



Human Interface Solutions



Graphics Display

Touch Sensing

Segmented LCD

Audio

Human Interface Solutions

Adding a modern, intuitive user interface to your design improves its ease-of-use, functionality and aesthetics. Graphics displays, touch interactivity and audio prompts add a modern, updated look and feel to any design.



Engineering teams that are tasked with creating human interfaces for new or legacy designs need solutions that create a high-impact user interface incorporating the latest in touch sensing and graphical display technologies. These solutions must be easy to integrate and lower total system cost.

Touch sensing interfaces such as keys/sliders and touch screens are fast becoming an alternative to traditional push button switch user interfaces owing to their many benefits – elegant and stylish designs, lower manufacturing costs achieved by lowering costs of molds, tooling and assembly, and increased reliability via fewer moving components. Application designers migrating to touch sensing interfaces require robust, low-cost and power-efficient solutions that are easy to integrate.

Digital displays improve the user interface of just about any application. Segmented LCDs have historically been a popular choice of display technology and continue 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 case 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.

Key Highlights

TOUCH SENSING SOLUTIONS

Keys & Sliders

- Longer battery life with eXtreme Low Power MCUs
- Sensing through metal, plastic or glass
- High noise immunity and low emissions
- Lower system cost with broad MCU portfolio
- Free software library enables easy integration and touch-sensing GUI speeds up development
- Get started quickly with low cost development kits

Touch Screen Controllers

- Turnkey analog resistive controllers for lowest system cost
- Highly flexible projected capacitive solution with low cost MCU implementation
- Fully processed and reliable touch coordinates
- Multi-touch and gesture capable
- Low power solutions with wide operating voltage
- Royalty-free source code solutions with complete starter kits

DISPLAY CONTROLLER SOLUTIONS

Segmented LCD

- Direct drive of inexpensive displays
- Up to 192 segments
- Integrated analog for sensor applications like temperature sensing in thermostats
- Integrated touch sensing function

Graphical Displays

- Up to WVGA (800x480) resolution
- Up to 24 bit per pixel
- Free Graphics Library and Graphics Display Designer GUI
- PIC24 “DA” family features integrated graphics acceleration and display controller
- High performance 32-bit MCUs with integrated Ethernet and CAN for remote interfaces
- Integrated USB OTG and mTouch sensing

AUDIO PROCESSING SOLUTIONS

- Generation of tones, alarms and musical notes
- Recording and playback of audio information
- Graphic equalizer

mTouch Solutions – Keys & Sliders

Expanding beyond the consumer market, touch sensing is now taking hold in medical, industrial and automotive applications. Examples include:

- Battery applications: automotive, cell phones, medical devices, remote controls and thermostats
- Line-powered applications: home appliances, printers, set top boxes, smart energy monitors and television

Microchip offers a broad portfolio of low power, low cost and flexible solutions to enable two types of touch-sensitive interfaces:

- Keys and sliders
- Touch screen controllers

mTouch™ Solutions – Keys and Sliders



User interfaces with push buttons have several moving parts which significantly decrease the reliability. They also require complex design and assembly as well as a major investment

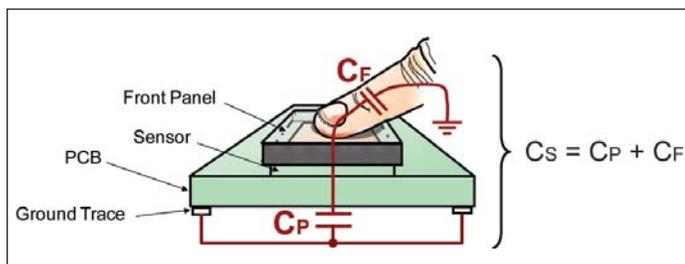
in tooling. Capacitive Touch technologies allow designers to create a high impact user interface at a lower total system cost. mTouch solutions provide a free and easy method for designers to add touch sensing keys to applications utilizing PIC® MCUs. You can integrate touch sensing functionality with your application code in a single, standard microcontroller, thus reducing the total system cost.

Capacitive Touch Sensing

How Capacitive Touch Sensing Works?

A capacitor is simply two electrically isolated conductors which are in close proximity to one another. The conductors can be wires, traces on a PCB or even the human body.

The capacitive touch sensor is a copper pad area, that is capacitively coupled to grounds located elsewhere in the system creating a parasitic capacitance. A covering plate material such as glass is used to provide the user touch surface. The introduction of the user's finger then produces an increase in capacitance which will be detected by the system.



Lowest Power Capacitive Sensing

mTouch solutions offer longer battery life and lower standby current. Using award-winning eXtreme Low Power technology, mTouch solutions bring you the industry's lowest power consumption for touch-sensing.

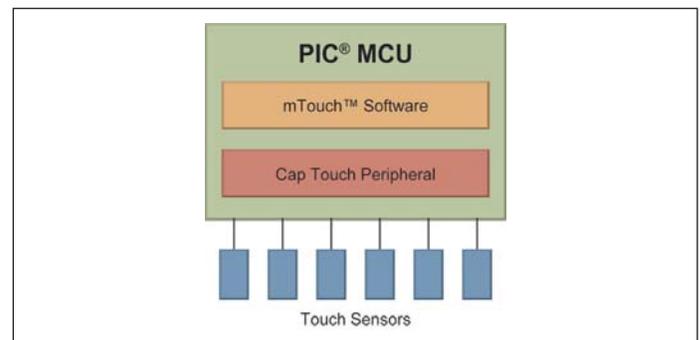
- Capacitive sensing in less than 5 µA
- Proximity sensing down to 1 µA
- MCU Sleep current down to 9 nA
- MCU Active current down to 50 µA/MHz
- MCU Real-time Clock down to 470 nA

Broad MCU Portfolio for Capacitive Sensing

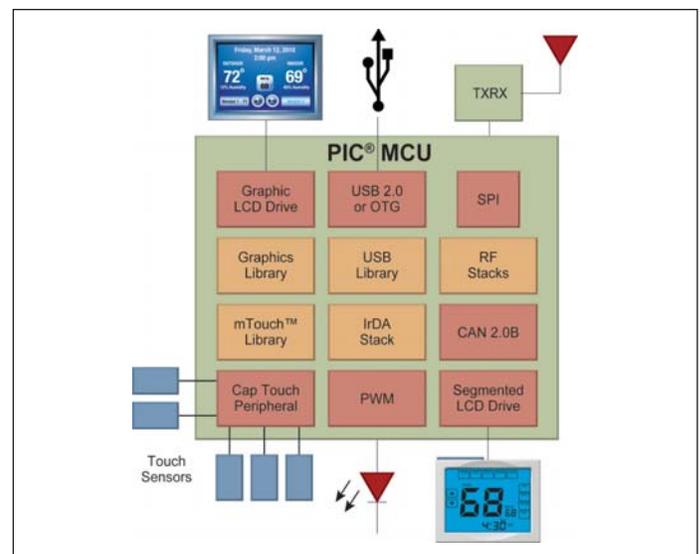
Microchip offers a variety of PIC MCUs enabling you to dedicate an MCU for touch function or integrate touch sensing with other application functions onto a single MCU:

- 8, 16 and 32-bit PIC MCUs for touch sensing
- 6-pin to over 100-pin devices
- Up to 512 KB Flash memory
- High noise immunity and low emissions: IEC61000, EFT, BCI
- On-chip integration options include USB, CAN, IrDA, wireless protocol stack, segmented LCD and graphics accelerator and LCD driver for TFT/STN displays
- Up to 32 capacitive touch channels
- No external components needed

Dedicated Touch Controllers (PIC10/12/16/18)



Highly Integrated Touch Controllers (PIC16/18/24/32)



mTouch Solutions – Capacitive Sensing for Keys & Sliders

Development Tools for Capacitive Touch

Enhanced mTouch Capacitive Evaluation Kit (DM183026-2)



The Enhanced mTouch Capacitive Evaluation Kit provides a simple platform for developing a variety of capacitive touch sense applications using 8, 16 and 32-bit PIC microcontrollers. The kit contains:

- 8-key sensor board direct interface
- 12-key matrix sensor board
- 4-channel slider sensor board
- 2-channel slider sensor board
- Four PIC MCU processor boards:
 - PIC16F1937
 - PIC18F46J50
 - PIC24FJ64GB106
 - PIC32MX795F512H
- Diagnostic GUI to analyze touch sensor data real-time via USB
- PICkit™ Serial Analyzer

In addition, a separate processor board – the PIC24H mTouch Capacitive Touch Evaluation Board* (AC243026) is available and enables the PIC24H family to work with the Enhanced mTouch Capacitive Evaluation Kit.

mTouch Capacitive Touch Software Package

The mTouch Software Package enables designers to easily integrate touch technologies into their application. It allows the implementation in a small dedicated controller as well as integrating the complete application in a single MCU. Two packages are available depending on the microcontroller: mTouch PIC16F Framework or mTouch PIC18/24/32 library.

Software package features include:

- Multiple demo projects
 - Swiping gesture
 - Proximity detection
 - Direct key sensing
 - Matrix key sensing
 - 2-channel sliders
 - 4-channel sliders
 - Graphics integration with keys (runs on DM240312 board)
 - Interoperability with Microchip Graphics and USB libraries
- Demo projects can be run directly on the enhanced mTouch Capacitive Evaluation Kit.

Application Notes for Capacitive Touch

- *Techniques for Robust Capacitive Touch Sensing*, AN1334
- *mTouch™ Metal Over Cap Technology*, AN1325
- *mTouch Conducted Noise Immunity Techniques for CTMU Peripheral*, AN1317
- *Capacitive Touch Using Only an ADC (CVD) (suitable for PIC10/12/16/24H/32 MCUs)*, AN1298
- *Microchip CTMU for Capacitive Touch Applications (suitable for PIC18 and PIC24F MCUs)*, AN1250
- *Capacitive Touch Algorithm Simulation*, AN1254

*Code also supports dsPIC33 DSC.

mTouch Solutions – Metal Over Cap Technology For Keys

Metal Over Cap Technology



mTouch capacitive touch solutions allow users to work with a variety of plastic or glass overlays to finish their user interface designs. With metal over cap technology users can also:

- Use polished or brushed metal surfaces including stainless steel and aluminium
- Sense through gloves
- Create water-proof designs
- Deploy Braille-friendly interfaces

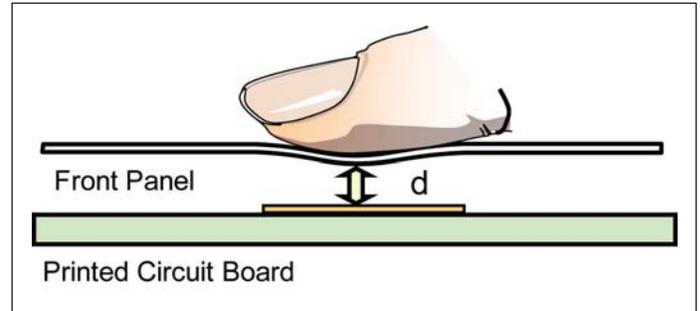
How Metal Over Cap Technology Works



The front panel and the sensor create a capacitor. When the user presses the key, the distance between both plates will decrease slightly, increasing the capacitor value. Thanks to their high SNR (Signal to Noise Ratio) and stability over voltage and temperature, Capacitive

Voltage Divider (CVD) and Charge Time Measurement Unit (CTMU) techniques allow the detection of deflection as low as 10 μm .

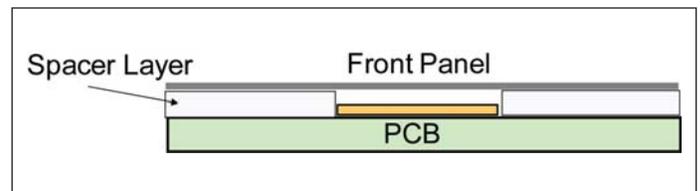
Metal Over Cap Technology can be implemented with the same hardware, PCB and electronics, and SW as capacitive touch technology.



Mechanical Construction

The only difference in mechanical construction between designing a capacitive touch interface and an interface that uses Metal Over Cap technology is the introduction of a spacer layer to allow the deflection of the front panel.

- The spacer layer should be non-deformable
- Thickness of the spacer layer should be between 50 μm and 150 μm
- Commonly used materials for the spacer layer include glue, FR4 or mylar



Getting Started with Metal Over Cap Technology

- Download App Note *mTouch™ Metal Over Cap Technology AN1325*
- Download the Metal Over Cap deflection tool

mTouch Solutions – Analog Resistive Touch Screen Controllers



Microchip offers a broad portfolio of touch screen controller solutions for resistive and projected capacitive applications that make it easy to add touch to your design without extensive development time, risk or cost.

Microchip's advanced touch screen controllers offer:

- High flexibility, low cost, low power
 - To reduce total system cost and increase flexibility
- Sophisticated, proprietary touch screen decoding algorithms
 - To send your application fully processed and reliable touch coordinates

Projected Capacitive vs. Resistive

Microchip offers resistive and projected capacitive solutions to allow you to choose the best fit for your touch screen design.

- Projected capacitive technology provides high durability, good optics and multi-touch capability which enables gestures
- Resistive touch is a good choice for a low cost, easy to integrate solution that accepts finger, stylus or glove input

Touch Screen Technology Comparison

	Analog Resistive	Projected Capacitive
Cost for screen < 6"	Lowest	Low
Cost for screen > 10"	Lowest	High
Optics	75%	90%
Screen Life	Good	Better
Ease of Integration	Easy	Moderate
Multi-Touch	Limited	Yes
Touch Object	Finger, Stylus/Glove	Finger

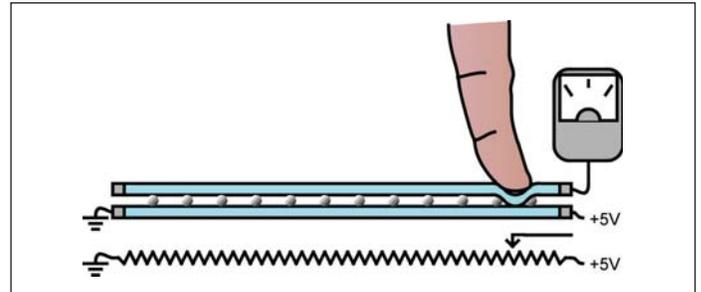
Analog Resistive Touch Screen Controllers

Microchip's AR1000 Analog Resistive touch screen controller solutions feature:

- Turnkey touch solution
- Built in decoding and advanced filtering
- Controller driven calibration
- Power-saving Sleep and Wake modes
- Low cost with few external components
- Universal 4, 5 and 8-wire support
- 4x4 QFN package
- SPI, I²C™, UART or USB interfaces

How Analog Resistive Works

- Two conductive coated polyester layers separated by a spacer layer
- When touched, top (flex) layer moves past spacer layer and contacts bottom (stable) layer
- Point of contact creates voltage divider in the X and Y directions



Development Tools for Resistive Touch

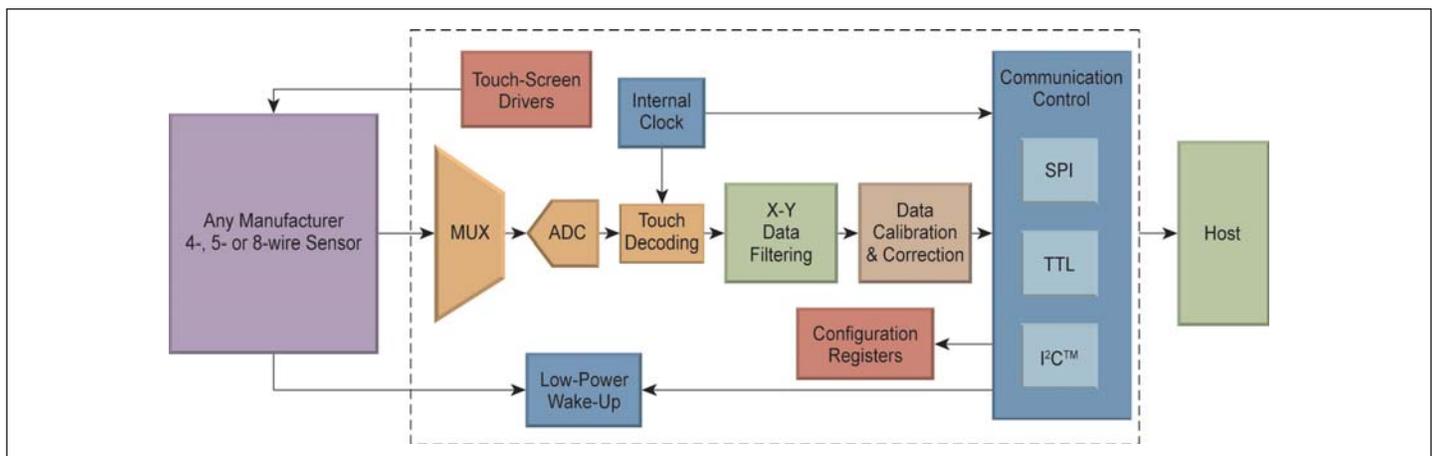
AR1000 Analog Resistive Development Kit (DV102011)

Provides everything designers need to get started:



- AR1020 development board
- 7" four-wire touch screen
- PICkit Serial Analyzer
- Technical documentation CD
- GUI-enabled AR1000 configuration utility

mTouch AR1000 Series Resistive Touch Screen Controllers



mTouch Solutions – Projected Capacitive Touch Screen Controllers

Projected Capacitive Touch Screen Solution

Microchip's mTouch projected capacitive touch screen sensing technology has the following features:

- Supports 3.5" touch screen, independent XY tracking for two touches in real time
- Gesture capable
- Royalty-free source code supports sensors with up to 32 channels
- Fast response time of <15 ms typical
- Report rate of 65 pps single, 55 pps dual
- Low operating power 1.5 mA typical
- Wide operating voltage 1.8V-5.5V
- 40-pin 5x5 mm uQFN package
- UART communication
- Auto adjusts for environmental changes (baseline, calibrate, drift)

How Projected Capacitive Works

- One or two thin layers of glass patterned with conductive coating, typically Indium Tin Oxide (ITO)
- Screen is configured as rows and columns
- Point of contact identified by change in capacitance of row and column cells



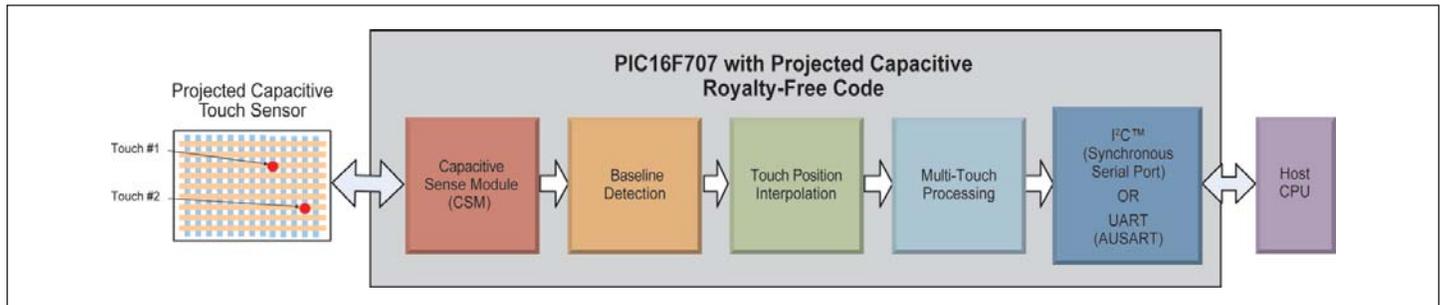
Development Tools for Projected Capacitive Touch

Projected Capacitive Development Kit (DM160211)

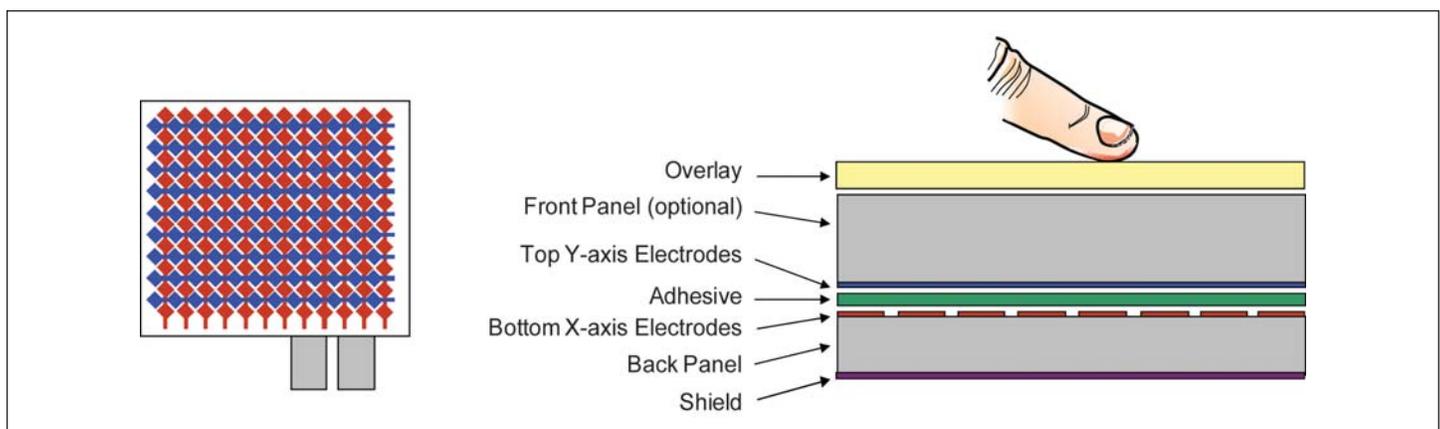


- Projected capacitive board with fully functional firmware on PIC16F707
- Includes sensor board with 3.5" projected capacitive 12" x 9" touch screen
- GUI-enabled projected capacitive configuration utility

PIC16F707 Programmed with Projected Capacitive Source Code



Implementation of Projected Capacitive Touch



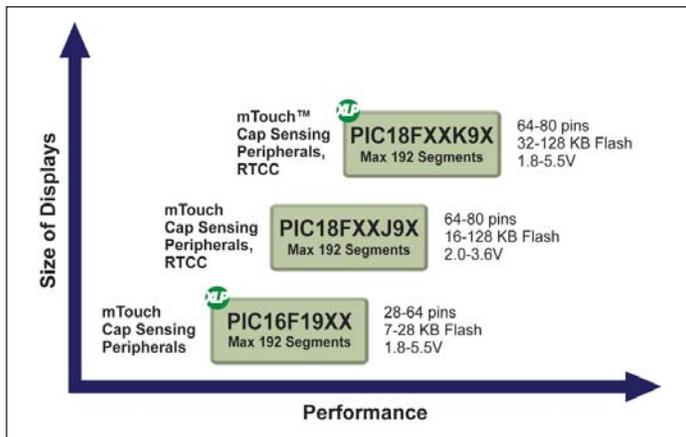
Display Controller Solutions – Segmented LCD

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 60 segments
 - 44 pins - up to 96 segments
 - 64 pins - up to 184 segments
 - 80 pins - up to 192 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 V_{DD} or beyond if you are using one of the MCUs with an integrated charge pump. Software contrast control allows the designer to vary the contrast on the LCD to account for different operating conditions such as temperature, lighting and humidity. Also, software contrast control can 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 seeing a crisp image on the display.

Development Tools for Segmented LCD

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)

Application Notes for LCD Displays

- *Interfacing PIC® MCUs to an LCD Module*, AN587
- *Low-Power Real Time Clock*, AN582
- *Four Channel Digital Voltmeter with Display and Keyboard*, AN557

Display Controller 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.

FREE Microchip Graphics Library

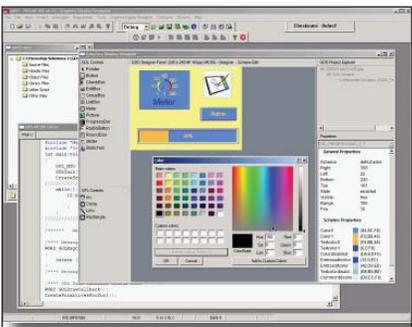


The Microchip Graphics Library is highly modular and is optimized for Microchip’s 16- and 32-bit microcontrollers. It is easy to use and has an open

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
- Includes buttons, charts, check boxes, scroll bars, list boxes, images and basic animation

FREE Microchip Graphics Display Designer



The Microchip Graphics Display Designer (GDD) is a visual design tool that provides customers with a quick and easy way of creating Graphical User Interface (GUI) screens for graphical interface applications on Microchip MCUs.

It provides the following advantages to the developers:

- Simplifies coding for the GUI screens with an ability to draw, resize and delete screen objects
- Eliminates the need to manually calculate the X/Y coordinates for on-screen object placements

- Generates output source files
- Ability to import various graphical resources, including custom fonts and bitmap images

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 96KB on chip
- PIC32 MCUs support up to 123KB on chip
- External SRAM can be used for larger frame buffers
- For advanced graphics, external graphics controllers have additional frame buffer storage

Display Resolution Typical Sizes			Color Depth/ Memory Requirement in (bytes)				
			1 bpp (Mono)	2 bpp (4 shades)	4 bpp (16 shades)	8 bpp (256 colors)	16 bpp (65K colors)
WVGA	800x480	7"	48,000	96,000	192,000	384,000	768,000
VGA	640x480	5.7"	38,400	76,800	153,600	307,200	614,400
WQVGA	480x272	4.3"	16,320	32,640	65,280	130,560	261,120
QVGA	320x240	3.2"	9,600	19,200	38,400	76,800	153,600
Common for OLED	128x64	1"-2.7"	1,024	2,048	4,096	8,192	16,384

Internal SRAM External SRAM

Target Applications

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

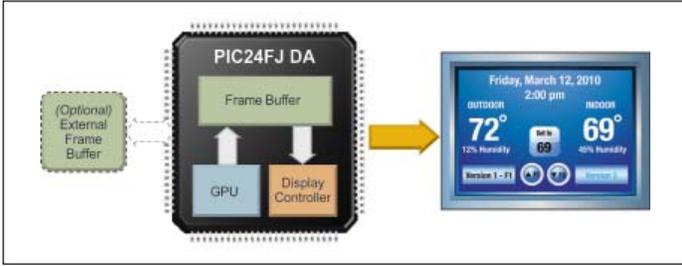
- Consumer:** Thermostats, Cordless Phones, Remote Controls
- Home Appliance:** Coffee Makers, Washing Machines, Ovens
- Industrial:** Digital Instrument Gauges, Storage Controls, Remote Terminals
- Portable Medical:** Glucometers, Blood-Pressure Monitors, Portable ECGs

Application Notes 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

Graphical Display Configurations

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

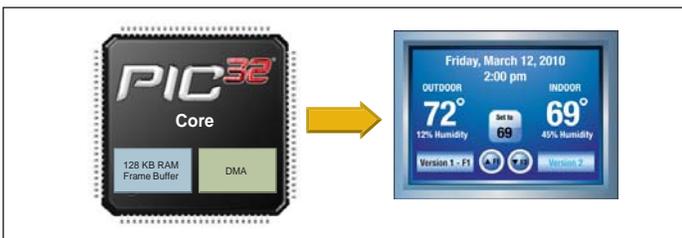


The PIC24F “DA” family makes it easy and cost-effective to add advanced graphics to your application by eliminating the need for external frame buffers or display controllers.

- 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 CPI 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



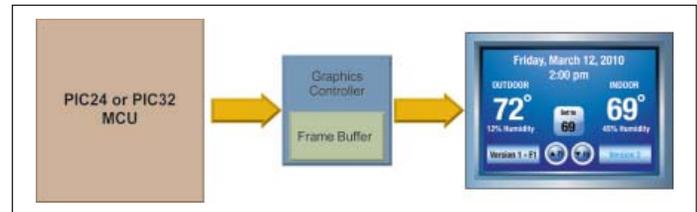
Microchip’s PIC32 line of 32-bit microcontrollers offers 80 MIPS and high performance DMA to render graphics directly to displays. This enables PIC32 devices to drive a display without an external graphics controller.

- Uses <5 MIPS and DMA to render graphics
 - Direct interface to STN, TFT displays
- Integrated 128 KB frame buffer
 - Supports QVGA 8 bpp with internal frame buffer
 - Supports WQVGA 16 bpp with external frame buffer using PMP (Parallel Master Port)
- Works with any PIC32 80 MIPS 32-bit microcontroller

With devices offering up to 512 KB Flash and 128 KB RAM, developers have 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 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.



The Solomon SSD1926 Graphics Controller has hardware graphics acceleration to free up the MIPS of the PIC MCU. This controller includes a 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 (800x480) 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 or PIC32 Starter Kits.

	PIC24 “DA” Integrated Graphics Controller	PIC32 Controllerless Graphics	External Solomon Graphics Controller SSD1926	External Epson Graphics Controller S1D13517
Display*	WQVGA 480x272	WQVGA 480x272	WQVGA 480x272	WVGA 800x480
Graphics	HW Acceleration: Rectangles, Characters, Images	DMA on PIC32 + <5 MIPS	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	128 KB on MCU + Ext SRAM	256 KB on Solomon Controller	Ext SDRAM
Core MIPS	16	80	–	–
Power	Better	Good	Good	Good
Cost	\$	\$	\$\$	\$\$\$

*Max size at 16 bpp, 60 Hz

Tools for Designing Graphical Displays

Development Tools for Graphical Display Controllers

Low Cost Solution Without External Graphics Controller



PIC24FJ256DA210 Board (DM240312)



Low-Cost Controllerless Graphics PICTail™ (AC164144)

Solutions with External Graphics Controllers



Graphics LCD Controller PICTail™ Plus SSD1926 Board (AC164127-5) (Includes Solomon SSD1926 Controller)



Graphics Controller PICTail™ Plus Epson S1D13517 Board (AC164127-7)



Multimedia Expansion Board (DM320005) (Includes Solomon SSD1926 Controller)

Family	Display Boards Supported				
	QVGA 3.2" Graphics Display Truly 240x320 Board (AC164127-4)	WQVGA 4.3" Graphics Display Powertip 480x272 Board (AC164127-6)	VGA 5.7" Graphics Display Truly 640x480 Board (AC164127-8)	WVGA 7" Graphics Display Truly 800x480 Board (AC164127-9)	Prototype Boards Connect Your Glass (AC164139)
PIC24 "DA" Family	PIC24FJ256DA210 Board (DM240312) + Display Board				Yes
PIC32 "LCC" Graphics	PIC32 Starter Kit (DM320001 or DM320003) + LCC Graphics Board (AC164144) + Display Board				Yes
PIC24 + Solomon SSD1926	Explorer 16 (DM240001) + Solomon GFX Board (AC164127-5) + Display Board				Yes
PIC32 + Solomon SSD1926	PIC32 Starter Kit (DM320001 or DM320003) + Multimedia Expansion Board (DM320005) Display Integrated on MEB				
PIC32 + Solomon SSD1926	PIC32 Starter Kit (DM320001 or DM320003) + Solomon GFX Board (AC164127-5) + Display Board				Yes
PIC24 + Epson S1D13517	Explorer 16 (DM240001) + Epson GFX Board (AC164127-7) + Display Board				Yes
PIC32 + Epson S1D13517	PIC32 Starter Kit (DM320001 or DM320003) + Epson GFX Board (AC164127-7) + Display Board				Yes

Speech & Audio Solutions

Adding audio capability, whether in the form of music playback or voice guidance, greatly improves the user experience of a product. Audio is useful in product language localization and providing assistance to the visually impaired. Audio prompts are very useful in applications requiring the end users visual attention elsewhere, such as automotive.

Microchip's microcontroller and digital signal controller products, software and tools allow the designer to include speech or audio interfaces, enabling functions such as:

- Generation of tones, alarms and musical notes
- Recording and playback of audio information

Featured Products

Most 8/16/32-bit PIC microcontrollers can generate tones, alarms and musical notes in various applications. The dsPIC DSCs and PIC32 MCUs have DSP libraries included in their respective compilers to enable higher performance and more efficient processing of high quality audio. The dsPIC DSCs offer certain specialized peripherals for audio applications, including:

- 16-bit D/A Converter
- Codec/Data Converter (I²S) Interface module

Microchip also offers a wide portfolio of low power, high performance operational amplifiers which can be used to buffer audio signals or drive small speakers.

Audio Application Support

Functions	Development Board	Accessories	Device Families Supported	Libraries Supported
Recording & Playback	MPLAB Starter Kit for dsPIC DSC (DM330011)	—	dsPIC33F DSC	ADPCM G711, G726A, Speex, dsPIC DSC Automatic Gain Control Library
Recording & Playback	Explorer 16 Development Board (DM240001)	Audio PICTail™ Plus Daughter Board (record & playback) (AC164129)	PIC24F, PIC24H, PIC32 MCUs, dsPIC33F DSC	ADPCM G711, G726A, Speex, Audio Library for PIC32MX, dsPIC DSC Speech and Audio Fast Forward (SAFF) Tool, dsPIC DSC Automatic Gain Control Library
Playback	Explorer 16 Development Board (DM240001)	Speech Playback PICTail Plus Daughter Board (AC164125)	PIC24F, PIC24H, PIC32 MCUs, dsPIC33F DSC	G711, G726A, Speex, Audio Library for PIC32MX, dsPIC DSC Speech and Audio Fast Forward (SAFF) Tool
Recording & Playback	Audio Development Board for PIC32 MCUs (AC320011)	Accessory development Platform for iPod/iPhone	PIC32 MCUs	G711, G726A, Speex, Audio Library for PIC32MX, MP3 Audio Decode, Sample Rate Conversion

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