# SEGGER emWin Graphic Library (emWinGraphics) 5.46

## Features

- The package integrates emWin 8051 Graphic Library for PSoC3 and full-featured emWin Graphic Library v5.46 for PSoC 4 and PSoC 5LP.
- The library can be used with the Keil_PK51, GCC and Keil MDK toolchains.
- CompactColor_16, FlexColor, and BitPlains display drivers are available for PSoC 4 and PSoC 5LP.

## General Description

The SEGGER emWin is an embedded graphic library and graphical user interface (GUI) designed to provide an efficient, processor- and LCD controller-independent GUI for any application that operates with a graphical display. It is compatible with single-task and multitask environments. Developed by SEGGER Microcontroller, emWin is extremely popular in the embedded industry. Cypress has licensed the emWin library from SEGGER and offers a full-featured graphic library free to customers.

### When to Use a emWinGraphics Library

This package provides access to and the functionality of the SEGGER emWin graphic library. The emWinGraphics is a complete, easy to use, software package for the PSoC 3, PSoC 4, and PSoC 5LP devices. The package consists of the emWin GUI provided in library form, the required header files, and the source files specific to the PSoC implementation.

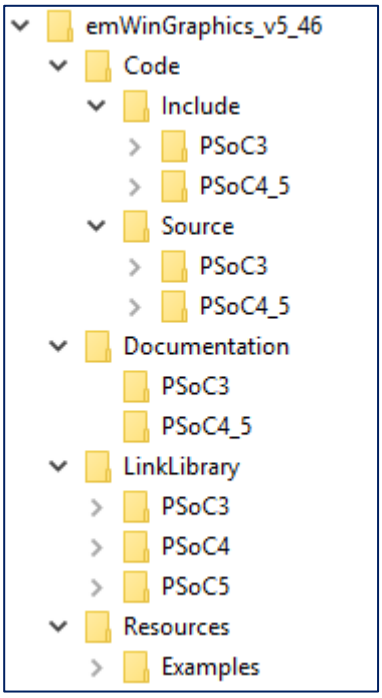
The emWin Graphics Library component allows you fast and efficient GUI development for any application that operates with a graphical LCD.

## Library Contents

The emWinGraphics library is supplied as a zip file. You can get the latest library version from the following location:

http://www.cypress.com/go/comp_emWin

The following shows the directory structure for the unzipped library.




The following table describes the contents of all major emWinGraphics Library directories.

| Directory | Contents |
|---|---|
| Code\Include | The GUI header files. |
| Code\Source | The source files that you need to add to your project |
| Documentation | The emWin User Guides |
| LinkLibrary | The emWin libraries for each of the supported toolchains and devices |
| Resources | emWin sample files and windows programs from SEGGER to work with bitmaps |

The *Code\Include*, *Code\Source*, and *Documentation* directories are divided into PSoC3 and PSoC4_5 subdirectories, because the implementations are different:

- PSoC 3 supports the limited library version (emWin 8051).
- PSoC 4 and PSoC 5LP supports the full-featured version of the standard emWin library.

The detailed functionality provided by each library version is documented in the SEGGER emWin documentation, located in the *Documentation\PSoC3* and *Documentation\PSoC4_5* directories. For details about the different areas of functionality for PSoC 3, PSoC 4 and PSoC 5LP, see the Functional Description section of this document.

# Using the emWinGraphics Library

To use the emWinGraphics library, follow these steps. All steps are explained further in subsequent sections.

1. Integrate the emWinGraphics Library into your PSoC Creator project.
2. Add a Component to communicate with a graphics LCD panel to your project.

   The emWinGraphics is a software only library. The communication to the panel is done using the appropriate hardware component for the panel. You can use the Graphics LCD Interface (parallel 8/16 bit indirect interface, I8080), Graphics LCD Controller (direct 16-bit RGB interface), SPI, or I2C Components. For more details on supported interfaces for the selected display driver, refer to the “Detailed display driver description” section of the *emWin User Manual* of selected device family.
3. Configure emWin; specify your display settings and display access functions.
4. Compile, link, and test using the provided sample code.

   The emWinGraphics library comes with sample code for both single- and multi-task environments. These examples can be used to learn the usage methodology of the library. These examples are found in the Resources directory.
5. For multi-tasking applications, adapt the library to your operation system (OS).

   If multiple tasks will have access to the display simultaneously, then OS interface routines must be defined. For details and sample applications, refer to the "Execution Model: Single Task/Multitask" section of the *emWin User Manual*.
6. Write your own application using emWin.

   At this point you should be ready to start programming using emWin. Refer to the *emWin User Manual* for the details of each capability the library provides.

# Integrating the Library into PSoC Creator

To integrate the emWinGraphics library into your PSoC Creator project, follow these steps. This example uses the GCC toolchain and PSoC 4200 BLE device. Other toolchains and devices are supported in a similar fashion.

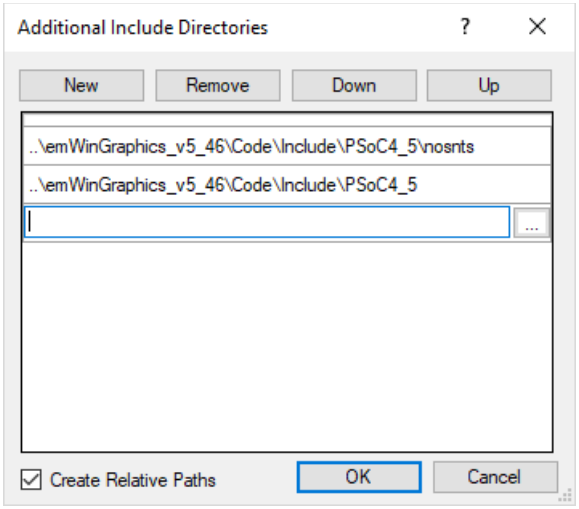
1. Decide which library you need.

   The decision is based on whether you are using an RTOS (os), a touchscreen (ts), or both. The emWin libraries are named according to the supported options. In this example, the library name is *libemWin_nosnts_cm0_gcc.a*, which is a library without OS (nos) and touchscreen (nts) support.
2. Add the necessary include files.

   The emWinGraphics *include* directory contains include files that are general to the entire application and specific include files in subdirectories based on the options chosen.

3. Open the PSoC Creator Build settings dialog and navigate to the **Additional Include Directories** field**: Project > Build Settings > Compiler > General > Additional Include Directories**.

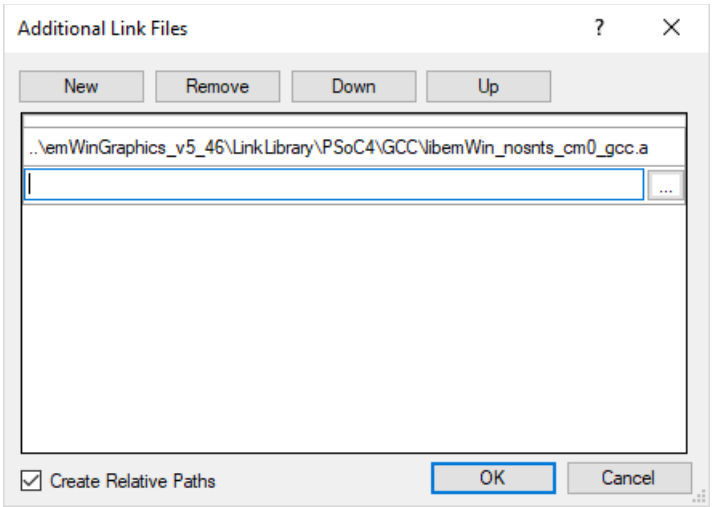
   The Compiler options should contain an entry that addresses the path to the general and library-specific include files. Specify the include path, as shown.



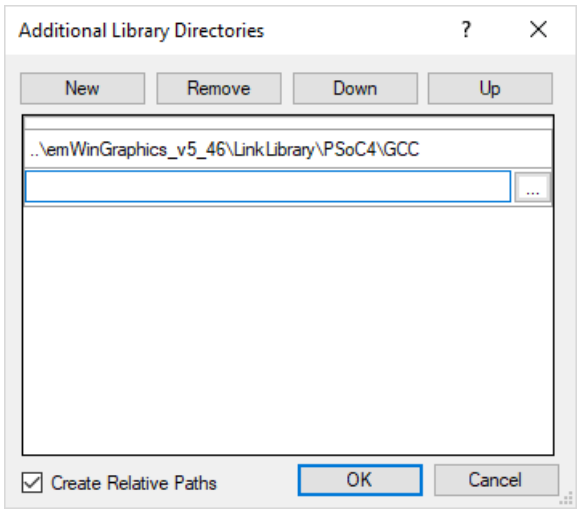

4. Add the link library file.

   The emWin Library can be used with the Keil_PK51, GNU CC, or KEIL MDK toolchain, so select the library according to the toolchain you choose.

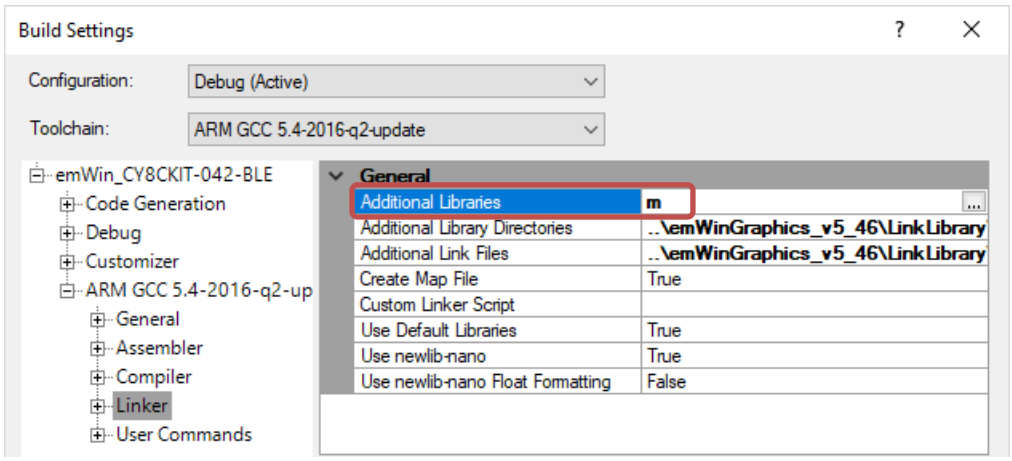
   On the Build Settings dialog, click **Additional Link Files**, and select the library file shown.



**Note** The process of adding the library to the linker is different for the Keil PK51 toolchain. In this case, you not need to specify additional library directory.

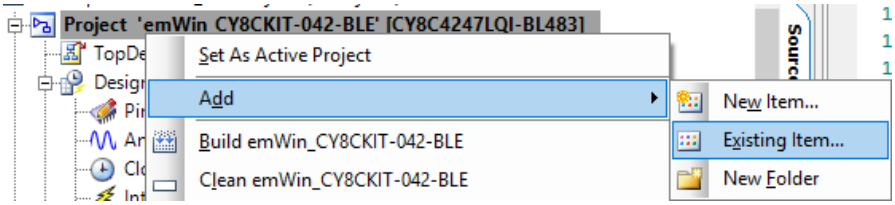



**Note** Some emWin features, such as arcs, require the *math.h* library. To include this library, add `m` to the **Additional Libraries** field.



5. Add the required source files to the project for the emWin display driver chosen. Select one of CompactColor_16, FlexColor, BitPlains, or Control drivers. Based on that selection, the files are available in the *Source\PSoC4_5\[DriverName]* directory.

   These files are typically edited for the specific project, so Cypress recommends that you copy the files into the root folder of your project and then add them to your project. Add the files by right-clicking on the project and selecting **Add > Existing Item**.

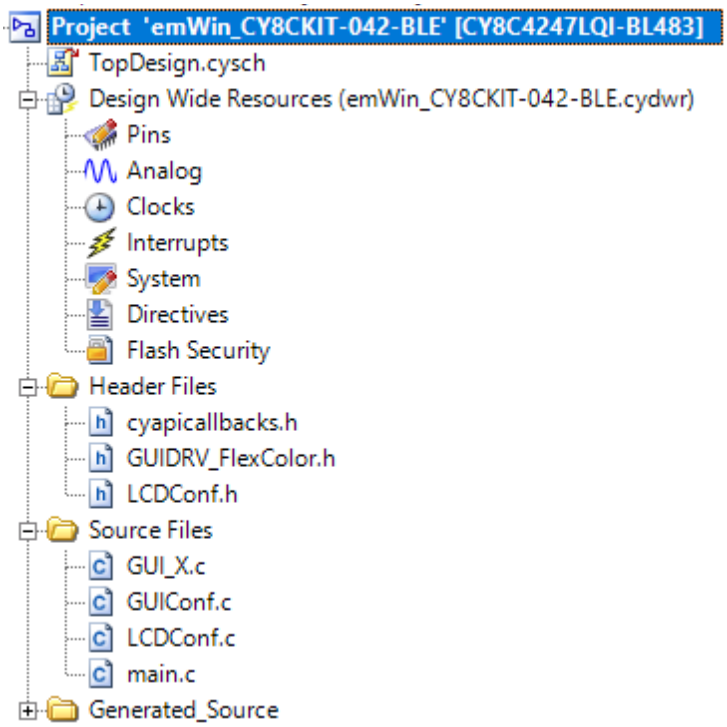



   If the include files are not placed in the root of the project directory, then the path to the include files must also be added to the **Additional Include Directories**.

   Depending on RTOS usage, add to project one of GUI_X files:

   - GUI_X.c – project without RTOS;
   - GUI_X_FreeRTOS.c, GUI_X_embOS.c, GUI_X_uCOS.c – project with FreeRTOS, embOS or uCOS.

The project as shown includes all needed files from the *Source\PSoC4_5\FlexColor* directory for a project without an RTOS.



# emWin Basic Configuration

The emWin source files, located at Source directory contains two type of files display driver files and configuration files. The following files are configuration files:

- GUI_X.c – contains the configuration of the emWin timing routines, by default starts the SysTick timer for emWin timing. Use this file when RTOS is not used.
- GUI_X_FreeRTOS.c, GUI_X_embOS.c, GUI_X_uCOS.c - contains the configuration of the emWin timing and multitask routines specific to selected RTOS.
- GUIConf.c – contains configuration of the memory assignment of emWin. This assignment does not change the memory allocation dynamically.
- LCDConf.h – contains the display driver constants.
- LCDConf.c – contains configuration of the display size, orientation and display driver initialization code.
- LCDConf_CompactColor_16.h – contains macros for display hardvare acces. Available only for CompactColor_16 diriver.

To configure emWin:

1. Specify the display resolution, color conversion, and other required display settings in the *LCDConf.c* file.

   **Note** For Control driver, additional settings are located in the *LCDConf.h* file.

2. Modify the emWin config files with your display interface access functions:
   - **CompactColor_16 driver:** LCD_WRITExxx and LCD_READxxx macros of the *LCDConf_CompactColor_16.h* file. The following is an example of the initialization for a GraphicLCDIntf Component, 8-bit mode:

```
#define LCD_WRITEM_A1(p, Num) GraphicLCDIntf_WriteM8_A1(p, Num)
#define LCD_WRITEM_A0(p, Num) GraphicLCDIntf_WriteM8_A0(p, Num)
#define LCD_READM_A1(p, Num) GraphicLCDIntf_ReadM8_A1(p, Num)
#define LCD_WRITE_A0(Data) GraphicLCDIntf_Write8_A0(Data)
#define LCD_WRITE_A1(Data) GraphicLCDIntf_Write8_A1(Data)
```

- **FlexColor driver:** The LCD interface access functions are in the *LCDConfig.c* file. Modify the GUI_PORT_API PortApi structure passed as the pointer to GUIDRV_FlexColor_SetFunc(). The following is an example of the initialization for a GraphicLCDIntf Component, 8-bit mode:

```
GUI_PORT_API PortAPI = {0};
. . .
PortAPI.pfWrite8_A0 = GraphicLCDIntf_Write8_A0;
PortAPI.pfWrite8_A1 = GraphicLCDIntf_Write8_A1;
PortAPI.pfWriteM8_A1 = GraphicLCDIntf_WriteM8_A1;
PortAPI.pfRead8_A1 = GraphicLCDIntf_Read8_A1;
PortAPI.pfReadM8_A1 = GraphicLCDIntf_ReadM8_A1;
GUIDRV_FlexColor_SetFunc(pDevice, &PortAPI, LCD_CONTROLLER,
GUIDRV_FLEXCOLOR_M16C0B8);
```

- **BitPlains driver:** This driver only manages display buffer and don't have any display specific code. Implement your own display access and update routines.
- **Control driver:** No modification is needed.

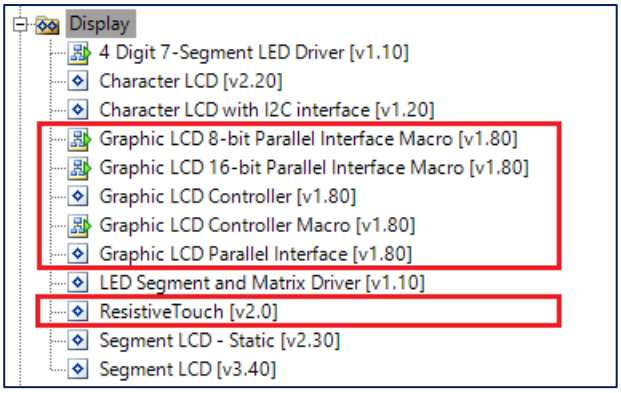
3. Insert the initialization code for the display interface and display the display driver IC in the _InitController() function of the LCDConf.c configuration file.

For details about emWin configuration, refer to the "Configuration" section of the *emWin User Manual*.

# Using PSoC Creator Components with emWin

The emWin is a software library. It does not include any hardware to drive a display. A display interface Component (Graphics LCD Interface, Graphics LCD Controller, SPI, or $I^2C$) is required to build a design using the emWin library. The Graphics LCD Interface and Graphics LCD Controller Components provide parallel 8/16-bit I8080 and direct 16-bit RGB interfaces.

These components are located in the **Display** folder of the Component Catalog.




For PSoC 3 and PSoC 5LP, there is also a ResistiveTouch Component that can be used with emWin to implement a touch user interface.

## Graphics LCD Interface (GraphicLCDIntf) Component

The GraphicLCDIntf Component is used to interface to a panel that has a graphic LCD controller and a driver device integrated into the LCD panel. This type of panel also includes a frame buffer that is managed by the LCD controller integrated into the panel. The Component performs read and write transactions to this controller.

To create a GraphicLCDIntf application:

1. Place the Graphic LCD Parallel Interface Macro onto the schematic. Select an 8-bit or 16-bit interface, based on the display controller used.
2. Configure the GraphicLCDIntf component to satisfy the requirements for write and read transactions to the LCD controller. For details about the configuration refer to the GraphicLCDIntf datasheet.
3. Make sure that either CompactColor_16 or FlexColor display driver files are included in your project. The files are located in the *Code\Source\PSoC4_5* directory.

**Note** For PSoC 3, the GraphicLCDIntf is only supported by the LCD667XX driver, which is located in the *Code\Source\PSoC3\Graphics LCD Interface Parallel* directory.

## Graphics LCD Controller (GraphicLCDCtrl) Component

The GraphicLCDCtrl Component provides the interface to an LCD panel that has an LCD driver, but not an LCD controller. This type of panel does not include a frame buffer. The frame buffer must be provided externally. This Component directly drives the control signals and manages the frame buffer in an external SRAM.

To create a GraphicLCDCtrl application:

1. Place the Graphic LCD Controller Macro onto the schematic.
2. Configure the GraphicLCDCtrl component to satisfy the screen refresh requirements and data transaction timing parameters of your LCD panel. For details about the configuration, refer to the GraphicLCDCtrl datasheet.
3. Make sure that all needed Control driver files are included in the project. The files are located in the *Code\Source\PSoC4_5\Control* directory.

**Note** For PSoC 3, the Control driver files are located in the *Code\Source\PSoC4_5\Graphics LCD Controller* directory.

# Available Libraries

The emWin GUI can be used with the Keil_PK51, GCC, or Keil MDK toolchain. For every toolchain, except Keil_PK51, the libraries are available for two options: OS (os) support and touchscreen (ts) support. The OS support provides the necessary hooks during initialization of the Graphics library and hooks for locking and unlocking resources within the library by the OS. The following table shows the options supported by the specific library names:

| Option | OS support | TS support |
|---|---|---|
| nosnts | NO | NO |
| nosts | NO | YES |
| osnts | YES | NO |
| osts | YES | YES |

# Application Programming Interface

The emWin Graphics does not include any API functions not present in the standard emWin library. Refer to the *emWin User Manual* for a detailed description of available emWin routines.

## emWin Sample Files

The emWin Library is shipped with many emWin sample files available for PSoC 3, PSoC 4, and PSoC 5LP. They are placed in the PSoC 3 or PSoC4_5 subdirectories of the *Resources\Samples* directory. If you are not familiar with emWin, Cypress recommends that you compile, link, and test sample programs before creating your own applications.

To get a sample file running:

1. Add one of the demo sample files to your project.
2. Edit the main source file (*main.c*) to include *GUI.h*. Enable interrupts and then call MainTask() as shown. All of the emWin examples use MainTask() as the entry point.

```
#include <project.h>
#include "GUI.h"

int main()
{
    CyGlobalIntEnable;
    MainTask();

    for(;;)
    {

    }
}
```

3. Build and run the project.

## API Memory Usage

The memory usage for the emWin library varies significantly, depending primarily on the application and features used. For more details, refer to the “Performance and Resource Usage” section of the *emWin User Manual*.

## MISRA Compliance

The emWin Library is not checked for MISRA compliance.

## Placement

The implementation is entirely software.

## Performance

The actual performance and resource usage depends on many factors (CPU, compiler, memory model, optimization, configuration, interface to LCD controller, and so on). This section contains performance values of image drawing operations and information about memory resource usage for a typical configuration.

| Device | CPU Speed (MHz) | Display Interface Component | bpp | filling | Small fonts | Large fonts | Bitmap 1 bpp | Bitmap 8 bpp | Bitmap 16 bpp |
|---|---|---|---|---|---|---|---|---|---|
| PSoC 3 | 24 | Graphics LCD Interface (16-bit) | 16 | 112K | 24K | 30K | 36K | 14K | NA |
| PSoC 3 | 60 | Graphics LCD Interface (16-bit) | 16 | 279K | 56K | 70K | 82K | 33K | NA |
| PSoC 3 | 24 | Graphics LCD Interface (8-bit) | 16 | 63K | 20K | 24K | 28K | 13K | NA |
| PSoC 3 | 60 | Graphics LCD Interface (8-bit) | 16 | 156K | 46K | 56K | 65K | 30K | NA |
| PSoC 3 | 24 | Graphics LCD Controller | 16 | 34K | 21K | 23K | 26K | 12K | NA |
| PSoC 3 | 60 | Graphics LCD Controller | 16 | 75K | 48K | 54K | 61K | 29K | NA |
| PSoC 4 | 24 | Graphics LCD Interface (16-bit) | 16 | 317K | 48K | 74K | 162K | 81K | 267K |
| PSoC 4 | 48 | Graphics LCD Interface (16-bit) | 16 | 588K | 86K | 132K | 294K | 141K | 493K |
| PSoC 4 | 24 | Graphics LCD Interface (8-bit) | 16 | 159K | 33K | 53K | 65K | 47K | 114K |
| PSoC 4 | 48 | Graphics LCD Interface (8-bit) | 16 | 347K | 61K | 96K | 122K | 84K | 238K |
| PSoC 4 | 24 | Graphics LCD Controller | 16 | 65K | 134K | 153K | 60K | 45K | 47K |

| Device | CPU Speed (MHz) | Display Interface Component | bpp | filling | Small fonts | Large fonts | Bitmap 1 bpp | Bitmap 8 bpp | Bitmap 16 bpp |
|---|---|---|---|---|---|---|---|---|---|
| PSoC 4 | 48 | Graphics LCD Controller | 16 | 91K | 203K | 222K | 84K | 68K | 92K |
| PSoC 5LP | 24 | Graphics LCD Interface (16-bit) | 16 | 558K | 170K | 231K | 292K | 152K | 443K |
| PSoC 5LP | 60 | Graphics LCD Interface (16-bit) | 16 | 1.09M | 371K | 521K | 655K | 347K | 874K |
| PSoC 5LP | 24 | Graphics LCD Interface (8-bit) | 16 | 280K | 88K | 102K | 114K | 82K | 183K |
| PSoC 5LP | 60 | Graphics LCD Interface (8-bit) | 16 | 592K | 195K | 231K | 260K | 190K | 401K |
| PSoC 5LP | 24 | Graphics LCD Controller | 16 | 92K | 174K | 187K | 82K | 70K | 90K |
| PSoC 5LP | 60 | Graphics LCD Controller | 16 | 162K | 310K | 368K | 150K | 132K | 167K |

# Functional Description

The detailed functionality is documented in the SEGGER emWin documentation. This section identifies each of the major categories of SEGGER functionality with respect to PSoC 3, PSoC 4, and PSoC 5LP devices.

| Library feature | PSoC 3 | PSoC 4 and PSoC 5LP |
|---|---|---|
| emWin version | 4.0 | 5.46 |
| 2-D graphics library | Full support | Full support |
| Displaying bitmap files | No support for formats other than compiled bitmap format.<br>No support for 16-bit bitmaps. Eight and smaller bit-count bitmaps are fully supported. | Support for all compiled bitmap formats<br>Other formats (JPEG, GIF, PNG) may be supportable, but may be impractical because of RAM requirements |
| Fonts | Support for proportional fonts only | Support for all font types |
| Bitmap converter | Compiled windows application shipped as a binary. | |
| Color support | Full support | Full support |
| Memory devices | No support | Full support |
| Multitask (RTOS) | No support | Full support |
| Window manager | No support | Full support |
| Window objects (widgets) | No support | Full support |
| Virtual screens/Virtual pages | Full support | Full support |
| Multilayer/Multidisplay | No support | No support |
| Pointer input devices | Full support of touchscreens only | Full support of touchscreens only |

| Library feature | PSoC 3 | PSoC 4 and PSoC 5LP |
|---|---|---|
| Sprites and cursors | No support | Full support |
| Antialiasing | No support | Full support |
| Foreign language | No support | No support |
| VNC | No support | No support |
| Drivers | LCD667XX<br>Cypress custom driver for GraphicLCDCtrl Component | CompactColor_16<br>FlexColor<br>BitPlains<br>Cypress custom driver for GraphicLCDCtrl Component |

# Library Changes

For a list of emWin library changes, refer to the *emWin User Manual.*

# SEGGER emWinLibrary Datasheet Changes

This section lists the major changes from the previous version.

| Version | Description of Changes | Reason for Changes / Impact |
|---|---|---|
| 5.46 | Updated emWin version from 5.00 to 5.46.<br><br>Added FlexColor and BitPlains drivers for PSoC 4 and PSoC 5LP devices. | The SEGGER emWin library was updated to version 5.46. Updated this datasheet to match.<br>To support additional devices. |
| 1.0 | Initial Version | |

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