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.

**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 WVGA (800 × 480) 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
- High-performance 32-bit MCUs with integrated Ethernet and CAN for remote interfaces
- USB OTG and mTouch® sensing solutions

**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 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

**Direct Drive for Segmented Displays**
The LCD PIC 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 VDD 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

Size of Displays vs. Performance

Maximum Number of Segments

<table>
<thead>
<tr>
<th>Product Family</th>
<th>Pins</th>
<th>1 Common</th>
<th>2 Commons</th>
<th>3 Commons</th>
<th>4 Commons</th>
<th>8 Commons</th>
</tr>
</thead>
<tbody>
<tr>
<td>PIC16(L)F1902/3/6</td>
<td>28</td>
<td>19</td>
<td>38</td>
<td>57</td>
<td>72</td>
<td>–</td>
</tr>
<tr>
<td>PIC16(L)F1933/6</td>
<td>28</td>
<td>16</td>
<td>32</td>
<td>48</td>
<td>60</td>
<td>–</td>
</tr>
<tr>
<td>PIC16(L)F1904/7</td>
<td>40</td>
<td>29</td>
<td>58</td>
<td>87</td>
<td>116</td>
<td>–</td>
</tr>
<tr>
<td>PIC16(L)F1934/7/9</td>
<td>40</td>
<td>24</td>
<td>48</td>
<td>72</td>
<td>96</td>
<td>–</td>
</tr>
<tr>
<td>PIC16(L)F1946/7</td>
<td>64</td>
<td>46</td>
<td>92</td>
<td>138</td>
<td>184</td>
<td>–</td>
</tr>
<tr>
<td>PIC18F6X90</td>
<td>64</td>
<td>32</td>
<td>64</td>
<td>96</td>
<td>128</td>
<td>–</td>
</tr>
<tr>
<td>PIC18F6X93</td>
<td>64</td>
<td>33</td>
<td>66</td>
<td>99</td>
<td>132</td>
<td>–</td>
</tr>
<tr>
<td>PIC18F6X94</td>
<td>64</td>
<td>34</td>
<td>68</td>
<td>102</td>
<td>136</td>
<td>240</td>
</tr>
<tr>
<td>PIC18F6X90</td>
<td>64</td>
<td>33</td>
<td>66</td>
<td>99</td>
<td>132</td>
<td>–</td>
</tr>
<tr>
<td>PIC18F8X90</td>
<td>80</td>
<td>48</td>
<td>96</td>
<td>144</td>
<td>192</td>
<td>–</td>
</tr>
<tr>
<td>PIC18F8X94</td>
<td>80</td>
<td>50</td>
<td>100</td>
<td>150</td>
<td>200</td>
<td>368</td>
</tr>
<tr>
<td>PIC18F8X93</td>
<td>80</td>
<td>48</td>
<td>96</td>
<td>144</td>
<td>192</td>
<td>–</td>
</tr>
<tr>
<td>PIC24FJXXXGA306</td>
<td>64</td>
<td>34</td>
<td>68</td>
<td>112</td>
<td>146</td>
<td>240</td>
</tr>
<tr>
<td>PIC24FJXXXGA308</td>
<td>64</td>
<td>34</td>
<td>68</td>
<td>112</td>
<td>146</td>
<td>240</td>
</tr>
<tr>
<td>PIC24FJXXXG006</td>
<td>64</td>
<td>34</td>
<td>68</td>
<td>112</td>
<td>146</td>
<td>240</td>
</tr>
<tr>
<td>PIC24FJXXXG008</td>
<td>80</td>
<td>50</td>
<td>100</td>
<td>150</td>
<td>200</td>
<td>368</td>
</tr>
<tr>
<td>PIC18F9X94</td>
<td>100</td>
<td>64</td>
<td>128</td>
<td>192</td>
<td>256</td>
<td>480</td>
</tr>
<tr>
<td>PIC24FJXXXGA310</td>
<td>100</td>
<td>64</td>
<td>128</td>
<td>192</td>
<td>264</td>
<td>480</td>
</tr>
<tr>
<td>PIC24FJXXXG010</td>
<td>100</td>
<td>64</td>
<td>128</td>
<td>192</td>
<td>264</td>
<td>480</td>
</tr>
<tr>
<td>PIC24FJXXXGB/GA4XX</td>
<td>121</td>
<td>64</td>
<td>128</td>
<td>192</td>
<td>256</td>
<td>512</td>
</tr>
</tbody>
</table>
Direct Drive for Segmented Displays

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 × 8 common segment LCD drivers
- Provides an ideal platform to evaluate a MCU with an × 8 common LCD driver on a 38 segment × 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, alphanumerics 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)

Application Notes for LCD Displays

- Low Power Techniques for LCD Applications, TB1098
- Implementing an LCD Using the PIC16F1947 Microcontroller, 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 Microcontrollers, AN658

Development Tools for Segmented LCD

Development Tools for Segmented LCD

Graphical and Segmented Display Solutions
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

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.

<table>
<thead>
<tr>
<th>Display Representation</th>
<th>Color Examples</th>
<th>Color Depth (bits per pixel)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mono</td>
<td>Black and White</td>
<td>1</td>
</tr>
<tr>
<td>Grayscale</td>
<td>4 shades</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>16 shades</td>
<td>4</td>
</tr>
<tr>
<td>Color</td>
<td>256 colors</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>65K colors</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>16 million colors</td>
<td>24</td>
</tr>
</tbody>
</table>

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
- For advanced graphics, external graphics controllers have additional frame buffer storage

Screen Size and Colors

<table>
<thead>
<tr>
<th>Display Resolution Typical Sizes</th>
<th>Color Depth/ Memory Requirement in (bytes)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 bpp</td>
</tr>
<tr>
<td>Colors</td>
<td>2</td>
</tr>
<tr>
<td>WVGA</td>
<td>48,000</td>
</tr>
<tr>
<td>VGA</td>
<td>38,400</td>
</tr>
<tr>
<td>WQVGA</td>
<td>16,320</td>
</tr>
<tr>
<td>QVGA</td>
<td>9,600</td>
</tr>
<tr>
<td>Common for OLED</td>
<td>1,024</td>
</tr>
</tbody>
</table>

*The minimum required for 24 bpp is more because of our 32-bit word length
Visual Design Tools

Microchip provides several visual design tools to help you with the development of graphics firmware. These GUI-based tools reduce the need to memorize graphics object information, improve the edits-compile-execute cycle and allow developers to work in the same space as users.

**MPLAB Harmony Graphics Composer (MHGC) for 32-bit Microcontrollers**

MPLAB Harmony Graphics Composer (MHGC) is Microchip’s industry-leading GUI design tool for PIC32 microcontrollers. As a fully-integrated component of MPLAB Harmony Configurator (MHC), MHGC will accelerate your application’s front end design without leaving the MPLAB X IDE.

- Concept to glass in minutes without writing a single line of code
- Configure project for your GUI requirements
- Drag and drop widget and objects directly into the design
- Extend your brand by importing custom images
- Design directly for MPLAB Harmony Graphics Primitive Library

MHGC is fully integrated into MHC which is available as an MPLAB X IDE plug in.

**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

**Visual Graphics Display Design (VGDD) for 16-bit Microcontrollers**

The Visual Graphics Display Designer is a standalone third-party graphics display designer tool with a companion VGDD-Link MPLAB X IDE plug in, supporting 16-bit PIC24 MCUs and dsPIC® Digital Signal Controllers. Compatible with MPLAB Code Configurator (MCC), VGDD utilizes the Microchip Graphics Library available as part of Microchip Libraries of Applications (MLA) to produce output source files that can be compiled using Microchip’s XC16 Compilers to create interactive GUIs.

VGDD-Link is available as an MPLAB X plug in for GUI design, providing a seamless development experience. The VGDD-Link tool can be directly downloaded and installed from the MPLAB X IDE Plug In menu.

- Concept to glass in minutes without writing a single line of code
- Configure projects for your GUI requirements
- Drag and drop widgets and objects directly into the design (WYSIWYG design simplicity)
- Extend your brand by importing custom images
- Designed directly for Microchip Libraries of Applications

**What’s New?**

- What You See Is What You Get (WYSIWYG) design
- Multi-platform (Windows®, Linux®, Mac®)
- Improved design tools
  - Drawing grid, auto widget alignment and other drawing shortcuts/ productivity features
  - Cut, copy, paste properties
- Improved screen navigation
  - PowerPoint® style screen listing

**Key Features**

- Allows you to resize, align and move widgets, create color schemes and add fonts and images to your application
- Generates source code ready for PIC24F microcontrollers and digital signal controllers
- Provides the same visual representation of the embedded screen to draw objects on the PC screen
- Eliminates the need to manually calculate the (x, y) coordinates for on-screen object placements
- General guidance and information on selected screen elements (e.g. memory resource impact, color placement, etc.)
- Information box to provide context-sensitive information
- Multi-screen thumbnails enable quick switching amongst screens to develop the flow of your graphical user interface
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  
- **Using PIC32 MCUs to Develop Low-Cost Controllerless (LCC) Graphics Solutions,** AN1387

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 PMP (Parallel Master Port)

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 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 PiCtail Plus Epson S1D13517 Board (AC164127-7) includes 128 MB SDRAM frame buffer and 64 MB serial Flash and interfaces to either Explorer 16 or PIC32 Starter Kits.
Tools for Designing Graphical Displays

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Display*</td>
<td>WQVGA 480 × 272</td>
<td>WVGA 800 × 480</td>
<td>WQVGA 480 × 272</td>
<td>WVGA 800 × 480</td>
</tr>
<tr>
<td>Frame Buffer</td>
<td>Color Lookup Table + 96 KB on MCU + Ext SRAM</td>
<td>512 KB on MCU + Ext SRAM</td>
<td>256 KB on Solomon Systech Controller</td>
<td>Ext SDRAM</td>
</tr>
<tr>
<td>Core MIPS</td>
<td>16</td>
<td>330</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Power</td>
<td>Better</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>Cost</td>
<td>$</td>
<td>$</td>
<td>$</td>
<td>$$$</td>
</tr>
</tbody>
</table>

*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 Development Board and one of Microchip’s LCD modules.

**PIC32 GUI Development Board with PCAP Touch (DM320001)**
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" WVQVGA touch display enabling development of graphics solutions without an external graphics controller.

**Multimedia Expansion Board II (DM320005-2)**
This board is a highly-integrated, compact and flexible development platform which works with PIC32MZ Starter Kits. This kit features a 4.3" WVQVGA 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.

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 Development Board (DM240001) 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 Development Board
- PIC32 Starter Kit Connector

**Multimedia Expansion Board (DM320005) (Includes Solomon Systech SSD1926 Controller)**
The Multimedia Expansion Board is an integrated, yet flexible, solution for development of high-impact user interfaces. The board comes with a 3.2" color TFT touch-screen display and interfaces to a PIC32 Starter Kit* allowing you to choose the device family that works best for you. The Multimedia Expansion Board comes with an on-board FCC certified Wi-Fi® module and includes a 24-bit stereo audio codec, a three-axis accelerometer, a joystick and a MicroSD memory card slot.

* A PIC32 Starter Kit is required to use this expansion board.
Tools for Designing Graphical Displays

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 Development Board (DM240001) 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 x 480 Board (AC164127-8) and the Graphics Display Truly 7” 800 x 480 Board (AC164127-9). Features include:
- Support for VGA, WVGA, QVGA, WQVGA displays
- Alpha blending
- Support for 24 bpp
- Touch interface
- 128-megabit (8M x 16) SDRAM for frame buffering
- 64-Megabit serial Flash memory for additional data storage

Display Boards

Graphics Display Truly 3.2” 240 x 320 Board (AC164127-4)

The Graphics Display Truly 3.2” 240 x 320 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 Powertip 4.3” 480 x 272 Board (AC164127-6)

The Graphics Display Powertip 4.3” 480 x 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 x 480 Board (AC164127-8)

The Graphics Display Truly 5.7” 640 x 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 Truly 7” 800 x 480 Board (AC164127-9)

The graphics Display Truly 7” 800 x 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).

Additional Graphics Development Boards

Remote Control Demo Board (DM240315-2)

Microchip’s Remote Control Demo Board integrates Graphics, mTouch technology, USB and RF4CE into a single demo. The board demonstrates a remote populated with a PIC24FJ256DA210 MCU, 3.5” Graphical TFT LCD with resistive touch screen, capacitive touch keys with plastic overlay, MRF24J40 2.4 GHz transceiver and ZENA™ wireless adapter. The Remote Control Demo Board offers the complete software and hardware including bill of materials, schematics and reference code.

Pervasive Displays E-Paper EPD PICtail Plus Daughter Board (Sold by Pervasive Displays #S0000AS0T3)

Microchip has partnered with Pervasive Displays to introduce an e-paper PICtail Plus Board that connects to Microchip’s Explorer 16 development platform. The sample Microchip MPLAB X IDE project provides an open source driving waveform, including global update and partial update capability with command interface to update content on the EPD panel without a graphic display controller or timing control board. The EPD PICtail Plus Daughter Board features:
- Support for driving 1.44”, 2” and 2.7” EPD panels; all three sizes are included
- Direct-drive EPD by a Microchip PIC24 or PIC32 microcontroller without the need for any external graphic or timing controller
- Open documentation and driving waveform for EPD panel
- Microchip MPLAB X IDE project source code with Microchip Graphic Library
Tools for Designing Graphical Displays

Visual Design Tools

<table>
<thead>
<tr>
<th>MLA Graphics Library v3.XX (PIC24/dsPIC/PIC32MX)</th>
<th>MLA Graphics Library v4.00+ (PIC24/dsPIC)</th>
<th>MPLAB® Harmony v1.03 and older (PIC32MX/MZ)</th>
<th>MPLAB Harmony v1.04+ (PIC32MX/MZ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VGDD with VGDD-Link MPLAB X IDE Plug In (VGDD-Link Plug In requires VGDD v9+ and MPLAB X IDE v3.00+)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>MPLAB Harmony Graphics Composer (requires MPLAB X IDE v3.00+)</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Microchip Graphics Solutions

These tables show 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

<table>
<thead>
<tr>
<th>Starter Kits</th>
<th>MLA Graphics Library v3.XX (PIC24/dsPIC/PIC32MX)</th>
<th>MLA Graphics Library v4.00+ (PIC24/dsPIC)</th>
<th>MPLAB® Harmony v1.03 and older (PIC32MX/MZ)</th>
<th>MPLAB Harmony v1.04+ (PIC32MX/MZ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PIC32 Starter Kit (DM320001)</td>
<td>Graphics Controller PICtail™ Plus SSD1926 Board (AC164127-5)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>PIC32 USB Starter Kit II (DM320003-2)</td>
<td>Graphics Controller PICtail™ Plus Epson SSD13517 Board (AC164127-7)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>PIC32 USB Starter Kit III (DM320003-3)</td>
<td>Graphics Controller PICtail™ Plus Epson SSD13517 Daughter Board (AC164144)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>PIC24E USB Starter Kit (DM240012)</td>
<td>Multimedia Expansion Board (DM320005)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>dsPIC33E USB Starter Kit (DM320012)</td>
<td>Multimedia Expansion Board II (DM320005-2)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

Notes:
1. SSD1926 supports up to WQVGA (480 x 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

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PIC24FJ256DA210 Development Board (DM240312)</strong></td>
<td>✓ (4)</td>
<td>✓ (5)</td>
<td>✓ (3)</td>
<td>–</td>
<td>✓ (2)</td>
</tr>
<tr>
<td><strong>Graphics LCD Controller PICtail Plus SSD1926 Board (AC164127-5)</strong></td>
<td>PIC24F PIMs</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>PIC32MX PIMs</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>PIC32MZ PIM</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>PIC24EP and dsPIC33P PIMs</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>PIC24H and dsPIC33F PIMs</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>–</td>
</tr>
<tr>
<td><strong>Graphics Controller PICtail Plus Epson S1D13517 Board (AC164127-7)</strong></td>
<td>PIC24F PIMs</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>PIC32MX PIMs</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>PIC32MZ PIM</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>PIC24EP and dsPIC33E PIMs</td>
<td>✓+</td>
<td>✓+</td>
<td>✓+</td>
<td>✓+</td>
</tr>
<tr>
<td></td>
<td>PIC24H and dsPIC33F PIMs</td>
<td>✓+</td>
<td>✓+</td>
<td>✓+</td>
<td>✓+</td>
</tr>
<tr>
<td><strong>Low-Cost Controllerless (LCC) Graphics PICtail Plus Daughter Board (AC164144)</strong></td>
<td>PIC24F PIMs</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>PIC32MX PIMs</td>
<td>✓</td>
<td>✓ (4)</td>
<td>✓</td>
<td>✓ (3)</td>
</tr>
<tr>
<td></td>
<td>PIC32MZ PIM</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>PIC24H and dsPIC33F PIMs</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
</tbody>
</table>

✓ = 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.

### Stand-Alone Development Boards

<table>
<thead>
<tr>
<th>Development Board</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remote Control Demo Board with ZENA™ Wireless Adapter (DM240315-2)</td>
<td>Stand-alone development board with built-in display that comes with the ZENA Wireless Adapter.</td>
</tr>
<tr>
<td>MPLAB® Starter Kit for PIC24H MCUs (DM240021)</td>
<td>Stand-alone development board with a built-in display.</td>
</tr>
<tr>
<td>MPLAB Starter Kit for PIC24F MCUs (DM240011)</td>
<td>Stand-alone development board with a built-in display.</td>
</tr>
</tbody>
</table>
| PIC24F PIMs | PIC24FJ128GA010 PIM (MA240011)  
PIC24FJ256GA110 PIM (MA240015)  
PIC24FJ256GB110 PIM (MA240014)  
PIC24FJ256GB210 PIM (MA240021) |
| PIC32MZ and PIC32MX PIMs | PIC32MX360F512L PIM (MA320001)  
PIC32MX460F512L PIM (MA320002)  
PIC32MX795F512L PIM (MA320003)  
PIC32MX450/470 PIM (MA320002-2)  
PIC32MZ EF PIM (MA320019) |
| PIC24EP and dsPIC33EP PIMs | dsPIC33EP512MU810 PIM (MA330025-1)  
PIC24EP512GU810 PIM (MA240025-1) |
| PIC24H and dsPIC33F PIMs | PIC24HJ128GP504 PIM (MA240016-2)  
dsPIC33FJ128GP804 PIM (MA330019-2) |
Support
Microchip is committed to supporting its customers in developing products faster and more efficiently. We maintain a worldwide network of field applications engineers and technical support ready to provide product and system assistance. In addition, the following service areas are available at www.microchip.com:

- **Support** link provides a way to get questions answered fast: [http://support.microchip.com](http://support.microchip.com)
- **Sample** link offers evaluation samples of any Microchip device: [http://sample.microchip.com](http://sample.microchip.com)
- **Forum** link provides access to knowledge base and peer help: [http://forum.microchip.com](http://forum.microchip.com)
- **Buy** link provides locations of Microchip Sales Channel Partners: [www.microchip.com/sales](http://www.microchip.com/sales)

Training
If additional training interests you, then Microchip can help. We continue to expand our technical training options, offering a growing list of courses and in-depth curriculum locally, as well as significant online resources – whenever you want to use them.

- Technical Training Centers and Other Resources: [www.microchip.com/training](http://www.microchip.com/training)
- MASTERS Conferences: [www.microchip.com/masters](http://www.microchip.com/masters)
- Worldwide Seminars: [www.microchip.com/seminars](http://www.microchip.com/seminars)
- eLearning: [www.microchip.com/webseminars](http://www.microchip.com/webseminars)

Sales Office Listing

**AMERICAS**

- **Atlanta**
  Tel: 678-957-9614
- **Austin**
  Tel: 512-257-3370
- **Boston**
  Tel: 774-760-0087
- **Chandler**
  Tel: 480-792-7200
- **Chicago**
  Tel: 630-285-0071
- **Cleveland**
  Tel: 216-447-0464
- **Dallas**
  Tel: 972-818-7423
- **Detroit**
  Tel: 248-848-4000
- **Houston**
  Tel: 281-894-5983
- **Indianapolis**
  Tel: 317-773-8323
- **Los Angeles**
  Tel: 814-5-934-9482
- **New York**
  Tel: 631-435-6000
- **San Jose**
  Tel: 408-735-9110
- **Toronto**
  Tel: 905-673-0699

**EUROPE**

- **Austria - Wels**
  Tel: 43-7242-2244-39
- **Denmark - Copenhagen**
  Tel: 45-4450-2828
- **France - Paris**
  Tel: 33-1-69-53-63-20
- **Germany - Dusseldorf**
  Tel: 49-2129-3766400
- **Germany - Karlsruhe**
  Tel: 49-721-625370
- **Germany - Munich**
  Tel: 49-89-627-144-0
- **Italy - Milan**
  Tel: 39-0331-742611
- **Italy - Venice**
  Tel: 39-049-7625286
- **Netherlands - Drunen**
  Tel: 31-416-690399
- **Poland - Warsaw**
  Tel: 48-22-3325737
- **Spain - Madrid**
  Tel: 34-91-708-08-90
- **Sweden - Stockholm**
  Tel: 46-8-5090-4654
- **UK - Wokingham**
  Tel: 44-118-921-5800

**ASIA/PACIFIC**

- **Australia - Sydney**
  Tel: 61-2-9868-6733
- **China - Beijing**
  Tel: 86-10-8569-7000
- **China - Chengdu**
  Tel: 86-28-8665-5511
- **China - Chongqing**
  Tel: 86-23-8980-9588
- **China - Hangzhou**
  Tel: 86-571-8792-8115
- **China - Hong Kong SAR**
  Tel: 852-2943-5100
- **China - Nanjing**
  Tel: 86-25-8473-2460
- **China - Qingdao**
  Tel: 86-532-8502-7355
- **China - Shangai**
  Tel: 86-21-5407-5549
- **China - Shenzhen**
  Tel: 86-755-8864-2200
- **China - Wuhan**
  Tel: 86-27-5980-5300
- **China - Xiamen**
  Tel: 86-592-2388138
- **China - Xian**
  Tel: 86-22-3837-7252
- **China - Zhuhai**
  Tel: 86-756-321-0040

**ASIA/PACIFIC**

- **India - Bangalore**
  Tel: 91-80-3090-4444
- **India - New Delhi**
  Tel: 91-11-4160-8631
- **India - Pune**
  Tel: 91-20-3019-1500
- **Japan - Osaka**
  Tel: 81-6-6152-7160
- **Japan - Tokyo**
  Tel: 81-3-6880-3770
- **Korea - Daegu**
  Tel: 82-53-744-4301
- **Korea - Seoul**
  Tel: 82-2-554-7200
- **Malaysia - Kuala Lumpur**
  Tel: 60-3-6201-9857
- **Malaysia - Penang**
  Tel: 60-4-227-8870
- **Philippines - Manila**
  Tel: 63-2-634-9065
- **Singapore**
  Tel: 65-6334-8870
- **Taiwan - Hsin Chu**
  Tel: 886-3-577-8366
- **Taiwan - Kaohsiung**
  Tel: 886-7-213-7830
- **Taiwan - Taipei**
  Tel: 886-2-2508-8600
- **Thailand - Bangkok**
  Tel: 66-2-694-1351

Microcontrollers • Digital Signal Controllers • Analog • Memory • Wireless

www.microchip.com

Microchip Technology Inc.
2355 W. Chandler Blvd.
Chandler, AZ 85224-6199