

MICRO

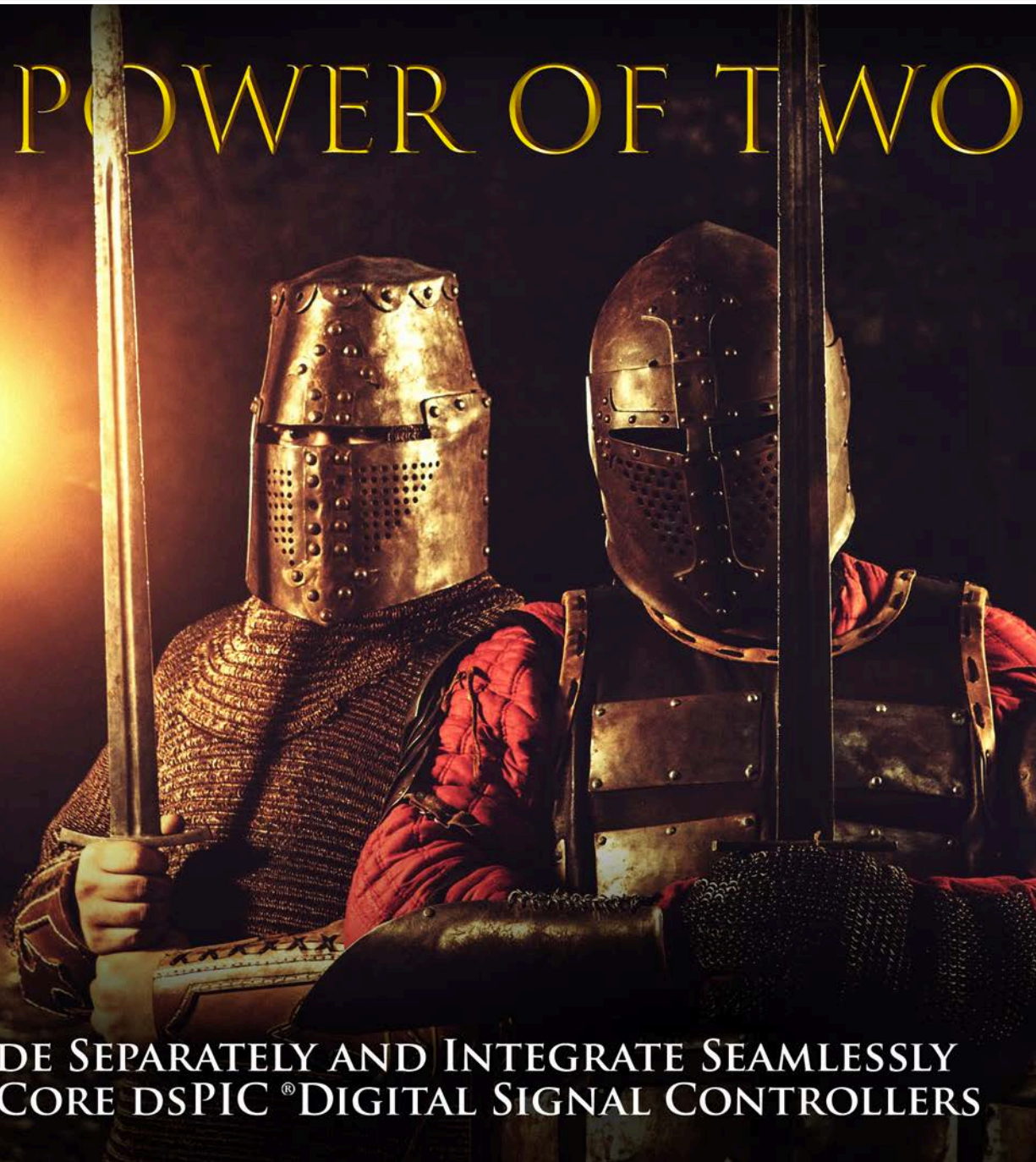


SOLUTIONS

A MICROCHIP TECHNOLOGY INC. PUBLICATION

SEPT/OCT 2018

THE POWER OF TWO



DESIGN CODE SEPARATELY AND INTEGRATE SEAMLESSLY
WITH DUAL-CORE DSPIC[®] DIGITAL SIGNAL CONTROLLERS

7 Securing IoT
Endpoints

14 Focused on
the Road

25 Python on
Microcontrollers

MICRO SOLUTIONS

A MICROCHIP TECHNOLOGY INC. PUBLICATION

contents

COVER STORY

4 The Power of Two

Design Code Separately and Integrate Seamlessly with Dual-Core dsPIC® Digital Signal Controllers

NEW PRODUCTS

7 Securing IoT Endpoints

SAM L11 is First 32-bit Microcontroller to Feature Robust, Chip-Level Security and Arm® TrustZone® Technology

9 Robust and Reliable

Increase Functionality in Sensor Nodes with New 8-bit tinyAVR® Microcontrollers

11 Small, Yet Powerful

New SAM HA Family of Low-Power, Multi-Chip System-in-Package Devices Simplifies Design of Complex LIN Nodes

14 Focused on the Road

Automotive-Qualified 3D Gesture Recognition Controller Adds Convenience and Limits Driver Distraction

16 Audiophile-Quality Sound

Create High-Resolution Audio Devices Using New Bluetooth® Audio System-on-Chip with Sony's LDAC™ Technology

17 Dual-Mode Power Monitoring

Single IC Offers Industry-Leading Accuracy for Real-Time Power Measurement of AC and DC Power Supplies

19 Communicating on the Smart Grid

PL360B Power Line Communication Modem Streamlines Deployment of Smart Energy Equipment

21 True Power Measurement

PAC1932 and PAC1933 DC Power Monitoring ICs Measure Power from 0V to 32V on Single Chip

NEW TOOLS

22 Goodbye Mechanical Buttons

24 It's a Snap

DESIGN CORNER

25 Python on Microcontrollers

28 Looking for New Options?

30 From Frustration to Funded

FEATURED VIDEO



Why Use Microchip's Serial EEPROMs?

The Microchip name and logo, the Microchip logo, AnyRate, AVR, AVR logo, AVR Freaks, BitCloud, CryptoMemory, CryptoRF, dsPIC, FlashFlex, flexPWR, Helder, JukeBlox, KEELOQ, Klear, LANCheck, LINK MD, maXStylus, maXTouch, MediaLB, megaAVR, MOST, MOST logo, MPLAB, OptoLyzer, PIC, picoPower, PICSTART, PIC32 logo, Prochip Designer, QTouch, SAM-BA, SpyNIC, SST, SST Logo, SuperFlash, tinyAVR, UNI/O, and XMEGA are registered trademarks of Microchip Technology Incorporated in the U.S.A. and other countries. ClockWorks, The Embedded Control Solutions Company, EtherSynch, Hyper Speed Control, HyperLight Load, IntelliMOS, mTouch, Precision Edge, and Quiet-Wire are registered trademarks of Microchip Technology Incorporated in the U.S.A.

Adjacent Key Suppression, AKS, Analog-for-the-Digital Age, Any Capacitor, AnyIn, AnyOut, BodyCom, chipKIT, chipKIT logo, CodeGuard, CryptoAuthentication, CryptoCompanion, CryptoController, dsPICDEM, dsPICDEM.net, Dynamic Average Matching, DAM, ECAN, EtherGREEN, In-Circuit Serial Programming, ICSP, Inter-Chip Connectivity, JitterBlocker, KlearNet, KlearNet logo, Mindi, MIWI, motorBench, MPASM, MPF, MPLAB Certified logo, MPLIB, MPLINK, MultiTRAK, NetDetach, Omniscient Code Generation, PICDEM, PICDEM.net, PICKIT, PICtail, PureSilicon, QMatrix, REAL ICE, Ripple Blocker, SAM-ICE, Serial Quad I/O, SMART-I.S., SQI, SuperSwitcher, SuperSwitcher II, Total Endurance, TSHARC, USBCheck, VariSense, ViewSpan, WiperLock, Wireless DNA, and ZENA are trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

SQTP is a service mark of Microchip Technology Incorporated in the U.S.A. Silicon Storage Technology is a registered trademark of Microchip Technology Inc. in other countries. GestIC and ULPP are registered trademarks of Microchip Technology Germany II GmbH & Co. & KG, a subsidiary of Microchip Technology Inc., in other countries. The LoRa name and associated logo are registered trademarks of Semtech Corporation or its subsidiaries. USB Type-C™ is a trademark of USB Implementers Forum. Arm and Cortex are registered trademarks of Arm Ltd. in the EU and other countries. All other trademarks mentioned herein are property of their respective companies. © 2018, Microchip Technology Incorporated, All Rights Reserved.



World-Class Technical Training and More

Attendees and Microchip training personnel from around the globe will be converging in Phoenix, Arizona, the week of August 20th to attend the 22nd Annual Worldwide MASTERS Conference. This is a valuable opportunity for software and hardware design engineers and engineering managers to learn about embedded control topics and to discuss their design challenges with their peers and Microchip engineers. The 2018 conference program features over 110 lectures and hands-on classes for all skill levels that are taught by Microchip's field applications engineers and other technical experts. By the time the week is over, conference attendees will be well equipped to use Microchip solutions to successfully bring their designs to life. But training is just one of the reasons why MASTERS is such a unique event.

This week-long conference is packed with professional opportunities. At the Ask the Experts area, attendees can meet with Microchip engineers to ask design and development questions about any of our products. They can also visit the Exhibitor area to meet with representatives from partner companies to explore their products and services. At the Dev Tool Store, they can shop and take advantage of discount pricing on a wide selection of some of our most popular development tools.

There are a variety of other educational and entertaining activities for attendees and their families. They can design and fly paper airplanes, search for silicon crickets, check out some robots built by local FIRST and VEX Robotics teams, take a bus to Fry's Electronics, visit the Inventor's Showcase to see some cool inventions, and much more. Other highlights include the annual keynote address by Steve Sanghi, Microchip's CEO, and an evening of comedy with Don McMillan of *Technically Funny*.

While you may be disappointed to have missed out on our main MASTERS Conference this year, there are smaller events scheduled to be held in other areas of the world that might fit into your schedule. You can also plan on attending MASTERS 2019. We will be announcing the dates soon after this year's conference is over. To get more information about MASTERS, visit www.microchip.com/masters.

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

Microchip Technology Inc.
2355 W. Chandler Blvd. | Chandler, AZ 85224 | www.microchip.com



Don't Miss the Next Issue of MicroSolutions

Published six times a year, MicroSolutions is a valuable resource for product and technology news about Microchip's innovative solutions. Subscribe today to receive email notifications when each new issue of MicroSolutions is ready. Use the link below:



Find Us on These Social Channels



THE POWER OF TWO

Design Code Separately and Integrate It Seamlessly with Dual-Core dsPIC® Digital Signal Controllers

dsPIC33CH Family Is Optimized for High-Performance and Time-Critical, Real-World Embedded Control

What is one of your biggest challenges when designing high-end embedded control applications? For many of our customers, their pain point is integrating software from multiple teams. In complex applications requiring sophisticated algorithms, frequently one team is focused on developing the time-critical control code while another is working on the code for housekeeping, diagnostics and communication functions. In this type of scenario, a microcontroller with an extra core is an ideal solution. The power of two cores provides higher performance and enables multi-team software development to meet the demanding requirements of digital power, motor control and other embedded designs. This includes applications such as wireless power, server power supplies, drones and automotive sensors.

(continued on page 5)

If you are looking for this type of flexibility for your next design, we have recently added a new series of Digital Signal Controllers (DSCs) with two dsPIC DSC cores in a single chip to our portfolio of 16-bit devices. The **dsPIC33CH** family has one core that is designed to function as a master while the other is designed to function as a slave. This new family of DSCs was designed specifically to facilitate independent code development for each core by separate design teams and then enable seamless integration when they are brought together in one chip.

The master core can be used to run the user interface, system monitoring and communications functions that can be customized for the end application. The slave core is useful for executing dedicated, time-critical control code.

For example, in a digital power supply, the slave core manages the math-intensive algorithms, while the master core independently manages the PMBus™ protocol stack and provides system monitoring functions, increasing overall system performance and responsiveness. Distributing the overall workload across two DSC cores in a single device enables higher power density through higher switching frequencies, leading to smaller components. The dsPIC33CH family was designed for live updating of the system, which is especially important for power supplies where firmware updates must be made with zero downtime.

In an automotive fan or pump, the slave core is dedicated to managing time-critical speed and torque control while the master manages the Controller Area Network Flexible Data rate (CAN-FD) communications, system monitoring and diagnostics. The two cores work seamlessly together, enabling advanced algorithms to improve efficiency and responsiveness.

In addition, each of the new cores in the dsPIC33CH devices has been designed to provide more performance than current dsPIC DSC cores. These enhancements include:

- More context-selected registers to improve interrupt responsiveness
- New instructions to accelerate Digital Signal Processor (DSP) performance
- Faster instruction execution

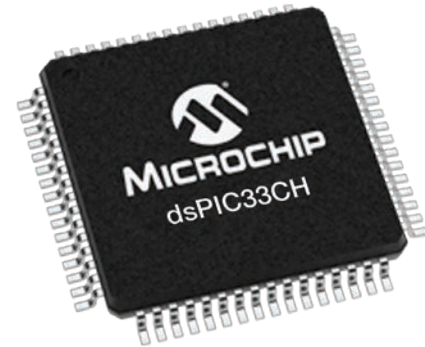
The dsPIC33CH family delivers unprecedented integration. In addition to featuring CAN-FD communications, the dsPIC33CH family's advanced peripherals are available to each core to reduce system costs and board size. These include high-speed Analog-to-Digital Converters (ADCs), Digital-to-Analog Converters (DACs) with waveform generation, analog comparators, analog programmable gain amplifiers and high-resolution Pulse Width Modulation (PWM) hardware. These dedicated peripherals, along with the dual cores, enable redundant monitoring for increased functional safety and robust system design.

Available in eight package variants ranging from 28 to 80 pins and measuring as small as 5 mm × 5 mm, the dsPIC33CH family also offers memory sizes ranging from 64 to 128 KB of Flash.

Development Support

If you are ready to get started with an application using the dsPIC33CH family, these new DSCs are supported by our MPLAB® development ecosystem including the free, downloadable and award-winning **MPLAB X Integrated Development Environment (IDE)** and **MPLAB Code Configurator**.

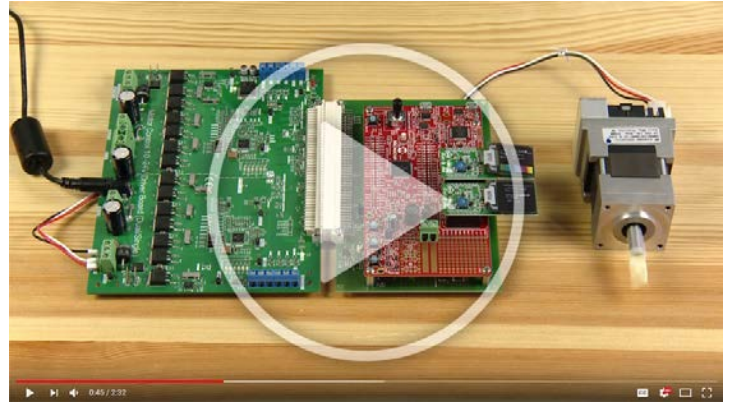
The **dsPIC33CH Curiosity Board (DM330028)**, a cost-effective and flexible development platform, is the perfect starting point for exploring the capabilities of the dsPIC33CH family and quickly creating a feature-rich prototype.



The dsPIC33CH family is optimized for high-performance digital power applications.

If you are developing a motor control application, you can use the **dsPIC33CH128MP508 Motor Control Plug-in Module** (MA330039) with the **dsPICDEM™ MCLV-2 Development Board** (DM330021-2), the **dsPICDEM MCHV-2 Development Board** (DM330023-2) and the **dsPICDEM MCHV-3 Development Board** (DM330023-3). The **dsPIC33CH128MP508 General Purpose Plug-In Module** (MA330040) is also available for use with the **Explorer 16/32 Development Board** (DM240001-2).

Do you want to take your design to the power of two? You can purchase the dsPIC33CH DSCs from **microchipDIRECT** or from **Microchip's worldwide distribution network**.



Video: dsPIC33CH Dual Core Demonstration

Want More Information?

Visit the website at:

www.microchip.com/dsPIC33CH

Improve Real-Time Performance and Accuracy

The ATtiny3217 Family Enables Robust, Reliable Sensor Interfaces



Securing IoT Endpoints

SAM L11 is the First 32-bit Microcontroller to Feature Robust, Chip-Level Security and Arm® TrustZone® Technology

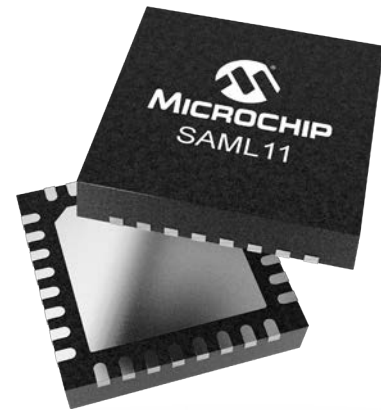
New Family Combines Industry's Best-in-Class Low Power Consumption and Water-Tolerant, Noise-Immune Capacitive Touch

With the booming growth of the Internet of Things (IoT), implementing security in endpoints is sometimes an afterthought for many designers. However, the increased frequency of security breaches brings a heightened risk of exposing Intellectual Property (IP) and sensitive information to hackers and other malicious attackers. While incorporating robust security early in the design cycle is essential, developers of battery-powered IoT endpoints also need to find ways to successfully reduce power consumption.

Providing an innovative approach to these design challenges, the new **SAM L10 and SAM L11** families of 32-bit Arm Cortex®-M23 based microcontrollers (MCUs) integrate a wide variety of peripherals, including security features, while offering the industry's lowest power consumption. Both MCU families also feature capacitive touch capability to enable designers to add attractive and reliable touch interfaces to their products.



Adding an exceptional touch-based user interface to your design is easy with the SAM L10 and SAM L11 microcontrollers.



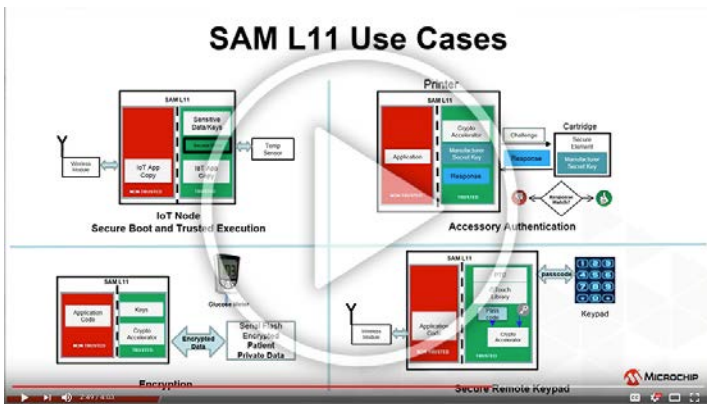
Robust Security

The SAM L11 family offers integrated hardware security, featuring Arm TrustZone for Armv8-M, a programmable environment that provides hardware isolation between certified libraries, IP and application code. This solution enables robust security by including chip-level tamper resistance, secure boot and secure key storage that, when combined with TrustZone technology, is designed to shield your IoT application from both physical and remote attacks.

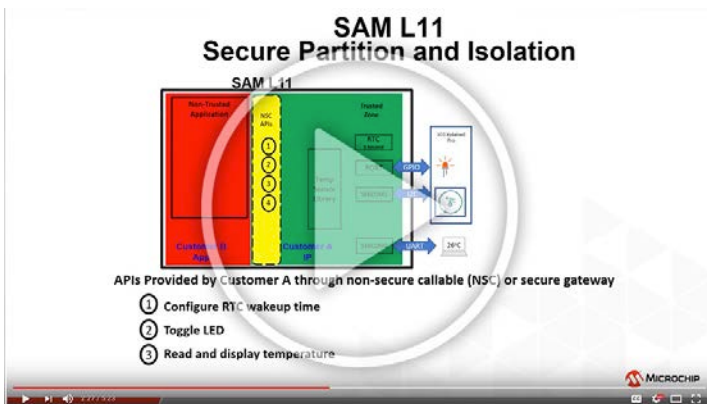
In addition to TrustZone technology, the SAM L11 security features include an on-board cryptographic module supporting Advanced Encryption Standard (AES), Galois Counter Mode (GCM) and Secure Hash Algorithm (SHA). The secure boot and secure key storage with tamper detection capabilities establish a hardware root of trust. The SAM L11 also offers a secure bootloader for secure firmware upgrades. Microchip has partnered with Trustonic, a member of Microchip's Security Design Partner Program, to offer a comprehensive security solution framework that simplifies implementation of security and enables you to introduce end products faster. Microchip has also partnered with Secure Thingz and Data I/O Corporation to offer secure provisioning services for SAM L11 customers that have a proven security framework.

We have created a video to describe how the SAM L11's security features, example use cases and other resources make it easy to implement security in your design. A second video provides you with an overview of how the SAM L11 Trusted Execution Environment can be used to implement a secure temperature sensor application while counteracting malware and physical attacks.

(continued on page 8)



Video: SAM L11 Security Features



Video: SAM L11 Trusted Execution Environment Demo

even in the presence of moisture and noise. The PTC makes the SAM L10 and SAM L11 well suited for use in a myriad of automotive, appliance, medical and consumer Human Machine Interface (HMI) applications. Watch this video to get a quick overview of the PTC implementing the Driven Shield Plus feature for creating a water-tolerant touch application:



Video: SAM L11 Driven Shield Plus

Industry's Lowest Power Consumption

Optimizing your system design for lower power consumption is especially important when you are creating battery-powered devices. As the lowest-power MCUs in their class, the SAM L10 and SAM L11 are built with Microchip's proprietary picoPower® technology, as well as other power-saving features, to provide low power consumption in active and all sleep modes. When benchmarked for power consumption, the SAM L10 received a ULPMark™ score of 405, which is over 200 percent better performance than the nearest competitor as certified by EEMBC®, the Embedded Microprocessor Benchmark Consortium.

Superior Capacitive Touch

Adding an exceptional touch-based user interface to your design is easy with the SAM L10 and SAM L11. Both MCU families feature an enhanced Peripheral Touch Controller (PTC) offering best-in-class water tolerance and high noise immunity. This PTC is four times faster than the previous generation and provides highly responsive and accurate touch sensing. The PTC enables you to implement a low-power touch interface that provides an impressively smooth and efficient user experience,

Development Support

To accelerate your development using these new MCUs, the **SAM L10 Xplained Pro Evaluation Kit** (DM320204) and **SAM L11 Xplained Pro Evaluation Kit** (DM320205) offer a range of features, including a microBUS™ socket for adding extra functionality using MikroElektronika click boards™. Security, low-power and touch demos are also available to help you get started with your project.

All SAM L10/L11 MCUs are supported by **Atmel Studio 7 Integrated Development Environment** (IDE), IAR Embedded Workbench and Arm Keil® MDK, as well as **Atmel START**, a free online tool to configure peripherals and software that accelerates your development. Atmel START also supports TrustZone technology to configure and deploy secure applications. A power debugger and data analyzer tool are available to monitor and analyze power consumption in real time and fine tune the consumption numbers on the fly to meet application needs. Microchip's QTouch® Modular Library, 2D Touch Surface Library and QTouch Configurator are also available to simplify touch development.

Don't let security be an afterthought in your next IoT design. The SAM L10 and SAM L11 devices are available in a variety of pin counts and package options to meet your design's requirements, and they can be ordered from **microchipDIRECT** or from **Microchip's worldwide distribution network.**

Robust and Reliable

Increase Functionality in Sensor Nodes with New 8-bit tinyAVR® Microcontrollers

ATtiny3217 and ATtiny3216 Offer Safety Functions and Large Memory for Application Code

Because of their cost effectiveness and ease of implementation, AVR® microcontrollers (MCUs) have long been used to create highly responsive sensor nodes. Sensor interfaces can be found a diverse range of applications, including industrial, consumer, appliances, automotive and the Internet of Things (IoT). To enhance the capability and responsiveness of these applications, Microchip's portfolio of tinyAVR MCUs has been expanded to include two new devices with advanced analog features, along with a variant that offers the largest Flash memory in this family of devices. Designed for reliable operation in harsh environments, these MCUs also come with built-in safety functions to help you create robust and safe systems.

Ideal for sensor applications that also incorporate capacitive touch interfaces, the **ATtiny3217 and ATtiny3216** offer two Analog-to-Digital Converters (ADCs) that enable systems to implement touch control simultaneously with other analog



measurements. One ADC can be used with the Peripheral Touch Controller (PTC) for touch signal acquisition, while the second one monitors other inputs such as thermistors and pressure sensors. Or, both ADCs can be used for faster sampling of different types of sensors.

Additional benefits of the ATtiny3217 and ATtiny3216 MCUs include:

- **Improved real-time performance and accuracy:** The dual ADC can be used for synchronous sampling of analog signals, such as voltage and current, thus improving real-time performance and accuracy of the overall system. The MCUs also feature a hardware-based Event System that enables inter-peripheral communication without CPU involvement, reducing latency and ensuring faster system response.
- **Robust and reliable performance:** Both devices come with built-in safety functions to help you detect and respond to voltage supply variations or drops. These functions include the Power On Reset (POR), programmable Brownout Detect (BOD), Voltage Level Monitor (VLM) and Windowed Watchdog Timer (WWDT).
- **Improved noise immunity and functionality in extreme environments:** The devices operate at up to 5V and are available in 125°C variants.
- **Increased functionality with more room for application code:** The variant with 32 KB of Flash provides plenty of room for application code while occupying a small physical footprint on the PCB.




The ATtiny3217 and ATtiny3216 microcontrollers enhance the capability and responsiveness of sensor interfaces.

Optimized for performance, power efficiency and ease of use and available in small packages, these new MCUs combine responsive touch sensing and built-in safety functions to make it easier for you to improve the user experience in applications such as home appliances, automotive and industrial automation.

Development Tools

The **ATtiny3217 Xplained Pro Evaluation Kit** (ATTINY3217-XPRO) is the ideal platform for rapid prototyping with these new tinyAVR MCUs. This USB-powered kit features an on-board programmer/debugger, touch buttons, LEDs and extension headers for quick setup. All tinyAVR MCUs are supported by **Atmel Studio 7 Integrated Development Environment** (IDE) and **Atmel START**, our free, online code configurator that accelerates your development.

If you are ready to improve the capabilities of your next sensor application, you can purchase the ATtiny3217 from **microchipDIRECT** or from **Microchip's worldwide distribution network**. Contact your local Microchip Sales Office for pricing and availability of the ATtiny3216. 

Want More Information?

Visit the website at:

www.microchip.com/attiny3217

Flawless Performance in Harsh Environments

Scalable, Robust Embedded Control
Using 32-bit SAM Microcontrollers



Small, Yet Powerful

New SAM HA Family of Low-Power, Multi-Chip System-in-Package Devices Simplifies Design of Complex LIN Nodes

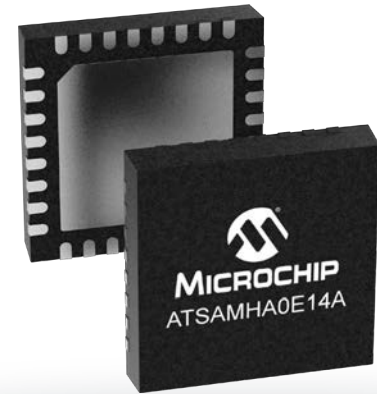
Reduces Power Consumption and Optimizes Space in Automotive Applications

In automotive applications, the typical Local Interconnect Network (LIN) node has a limited set of functions such as monitoring mechanical switches or touch buttons on a steering wheel and sending the information to the connected LIN master. For tasks like these that involve minimal computing, the primary design factors are low cost and size constraints. However, as multiple Embedded Control Units (ECUs) are being integrated into modern cars, power consumption for each module needs to be optimized.

While new technologies like CAN Partial Networking (CAN-PN) are introducing new methods to reduce power consumption on a bus-wide level, it is also important to equip microcontrollers (MCUs) with the right peripherals and functionalities to allow for very-low static power consumption for ECUs that are in standby while the ignition is off. Space is another concern. As more ECUs are used in vehicles to offer additional functionality, the modules need to become smaller and lighter. It is crucial to optimize devices so they can be used to create small ECUs.



As more ECUs are used in vehicles to offer additional functionality, the modules need to become smaller and lighter.



As designers face the necessity of developing increasingly complex LIN nodes while maintaining, or even reducing, the amount of space these nodes occupy, Microchip now offers a new family of low-power, multi-chip System-in-Package (SiP) devices to address these requirements. The **SAM HA** series of SiPs combines the performance and energy efficiency of a 32-bit Arm® Cortex®-M0 based microcontroller (MCU) and the optimized architecture and peripheral set of a feature-rich LIN System Basis Chip (SBC) with a fully integrated LIN transceiver.

The integration of these two functionalities within one package saves valuable board space and simplifies Printed Circuit Board (PCB) layout. Routing the TXD and RXD signals between the two Integrated Circuits (ICs) is not necessary, since this connection is made internally to free up pins for other I/O functionality. To provide flexibility in planning your system design, the two devices have separate power supplies. You can use the battery to power the whole system and use the internal voltage regulator with a 3.3V/85 mA output to supply the MCU and additional components on the PCB.

Many of these peripherals are highly optimized blocks.

A broad set of peripherals is available to meet the requirements of a wide range of LIN applications. These include an integrated DMA controller and Event System. Many of these peripherals are highly optimized blocks that have evolved and been refined over many decades of MCU design and innovation. To provide you with additional flexibility for your design, each of

(continued on page 12)

the members of the SAM HA series of SiPs offers distinctive functionality and comes with up to 64 KB of Flash memory and 8 KB of RAM.

The first device to be introduced, the ATSAMHAXGxxA, is a general-purpose device offering a wide range of features in a small 48-pin QFN package. The recently released ATSAMHAXExxA is a 32-pin QFN device that measures just 5 mm × 5 mm and yet integrates all the functionality required for creating even smaller LIN nodes. Table 1 provides an overview of the features of both sets of devices. Note that they both provide the same LIN functionality but the number of peripherals available in the MCU varies by package size.

Feature	ATSAMHAXEXXA (32-pin QFN)	ATSAMHAXGXXA (48-pin QFN)
Max Flash (KB)	64	64
Max RAM (KB)	8	8
Max I/O	19	32
SERCOM	4	5
Timer Counter (TC)	2	4
Timer Counter Control (TCC)	3	3
Self-Capacitance Touch Channels	4	9
PWM Channels	12	13
ADC Channels	6	13
DAC Channels	1	1
AC Channels	1	2
3.3V/85 mA V _{REG}	1	1
LIN TRX	1	1

Table 1: Comparison of Features in SAM HA Series of Devices

Event Detection and Power Management

The Event System allows autonomous, low-latency and configurable communication between peripherals. It can be used to trigger actions in other peripherals and to wake up the MCU without intervention from the CPU. Most peripherals can be configured to generate events and respond to events coming from other peripherals. To do this, a direct connection is made between two peripherals using one of the 12 available channels, which is then set aside solely for this event. This reduces the load on the CPU and other system resources as compared to a traditional interrupt-based system.

Peripheral Touch Controller

If you would like to implement a touch-enabled interface in your automotive application, some devices in the SAM HA series of SiPs include a Peripheral Touch Controller (PTC) that offers hardware support for capacitive touch recognition. The QTouch® Library can be used to implement buttons, sliders, wheels and proximity detection. The PTC can be used in two modes. Self-capacitance mode allows a connection to one touch sensor per I/O pin, while mutual capacitance mode supports up to 90 channels by connecting them in a matrix to the X- and Y-channels. The number of available channels depends on which device in the family is used. No external components are needed to perform the touch acquisition in either mode. The difference is illustrated in Figure 1.

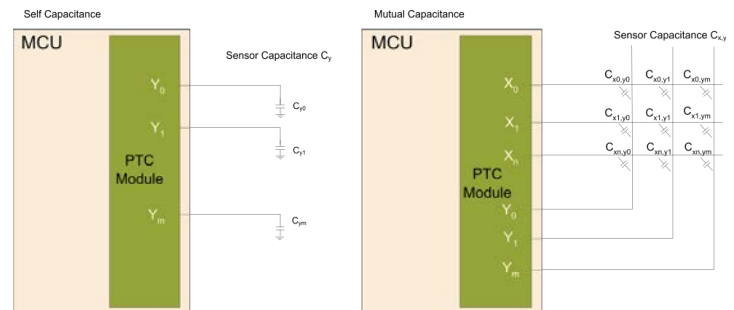


Figure 1: Self Capacitance and Mutual Capacitance Touch Implementations

To save power, the PTC places the device in a state of very low current consumption while periodically scanning the capacitive touch buttons to detect a signal to wake up. The Event System also enables the MCU to stay in deep sleep mode and only be awakened when a touch event occurs. The PTC is able to monitor the channels completely independent from the MCU.

Serial Communication Interface

Providing excellent flexibility for automotive applications, the SAM HA series of SiPs offers up to five serial communication interface (SERCOM) peripherals. This innovative module is fully software configurable to handle I²C, USART, LIN and SPI communications. Proven and qualified LIN stacks, available from various vendors, use the SERCOM to provide LIN functionality for one or more slave nodes on the same controller. To save power, the SERCOM can also be used to wake up the device from standby mode only if there is activity on the LIN bus. The device can wake up quickly enough to receive and respond to the first frame.

(continued on page 13)

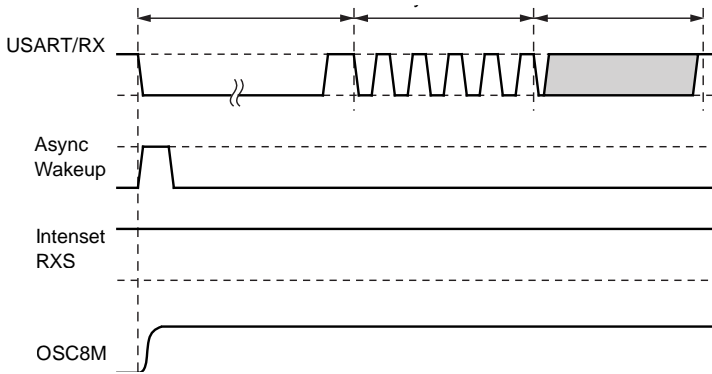


Figure 2: LIN Frame

SleepWalking

Microchip's SleepWalking technology is another feature available in the SAM HA series of SiPs. Designed to minimize current consumption, SleepWalking allows a system to save power by only activating clocks when they are necessary for a peripheral to perform its function. While the device is in sleep mode, all the clocks are usually switched off to avoid unnecessary power consumption. The necessary clocks can be temporarily enabled without CPU intervention, allowing the CPU to remain in sleep mode for the whole process. The Event System and the SleepWalking capability can be combined to minimize power consumption as illustrated in the following example:

- The CPU is sleeping and a timer is triggering an Analog-to-Digital Converter (ADC) measurement every second via the Event System.
- When that trigger occurs, the ADC will turn on the clock necessary to run the ADC measurement and will turn it off when it is no longer needed.
- The ADC will compare the sampled value to the previously stored threshold and wake up the CPU if the sampled value is within the window.
- During this entire process, the CPU remains in sleep mode and the relevant clocks are only active when they are actually needed.
- Another benefit is that the latency between the timer elapsing and the actual processing of the event is shorter and deterministic as shown in Figure 3.

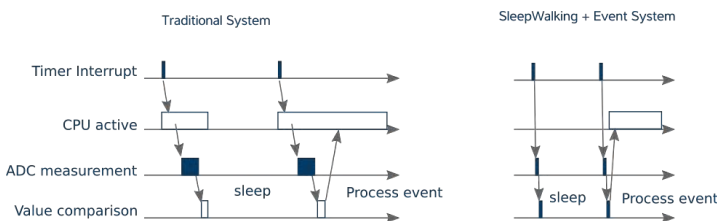


Figure 3: Timing Comparison between Traditional System and Combination of SleepWalking and Event System

Integrated Voltage Regulator

Because of its very flexible peripherals, the SAM HA family of SiPs can address the requirements of a wide range of applications. For example, the integrated voltage regulator eliminates the need for external components to save costs, while reducing the footprint of the device to make it ideal for small modules.

Integrated LIN-SBC

The space-saving, integrated LIN-SBC has two functions. First, it provides a 3.3V/85 mA low-drop voltage regulator that is intended to power the MCU and other devices on the module. This enables small modules to be powered entirely via the battery without the need for an additional voltage regulator. Second, it provides a LIN transceiver designed according to the LIN 2.2A, ISO17987 and the SAEJ2602-2 specifications. TXD and RXD are connected internally and only the bus pin needs to be routed on the PCB.

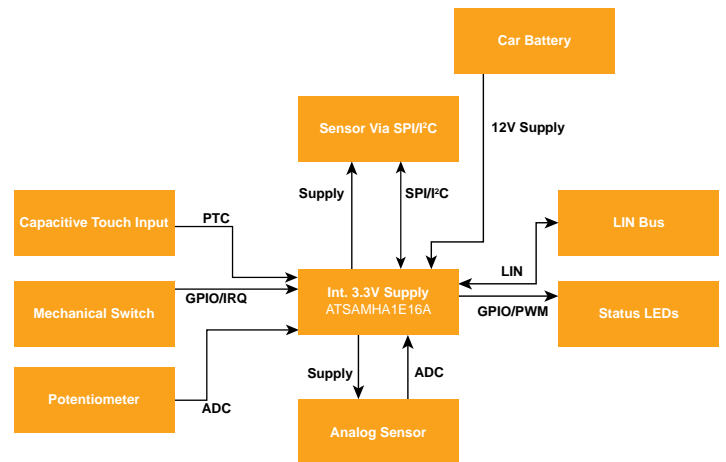


Figure 4: Example Application Using a SAM HA Solution

To get started with developing low-cost and yet highly integrated LIN-connected automotive applications using the new SAM HA family, visit our [LIN System-in-Package Solutions page](#). For extra design flexibility, the two ICs used in these SiPs are available as standalone families of devices with additional variants. You can choose devices with different pin counts, devices without LIN functionality and devices with other options. This enables to you to reuse code as you develop similar applications with slightly different requirements. The SAM HA devices can be purchased from [microchipDIRECT](#) or from [Microchip's worldwide distribution network](#).

Focused on the Road

Automotive-Qualified 3D Gesture Recognition Controller Adds Convenience and Limits Driver Distraction

MGC3140 Simplifies Automotive Human-Machine Interface Designs

As more technology is making its way into modern vehicles, car manufacturers are increasingly implementing functional safety features in an effort to reduce driver distraction. Many Human-Machine Interface (HMI) designers are turning to gesture recognition as a solution to improve driver and vehicle safety without sacrificing interior design. These gesture-controlled applications allow drivers to easily control everything from switching on lights to answering phone calls while still focusing on the road.

Well-suited for a range of applications that limit driver distraction and add convenience to vehicles, the **MGC3140** has recently been added to our family of easy-to-use, three-dimensional (3D) gesture controllers. As the first Microchip 3D gesture controller to be qualified for automotive use, this capacitive technology-based air gesture controller is an excellent option for navigating infotainment systems, sun shade operation, interior lighting and other applications. The technology also

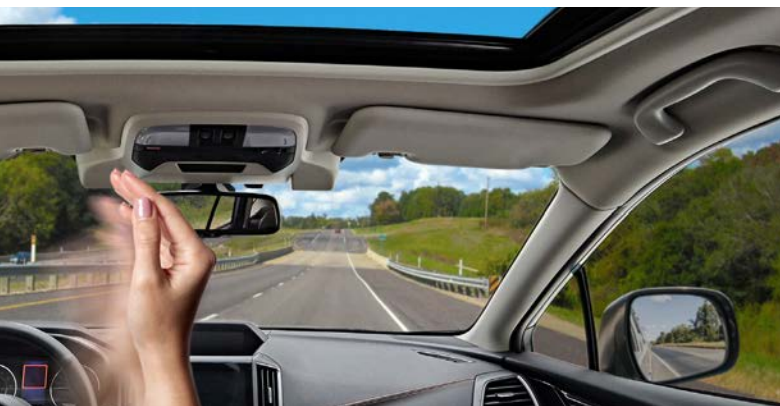


supports the opening of foot-activated rear liftgates and other functions that can be operated with a simple gesture action.

Each 3D gesture system consists of a sensor that can be constructed from any conductive material plus the MGC3140, which is tuned for each individual application. While existing solutions such as infrared and time-of-flight technologies can be costly and operate poorly in bright or direct sunlight, the MGC3140 offers reliable sensing in full sunlight and harsh environments. Other solutions on the market also come with mechanical integration challenges and require significant infrastructure and space to be integrated in a vehicle. Since the sensor can be hidden from view in an MGC3140-based HMI design, innovative and ergonomic interior designs can be created with fewer physical constraints.

It offers reliable sensing
in full sunlight and
harsh environments.

This durable, single-chip solution for advanced automotive HMI designs offers the lowest system cost in the automotive industry. The MGC3140 is Automotive Electronics Council AEC-Q100 qualified with an operating temperature range of -40 to +125°C, and it meets the strict Electromagnetic Interference (EMI) and Electromagnetic Compatibility (EMC) requirements of automotive system designs.




The MGC3140 is the first Microchip 3D gesture controller to be qualified for automotive use.

Development Tools

The Emerald Evaluation Kit provides a convenient evaluation platform for getting started with the MGC3140 3D gesture recognition controller. The kit includes a reference Printed Circuit Board (PCB) with the MGC3140 controller, a PCB-based sensor to recognize gestures, as well as all necessary cables, software and documentation to support an easy-to-use development experience. The MGC3140 is also compatible with the Aurea software development environment that supports all Microchip 3D gesture controllers.

To take advantage of our proven gesture technology and create an intuitive HMI to reduce driver distraction in vehicles, contact

NEW PRODUCTS

any **Microchip sales representative or authorized worldwide distributor** to get information about pricing and request samples of the MGC3140. 

Want More Information?

Visit the website at:

www.microchip.com/MGC3140



Special High-Volume Pricing Available Directly from Microchip

Quotes Will be Processed Within 48 hours.
Use Your Requested Quantity for Multiple Purchases Throughout the Year

microchip
DIRECT

This Feature is Only Available for Business Accounts

Audiophile-Quality Sound

NEW PRODUCTS

Create High-Resolution Audio Devices Using New Bluetooth® Audio System-on-Chip with Sony's LDAC™ Technology

Enables Immersive Audio Sound in Audeze's Award-Winning and High-End Mobius Gaming Headphones

With mainstream consumer demand for high-quality audio experiences growing, users expect Bluetooth audio devices to create an immersive and uninterrupted listening experience. However, Bluetooth audio designs are often limited by the bit depth and frequency rate of existing codecs, which are the communication and compression technology used to send audio over the air.

To address this increasing demand for high-quality audio with the convenience and ubiquity of Bluetooth wireless, the **IS2064GM-0L3** is a fully-certified, Bluetooth 5-compliant System-on-Chip (SoC) with Sony's LDAC audio codec technology*. This SoC allows manufacturers to develop a new generation of audio devices with an advanced codec, extending high-resolution audio beyond audiophiles and into mass market Bluetooth wireless products.


Upscale headphone manufacturer, Audeze, has implemented the SoC into their high-end Mobius gaming headphone. This headphone utilizes Microchip's IS2064GM-0L3 SoC for the Bluetooth wireless connection supporting LDAC and other audio



codec interfaces. Sony's LDAC is considered the highest-quality audio codec available. It transmits up to 990 kbps data throughput, which is three times higher than the standard Bluetooth Sub-band Codec (SBC), and maintains frequency and bit depth of up to 96 kHz/24-bit. The high compression and reproduction efficiency enables high-resolution audio listening experiences for Bluetooth audio devices.

"Our new Mobius headphone features many groundbreaking technologies. To ensure high-quality Bluetooth audio we implemented Microchip's IS2064GM-0L3 SoC in our headphones," said Sankar Thiagasamudram, CEO of Audeze. "Thanks to the outstanding support from Microchip, we were able to incorporate the LDAC codec quickly and easily into our products."

The IS2064GM-0L3 SoC not only makes the LDAC codec available to the broader market of audio product vendors, it also allows customers to utilize Microchip's outstanding global technical support to assist them with implementation and getting to market faster. The LDAC codec is also integrated into the Android 8.0 Oreo™ operating system Bluetooth stack, making the LDAC technology more widely available on the transmit side.

The IS2064GM-0L3 is available to customers upon request after approval. For additional information, contact any **Microchip sales representative** or send an email to **BTAudio@microchip.com**. Contact Sony directly for information on licensing requirements when using **LDAC technology**. To learn more about Microchip's complete line of Bluetooth audio products, visit our **Bluetooth Audio Design Center**. 

**A separate license from Sony Video & Sound Products Inc. is required to implement the LDAC audio codec technology. LDAC is a trademark of Sony Corporation. Android 8.0 Oreo is a trademark of Google LLC.*



Dual-Mode Power Monitoring

Single IC Offers Industry-Leading Accuracy for Real-Time Power Measurement of AC and DC Power Supplies

Maximize System Performance with MCP39F511A Power Monitoring IC

In the rapidly evolving energy management market, the need for power monitoring has become more prevalent as developers look to monitor product performance and improve energy usage for applications like smart cities and smart homes. In systems that use both AC and DC power, such as solar inverters, smart lighting and cloud servers, the implementation of dual-mode power monitoring traditionally requires multiple ICs to ensure superior performance and accuracy.

To optimize performance and ease development of these systems, the **MCP39F511A** is a flexible dual-mode power monitoring IC that measures both AC and DC power supplies with industry-leading accuracy of 0.1 percent error across a wide 4000:1 range. The MCP39F511A automatically senses power supply types and switches between AC and DC modes, optimizing measurement results. With standard power calculations such as active, reactive and apparent power, active and reactive energy, root-mean-square (RMS) current and voltage,

line frequency and power factor, as well as event monitoring included in this single compact IC, you can easily add highly accurate power monitoring functions to your end application with minimal firmware development.

Suitable for a wide range of applications, the MCP39F511A is a highly integrated device.

Suitable for a wide range of consumer, Internet of Things (IoT) and industrial applications, the MCP39F511A is a highly integrated device that addresses the growing need for more accurate power measurements in high-performance designs. To simplify calibration procedures and support most accuracy requirements, two 24-bit delta-sigma Analog-to-Digital Converters (ADCs) with 94.5 dB of signal-to-noise ratio plus distortion (SINAD) performance and a 16-bit calculation engine are included. The device also includes an on-chip EEPROM that logs critical events to help you troubleshoot issues, as well as an integrated low-drift voltage reference and internal oscillator to reduce implementation costs.

To further simplify your development efforts, the MCP39F511A includes advanced features such as auto-save and auto-load of power quantities to and from the EEPROM at power loss or start, ensuring that measurement results are never lost if power is disrupted unexpectedly. Event monitoring of various power



Monitor product performance and improve energy usage for applications like smart cities and smart homes.

(continued on page 18)


conditions also enhances preventive system maintenance and enables you to better manage power consumption.

NEW PRODUCTS

Development Tools

To help you get started with your development, the **MCP39F511A Power Monitor Demonstration Board** (ADM00667) is a fully functional single-phase power and energy monitoring system. The system calculates and displays active power, reactive power, RMS current, RMS voltage, active energy (both import and export) and four-quadrant reactive energy. It connects easily through USB to the Power Monitor Utility Software. This software offers automated control to allow you to easily evaluate all system configuration settings and can also be used to create custom calibration setups. For volume purchases, Microchip's Application Center of Excellence offers custom

firmware devices based on the calibration of your hardware, helping to save calibration cost and time.

If you are ready to add accurate, real-time measurement of input power for AC or DC power supplies, the MCP39F511A is available in a space-saving 28-pin QFN package. You can order this new IC from **microchipDIRECT** or from **Microchip's worldwide distribution network**. 

Want More Information?

Visit the website at:

www.microchip.com/MCP39F511A

How Smart are Your Detachables?



Communicating on the Smart Grid

PL360B Power Line Communication Modem Streamlines Deployment of Smart Energy Equipment

Flexible, Programmable Solution Addresses a Variety of Smart Metering Markets and Requirements

Utilities around the world are starting to deploy the smart grid to deliver energy to their customers more reliably and efficiently. As a result of the uptick in the adoption of this new energy management infrastructure, smart meters must be designed to offer improved performance and reliability to address the needs of multiple markets. Equipment manufacturers are dedicating extensive resources to the development of different versions of products based on existing and emerging industry-standard Power Line Communication (PLC) protocols. Developing this multi-protocol and field-upgradable metering infrastructure equipment presents a number of design challenges.

To help meet these challenges, Microchip has introduced a new device to its portfolio of industry-leading smart energy products. The **PL360B** is a flexible and programmable PLC modem



that can support multiple standard and proprietary protocols in the frequency band up to 500 kHz. It is designed to address PLC protocols such as ITU G.9903 (G3-PLC) and ITU G.9904 (PRIME), as well as CENELEC, FCC and ARIB compliant applications, including Internet of Things (IoT) and smart energy implementations. For applications where security is a concern, the PL360B incorporates a cryptographic engine and secure boot to support Advanced Encryption Standard (AES) 128, 192, and 256 operations.

With its efficient use of power, the PL360B modem delivers up to a 25 percent improvement in power consumption over previous generations of devices. It also features a Class D amplification scheme that optimizes the modem transmission efficiency even further.

The PL360B provides an additional level of design flexibility on the host side.

Developed to be driven by a range of external Microchip host devices, the PL360B provides an additional level of design flexibility on the host side. This PLC modem enables equipment manufacturers to address different end-customer regulations, markets and operational requirements. The single device can be adapted simply with firmware, significantly reducing development costs and time to market.



Smart meters must be designed to offer improved performance and reliability to address the needs of multiple markets.

(continued on page 20)

Development Tools

To provide a starting point for developing a complete smart meter, the **PL360B Evaluation Kit** (ATPL360-EK) includes two evaluation boards to establish point-to-point communication. It also provides PC tools designed to evaluate the performance of the PL360B, including a PHY tester for point-to-point test, a PLC “sniffer” to capture PLC traffic in a deployed network and a PLC manager to manage the resulting network. G3-PLC and PRIME-PLC communications firmware is provided free of charge.

Reference designs, which include design files, bill of materials and schematics, are also available. These include designs for a complete electricity meter with PLC, for a single PLC modem and for a master PLC device in charge of mastering a complete network of PLC nodes.

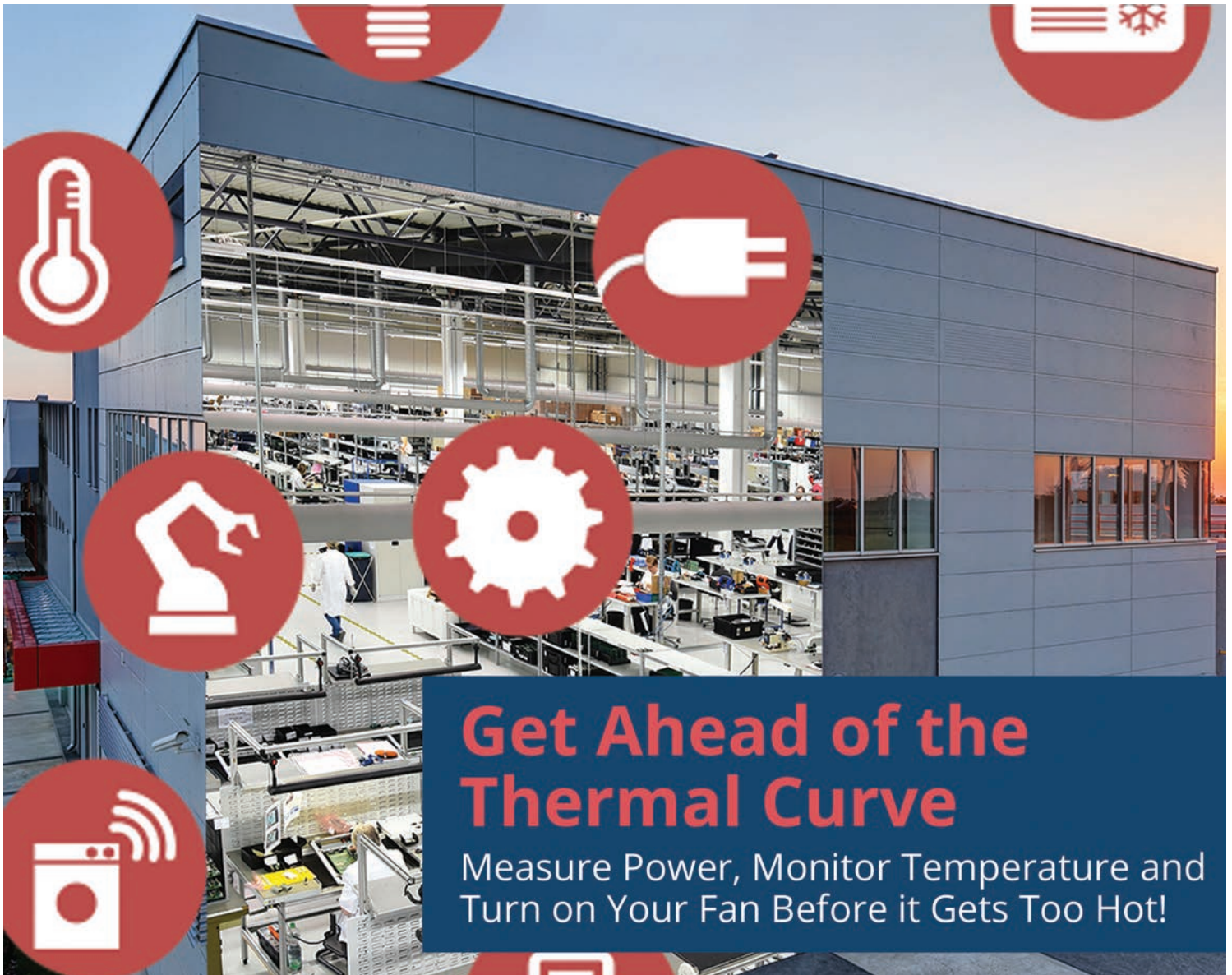
NEW PRODUCTS

If you are looking for a flexible and programmable solution to develop a high-performance smart meter, the PL360B PLC modem is available in 48-pin TQFP and QFN packages and can be purchased from **microchipDIRECT** or from **Microchip's worldwide distribution network.**

Want More Information?

Visit the website at:

www.microchip.com/PL360B



Get Ahead of the Thermal Curve
Measure Power, Monitor Temperature and Turn on Your Fan Before it Gets Too Hot!

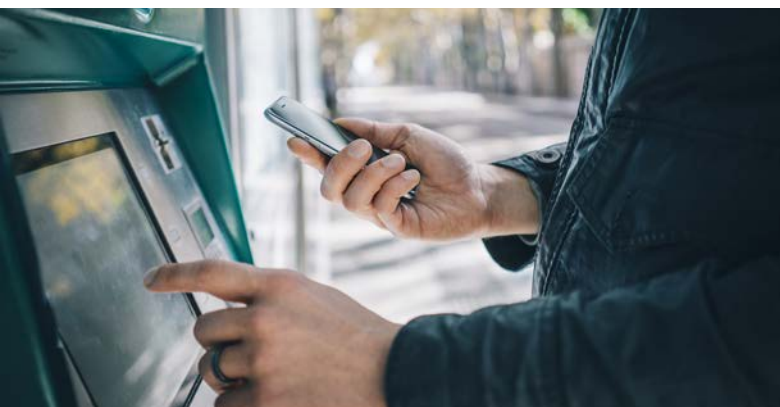
True Power Measurement

PAC1932 and PAC1933 DC Power Monitoring ICs Measure Power from 0V to 32V on Single Chip

Industry's First Two-Channel Device with Native 16-bit Resolution Improves Power Measurement Accuracy

Managing and reducing power consumption is crucial in low-voltage, high-power applications such as Field-Programmable Gate Arrays (FPGAs), Graphics Processing Units (GPUs) and embedded computing devices. These devices must first accurately measure power before they can manage it, but precision power measurement solutions are often costly and require multiple ICs or power configurations to measure different rails.

Two new options are now available for improving power measurement accuracy in a range of low-voltage, high-performance embedded computing, industrial and portable power applications. The **PAC1932** and **PAC1933** are easy-to-adopt DC power monitoring devices that can measure from 0V to 32V. The two-channel PAC1932 and three-channel PAC1933 integrate their multiple channels in a single package for applications such as Point of Sale (POS) systems, ATMs and building



The PAC1932 and PAC1933 integrate their multiple channels in a single package for applications such as ATMs.

NEW PRODUCTS




automation. This reduces design costs while also consolidating the Bill of Materials (BOM), as the measurement of sub 1V to 20V voltage rails normally require separate components to measure each rail efficiently. Since the PAC1932 and PAC1933 can measure voltage rails under 1V to as high as 32V, you do not need to reconfigure measurement resolution between low- and high-current load events. The devices also include two 16-bit Analog-to-Digital Converters (ADCs) that can measure voltage and current simultaneously, so you can extract a true power measurement and design your system to efficiently save power.

The PAC1932 is also the industry's first two-channel power monitor with native 16-bit resolution, providing leading flexibility across a wide measurement range. It can measure without host intervention for 17 minutes, so you do not need to adjust the voltage or current range to measure power and energy.

Development Tools

The PAC1932 and PAC1933 work in conjunction with Linux® and Windows® 10 software drivers. As members of the same family of devices as the PAC1934, the PAC1932 and PAC1933 are register compatible with the **PAC1934 4-Channel DC Power Monitor Evaluation Board** (ADM00805), which can be used to start development with a graphical user interface reporting V_{SENSE}, V_{BUS}, power and accumulated power.

If you are seeking a precise DC power measurement solution to reduce power consumption in your application, you can purchase devices in the PAC193x family from [microchipDIRECT](#) or from [Microchip's worldwide distribution network](#). 

Goodbye Mechanical Buttons

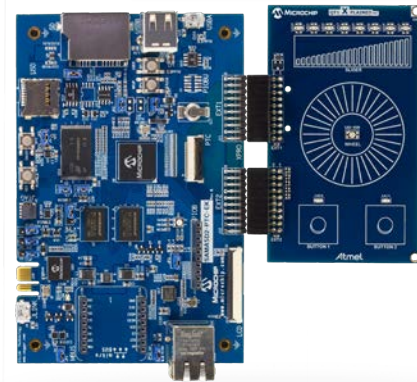
SAMA5D2 Microprocessor Features
Embedded Capacitive Touch Capabilities

Development Tools Simplify Implementation of
Feature-Rich User Interfaces for Modern Designs

As users are increasing coming to expect touch interfaces in the products that they interact with on a daily basis, it seems like mechanical buttons and switches are being relegated to the annals of inventions whose time has come and gone. But selecting the right device to provide this type of functionality can be challenging for embedded designers.

The high-performance, ultra-low-power **SAMA5D2** series of Arm® Cortex®-A5 based microprocessors (MPUs) is an excellent choice for a wide range of home automation, consumer and industrial applications that require user input to implement control functions. These devices integrate powerful peripherals for connectivity and user interface applications and offer advanced security functions to meet many of your design requirements. The connectivity peripherals include a 10/100 Ethernet MAC, up to three high-speed USB controllers, two CAN controllers and up to 10 UARTs.

For developing user interfaces, the integrated Peripheral Touch Controller (PTC) with QTouch® technology supports both



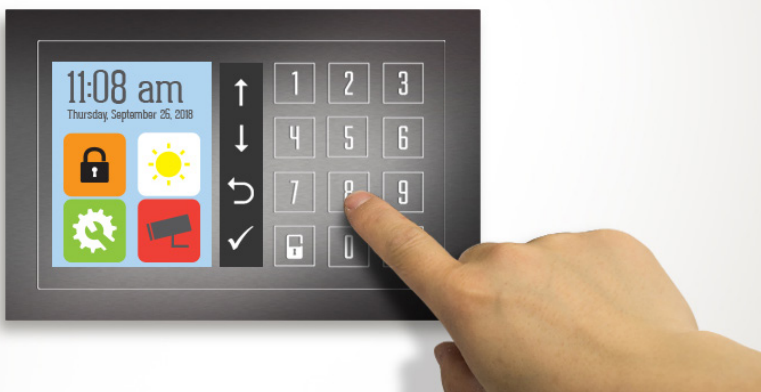
mutual and self-capacitive measurement without the need for any external components. The PTC enables you to add up to 64 robust capacitive touch buttons, sliders, wheels, and proximity detection to your user interface. Other user interface peripherals include an LCD TFT controller, a class D amplifier, audio PLL and a CMOS sensor (camera) interface.

To protect customer code and secure external data transfers, the SAMA5D2 MPUs include Arm TrustZone® technology, tamper detection, secure data storage for private keys, a hardware encryption engine, on-the-fly decryption of code stored in external DDR or QSPI memory and secure boot.

Software support for the SAMA5D2 family MPUs is available from a range of **Real Time OS (RTOS) providers**. If you are creating an application based on the Linux® Operating System (OS), Microchip has created and supports a free **Linux** distribution. To meet the needs of this open-source community, we provide full coverage of the SAMA5D2 peripherals in the Linux kernel, as well as bootloaders such as AT91Bootstrap, U-Boot and Barebox. Cross-build environments such as Buildroot and OpenEmbedded/Yocto allow you to generate Linux user-space applications and customized root file systems.

The PTC and Conducted Noise Immunity

The PTC has been designed to make it easy to develop a capacitive touch solution while maintaining a high quality of touch and performance. However, when developing a touch sensing application, you should consider how any electrical interference in the target environment might affect the performance of the



The ultra-low-power SAMA5D2 series of microprocessors is an excellent choice for applications that require user input.

(continued on page 23)

sensors and where to appropriately apply suitable techniques to address the effects of unwanted noise disturbances.

Conducted noise refers to unwanted “noisy” RF voltages and currents carried by external wires and cables. The source of this unwanted noise can include RF transmitters, switched-mode power supplies and other interconnected devices that have electronic activity in the RF range. Conducted noise is generally in Common-Mode (CM) and appears across all connecting cables to a device. Capacitive touch applications are generally not affected by CM noise until human interaction takes place. The user’s finger provides a return path and effectively couples noise directly into the capacitive sensor. When this noise reaches levels where normal filtering algorithms become ineffective, errors are introduced into the touch measurement and the system becomes unreliable. This can manifest itself by way of undetected touches, false touches or, in some cases, a complete system lock-up.

Microchip performed measurements using the PTC in noisy conditions, indicating that touch operation in the presence of noise is possible. Conducted immunity tests at 1V, 3V, 6V and 10V were carried out in self-capacitive configuration (with maximum filtering setup) and no false events were observed. Conducted immunity tests at 1V, 3V and 6V were carried out in mutual configuration (with maximum filtering setup) and no false events were observed.

Keep in mind that noise immunity comes at a cost of increased touch response time and power consumption, so it is important to properly tune the touch sensors to ensure the best noise immunity performance. Our application note, [AN2585: Implementing QTouch PTC Subsystem on SAMA5D2 MPU](#), provides the recommended configuration values to optimize the PTC module.

Jump-Start Your Capacitive Touch Development

Once you have made the decision to use a SAMA5D2 MPU in your touch-enabled design, Microchip offers a set of easy-to-use and intuitive development tools that will enable you to leverage the high performance of the PTC to add low-power, high-sensitivity and environmentally robust capacitive touch buttons, sliders and wheels to your user interface.

The featured-packed **SAMA5D2 PTC Evaluation Kit Bundle** (DM320108-BNDL) is an excellent way to get acquainted with the capabilities of the PTC. It includes the SAMA5D2-PTC-EK development board and the QT1 Xplained Pro Extension Kit, which contains one board for implementing self-capacitive touch and one board for implementing mutual capacitive touch.

The SAMA5D2-PTC-EK development board is configured with an external UART port via a PC running the Windows® operating system. An easy-to-use MPU QTouch Configurator Graphical User Interface (GUI) provides you with access to the PTC Toolbox, which is a set of Read/Write console instructions that you can use to configure the touch sensor for robustness, speed or sensitivity. The GUI provides a visualization of the sensors’ data signals and performance to accurately show touch behavior in real time. When you have finished optimizing the touch parameters, you can export a file containing the configuration data. This can then be used with the QTouch Library software drivers for Linux ([linux4sam](#)), bare-metal and RTOS ([Software Package](#)). These tools speed the development of your touch-enabled design by eliminating the need for any specific touch software development.

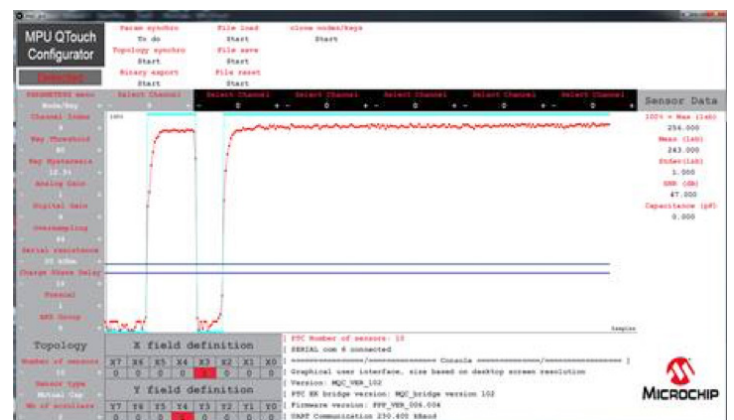



Figure 1: MPU QTouch® Configurator displays touch sensor behavior in real time

So say goodbye to mechanical buttons. Take advantage of the robust and reliable capacitive touch capabilities and easy-to-use development environment of the SAMA5D2 series of MPUs and add a sleek and intuitive touch interface to your new product. 

It's a Snap

Affordable, Fast and Easy Debugging is Now Available for Most Microchip Microcontrollers

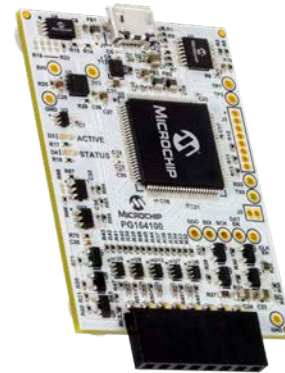
MPLAB® Snap In-Circuit Debugger/Programmer Is Latest Addition to MPLAB Development Ecosystem

Cost, speed and ease of use: when it comes to selecting the right development tools for your project, all three of these factors are important. Sometimes a full-featured tool is too expensive and too hard to use, especially for entry-level users. Flexibility is also important. The tool that you invest in should be able to support a wide range of devices to give you the freedom to innovate.

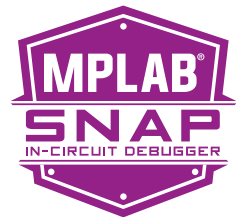
Making its debut at MASTERS 2018, the **MPLAB Snap In-Circuit Debugger/Programmer** (PG164100) is our most affordable debugger to date. Costing just \$14.95, the MPLAB Snap offers affordable, fast and easy debugging of most PIC® and AVR® Flash microcontrollers (MCUs), as well as dsPIC® Digital Signal Controllers (DSCs). It is especially designed to deliver all the speed and features entry-level users need to quickly learn about Microchip's products.

The MPLAB Snap doesn't skimp on performance though. Just like its companions in the MPLAB development ecosystem—the MPLAB PICKit™ 4 In-Circuit Debugger/Programmer and MPLAB ICD 4 In-Circuit Debugger—the MPLAB Snap features a 32-bit SAM E70 Arm® Cortex®-M7 based microcontroller (MCU) running at 300 MIPS. This means that your programming time is now only limited by the programming speed of your target device. Regardless of how large your code size is, the MPLAB Snap can deliver quick programming iterations and basic debugging functionality at an amazingly low price.


NEW TOOLS



To get started, simply connect the MPLAB Snap to your computer using the high-speed USB 2.0 interface, and then connect it to your target MCU using the 8-pin Single In-Line (SIL) connector. This connector uses two device I/O pins and the reset line to implement in-circuit debugging and In-Circuit Serial Programming™ (ICSP™). The MPLAB Snap also supports advanced interfaces like 4-wire JTAG and Serial Wire Debug (SWD) with streaming Data Gateway. It is backward compatible with demo boards, headers and target systems using 2-wire JTAG and ICSP.



The MPLAB Snap uses the powerful Graphical User Interface (GUI) of MPLAB X Integrated Development Environment (IDE) version 5.05 and later. While the MPLAB Snap supports most Microchip MCUs, the firmware will continue to be upgraded to add support for new devices. Feature upgrades can be easily managed by installing the latest version of MPLAB X IDE.

Would you like to program and debug your projects in a snap and at an amazingly low price? You can order the MPLAB Snap from **microchipDIRECT** today. 

Want More Information?


Visit the website at:

www.microchip.com/snap

PYTHON ON MICROCONTROLLERS

CREATE POWERFUL PROJECTS BASED ON ADAFRUIT HARDWARE AND PYTHON-DERIVED PROGRAMMING LANGUAGES

Contributed by Adafruit



In the ever-evolving world of technology, an interesting development in programming is currently uncoiling. A new wave of young engineers is entering the workforce, and these millennials are far more likely to be conversant in the Python programming language than in assembly and in C/C++. As Eben Upton, founder of the Raspberry Pi Foundation, discovered when recruiting master's level students, the educational system is trending towards teaching higher-level languages. According to a recent article published by *The Economist*¹, by 2014 Python was the most popular introductory programming language taught in American universities. Just as assembly made way for C/C++ during the 1980s and 1990s, now C/C++ is starting to yield to Python in some areas.

(continued on page 26)

There are several good reasons why this is the case. As an interpreted language, Python offers advantages not available to the previous generation of programmers. The structure is readable and there are no type declarations. Entering text is as simple as typing a text message. Any change to the code can just be rerun without any need for compiling. This simplifies the learning and project development processes significantly. It provides students with the ability to see that their programs are functional within one class period, rather than trying to get to a “Hello World” experience over several hours or even several weeks of class time. From the educator’s perspective, Python also has benefits. Many schools do not have the resources to maintain a fleet of networked Windows® machines loaded with compilers and offering access to the Internet. Using Python allows educators to work with the lightweight and application-locked hardware that they do have available.

As new graduates move into their engineering careers, they are bringing their knowledge of Python with them. There are some fundamental reasons why Python is very suitable for professional developers who are working on projects using hardware platforms featuring today’s powerful and capable microcontrollers (MCUs) that also offer more RAM and Flash memory.

Ease of Use and Simplified Development Environment

As a high-level programming language, Python is easier to read, write and maintain. Because it provides a built-in interpreter, a separate compiler is not necessary. Code can be written on any operating system, providing flexibility for developers. Python also offers support for modules and packages, making it easy to reuse code for other projects.

Ease of Transferring Code to an MCU

The next innovation that has made Python a viable programming option is the USB Flash drive. Earlier development environments

required that the engineer have experience in using DFU or COM port commands to connect a device to a computer. An MCU board running Python can simply be plugged into the computer and appear as a common external USB Flash drive. This allows code and other files, such as audio files, to be copied to the device in seconds.

Ease of Communicating with the User

Most of the hardware platforms that are available today have some sort of status Light Emitting Diodes (LEDs) to indicate to the user what is going on inside the silicon. But in many cases, providing some sort of text message to the user is also important. The Mu editor that is available for **Micropython** and **CircuitPython** provides an editing environment, downloads code without hassle, and provides text and plotting capabilities for user interaction.

The one downside of using Python code on MCUs is also one of the strengths mentioned earlier: it is interpreted when it is run. While this makes it quick and easy to change and update the code, it requires more compute power than some older development boards were capable of providing. Fortunately, the MCUs used on many of the latest development boards are more than capable of providing the necessary computing power for Python programming. Microchip’s recently introduced low-cost, high-power SAM D line of 32-bit MCUs provide the memory and speed required for Python-based applications.

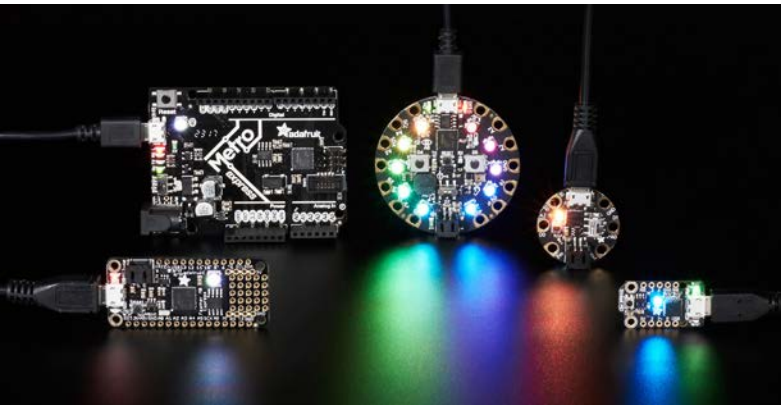
At Adafruit, we have selected the SAM D21 Arm® Cortex®-M0+ based MCU series for our simpler, “getting started” **CircuitPython boards** and the high-power SAM D51 Arm Cortex-M4 based MCU for a speedy and higher-memory development experience. The most important peripheral on both MCUs is the built-in USB support. Having a solid USB stack and tons of endpoints is essential for CircuitPython, since we have a composite USB interface with support for serial USB CDC, mass storage device, HID for keyboard/mouse and possibly even WebUSB in the future.

Another great peripheral on the SAM D51 MCU is the Quad Serial Peripheral Interface (QSPI) to make storing a filesystem with code on SPI Flash easy and incredibly fast. Both the SAM D21 and SAM D51 series of MCUs have plenty of Analog-to-Digital Converters (ADCs), which makes sensor interfacing a breeze. The SERCOMs that are available on the SAM D MCUs also work well with CircuitPython, since they enable us to dynamically create bus devices on just about any group of pins.

(continued on page 27)



Our favorite peripheral is the Digital-to-Analog Converter (DAC). The SAM D21 series has a single 10-bit DAC, while the SAM D51 has a dual 12-bit DAC. By using timers, events and lots of DMA all over the place to speed things up, we are able to decode and play a wave file audio right from the SPI Flash for audio effects and musical playback. This makes for some great interactivity.



Adafruit's family of CircuitPython boards

At this point in history, it looks like Python is among the programming languages that will be significant in coming years in both the educational world and the professional world. It will be used to program devices ranging from microcontrollers to mainframes, and code development will be able to be done on any machine and be modified on the go. CircuitPython and the current generation of 32-bit Microchip MCUs provide the capabilities and the hardware developers need today and into the future.

To learn more about Adafruit and its products, and to find out more about using CircuitPython to create your next project, please visit www.adafruit.com.

'Python has brought computer programming to a vast new audience,' The Economist (July 19, 2018). Retrieved from: <https://www.economist.com/science-and-technology/2018/07/21/python-has-brought-computer-programming-to-a-vast-new-audience>

Covering Analog Needs From Simple to Complex

High-Performance Devices to Handle Every Design Challenge



Looking for New Options?

Flexible and Cost-Saving Approaches to Development Tool Ownership

With the ongoing pressure to minimize costs, design engineers and purchasing managers need creative options when it comes to investing in development resources. The conventional model—where a company purchases the development tools, code libraries and generators that they require for a specific project—typically results in these tools being used for a limited time until that project is complete. While there might be a future opportunity to use some of these resources again before they become obsolete, they generally end up being budgeted as Non-Recurring Engineering (NRE) costs.

As new paradigms for accessing development tools have emerged, Microchip has introduced several flexible ownership models that can reduce costs while giving you access to our powerful ecosystem of tools for development of projects based on PIC® microcontrollers (MCUs) and dsPIC® Digital Signal Controllers (DSCs). These include a monthly subscription for the MPLAB® XC PRO Compilers, our free cloud-based MPLAB Xpress Integrated Development Environment (IDE) and the ability to manage multiple development tool licenses within a single account on microchipDIRECT.

Monthly Compiler Subscriptions

While the optimizations available in the free versions of the **MPLAB XC Compilers** generally provide code size reductions and speed enhancements that meet the requirements of

most projects, sometimes your application might need the maximum optimizations and best performance. Rather than requiring that you make a permanent investment in software development tools that are destined for short-term use,

Microchip has introduced monthly subscription licenses for the PRO Editions of these compilers. This means that you only need to pay for access to the PRO version while you are actively using it. The renewable monthly subscription for the MPLAB XC PRO Compilers can be canceled without penalty at the end of your development phase and reinstated when your next product reaches the software development stage. This option not only allows you to minimize and spread out your investment in software development tools, it also provides you with access to the latest version of the PRO compiler. Rather than relying on a legacy development kit which was purchased for an earlier design, you can be sure that you are using the most up-to-date tool to meet the demands of your project.



Free Cloud-Based Development

Easy and free access to development resources is another way to cut your costs while simplifying your design process. **MPLAB Xpress Integrated Development Environment (IDE)**

(continued on page 29)


is a cloud-based development platform for 8- and 16-bit PIC MCUs and dsPIC DSCs. It offers an easy-to-use Graphical User Interface (GUI) and can be accessed via any Internet-connected computer running Windows® or Mac OS® operating system software. Offering plenty of storage, this platform can be used around the world by students, educators, makers and professional design engineers to create designs without being tied to a PC. One of the advantages of using MPLAB Xpress IDE is the ability to interact with the community of other users. You can share ideas and projects and get inspired by other users' contributions to the code repository. We also offer MPLAB Xpress Evaluation Boards, Curiosity Development Boards and the Explorer 16/32 Development Board, all of which can be used with MPLAB Xpress IDE to help you get started with your embedded application.

Using a Single Account to Manage Licenses

For commercial users, managing development tool licenses can be a challenging task. However, we have simplified this

process. When you purchase multiple hardware or software tools from **microchipDIRECT**, the registration information is captured within your account. The development licenses can be accessed, reviewed, activated or updated at any time, all from a single account. This saves you time and eliminates the frustration of searching for registration information associated with different tools and using multiple websites to manage the licenses.

As the pressures intensify to bring your products to market cost effectively and ahead of the competition, these flexible options for development tool ownership will provide you with a lower-cost entry point into designing your projects and reduce your total expenditure on development resources.

Please visit our [Development Tools](#) page to learn about the many resources we offer to get your design up and running in no time. 



Effortless Design with Microchip

Easy-to-Use Embedded Intelligence Supported by World-Class Development Tools and Software

From Frustration to Funded



Open Source LoRaWAN™ Compatible Device Makes It Easy to Configure and Deploy Internet of Things Applications

Contributed by Third Venture, Inc.

Prior to founding Third Venture, Steven Osborn worked on a solution to enable vineyard owners to remotely monitor the status of their wine grapes. Originally using expensive and not very robust XBee radios, this solution also offered poor tools for testing network health. It was pretty challenging and frustrating. Over the past two years, Steven has been working with devices that take advantage of the long-range and low-power LoRa® wireless technology to meet the needs of this project. As a result, he ended up designing the LoStik to make working with Internet of Things (IoT) networks much simpler for the vineyard owners.

Third Venture's design goal for LoStik was to build an easy-to-use device for developers and integrators that could primarily be used for testing and deploying new or existing LoRaWAN networks. This USB dongle plugs into any PC and is compatible with **The Things Network**, enabling you to configure the device for LoRaWAN connectivity and begin sending packets in mere minutes. It was designed to be portable so that you can work out in the field without carrying around development boards, programmers, serial adapters and wires. Featuring Microchip's **RN2903** (US) or **RN2483** (EU) LoRa technology module, the LoStik requires no additional coding or external microcontroller (MCU). LoStik's open-source hardware and software design includes several code samples for configuring, sending and receiving packets in Python. It is even possible to blink the two user-programmable LEDs by toggling the GPIO pins over the UART connection.

With its high-level interface, the RN2903/RN2483 module was the obvious choice for the LoStik. It provides a versatile solution for LoRa technology-based client development, and it really shines for ease of use with the provided text-based UART interface. This enables you to build low-power, battery-driven devices using your choice of MCU. The RN2903/RN2483 is also great for interfacing with a Raspberry Pi® or Arduino® device, so it can inspire you to create some great DIY projects.




The various prototype stages of LoStik, with the most current version shown on the far right.

(continued on page 31)

Having used LoStik in the field for many months, Third Venture decided to open source the design and share it with other developers. At the same time, they launched a funding campaign through **Crowd Supply**. This campaign quickly reached its funding goal, and LoStik became a featured product on the site.

LoRa wireless technology is quickly finding a home in a wide range of applications. Whether you are a hobbyist just getting started out in creating a project for the IoT, or a professional

who is already familiar with LoRa technology and LoRaWAN networks, LoStik offers a variety of features that will make it easy for you to get your project up and running quickly. Please contact Third Venture at steven@thirdventure.co if you would like additional information on LoStik. 

Control of Anything, From Anywhere with Peace of Mind



Fast Debugging at an Affordable Price

MPLAB® Snap Offers Uncompromised Speed at an Amazing Low Price



The MPLAB Snap In-Circuit Debugger/Programmer allows affordable, fast and easy debugging and programming of most PIC® and AVR® Flash microcontrollers and dsPIC® digital signal controllers, using the powerful graphical user interface of MPLAB X Integrated Development Environment (IDE).

The MPLAB Snap Debugger/Programmer can be connected to your computer using a Hi-Speed USB 2.0 interface and can be connected to the target via an 8-pin Single In-Line (SIL) connector. The connector uses two device I/O pins and the reset line to implement in-circuit debugging and In-Circuit Serial Programming™ (ICSP™). It has all the speed and features entry-level users need to quickly debug their prototype.



www.microchip.com/snap

