HOW SECURE IS YOUR IoT DESIGN?

A Billion Possibilities

Single-Chip Timing

Step Up to Sliders or Wheels
How Secure Is Your IoT Design?
Simplifying Hardware Security Implementation for IoT Nodes
With the Award-Winning SAM L11 Microcontroller

A Billion Possibilities
Industry's Lowest-Power LoRa® System-in-Package Family
Accelerates Development of Remote IoT Nodes

No Need to Compromise
Extend Battery Life in Portable Devices and Save Space
With New Ultra-Low Iq LDO

Keep Your Gloves On
New Single-Chip maXTouch® Touchscreen Controllers
Support Automotive Touchscreens Up to 20 Inches

Single-Chip Timing
Industry’s Smallest Multi-Output MEMS Clock Generator
Offers Up to 80 Percent Board Space Savings on Timing Components

Freedom to Innovate
Industry’s First RISC-V SoC FPGA Architecture Brings
Real-Time to Linux® for Creating Low-Power, Secure and Reliable Designs

One Cable for All
INICnet™ Technology for Automotive Infotainment
Networking Supports Ethernet, Audio and Video

How to Implement Capacitive Touch With an AVR® Microcontroller
Take Your Idea to the Cloud

What data would you send to the Google Cloud and why? We have teamed up with Electromaker to give you the opportunity to try out our new AVR-IoT WG Development Board. To apply for a free board, think of an interesting project or application idea that you would like to build using it, and submit your project proposal to the Microchip IoT Contest. If we like the idea, then we will send you a board absolutely free. Once you have your board, you can start building your project and document your work on the Electromaker.io platform. We will then be awarding prizes for the top three project entries.

Featuring a powerful ATmega4808 AVR® microcontroller, an ATWINC1510 Wi-Fi® network controller and an ATECC608A secure element, the AVR-IoT WG Development Board is a smart, connected and secure platform that makes it easy to deploy IoT sensor nodes to the cloud in just minutes. It is also preconfigured to transmit light and temperature data to the cloud, allowing you to start collecting data instantly. The on-board mikroBUS™ connector is compatible with more than 500 MikroElektronika Click boards™, so you can add more sensors or other functionality to your design.

Some great prizes will be awarded to the top three project entries. The first prize is one free conference admission to a MASTERs 2019 event in the USA, Europe, South America, China, India, Taiwan or South Korea. The second and third prize winners will receive a hardware bundle containing a Curiosity PIC32MZEF Development Board, MPLAB® Snap Debugger, Arduino® Uno WiFi and five boards from MikroElektronika.

The contest is open now, and the deadline for applying for the free AVR-IoT WG Development Board is January 1, 2019. So, get your thinking cap on and write up your proposal for your innovative project soon. Visit the Microchip IoT Contest website to review the contest rules, terms and conditions and requirements. Good luck!

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
How Secure Is Your IoT Design?

Simplifying Hardware Security Implementation for IoT Nodes With the Award-Winning SAM L11 Microcontroller

Comprehensive Security Solution Framework Shortens Design Time to Bring Projects to Market More Quickly

The amalgamation of ultra-low-power computing plus connectivity that characterizes the Internet of Things (IoT) is at a critical crossroads. On the one hand, IoT nodes are promising to transform automotive, industrial, smart home, medical and a wide range of other applications. On the other hand, a continuous stream of news about security breaches—ranging from malware injections to Distributed Denial-of-Service (DDoS) attacks to battery-drain attacks—has eroded confidence in the IoT and jeopardized its future. Not surprisingly, vulnerabilities associated with security breaches in edge devices have become a major concern for IoT developers.

In a recent, high-profile example of how unprotected IoT nodes can be attacked, hackers were able to exploit the vulnerabilities in the connected thermometer in a casino’s fish tank to gain access to a database

(continued on page 5)
of high-roller gamblers. This attack illustrates how problematic IoT applications used in home and building automation can be if their connected thermostats, refrigeration and HVAC systems are not properly protected. Banks and commercial buildings are also potential targets since, many times, CCTV cameras that are connected across data networks lack the proper security to prevent hacking.

While security is typically implemented at the server and gateway levels in conventional connected applications, adding robust security to IoT node designs is much more challenging. This is due to the power constraints and small footprints of edge devices. Development of a comprehensive security scheme for IoT nodes can add significant overhead in terms of time and cost. As a result, designers need to strike an acceptable balance between low power usage and security. In other words, what they need is a solution that enables a low-power yet highly secure design, without compromising on performance, development time and cost.

For IoT edge devices running on batteries, conserving power is crucial. They require a power-efficient microcontroller (MCU) that can drastically reduce power consumption. Low-cost IoT node designs also require a simple, yet robust, solution for implementing secure boot, authentication, key storage and other security features. For many designers, security management is a highly complex subject with a steep learning curve, so the effort to add security to their project can potentially be a daunting and time-consuming process.

An Award-Winning 32-bit Microcontroller for Securing the IoT

As the winner of the 2018 Arm® TechCon Innovation Award for the best contribution to IoT security, our new SAM L11 Arm Cortex®-M23 based MCU was designed to meet the unique challenges of implementing security on IoT nodes. Boasting the industry’s lowest power consumption in its class, the SAM L11 is also the first 32-bit MCU to integrate chip-level security and Arm TrustZone® technology to help protect IoT nodes from physical tampering as well as man-in-the-middle and remote malware attacks. It is an optimal solution for developing secure, battery-powered applications.

The SAM L11’s hardware-based security features include an on-board cryptography accelerator (CRYA) that supports Advanced Encryption Standard (AES) encryption and decryption, Secure Hash Algorithm 2 (SHA-256) authentication and Galois Counter Mode (GCM) encryption and authentication. It also has an NIST-compliant True Random Number Generator (TRNG). With its combination of hardware-based security features, this MCU offers immutable secure boot and facilitates secure key provisioning to establish hardware root of trust.

The integrated Arm TrustZone technology allows the creation of a secure zone within the SAM L11 to restrict access to specific memory, peripheral and I/O components. It partitions the MCU into trusted and non-trusted zones and enables hardware isolation between certified libraries, IPs and application code. This hardware isolation, in turn, can play an essential role in protecting and isolating critical and sensitive data. The SAM L11’s immutable secure boot combined with Arm TrustZone technology creates a Trusted Execution Environment that can help counteract malware attacks, increasing the reliability of IoT nodes and preventing downtime during critical functions.

Anti-tampering features are available to enhance the physical security of an IoT node. The SAM L11 comes with up to four tamper pins to detect board-level tampering. The TrustRAM peripheral provides 256 bytes of RAM that protects against chip-level microprobing attacks and data remanence attacks. The SAM L11 can be programmed to timestamp any tampering events and erase critical and sensitive data if a tamper event is detected. This feature helps protect a system from cloning and intellectual property theft.

Creating extremely power-efficient IoT end nodes is also important. The SAM L11 microcontroller runs at 32 MHz and comes with up to 64 KB Flash and 16 KB SRAM memory. Built with picoPower® technology, which ensures low power
manufacturing phase, to implementation of security during your application development phase, to remote firmware upgrades any time during the lifecycle of the device. The framework includes Trustonic’s Kinibi-M security software that abstracts the lower-level details of the SAM L11’s security features and provides a modular GUI-based interface that enables you to pick and choose the relevant security module for your application.

For example, if you want to quickly implement a secure bootloader in your application, a module for this is available in the security framework. Not only does this eliminate the need for you to sift through hundreds of pages of the MCU’s data sheet to find out how to do this, it also means you don’t need any special training on embedded security, so you can focus on other aspects of your design. The various modules that are available in the security framework are shown in Figure 2.

Key Provisioning Options
Secure key provisioning helps establish a unique identity for each MCU and is one important way to protect your IoT end node. During the silicon manufacturing process at Microchip’s secure facility, the SAM L11 can be securely provisioned using Trustonic’s Root of Trust (RoT) flow.

If you have a proven security software framework, you can also use secure key provisioning services from SecureThingz. Key provisioning services from SecureThingz will be available at various distributor and contract manufacturing locations.

Simplifying Embedded Security
If you are ready to implement the SAM L11’s security features in a low-power and space-constrained IoT node design, the SAM L11’s Comprehensive Security Solution Framework will simplify your development effort and shorten your design time so you can bring your project to market more quickly. This framework provides an end-to-end security solution, from key provisioning done at Microchip’s secure facility during the silicon consumption in active and all sleep modes, the SAM L11 has achieved an EEMBC®-certified ULPMark™ score of 405. This means that you can implement the security your design needs without taking a hit on power consumption.
as well as extension headers for connecting a variety of Xplained Pro extension kits. The integrated Xplained Pro Analog Module (XAM) can be used to analyze and measure power consumption, and the on-board programmer and debugger eliminates the need for external programmers. If you don’t want to use Trustonic’s end-to-end solution, the free code examples, application notes, reference guides and product demos are still excellent resources for getting started with your SAM L11 MCU-based project.

The rate at which IoT edge devices are being connected has been outpacing the rate at which these devices are being securely deployed. One reason for this is because security has been an afterthought in the embedded application space. The other contributing factor to this trend is that not many MCUs are available in the market today that incorporate robust security in footprints of 64 KB Flash or below to meet the price points of cost-constrained IoT nodes.

However, while embedded security vulnerabilities are providing new attack vectors for hackers, a new crop of microcontrollers, like the SAM L11, is making it easy for IoT node developers to configure and deploy security features quickly, efficiently and economically.

Want More Information?
Visit the website at:
www.microchip.com/SAML11
A Billion Possibilities

Industry’s Lowest-Power LoRa® System-in-Package Family Accelerates Development of Remote IoT Nodes

Low-power, long-range LoRa wireless technology is extending the reach of the Internet of Things (IoT) around the globe. LoRa technology is designed to enable low-power applications to communicate over longer ranges than Zigbee®, Wi-Fi® and Bluetooth® using the LoRaWAN™ open protocol. Ideal for a vast range of applications such as smart cities, agricultural monitoring and supply chain tracking, LoRaWAN enables the creation of flexible IoT networks that can operate in both urban and rural environments. According to the LoRa Alliance™, the number of LoRaWAN operators has doubled from 40 to 80 over the last 12 months, with more than 100 countries actively developing LoRaWAN networks. This means that LoRa technology could potentially find its way into billions of connected devices in the coming years.

If you are developing a LoRa-based connected solution, our new, highly-integrated SAM R34/R35 LoRa System-in-Package family can significantly reduce your time to market.

These devices include an ultra-low-power SAM L21 Arm® Cortex®-M0+ based 32-bit microcontroller (MCU), sub-GHz RF LoRa transceiver and software stack. The SAM R34/R35 SiPs also come with certified reference designs and proven interoperability with major LoRaWAN gateway and network providers. The combination of hardware, software and support significantly simplifies your entire development process.

The SAM R34 devices provide sleep modes as low as 790 nA.

Most LoRa end devices remain in sleep mode for extended periods of time, only waking up occasionally to transmit small data packets. The SAM R34 devices provide sleep modes as low as 790 nA to significantly reduce power consumption and extend battery life in end applications. Available in a compact 6 mm × 6 mm package, the SAM R34/R35 family is ideal for a broad array of long-range, low-power IoT applications that require small form factor designs and multiple years of battery life.

Microchip’s LoRaWAN stack and a certified and proven chip-down package are available to accelerate your development of RF applications while reducing your design risk. The SAM R34/R35 devices offer multi-region support for worldwide LoRaWAN operation from 862 to 1020 MHz, which allows you to use a single part variant across geographies, simplifying your
design process and reducing the need for excessive inventory. The SAM R34/R35 family supports Class A and Class C end devices as well as proprietary point-to-point connections.

You can combine your application code with our LoRaWAN stack and then quickly prototype your design with the **SAM R34 Xplained Pro Evaluation Kit** (DM320111), which is supported by the Atmel Studio 7 Software Development Kit (SDK). The development board is certified with the Federal Communications Commission (FCC), Industry Canada (IC) and Radio Equipment Directive (RED), so you can be confident that your design will meet government requirements across geographies.

The SAM R34/R35 LoRa family is available in six device variants, giving you the flexibility to choose the best combination of memory and peripherals for your end application. So, if you want to explore the possibilities for designing a long-range, low-power connected application, you can purchase the SAM R34/R35 SiPs directly from Microchip or from Microchip’s global distribution network.

**Want More Information?**

Visit the website at: [www.microchip.com/SAMR34](http://www.microchip.com/SAMR34)
No Need to Compromise

Extend Battery Life in Portable Devices and Save Space With New Ultra-Low Iq LDO

MCP1811 Prolongs Battery Life Up to Four Times Longer Than Traditional Ultra-Low Iq LDOs

Portable electronic devices are now expected to run for months or even years on a single battery. This means that minimizing power consumption in battery-powered applications is a top priority for product designers. Reducing standby power consumption is also critical in remote, battery-powered sensor nodes, where battery replacement is difficult and operating life requirements are high. Designers need innovative solutions to extend battery life in these types of applications without compromising on board space.

A recent, new addition to Microchip’s portfolio of power management devices is the MCP1811, a linear Low Dropout (LDO) regulator that extends battery life in portable devices up to four times longer than traditional ultra-low quiescent (Iq) LDOs. With an ultra-low Iq of 250 nanoamps (nA) versus the approximately 1 uA operation of traditional devices, the MCP1811 LDO reduces quiescent current to save battery life, enabling end users to recharge or replace batteries less often.

Ideal for IoT and battery-operated applications such as wearables, remotes and hearing aids, the MCP1811 reduces power consumption in applications by minimizing standby or shutdown current. An additional benefit the MCP1811 offers is faster load line and transient response when compared to other ultra-low Iq LDOs. Faster response times can accelerate wake-up speed in devices such as monitors or sensors that require immediate attention. Faster transient response can help you avoid undervoltage and overvoltage lockout measures used in sensitive applications where transient spikes can lead to catastrophic results.

To meet the requirements of today’s compact portable electronic designs and minimize the amount of board space needed, the MCP1811 is available in package options as small as 1 mm × 1 mm. Depending on your application and number of LDOs it requires, you can take advantage of the extra board space by using a larger battery to further increase battery life. The MCP1811 can also be paired with other ultra-low current devices, such as Microchip’s nanoWatt eXtreme Low Power (XLP) technology microcontrollers (MCUs), for designing a complete ultra-low-power solution.

So, there’s no need to compromise when it comes to finding the right LDO regulator for your battery-powered design. You can purchase the MCP1811 directly from Microchip or from Microchip’s worldwide distribution network.

Want More Information?

Visit the website at: www.microchip.com/MCP1811

To meet the needs of compact, portable designs, the MCP1811 is available in package options as small as 1 mm × 1 mm.
Found in most of the latest car designs, touchscreen displays are getting larger to enable better visibility and usability. Drivers expect these screens to offer the same touch experience they have with their mobile phones. However, because screens in automobiles need to meet stringent head impact and vibration tests, they require thicker cover lenses that potentially impact the touch interface performance. As screens grow larger, they are also more likely to interfere with other frequencies such as AM radio and car access systems. These factors become a major challenge in the design of modern automotive capacitive touch systems.

Designed to address the current trends of increasing screen sizes and reduced finger touch separation in automotive touchscreen applications, our new family of single-chip maXTouch touchscreen controllers can support screens up to 20 inches in size. The MXT2912TD-A, with nearly 3,000 touch sensing nodes, and MXT2113TD-A, supporting more than 2,000 nodes, offer consumers the touchscreen user experience they expect in vehicles. These new devices build upon our existing maXTouch touchscreen technology that has been widely adopted by manufacturers worldwide. These latest solutions offer superior signal-to-noise capability to address the requirements of thick lenses, even supporting multiple finger touches through thick gloves and in the presence of moisture.

Safe and reliable operation becomes even more critical as automakers use screens to replace mechanical switches on the dash for sleeker interior designs. The MXT2912TD and MXT2113TD devices incorporate self- and sensor-diagnostic functions, which constantly monitor the integrity of the touch system. These smart diagnostic features support the Automotive Safety Integrity Level (ASIL) classification index as defined by the ISO 26262 Functional Safety Specification for Passenger Vehicles.

These new devices feature technology that enables adaptive touch utilizing self-capacitance and mutual-capacitance measurements to recognize all touches while avoiding false touch detections. They also feature Microchip’s proprietary new signal shaping technology that significantly lowers emissions to help large touchscreens using maXTouch controllers meet CISPR-25 Level 5 requirements for electromagnetic interference in automobiles. The new touch controllers also meet automotive

The MXT2912TD/MXT2113TD devices support multiple finger touches through thick gloves and in the presence of moisture.

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NEW PRODUCT

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Circuit (FPC) to connect to the sensor display, a converter PCB to connect the kit to the host computer via USB, as well as cables, software and documentation. All parts are also compatible with maXTouch Studio, a full software development environment to support the evaluation of maXTouch touchscreen controllers. You can purchase one of the evaluation kits directly from Microchip or Microchip’s global distribution network.

The MXT2912TD-A and MXT2113TD-A devices are available now in sampling and volume quantities in LQFP176 and LQFP144 packages, respectively. For additional information on purchasing these devices, contact a Microchip sales representative or authorized worldwide distributor.

Want More Information?
Visit the website at:
www.microchip.com/ATMXT2912TD-A

Development Tools
An evaluation kit is available for each of the parts in the new maXTouch touchscreen controller family. The kit includes a Printed Circuit Board (PCB) with the maXTouch touchscreen controller, a touch sensor on a clear glass lens, the Flat Printed Circuit (FPC) to connect to the sensor display, a converter PCB to connect the kit to the host computer via USB, as well as cables, software and documentation. All parts are also compatible with maXTouch Studio, a full software development environment to support the evaluation of maXTouch touchscreen controllers. You can purchase one of the evaluation kits directly from Microchip or Microchip’s global distribution network.

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Want More Information?
Visit the website at:
www.microchip.com/ATMXT2912TD-A
Single-Chip Timing

Industry’s Smallest Multi-Output MEMS Clock Generator Offers Up to 80 Percent Board Space Savings on Timing Components

Flexible Solution Covers a Wide Frequency Range Without Requiring an External Crystal

Timing devices are central to the operation of compact Internet of Things (IoT) and portable electronics. But, to support the range of frequencies required in today’s smart devices, traditional clock sources are composed of multiple components that eat up precious board space and consume power in these space-constrained, battery-powered applications. Designers need to either place multiple crystals/oscillators next to the controllers on a board or use a clock generator with an external crystal for the reference input. A smaller and lower-power timing solution can play a critical role in the ongoing struggle to reduce device size and extend battery life in the latest product designs.

As the industry’s smallest Micro-Electro-Mechanical Systems (MEMS) clock generator, our new DSC613 family is a true single-chip solution that integrates a MEMS resonator and two low-power Phase-Locked Loops (PLLs) into a 6-pin DFN package as small as 1.6 mm × 1.2 mm. The small package size and extensive frequency flexibility makes the DSC613 family well suited for compact devices that require low-power operation, such as digital cameras, smart speakers, Virtual Reality (VR) headsets, streaming sticks and set-top boxes.

The DSC613 family supports up to three clock outputs.

The DSC613 family supports up to three clock outputs from 2 kilohertz (kHz) to 100 megahertz (MHz), making it ideal for microcontroller (MCU) and microprocessor (MPU)-based embedded systems. For example, the clock generator in an IoT application can be used to provide a MHz main reference clock and 32.768 kHz Real-Time Clock (RTC) for the MCU, as well as another MHz clock for functions such as connectivity and sensors. The DSC613 family includes two low-power fractional PLLs with AnyRate® clock synthesizers, which enable the device to generate any frequency between 2 kHz and 100 MHz. At approximately 5 milliamps (mA) power consumption with three outputs running, the family provides up to 45 percent power savings when compared to a solution that uses three low-power quartz oscillators. For additional power savings, the clock output can be turned off through the output enable pin.

MEMS products are built entirely with standard semiconductor processes, providing the same reliability and stability as

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integrated circuits. The devices support up to -40 to +125°C temperature range with a stability of ± 20 ppm. All products are backed by Microchip’s customer-driven obsolescence practice that ensures that devices will be available for as long as customers need them.

![Figure 1: DSC613 Block Diagram](image)

Development Tools
To simplify your design process, the DSC613 family is supported by Microchip’s online ClockWorks® Configurator, where you can enter a clock configuration and receive a customized part number and data sheet, as well as order free samples all in one place. Clock configuration includes output frequency, control pin function, package size, PPM accuracy and temperature range. Up to three output drive strengths are available based on the custom board loading condition. Spread-spectrum clocks are also available for EMI reduction. Application support, including board layout guidelines and schematics review, is also available.

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<td>2</td>
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If you are looking for a true single-chip timing solution that is a great companion to one our MCUs or MPUs, you can order devices in the DSC613 family directly from Microchip or from Microchip’s worldwide distributor network.

Want More Information?
Visit the website at: www.microchip.com/DSC613
In a new era of computing driven by the convergence of 5G, machine learning and the Internet of Things (IoT), embedded developers need the richness of Linux-based operating systems. These systems must meet deterministic requirements in ever-lower-power, thermally constrained design environments, while also addressing critical security and reliability requirements. Traditional System-on-Chip (SoC) Field Programmable Gate Arrays (FPGAs) that blend reconfigurable hardware with Linux-capable processing on a single chip are ideal devices for customization, yet they consume too much power, lack proven levels of security and reliability, or use inflexible and expensive processing architectures.

In response to these challenges, Microchip, via our Microsemi subsidiary, recently extended our Mi-V ecosystem by unveiling the architecture for a new class of SoC FPGAs that combine the industry’s lowest-power mid-range PolarFire™ FPGA family with a complete microprocessor subsystem based on the open, royalty-free RISC-V Instruction Set Architecture (ISA).

Announced by Patrick Johnson—vice president of Microchip’s Mixed Signal and FPGA business units—during his keynote address at the 2018 RISC-V Summit in Santa Clara, California, our new PolarFire SoC architecture brings real-time deterministic Asymmetric Multiprocessing (AMP) capability to Linux platforms in a multi-core coherent Central Processing Unit (CPU) cluster.

Designers can create innovative Linux®-based SoCs tailored for their domain-specific requirements.

The PolarFire SoC architecture, developed in collaboration with SiFive, is a fully customizable, programmable RISC-V platform that allows embedded developers to create innovative Linux-based SoCs tailored for their domain-specific requirements. It leverages SiFive’s U54-MC CPU core complex to help overcome the universal challenge of building real-time systems with predictable behaviors. It also features a flexible 2 MB L2 memory subsystem that can be configured as a cache, scratchpad or a direct access memory. This allows designers to implement deterministic real-time embedded applications simultaneously with a rich operating system for a variety of thermal- and space-constrained applications in collaborative, networked IoT systems.
PolarFire SoC offers extensive debug capabilities including instruction trace, 50 breakpoints, passive run-time configurable Advanced eXtensible Interface (AXI) bus monitors and FPGA fabric monitors, and SmartDebug, Microchip’s built-in two-channel logic analyzer. The PolarFire SoC architecture includes reliability and security features such as Single Error Correction and Double Error Detection (SEC-DED) on all memories, physical memory protection, a Differential Power Analysis (DPA) safe crypto core, defense-grade secure boot and 128 Kb Flash boot memory.

Figure 1: PolarFire™ SoC Architecture

Development Tools
Designers can evaluate and begin working on a PolarFire SoC design using the antmicro Renode™ system modeling platform, which is now integrated with Microchip’s SoftConsole Integrated Design Environment (IDE) for embedded designs targeting PolarFire SoCs. A PolarFire SoC Development Kit is also available now, consisting of the PolarFire FPGA-enabled HiFive Unleashed Expansion Board and SiFive’s HiFive Unleashed Development Board with its RISC-V microprocessor subsystem.

Our new Mi-V™ Embedded Experts Program is a worldwide network of qualified third-party design houses who can assist developers with their PolarFire SoC hardware/software designs. These partners provide support through the entire lifecycle of a project and will help jump-start designs and get products to market quickly. Members also get access to direct technical support and early access to development platforms and silicon.

If you are looking for the freedom to innovate and meet computing’s next great challenges using PolarFire SoC, please visit the PolarFire SoC web page or contact us at PolarFireSoC@microchip.com.

Establish Trust
Crypto-Enabled MCU Supports DICE and Azure IoT Hub
New cars setting out on the highways today are offering an extensive range of advanced features. The addition of mobile services, cross-domain communication and autonomous driving applications to in-vehicle networking means that automotive infotainment systems require a more flexible and future-proof solution for transporting packet, stream and control content. Existing implementations are either costly and cumbersome, or too limited in bandwidth and packet data capabilities to support system updates and inter-networking requirements.

To address this need, Microchip’s INICnet™ technology is the industry’s most efficient automotive infotainment networking solution. This synchronous, scalable technology significantly simplifies building audio and infotainment systems, offering seamless implementation in vehicles that have Ethernet-oriented system architectures. It supports all data types, including audio, video, control and Ethernet, over a single cable.

Since audio is a key infotainment feature in vehicles, INICnet technology provides full flexibility through its support for a variety of digital audio formats with multiple sources and sinks. INICnet technology also provides high-speed packet-data communications with support for file transfers, Over-The-Air (OTA) software updates and system diagnostics via standard Ethernet frames. INICnet technology, therefore, supports seamless integration of Internet Protocol (IP)-based system management and data communications, along with very efficient transport of stream data. INICnet technology does not require the development and licensing of additional protocols or software stacks, reducing your development costs, effort and time.

INICnet technology supports deployment of complex audio and acoustics applications.

INICnet technology provides a standardized solution that works with both Unshielded Twisted Pair (UTP) at 50 Mbps and coaxial cable at 150 Mbps. With low and deterministic latency, INICnet technology supports deployment of complex audio and acoustics applications. Integrated network management supports networks ranging from two to 50 nodes, as well as processor-less or slim modules where the node is remotely configured and managed. The solution’s Phantom Powering capability saves costs on power management for microphones.
and other slim modules. Nodes can be arranged in any order with the same result, and any node in the system can directly communicate with any other node in the system.

Development Tools
INICnet technology comes with **Unified Centralized Network Stack (UNICENS)**, a free-of-charge network management software. UNICENS shortens development cycles, reduces software complexity and simplifies system verification for an infotainment system linked by INICnet technology. UNICENS easily coexists with IP-based system management, simplifying the application code by separating system management from resource management.

Additional INICnet technology tools include a network analyzer, a network configuration tool, as well as evaluation boards with various feature sets, all through Microchip’s K2L subsidiary.

Microchip’s Intelligent Network Interface Controllers (INICs) are advanced integrated circuits that support in-vehicle multimedia networking. 150 Mbps INICnet devices for coaxial, optical and hybrid networks are available today in volume production qualities. Samples of 50 Mbps INICnet devices for Unshielded Twisted Pair (UTP) networks are available now and will be in volume production in 2019.

If you are looking for single-cable simplicity for your automotive networking design, contact your local **Microchip Sales Office** to purchase these devices and get more information about INICnet technology. 

Want More Information?
Visit the website at:  
[www.microchip.com/INICnet](http://www.microchip.com/INICnet)
touch solutions are designed to take you a giant step closer towards that goal.

An excellent option is to add a touch slider or wheel to your next design. A slider enables intuitive and quick changes to a wide variety of functions, such as brightness, volume, speed and more. A touch slider or wheel also offers more freedom and creativity than a touch button when designing your user interface. A touch button only allows two states: either touch (on) or no touch (off). However, a slider offers more analog output options while also retaining the awareness that the slider has or hasn’t been touched.

A slider or wheel will also increase usability. The most obvious example is the volume control on a radio. In a touch button design, you need to press the button multiple times to increase or decrease the volume. In a slider design, the volume can be adjusted by a simple swipe of your finger. You can make minor adjustments to the volume by moving your finger slightly or slowly backward or forward. It’s a simple, fast and intuitive way to control volume or other types of functions.

So, now that you are sold on the idea of adding a slider or wheel to your project, how do you get started? Microchip’s touch libraries for touch sensing on PIC®, AVR® and SAM microcontrollers (MCUs) offer a straightforward and speedy path to take your project from concept to finished product. These touch libraries offer slider and wheel decoding right out of the
box and can be combined with our free graphical programming environments—MPLAB® Code Configurator (MCC) for use with the cloud-based MPLAB Xpress Integrated Development Environment (IDE) and Atmel START for use with Atmel Studio 7 IDE—to configure peripherals and functions specific to your application and generate production-ready code. You can read more about these resources in the “Accelerate Your Touch Design” article that appeared in the January/February 2018 issue of MicroSolutions.

Here is a quick overview of the steps that will take you along the path to implementing an innovative and intuitive slider interface using Microchip’s solutions.

Create a Great Demo

A great idea for upgrading your product with a slider will most likely need to get marketing and/or management approval. A real and functional implementation beats any presentation, so building a slider demo will be an excellent way to pass along your vision to your colleagues. The QT7 Xplained Pro Extension Kit (ATQT7-XPRO) has all the features that you need and can be used with Xplained Pro or Curiosity Nano boards.

Figure 1: Develop Your Touch Slider Prototype With the QT7 Xplained Pro Extension Kit

Launch Atmel START, search for “QT7”, and you’ll immediately see some examples come up that you can use in either Atmel START or MCC. From there, you can add the code straight into Atmel Studio or MPLAB X IDE, and your demo will quickly be up and running.

Figure 2: QT7 Xplained Pro Examples in Atmel START

Create Your Application

There’s no need for you to do any coding for sliders or wheels at all when you take advantage of Microchip’s tools. Simply choose MCC or Atmel START as your code configurator, and you will be able to easily select and configure the touch functionality and features you want for your project. Just click to set up the slider based on your application’s requirements, such as the number of segments, output resolution and more. You can set the targets, and MCC or Atmel START will deliver lean and reliable code tailored to meet the specific requirements of your design that you can insert into the IDE of your choice.

Figure 3: Configuring a Slider Using the QTouch® Configurator in Atmel START

Figure 4: Configuring a Slider Using the mTouch® Library in MPLAB® Code Configurator

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Lay Out the Sensors
Using the touch library to develop the code and create an API is one part of the equation in your touch slider project, but you also need to make sure that your layout is well designed. We offer a couple of helpful resources to shorten your development time. You’ll find a number of layout examples and design guidelines in the “Guide for Slider Sensor Design When Using Modular QTouch® Library” article on our Developer Help website. You can also use the Microchip plug-in for Altium Designer to add buttons, sliders or wheels to your touch-enabled design.

Tune and Debug Your Application
To maximize the performance and reliability of your slider design, you can use Data Visualizer, a powerful tool that is available as a free download from Microchip Gallery. Simply configure the slider in MCC or Atmel START and begin streaming data to activate the debugging. Data Visualizer will automatically display slider position, real-time touch data, thresholds and more. Read the “Guide to Tuning Slider and Wheel” article on our Developer Help site to get additional assistance with performance optimization.

Your Favorite Development Environment is Now Compatible with AVR® Microcontrollers
MPLAB® X IDE Integrates Support for AVR® Microcontrollers
A Comparison of Common Architectures Used Within Instrumentation Amplifiers

Instrumentation amplifiers, or INAs, are specifically designed and used for their differential gain and common-mode rejection capabilities. An instrumentation amplifier will amplify the difference between the inverting and non-inverting inputs while rejecting any signal that is common to both inputs, resulting in no common-mode component being present at the output of the INA. Figure 1 highlights a few typical applications for instrumentation amplifiers. A variety of sensors are shown that are accurately amplified by an INA feeding a converter and/or microcontroller (MCU).

Figure 1: Typical Sensors Used With Instrumentation Amplifiers

Two common architectures implemented within monolithic instrumentation amplifiers are a traditional three-amplifier configuration and an indirect current feedback architecture. This article will take a closer look at these two approaches and highlight some of the system-level trade-offs.

The Three-Op Amp IC Approach

In the three-op amp configuration, a common INA is packaged in a single Integrated Circuit (IC), as shown in Figure 2.

Figure 2: Block Diagram of Three-Op Amp Instrumentation Amplifier

The circuit is divided into two stages: the input stage has two inverting buffer amplifiers, and the output stage is a traditional difference amplifier. The internal resistors used throughout this design are matched to a very close tolerance only possible with

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trimmed resistor semiconductor designs, resulting in a much higher Common-Mode Rejection Ratio (CMRR).

The input-stage amplifiers also provide high impedance, which minimizes loading of the sensors. The gain-setting resistor \( R_\text{g} \) allows you to select any gain within the operating region of the device (typically 1 V/V to 1,000 V/V).

The output stage is a traditional difference amplifier. The ratio of internal resistors, \( R_2/R_1 \), sets the gain of the internal difference amplifier, which is typically \( G = 1 \) V/V for most instrumentation amplifiers (the overall gain is driven by the amplifiers in the first stage). The balanced signal paths from the input to the output yield excellent CMRR.

The design is simple to implement, has a small footprint and fewer components, leading to lower system costs. The design is also compatible with single-source supplies using the \( V_{\text{ref}} \) pin. However, even with this design, there are limitations to consider.

Three-op amp INAs achieve high CMRR at DC by matching the on-chip resistors of the difference amplifier, but the feedback architecture can substantially degrade the AC CMRR. In addition, parasitic capacitances can’t be completely matched, causing mismatches and reduced CMRR over frequency. The common-mode voltage input range is limited so that internal nodes don’t saturate. The \( V_{\text{ref}} \) pin requires a buffer amplifier for optimal performance. Lastly, the temperature coefficients of the external and internal gain resistors are not matched, which contributes to a decline in CMRR. The gain for the three-op amp INA is:

\[
V_{\text{out}} = (G \times V_{\text{dm}}) + V_{\text{ref}}
\]

where

\[
G = 1 + [1 + (2R_\text{f}/R_\text{g})] (R_2/R_1)
\]

\[
V_{\text{dm}} = (V_{\text{in}+} - V_{\text{in}–})
\]

The Indirect Current Feedback Approach

The Indirect Current Feedback (ICF) INA uses a novel voltage-to-current conversion approach, as seen in Figure 3.

It is comprised of two matched transconductance amplifiers, \( G_{M1} \) and \( G_{M2} \), and a high-gain transimpedance amplifier \( (A3) \). The design doesn’t rely on balanced resistors, so internally trimmed resistors aren’t required, thereby reducing manufacturing cost. Another advantage is that the external resistors needn’t match any on-chip resistors. Only the temperature coefficients of the \( R_\text{f} \) and \( R_\text{g} \) external resistors need to match as closely as possible for minimal gain drift.

The DC CMRR is high since amplifier \( G_{M1} \) rejects common-mode signals. AC CMRR doesn’t decrease significantly with increased frequency. It was mentioned that the three-op amp approach input range is limited to prevent internal node saturation. With an ICF, the output voltage swing isn’t coupled to the input common-mode voltage, resulting in an expanded range of operation not possible with the three-op amp architecture.

The second stage \( (G_{M2} \text{ and } A3) \) differentially amplifies the signal and further rejects common-mode noise on \( V_{\text{fg}} \) and \( V_{\text{ref}} \). Single-supply operation can still be used by applying a bias to \( V_{\text{ref}} \). The ICF INA gain is:

\[
V_{\text{out}} = (G \times V_{\text{dm}}) + V_{\text{ref}}
\]

Where

\[
V_{\text{dm}} \text{ is the differential-mode voltage:}
\]

\[
V_{\text{dm}} = (V_{\text{in}+} - V_{\text{in}–})
\]

\[
= (V_{\text{fg}} - V_{\text{ref}})
\]

The need to amplify small signals in the presence of noise has gone through an evolution over the years. The integrated three-op amp approach has significant advantages, including high DC CMRR and balanced and high input impedances with one gain resistor. However, there are common-mode voltage limitations and it is difficult to match internal versus external resistor temperature coefficients, resulting in gain drift. The impedance at the \( V_{\text{ref}} \) pin can also negatively impact CMRR unless a buffer is used. The ICF approach also has a high CMRR (even at higher frequencies), a wider common-mode input voltage range and no on-chip trimmed resistors, resulting in lower cost and lower temperature-coefficient gain drift.

For more information, visit our Instrumentation Amplifiers page to learn how our growing family of instrumentation amplifiers can meet the demands of your sensor amplification or other data acquisition applications.
Now, Where Was I?

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