (0);
}

/*********************************************************************
* Function: void EnablePalette(void)
*
* Overview: Enables the Palette mode
*
* PreCondition: none
*
* Input: none
*
* Output: none
*
* Side Effects:
*
********************************************************************/
void EnablePalette(void)
{
    SetPaletteBpp(PaletteBpp);
}

/*********************************************************************
* Function: void DisablePalette(void)
*
* Overview: Disables the Palette mode
*
* PreCondition: none
*
* Input: none
*
* Output: none
*
* Side Effects:
*
********************************************************************/
void DisablePalette(void)
{
    SetPaletteBpp(16);
}

/*********************************************************************
* Function: BYTE IsPaletteEnabled(void)
*
* Overview: Returns if the Palette mode is enabled or not
*
* PreCondition: none
*
* Input: none
*
* Output: Enabled -> 1, Disabled -> 0
*
* Side Effects:
*
********************************************************************/
BYTE IsPaletteEnabled(void)
{
    return ((PaletteBpp == 16) ? 0 : 1);
}

/*********************************************************************
* Function: void StartVBlankInterrupt(void)
*
* Overview: Sets up the Vertical Blanking Interrupt
*
* PreCondition: Interrupts must be enabled
*
* Input: none
*
* Output: none
*
* Side Effects: none
*
********************************************************************/
void StartVBlankInterrupt(void)
{

    /* We don't use Vertical Blanking Interrupt in SSD1926 */
    if(pPendingPalette != NULL)
    {
        blPaletteChangeError = SetPalette(pPendingPalette, PendingStartEntry,
PendingLength);
        if(!blPaletteChangeError)
        {
            _palette = pPendingPalette;
        }
    }
}

/*********************************************************************
* Function: BYTE SetPaletteFlash(PALETTE_ENTRY *pPaletteEntry, WORD startEntry, WORD length)
```

```
*
* Overview: Loads the palettes from the flash immediately.
*
* PreCondition: PaletteInit() must be called before.
*
* Input: pPaletteEntry   - Pointer to the palette table in ROM
*        startEntry      - Start entry to load (inclusive)
*        length          - Number of entries
*
* Output: Status: Zero -> Success, Non-zero -> Error.
*
* Side Effects: There may be a slight flicker when the Palette entries
*               are getting loaded one by one.
*
*********************************************************************/
BYTE SetPaletteFlash(PALETTE_ENTRY *pPaletteEntry, WORD startEntry, WORD length)
{
    WORD    counter;

    if((pPaletteEntry == NULL) || ((startEntry + length) > 256))
    {
        return (-1);
    }

    for(counter = 0; counter < length; counter++)
    {
        SetReg(REG_LUT_RED_WRITE_DATA, RED8(pPaletteEntry[counter].value));
        SetReg(REG_LUT_GREEN_WRITE_DATA, GREEN8(pPaletteEntry[counter].value));
        SetReg(REG_LUT_BLUE_WRITE_DATA, BLUE8(pPaletteEntry[counter].value));
        SetReg(REG_LUT_WRITE_ADDR, startEntry + counter);
    }

    return (0);
}

#endif

#endif // #if (GFX_USE_DISPLAY_CONTROLLER_SSD1926)
```

14.3.12 SSD1926.h

Functions

	Name	Description
	DisplayBrightness (see page 404)	Sets the brightness of the display.

Macros

Name	Description
GFX_LCD_CSTN (see page 42)	Type Color STN Display
GFX_LCD_MSTN (see page 42)	Type Mono STN Display
GFX_LCD_TFT (see page 43)	Type TFT Display

Description

This is file SSD1926.h.

Body Source

```
/*****************************************************************************
 *  Module for Microchip Graphics Library
 *  Solomon Systech. SSD1926 LCD controllers driver
 *  to be used with GFX 3 PICtail board
 *****************************************************************************
 * FileName:        SSD1926.h
 * Processor:       PIC24, PIC32
 * Compiler:        MPLAB C30, MPLAB C32
 * Company:         Microchip Technology Incorporated
 *
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 * CLAIMS BY THIRD PARTIES (INCLUDING BUT NOT LIMITED TO ANY DEFENSE THEREOF),
 * OR OTHER SIMILAR COSTS.
 *
 * Date         Comment
 *~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
 * 08/27/08     ...
 * 30/07/09     Added Palette Support
 * 03/03/10     Enabled accelerated Circle() function.
 * 02/14/11     - for Graphics Library Version 3.00
 *              - Removed USE_DRV_xxxx switches. This is not needed anymore
 *                since Primitive Lyer implements weak attributes on
 *                Primitive Routines that can be implemented in hardware.
 *              - Removed Circle Function implementation (SSD1926 bug)
 *              - Moved common APIs to DisplayDriver.h. DisplayDriver.h
 *                is now a common file that should be included in the
 *                the driver source code.
 *              - Added #define GFX_LCD_TFT  0x01 // Type TFT Display
 *                      #define GFX_LCD_CSTN 0x03 // Type Color STN Display
 *                      #define GFX_LCD_MSTN 0x02 // Type Mono STN Display
 *                to select type of display panel.
 *****************************************************************************/

#ifndef _SSD1926_H
    #define _SSD1926_H

    #include "HardwareProfile.h"
    #include "GenericTypeDefs.h"

    #ifdef USE_PALETTE
        #include "Graphics/Palette.h"
    #endif

/*********************************************************************
* Error Checking
*********************************************************************/
    #ifndef DISP_HOR_RESOLUTION
        #error DISP_HOR_RESOLUTION must be defined in HardwareProfile.h
    #endif
    #ifndef DISP_VER_RESOLUTION
        #error DISP_VER_RESOLUTION must be defined in HardwareProfile.h
    #endif
    #ifndef DISP_ORIENTATION
        #error DISP_ORIENTATION must be defined in HardwareProfile.h
    #endif

/*********************************************************************
* Overview: Horizontal synchronization timing in pixels
*                  (from the glass datasheet).
```

```
*********************************************************************/

    #ifndef DISP_HOR_PULSE_WIDTH
        #error DISP_HOR_PULSE_WIDTH must be defined in HardwareProfile.h
    #endif
    #ifndef DISP_HOR_BACK_PORCH
        #error DISP_HOR_BACK_PORCH must be defined in HardwareProfile.h
    #endif
    #ifndef DISP_HOR_FRONT_PORCH
        #error DISP_HOR_FRONT_PORCH must be defined in HardwareProfile.h
    #endif

/*********************************************************************
* Overview: Vertical synchronization timing in lines
*                   (from the glass datasheet).
*********************************************************************/
    #ifndef DISP_VER_PULSE_WIDTH
        #error DISP_VER_PULSE_WIDTH must be defined in HardwareProfile.h
    #endif
    #ifndef DISP_VER_BACK_PORCH
        #error DISP_VER_BACK_PORCH must be defined in HardwareProfile.h
    #endif
    #ifndef DISP_VER_FRONT_PORCH
        #error DISP_VER_FRONT_PORCH must be defined in HardwareProfile.h
    #endif

/*********************************************************************
* PARAMETERS VALIDATION
*********************************************************************/
    #if COLOR_DEPTH != 16
        #error This driver supports 16 BPP only.
    #endif
    #if (DISP_HOR_RESOLUTION % 8) != 0
        #error Horizontal resolution must be divisible by 8.
    #endif
    #if (DISP_ORIENTATION != 0) && (DISP_ORIENTATION != 180) && (DISP_ORIENTATION != 90) &&
(DISP_ORIENTATION != 270)
        #error The display orientation selected is not supported. It can be only 0,90,180
or 270.
    #endif

/*********************************************************************
* Function:  void SetReg(WORD index, BYTE value);
*
* PreCondition: none
*
* Input: index - register number
*        value - data to be written to the register
*
* Output: none
*
* Side Effects: none
*
* Overview: Writes the given value to the register defined by index.
*
* Note: none
*
********************************************************************/
void            SetReg(WORD index, BYTE value);


/*********************************************************************
* Function:  BYTE GetReg(WORD index)
*
* PreCondition: none
*
* Input: index - register number
*
* Output: none
*
* Side Effects: none
*
```

```
* Overview: returns graphics controller register value (byte access)
*
* Note: none
*
********************************************************************/
BYTE            GetReg(WORD index);

/*********************************************************************
* Function:  void DisplayBrightness(WORD level)
*
* PreCondition: none
*
* Input: level - Brightness level. Valid values are 0 to 100.
*            - 0: brightness level is zero or display is turned off
*            - 1: brightness level is maximum
*
* Output: none
*
* Side Effects: none
*
* Overview: Sets the brightness of the display.
*
* Note: none
*
********************************************************************/
void            DisplayBrightness(WORD level);

/*********************************************************************
* Overview: SSD1926 registers definitions.
*********************************************************************/
    #define REG_PLL_CONFIG_0                    0x126
    #define REG_PLL_CONFIG_1                    0x127
    #define REG_PLL_CONFIG_2                    0x12b

    #define REG_DISP_BUFFER_SIZE                0x01
    #define REG_CONFIG_READBACK                 0x02
    #define REG_REVISION_CODE                   0x03
    #define REG_MEMCLK_CONFIG                   0x04
    #define REG_PCLK_CONFIG                     0x05
    #define REG_VCLK_CONFIG_0                   0x06
    #define REG_VCLK_CONFIG_1                   0x07
    #define REG_LUT_BLUE_WRITE_DATA             0x08
    #define REG_LUT_GREEN_WRITE_DATA            0x09
    #define REG_LUT_RED_WRITE_DATA              0x0a
    #define REG_LUT_WRITE_ADDR                  0x0b
    #define REG_LUT_BLUE_READ_DATA              0x0c
    #define REG_LUT_GREEN_READ_DATA             0x0d
    #define REG_LUT_RED_READ_DATA               0x0e
    #define REG_LUT_READ_ADDR                   0x0f
    #define REG_PANEL_TYPE                      0x10
    #define REG_MOD_RATE                        0x11
    #define REG_HORIZ_TOTAL_0                   0x12
    #define REG_HORIZ_TOTAL_1                   0x13
    #define REG_HDP                             0x14
    #define REG_HDP_START_POS0                  0x16
    #define REG_HDP_START_POS1                  0x17
    #define REG_VERT_TOTAL0                     0x18
    #define REG_VERT_TOTAL1                     0x19
    #define REG_VDP0                            0x1c
    #define REG_VDP1                            0x1d
    #define REG_VDP_START_POS0                  0x1e
    #define REG_VDP_START_POS1                  0x1f
    #define REG_HSYNC_PULSE_WIDTH               0x20
    #define REG_LLINE_PULSE_START_SUBPIXEL_POS  0x21
    #define REG_HSYNC_PULSE_START_POS0          0x22
    #define REG_HSYNC_PULSE_START_POS1          0x23
    #define REG_VSYNC_PULSE_WIDTH               0x24
    #define REG_VSYNC_PULSE_START_POS0          0x26
    #define REG_VSYNC_PULSE_START_POS1          0x27
    #define REG_POST_PROCESSING_SATURATION      0x2c
    #define REG_POST_PROCESSING_BRIGHTNESS      0x2d
    #define REG_POST_PROCESSING_CONTRAST        0x2e
```

```
#define REG_POST_PROCESSING_CTRL            0x2f

#define REG_FPFRAME_START_OFFSET0           0x30
#define REG_FPFRAME_START_OFFSET1           0x31
#define REG_FPFRAME_STOP_OFFSET0            0x34
#define REG_FPFRAME_STOP_OFFSET1            0x35
#define REG_LSHIFT_POLARITY                 0x38
#define REG_GPIO1_PULSE_START               0x3c
#define REG_GPIO1_PULSE_STOP                0x3e
#define REG_GPIO2_PULSE_DELAY               0x40
#define REG_LCD_SUBPIXEL_ALIGNMENT          0x42
#define REG_STN_COLOR_DEPTH                 0x45

#define REG_INTERRUPT_FLAG                  0x48
#define REG_INTERRUPT_ENABLE                0x4A

#define REG_DYN_DITHER_CONTROL              0x50

#define REG_DISPLAY_MODE                    0x70
#define REG_SPECIAL_EFFECTS                 0x71
#define REG_RGB_SETTING                     0x1a4

#define REG_MAIN_WIN_DISP_START_ADDR0       0x74
#define REG_MAIN_WIN_DISP_START_ADDR1       0x75
#define REG_MAIN_WIN_DISP_START_ADDR2       0x76
#define REG_MAIN_WIN_ADDR_OFFSET0           0x78
#define REG_MAIN_WIN_ADDR_OFFSET1           0x79
#define REG_FLOAT_WIN_DISP_START_ADDR0      0x7c
#define REG_FLOAT_WIN_DISP_START_ADDR1      0x7d
#define REG_FLOAT_WIN_DISP_START_ADDR2      0x7e
#define REG_FLOAT_WIN_ADDR_OFFSET0          0x80
#define REG_FLOAT_WIN_ADDR_OFFSET1          0x81
#define REG_FLOAT_WIN_X_START_POS0          0x84
#define REG_FLOAT_WIN_X_START_POS1          0x85
#define REG_FLOAT_WIN_Y_START_POS0          0x88
#define REG_FLOAT_WIN_Y_START_POS1          0x89
#define REG_FLOAT_WIN_X_END_POS0            0x8c
#define REG_FLOAT_WIN_X_END_POS1            0x8d
#define REG_FLOAT_WIN_Y_END_POS0            0x90
#define REG_FLOAT_WIN_Y_END_POS1            0x91
#define REG_POWER_SAVE_CONFIG               0xa0
#define REG_SOFTWARE_RESET                  0xa2
#define REG_SCRATCH_PAD0                    0xa4
#define REG_SCRATCH_PAD1                    0xa5
#define REG_GPIO_CONFIG0                    0xa8
#define REG_GPIO_CONFIG1                    0xa9
#define REG_GPIO_STATUS_CONTROL0            0xac
#define REG_GPIO_STATUS_CONTROL1            0xad
#define REG_PWM_CV_CLOCK_CONTROL            0xb0
#define REG_PWM_CV_CLOCK_CONFIG             0xb1
#define REG_CV_CLOCK_BURST_LENGTH           0xb2
#define REG_PWM_CLOCK_DUTY_CYCLE            0xb3

#define REG_PWM1_CLOCK_CONTROL              0xb4
#define REG_PWM1_CLOCK_CONFIG               0xb5
#define REG_PWM1_CLOCK_DUTY_CYCLE           0xb7

#define REG_PWM2_CLOCK_CONTROL              0xb8
#define REG_PWM2_CLOCK_CONFIG               0xb9
#define REG_PWM2_CLOCK_DUTY_CYCLE           0xbb

#define REG_PWM3_CLOCK_CONTROL              0xbc
#define REG_PWM3_CLOCK_CONFIG               0xbd
#define REG_PWM3_CLOCK_DUTY_CYCLE           0xbf

#define REG_CURSOR_FEATURE                  0xc0
#define REG_CURSOR1_BLINK_TOTAL0            0xc4
#define REG_CURSOR1_BLINK_TOTAL1            0xc5
#define REG_CURSOR1_BLINK_ON0               0xc8
#define REG_CURSOR1_BLINK_ON1               0xc9
#define REG_CURSOR1_MEM_START0              0xcc
#define REG_CURSOR1_MEM_START1              0xcd
```

```
#define REG_CURSOR1_MEM_START2              0xce
#define REG_CURSOR1_POSX0                   0xd0
#define REG_CURSOR1_POSX1                   0xd1
#define REG_CURSOR1_POSY0                   0xd4
#define REG_CURSOR1_POSY1                   0xd5
#define REG_CURSOR1_HORIZ_SIZE_0            0xd8
#define REG_CURSOR1_HORIZ_SIZE_1            0xd9
#define REG_CURSOR1_VERT_SIZE_0             0xdc
#define REG_CURSOR1_VERT_SIZE_1             0xdd
#define REG_CURSOR1_COL_IND1_0              0xe0
#define REG_CURSOR1_COL_IND1_1              0xe1
#define REG_CURSOR1_COL_IND1_2              0xe2
#define REG_CURSOR1_COL_IND1_3              0xe3
#define REG_CURSOR1_COL_IND2_0              0xe4
#define REG_CURSOR1_COL_IND2_1              0xe5
#define REG_CURSOR1_COL_IND2_2              0xe6
#define REG_CURSOR1_COL_IND2_3              0xe7
#define REG_CURSOR1_COL_IND3_0              0xe8
#define REG_CURSOR1_COL_IND3_1              0xe9
#define REG_CURSOR1_COL_IND3_2              0xea
#define REG_CURSOR1_COL_IND3_3              0xeb
#define REG_CURSOR2_BLINK_TOTAL0            0xec
#define REG_CURSOR2_BLINK_TOTAL1            0xed
#define REG_CURSOR2_BLINK_ON0               0xf0
#define REG_CURSOR2_BLINK_ON1               0xf1
#define REG_CURSOR2_MEM_START0              0xf4
#define REG_CURSOR2_MEM_START1              0xf5
#define REG_CURSOR2_MEM_START2              0xf6
#define REG_CURSOR2_POSX0                   0xf8
#define REG_CURSOR2_POSX1                   0xf9
#define REG_CURSOR2_POSY0                   0xfc
#define REG_CURSOR2_POSY1                   0xfd
#define REG_CURSOR2_HORIZ_SIZE_0            0x100
#define REG_CURSOR2_HORIZ_SIZE_1            0x101
#define REG_CURSOR2_VERT_SIZE_0             0x104
#define REG_CURSOR2_VERT_SIZE_1             0x105
#define REG_CURSOR2_COL_IND1_0              0x108
#define REG_CURSOR2_COL_IND1_1              0x109
#define REG_CURSOR2_COL_IND1_2              0x10a
#define REG_CURSOR2_COL_IND1_3              0x10b
#define REG_CURSOR2_COL_IND2_0              0x10c
#define REG_CURSOR2_COL_IND2_1              0x10d
#define REG_CURSOR2_COL_IND2_2              0x10e
#define REG_CURSOR2_COL_IND2_3              0x10f
#define REG_CURSOR2_COL_IND3_0              0x110
#define REG_CURSOR2_COL_IND3_1              0x111
#define REG_CURSOR2_COL_IND3_2              0x112
#define REG_CURSOR2_COL_IND3_3              0x113

#define REG_MAIN_REFLESH                    0x12c

#define REG_PCLK_FREQ_RATIO_0               0x158
#define REG_PCLK_FREQ_RATIO_1               0x159
#define REG_PCLK_FREQ_RATIO_2               0x15a

#define REG_DV_OP_MODE                      0x160
#define REG_DV_FRAME_SAMPLING               0x161

#define REG_DV_NFRAME_POS_0                 0x162
#define REG_DV_NFRAME_POS_1                 0x163
#define REG_DV_JHORI_SIZE_0                 0x164
#define REG_DV_JHORI_SIZE_1                 0x165
#define REG_DV_JVERT_SIZE_0                 0x168
#define REG_DV_JVERT_SIZE_1                 0x169

#define REG_DV_JMEM_STR_0                   0x16c
#define REG_DV_JMEM_STR_1                   0x16d
#define REG_DV_JMEM_STR_2                   0x16e
#define REG_DV_JMEM_STR_3                   0x16f

#define REG_DV_VHDEC_RATIO                  0x170
#define REG_DV_VVDEC_RATIO                  0x171
```

```
#define REG_DV_JHDEC_RATIO                    0x172
#define REG_DV_JVDEC_RATIO                    0x173

#define REG_DV_HORI_PERIOD_0                  0x174
#define REG_DV_HORI_PERIOD_1                  0x175

#define REG_DV_HORI_MAX_0                     0x17c
#define REG_DV_HORI_MAX_1                     0x17d

#define REG_DV_VERT_MAX_0                     0x180
#define REG_DV_VERT_MAX_1                     0x181

#define REG_DV_HCROP_STR_0                    0x184    //x
#define REG_DV_HCROP_STR_1                    0x185    //x
#define REG_DV_VCROP_STR_0                    0x188    //x
#define REG_DV_VCROP_STR_1                    0x189    //x
#define REG_DV_HCROP_SIZE_0                   0x18c
#define REG_DV_HCROP_SIZE_1                   0x18d

#define REG_DV_VCROP_SIZE_0                   0x190
#define REG_DV_VCROP_SIZE_1                   0x191

#define REG_DV_FRAME_PULSE_WIDTH              0x194
#define REG_DV_VMEM_STR_ADDR1_0               0x19c
#define REG_DV_VMEM_STR_ADDR1_1               0x19d
#define REG_DV_VMEM_STR_ADDR1_2               0x19e
#define REG_DV_VMEM_STR_ADDR1_3               0x19f

#define REG_DV_VMEM_STR_ADDR2_0               0x1a0
#define REG_DV_VMEM_STR_ADDR2_1               0x1a1
#define REG_DV_VMEM_STR_ADDR2_2               0x1a2
#define REG_DV_VMEM_STR_ADDR2_3               0x1a3

#define REG_DV_OFORMAT                        0x1a4
#define REG_DV_ALPHA                          0x1a5
#define REG_DV_SUBPIXEL_MODE                  0x1a6
#define REG_DV_CSC_MODE                       0x1a8
#define REG_DV_Y                              0x1a9
#define REG_DV_CB                             0x1aa
#define REG_DV_CR                             0x1ab

#define REG_DV_TV_0                           0x1ac
#define REG_DV_TV_1                           0x1ad
#define REG_DV_TV_2                           0x1ae

#define REG_DV_ENB                            0x1af

#define REG_DV_DV0_START_ADDR_0               0x1b0
#define REG_DV_DV0_START_ADDR_1               0x1b1
#define REG_DV_DV0_START_ADDR_2               0x1b2

#define REG_DV_DV1_START_ADDR_0               0x1b4
#define REG_DV_DV1_START_ADDR_1               0x1b5
#define REG_DV_DV1_START_ADDR_2               0x1b6

#define REG_2D_1d0                        0x1d0
#define REG_2D_1d1                        0x1d1
#define REG_2D_1d2                        0x1d2
#define REG_2D_1d4                        0x1d4
#define REG_2D_1d5                        0x1d5
#define REG_2D_1d6                        0x1d6
#define REG_2D_1d8                        0x1d8
#define REG_2D_1d9                        0x1d9
#define REG_2D_1dc                        0x1dc
#define REG_2D_1dd                        0x1dd
#define REG_2D_1de                        0x1de
#define REG_2D_1e4                        0x1e4
#define REG_2D_1e5                        0x1e5
#define REG_2D_1e8                        0x1e8
#define REG_2D_1e9                        0x1e9
#define REG_2D_1ec                        0x1ec
#define REG_2D_1ed                        0x1ed
```

```
#define REG_2D_1f0                    0x1f0
#define REG_2D_1f1                    0x1f1
#define REG_2D_1f4                    0x1f4
#define REG_2D_1f5                    0x1f5
#define REG_2D_1f6                    0x1f6
#define REG_2D_1f8                    0x1f8
#define REG_2D_1f9                    0x1f9
#define REG_2D_1fc                    0x1fc
#define REG_2D_1fd                    0x1fd
#define REG_2D_1fe                    0x1fe
#define REG_2D_204                    0x204
#define REG_2D_205                    0x205
#define REG_2D_206                    0x206
#define REG_2D_208                    0x208
#define REG_2D_209                    0x209
#define REG_2D_214                    0x214
#define REG_2D_215                    0x215
#define REG_2D_218                    0x218
#define REG_2D_219                    0x219
#define REG_2D_220                    0x220

#define REG_2D_CMD_1                  0x1d0
#define REG_2D_CMD_2                  0x1d1
#define REG_2D_CMD_FIFO_STATUS        0x1d2
#define REG_2D_SRC_WND_START_ADDR0    0x1d4
#define REG_2D_SRC_WND_START_ADDR1    0x1d5
#define REG_2D_SRC_WND_START_ADDR2    0x1d6
#define REG_2D_SRC_WND_ADDR_OFFSET0   0x1d8
#define REG_2D_SRC_WND_ADDR_OFFSET1   0x1d9
#define REG_2D_SRC_WND_COLOR_MODE     0x1dc
#define REG_2D_DEST_WND_COLOR_MODE    0x1dd
#define REG_2D_SRC_WND_WIDTH0         0x1e4
#define REG_2D_SRC_WND_WIDTH1         0x1e5
#define REG_2D_SRC_WND_HEIGHT0        0x1e8
#define REG_2D_SRC_WND_HEIGHT1        0x1e9
#define REG_2D_DEST_WND_WIDTH0        0x1ec
#define REG_2D_DEST_WND_WIDTH1        0x1ed
#define REG_2D_DEST_WND_HEIGHT0       0x1f0
#define REG_2D_DEST_WND_HEIGHT1       0x1f1
#define REG_2D_DEST_WND_START_ADDR0   0x1f4
#define REG_2D_DEST_WND_START_ADDR1   0x1f5
#define REG_2D_DEST_WND_START_ADDR2   0x1f6
#define REG_2D_DEST_WND_ADDR_OFFSET0  0x1f8
#define REG_2D_DEST_WND_ADDR_OFFSET1  0x1f9
#define REG_2D_WRTIE_PATTERN0         0x1fc
#define REG_2D_WRTIE_PATTERN1         0x1fd
#define REG_2D_WRTIE_PATTERN2         0x1fe
#define REG_2D_BRUSH_WND_START_ADDR0  0x204
#define REG_2D_BRUSH_WND_START_ADDR1  0x205
#define REG_2D_BRUSH_WND_START_ADDR2  0x206
#define REG_2D_BRUSH_WND_ADDR_OFFSET0 0x208
#define REG_2D_BRUSH_WND_ADDR_OFFSET1 0x209
#define REG_2D_BRUSH_WND_WIDTH0       0x214
#define REG_2D_BRUSH_WND_WIDTH1       0x215
#define REG_2D_BRUSH_WND_HEIGHT0      0x218
#define REG_2D_BRUSH_WND_HEIGHT1      0x219
#define REG_2D_CMD_FIFO_INT_EN        0x21c
#define REG_2D_CMD_FIFO_INT_STATUS    0x21e
#define REG_2D_CMD_FIFO_FLAG          0x220
#define REG_2D_CMD_FIFO_IND           0x222

#define REG_I2C_DATA_OUT              0x230
#define REG_I2C_CTL                   0x231
#define REG_I2C_EN_OUT                0x232
#define REG_I2C_BAUD                  0x233
#define REG_I2C_STATUS                0x234
#define REG_I2C_INTERRUPT             0x235
#define REG_I2C_DATA_READY            0x236
#define REG_I2C_DATA_IN               0x237

#define REG_Sub_mode                  0x250
#define REG_Sub_CLK_Divide            0x252
```

```
      #define REG_Sub_Hori_Size                0x254
      #define REG_Sub_Vert_Size                0x25c
      #define REG_Sub_Type                     0x260
      #define REG_Sub_Bpp                      0x261
      #define REG_Sub_TFT_Start                0x262
      #define REG_Sub_SCLK_Divide              0x263

      #define REG_Sub_Ctl_0                    0x270
      #define REG_Sub_Ctl_1                    0x271
      #define REG_Sub_YVU                      0x268
      #define REG_Sub_Y_Offset                 0x269
      #define REG_Sub_Cb_Offset                0x26a
      #define REG_Sub_Cr_Offset                0x26b
      #define REG_Sub_Data_0                   0x26c
      #define REG_Sub_Data_1                   0x26d
      #define REG_Sub_RS                       0x26e
      #define REG_Sub_Start_Adr_0              0x274
      #define REG_Sub_Start_Adr_1              0x275
      #define REG_Sub_Start_Adr_2              0x276
      #define REG_Sub_Offset_0                 0x278
      #define REG_Sub_Offset_1                 0x279
      #define REG_Sub_Ready                    0x27d

      #define REG_LCD0_Rise_0                  0x2b0
      #define REG_LCD0_Rise_1                  0x2b1
      #define REG_LCD0_Fall_0                  0x2b4
      #define REG_LCD0_Fall_1                  0x2b5
      #define REG_LCD0_Period_0                0x2b8
      #define REG_LCD0_Period_1                0x2b9
      #define REG_LCD0_Ctl_0                   0x2bc
      #define REG_LCD0_Ctl_1                   0x2bd
      #define REG_LCD1_Rise_0                  0x2c0
      #define REG_LCD1_Rise_1                  0x2c1
      #define REG_LCD1_Fall_0                  0x2c4
      #define REG_LCD1_Fall_1                  0x2c5
      #define REG_LCD1_Period_0                0x2c8
      #define REG_LCD1_Period_1                0x2c9
      #define REG_LCD1_Ctl_0                   0x2cc
      #define REG_LCD1_Ctl_1                   0x2cd
      #define REG_LCD2_Rise_0                  0x2d0
      #define REG_LCD2_Rise_1                  0x2d1
      #define REG_LCD2_Fall_0                  0x2d4
      #define REG_LCD2_Fall_1                  0x2d5
      #define REG_LCD2_Period_0                0x2d8
      #define REG_LCD2_Period_1                0x2d9
      #define REG_LCD2_Ctl_0                   0x2dc
      #define REG_LCD2_Ctl_1                   0x2dd
      #define REG_LCD3_Rise_0                  0x2e0
      #define REG_LCD3_Rise_1                  0x2e1
      #define REG_LCD3_Fall_0                  0x2e4
      #define REG_LCD3_Fall_1                  0x2e5
      #define REG_LCD3_Period_0                0x2e8
      #define REG_LCD3_Period_1                0x2e9
      #define REG_LCD3_Ctl_0                   0x2ec
      #define REG_LCD3_Ctl_1                   0x2ed
      #define REG_LCD4_Rise_0                  0x2f0
      #define REG_LCD4_Rise_1                  0x2f1
      #define REG_LCD4_Fall_0                  0x2f4
      #define REG_LCD4_Fall_1                  0x2f5
      #define REG_LCD4_Period_0                0x2f8
      #define REG_LCD4_Period_1                0x2f9
      #define REG_LCD4_Ctl_0                   0x2fc
      #define REG_LCD4_Ctl_1                   0x2fd
      #define REG_LCD5_Rise_0                  0x300
      #define REG_LCD5_Rise_1                  0x301
      #define REG_LCD5_Fall_0                  0x304
      #define REG_LCD5_Fall_1                  0x305
      #define REG_LCD5_Period_0                0x308
      #define REG_LCD5_Period_1                0x309
      #define REG_LCD5_Ctl_0                   0x30c
      #define REG_LCD5_Ctl_1                   0x30d
      #define REG_LCD6_Rise_0                  0x310
```

```
    #define REG_LCD6_Rise_1                0x311
    #define REG_LCD6_Fall_0                0x314
    #define REG_LCD6_Fall_1                0x315
    #define REG_LCD6_Period_0              0x318
    #define REG_LCD6_Period_1              0x319
    #define REG_LCD6_Ctl_0                 0x31c
    #define REG_LCD6_Ctl_1                 0x31d
    #define REG_LCD7_Rise_0                0x320
    #define REG_LCD7_Rise_1                0x321
    #define REG_LCD7_Fall_0                0x324
    #define REG_LCD7_Fall_1                0x325
    #define REG_LCD7_Period_0              0x328
    #define REG_LCD7_Period_1              0x329
    #define REG_LCD7_Ctl_0                 0x32c
    #define REG_LCD7_Ctl_1                 0x32d

    #define REG_FRC_FRAME_CTL              0x334
    #define REG_FRC_ENABLE                 0x336

    #define REG_JPEG_RESIZER_CTL           0x360
    #define REG_JPEG_RESIZER_STARTX_0      0x364
    #define REG_JPEG_RESIZER_STARTX_1      0x365
    #define REG_JPEG_RESIZER_STARTY_0      0x366
    #define REG_JPEG_RESIZER_STARTY_1      0x367
    #define REG_JPEG_RESIZER_ENDX_0        0x368
    #define REG_JPEG_RESIZER_ENDX_1        0x369
    #define REG_JPEG_RESIZER_ENDY_0        0x36a
    #define REG_JPEG_RESIZER_ENDY_1        0x36b
    #define REG_JPEG_RESIZER_OP_0          0x36c
    #define REG_JPEG_RESIZER_OP_1          0x36e

    #define REG_JPEG_CTRL                  0x380
    #define REG_JPEG_STATUS                0x382
    #define REG_JPEG_STATUS1               0x383

    #define REG_JPEG_RAW_STATUS            0x384
    #define REG_JPEG_RAW_STATUS1           0x385

    #define REG_JPEG_INTR_CTL0             0x386
    #define REG_JPEG_INTR_CTL1             0x387

    #define REG_JPEG_START_STOP            0x38a

    #define REG_JPEG_FIFO_CTL              0x3a0
    #define REG_JPEG_FIFO_STATUS           0x3a2
    #define REG_JPEG_FIFO_SIZE             0x3a4

    #define REG_JPEG_ENCODE_SIZE_LIMIT_0   0x3B0
    #define REG_JPEG_ENCODE_SIZE_LIMIT_1   0x3B1
    #define REG_JPEG_ENCODE_SIZE_LIMIT_2   0x3B2

    #define REG_JPEG_ENCODE_SIZE_RESULT_0  0x3b4
    #define REG_JPEG_ENCODE_SIZE_RESULT_1  0x3b5
    #define REG_JPEG_ENCODE_SIZE_RESULT_2  0x3b6

    #define REG_JPEG_FILE_SIZE_0           0x3B8
    #define REG_JPEG_FILE_SIZE_1           0x3B9
    #define REG_JPEG_FILE_SIZE_2           0x3BA

    #define REG_JPEG_DECODE_X_SIZE         0x3d8
    #define REG_JPEG_DECODE_Y_SIZE         0x3dc

    #define REG_JPEG_OP_MODE_ENC           0x400
    #define REG_JPEG_OP_MODE               0x401

    #define REG_JPEG_CMD                   0x402

    #define REG_DRI_SETTING                0x40a

    #define REG_JPEG_DECODE_VALUE          0x404

    #define REG_JPEG_Y_PIXEL_SIZE_0        0x40c
```

```
#define REG_JPEG_Y_PIXEL_SIZE_1         0x40d
#define REG_JPEG_X_PIXEL_SIZE_0         0x40e
#define REG_JPEG_X_PIXEL_SIZE_1         0x40f

#define REG_JPEG_SRC_START_ADDR_0       0x410
#define REG_JPEG_SRC_START_ADDR_1       0x411
#define REG_JPEG_SRC_START_ADDR_2       0x412
#define REG_JPEG_SRC_START_ADDR_3       0x413

#define REG_JPEG_DEST_START_ADDR_0      0x414
#define REG_JPEG_DEST_START_ADDR_1      0x415
#define REG_JPEG_DEST_START_ADDR_2      0x416
#define REG_JPEG_DEST_START_ADDR_3      0x417

#define REG_JPEG_RST_MARKER             0x41c

#define REG_JPEG_RST_MARKER_STATUS      0x41e

#define REG_JPEG_INSERT_MARKER00        0x420
#define REG_JPEG_INSERT_MARKER01        0x422
#define REG_JPEG_MARKER_LENGTH00        0x424
#define REG_JPEG_MARKER_LENGTH01        0x426

#define REG_JPEG_MARKER_DATA_00         0x428
#define REG_JPEG_MARKER_DATA_01         0x42a
#define REG_JPEG_MARKER_DATA_02         0x42c
#define REG_JPEG_MARKER_DATA_03         0x42e
#define REG_JPEG_MARKER_DATA_04         0x430
#define REG_JPEG_MARKER_DATA_05         0x432
#define REG_JPEG_MARKER_DATA_06         0x434
#define REG_JPEG_MARKER_DATA_07         0x436
#define REG_JPEG_MARKER_DATA_08         0x438
#define REG_JPEG_MARKER_DATA_09         0x43a
#define REG_JPEG_MARKER_DATA_10         0x43c
#define REG_JPEG_MARKER_DATA_11         0x43e
#define REG_JPEG_MARKER_DATA_12         0x440
#define REG_JPEG_MARKER_DATA_13         0x442
#define REG_JPEG_MARKER_DATA_14         0x444
#define REG_JPEG_MARKER_DATA_15         0x446
#define REG_JPEG_MARKER_DATA_16         0x448
#define REG_JPEG_MARKER_DATA_17         0x44a
#define REG_JPEG_MARKER_DATA_18         0x44c
#define REG_JPEG_MARKER_DATA_19         0x44e
#define REG_JPEG_MARKER_DATA_20         0x450
#define REG_JPEG_MARKER_DATA_21         0x452
#define REG_JPEG_MARKER_DATA_22         0x454
#define REG_JPEG_MARKER_DATA_23         0x456
#define REG_JPEG_MARKER_DATA_24         0x458
#define REG_JPEG_MARKER_DATA_25         0x45a
#define REG_JPEG_MARKER_DATA_26         0x45c
#define REG_JPEG_MARKER_DATA_27         0x45e
#define REG_JPEG_MARKER_DATA_28         0x460
#define REG_JPEG_MARKER_DATA_29         0x462
#define REG_JPEG_MARKER_DATA_30         0x464
#define REG_JPEG_MARKER_DATA_31         0x466

#define REG_JPEG_SOI_CONST_00           0x468
#define REG_JPEG_SOI_CONST_01           0x46a

#define REG_JPEG_JFIF_CONST_00          0x46c
#define REG_JPEG_JFIF_CONST_01          0x46e
#define REG_JPEG_JFIF_CONST_02          0x470
#define REG_JPEG_JFIF_CONST_03          0x472
#define REG_JPEG_JFIF_CONST_04          0x474
#define REG_JPEG_JFIF_CONST_05          0x476
#define REG_JPEG_JFIF_CONST_06          0x478
#define REG_JPEG_JFIF_CONST_07          0x47a
#define REG_JPEG_JFIF_CONST_08          0x47c
#define REG_JPEG_JFIF_CONST_09          0x47e
#define REG_JPEG_JFIF_CONST_10          0x480
#define REG_JPEG_JFIF_CONST_11          0x482
#define REG_JPEG_JFIF_CONST_12          0x484
```

```
#define REG_JPEG_JFIF_CONST_13          0x486
#define REG_JPEG_JFIF_CONST_14          0x488
#define REG_JPEG_JFIF_CONST_15          0x48a
#define REG_JPEG_JFIF_CONST_16          0x48c
#define REG_JPEG_JFIF_CONST_17          0x48e

#define REG_JPEG_LUM_DC_HT_CONST_00     0x490
#define REG_JPEG_LUM_DC_HT_CONST_01     0x492
#define REG_JPEG_LUM_DC_HT_CONST_02     0x494
#define REG_JPEG_LUM_DC_HT_CONST_03     0x496
#define REG_JPEG_LUM_DC_HT_CONST_04     0x498

#define REG_JPEG_CHR_DC_HT_CONST_00     0x4a0
#define REG_JPEG_CHR_DC_HT_CONST_01     0x4a2
#define REG_JPEG_CHR_DC_HT_CONST_02     0x4a4
#define REG_JPEG_CHR_DC_HT_CONST_03     0x4a6
#define REG_JPEG_CHR_DC_HT_CONST_04     0x4a8

#define REG_JPEG_LUM_AC_HT_CONST_00     0x4b0
#define REG_JPEG_LUM_AC_HT_CONST_01     0x4b2
#define REG_JPEG_LUM_AC_HT_CONST_02     0x4b4
#define REG_JPEG_LUM_AC_HT_CONST_03     0x4b6
#define REG_JPEG_LUM_AC_HT_CONST_04     0x4b8

#define REG_JPEG_CHR_AC_HT_CONST_00     0x4c0
#define REG_JPEG_CHR_AC_HT_CONST_01     0x4c2
#define REG_JPEG_CHR_AC_HT_CONST_02     0x4c4
#define REG_JPEG_CHR_AC_HT_CONST_03     0x4c6
#define REG_JPEG_CHR_AC_HT_CONST_04     0x4c8

#define REG_JPEG_LUM_QT_CONST_00        0x4d0
#define REG_JPEG_LUM_QT_CONST_01        0x4d2
#define REG_JPEG_LUM_QT_CONST_02        0x4d4
#define REG_JPEG_LUM_QT_CONST_03        0x4d6
#define REG_JPEG_LUM_QT_CONST_04        0x4d8

#define REG_JPEG_CHR_QT_CONST_00        0x4e0
#define REG_JPEG_CHR_QT_CONST_01        0x4e2
#define REG_JPEG_CHR_QT_CONST_02        0x4e4
#define REG_JPEG_CHR_QT_CONST_03        0x4e6
#define REG_JPEG_CHR_QT_CONST_04        0x4e8

#define REG_JPEG_SOF_CONST_00           0x4f0
#define REG_JPEG_SOF_CONST_01           0x4f2
#define REG_JPEG_SOF_CONST_02           0x4f4
#define REG_JPEG_SOF_CONST_03           0x4f6
#define REG_JPEG_SOF_CONST_04           0x4f8

#define REG_JPEG_QUANT_T0_00            0x500
#define REG_JPEG_QUANT_T0_01            0x502
#define REG_JPEG_QUANT_T0_02            0x504
#define REG_JPEG_QUANT_T0_03            0x506
#define REG_JPEG_QUANT_T0_04            0x508
#define REG_JPEG_QUANT_T0_05            0x50a
#define REG_JPEG_QUANT_T0_06            0x50c
#define REG_JPEG_QUANT_T0_07            0x50e
#define REG_JPEG_QUANT_T0_08            0x510
#define REG_JPEG_QUANT_T0_09            0x512
#define REG_JPEG_QUANT_T0_10            0x514
#define REG_JPEG_QUANT_T0_11            0x516
#define REG_JPEG_QUANT_T0_12            0x518
#define REG_JPEG_QUANT_T0_13            0x51a
#define REG_JPEG_QUANT_T0_14            0x51c
#define REG_JPEG_QUANT_T0_15            0x51e
#define REG_JPEG_QUANT_T0_16            0x520
#define REG_JPEG_QUANT_T0_17            0x522
#define REG_JPEG_QUANT_T0_18            0x524
#define REG_JPEG_QUANT_T0_19            0x526
#define REG_JPEG_QUANT_T0_20            0x528
#define REG_JPEG_QUANT_T0_21            0x52a
#define REG_JPEG_QUANT_T0_22            0x52c
#define REG_JPEG_QUANT_T0_23            0x52e
```

```
#define REG_JPEG_QUANT_T0_24            0x530
#define REG_JPEG_QUANT_T0_25            0x532
#define REG_JPEG_QUANT_T0_26            0x534
#define REG_JPEG_QUANT_T0_27            0x536
#define REG_JPEG_QUANT_T0_28            0x538
#define REG_JPEG_QUANT_T0_29            0x53a
#define REG_JPEG_QUANT_T0_30            0x53c
#define REG_JPEG_QUANT_T0_31            0x53e
#define REG_JPEG_QUANT_T0_32            0x540
#define REG_JPEG_QUANT_T0_33            0x542
#define REG_JPEG_QUANT_T0_34            0x544
#define REG_JPEG_QUANT_T0_35            0x546
#define REG_JPEG_QUANT_T0_36            0x548
#define REG_JPEG_QUANT_T0_37            0x54a
#define REG_JPEG_QUANT_T0_38            0x54c
#define REG_JPEG_QUANT_T0_39            0x54e
#define REG_JPEG_QUANT_T0_40            0x550
#define REG_JPEG_QUANT_T0_41            0x552
#define REG_JPEG_QUANT_T0_42            0x554
#define REG_JPEG_QUANT_T0_43            0x556
#define REG_JPEG_QUANT_T0_44            0x558
#define REG_JPEG_QUANT_T0_45            0x55a
#define REG_JPEG_QUANT_T0_46            0x55c
#define REG_JPEG_QUANT_T0_47            0x55e
#define REG_JPEG_QUANT_T0_48            0x560
#define REG_JPEG_QUANT_T0_49            0x562
#define REG_JPEG_QUANT_T0_50            0x564
#define REG_JPEG_QUANT_T0_51            0x566
#define REG_JPEG_QUANT_T0_52            0x568
#define REG_JPEG_QUANT_T0_53            0x56a
#define REG_JPEG_QUANT_T0_54            0x56c
#define REG_JPEG_QUANT_T0_55            0x56e
#define REG_JPEG_QUANT_T0_56            0x570
#define REG_JPEG_QUANT_T0_57            0x572
#define REG_JPEG_QUANT_T0_58            0x574
#define REG_JPEG_QUANT_T0_59            0x576
#define REG_JPEG_QUANT_T0_60            0x578
#define REG_JPEG_QUANT_T0_61            0x57a
#define REG_JPEG_QUANT_T0_62            0x57c
#define REG_JPEG_QUANT_T0_63            0x57e

#define REG_JPEG_QUANT_T1_00            0x580
#define REG_JPEG_QUANT_T1_01            0x582
#define REG_JPEG_QUANT_T1_02            0x584
#define REG_JPEG_QUANT_T1_03            0x586
#define REG_JPEG_QUANT_T1_04            0x588
#define REG_JPEG_QUANT_T1_05            0x58a
#define REG_JPEG_QUANT_T1_06            0x58c
#define REG_JPEG_QUANT_T1_07            0x58e
#define REG_JPEG_QUANT_T1_08            0x590
#define REG_JPEG_QUANT_T1_09            0x592
#define REG_JPEG_QUANT_T1_10            0x594
#define REG_JPEG_QUANT_T1_11            0x596
#define REG_JPEG_QUANT_T1_12            0x598
#define REG_JPEG_QUANT_T1_13            0x59a
#define REG_JPEG_QUANT_T1_14            0x59c
#define REG_JPEG_QUANT_T1_15            0x59e
#define REG_JPEG_QUANT_T1_16            0x5a0
#define REG_JPEG_QUANT_T1_17            0x5a2
#define REG_JPEG_QUANT_T1_18            0x5a4
#define REG_JPEG_QUANT_T1_19            0x5a6
#define REG_JPEG_QUANT_T1_20            0x5a8
#define REG_JPEG_QUANT_T1_21            0x5aa
#define REG_JPEG_QUANT_T1_22            0x5ac
#define REG_JPEG_QUANT_T1_23            0x5ae
#define REG_JPEG_QUANT_T1_24            0x5b0
#define REG_JPEG_QUANT_T1_25            0x5b2
#define REG_JPEG_QUANT_T1_26            0x5b4
#define REG_JPEG_QUANT_T1_27            0x5b6
#define REG_JPEG_QUANT_T1_28            0x5b8
#define REG_JPEG_QUANT_T1_29            0x5ba
#define REG_JPEG_QUANT_T1_30            0x5bc
```

```
#define REG_JPEG_QUANT_T1_31            0x5be
#define REG_JPEG_QUANT_T1_32            0x5c0
#define REG_JPEG_QUANT_T1_33            0x5c2
#define REG_JPEG_QUANT_T1_34            0x5c4
#define REG_JPEG_QUANT_T1_35            0x5c6
#define REG_JPEG_QUANT_T1_36            0x5c8
#define REG_JPEG_QUANT_T1_37            0x5ca
#define REG_JPEG_QUANT_T1_38            0x5cc
#define REG_JPEG_QUANT_T1_39            0x5ce
#define REG_JPEG_QUANT_T1_40            0x5d0
#define REG_JPEG_QUANT_T1_41            0x5d2
#define REG_JPEG_QUANT_T1_42            0x5d4
#define REG_JPEG_QUANT_T1_43            0x5d6
#define REG_JPEG_QUANT_T1_44            0x5d8
#define REG_JPEG_QUANT_T1_45            0x5da
#define REG_JPEG_QUANT_T1_46            0x5dc
#define REG_JPEG_QUANT_T1_47            0x5de
#define REG_JPEG_QUANT_T1_48            0x5e0
#define REG_JPEG_QUANT_T1_49            0x5e2
#define REG_JPEG_QUANT_T1_50            0x5e4
#define REG_JPEG_QUANT_T1_51            0x5e6
#define REG_JPEG_QUANT_T1_52            0x5e8
#define REG_JPEG_QUANT_T1_53            0x5ea
#define REG_JPEG_QUANT_T1_54            0x5ec
#define REG_JPEG_QUANT_T1_55            0x5ee
#define REG_JPEG_QUANT_T1_56            0x5f0
#define REG_JPEG_QUANT_T1_57            0x5f2
#define REG_JPEG_QUANT_T1_58            0x5f4
#define REG_JPEG_QUANT_T1_59            0x5f6
#define REG_JPEG_QUANT_T1_60            0x5f8
#define REG_JPEG_QUANT_T1_61            0x5fa
#define REG_JPEG_QUANT_T1_62            0x5fc
#define REG_JPEG_QUANT_T1_63            0x5fe

#define REG_JPEG_DC_T0_R0_00            0x600
#define REG_JPEG_DC_T0_R0_01            0x602
#define REG_JPEG_DC_T0_R0_02            0x604
#define REG_JPEG_DC_T0_R0_03            0x606
#define REG_JPEG_DC_T0_R0_04            0x608
#define REG_JPEG_DC_T0_R0_05            0x60a
#define REG_JPEG_DC_T0_R0_06            0x60c
#define REG_JPEG_DC_T0_R0_07            0x60e
#define REG_JPEG_DC_T0_R0_08            0x610
#define REG_JPEG_DC_T0_R0_09            0x612
#define REG_JPEG_DC_T0_R0_10            0x614
#define REG_JPEG_DC_T0_R0_11            0x616
#define REG_JPEG_DC_T0_R0_12            0x618
#define REG_JPEG_DC_T0_R0_13            0x61a
#define REG_JPEG_DC_T0_R0_14            0x61c
#define REG_JPEG_DC_T0_R0_15            0x61e

#define REG_JPEG_DC_T0_R1_00            0x620
#define REG_JPEG_DC_T0_R1_01            0x622
#define REG_JPEG_DC_T0_R1_02            0x624
#define REG_JPEG_DC_T0_R1_03            0x626
#define REG_JPEG_DC_T0_R1_04            0x628
#define REG_JPEG_DC_T0_R1_05            0x62a
#define REG_JPEG_DC_T0_R1_06            0x62c
#define REG_JPEG_DC_T0_R1_07            0x62e
#define REG_JPEG_DC_T0_R1_08            0x630
#define REG_JPEG_DC_T0_R1_09            0x632
#define REG_JPEG_DC_T0_R1_10            0x634
#define REG_JPEG_DC_T0_R1_11            0x636

#define REG_JPEG_AC_T0_R0_00            0x640
#define REG_JPEG_AC_T0_R0_01            0x642
#define REG_JPEG_AC_T0_R0_02            0x644
#define REG_JPEG_AC_T0_R0_03            0x646
#define REG_JPEG_AC_T0_R0_04            0x648
#define REG_JPEG_AC_T0_R0_05            0x64a
#define REG_JPEG_AC_T0_R0_06            0x64c
#define REG_JPEG_AC_T0_R0_07            0x64e
```

```
#define REG_JPEG_AC_T0_R0_08            0x650
#define REG_JPEG_AC_T0_R0_09            0x652
#define REG_JPEG_AC_T0_R0_10            0x654
#define REG_JPEG_AC_T0_R0_11            0x656
#define REG_JPEG_AC_T0_R0_12            0x658
#define REG_JPEG_AC_T0_R0_13            0x65a
#define REG_JPEG_AC_T0_R0_14            0x65c
#define REG_JPEG_AC_T0_R0_15            0x65e

#define REG_JPEG_AC_T0_R1_00            0x660
#define REG_JPEG_AC_T0_R1_01            0x662
#define REG_JPEG_AC_T0_R1_02            0x664
#define REG_JPEG_AC_T0_R1_03            0x666
#define REG_JPEG_AC_T0_R1_04            0x668
#define REG_JPEG_AC_T0_R1_05            0x66a
#define REG_JPEG_AC_T0_R1_06            0x66c
#define REG_JPEG_AC_T0_R1_07            0x66e
#define REG_JPEG_AC_T0_R1_08            0x670
#define REG_JPEG_AC_T0_R1_09            0x672
#define REG_JPEG_AC_T0_R1_10            0x674
#define REG_JPEG_AC_T0_R1_11            0x676
#define REG_JPEG_AC_T0_R1_12            0x678
#define REG_JPEG_AC_T0_R1_13            0x67a
#define REG_JPEG_AC_T0_R1_14            0x67c
#define REG_JPEG_AC_T0_R1_15            0x67e
#define REG_JPEG_AC_T0_R1_16            0x680
#define REG_JPEG_AC_T0_R1_17            0x682
#define REG_JPEG_AC_T0_R1_18            0x684
#define REG_JPEG_AC_T0_R1_19            0x686
#define REG_JPEG_AC_T0_R1_20            0x688
#define REG_JPEG_AC_T0_R1_21            0x68a
#define REG_JPEG_AC_T0_R1_22            0x68c
#define REG_JPEG_AC_T0_R1_23            0x68e
#define REG_JPEG_AC_T0_R1_24            0x690
#define REG_JPEG_AC_T0_R1_25            0x692
#define REG_JPEG_AC_T0_R1_26            0x694
#define REG_JPEG_AC_T0_R1_27            0x696
#define REG_JPEG_AC_T0_R1_28            0x698
#define REG_JPEG_AC_T0_R1_29            0x69a
#define REG_JPEG_AC_T0_R1_30            0x69c
#define REG_JPEG_AC_T0_R1_31            0x69e
#define REG_JPEG_AC_T0_R1_32            0x6a0
#define REG_JPEG_AC_T0_R1_33            0x6a2
#define REG_JPEG_AC_T0_R1_34            0x6a4
#define REG_JPEG_AC_T0_R1_35            0x6a6
#define REG_JPEG_AC_T0_R1_36            0x6a8
#define REG_JPEG_AC_T0_R1_37            0x6aa
#define REG_JPEG_AC_T0_R1_38            0x6ac
#define REG_JPEG_AC_T0_R1_39            0x6ae
#define REG_JPEG_AC_T0_R1_40            0x6b0
#define REG_JPEG_AC_T0_R1_41            0x6b2
#define REG_JPEG_AC_T0_R1_42            0x6b4
#define REG_JPEG_AC_T0_R1_43            0x6b6
#define REG_JPEG_AC_T0_R1_44            0x6b8
#define REG_JPEG_AC_T0_R1_45            0x6ba
#define REG_JPEG_AC_T0_R1_46            0x6bc
#define REG_JPEG_AC_T0_R1_47            0x6be
#define REG_JPEG_AC_T0_R1_48            0x6c0
#define REG_JPEG_AC_T0_R1_49            0x6c2
#define REG_JPEG_AC_T0_R1_50            0x6c4
#define REG_JPEG_AC_T0_R1_51            0x6c6
#define REG_JPEG_AC_T0_R1_52            0x6c8
#define REG_JPEG_AC_T0_R1_53            0x6ca
#define REG_JPEG_AC_T0_R1_54            0x6cc
#define REG_JPEG_AC_T0_R1_55            0x6ce
#define REG_JPEG_AC_T0_R1_56            0x6d0
#define REG_JPEG_AC_T0_R1_57            0x6d2
#define REG_JPEG_AC_T0_R1_58            0x6d4
#define REG_JPEG_AC_T0_R1_59            0x6d6
#define REG_JPEG_AC_T0_R1_60            0x6d8
#define REG_JPEG_AC_T0_R1_61            0x6da
#define REG_JPEG_AC_T0_R1_62            0x6dc
```

```
#define REG_JPEG_AC_T0_R1_63            0x6de
#define REG_JPEG_AC_T0_R1_64            0x6e0
#define REG_JPEG_AC_T0_R1_65            0x6e2
#define REG_JPEG_AC_T0_R1_66            0x6e4
#define REG_JPEG_AC_T0_R1_67            0x6e6
#define REG_JPEG_AC_T0_R1_68            0x6e8
#define REG_JPEG_AC_T0_R1_69            0x6ea
#define REG_JPEG_AC_T0_R1_70            0x6ec
#define REG_JPEG_AC_T0_R1_71            0x6ee
#define REG_JPEG_AC_T0_R1_72            0x6f0
#define REG_JPEG_AC_T0_R1_73            0x6f2
#define REG_JPEG_AC_T0_R1_74            0x6f4
#define REG_JPEG_AC_T0_R1_75            0x6f6
#define REG_JPEG_AC_T0_R1_76            0x6f8
#define REG_JPEG_AC_T0_R1_77            0x6fa
#define REG_JPEG_AC_T0_R1_78            0x6fc
#define REG_JPEG_AC_T0_R1_79            0x6fe
#define REG_JPEG_AC_T0_R1_80            0x700
#define REG_JPEG_AC_T0_R1_81            0x702
#define REG_JPEG_AC_T0_R1_82            0x704
#define REG_JPEG_AC_T0_R1_83            0x706
#define REG_JPEG_AC_T0_R1_84            0x708
#define REG_JPEG_AC_T0_R1_85            0x70a
#define REG_JPEG_AC_T0_R1_86            0x70c
#define REG_JPEG_AC_T0_R1_87            0x70e
#define REG_JPEG_AC_T0_R1_88            0x710
#define REG_JPEG_AC_T0_R1_89            0x712
#define REG_JPEG_AC_T0_R1_90            0x714
#define REG_JPEG_AC_T0_R1_91            0x716
#define REG_JPEG_AC_T0_R1_92            0x718
#define REG_JPEG_AC_T0_R1_93            0x71a
#define REG_JPEG_AC_T0_R1_94            0x71c
#define REG_JPEG_AC_T0_R1_95            0x71e
#define REG_JPEG_AC_T0_R1_96            0x720
#define REG_JPEG_AC_T0_R1_97            0x722
#define REG_JPEG_AC_T0_R1_98            0x724
#define REG_JPEG_AC_T0_R1_99            0x726
#define REG_JPEG_AC_T0_R1_100           0x728
#define REG_JPEG_AC_T0_R1_101           0x72a
#define REG_JPEG_AC_T0_R1_102           0x72c
#define REG_JPEG_AC_T0_R1_103           0x72e
#define REG_JPEG_AC_T0_R1_104           0x730
#define REG_JPEG_AC_T0_R1_105           0x732
#define REG_JPEG_AC_T0_R1_106           0x734
#define REG_JPEG_AC_T0_R1_107           0x736
#define REG_JPEG_AC_T0_R1_108           0x738
#define REG_JPEG_AC_T0_R1_109           0x73a
#define REG_JPEG_AC_T0_R1_110           0x73c
#define REG_JPEG_AC_T0_R1_111           0x73e
#define REG_JPEG_AC_T0_R1_112           0x740
#define REG_JPEG_AC_T0_R1_113           0x742
#define REG_JPEG_AC_T0_R1_114           0x744
#define REG_JPEG_AC_T0_R1_115           0x746
#define REG_JPEG_AC_T0_R1_116           0x748
#define REG_JPEG_AC_T0_R1_117           0x74a
#define REG_JPEG_AC_T0_R1_118           0x74c
#define REG_JPEG_AC_T0_R1_119           0x74e
#define REG_JPEG_AC_T0_R1_120           0x750
#define REG_JPEG_AC_T0_R1_121           0x752
#define REG_JPEG_AC_T0_R1_122           0x754
#define REG_JPEG_AC_T0_R1_123           0x756
#define REG_JPEG_AC_T0_R1_124           0x758
#define REG_JPEG_AC_T0_R1_125           0x75a
#define REG_JPEG_AC_T0_R1_126           0x75c
#define REG_JPEG_AC_T0_R1_127           0x75e
#define REG_JPEG_AC_T0_R1_128           0x760
#define REG_JPEG_AC_T0_R1_129           0x762
#define REG_JPEG_AC_T0_R1_130           0x764
#define REG_JPEG_AC_T0_R1_131           0x766
#define REG_JPEG_AC_T0_R1_132           0x768
#define REG_JPEG_AC_T0_R1_133           0x76a
#define REG_JPEG_AC_T0_R1_134           0x76c
```

```
#define REG_JPEG_AC_T0_R1_135            0x76e
#define REG_JPEG_AC_T0_R1_136            0x770
#define REG_JPEG_AC_T0_R1_137            0x772
#define REG_JPEG_AC_T0_R1_138            0x774
#define REG_JPEG_AC_T0_R1_139            0x776
#define REG_JPEG_AC_T0_R1_140            0x778
#define REG_JPEG_AC_T0_R1_141            0x77a
#define REG_JPEG_AC_T0_R1_142            0x77c
#define REG_JPEG_AC_T0_R1_143            0x77e
#define REG_JPEG_AC_T0_R1_144            0x780
#define REG_JPEG_AC_T0_R1_145            0x782
#define REG_JPEG_AC_T0_R1_146            0x784
#define REG_JPEG_AC_T0_R1_147            0x786
#define REG_JPEG_AC_T0_R1_148            0x788
#define REG_JPEG_AC_T0_R1_149            0x78a
#define REG_JPEG_AC_T0_R1_150            0x78c
#define REG_JPEG_AC_T0_R1_151            0x78e
#define REG_JPEG_AC_T0_R1_152            0x790
#define REG_JPEG_AC_T0_R1_153            0x792
#define REG_JPEG_AC_T0_R1_154            0x794
#define REG_JPEG_AC_T0_R1_155            0x796
#define REG_JPEG_AC_T0_R1_156            0x798
#define REG_JPEG_AC_T0_R1_157            0x79a
#define REG_JPEG_AC_T0_R1_158            0x79c
#define REG_JPEG_AC_T0_R1_159            0x79e
#define REG_JPEG_AC_T0_R1_160            0x7a0
#define REG_JPEG_AC_T0_R1_161            0x7a2

#define REG_JPEG_DC_T1_R0_00             0x800
#define REG_JPEG_DC_T1_R0_01             0x802
#define REG_JPEG_DC_T1_R0_02             0x804
#define REG_JPEG_DC_T1_R0_03             0x806
#define REG_JPEG_DC_T1_R0_04             0x808
#define REG_JPEG_DC_T1_R0_05             0x80a
#define REG_JPEG_DC_T1_R0_06             0x80c
#define REG_JPEG_DC_T1_R0_07             0x80e
#define REG_JPEG_DC_T1_R0_08             0x810
#define REG_JPEG_DC_T1_R0_09             0x812
#define REG_JPEG_DC_T1_R0_10             0x814
#define REG_JPEG_DC_T1_R0_11             0x816
#define REG_JPEG_DC_T1_R0_12             0x818
#define REG_JPEG_DC_T1_R0_13             0x81a
#define REG_JPEG_DC_T1_R0_14             0x81c
#define REG_JPEG_DC_T1_R0_15             0x81e

#define REG_JPEG_DC_T1_R1_00             0x820
#define REG_JPEG_DC_T1_R1_01             0x822
#define REG_JPEG_DC_T1_R1_02             0x824
#define REG_JPEG_DC_T1_R1_03             0x826
#define REG_JPEG_DC_T1_R1_04             0x828
#define REG_JPEG_DC_T1_R1_05             0x82a
#define REG_JPEG_DC_T1_R1_06             0x82c
#define REG_JPEG_DC_T1_R1_07             0x82e
#define REG_JPEG_DC_T1_R1_08             0x830
#define REG_JPEG_DC_T1_R1_09             0x832
#define REG_JPEG_DC_T1_R1_10             0x834
#define REG_JPEG_DC_T1_R1_11             0x836

#define REG_JPEG_AC_T1_R0_00             0x840
#define REG_JPEG_AC_T1_R0_01             0x842
#define REG_JPEG_AC_T1_R0_02             0x844
#define REG_JPEG_AC_T1_R0_03             0x846
#define REG_JPEG_AC_T1_R0_04             0x848
#define REG_JPEG_AC_T1_R0_05             0x84a
#define REG_JPEG_AC_T1_R0_06             0x84c
#define REG_JPEG_AC_T1_R0_07             0x84e
#define REG_JPEG_AC_T1_R0_08             0x850
#define REG_JPEG_AC_T1_R0_09             0x852
#define REG_JPEG_AC_T1_R0_10             0x854
#define REG_JPEG_AC_T1_R0_11             0x856
#define REG_JPEG_AC_T1_R0_12             0x858
#define REG_JPEG_AC_T1_R0_13             0x85a
```

```
    #define REG_JPEG_AC_T1_R0_14            0x85c
    #define REG_JPEG_AC_T1_R0_15            0x85e

    #define REG_JPEG_AC_T1_R1_00            0x860
    #define REG_JPEG_AC_T1_R1_01            0x862
    #define REG_JPEG_AC_T1_R1_02            0x864
    #define REG_JPEG_AC_T1_R1_03            0x866
    #define REG_JPEG_AC_T1_R1_04            0x868
    #define REG_JPEG_AC_T1_R1_05            0x86a
    #define REG_JPEG_AC_T1_R1_06            0x86c
    #define REG_JPEG_AC_T1_R1_07            0x86e
    #define REG_JPEG_AC_T1_R1_08            0x870
    #define REG_JPEG_AC_T1_R1_09            0x872
    #define REG_JPEG_AC_T1_R1_10            0x874
    #define REG_JPEG_AC_T1_R1_11            0x876
    #define REG_JPEG_AC_T1_R1_12            0x878
    #define REG_JPEG_AC_T1_R1_13            0x87a
    #define REG_JPEG_AC_T1_R1_14            0x87c
    #define REG_JPEG_AC_T1_R1_15            0x87e
    #define REG_JPEG_AC_T1_R1_16            0x880
    #define REG_JPEG_AC_T1_R1_17            0x882
    #define REG_JPEG_AC_T1_R1_18            0x884
    #define REG_JPEG_AC_T1_R1_19            0x886
    #define REG_JPEG_AC_T1_R1_20            0x888
    #define REG_JPEG_AC_T1_R1_21            0x88a
    #define REG_JPEG_AC_T1_R1_22            0x88c
    #define REG_JPEG_AC_T1_R1_23            0x88e
    #define REG_JPEG_AC_T1_R1_24            0x890
    #define REG_JPEG_AC_T1_R1_25            0x892
    #define REG_JPEG_AC_T1_R1_26            0x894
    #define REG_JPEG_AC_T1_R1_27            0x896
    #define REG_JPEG_AC_T1_R1_28            0x898
    #define REG_JPEG_AC_T1_R1_29            0x89a
    #define REG_JPEG_AC_T1_R1_30            0x89c
    #define REG_JPEG_AC_T1_R1_31            0x89e
    #define REG_JPEG_AC_T1_R1_32            0x8a0
    #define REG_JPEG_AC_T1_R1_33            0x8a2
    #define REG_JPEG_AC_T1_R1_34            0x8a4
    #define REG_JPEG_AC_T1_R1_35            0x8a6
    #define REG_JPEG_AC_T1_R1_36            0x8a8
    #define REG_JPEG_AC_T1_R1_37            0x8aa
    #define REG_JPEG_AC_T1_R1_38            0x8ac
    #define REG_JPEG_AC_T1_R1_39            0x8ae
    #define REG_JPEG_AC_T1_R1_40            0x8b0
    #define REG_JPEG_AC_T1_R1_41            0x8b2
    #define REG_JPEG_AC_T1_R1_42            0x8b4
    #define REG_JPEG_AC_T1_R1_43            0x8b6
    #define REG_JPEG_AC_T1_R1_44            0x8b8
    #define REG_JPEG_AC_T1_R1_45            0x8ba
    #define REG_JPEG_AC_T1_R1_46            0x8bc
    #define REG_JPEG_AC_T1_R1_47            0x8be
    #define REG_JPEG_AC_T1_R1_48            0x8c0
    #define REG_JPEG_AC_T1_R1_49            0x8c2
    #define REG_JPEG_AC_T1_R1_50            0x8c4
    #define REG_JPEG_AC_T1_R1_51            0x8c6
    #define REG_JPEG_AC_T1_R1_52            0x8c8
    #define REG_JPEG_AC_T1_R1_53            0x8ca
    #define REG_JPEG_AC_T1_R1_54            0x8cc
    #define REG_JPEG_AC_T1_R1_55            0x8ce
    #define REG_JPEG_AC_T1_R1_56            0x8d0
    #define REG_JPEG_AC_T1_R1_57            0x8d2
    #define REG_JPEG_AC_T1_R1_58            0x8d4
    #define REG_JPEG_AC_T1_R1_59            0x8d6
    #define REG_JPEG_AC_T1_R1_60            0x8d8
    #define REG_JPEG_AC_T1_R1_61            0x8da
    #define REG_JPEG_AC_T1_R1_62            0x8dc
    #define REG_JPEG_AC_T1_R1_63            0x8de
    #define REG_JPEG_AC_T1_R1_64            0x8e0
    #define REG_JPEG_AC_T1_R1_65            0x8e2
    #define REG_JPEG_AC_T1_R1_66            0x8e4
    #define REG_JPEG_AC_T1_R1_67            0x8e6
    #define REG_JPEG_AC_T1_R1_68            0x8e8
```

```
#define REG_JPEG_AC_T1_R1_69            0x8ea
#define REG_JPEG_AC_T1_R1_70            0x8ec
#define REG_JPEG_AC_T1_R1_71            0x8ee
#define REG_JPEG_AC_T1_R1_72            0x8f0
#define REG_JPEG_AC_T1_R1_73            0x8f2
#define REG_JPEG_AC_T1_R1_74            0x8f4
#define REG_JPEG_AC_T1_R1_75            0x8f6
#define REG_JPEG_AC_T1_R1_76            0x8f8
#define REG_JPEG_AC_T1_R1_77            0x8fa
#define REG_JPEG_AC_T1_R1_78            0x8fc
#define REG_JPEG_AC_T1_R1_79            0x8fe
#define REG_JPEG_AC_T1_R1_80            0x900
#define REG_JPEG_AC_T1_R1_81            0x902
#define REG_JPEG_AC_T1_R1_82            0x904
#define REG_JPEG_AC_T1_R1_83            0x906
#define REG_JPEG_AC_T1_R1_84            0x908
#define REG_JPEG_AC_T1_R1_85            0x90a
#define REG_JPEG_AC_T1_R1_86            0x90c
#define REG_JPEG_AC_T1_R1_87            0x90e
#define REG_JPEG_AC_T1_R1_88            0x910
#define REG_JPEG_AC_T1_R1_89            0x912
#define REG_JPEG_AC_T1_R1_90            0x914
#define REG_JPEG_AC_T1_R1_91            0x916
#define REG_JPEG_AC_T1_R1_92            0x918
#define REG_JPEG_AC_T1_R1_93            0x91a
#define REG_JPEG_AC_T1_R1_94            0x91c
#define REG_JPEG_AC_T1_R1_95            0x91e
#define REG_JPEG_AC_T1_R1_96            0x920
#define REG_JPEG_AC_T1_R1_97            0x922
#define REG_JPEG_AC_T1_R1_98            0x924
#define REG_JPEG_AC_T1_R1_99            0x926
#define REG_JPEG_AC_T1_R1_100           0x928
#define REG_JPEG_AC_T1_R1_101           0x92a
#define REG_JPEG_AC_T1_R1_102           0x92c
#define REG_JPEG_AC_T1_R1_103           0x92e
#define REG_JPEG_AC_T1_R1_104           0x930
#define REG_JPEG_AC_T1_R1_105           0x932
#define REG_JPEG_AC_T1_R1_106           0x934
#define REG_JPEG_AC_T1_R1_107           0x936
#define REG_JPEG_AC_T1_R1_108           0x938
#define REG_JPEG_AC_T1_R1_109           0x93a
#define REG_JPEG_AC_T1_R1_110           0x93c
#define REG_JPEG_AC_T1_R1_111           0x93e
#define REG_JPEG_AC_T1_R1_112           0x940
#define REG_JPEG_AC_T1_R1_113           0x942
#define REG_JPEG_AC_T1_R1_114           0x944
#define REG_JPEG_AC_T1_R1_115           0x946
#define REG_JPEG_AC_T1_R1_116           0x948
#define REG_JPEG_AC_T1_R1_117           0x94a
#define REG_JPEG_AC_T1_R1_118           0x94c
#define REG_JPEG_AC_T1_R1_119           0x94e
#define REG_JPEG_AC_T1_R1_120           0x950
#define REG_JPEG_AC_T1_R1_121           0x952
#define REG_JPEG_AC_T1_R1_122           0x954
#define REG_JPEG_AC_T1_R1_123           0x956
#define REG_JPEG_AC_T1_R1_124           0x958
#define REG_JPEG_AC_T1_R1_125           0x95a
#define REG_JPEG_AC_T1_R1_126           0x95c
#define REG_JPEG_AC_T1_R1_127           0x95e
#define REG_JPEG_AC_T1_R1_128           0x960
#define REG_JPEG_AC_T1_R1_129           0x962
#define REG_JPEG_AC_T1_R1_130           0x964
#define REG_JPEG_AC_T1_R1_131           0x966
#define REG_JPEG_AC_T1_R1_132           0x968
#define REG_JPEG_AC_T1_R1_133           0x96a
#define REG_JPEG_AC_T1_R1_134           0x96c
#define REG_JPEG_AC_T1_R1_135           0x96e
#define REG_JPEG_AC_T1_R1_136           0x970
#define REG_JPEG_AC_T1_R1_137           0x972
#define REG_JPEG_AC_T1_R1_138           0x974
#define REG_JPEG_AC_T1_R1_139           0x976
#define REG_JPEG_AC_T1_R1_140           0x978
```

```
    #define REG_JPEG_AC_T1_R1_141            0x97a
    #define REG_JPEG_AC_T1_R1_142            0x97c
    #define REG_JPEG_AC_T1_R1_143            0x97e
    #define REG_JPEG_AC_T1_R1_144            0x980
    #define REG_JPEG_AC_T1_R1_145            0x982
    #define REG_JPEG_AC_T1_R1_146            0x984
    #define REG_JPEG_AC_T1_R1_147            0x986
    #define REG_JPEG_AC_T1_R1_148            0x988
    #define REG_JPEG_AC_T1_R1_149            0x98a
    #define REG_JPEG_AC_T1_R1_150            0x98c
    #define REG_JPEG_AC_T1_R1_151            0x98e
    #define REG_JPEG_AC_T1_R1_152            0x990
    #define REG_JPEG_AC_T1_R1_153            0x992
    #define REG_JPEG_AC_T1_R1_154            0x994
    #define REG_JPEG_AC_T1_R1_155            0x996
    #define REG_JPEG_AC_T1_R1_156            0x998
    #define REG_JPEG_AC_T1_R1_157            0x99a
    #define REG_JPEG_AC_T1_R1_158            0x99c
    #define REG_JPEG_AC_T1_R1_159            0x99e
    #define REG_JPEG_AC_T1_R1_160            0x9a0
    #define REG_JPEG_AC_T1_R1_161            0x9a2

    #define REG_JPEG_QTABLE_CONST_0          0x9b0
    #define REG_JPEG_QTABLE_CONST_1          0x9b2
    #define REG_JPEG_QTABLE_CONST_2          0x9b4
    #define REG_JPEG_QTABLE_CONST_3          0x9b6

    #define REG_JPEG_QTABLE0_SAMPLE          0x9b8
    #define REG_JPEG_QTABLE1_SAMPLE          0x9bc
    #define REG_JPEG_QTABLE2_SAMPLE          0x9c0

    #define REG_JPEG_DRI_CONST_0             0x9c4
    #define REG_JPEG_DRI_CONST_1             0x9c6
    #define REG_JPEG_DRI_CONST_2             0x9c8
    #define REG_JPEG_DRI_CONST_3             0x9ca

    #define REG_JPEG_SOS_CONST_0             0x9cc
    #define REG_JPEG_SOS_CONST_1             0x9ce
    #define REG_JPEG_SOS_CONST_2             0x9d0
    #define REG_JPEG_SOS_CONST_3             0x9d2
    #define REG_JPEG_SOS_CONST_4             0x9d4

    #define REG_JPEG_EOI_CONST_0             0x9e4
    #define REG_JPEG_EOI_CONST_1             0x9e6
    #define REG_JPEG_EOI_CONST_2             0x9e8
    #define REG_JPEG_EOI_CONST_3             0x9ea
    #define REG_JPEG_EOI_CONST_4             0x9ec

    #define REG_JPEG_VERT_PIX_SIZE0          0x9f0
    #define REG_JPEG_VERT_PIX_SIZE1          0x9f2
    #define REG_JPEG_HORI_PIX_SIZE0          0x9f4
    #define REG_JPEG_HORI_PIX_SIZE1          0x9f6
    #define REG_JPEG_DRI_CONFIG0             0x9f8
    #define REG_JPEG_DRI_CONFIG1             0x9fa

    #define GFX_LCD_TFT  0x01            // Type TFT Display
    #define GFX_LCD_CSTN 0x03            // Type Color STN Display
    #define GFX_LCD_MSTN 0x02            // Type Mono STN Display

#endif // _SSD1926_H
```

14.3.13 TCON_HX8238.c

This is file TCON_HX8238.c.

Body Source

```
/*****************************************************************************
 *  Module for Microchip Graphics Library
 *  Himax HX8238 TCON driver
 *****************************************************************************
 * FileName:        TCON_HX8238.c
 * Processor:       PIC24, PIC32
 * Compiler:        MPLAB C30, MPLAB C32
  * Company:        Microchip Technology Incorporated
 *
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 * CLAIMS BY THIRD PARTIES (INCLUDING BUT NOT LIMITED TO ANY DEFENSE THEREOF),
 * OR OTHER SIMILAR COSTS.
 *
 * Date         Comment
 *~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
 * 11/17/08     ...
 * 04/13/11     - Added GFX_USE_DISPLAY_CONTROLLER_xxx check.
 *              - Replaced TCON_Delay() with Delay10us() from TimeDelay.h
 *              - Renamed TCON_Init() to GfxTconInit() and the rest
 *                of the internal functions.
 *              - Graphics Library Version 3.00 Support
 *****************************************************************************/
#include "GraphicsConfig.h"
#include "HardwareProfile.h"
#include "TimeDelay.h"

#ifdef USE_TCON_HX8238

#if defined (GFX_USE_DISPLAY_CONTROLLER_SSD1926)
    #include "Graphics/SSD1926.h"
#elif defined (GFX_USE_DISPLAY_CONTROLLER_MCHP_DA210) || defined
(GFX_USE_DISPLAY_CONTROLLER_DMA)
    // do not need any driver header file
#else
    #warning "This Timing Controller Driver is written for SSD1926, Microchip Display
Controller using DMA and Microchip Graphics Module driver. If you are not using those
drivers you may need to re-write this driver."
#endif

/*
    This module can use SPI or bitbang the SPI transfer using
    the SSD1926 GPIO pins.
    This assumes that the timing controller uses SPI to
    receive Timing Programming data.
    Select the usage using the hardware profile.
*/
    // BB means BitBang
    #define BB_CS                   0x01
    #define BB_SCL                  0x02
```

```
    #define BB_SDO                  0x04
    #define BB_DC                   0x08

#if defined (GFX_USE_DISPLAY_CONTROLLER_MCHP_DA210) || defined
(GFX_USE_DISPLAY_CONTROLLER_DMA)

    #define TCON_CSLow()            (TCON_CS_LAT = 0)
    #define TCON_CSHigh()           (TCON_CS_LAT = 1)
    #define TCON_CLKLow()           (TCON_SCL_LAT = 0)
    #define TCON_CLKHigh()          (TCON_SCL_LAT = 1)
    #define TCON_DataLow()          (TCON_SDO_LAT = 0)
    #define TCON_DataHigh()         (TCON_SDO_LAT = 1)

    #define TCON_SetCommand()       (TCON_DC_LAT = 0)
    #define TCON_SetData()          (TCON_DC_LAT = 1)

    // set the IOs used to outputs. and initialize them all to "1"
    // set up the TRIS first for outputs, then set the pins
    // to digital in case it is needed and initialize the signals
    // to all high.
    #define InitBitBangedIO() {                     \
                                TCON_CS_TRIS = 0;   \
                                TCON_SCL_TRIS = 0;  \
                                TCON_SDO_TRIS = 0;  \
                                TCON_DC_TRIS = 0;   \
                                TCON_CS_DIG();      \
                                TCON_SCL_DIG();     \
                                TCON_SDO_DIG();     \
                                TCON_DC_DIG();      \
                                TCON_CSHigh();      \
                                TCON_CLKHigh();     \
                                TCON_DataHigh();    \
                                TCON_SetData();     \
                              }

// end of #if defined (USE_DISPLAY_CONTROLLER_MCHP_DA210)


#elif defined (GFX_USE_DISPLAY_CONTROLLER_SSD1926)

    // use the bitbang version using SSD1926 GPIO pins

    #define TCON_CSLow()            (GfxTconSetIO(CS, 0))
    #define TCON_CSHigh()           (GfxTconSetIO(CS, 1))
    #define TCON_CLKLow()           (GfxTconSetIO(SCL, 0))
    #define TCON_CLKHigh()          (GfxTconSetIO(SCL, 1))
    #define TCON_DataLow()          (GfxTconSetIO(SDO, 0))
    #define TCON_DataHigh()         (GfxTconSetIO(SDO, 1))

    #define TCON_SetCommand()       (GfxTconSetIO(DC, 0))
    #define TCON_SetData()          (GfxTconSetIO(DC, 1))

    // this is only needed here since the controller IO's are used
    // instead of the IO's from the PIC device.
    #define SetCtrlBitBangedIO(addr, data)    (SetReg(addr, data))

    // set the GPIO of SSD1926 to as outputs. (used for TCON signals)
    // and initialize them all to "1"
    #define InitBitBangedIO() {                                 \
                                SetCtrlBitBangedIO(0xA8, 0x1F);     \
                                SetCtrlBitBangedIO(0xAC, 0x1F);     \
                              }
// end of #elif defined (USE_TCON_SSD1289)

#endif

/*********************************************************************
* Function: void GfxTconSetIO(BYTE mask, BYTE
level)
*
* Overview: This sets the IO specified by mask to the value set by
*           level.
```

```
*
* Input: mask - specifies the IO to be toggles.
*        level - specifies the logic where the IO will be set.
*
* Output: none
*
*************************************************************************/
void GfxTconSetIO(BYTE mask, BYTE level)
{

 #if defined (GFX_USE_DISPLAY_CONTROLLER_MCHP_DA210) || defined
(GFX_USE_DISPLAY_CONTROLLER_DMA)

    switch(mask)
    {
        case BB_CS:    (level == 1 ? TCON_CSHigh() : TCON_CSLow());
                    break;

        case BB_SCL:   (level == 1 ? TCON_CLKHigh() : TCON_CLKLow());
                    break;

        case BB_SDO:   (level == 1 ? TCON_DataHigh() : TCON_DataLow());
                    break;

        case BB_DC:    (level == 1 ? TCON_SetData() : TCON_SetCommand());
                    break;
        default:
                    break;
    }

    Nop();

 #elif defined (GFX_USE_DISPLAY_CONTROLLER_SSD1926)

    static BYTE value = 0xFF;

    if(level == 0)
    {
        value &= ~mask;
    }
    else
    {
        value |= mask;
    }

    SetCtrlBitBangedIO(0xAC, value);

#endif

}

/*************************************************************************
* Function: void GfxTconWriteByte(BYTE value)
*
* Overview: This writes a bytes to SPI.
*
* Input: value - the byte data to be written.
*
* Output: none
*
*************************************************************************/
void GfxTconWriteByte(BYTE value)
{
    BYTE    mask;

    mask = 0x80;
    while(mask)
    {
        GfxTconSetIO(BB_SCL, 0);
        Delay10us(1);
        if(mask & value)
        {
            GfxTconSetIO(BB_SDO, 1);
        }
        else
        {
            GfxTconSetIO(BB_SDO, 0);
        }

        GfxTconSetIO(BB_SCL, 1);
        mask >>= 1;
    }
}

/************************************************************************
* Function: void GfxTconWriteCommand(BYTE index, WORD
value)
*
* Overview: This writes a word to SPI by calling the write byte
*           routine.
*
* Input: index - The index (or address) of the register to be written.
*        value - The value that will be written to the register.
*
* Output: none
*
************************************************************************/
void GfxTconWriteCommand(WORD index, WORD value)
/* */
{
    GfxTconSetIO(BB_CS, 0);

    // Index
    GfxTconWriteByte(0x70);
    GfxTconWriteByte(((WORD_VAL) index).v[1]);
    GfxTconWriteByte(((WORD_VAL) index).v[0]);

    GfxTconSetIO(BB_CS, 1);
    Delay10us(1);
    GfxTconSetIO(BB_CS, 0);

    // Data
    GfxTconWriteByte(0x72);
    GfxTconWriteByte(((WORD_VAL) value).v[1]);
    GfxTconWriteByte(((WORD_VAL) value).v[0]);
    GfxTconSetIO(BB_CS, 1);
    Delay10us(1);
}


/************************************************************************
* Function: void GfxTconInit(void)
*
* Overview: Initialize the IOs to implement Bitbanged SPI interface
*           to connect to the Timing Controller through SPI.
*
* Input: none
*
* Output: none
*
************************************************************************/
void GfxTconInit(void)
{
    InitBitBangedIO();

    DelayMs(20);

    GfxTconWriteCommand(0x0001, 0x6300);  //Driver Output Control
    GfxTconWriteCommand(0x0002, 0x0200);  //LCD-Driving-Waveform Control:N-line
inversion,N=0
    GfxTconWriteCommand(0x0003, 0x7184);  //Power control 1:Set the step-up cycle of the
step-up circuit for 262k-color mode
    DelayMs(100);
    GfxTconWriteCommand(0x0004, 0x0447);  //Input Data and Color Filter Control
    GfxTconWriteCommand(0x0005, 0xb854);  //Function Control
    GfxTconWriteCommand(0X000a, 0x4008);  //Contrast/Brightness Control

    //GfxTconWriteCommand(0X000a,0xff18);//Contrast/Brightness Control

    DelayMs(40);
    GfxTconWriteCommand(0x000b, 0xd400);  //Frame Cycle Control
    GfxTconWriteCommand(0x000d, 0x123a);  //Power Control 2
    DelayMs(200);
    GfxTconWriteCommand(0x000e, 0x3000);  //Power Control 3
    DelayMs(200);
    GfxTconWriteCommand(0x000f, 0x0000);  //Gate Scan Position
    GfxTconWriteCommand(0x0016, 0x9f80);  //Horizontal Porch
    GfxTconWriteCommand(0x0017, 0x2212);  //Vertical Porch
    DelayMs(200);
    GfxTconWriteCommand(0x001e, 0x00ef);  //Set the VCOMH voltage
    DelayMs(200);

    GfxTconWriteCommand(0x0030, 0x0507);  //Gamma Control
    GfxTconWriteCommand(0x0031, 0x0004);  //Gamma Control
    GfxTconWriteCommand(0x0032, 0x0707);  //Gamma Control
    GfxTconWriteCommand(0x0033, 0x0000);  //Gamma Control
    GfxTconWriteCommand(0x0034, 0x0000);  //Gamma Control
    GfxTconWriteCommand(0x0035, 0x0307);  //Gamma Control
    GfxTconWriteCommand(0x0036, 0x0700);  //Gamma Control
    GfxTconWriteCommand(0x0037, 0x0000);  //Gamma Control
    GfxTconWriteCommand(0x003a, 0x140b);  //Gamma Control
    GfxTconWriteCommand(0x003b, 0x140b);  //Gamma Control
}

#endif // #ifdef USE_TCON_HX8238
```

14.3.14 TCON_SSD1289.c

This is file TCON_SSD1289.c.

Body Source

```
/*****************************************************************************
 *  Module for Microchip Graphics Library
 *  Solomon Systech. SSD1289 TCON  driver
 *****************************************************************************
 * FileName:        TCON_SSD1289.c
 * Processor:       PIC24, PIC32
 * Compiler:        MPLAB C30, MPLAB C32
 * Company:         Microchip Technology Incorporated
 *
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 * OR OTHER SIMILAR COSTS.
 *
 * Date         Comment
 *~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
 * 11/17/08
 * 04/05/10     Modified initialization to reduce flicker.
 * 02/11/11     - Added GFX_USE_DISPLAY_CONTROLLER_xxx check.
 *              - Replaced TCON_Delay() with Delay10us() from TimeDelay.h
 *              - Renamed TCON_Init() to GfxTconInit() and the rest
 *                of the internal functions.
 *****************************************************************************/
#include "GraphicsConfig.h"
#include "HardwareProfile.h"
#include "TimeDelay.h"

#if defined(USE_TCON_SSD1289)

#if defined (GFX_USE_DISPLAY_CONTROLLER_SSD1926)
    #include "Graphics/SSD1926.h"
#elif defined (GFX_USE_DISPLAY_CONTROLLER_S1D13517)
    #include "Graphics/S1D13517.h"
#elif defined (GFX_USE_DISPLAY_CONTROLLER_MCHP_DA210) || defined
(GFX_USE_DISPLAY_CONTROLLER_DMA)
    // do not need any driver header file
#else
    #warning "This Timing Controller Driver is written for SSD1926, S1D13517 and Microchip
Graphics Module driver. If you are not using those drivers you may need to re-write this
driver."
#endif

/*
    This module can use SPI or bitbang the SPI transfer using
    the SSD1926 GPIO pins.
    This assumes that the timing controller uses SPI to
    receive Timing Programming data.
    Select the usage using the hardware profile.
*/
    // BB means BitBang
    #define BB_CS                   0x01
    #define BB_SCL                  0x02
    #define BB_SDO                  0x04
    #define BB_DC                   0x08
    #define BB_BL                   0x10

#if defined (GFX_USE_DISPLAY_CONTROLLER_MCHP_DA210) || defined
(GFX_USE_DISPLAY_CONTROLLER_DMA)

    #define TCON_CSLow()            (TCON_CS_LAT = 0)
    #define TCON_CSHigh()           (TCON_CS_LAT = 1)
    #define TCON_CLKLow()           (TCON_SCL_LAT = 0)
    #define TCON_CLKHigh()          (TCON_SCL_LAT = 1)
    #define TCON_DataLow()          (TCON_SDO_LAT = 0)
    #define TCON_DataHigh()         (TCON_SDO_LAT = 1)

    #define TCON_SetCommand()       (TCON_DC_LAT = 0)
    #define TCON_SetData()          (TCON_DC_LAT = 1)

    // set the IOs used to outputs. and initialize them all to "1"
    // set up the TRIS first for outputs, then set the pins
    // to digital in case it is needed and initialize the signals
    // to all high.
    #define InitBitBangedIO() {                     \
                                TCON_CS_TRIS = 0;   \
                                TCON_SCL_TRIS = 0;  \
                                TCON_SDO_TRIS = 0;  \
                                TCON_DC_TRIS = 0;   \
                                TCON_CS_DIG();      \
                                TCON_SCL_DIG();     \
                                TCON_SDO_DIG();     \
                                TCON_DC_DIG();      \
                                TCON_CSHigh();      \
```

```
                                TCON_CLKHigh();     \
                                TCON_DataHigh();    \
                                TCON_SetData();     \
                              }

// end of #if defined (USE_DISPLAY_CONTROLLER_MCHP_DA210)


#elif defined (GFX_USE_DISPLAY_CONTROLLER_SSD1926)

    // use the bitbang version using SSD1926 GPIO pins

    #define TCON_CSLow()             (GfxTconSetIO(BB_CS, 0))
    #define TCON_CSHigh()            (GfxTconSetIO(BB_CS, 1))
    #define TCON_CLKLow()            (GfxTconSetIO(BB_SCL, 0))
    #define TCON_CLKHigh()           (GfxTconSetIO(BB_SCL, 1))
    #define TCON_DataLow()           (GfxTconSetIO(BB_SDO, 0))
    #define TCON_DataHigh()          (GfxTconSetIO(BB_SDO, 1))

    #define TCON_SetCommand()        (GfxTconSetIO(BB_DC, 0))
    #define TCON_SetData()           (GfxTconSetIO(BB_DC, 1))

    // this is only needed here since the controller IO's are used
    // instead of the IO's from the PIC device.
    #define SetCtrlBitBangedIO(addr, data)    (SetReg(addr, data))

    // set the GPIO of SSD1926 to as outputs. (used for SSD1289 TCON signals)
    // and initialize them all to "1"
    #define InitBitBangedIO() {                                 \
                                SetCtrlBitBangedIO(0xA8, 0x1F);     \
                                SetCtrlBitBangedIO(0xAC, 0x1F);     \
                              }
// end of #elif defined (USE_TCON_SSD1289)

#elif defined (GFX_USE_DISPLAY_CONTROLLER_S1D13517)

     // use the bitbang version using SSD1926 GPIO pins

    #define TCON_CSLow()             (GfxTconSetIO(CS, 0))
    #define TCON_CSHigh()            (GfxTconSetIO(CS, 1))
    #define TCON_CLKLow()            (GfxTconSetIO(SCL, 0))
    #define TCON_CLKHigh()           (GfxTconSetIO(SCL, 1))
    #define TCON_DataLow()           (GfxTconSetIO(SDO, 0))
    #define TCON_DataHigh()          (GfxTconSetIO(SDO, 1))

    #define TCON_SetCommand()        (GfxTconSetIO(DC, 0))
    #define TCON_SetData()           (GfxTconSetIO(DC, 1))

    // this is only needed here since the controller IO's are used
    // instead of the IO's from the PIC device.
    #define SetCtrlBitBangedIO(addr, data)    (SetReg(addr, data))

    // set the GPIO of SSD1926 to as outputs. (used for SSD1289 TCON signals)
    // and initialize them all to "1"
    #define InitBitBangedIO() {                                 \
                                SCL_TRIS = 0;                       \
                                SDO_TRIS = 0;                       \
                              }

// end of #elif defined (USE_DISPLAY_CONTROLLER_S1D13517)

#endif

/*************************************************************************
* Function: void GfxTconSetIO(BYTE mask, BYTE
level)
*
* Overview: This sets the IO specified by mask to the value set by
*           level.
*
* Input: mask - specifies the IO to be toggles.
*        level - specifies the logic where the IO will be set.
```

```
*
* Output: none
*
************************************************************************/
void GfxTconSetIO(BYTE mask, BYTE level)
{
  #if defined (GFX_USE_DISPLAY_CONTROLLER_MCHP_DA210) || defined
(GFX_USE_DISPLAY_CONTROLLER_DMA)

    switch(mask)
    {
        case BB_CS:    (level == 1 ? TCON_CSHigh() : TCON_CSLow());
                    break;

        case BB_SCL:   (level == 1 ? TCON_CLKHigh() : TCON_CLKLow());
                    break;

        case BB_SDO:   (level == 1 ? TCON_DataHigh() : TCON_DataLow());
                    break;

        case BB_DC:    (level == 1 ? TCON_SetData() : TCON_SetCommand());
                    break;
        default:
                    break;
    }

    Nop();

  #elif defined (GFX_USE_DISPLAY_CONTROLLER_SSD1926)

    static BYTE value = 0xFF;

    if(level == 0)
    {
        value &= ~mask;
    }
    else
    {
        value |= mask;
    }

    SetCtrlBitBangedIO(0xAC, value);

#elif defined (GFX_USE_DISPLAY_CONTROLLER_S1D13517)

    switch(mask)
    {
        case CS:
                    temp = GetReg(REG6E_GPO_1);
                    if(level == 1)  temp  |= 0x02;
                    else            temp  &= 0xFD;
                    SetReg(REG6E_GPO_1,temp);
                    break;

        case SCL:   SCL_PORT = level;
                    break;

        case SDO:   SDO_PORT = level;
                    break;

        case DC:
                    temp = GetReg(REG6E_GPO_1);
                    if(level == 1)  temp  |= 0x04;
                    else            temp  &= 0xFB;
                    SetReg(REG6E_GPO_1,temp);
                    break;
    }

    Nop();

#else
```

```
    #error "This TCON_SSD1289 is written for SSD1926, S1D13517 and Microchip Graphics
Module driver. If you are not using those drivers you may need to re-write this driver and
remove this error message."


#endif

}

/*************************************************************************
* Function: void GfxTconWriteByte(BYTE value)
*
* Overview: This writes a bytes to SPI.
*
* Input: value - the byte data to be written.
*
* Output: none
*
************************************************************************/
void GfxTconWriteByte(BYTE value)
{
    BYTE    mask;

    mask = 0x80;
    while(mask)
    {
        GfxTconSetIO(BB_SCL, 0);
        Delay10us(1);
        if(mask & value)
        {
            GfxTconSetIO(BB_SDO, 1);
        }
        else
        {
            GfxTconSetIO(BB_SDO, 0);
        }

        GfxTconSetIO(BB_SCL, 1);
        mask >>= 1;
    }
}

/*************************************************************************
* Function: void GfxTconWriteCommand(BYTE index, WORD
value)
*
* Overview: This writes a word to SPI by calling the write byte
*           routine.
*
* Input: index - The index (or address) of the register to be written.
*        value - The value that will be written to the register.
*
* Output: none
*
************************************************************************/
void GfxTconWriteCommand(WORD index, WORD value)
{
    GfxTconSetIO(BB_CS, 0);

    // Index
    GfxTconSetIO(BB_DC, 0);
    GfxTconWriteByte(((WORD_VAL) index).v[1]);
    GfxTconWriteByte(((WORD_VAL) index).v[0]);

    GfxTconSetIO(BB_CS, 1);
    Delay10us(1);
    GfxTconSetIO(BB_CS, 0);

    // Data
    GfxTconSetIO(BB_DC, 1);
    GfxTconWriteByte(((WORD_VAL) value).v[1]);
    GfxTconWriteByte(((WORD_VAL) value).v[0]);
    GfxTconSetIO(BB_CS, 1);
    Delay10us(1);
}

/*************************************************************************
* Function: void GfxTconInit(void)
*
* Overview: Initialize the IOs to implement Bitbanged SPI interface
*           to connect to the Timing Controller through SPI.
*
* Input: none
*
* Output: none
*
*************************************************************************/
void GfxTconInit(void)
{
    InitBitBangedIO();

    GfxTconWriteCommand(0x0028, 0x0006);
    GfxTconWriteCommand(0x0000, 0x0001);
    DelayMs(15);

    GfxTconWriteCommand(0x002B, 0x9532);
    GfxTconWriteCommand(0x0003, 0xAAAC);
    GfxTconWriteCommand(0x000C, 0x0002);
    GfxTconWriteCommand(0x000D, 0x000A);
    GfxTconWriteCommand(0x000E, 0x2C00);
    GfxTconWriteCommand(0x001E, 0x00AA);
    GfxTconWriteCommand(0x0025, 0x8000);
    DelayMs(15);

    GfxTconWriteCommand(0x0001, 0x2B3F);
    GfxTconWriteCommand(0x0002, 0x0600);
    GfxTconWriteCommand(0x0010, 0x0000);
    DelayMs(20);

    GfxTconWriteCommand(0x0005, 0x0000);
    GfxTconWriteCommand(0x0006, 0x0000);


    GfxTconWriteCommand(0x0016, 0xEF1C);
    GfxTconWriteCommand(0x0017, 0x0003);
    GfxTconWriteCommand(0x0007, 0x0233);
    GfxTconWriteCommand(0x000B, 0x5312);
    GfxTconWriteCommand(0x000F, 0x0000);
    DelayMs(20);

    GfxTconWriteCommand(0x0041, 0x0000);
    GfxTconWriteCommand(0x0042, 0x0000);
    GfxTconWriteCommand(0x0048, 0x0000);
    GfxTconWriteCommand(0x0049, 0x013F);
    GfxTconWriteCommand(0x0044, 0xEF00);
    GfxTconWriteCommand(0x0045, 0x0000);
    GfxTconWriteCommand(0x0046, 0x013F);
    GfxTconWriteCommand(0x004A, 0x0000);
    GfxTconWriteCommand(0x004B, 0x0000);
    DelayMs(20);

    GfxTconWriteCommand(0x0030, 0x0707);
    GfxTconWriteCommand(0x0031, 0x0704);
    GfxTconWriteCommand(0x0032, 0x0204);
    GfxTconWriteCommand(0x0033, 0x0201);
    GfxTconWriteCommand(0x0034, 0x0203);
    GfxTconWriteCommand(0x0035, 0x0204);
    GfxTconWriteCommand(0x0036, 0x0204);
    GfxTconWriteCommand(0x0037, 0x0502);
    GfxTconWriteCommand(0x003A, 0x0302);
    GfxTconWriteCommand(0x003B, 0x0500);
    DelayMs(20);

    TCON_CLKLow();
```

```
}

#endif // #ifdef USE_TCON_SSD1289
```

14.3.15 TCON_HX8257.c

This is file TCON_HX8257.c.

Body Source

```
/*****************************************************************************
 *  Module for Microchip Graphics Library
 *  Himax. HX8257 TCON  driver
 *****************************************************************************
 * FileName:        TCON_HX8257.c
 * Processor:       PIC24, PIC32
 * Compiler:        MPLAB C30, MPLAB C32
 * Company:         Microchip Technology Incorporated
 *
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 * COST OF PROCUREMENT OF SUBSTITUTE GOODS, TECHNOLOGY, SERVICES, OR ANY
 * CLAIMS BY THIRD PARTIES (INCLUDING BUT NOT LIMITED TO ANY DEFENSE THEREOF),
 * OR OTHER SIMILAR COSTS.
 *
 * Date         Comment
 *~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
 * 01/12/09
 * 04/13/11     - Added GFX_USE_DISPLAY_CONTROLLER_xxx check.
 *              - Replaced TCON_Delay() with Delay10us() from TimeDelay.h
 *              - Renamed TCON_Init() to GfxTconInit() and the rest
 *                of the internal functions.
 *              - Graphics Library Version 3.00 Support
 *****************************************************************************/
#include "GraphicsConfig.h"
#include "HardwareProfile.h"
#include "TimeDelay.h"

#ifdef USE_TCON_HX8257

#if defined (GFX_USE_DISPLAY_CONTROLLER_SSD1926)
    #include "Graphics/SSD1926.h"
#elif defined (GFX_USE_DISPLAY_CONTROLLER_MCHP_DA210) || defined
(GFX_USE_DISPLAY_CONTROLLER_DMA)
    // do not need any driver header file
#else
    #warning "This Timing Controller Driver is written for SSD1926, Microchip Display
Controller using DMA and Microchip Graphics Module driver. If you are not using those
```

```
drivers you may need to re-write this driver."
#endif

/*
    This module can use SPI or bitbang the SPI transfer using
    the SSD1926 GPIO pins.
    This assumes that the timing controller uses SPI to
    receive Timing Programming data.
    Select the usage using the hardware profile.
*/
    // BB means BitBang
    #define BB_CS                   0x01
    #define BB_SCL                  0x02
    #define BB_SDO                  0x04
    #define BB_DC                   0x08

#if defined (GFX_USE_DISPLAY_CONTROLLER_MCHP_DA210) || defined
(GFX_USE_DISPLAY_CONTROLLER_DMA)

    #define TCON_CSLow()            (TCON_CS_LAT = 0)
    #define TCON_CSHigh()           (TCON_CS_LAT = 1)
    #define TCON_CLKLow()           (TCON_SCL_LAT = 0)
    #define TCON_CLKHigh()          (TCON_SCL_LAT = 1)
    #define TCON_DataLow()          (TCON_SDO_LAT = 0)
    #define TCON_DataHigh()         (TCON_SDO_LAT = 1)

    #define TCON_SetCommand()       (TCON_DC_LAT = 0)
    #define TCON_SetData()          (TCON_DC_LAT = 1)

    // set the IOs used to outputs. and initialize them all to "1"
    // set up the TRIS first for outputs, then set the pins
    // to digital in case it is needed and initialize the signals
    // to all high.
    #define InitBitBangedIO() {                     \
                                TCON_CS_TRIS = 0;   \
                                TCON_SCL_TRIS = 0;  \
                                TCON_SDO_TRIS = 0;  \
                                TCON_DC_TRIS = 0;   \
                                TCON_CS_DIG();      \
                                TCON_SCL_DIG();     \
                                TCON_SDO_DIG();     \
                                TCON_DC_DIG();      \
                                TCON_CSHigh();      \
                                TCON_CLKHigh();     \
                                TCON_DataHigh();    \
                                TCON_SetData();     \
                              }

// end of #if defined (USE_DISPLAY_CONTROLLER_MCHP_DA210)


#elif defined (GFX_USE_DISPLAY_CONTROLLER_SSD1926)

    // use the bitbang version using SSD1926 GPIO pins

    #define TCON_CSLow()            (GfxTconSetIO(CS, 0))
    #define TCON_CSHigh()           (GfxTconSetIO(CS, 1))
    #define TCON_CLKLow()           (GfxTconSetIO(SCL, 0))
    #define TCON_CLKHigh()          (GfxTconSetIO(SCL, 1))
    #define TCON_DataLow()          (GfxTconSetIO(SDO, 0))
    #define TCON_DataHigh()         (GfxTconSetIO(SDO, 1))

    #define TCON_SetCommand()       (GfxTconSetIO(DC, 0))
    #define TCON_SetData()          (GfxTconSetIO(DC, 1))

    // this is only needed here since the controller IO's are used
    // instead of the IO's from the PIC device.
    #define SetCtrlBitBangedIO(addr, data)    (SetReg(addr, data))

    // set the GPIO of SSD1926 to as outputs. (used for TCON signals)
    // and initialize them all to "1"
    #define InitBitBangedIO() {                                     \
                                SetCtrlBitBangedIO(0xA8, 0x1F);     \
                                SetCtrlBitBangedIO(0xAC, 0x1F);     \
                              }
// end of #elif defined (USE_TCON_SSD1289)

#endif


/************************************************************************
* Function: void GfxTconSetIO(BYTE mask, BYTE
level)
*
* Overview: This sets the IO specified by mask to the value set by
*           level.
*
* Input: mask - specifies the IO to be toggles.
*        level - specifies the logic where the IO will be set.
*
* Output: none
*
************************************************************************/
void GfxTconSetIO(BYTE mask, BYTE level)
{

 #if defined (GFX_USE_DISPLAY_CONTROLLER_MCHP_DA210) || defined
(GFX_USE_DISPLAY_CONTROLLER_DMA)

    switch(mask)
    {
        case BB_CS:    (level == 1 ? TCON_CSHigh() : TCON_CSLow());
                    break;

        case BB_SCL:   (level == 1 ? TCON_CLKHigh() : TCON_CLKLow());
                    break;

        case BB_SDO:   (level == 1 ? TCON_DataHigh() : TCON_DataLow());
                    break;

        case BB_DC:    (level == 1 ? TCON_SetData() : TCON_SetCommand());
                    break;
        default:
                    break;
    }

    Nop();

 #elif defined (GFX_USE_DISPLAY_CONTROLLER_SSD1926)

    static BYTE value = 0xFF;

    if(level == 0)
    {
        value &= ~mask;
    }
    else
    {
        value |= mask;
    }

    SetCtrlBitBangedIO(0xAC, value);

#endif

}
/************************************************************************
* Function: void GfxTconWriteByte(BYTE value)
*
* Overview: This writes a bytes to SPI.
*
* Input: value - the byte data to be written.
*
* Output: none
```

```
*
*************************************************************************/
void GfxTconWriteByte(BYTE value)
{
    BYTE    mask;

    mask = 0x80;
    while(mask)
    {
        GfxTconSetIO(BB_SCL, 0);
        Delay10us(1);
        if(mask & value)
        {
            GfxTconSetIO(BB_SDO, 1);
        }
        else
        {
            GfxTconSetIO(BB_SDO, 0);
        }

        GfxTconSetIO(BB_SCL, 1);
        mask >>= 1;
    }
}

/*************************************************************************
* Function: void GfxTconWriteCommand(BYTE index, WORD
value)
*
* Overview: This writes a word to SPI by calling the write byte
*           routine.
*
* Input: index - The index (or address) of the register to be written.
*        value - The value that will be written to the register.
*
* Output: none
*
*************************************************************************/
void GfxTconWriteCommand(WORD index, WORD value)
{
    TCON_CTRL(BB_CS, 0);

    // Index
    TCONWriteByte(0x70);
    TCONWriteByte(((WORD_VAL) index).v[1]);
    TCONWriteByte(((WORD_VAL) index).v[0]);

    TCON_CTRL(BB_CS, 1);
    TCON_Delay();
    TCON_CTRL(BB_CS, 0);

    // Data
    TCONWriteByte(0x72);
    TCONWriteByte(((WORD_VAL) value).v[1]);
    TCONWriteByte(((WORD_VAL) value).v[0]);
    TCON_CTRL(BB_CS, 1);
    TCON_Delay();
}

/*************************************************************************
* Function: void GfxTconInit(void)
*
* Overview: Initialize the IOs to implement Bitbanged SPI interface
*           to connect to the Timing Controller through SPI.
*
* Input: none
*
* Output: none
*
*************************************************************************/
void GfxTconInit(void)
{
    InitBitBangedIO();

    DelayMs(20);
    GPIO_TCON(0x0006, 0x2020);
    DelayMs(20);
}

#endif // #ifdef USE_TCON_HX8257
```

14.3.16 CustomDisplayDriver.c

This is file CustomDisplayDriver.c.

Body Source

```
/*****************************************************************************
 *  Module for Microchip Graphics Library
 *  Custom display controller driver template
 *****************************************************************************
 * FileName:        CustomDisplayDriver.c
 * Dependencies:    Graphics.h
 * Processor:       PIC24, PIC32
 * Compiler:        MPLAB C30, MPLAB C32
 * Linker:          MPLAB LINK30, MPLAB LINK32
 * Company:         Microchip Technology Incorporated
 *
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 * COST OF PROCUREMENT OF SUBSTITUTE GOODS, TECHNOLOGY, SERVICES, OR ANY
 * CLAIMS BY THIRD PARTIES (INCLUDING BUT NOT LIMITED TO ANY DEFENSE THEREOF),
 * OR OTHER SIMILAR COSTS.
 *
 * Author               Date        Comment
 *~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
 *
 *****************************************************************************/
#include "Graphics/Graphics.h"

// Color
WORD_VAL    _color;

// Clipping region control
SHORT       _clipRgn;

// Clipping region borders
SHORT       _clipLeft;
SHORT       _clipTop;
SHORT       _clipRight;
SHORT       _clipBottom;
```

```
/*********************************************************************
* Function:  void  DelayMs(WORD time)
*
* PreCondition: none
*
* Input: time - delay in ms
*
* Output: none
*
* Side Effects: none
*
* Overview: delays execution on time specified in ms
*
* Note: none
*
********************************************************************/
#ifdef __PIC32MX

/* */
void DelayMs(WORD time)
{
    while(time--)
    {
        unsigned int    int_status;

        int_status = INTDisableInterrupts();
        OpenCoreTimer(GetSystemClock() / 2000); // core timer is at 1/2 system clock
        INTRestoreInterrupts(int_status);

        mCTClearIntFlag();

        while(!mCTGetIntFlag());
    }

    mCTClearIntFlag();
}

#else
    #define DELAY_1MS   16000 / 5               // for 16MIPS

/* */
void DelayMs(WORD time)
{
    unsigned    delay;
    while(time--)
        for(delay = 0; delay < DELAY_1MS; delay++);
}

#endif

/*********************************************************************
* Function:  void ResetDevice()
*
* PreCondition: none
*
* Input: none
*
* Output: none
*
* Side Effects: none
*
* Overview: resets LCD, initializes PMP
*
* Note: none
*
********************************************************************/
void ResetDevice(void)
{ }

/*********************************************************************
* Function: void PutPixel(SHORT x, SHORT y)
```

```
*
* PreCondition: none
*
* Input: x,y - pixel coordinates
*
* Output: none
*
* Side Effects: none
*
* Overview: puts pixel
*
* Note: none
*
********************************************************************/
void PutPixel(SHORT x, SHORT y)
{ }

/*********************************************************************
* Function: WORD GetPixel(SHORT x, SHORT y)
*
* PreCondition: none
*
* Input: x,y - pixel coordinates
*
* Output: pixel color
*
* Side Effects: none
*
* Overview: returns pixel color at x,y position
*
* Note: none
*
********************************************************************/
WORD GetPixel(SHORT x, SHORT y)
{
    return (0);
}
```

14.3.17 UC1610.c

This is file UC1610.c.

Body Source

```
/*****************************************************************************
 *  Module for Microchip Graphics Library
 *  UltraChip UC1610 controller driver
 *****************************************************************************
 * FileName:        UC1610.c
 * Dependencies:    Graphics.h
 * Processor:       PIC24
 * Compiler:        MPLAB C30
 * Linker:          MPLAB LINK30
 * Company:         Microchip Technology Incorporated
 *
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 * OR OTHER SIMILAR COSTS.
 *
 * Date         Comment
 *~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
 * 02/25/09     ...
 * 04/12/11     Graphics Library Version 3.00 Support
 *****************************************************************************/
#include "HardwareProfile.h"

#if defined (GFX_USE_DISPLAY_CONTROLLER_UC1610)

#include "Compiler.h"
#include "Graphics/DisplayDriver.h"
#include "Graphics/UC1610.h"
#include "Graphics/Primitive.h"

#if defined (USE_GFX_PMP)
    #include "Graphics/gfxpmp.h"
#elif defined (USE_GFX_EPMP)
    #include "Graphics/gfxepmp.h"
#endif

// Unsupported Graphics Library Features
#ifdef USE_TRANSPARENT_COLOR
    #warning "This driver does not support the transparent feature on PutImage(). Build
will use the PutImage() functions defined in the Primitive.c"
#endif

// Color
GFX_COLOR   _color;
#ifdef USE_TRANSPARENT_COLOR
GFX_COLOR   _colorTransparent;
SHORT       _colorTransparentEnable;
#endif

// Clipping region control
SHORT   _clipRgn;

// Clipping region borders
SHORT   _clipLeft;
SHORT   _clipTop;
SHORT   _clipRight;
SHORT   _clipBottom;

////////////////////// LOCAL FUNCTIONS PROTOTYPES ////////////////////////////
#ifndef USE_TRANSPARENT_COLOR
void    PutImage1BPP(SHORT left, SHORT top, FLASH_BYTE *image, BYTE stretch);
void    PutImage4BPP(SHORT left, SHORT top, FLASH_BYTE *image, BYTE stretch);
void    PutImage1BPPExt(SHORT left, SHORT top, void *image, BYTE stretch);
void    PutImage4BPPExt(SHORT left, SHORT top, void *image, BYTE stretch);
#endif

/*********************************************************************
* Function:  void ResetDevice()
*
* PreCondition: none
*
* Input: none
*
* Output: none
*
* Side Effects: none
*
```

```
* Overview: resets LCD, initializes PMP
*
* Note: none
*
********************************************************************/
void ResetDevice(void)
{
    // Initialize the device
    DriverInterfaceInit();

    DisplayEnable();

    DisplaySetCommand();
    // set Vbias
    DeviceWrite(CMD_BIAS_RATIO_12);
    DeviceWrite(CMD_CONTRAST);
    DeviceWrite(82);

    // set panel loading
    DeviceWrite(CMD_PANEL_LOADING_38NF);

    // set connected COM electrodes
    DeviceWrite(CMD_DISPLAY_START);
    DeviceWrite(4 * (DISP_START_PAGE + 1) - 1);
    DeviceWrite(CMD_DISPLAY_END);
    DeviceWrite(4 * (DISP_END_PAGE + 1) - 1);
    DeviceWrite(CMD_COM_END);
    DeviceWrite(4 * (DISP_END_PAGE + 1) - 1);

    // set line rate
    DeviceWrite(CMD_LINE_RATE_12KLPS);

    DeviceWrite(CMD_MAPPING_MY);

    // inverse color
    DeviceWrite(CMD_INVERSE_ON);

    // set programm window
    DeviceWrite(CMD_WND_PRG_DISABLE);
    DeviceWrite(CMD_START_COLUMN);
    DeviceWrite(DISP_START_COLUMN);
    DeviceWrite(CMD_END_COLUMN);
    DeviceWrite(DISP_END_COLUMN);
    DeviceWrite(CMD_START_PAGE);
    DeviceWrite(DISP_START_PAGE);
    DeviceWrite(CMD_END_PAGE);
    DeviceWrite(DISP_END_PAGE);
    DeviceWrite(CMD_WND_PRG_ENABLE);

    // set autoincrement
    DeviceWrite(CMD_RAM_ADDR_INCR_ON);

    DeviceWrite(CMD_DISPLAY_ON);

    DisplaySetData();

    DisplayDisable();
}

/*********************************************************************
* Function: void ContrastSet(BYTE contrast)
*
* PreCondition: none
*
* Input: contrast value
*
* Output: none
*
* Side Effects: none
*
* Overview: sets contrast
*
```

```
* Note: none
*
********************************************************************/
void ContrastSet(BYTE contrast)
{
    DisplayEnable();
    DisplaySetCommand();
    DeviceWrite(CMD_CONTRAST);
    DeviceWrite(contrast);
    DisplaySetData();
    DisplayDisable();
}

#ifdef USE_TRANSPARENT_COLOR
/*********************************************************************
* Function:  void TransparentColorEnable(GFX_COLOR color)
*
* Overview: Sets current transparent color.
*
* PreCondition: none
*
* Input: color - Color value chosen.
*
* Output: none
*
* Side Effects: none
*
********************************************************************/
void TransparentColorEnable(GFX_COLOR color)
{
    _colorTransparent = color;
    _colorTransparentEnable = TRANSPARENT_COLOR_ENABLE;

}
#endif

/*********************************************************************
* Function: void PutPixel(SHORT x, SHORT y)
*
* PreCondition: none
*
* Input: pixel position
*
* Output: none
*
* Side Effects: none
*
* Overview: puts pixel with current color at given position
*
* Note: none
*
********************************************************************/
void PutPixel(SHORT x, SHORT y)
{
    BYTE    value;

    if(_clipRgn)
    {
        if(x < _clipLeft)
            return;
        if(x > _clipRight)
            return;
        if(y < _clipTop)
            return;
        if(y > _clipBottom)
            return;
    }

    x += DISP_START_COLUMN;

    DisplayEnable();
    // set address
    DisplaySetCommand();
    DeviceWrite(CMD_COLUMN_ADDR_LSB | (x & 0x0f));
    DeviceWrite(CMD_COLUMN_ADDR_MSB | ((x >> 4) & 0x0f));
    DeviceWrite(CMD_PAGE_ADDR | (DISP_START_PAGE + (y >> 2)));
    DisplaySetData();

    // read 4 pixels
    value = DeviceRead();
    value = DeviceRead();

    // set pixel
    switch(y & 0x03)
    {
        case 0: value &= 0b11111100; value |= _color; break;
        case 1: value &= 0b11110011; value |= _color << 2; break;
        case 2: value &= 0b11001111; value |= _color << 4; break;
        case 3: value &= 0b00111111; value |= _color << 6; break;
    }

    // set address
    DisplaySetCommand();
    DeviceWrite(CMD_COLUMN_ADDR_LSB | (x & 0x0f));
    DeviceWrite(CMD_COLUMN_ADDR_MSB | ((x >> 4) & 0x0f));
    DeviceWrite(CMD_PAGE_ADDR | (DISP_START_PAGE + (y >> 2)));
    DisplaySetData();

    // write 4 pixels back
    DeviceWrite(value);

    DisplayDisable();
}

/*********************************************************************
* Function: WORD GetPixel(SHORT x, SHORT y)
*
* PreCondition: none
*
* Input: pixel position
*
* Output: pixel color
*
* Side Effects: none
*
* Overview: returns pixel at given position
*
* Note: none
*
********************************************************************/
GFX_COLOR GetPixel(SHORT x, SHORT y)
{
    BYTE    value;

    x += DISP_START_COLUMN;

    DisplayEnable();

    // set address
    DisplaySetCommand();
    DeviceWrite(CMD_COLUMN_ADDR_LSB | (x & 0x0f));
    DeviceWrite(CMD_COLUMN_ADDR_MSB | ((x >> 4) & 0x0f));
    DeviceWrite(CMD_PAGE_ADDR | (DISP_START_PAGE + (y >> 2)));
    DisplaySetData();

    // read 4 pixels
    value = DeviceRead();
    value = DeviceRead();

    DisplayDisable();

    // get pixel
    switch(y & 0x03)
    {
        case 0: break;
        case 1: value >>= 2; break;
        case 2: value >>= 4; break;
        case 3: value >>= 6; break;
    }

    value &= 0x03;
    return ((GFX_COLOR)value);
}

/*********************************************************************
* Function: SetClipRgn(left, top, right, bottom)
*
* Overview: Sets clipping region.
*
* PreCondition: none
*
* Input: left - Defines the left clipping region border.
*        top - Defines the top clipping region border.
*        right - Defines the right clipping region border.
*        bottom - Defines the bottom clipping region border.
*
* Output: none
*
* Side Effects: none
*
********************************************************************/
void SetClipRgn(SHORT left, SHORT top, SHORT right, SHORT bottom)
{
    _clipLeft=left;
    _clipTop=top;
    _clipRight=right;
    _clipBottom=bottom;

}

/*********************************************************************
* Function: SetClip(control)
*
* Overview: Enables/disables clipping.
*
* PreCondition: none
*
* Input: control - Enables or disables the clipping.
*           - 0: Disable clipping
*           - 1: Enable clipping
*
* Output: none
*
* Side Effects: none
*
********************************************************************/
void SetClip(BYTE control)
{
    _clipRgn=control;
}

/*********************************************************************
* Function: IsDeviceBusy()
*
* Overview: Returns non-zero if LCD controller is busy
*           (previous drawing operation is not completed).
*
* PreCondition: none
*
* Input: none
*
* Output: Busy status.
*
* Side Effects: none
*
```

```
********************************************************************/
WORD IsDeviceBusy(void)
{
    return (0);
}

/*********************************************************************
* Function: void ClearDevice(void)
*
* PreCondition: none
*
* Input: none
*
* Output: none
*
* Side Effects: none
*
* Overview: clears screen with current color
*
* Note: none
*
********************************************************************/
void ClearDevice(void)
{
    WORD    counter;
    BYTE    pattern;

    pattern = _color;
    pattern |= pattern << 2;
    pattern |= pattern << 4;

    DisplayEnable();
    DisplaySetCommand();
    DeviceWrite(CMD_COLUMN_ADDR_LSB | (DISP_START_COLUMN & 0x0f));
    DeviceWrite(CMD_COLUMN_ADDR_MSB | ((DISP_START_COLUMN >> 4) & 0x0f));
    DeviceWrite(CMD_PAGE_ADDR | DISP_START_PAGE);
    DisplaySetData();

    for(counter = 0; counter < (DWORD) (GetMaxX() + 1) * (GetMaxY() + 1) / 4; counter++)
    {
        DeviceWrite(pattern);
    }

    DisplayDisable();
}

#ifndef USE_TRANSPARENT_COLOR

#ifdef USE_BITMAP_FLASH

/*********************************************************************
* Function: void PutImage1BPP(SHORT left, SHORT top, FLASH_BYTE* image, BYTE stretch)
*
* PreCondition: none
*
* Input: left,top - left top image corner,
*        image - image pointer,
*        stretch - image stretch factor
*
* Output: none
*
* Side Effects: none
*
* Overview: outputs monochrome image starting from left,top coordinates
*
* Note: image must be located in flash
*
********************************************************************/
void PutImage1BPP(SHORT left, SHORT top, FLASH_BYTE *image, BYTE stretch)
{
    register FLASH_BYTE *flashAddress;
    register FLASH_BYTE *tempFlashAddress;
    BYTE                temp;
    WORD                sizeX, sizeY;
    WORD                x, y;
    WORD                cx, cy;
    BYTE                stretchX, stretchY;
    BYTE                palette[2];
    BYTE                mask;

    // Move pointer to size information
    flashAddress = image + 2;

    // Read image size
    sizeY = *((FLASH_WORD *)flashAddress);
    flashAddress += 2;
    sizeX = *((FLASH_WORD *)flashAddress);
    flashAddress += 2;
    palette[0] = (BYTE) * (flashAddress + 1);
    palette[0] >>= 3;
    palette[0] &= 0x03;
    flashAddress += 2;
    palette[1] = (BYTE) * (flashAddress + 1);
    palette[1] >>= 3;
    palette[1] &= 0x03;
    flashAddress += 2;

    cy = top;
    for(y = 0; y < sizeY; y++)
    {
        tempFlashAddress = flashAddress;
        for(stretchY = 0; stretchY < stretch; stretchY++)
        {
            flashAddress = tempFlashAddress;
            cx = left;
            mask = 0;
            for(x = 0; x < sizeX; x++)
            {

                // Read 8 pixels from flash
                if(mask == 0)
                {
                    temp = *flashAddress;
                    flashAddress++;
                    mask = 0x80;
                }

                // Set color
                if(mask & temp)
                {
                    SetColor(palette[1]);
                }
                else
                {
                    SetColor(palette[0]);
                }

                // Write pixel to screen
                for(stretchX = 0; stretchX < stretch; stretchX++)
                {
                    PutPixel(cx++, cy);
                }

                // Shift to the next pixel
                mask >>= 1;
            }

            cy++;
        }
    }
}

/*********************************************************************
* Function: void PutImage4BPP(SHORT left, SHORT top, FLASH_BYTE* image, BYTE stretch)
```

```
 *
 * PreCondition: none
 *
 * Input: left,top - left top image corner, image - image pointer,
 *        stretch - image stretch factor
 *
 * Output: none
 *
 * Side Effects: none
 *
 * Overview: outputs 16 color image starting from left,top coordinates
 *
 * Note: image must be located in flash
 *
 ********************************************************************/
void PutImage4BPP(SHORT left, SHORT top, FLASH_BYTE *image, BYTE stretch)
{
    register FLASH_BYTE *flashAddress;
    register FLASH_BYTE *tempFlashAddress;
    WORD                sizeX, sizeY;
    WORD                x, y;
    WORD                cx, cy;
    BYTE                temp;
    register BYTE       stretchX, stretchY;
    BYTE                palette[16];
    WORD                counter;

    // Move pointer to size information
    flashAddress = image + 2;

    // Read image size
    sizeY = *((FLASH_WORD *)flashAddress);
    flashAddress += 2;
    sizeX = *((FLASH_WORD *)flashAddress);
    flashAddress += 2;

    // Read pallete
    for(counter = 0; counter < 16; counter++)
    {
        palette[counter] = (BYTE) * (flashAddress + 1);
        palette[counter] >>= 3;
        palette[counter] &= 0x03;
        flashAddress += 2;
    }

    cy = top;
    for(y = 0; y < sizeY; y++)
    {
        tempFlashAddress = flashAddress;
        for(stretchY = 0; stretchY < stretch; stretchY++)
        {
            flashAddress = tempFlashAddress;
            cx = left;
            for(x = 0; x < sizeX; x++)
            {

                // Read 2 pixels from flash
                if(x & 0x0001)
                {

                    // second pixel in byte
                    SetColor(palette[temp >> 4]);
                }
                else
                {
                    temp = *flashAddress;
                    flashAddress++;

                    // first pixel in byte
                    SetColor(palette[temp & 0x0f]);
                }
                // Write pixel to screen
                for(stretchX = 0; stretchX < stretch; stretchX++)
                {
                    PutPixel(cx++, cy);
                }
            }

            cy++;
        }
    }
}

#endif
#ifdef USE_BITMAP_EXTERNAL

/*********************************************************************
* Function: void PutImage1BPPExt(SHORT left, SHORT top, void* image, BYTE stretch)
*
* PreCondition: none
*
* Input: left,top - left top image corner, image - image pointer,
*        stretch - image stretch factor
*
* Output: none
*
* Side Effects: none
*
* Overview: outputs monochrome image starting from left,top coordinates
*
* Note: image must be located in external memory
*
********************************************************************/
void PutImage1BPPExt(SHORT left, SHORT top, void *image, BYTE stretch)
{
    register DWORD  memOffset;
    BITMAP_HEADER   bmp;
    WORD            pallete[2];
    BYTE            lineBuffer[((GetMaxX() + 1) / 8) + 1];
    BYTE            *pData;
    SHORT           byteWidth;

    BYTE            temp;
    BYTE            mask;
    WORD            sizeX, sizeY;
    WORD            x, y;
    WORD            cx, cy;
    BYTE            stretchX, stretchY;

    // Get image header
    ExternalMemoryCallback(image, 0, sizeof(BITMAP_HEADER), &bmp);

    // Get pallete (2 entries)
    ExternalMemoryCallback(image, sizeof(BITMAP_HEADER), 2 * sizeof(WORD), palette);

    palette[0] >>= 3;
    palette[0] &= 0x03;
    palette[1] >>= 3;
    palette[1] &= 0x03;

    // Set offset to the image data
    memOffset = sizeof(BITMAP_HEADER) + 2 * sizeof(WORD);

    // Line width in bytes
    byteWidth = bmp.width >> 3;
    if(bmp.width & 0x0007)
        byteWidth++;

    // Get size
    sizeX = bmp.width;
    sizeY = bmp.height;

    cy = top;
    for(y = 0; y < sizeY; y++)
    {

        // Get line
        ExternalMemoryCallback(image, memOffset, byteWidth, lineBuffer);
        memOffset += byteWidth;
        for(stretchY = 0; stretchY < stretch; stretchY++)
        {
            pData = lineBuffer;
            cx = left;
            mask = 0;
            for(x = 0; x < sizeX; x++)
            {

                // Read 8 pixels from flash
                if(mask == 0)
                {
                    temp = *pData++;
                    mask = 0x80;
                }

                // Set color
                if(mask & temp)
                {
                    SetColor(palette[1]);
                }
                else
                {
                    SetColor(palette[0]);
                }

                // Write pixel to screen
                for(stretchX = 0; stretchX < stretch; stretchX++)
                {
                    PutPixel(cx++, cy);
                }

                // Shift to the next pixel
                mask >>= 1;
            }

            cy++;
        }
    }
}

/*********************************************************************
* Function: void PutImage4BPPExt(SHORT left, SHORT top, void* image, BYTE stretch)
*
* PreCondition: none
*
* Input: left,top - left top image corner, image - image pointer,
*        stretch - image stretch factor
*
* Output: none
*
* Side Effects: none
*
* Overview: outputs monochrome image starting from left,top coordinates
*
* Note: image must be located in external memory
*
********************************************************************/
void PutImage4BPPExt(SHORT left, SHORT top, void *image, BYTE stretch)
{
    register DWORD  memOffset;
    BITMAP_HEADER   bmp;
    WORD            palette[16];
    BYTE            lineBuffer[((GetMaxX() + 1) / 2) + 1];
    BYTE            *pData;
    SHORT           byteWidth;
    BYTE            temp;
    WORD            sizeX, sizeY;
    WORD            x, y;
    WORD            cx, cy;
    BYTE            stretchX, stretchY;

    // Get image header
    ExternalMemoryCallback(image, 0, sizeof(BITMAP_HEADER), &bmp);

    // Get pallete (16 entries)
    ExternalMemoryCallback(image, sizeof(BITMAP_HEADER), 16 * sizeof(WORD), palette);

    for(temp = 0; temp < 16; temp++)
    {
        palette[temp] >>= 3;
        palette[temp] &= 0x03;
    }

    // Set offset to the image data
    memOffset = sizeof(BITMAP_HEADER) + 16 * sizeof(WORD);

    // Line width in bytes
    byteWidth = bmp.width >> 1;
    if(bmp.width & 0x0001)
        byteWidth++;

    // Get size
    sizeX = bmp.width;
    sizeY = bmp.height;

    cy = top;
    for(y = 0; y < sizeY; y++)
    {

        // Get line
        ExternalMemoryCallback(image, memOffset, byteWidth, lineBuffer);
        memOffset += byteWidth;
        for(stretchY = 0; stretchY < stretch; stretchY++)
        {
            pData = lineBuffer;
            cx = left;

            for(x = 0; x < sizeX; x++)
            {

                // Read 2 pixels from flash
                if(x & 0x0001)
                {

                    // second pixel in byte
                    SetColor(palette[temp >> 4]);
                }
                else
                {
                    temp = *pData++;

                    // first pixel in byte
                    SetColor(palette[temp & 0x0f]);
                }

                // Write pixel to screen
                for(stretchX = 0; stretchX < stretch; stretchX++)
                {
                    PutPixel(cx++, cy);
                }
            }

            cy++;
        }
    }
}
```

```
#endif

#endif //#ifndef USE_TRANSPARENT_COLOR

#endif //#if defined (GFX_USE_DISPLAY_CONTROLLER_UC1610)
```

14.3.18 UC1610.h

This is file UC1610.h.

Body Source

```
/*****************************************************************************
 *  Module for Microchip Graphics Library
 *  UltraChip UC1610 LCD controllers driver
 *****************************************************************************
 * FileName:        UC1610.h
 * Dependencies:    p24Fxxxx.h
 * Processor:       PIC24
 * Compiler:        MPLAB C30
 * Linker:          MPLAB LINK30
 * Company:         Microchip Technology Incorporated
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 * CLAIMS BY THIRD PARTIES (INCLUDING BUT NOT LIMITED TO ANY DEFENSE THEREOF),
 * OR OTHER SIMILAR COSTS.
 *
 * Date         Comment
 *~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
 * 02/25/09     ...
 * 04/12/11     Graphics Library Version 3.00 Support
 *****************************************************************************/
#ifndef _UC1610_H
    #define _UC1610_H

    #include "HardwareProfile.h"
    #include "GraphicsConfig.h"
    #include "GenericTypeDefs.h"

    #ifdef USE_16BIT_PMP
        #error This driver doesn't support 16-bit PMP (remove USE_16BIT_PMP option from
HardwareProfile.h)
    #endif
    #ifndef DISP_HOR_RESOLUTION
        #error DISP_HOR_RESOLUTION must be defined in HardwareProfile.h
    #endif
    #ifndef DISP_VER_RESOLUTION
```

```
        #error DISP_VER_RESOLUTION must be defined in HardwareProfile.h
    #endif
    #ifndef COLOR_DEPTH
        #error COLOR_DEPTH must be defined in GraphicsConfig.h
    #endif
    #ifndef DISP_ORIENTATION
        #error DISP_ORIENTATION must be defined in HardwareProfile.h
    #endif

/*********************************************************************
* Overview: Horizontal and vertical screen size.
*********************************************************************/
    #if (DISP_HOR_RESOLUTION != 160)
        #error This driver doesn't supports this resolution. Horizontal resolution must be
160 pixels.
    #endif
    #if (DISP_VER_RESOLUTION != 100)
        #error This driver doesn't supports this resolution. Vertical resolution must be
100 pixels.
    #endif

/*********************************************************************
* Overview: Display orientation.
*********************************************************************/
    #if (DISP_ORIENTATION != 0)
        #error This driver doesn't support this orientation. It must be 0.
    #endif

/*********************************************************************
* Overview: Color depth.
*********************************************************************/
    #if (COLOR_DEPTH != 8)
        #error This driver doesn't support the selected color depth. It should be 8 but the
device uses only 2 bits. The 6 MSbits will be ignored.
    #endif
    #define CMD_DISPLAY_ON          0b10101111
    #define CMD_DISPLAY_OFF         0b10101110

    #define CMD_INVERSE_ON          0b10100111
    #define CMD_INVERSE_OFF         0b10100110

    #define CMD_PANEL_LOADING_16NF  0b00101000
    #define CMD_PANEL_LOADING_21NF  0b00101001
    #define CMD_PANEL_LOADING_28NF  0b00101010
    #define CMD_PANEL_LOADING_38NF  0b00101011

    #define CMD_LINE_RATE_12KLPS    0b10100000
    #define CMD_LINE_RATE_13KLPS    0b10100001
    #define CMD_LINE_RATE_14KLPS    0b10100010
    #define CMD_LINE_RATE_16KLPS    0b10100011

    #define CMD_DISPLAY_START       0b11110010
    #define CMD_DISPLAY_END         0b11110011
    #define CMD_COM_END             0b11110001

    #define CMD_BIAS_RATIO_5        0b11101000
    #define CMD_BIAS_RATIO_10       0b11101001
    #define CMD_BIAS_RATIO_11       0b11101010
    #define CMD_BIAS_RATIO_12       0b11101011

    #define CMD_CONTRAST            0b10000001

    #define CMD_RAM_ADDR_INCR_OFF   0b10001000
    #define CMD_RAM_ADDR_INCR_ON    0b10001101

    #define CMD_MAPPING_CTRL        0b11000000
    #define CMD_MAPPING_MY          0b11000100
    #define CMD_MAPPING_MX          0b11000010

    #define CMD_WND_PRG_DISABLE     0b11111000
    #define CMD_WND_PRG_ENABLE      0b11111001
    #define CMD_START_COLUMN        0b11110100
    #define CMD_START_PAGE          0b11110101
    #define CMD_END_COLUMN          0b11110110
    #define CMD_END_PAGE            0b11110111

    #define CMD_COLUMN_ADDR_LSB     0b00000000
    #define CMD_COLUMN_ADDR_MSB     0b00010000
    #define CMD_PAGE_ADDR           0b01100000

    #define DISP_START_COLUMN       0
    #define DISP_START_PAGE         7
    #define DISP_END_COLUMN         159
    #define DISP_END_PAGE           31

/*********************************************************************
* Macros: SetPalette(colorNum, color)
*
* Overview:  Sets palette register.
*
* PreCondition: none
*
* Input: colorNum - Register number.
*        color - Color.
*
* Output: none
*
* Side Effects: none
*
********************************************************************/
    #define SetPalette(colorNum, color)

/*********************************************************************
* Function: void ContrastSet(BYTE contrast)
*
* PreCondition: none
*
* Input: contrast value
*
* Output: none
*
* Side Effects: none
*
* Overview: sets contrast
*
* Note: none
*
********************************************************************/
void    ContrastSet(BYTE contrast);
#endif // _UC1610_H
```

14.3.19 TCON_Custom.c

This is file TCON_Custom.c.

Body Source

```
/*****************************************************************************
 *  Module for Microchip Graphics Library
 *  Custom TCON controller driver
 *****************************************************************************
 * FileName:        TCON_Custom.c
 * Dependencies:    Graphics.h
 * Processor:       PIC24, PIC32
 * Compiler:        MPLAB C30, MPLAB C32
 * Linker:          MPLAB LINK30, MPLAB LINK32
 * Company:         Microchip Technology Incorporated
 *
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 *
 * Author               Date        Comment
 *~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
 * Anton Alkhimenok     11/17/08
 *****************************************************************************/
#include "Graphics/Graphics.h"

/* */

void TCON_Init(void)
{ }
```

15 References

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3. Microchip Application Note AN1136, “How to Use Widgets in Microchip Graphics Library” (DS01136), Microchip Technology Incorporated.
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5. Microchip Application Note AN1227, “Using a Keyboard with the Microchip Graphics Library” (DS01227), Microchip Technology Incorporated.
6. Microchip Application Note AN1246, “How to Create Widgets in Microchip Graphics Library” (DS01246), Microchip Technology Incorporated.
7. HIF 2131 – Designing with Microchip Graphics Library, Microchip Regional Training Center web site (www.microchip.com/rtc).
8. Microchip Technical Brief TB3012 - "Conversion of Graphics PICtail Plus Board 2 for Compatibility with USB PICtail Plus" (DS93012), Microchip Technology Incorporated.

Index