



Graphical and Segmented Display Solutions



Digital displays improve the user interface of just about any application. Segmented LCDs have historically been a popular choice of display technology and their use continues to grow in a variety of medical and industrial applications. In recent years there has been a significant rise in the use of graphical displays—such as TFT, OLED and CSTN—in consumer, appliance and automotive applications. Users prefer intuitive menus, vivid graphics, touch panel interaction and, in some cases, the ability to interact remotely with a system. Designers migrating toward graphical displays face several challenges such as cost of components associated with driving the display, complexity of software needed for updating graphics, battery life and remote connectivity.

If you are looking to add newer and feature-rich interfaces to your products in an aesthetically pleasing manner, Microchip has a broad portfolio of solutions that include touch sensing and display technologies. Microchip delivers these latest advancements as complete hardware and software solutions to get your design to market faster at a lower total system cost.

Direct Drive for Segmented Displays

Display Solutions for Segmented LCD

Segmented displays are used in a wide variety of applications, ranging from meters to portable medical devices to thermostats to exercise equipment. PIC® and SAM microcontrollers with integrated LCD drivers can directly drive segmented displays with letters, numbers, characters and icons. The main features of Microchip's LCD portfolio include:

- Flexible LCD segments
 - 28 pins, up to 72 segments
 - 40 pins, up to 116 segments
 - 64 pins, up to 240 segments
 - 80 pins, up to 368 segments
 - 100 pins, up to 480 segments
 - 121 pins, up to 512 segments
- Variable clock inputs
- Integrated voltage bias generation
- Direct drive for both 3V and 5V powered displays
- Software contrast control for boosting or dimming for different temperature or lighting conditions
- Drive LCD while conserving power in Sleep mode
- Integrated real time clock and calendar for displaying time and date information
- mTouch capacitive touch sensing capability

Display Controller Solutions

Segmented LCD

- Direct drive of inexpensive displays
- Up to 512 segments
- Integrated analog for sensor applications like temperature sensing in thermostats
- Touch sensing function
- Integrated cryptographic engine with secure RAM key management for secure applications

Graphical Displays

- Up to SXGA (1280 x 1024) resolution
- Up to 24 bit per pixel
- Graphics Display Design GUI and free graphics library
- PIC24 “DA” family features integrated graphics acceleration and display controller
- Aria Graphics Suit for PIC32 MCUs
- PIC32MZ “DA” family features integrated GPU and DDR2 memory
- High-performance 32-bit MCUs with integrated Ethernet and CAN for remote interfaces
- USB OTG and mTouch® sensing solutions

Direct Drive for Segmented Displays

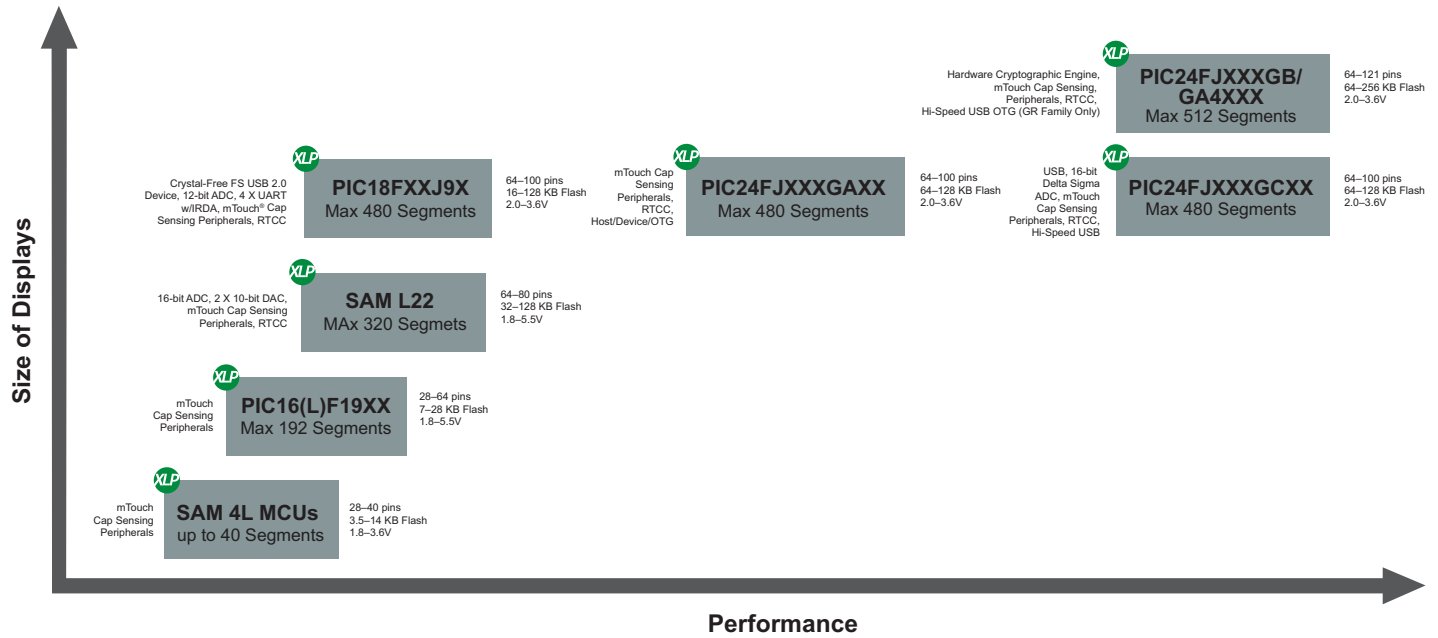
The PIC and SAM microcontrollers support direct LCD panel drive capability with no external components needed, lowering total system cost. They have integrated voltage bias generation which allows the MCU to generate the different voltage levels that are required to drive the LCD segment pins and provide good contrast for the display. The LCD MCUs support a range of fixed and variable bias options as well as variable clock inputs that enable the flexibility to work with many different glass vendors.

Contrast Control

Software contrast control is a key feature using firmware to either boost or dim the contrast of the display. Boost the contrast up to V_{DD} or beyond if you are using one of the MCUs with an integrated charge pump. Software contrast control allows you to vary the contrast on the LCD to account for different operating conditions such as temperature, lighting and humidity. Software contrast control can also be invaluable for portable applications. As the battery level starts to drop, the firmware can apply a boost to the contrast, helping extend the battery life while still producing a crisp image on the display.

Direct Drive for Segmented Displays

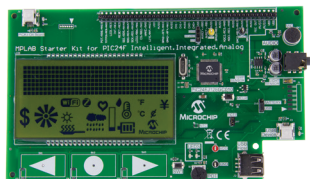
Positioning Graph



Maximum Number of Segments						
Product Family	Pins	1 Common	2 Commons	3 Commons	4 Commons	8 Commons
PIC16(L)F1902/3/6	28	19	38	57	72	–
PIC16(L)F1933/6	28	16	32	48	60	–
PIC16(L)F1904/7	40	29	58	87	116	–
PIC16(L)F1934/7/9	40	24	48	72	96	–
PIC16(L)F1946/7	64	46	92	138	184	–
PIC18F6XJ90	64	32	64	96	128	–
PIC18F6XJ93	64	33	66	99	132	–
PIC18F6XJ94	64	34	68	102	136	240
PIC18F6XK90	64	33	66	99	132	–
PIC18F8XJ90	80	48	96	144	192	–
PIC18F8XJ94	80	50	100	150	200	368
PIC18F8XJ93	80	48	96	144	192	–
PIC18F8XK90	80	48	96	144	192	–
PIC24FJXXXGA306	64	34	68	112	146	240
PIC24FJXXXGC006	64	34	68	112	146	240
PIC24FJXXXGA308	80	50	100	150	200	368
PIC18F9XJ94	100	64	128	192	256	480
PIC24FJXXXGA310	100	64	128	192	264	480
PIC24FJXXXGC010	100	64	128	192	264	480
PIC24FJXXXGB/GA4XX	121	64	128	192	256	512
SAML22N	100	44	88	132	176	320
SAM4L	100	40	80	120	160	–

Development Tools for Segmented LCD

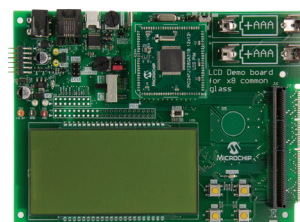
PIC24F Intelligent Analog Starter Kit (DM240015)



This development kit featuring the PIC24F “GC” family of 16-bit microcontrollers offers an analog header, allowing clean analog signals to be accessed to preserve signal integrity. To complement the header, the board also features on-board sensors including a light sensor, potentiometer, microphone, temperature and capacitive touch. The custom LCD display features a 296 dot-matrix array for text display and 17 special icons. The board includes connections for microphone and headphones as well as on-board light and temperature sensors. The segmented display showcases custom icons and a scrolling banner. The board also includes cap touch buttons, USB connection and easy connection for RF modules.

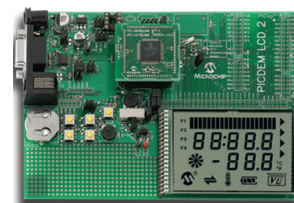
LCD Explorer Development Board (DM240314)

- Supports Microchip’s 100-pin microcontrollers with $\times 8$ common segment LCD drivers
- Provides an ideal platform to evaluate a MCU with an $\times 8$ common LCD driver on a 38 segment $\times 8$ common LCD display
- PICtail™ Plus connections enable evaluation of selected MCUs in a complex system by adding PICtail Plus daughter boards
- PIC18F97J94 PIM (MA180034)



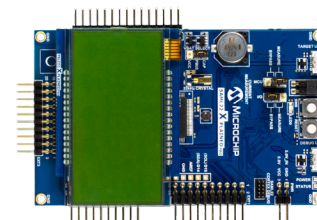
PICDEM™ LCD 2 Demo Board (DM163030)

- Illustrates and supports the main features of Microchip’s 28-, 40-, 64- and 80-pin LCD PIC microcontrollers
- LCD glass with icons, numbers, alphanumeric and starburst display
- Demonstrates booster capability for contrast control and dimming
- Separate Processor Plug-in Modules (PIMs) are available to evaluate all of the LCD products
 - PIC18F87J90 PIM (MA180025)
 - PIC18F87K90 PIM (MA180027)
 - PIC16F1947 PIM (MA160016)
 - LCD PIM Pack (PIC16) (MA180019)



SAM L22 Xplained Pro Evaluation Kit (ATSAML22-XPRO-B)

The SAM L22 Xplained Pro Evaluation Kit is the ideal for evaluating the ultra-low-power SAM L22 Arm® Cortex®-M0+ microcontroller with a touch segment LCD. This kit includes the TSLCD1 Xplained Pro extension board which offers a segment LCD display with 8x24 segments and five on-glass mutual capacitance touch sensors for evaluation with the Peripheral Touch Controller (PTC) module.



Application Notes for LCD Displays

- Low-power techniques for LCD applications, TB1098
- Implementing an LCD using the PIC16F1947 MCU, AN1354
- Solving Sensor Offset Problem, AN781
- Low-Power Real-Time Clock, AN582
- LCD Biasing and Contrast Control Methods, AN1428
- LCD Fundamentals and the LCD Driver Module for 8-bit PIC MCUs, AN658

Graphical Displays

Microchip offers varying levels of solutions to drive everything from simple monochrome LCDs to full-color WVGA user interfaces. Graphics support includes the following approaches:

- PIC24F “DA” integrated graphics controller
- PIC32 controllerless graphics
- Support for PIC MCU with external graphics controllers
- PIC32MZ “DA” with integrated graphics controller and on chip DDR memory.

The silicon offering is complemented with powerful, free and easy-to-use graphics library, display designer GUI and hardware development kits with flexible interface to various glass sizes.

Supported Screen Sizes and Colors

Microchip graphics solutions support various screen sizes and colors ranging from small monochrome OLED displays up to WVGA displays with vivid color. The table below shows the bits per pixel required to represent color.

Display Representation	Color Examples	Color Depth (bits per pixel)
Mono	Black and White	1
Grayscale	4 shades	2
	16 shades	4
Color	256 colors	8
	65K colors	16
	16 million colors	24

As the color depth and display resolution increase, the frame buffer grows. Depending on the size, the frame buffer can be stored in the microcontroller RAM, in external SRAM or integrated into an external graphics controller. The table below shows examples of the frame buffer sizes required for some popular resolution and color depths.

- PIC24 “DA” family supports up to 96 KB on chip
- PIC32 MCUs support up to 512 KB on chip
- External SRAM can be used for larger frame buffers
- PIC32MZ “DA” family supports 32 MB on chip DDR RAM
- For advanced graphics, external graphics controllers have additional frame buffer storage

Free Microchip Graphics Library



The Microchip graphics library is highly modular and is optimized for Microchip’s 16- and 32-bit microcontrollers. It is easy to use and has an

open documented interface for driver or controller support.

The library supports the following features:

- Pre-made graphics objects
- Multiple fonts and languages
- User interface for mTouch sensing solutions
- Includes buttons, charts, check boxes, scroll bars, list boxes, images and basic animation
- For PIC32 MCUs the graphics library is available as a part of MPLAB® Harmony
- For 16-bit MCUs the graphics library is available through the Microchip Library for Applications (MLA)

Graphics Library for 32-bit MCUs

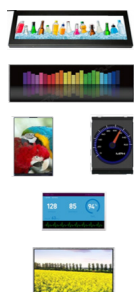
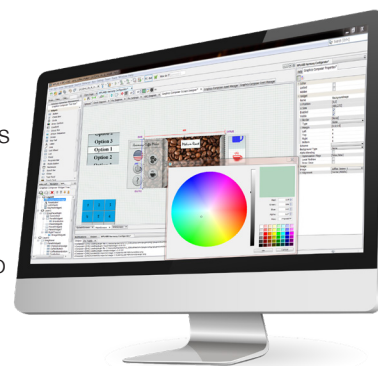
The Graphics Library available as part of MPLAB Harmony, is a free, modular library optimized for Microchip’s 32-bit microcontrollers. The library includes features such as alpha blending, gradient fills and anti-aliased fonts. Applications can take advantage of these features to enhance the user experience while delivering performance required by the application. The Graphics Library features:

- Up to 24-bit or 16.7M colors
- Parent-child tree system allows for modular assembly of advanced GUI design
- Modern input widgets which include graphing widgets, radial menu (3D), arc widgets (drawing, slider, gauges), list wheel
- Run length encoding image compression
- Capacitive and resistive touch screen, keypad
- World-class multi-lingual localization system
- Extensive support available for external display controllers

MPLAB Harmony Graphics Visual Design Tools

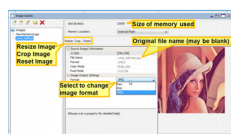
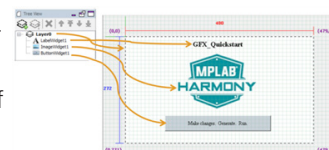
Creating professional-looking graphical user interfaces (GUI) on memory and cost efficient microcontrollers (MCU) has never been easier than with the MPLAB Harmony Graphics Composer (MHGC) tools suite and libraries. This tightly-integrated system of GUI-based tools and software were built by the leader in high-performance 32-bit graphics MCU's, so there is less time and cost required in bug fixing and re-integration of code from outside tool sets and libraries. MHGC is "what you see is what you get", or WYSIWYG, based GUI development system with loads of features that are both unique in the industry and completely free.

- **Tightly Integrated Tools Environment** - Tight integration between MHGC, MPLAB X, and MPLAB Harmony produces an enhanced, interactive development environment where design and debug can be focused on application-specific code, leading to shorter time-to-market, lower overall development costs, and higher quality products.
- **Performance** - MHGC was designed from the ground up to enable code portability across multiple 32-bit families while also making maximum use of available graphics processing units (GPU), multi-layer overlay graphics controllers, and DRAM available on Microchip's high-performance 32-bit MCUs.
- **Cost** - MHGC is free to design with and free to use with Microchip's 32-bit MCUs. It's also royalty free. All components of MHGC are available in each public release of MPLAB Harmony, Microchip's framework for 32-bit MCU development, and works with the free version of MPLAB XC32 compiler.



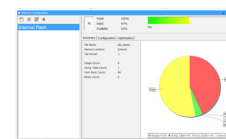
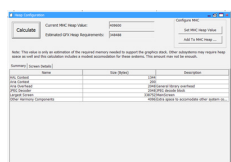
The **Display Manager** plug-in enables quick support for new and unsupported displays in MPLAB Harmony. Brings relevant configuration settings needed by the Display Manager are arranged on to one screen, making the tools easy to use. It also provides simulated timing characteristics for a deeper system understanding. All of this enables fast prototyping of new displays. Seamless conversion of datasheet timing values to simulated timing waveform cuts down development time from weeks to hours. Supporting non-standard display resolutions and aspect ratios opens up designs to unique and attractive form factors and lowers the barrier of entry for novice graphics developers.

The Graphics Composer **Event Manager** provides a GUI interface to manage all the events associated with a graphics application. Rapid event handler configuration of button pushes, key strokes, touch gestures ties actions to events associated with graphics widgets as well as events outside of the graphics library.



Image, font and string asset managers provide valuable tools for understanding and modifying the affects that fonts and pictures have on your overall graphics design. Configure memory allocations for graphics assets, including external media, allowing for resize, crop and reformat images for optimal quality and memory usage. Manage languages, fonts and strings and direct fonts to specific locations in memory.

Resource Allocation Monitor Provides a detailed report of asset allocation, which is useful for optimizing flash resources and memory usage including compression, color and feature settings.

Name	Size	Location
...
...
...

The **Heap Usage Calculator** provides accurate estimates of heap consumption based on assets and screen design, saving significant time and effort.

SEGGER emWin Pro Library

emWin from SEGGER Microcontroller GmbH and Co. KG is a software graphics library that provides efficient GUI building blocks for applications that operate with a graphical LCD.

- Complete ANSI C code, no need to C++
- RTOS independent
- GUIBuilder drag-and-drop design interface
- Robust graphics widget and shape drawing library
- Alternative for MPLAB Harmony Graphics Object Library and Primitive Layer
- User SEGGER development tool chain and utilities
- Integrated with MPLAB Harmony Configurator

Target Applications

Applications that benefit from attractive and easy-to-use graphical displays include:

Consumer: Thermostats, cordless phones, remote controls

Home Appliance: Coffee makers, washing machines, refrigerators, ovens

Industrial: Digital instrument gauges, storage controls, remote terminals

Portable Medical: Glucometers, blood pressure monitors, portable ECGs

Application Notes and Documentation for Graphical Displays

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

PIC24F with Integrated Graphics Controller: Low Cost, Easy to Use

The PIC24F “DA” family makes it easy and cost-effective to add advanced graphics to your application by eliminating the need for external frame buffers or display controllers.

- Dedicated graphics clock for a continuous, clean display
- On-chip display controller provides direct interface to TFT, STN and OLED displays
- Easy-to-use Graphics Processing Units for hardware acceleration
 - Move and copy rectangles with smooth, fast memory transfers
 - Decompress images without CPU intervention
 - Render text without CPU intervention
- Color look-up table and 96 KB frame buffer to support multiple colors
 - Supports QVGA 8 bpp with internal frame buffer
 - Supports WQVGA 16 bpp with external frame buffer using Parallel Master Port (PMP)

With the hardware acceleration, this family is able to process and render graphics without using any MCU MIPS. The dedicated graphics engine is able to continuously drive a display without being shared with any other function.

PIC32 Low Cost Controllerless Graphics: 32-bit Performance, Flexibility, Integration

Microchip’s PIC32 line of 32-bit microcontrollers offers up to 330 DMIPS and high-performance DMA to render graphics directly to displays. This enables PIC32 devices to drive a display without an external graphics controller.

- Uses <5 MIPS and DMA to render graphics
 - Direct interface to STN, TFT displays
- Integrated up to 512 KB RAM for frame buffering
- Works with any PIC32 microcontroller

These devices offer up to 2 MB Flash and 512 KB RAM, giving you plenty of space for application code, communications stacks and data buffering. In addition to the graphics capabilities, PIC32 MCUs also have integrated peripherals for USB, CAN, Ethernet, I²C, SPI, EBI, Crypto Engine and capacitive touch sensing.

External Graphics Controller: PIC24 or PIC32 with Parallel Master Port (PMP)

PIC24 and PIC32 MCUs can also work with an external graphics controller to support larger screen sizes or more advanced graphical features. Many external graphics controllers are supported by the graphics library; a few that we support with development tools are highlighted below.

The Solomon Systech SSD1926 Graphics Controller has hardware graphics acceleration to free up the MIPS of the PIC MCU. This controller includes an SD™ Card interface and JPEG decode engine as well as 256 KB RAM. The Graphics PICtail Plus SSD1926 Board (AC164127-5) includes serial Flash for data storage and interfaces to either Explorer 16/32 or PIC32 Starter Kits.

The Epson S1D13517 Graphics Controller includes alpha blending, picture-in-picture and supports up to WVGA (800 × 480) at 24 bpp. This controller has an SDRAM interface for connection to low-cost external memory. The Graphics Controller PICtail Plus Epson S1D13517 Board (AC164127-7) includes 128 MB SDRAM frame buffer and 64 MB serial Flash and interfaces to either Explorer 16/32 Explorer 16 or PIC32 Starter Kits.

PIC32MZ DA with Integrated Graphics Controller and Graphics Processor

The PIC32MZ “DA” series, with its integrated graphics controller, graphics processor and available on-chip 32 MB of DDR2 DRAM, lifts Graphical User Interface (GUI) designs to performance and quality levels not yet seen in embedded microcontroller applications. The PIC32MZ DA series provides microprocessor-like graphics quality with the ease of design of an MCU. Additionally, with MPLAB Harmony Graphics 2.0, you can finish and display your GUI design faster than you’d ever thought possible.

- 3-Layer Graphics Controller capable of driving 24-bit color WVGA
- High-performance 2D Graphics Processing Unit (GPU)
- 32 MB integrated DDR2 DRAM or 128 MB externally addressable
- Up to 2 MB Flash and 640 KB RAM
- 12-bit ADC Throughput at 18 Msps
- Full-featured hardware crypto engine with Random Number Generator (RNG) for data encryption/decryption and authentication

	PIC24 “DA” Integrated Graphics Controller	PIC32MZ “DA” Integrated Graphics Controller	PIC32 Controllerless Graphics	External Solomon Systech Graphics Controller SSD1926	External Epson Graphics Controller S1D13517
Display*	WQVGA 480 × 272	SXGA 1280 × 1024	WVGA 800 × 480	WQVGA 480 × 272	WVGA 800 × 480
Graphics	HW Acceleration: rectangles, characters, images	2D Graphics, bit and raster, alpha-blending, image scaling	Alpha-blending, speed, picture-in-picture, layering	HW Acceleration, SD™ Card, I/F, JPEG engine	SDRAM, I/F, alpha-blending, picture-in-picture
Frame Buffer	Color Lookup Table + 96 KB on MCU + Ext SRAM	32 MB on chip DDR or up to 128 MB ext DDR SRAM	512 KB on MCU + Ext SRAM	256 KB on Solomon Systech Controller	Ext SDRAM
Core MIPS	16	330	330	–	–
Power	Better	Good	Good	Good	Good
Cost	\$	\$\$	\$	\$\$	\$\$\$

*Max resolution at 16 bpp

Low-Cost Solution Without External Graphics Controller

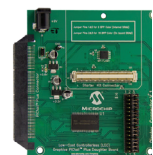
PIC24FJ256DA210 Development Board (DM240312)



This board is a low-cost and efficient development board to evaluate the features and performance of the PIC24FJ256DA210 with integrated graphics, mTouch sensing and USB.

The development board requires a display board to complete the two-board setup. It has a Microchip display connector V1, and allows you to match it with any of the listed 3.2", 4.3" TFT displays, or the graphics prototype board available from Microchip.

Low-Cost Controllerless (LCC) Graphics PICtail Plus Board (AC164144)



This board enables development of graphics solutions without an external graphics controller. The board is designed to attach to a PIC32 Starter Kit or an Explorer 16/32 Development Board and one of Microchip’s LCD modules.

PIC32 GUI Development Board with PCAP Touch (DM320015)



This board enables development of cost-effective multi-touch graphical user interfaces. It is based on the PIC32MX795F512H with 105 DMIPS performance, 512 KB Flash and 128 KB RAM. The PIC32 is coupled with a low-cost PSRAM as a high-speed

graphics frame buffering and a 4.3" WQVGA touch display enabling development of graphics solutions without an external graphics controller.

Multimedia Expansion Board II (DM320005-5)



This board is a highly-integrated, compact and flexible development platform which works with PIC32MZ Starter Kits. This kit features a 4.3" WQVGA PCAP touch display daughter board and supports detachable display boards allowing for a variety of resolutions. The kit also has an on-board 24-bit stereo audio codec, VGA camera, 802.11b/g wireless module, Bluetooth® HCI transceiver, temperature sensor, microSD™ slot and analog accelerometer.

High-Performance WVGA LCD Display Module with maXTouch® Technology (AC320005-5)



The High-Performance WVGA LCD Display Module with maXTouch Technology (AC320005-5) is designed for evaluating the Microchip graphics display solution and graphics library for 32-bit microcontrollers and microprocessors. This board is compatible with Multimedia Expansion Board II (DM320005-5), as well as with Xplained Pro and Xplained Ultra evaluation kits. This board has a TFT 800 x 480 display with a 24-bit parallel RGB interface with a maXTouch capacitive touch interface.

Tools for Designing Graphical Displays

Solutions with External Graphics Controllers

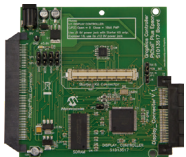
Graphics LCD Controller PICtail Plus SSD1926 Board (AC164127-5) (Includes Solomon Systech SSD1926 Controller)



The Graphics LCD Controller PICtail Plus SSD1926 Board is a demonstration board for evaluating Microchip's graphic display solution and graphics library for 16- and 32-bit microcontrollers. It is an expansion board compatible with the Explorer 16/32 Development Board (DM240001-2) or one of the PIC32 Starter Boards (DM320001, DM320003). The controller board has a connection for the display boards, such as the Graphics Display Truly 3.2" 240 × 320 Board (AC164127-4). The features include:

- Solomon Systech SSD1926 Graphics Display Controller supporting 4/8-bit STN, 4/8-bit CSTN, 18-bit HR-TFT and 9/12/18/24-bit TFT interface
- SD/MMC Card socket, connected to SSD1926 via 4-wire interface
- 16 Megabit (2M × 8) serial Flash memory for additional data storage
- Display connector for interfacing with different display boards
- PICtail Plus Interface for connecting to Explorer 16/32 Development Board
- PIC32 Starter Kit Connector

Graphics Controller PICtail Plus Epson S1D13517 Board (AC164127-7)



The Graphics PICtail Plus Epson S1D13517 Board is a demonstration board for evaluating Microchip's graphics-display solution and graphics library for 16- and 32-bit microcontrollers.

This expansion board is compatible with the Explorer 16/32 Development Board (DM240001-2) or one of the PIC32 Starter Boards (DM320001, DM320003). The controller board has a connection for display boards such as Graphics Display Truly 5.7" 640 × 480 Board (AC164127-8) and the Graphics Display Truly 7 800 × 480 Board (AC164127-9). Features include:

- Support for VGA, WVGA, QVGA, WQVGA displays
- Alpha blending
- Support for 24 bpp
- Touch interface
- 128-megabit (8M × 16) SDRAM for frame buffering
- 64-Megabit serial Flash memory for additional data storage

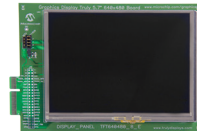
Display Boards

Graphics Display Powertip 4.3" 480 × 272 Board (AC164127-6)



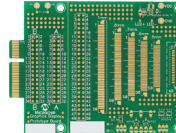
The Graphics Display Powertip 4.3" 480 × 272 Board is a demonstration board for evaluating Microchip's graphic display solution and graphics library for 16- and 32-bit microcontrollers. It is an expansion board compatible with the LCD controller boards such as the Graphics LCD Controller PICtail Plus SSD1926 Board (AC164127-5).

Graphics Display Truly 5.7" 640 × 480 Board (AC164127-8)



The Graphics Display Truly 5.7" 640 × 480 Board is a demonstration board for evaluating Microchip's graphics display solution and graphics library for 16 and 32-bit microcontrollers. This expansion board is compatible with LCD controller boards such as the Graphics Controller PICtail Plus Epson S1D13517 Board (AC164127-7).

Graphics Display Prototype Board (AC164139)



The Graphics Display Prototype Board (set of three) provides an easy path to integrate a graphics LCD panel of your choice to one of the following platforms:

- PIC24FJ256DA210 development board (DM240312)
- Graphics LCD Controller PICtail Plus SSD1926 Board (AC164127-5)

Visual Design Tools

	MLA Graphics Library v3.XX (PIC24/dsPIC® DSC/PIC32MX)	MLA Graphics Library v4.00+ (PIC24/dsPIC DSC)	MPLAB Harmony v2.xx and MPLAB Harmony v1.04+ (PIC32MX/MZ)
VGDD with VGDD-Link MPLAB X IDE Plug In (VGDD-Link Plug In requires VGDD v9+ and MPLAB X IDE v3.00+)	✓	✓	
MPLAB Harmony Graphics Composer (requires MPLAB X IDE v3.00+)			✓

Microchip Graphics Solutions

These tables shows the out-of-the-box support for the following development boards and kits. With proper software and hardware configuration, compatibility of certain hardware combinations and other PIC devices can be achieved.

PIC32 Starter Kit-Based Tools

Starter Kits		Graphics LCD Controller PICtail™ Plus SSD1926 Board (AC164127-5)	Graphics Controller PICtail Plus Epson S1D13517 Board (AC164127-7)	Low-Cost Controllerless (LCC) Graphics PICtail Plus Daughter Board (AC164144)	Multimedia Expansion Board II (DM320005-5)
PIC32 Starter Kit (DM320001)					
PIC32 USB Starter Kit III (DM320003-3)					
PIC32 Starter Kit (DM320001)	Graphics Display Powertip 4.3" 480 × 272 Board (AC164127-6)	✓	✓	✓ ⁽⁴⁾	
PIC32 USB Starter Kit III (DM320003-3)		✓+	✓+	✓ ⁺⁽⁴⁾	
PIC32MZ EF Starter Kit (DM320007)					✓
PIC32MZ EF Starter Kit with Crypto Engine (DM320007-C)					✓
PIC32MZ Embedded Graphics with Stacked DRAM (DA) Starter Kit (DM320010)					✓
PIC32MZ Embedded Graphics with Stacked DRAM (DA) Starter Kit with crypto (DM320010-C)					✓
PIC32MZ Embedded Graphics with External DRAM (DA) Starter Kit (DM320008)					✓
PIC32MZ Embedded Graphics with External DRAM (DA) Starter Kit with crypto (DM320008-C)					✓
PIC32 Starter Kit (DM320001)	Graphics Display Truly 5.7" 640 × 480 Board (AC164127-8)	–1	✓	✓ ⁺⁽³⁾	
PIC32 USB Starter Kit II (DM320003-2)		–1	✓	✓ ⁺⁽³⁾	
PIC32 USB Starter Kit III (DM320003-3)		–1	✓+	✓ ⁺⁽³⁾	
PIC32 Starter Kit (DM320001)	Graphics Display Prototype Board (AC164139)	✓ ⁽²⁾	✓ ⁽²⁾	✓ ⁽²⁾	–
PIC32 USB Starter Kit III (DM320003-3)		✓ ⁽²⁾	✓ ⁽²⁾	✓ ⁽²⁾	–
PIC32MZ EF Starter Kit (DM320007)		✓ ⁺⁽²⁾	✓ ⁺⁽²⁾	✓ ⁺⁽²⁾	✓ ⁽²⁾
PIC32MZ EF Starter Kit with Crypto Engine (DM320007-C)		✓ ⁺⁽²⁾	✓ ⁺⁽²⁾	✓ ⁺⁽²⁾	✓ ⁽²⁾

- ✓ = Compatible (out of the box)
✓+ = Compatible (will need firmware modification)
– = Incompatible

- Notes:**
1. SSD1926 supports up to WQVGA (480 × 272) displays.
2. Manually assemble chosen display panel to the prototyping board.
3. Run at 8 bpp with external memory.

4. 8 bpp or less using internal memory, 8 bpp or 16 bpp using external memory.
5. 8 bpp or 16 bpp with external memory.
6. Only works with PIC32MZ Starter Kits.

Tools for Designing Graphical Displays

Other Development Tools

	Explorer 16/32 Development Board (DM240001-2) + Plug-In Modules (PIMs)		Graphics Display Powertip 4.3" 480 × 272 Board (AC164127-6)	Graphics Display Truly 5.7" 640 × 480 Board (AC164127-8)	Graphics Display Prototype Board (AC164139)
PIC24FJ256DA210 Development Board (DM240312)			✓ ⁽⁶⁾	✓ ⁽³⁾	✓ ⁽²⁾
Graphics LCD Controller PICtail Plus SSD1926 Board (AC164127-5)	PIC24F PIMs	✓	✓		✓ ⁽²⁾
	PIC32MX PIMs	✓	✓		✓ ⁽²⁾
	PIC32MZ PIM	✓	✓		✓ ⁽²⁾
	PIC24EP and dsPIC33P PIMs	✓	✓		✓ ⁽²⁾
	PIC24H and dsPIC33F PIMs	✓	✓		✓ ⁽²⁾
Graphics Controller PICtail Plus Epson S1D13517 Board (AC164127-7)	PIC24F PIMs	✓	✓	✓	✓ ⁽²⁾
	PIC32MX PIMs	✓	✓	✓	✓ ⁽²⁾
	PIC32MZ PIM	✓	✓	✓	✓ ⁽²⁾
	PIC24EP and dsPIC33EP PIMs	✓+	✓	✓	✓ ⁽²⁾
	PIC24H and dsPIC33F PIMs	✓+	✓+	✓+	✓ ⁽²⁾
Low-Cost Controllerless (LCC) Graphics PICtail Plus Daughter Board (AC164144)	PIC24F PIMs				
	PIC32MX PIMs	✓	✓	✓ ⁽³⁾	✓ ⁽²⁾
	PIC32MZ PIM	✓	✓	✓	✓ ⁽²⁾
	PIC24H and dsPIC33F PIMs				

- ✓ = Compatible (out of the box)
 ✓+ = Compatible (will need firmware modification)
 - = Incompatible

Notes:
 1. SSD1926 supports up to WQVGA (480 × 272) displays.
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