SENSOR FUSION IS IN YOUR HANDS

SSC7102 SENSOR HUB

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chipKIT
SOFTWARE
KOOLTHINGS
USB KEYPAD
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The new SSC7102 sensor hub makes implementing sensor fusion in the latest Windows® 8-based handheld devices easy

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Are You Ready for the Internet of Things?

Although the idea has been around for years, it seems like momentum is building around bringing the Internet of Things (IoT) fully into reality. In a flurry of activity, many potential players—from large corporations to start-up companies to hobbyists—are coming out with creative concepts and actual physical products designed to connect and interact with each other over the Internet. In an article entitled, "The Next Big Thing for Tech: The Internet of Everything," which appeared on Time.com, author Tim Bajarin noted that it was difficult to find a product that didn’t offer some type of connectivity at the recent CES 2014.

This burst of product innovation has been enabled in part by recent advances in wireless connectivity and Cloud computing. Also, it is becoming easier and less expensive to produce hardware. Many IoT innovators are turning to crowdfunding sites like Kickstarter and Indiegogo to give their projects the financial boost they need to come fully into production. Added to this, advancements in the semiconductor and sensors markets are making what seemed impossible to do just several years ago now possible, in the smaller form factors necessary for the newest space-constrained designs.

In this issue of MicroSolutions, you’ll learn how our new Sensor Hub makes implementing sensor fusion easy for the next generation of mobile devices, including those intended for IoT applications. You’ll also find out how a PIC® MCU plays a significant role in the design of the “iWanditAll” KoolThings platform, a multi-sensor iOS- and Android™-based platform which that leverages the IoT to help consumers integrate and connect their wireless gadgets together into one easy-to-use system. Microchip is ready to offer you solutions and provide the design support you need to develop your new IoT product too.

As always, we would be happy to get your feedback on MicroSolutions. Feel free to email us at MSFeedback@microchip.com.

Find us on these social channels:
Sensor technology has evolved rapidly in a relatively short time. Due to their increased sophistication, low cost and small size, sensors are now being integrated into a vast array of products. IHS iSuppli predicts that more than 6 billion motion sensors are expected to ship in mobile handsets and tablets by 2016. The next generation of devices will require sensors that provide complex information about the surrounding environment and user activities to offer more customized, user-friendly and enjoyable solutions for computing, mobile, gaming, healthcare, fitness, industrial systems, Internet of Things and a myriad of other evolving applications.

Position and motion data is obtained from motion sensors such as accelerometers, magnetometers, and gyroscopes. Other information comes from environmental sensors which measure light, temperature, humidity, and pressure. Designers of leading-edge products need a flexible and easy solution to allow them to combine or “fuse” an abundance of data from multiple sensors and process it to provide important information to the system.

The new SSC7102 is a low-power, flexible and turnkey sensor hub that makes implementing sensor fusion in mobile devices easy and provides an extremely large selection of supported sensors. We have directly partnered with multiple industry-leading sensor manufacturers and sensor-fusion specialists to create this solution, enabling faster time to market without the need for sensor-fusion expertise. The SSC7102 is also extremely efficient. It consumes ~4 mA while running complex sensor-fusion algorithms, resulting in longer battery life for Windows 8.1 tablets, laptops, ultrabooks and smartphones.

Microchip has long been a leader in embedded controllers for PCs and laptops. As the PC platform evolves with ultrabooks and tablets, we are extending our product portfolio to support the growing need for processing motion data. In developing the SSC7102, we partnered with industry-leading companies such as Bosch and Movea to deliver an easy-to-use, Windows 8.1-certified HID-over-I^2C™ solution with exceptionally low power consumption.

Samples of the SSC7102 sensor hub—which comes in a 6 x 6 mm body BGA package—are available from your Microchip sales representative. The Bosch version is in production now and the Movea version will be in production by the end of this quarter. Visit our Sensor Hub page at www.microchip.com/sensorhub for additional information.
Small and Fast

New 5 GHz 50Ω Matched WLAN Front End Module Is Ideal for Space-Constrained IEEE 802.11a/n/ac Applications

High-Efficiency and Compact SST11LF04 Provides Ultra-High Data Rate for Mobile Device, Multi-Channel Access Point/Routers and Set-Top Box Equipment

S\underline{m}aller board sizes mean that designers of space-constrained applications such as mobile devices, multi-channel access point/routers and set-top boxes need more compact and yet highly reliable solutions. Building on our strong position in the WLAN market, our new SST11LF04 5 GHz, 50Ω Matched WLAN Front End Module (FEM) offers the same reliability combined with high-power efficiencies of our RF power amplifiers in a compact 2.5 x 2.5 x 0.4 mm, 16-pin QFN package.

The SST11LF04 features a transmitter power amplifier, a receiver low-noise amplifier with bypass and a low-loss, single-pole two-throw antenna switch for 5 GHz WLAN connectivity, making it ideal for high-data-rate mobile device applications. With its small footprint, high linear output power of up to 16 dBm and 17 dBm, at 3.3V and 5V Vcc respectively—for 1.75% dynamic EVM using MCS9-HT80 modulation and 80 MHz bandwidth along with 18 dBm and 19 dBm linear power for 3% EVM at 3.3V and 5V, respectively—the SST11LF04 extends the range of IEEE 802.11a WLAN systems while providing exceptional transmit power at the maximum 11ac high-data-rate modulation.

The receiver has a 12 dB gain and a greater than −6 dBm input (1 dB) compression level. In LNA bypass mode, the receiver has a 2.5 dB noise figure and a −6 dBm input compression level.

The SST11LF04 extends the range of IEEE 802.11a WLAN systems.

This new 5 GHz 50Ω matched FEM enables you to create highly efficient designs with smaller board size requirements, which reduces your time to market. Its high linear power enables 802.11a/n/ac operation and increases data rates, while its small size makes it well-suited for a variety of mobile devices.

Evaluation boards for the SST11LF04 are available through Microchip's sales representatives to support your product development. The SST11LF04 is available from Microchip's worldwide distribution network or it can be ordered from microchipDIRECT.
Tame Your Power-Hungry Designs

MCP39F501 Power Monitoring IC Offers High-Accuracy Signal Acquisition and Power Calculations

Add Advanced Power Monitoring Capabilities to Your Applications with Minimal Effort

Government regulations, technology innovations and end customer expectations are driving the need for better power monitoring solutions in a variety of consumer, commercial and industrial products. In an effort to improve power management schemes in power-hungry applications—such as data centers, lighting and heating systems, industrial equipment and consumer appliances—power-system designers are driving the need for enhanced power monitoring solutions. This includes requirements for better accuracy across current loads, additional power calculations and event monitoring of various power conditions.

Our new MCP39F501 is a highly integrated, single-phase power-monitoring IC designed for real-time measurement of AC power. It includes two 24-bit delta-sigma ADCs, a 16-bit calculation engine, EEPROM and a flexible two-wire interface. An integrated low-drift voltage reference in addition to 94.5 dB of SINAD performance on each measurement channel allows accurate designs with just 0.1% error across a 4000:1 dynamic range.

The MCP39F501 allows you to add power monitoring to your applications with minimal firmware development. Its performance enables designs capable of 0.1% error over a wider dynamic range and superior light load measurement versus current competing solutions. The built-in calculations include active, reactive and apparent power, RMS current and RMS voltage, line frequency, power factor as well as programmable event notifications.

You can use the MCP39F501 to develop high-performance, cost-effective designs for a number of applications, including server and networking power supplies, power distribution units, lighting systems, appliances, smart plugs, power meters, and industrial equipment.

Additionally, with its support for a wide operating temperature range from -40°C to +125°C, the MCP39F501 can be utilized in designs which are intended for more extreme environments, such as industrial machinery applications.

To help you get started with using the MCP39F01 in your power monitoring project, we also offer the MCP39F501 Demonstration Board (ARD00455), which is scheduled to be available in mid-February. You can purchase the MCP39F501 from Microchip’s worldwide distribution network or it can be ordered online from microchipDIRECT.
Wireless, Motors and Internet

New Wi-Fi® Development Board, Motor Control Shield and Internet of Things Cloud Software Added to Arduino™ Compatible chipKIT™ Ecosystem

Hobbyists, makers, students, academics and the engineering community now have more options for using the chipKIT platform in their Arduino-based projects. Two new development tools from Digilent, Inc., and an embedded cloud software framework will help you to learn about and add enhanced features and capabilities to wireless, motor control and Internet of Things (IoT) applications.

The chipKIT WF32 board minimizes the need to purchase additional hardware or shields by integrating our 32-bit PIC32MX695F512L microcontroller (MCU) with Full Speed USB 2.0 Host/Device/OTG, our agency-certified MRF24WG0MA Wi-Fi module and an energy-saving switch-mode power supply that employs our MCP16301 DC-DC converter, along with a microSD™ card—all while maintaining an Arduino hardware-compatible form factor.

On the software side, an embedded cloud software framework enables you to easily create IoT applications with the chipKIT WF32. Additionally, Digilent facilitates the rapid development of wireless HTTP server applications via its comprehensive sample application that supports static pages loaded from the chipKIT WF32’s microSD card, as well as dynamically generated Web pages.

Are you looking for an easy way to add wireless connectivity to your Arduino projects? Then you can combine the chipKIT WF32 base board and its HTTP server example application. If you are a professional engineer, you can use the chipKIT WF32 to rapidly evaluate Wi-Fi in your embedded designs and to create embedded cloud computing services using Exosite. Additionally, as with all chipKIT base boards, the chipKIT WF32 can be connected to our PICkit™ 3 programmer/debugger, allowing you to seamlessly move into our professional MPLAB® X IDE and XC32 C and C++ compilers.

The chipKIT WF32 and chipKIT Motor Control Shield can be purchased from microchipDIRECT. For more information and additional chipKIT resources, please visit the chipKIT Community Site.
Motor control applications are becoming increasingly more complicated. The need for energy efficiency is driving complex designs that utilize sensorless control technology and closed-loop algorithms. These sophisticated signal-processing applications require both high-level math abstraction and low-level programming knowledge. The ability to easily design complex algorithms using tools such as MathWorks’ Simulink graphical environment for simulation and model-based design—instead of hand coding—can speed a product’s time to market.

Our MPLAB Device Blocks for Simulink software makes it easy to develop complex designs using our dsPIC30 and dsPIC33 digital signal controllers (DSCs). This software provides a set of user interfaces to Simulink, where code for the application is generated, compiled and loaded onto a target dsPIC® DSC in a single, one-click step. It also enables you to go back and forth from simulation to real hardware test quickly, without the burden of low-level programming tasks.

Microchip’s Device Blocks provide complete, model-based control of most dsPIC DSC on-chip peripherals for greater flexibility and higher utilization, including digital I/Os, ADCs, PWMs, change notifications, output compares, input captures, quadrature encoder interfaces, interrupts and resets, as well as communication interfaces such as I2C™, SPI and UARTs. You can monitor, tune and log your algorithms and applications in real time via a GUI.

The Device Blocks are also simple to set up. One configuration can be used across all dsPIC DSCs, which enables easy in-process design changes and seamless migration. Target configuration blocks include Master Block, Simulink Reset Config, Compiler Option and Data Sheet. The Device Blocks’ facility to invoke dsPIC3X dedicated functions written in C, via a C function-call block, allows you to write less code by utilizing many of our application, algorithm and operation libraries directly from a Simulink model.

The new Version 3.30 of MPLAB Device Blocks for Simulink has been updated to include multi-rate and interrupt-capable device blocks. A Free edition for up to seven I/O ports eliminates the compile wait time found on prior Free editions. The PRO edition (SW007023) is available from microchipDIRECT and costs $1495. Existing PRO users can upgrade for free. 

**Model-Based Control**

MPLAB® Device Blocks for Simulink® Software Makes Sophisticated Algorithm Design Easy

**Develop complex designs using our dsPIC30 and dsPIC33 DSCs.**
Getting the Job Done

Advanced Emulation Tool Offers Many New and Powerful Debugging Features

Time is money, as the saying goes. In the embedded design world, engineers who are outfitted with powerful and easy-to-use advanced debugging solutions are better equipped to meet the challenges of tighter product design schedules and constantly decreasing budgets.

Recognizing this, we have recently released the new PIC16(L)F1939-ME2 Emulation Extension Pak (AC244055), the first in a series of emulation extension paks that we plan to release for select existing and future 8-bit MCU families. The PIC16(L)F1939 Emulation Extension Pak emulates PIC16(L)F1933/4/6/7/8/9 Enhanced Midrange devices and includes an Emulation Header board, a trace cable, a trace adapter board, and gold SIP header pins.

When paired with an MPLAB® REAL ICE™ in-circuit emulator, an MPLAB ICD 3 in-circuit debugger or a PICkit™ 3 in-circuit debugger—along with the MPLAB X IDE—this low-cost, second-generation in-circuit emulator system provides a toolbox full of features to assist you with your tough code debugging jobs. It gives you more choices to efficiently solve the task at hand at minimal cost.

One of the most important features offered by this emulation tool is its real-time hardware instruction trace capability when used with a MPLAB REAL ICE in-circuit emulator. Certain code troubleshooting situations lend themselves very well to gathering instruction trace data in order to find the root cause quickly and efficiently. The PIC16(L)F1939 Emulation Extension Pak can help your bugs disappear with a trace.

Up to 32 powerful hardware address/data breakpoints are available for use on the PIC16(L)F1939 Emulation Extension Pak, again when used with an MPLAB REAL ICE in-circuit emulator. Software breakpoints are useful, but there’s nothing like real hardware breakpoints when you need unfettered control of qualifying the breakpoint/event conditions beyond the address matching that simple software breakpoints provide. Add to the mix a special interrupt contextual qualifier and these hardware breakpoints offer a high degree of configurability.

The PIC16(L)F1939 Emulation Extension Pak’s on-board ME2 silicon contains a Background Debug Mode control interface that allows read/write access to user RAM memory, SFRs, and

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emulation registers while the user program is running or even sleeping. This is significant because, in some cases, stopping the user application in order to view and modify registers can cause damage to the system being debugged, or disrupt application functions to the extent that debugging is actually counterproductive. For example, halting applications with communications between multiple microprocessors can lead to unrecoverable communications errors.

An Event Combiner monitors multiple event inputs from the event source pool and can generate a halt or a trigger out based on combinations and sequences of those inputs. The PIC16(L)F1939 Emulation Extension Pak has four Event Combiners. Each combines eight combinational or sequential events into a single event trigger. Individual breakpoints may be grouped into sequences, logical ‘AND’ lists, or a nested combination of these for more complex control. The Event Combiners were modeled after legacy MPLAB ICE 2000 complex triggers.

Additional features include:

- 32 runtime data watch points
- Hardware stack snapshot
- External trigger I/O
- Enhanced stopwatch cycle counter
- Previous program counter (PC) query
- Execution out-of-bounds detection

The PIC16(L)F1939 Emulation Extension Pak can be purchased from microchipDIRECT. For more information, visit the 8-bit PIC® MCU Emulation Extension Paks page on the Microchip website.
Cool Deals for February

There are no frozen prices in our latest supply of Development Tools Deals. To take advantage of these special sale prices, go to microchipdirect.com and add the item to your cart. Add the coupon code during checkout. These are limited time offers so act quickly to get yours while the deals are still available and supplies last.

Explorer 16 Development Board
microchipDIRECT Coupon Code: TP1361
The Explorer 16 Development Board is our “go to” tool for anyone new to our 16-bit and 32-bit MCUs. It’s a low-cost modular development system that supports devices from our PIC24F and PIC32 families of MCUs and our dsPIC® DSCs. Processor Plug-In Modules (PIMs) are available to enable you to easily swap devices and use the Explorer 16 for prototyping, demonstration or development with a variety of MCUs from other families. Get yours for $79.99, which is $50 off the regular price.

MPLAB® REAL ICE™ Power Monitor Module
microchipDIRECT Coupon Code: TP1362
If you are looking for a cost-effective way to squeeze every last drop of power efficiency out of your code, MPLAB REAL ICE™ Power Monitor Module helps you identify and eliminate code—in real time—that consumes high current. When combined with the MPLAB REAL ICE in-circuit emulator and MPLAB X IDE, this development platform will allow you to measure, graphically profile and optimize code power consumption for all our 8-bit, 16-bit, and 32-bit PIC® MCUs. At a savings of $100, it is available for $279.99.

Smart Card/SIM Card (SC) PICtail Daughter Board
microchipDIRECT Coupon Code: TP1363
Are you interested in developing smart card applications for our PIC18 or PIC24 MCUs? The Smart Card/SIM Card (SC) PICtail™ Daughter Board—when used in combination with an Explorer 16 or PIC18 Explorer development board—will help you evaluate, read and write data on a wide range of smart cards and SIM cards. It’s now on sale for $19.99, a 33% savings off the regular price.

(continued on page 12)
PIC32 mTouch™ Capacitive Touch Evaluation Board
microchipDIRECT Coupon Code: TP1364
Our mTouch sensing solutions make it easy for you to design and integrate touch technologies into your capacitive touch-based applications. You can save 20% and get the PIC32 mTouch Capacitive Touch Evaluation Board for just $19.99. Used for developing applications using PIC32-series MCUs, this evaluation board includes an on-board PICkit™ serial interface, an ICSP header, a USB connector (for power only) and a 16-bit LED display.

Now in its 18th consecutive year, Microchip’s MASTERs Conference is where software and hardware design engineers and engineering managers will find solutions to their embedded control challenges. Attendees will not only benefit from an in-depth education on Microchip’s products, but will also have many opportunities to interface with Microchip Field Applications Engineers and other technical experts.

On-line registration with special early bird discounts will be available in April, 2014. Visit www.microchip.com/usmasters for more information and to sign up to be notified by email when registration opens.

**Pre-Conference Dates**
August 18-19, 2014

**Conference Dates**
August 20-23, 2014
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Advanced Audio Coding (AAC) is a standardized lossy compression technique used for encoding digital audio files based on perceptual audio encoding. It is designed to be the successor to the MP3 format and is said to offer better sound quality at the same bit rate. AAC encoding minimizes the amount of data required to impart high-quality digital audio. It achieves this by discarding irrelevant signal components and wiping out redundancies in the coded audio signal.

The PIC32 Advanced Audio Coding (AAC) Decode Library provides easy-to-use APIs for decoding an audio stream encoded using AAC. The Library is available in non-modifiable binary code and source code formats for use with high-performance PIC32 MCU devices and supports the following audio data rates:

- Sample rates:
  - 8, 11.025, 12, 16, 22.05, 24, 32, 44.1, 48, 64, 88.2 and 96 KHz
- Bit rates:
  - 32, 40, 48, 56, 64, 80, 96, 112, 128, 160, 192, 224, 256, 320, 384 kbps and VBR

AAC Decode Library (Non-modifiable Binary Code)
The AAC algorithm (non-modifiable binary code) is designed for 80 MHz or greater PIC32 MCUs. This code requires 62 MIPS peak 34 MIPS average performance, 61 KB Flash and 12 KB RAM without frame buffer memory for operation on the PIC32 MCU. This product is the non-modifiable binary code. Users remain responsible for licensing their products through Via Licensing.

AAC Decode Library (Source Code)
This AAC algorithm (source code) is designed for 80 MHz or greater PIC32 MCUs. This code requires 62 MIPS peak 34 MIPS average performance, 61 KB Flash and 12 KB RAM without frame buffer memory for operation on the PIC32 MCU. This product is the modifiable source code. Users remain responsible for licensing for their products through Via Licensing.

Visit microchipDIRECT to purchase and download both the non-modifiable binary code and the source code versions of the PIC32 AAC Decode Library.
The Internet of KoolThings

Reports from the show floor at CES 2014 confirm that a surge of new wireless gadgets designed to help consumers enhance, enjoy and manage their lifestyles is on its way. With the number of smartphone users steadily increasing, Bluetooth® Low Energy (BTLE) or Bluetooth Smart is becoming the dominant wireless standard for use in applications such as security tagging and cloud-based smart home services. Another growing trend is wearable technology, which offers consumers devices for a myriad of applications including health tracking, sports and fitness analysis, personal security, property tracking, gaming and personal entertainment.

DeviceLab Inc., a Microchip Design Partner, has teamed up with KoolTechs Inc. to create a user-friendly multi-functional system called the “iWanditAll” KoolThings platform. This multi-sensor iOS- and Android™-based platform leverages the Internet of Things to help consumers integrate and connect their wireless gadgets together into one easy-to-use system. To help bring the KoolThings platform to mass production, KoolTechs has recently launched a Kickstarter campaign, where you can watch a video which provides additional details on the platform’s features and its potential applications.

The “iWanditAll” KoolThings system includes a wearable keyfob-like device called the KoolWand, a small wireless hub/media player called the KoolBridge and optional KoolSensors/KoolDongles—which connect using a smartphone’s headphone jack—that can work independently or together to replace wireless gadgets and simplify everyday life.

The KoolThings platform uses a PIC® MCU in all of its sub-components. The PIC MCU’s low power consumption was crucial for use in the KoolWand, and particularly in the design of headphone jack-based KoolDongles—such as the Universal IR remote dongle and the temperature/humidity (continued on page 16)
It’s safe, it’s fast and it’s free to register.

PayPal enables you to make purchases without revealing your credit card number or financial information. PayPal can link to your financial account and allow you to pay in most local currencies.

We have recently expanded our ability to accept PayPal in European countries where microchipDIRECT is available. We now offer coverage for all countries that use the GBP or Euro.

For more details on our payment options or to place an order, visit us today at www.microchipDIRECT.com.

donut—making it possible to power all of the dongle’s electronics using the "music" energy from the iOS device’s audio jack.

Offering more than 30 features, the KoolThings system can eliminate the need for separate devices such as TV/DVD remotes, pedometers, tagging devices for theft prevention, tracking devices to find lost items, or alert devices to prevent children from wandering. The following are some sample applications made possible by integrating different technologies into the KoolThings platform:

- Very simple setup of a security camera system using Apple® FaceTime® video calling and an iOS device
- Snap a photo or short video clip when a garage door is opened, notify the home owner via a smartphone message, and remotely close/open garage door using a smartphone app
- Control and interact with home appliances using Siri® or Google Voice™ speech recognition services
- Wirelessly stream music via Wi-Fi® or Bluetooth from a mobile device or the cloud to home stereos or even to a car’s sound system
- Synchronize music with LED lights to create a music light show
- Use the KoolWand to control TV viewing time based on reaching exercise goals

You will find additional information on the KoolThings platform on KoolTech’s website at www.kooltechs.com.

Figure 2 - KoolThings System Diagram
Crystal-Free USB Operation Driven By a Single Device

Most computer users are familiar with the numeric keypad section on a computer keyboard. The numeric keypad is generally used to enter long sequences of numbers while working with applications such as a calculator, spreadsheet and accounting programs. However, due to space constraints, most laptop manufacturers do not provide a numeric keypad section on their keyboards.

We have partnered with Lumvatech to create a USB Keypad Reference Design demonstrating crystal-free USB operation in a low-cost aesthetic design with integrated touch capability and LED lighting. All features are driven with a single PIC16F1459 MCU. This same technology can be used for a number of other USB and capacitive touch applications that require a key code entry such as security doors and gates, keypads for a security safe, ATM machines and data entry devices.

USB is one of the most commonly used serial interfaces for a wide variety of applications. The USB 2.0 module with clock recovery from a USB host eliminates the need for an external crystal, thereby reducing BOM costs and saving space. The PIC16F145X, PIC18F2X/4XK50 and PIC18FXXJ94 families all feature Active Clock Tuning (ACT) which guarantees a 0.25% accurate 48 MHz internal oscillator across all temperature ranges when connected to a USB host.

This design also features the integration of 18 touch buttons based on the Capacitive Voltage Divider (CVD) technique from Microchip. A matrix-based approach is followed. Nine ADC channels are available; five are...

USB Keypad Features

- Crystal-free USB operation
- 18 touch buttons using Microchip’s Capacitive Voltage Divider (CVD) technique
- LED backlight with proximity sensing ON and auto power OFF
- Audio feedback using piezo buzzer
- USB Human Interface Device (HID) interface
- Plug-and-play
- Low-cost, lightweight design
- Integration of USB and mTouch™ sensing framework from Microchip Libraries for Applications (MLA)

(continued on page 18)
used for row detection and four are used for column detection. Two columns are also used for proximity detection. An LED backlight for the keypad with auto power off and audio feedback using a piezo buzzer is also implemented.

USB Keypad Overview
The USB keypad features are driven by an 8-bit PIC16F1459 device with integrated peripherals such as 14 KB Flash, 1 KB RAM, Full Speed USB peripheral with ACT, 10-bit Analog-to-Digital Converter (ADC) with nine channels, two Pulse-Width Modulator (PWM) modules, Complementary Waveform Generator (CWG) and more.

Capacitive Touch Buttons
The Capacitive Voltage Divider (CVD) technique is used for implementing 18 touch buttons and the proximity sensor. The CVD technique has been developed to require only an ADC and minimal digital processing overhead. For more information on the CVD technique, refer to mTouch™ Sensing Solution Acquisition Methods Capacitive Voltage Divider™ (AN1478) or visit the mTouch Sensing Solutions area on Microchip’s website.

All of the nine ADC channels available on the PIC16F1459 device are configured as CVD sensors. To allow a larger number of touch buttons, nine CVD sensors are arranged in a 5 x 4 matrix as shown in Figure 3 on the next page. The 5 x 4 matrix allows a maximum of 20 touch buttons. However, the USB keypad implements 18 touch buttons.

Each touch button includes a pair of row and column. The rows and columns in a touch button are separated by a distance of 1.5 mm. Most of the touch buttons on the USB keypad have an overall size of 12 x 12 mm. There are two touch buttons with a size of 12 x 31 mm.

Figure 4 illustrates the dimensions for an individual button. The CVD firmware determines if any touch button is pressed by scanning all of the nine sensors at a periodic interval and by checking if any combination of row and column is pressed.

All of the four column sensors are also used for proximity sensing. The CVD firmware scans these four column sensors separately to find
out if any change in the capacitance is detected due to the presence of an object such as human interference.

Each touch button is surrounded by a guard ring to shield the buttons from parasitic capacitance, thus increasing the sensitivity of the button. The guard ring is driven by an I/O. The guard ring has a width of 1 mm and is placed at a distance of 3 mm from the touch buttons.

**Full-Speed USB with ACT**

The USB keypad is a Full Speed USB device which enumerates as HID keyboard to a USB host. The USB HID driver is inbuilt for most operating systems (Windows®, Linux®, Mac OS®, etc.). The device drivers are installed automatically on these operating systems as the user plugs in the keypad to the USB connector on the host.

The PIC16F1459 device contains a Full Speed (12 Mbps) and Low Speed (1.5 Mbps) compatible USB Serial Interface Engine (SIE) that allows fast communication between any USB host and the MCU. The SIE can be interfaced directly to the USB host by utilizing the internal transceiver.

USB standards specify that Full Speed USB clock tolerance should be within ±0.25%. Most USB systems achieve this requirement by using an external crystal. However, the PIC16F1459 device’s ACT feature eliminates the need for a high-speed, high-accuracy external crystal in a Full Speed USB system. The ACT continuously adjusts the 16 MHz internal oscillator using an available external reference, to achieve ±0.20% accuracy. In a Full Speed USB system, the Start-of-Frame (SOF) signal received every millisecond from a USB host can be used as the external reference. The ACT feature helps save BOM and assembly costs on the external crystal and also saves some board space.

**Development Made Easy**

Both the USB stack and mTouch framework have been integrated into the Microchip Libraries for Applications (MLA), providing a USB HID interface which makes the keypad ‘plug and play’.

To get started with your design, go to the **USB Keypad Demonstration page** and download the Application Note, Schematic and ‘C’ source code. The code can easily be modified to your specific application needs. Leveraging the expertise and products from Microchip’s partners further ensures quick development of high quality USB and mTouch sensing applications.

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**Figure 3 - Matrix Keypad Design**

**Figure 4 - Touch Button Dimensions**
Microchip Event Calendar

Microchip will be exhibiting its products and technologies at the following upcoming events. Stop by our booth to view our demos and meet with our staff to get your questions answered.

**Strategies In Light**
Santa Clara Convention Center, Santa Clara, California
February 25-27, 2014
Visit Microchip at Booth 906
The world's largest and longest-running conference and exhibition covering the LEDs and Solid-State Lighting sectors, Strategies in Light's 15-year tradition of educational excellence provides an unprecedented platform for information exchange, networking and new business development.

**Applied Power Electronics Conference (APEC) 2014**
Fort Worth Convention Center, Fort Worth, Texas
March 16-20, 2014
Visit Microchip at Booth 906
As The Premier Event in Applied Power Electronics™, APEC focuses on the practical and applied aspects of the power electronics business. This is not just a designer's conference, APEC has something of interest for anyone involved in power electronics.

**electronica China**
Shanghai New International Expo Center (SNIEC), Shanghai, China
March 18-20, 2014
Visit Microchip at Booth 1218
electronica China is the Chinese edition of the renowned electronica show in Germany, organized by Messe Munchen International. The show focuses on electronic components, systems and applications with an expanding semiconductor zone. Most of the major players in the semiconductor industry will be there to showcase their latest products and solutions.

**Electrical and Computer Engineering Department Heads Association (ECEDHA) Conference and ECExpo**
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