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How Arm® extended its TrustZone® technology from the mobile to MCU-based embedded systems

AMERICAS EDITION

Application Spotlight on:

## Embedded Processing and Software



### Libero SoC release provides single design suite for latest Microchip FPGAs

Microchip has announced the release of Libero SoC version 12.0 FPGA design software, delivering new gains in run-time and quality of results. The release also creates for the first time a single, unified design suite for all the company's latest FPGA families, including new production releases of its PolarFire FPGAs.

By upgrading to Libero SoC v12.0, designers will see run-time reduction of 60% for timing, 25% for place and route, and 18% for power results.

### New 600W DOSA-compliant DC-DC converter brick

Murata Power Solutions has launched a series of DOSA-compliant 600W digital quarter-brick DC-DC converter modules which provide a 12V output. The modules, which include a 32-bit Arm® processor core, support the latest PMBus commands for digital control and telemetry functions.

The DSQ, DCQ and DAQ series converters operate from an input-voltage range of 36V to 75V, and offer typical efficiency of 96% at full load from a 48V input.

The modules are supplied with a base plate to provide for optimal thermal performance.

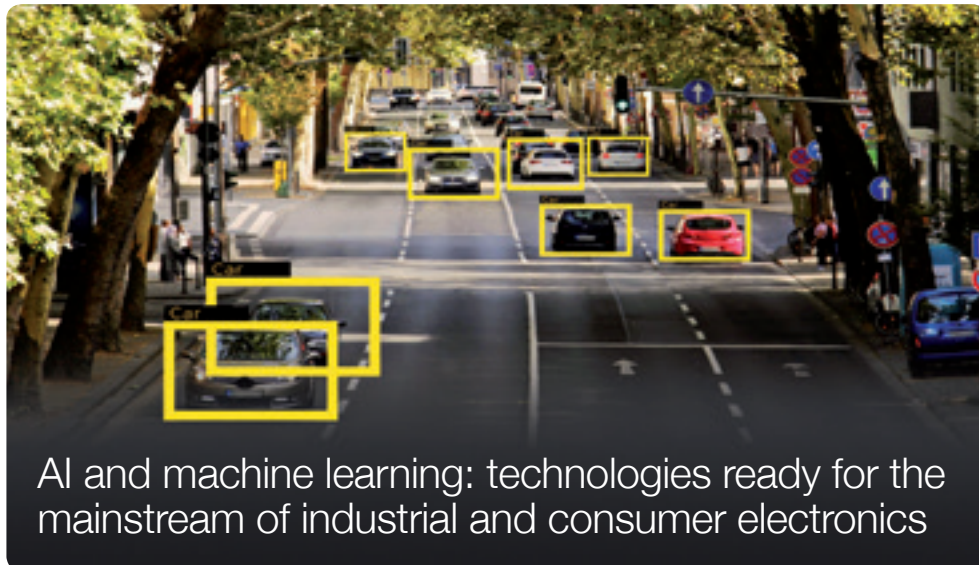
### Breakthrough in high-frequency operation of high-power infrared LEDs

Lumileds and Melexis have developed an evaluation kit which enables designers to operate Lumileds' LUXEON infrared LEDs at high frequencies of up to 40MHz. The LUXEON IR LEDs produce the clean and repeatable response curve required for time-of-flight measurement operations performed in distance measurement and ranging applications at a range of up to 3m.

The illuminator evaluation kit developed by Lumileds reduces the rise and fall times of the light pulses to 6ns, superior by a factor of four to similar LED devices. In the evaluation kit, the LUXEON LEDs are paired with Melexis' Automotive QVGA time-of-flight sensor chipset.

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AI and machine learning: technologies ready for the mainstream of industrial and consumer electronics

**The latest trend in embedded processing will be front and center at the Embedded World exhibition (Nuremberg, Germany, 26-28 February 2019): all the key players in our industry are investing in machine learning and Artificial Intelligence (AI) developments.**

AI is not in fact a new technology: the term 'machine learning' was coined in 1959 by IBM's Arthur Samuel. Initially its application had been mainly limited to demonstrations, such as Samuels' own machine for playing the game of checkers. It is finally, however, becoming accessible to electronics product developers in all market segments.

Its use in autonomous vehicles attracts the widest publicity today. But AI offers exciting opportunities to improve the operation of, or add valuable features to, many kinds of end products. For instance, the addition of speech recognition can make a human-machine interface touch-free – potentially useful in hazardous or space-constrained operating environments. An ultra-low power FPGA, such as QuickLogic's EOS S3, as shown on page 11, is the ideal hardware platform for such an application.

Similarly, the addition of a trained camera to access-control or security systems enables it not only to detect the presence of a person, but also to indicate a person's age and identity for security purposes, or to apply age-defined comfort settings. Future Electronics' Avalanche development board, which is based on a mid-range PolarFire FPGA from Microchip, can recognise up to 20 different objects such as birds and cars.

Why now, after nearly 60 years, is the rate of adoption of AI suddenly accelerating? Two changes have occurred: first, processors and FPGAs have become powerful enough to train neural networks. According to Dr Shane Legg, a co-founder of Google's DeepMind subsidiary, a training run that takes one day on a current tensor processing unit – an AI accelerator chip developed by Google for neural network

machine learning – would take 250 million years on an 80486 microprocessor from 1990.

Second, there is now a vast volume of data available to generate models. Estimates suggest that 90% of the data available today was generated in the past two years.

Technologies supporting the use of AI in mainstream industrial and consumer systems will be open for viewing and evaluation at the Future Electronics stand 3.225 at Embedded World. For instance, a Future Electronics example project, for identifying street signs, shows how microcontrollers can accelerate machine learning through the use of Arm's CMSIS-NN, a collection of efficient neural network kernels which maximise the performance and minimise the memory footprint of neural networks on Cortex®-M processor cores.

Predictive maintenance demonstrations will also be on view, based on technologies from STMicroelectronics and QuickLogic.

Real-world applications of AI and machine learning can be implemented today, and your local branch of Future Electronics will be pleased to tell you more about the technologies and demonstrations available from franchised suppliers, or call 1.800.FUTURE.1 for help.



**John Robins**  
EMEA Vertical Segment Manager (Embedded Systems),  
Future Electronics



## Digital and analog MEMS microphones deliver enhanced audio quality in miniature packages

CUI INC

**CUI's Audio Group has introduced a comprehensive line of MEMS microphones which are ideal for a range of portable consumer electronics applications.**

Offering high audio quality, performance and reliability, CUI's CMM series is housed in compact, low-profile packages as small as 2.75mm x 1.85mm x 0.95mm, and in round and rectangular form factors. The microphones are compatible with reflow solder assembly

processes, so they afford designers flexibility for use when surface-mount assembly is required.

Designers can choose from a wide range of operating parameters in order to meet the performance requirements of any design. Sensitivity ratings for the CMM series models vary in a range from -44dB up to -26dB. Tight sensitivity tolerance of as little as  $\pm 1$ dB means that the CMM series products work well in the microphone arrays used to perform functions such as beam forming and noise cancelation.

CUI's MEMS microphones also deliver reduced vibration sensitivity, low current draw of as little as 80 $\mu$ A, and wide operating temperature ranges from -40°C to 105°C.

A unique inner chamber construction also provides more stable performance and gives these silicon-based microphones added protection against moisture and dust.



#### APPLICATIONS

- Smartphones
- Tablets
- Smart home devices
- Portable electronic devices

#### FEATURES

- Omnidirectional sensitivity
- Signal-to-noise ratio range: 57dBA to 65dBA
- Analog or digital Pulse Density Modulation (PDM) outputs
- Top or bottom port

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CUI's CMM series microphones support surface-mount assembly processes

## Precision resistor offers low current noise to give high sound quality in audio applications

SUSUMU

**Susumu has introduced the RS series of thin-film chip resistors which enable designers of audio systems to achieve superior sound quality.**

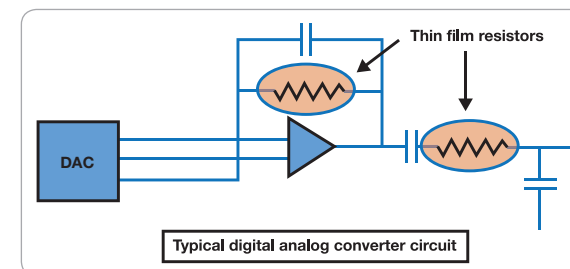
Thin-film resistors offer better frequency characteristics, less noise, and less signal distortion than other types of resistors. Previously, however, the use of thin-film resistors has been limited to high-end audio equipment: these devices have not commonly been found in the most widely used audio devices on the market: smartphones and automotive audio systems.

Now the introduction of the Susumu RS series of precision resistors enables these systems as well to benefit from the superior audio characteristics of thin-film resistors. The acoustic performance of the RS series benefits from Susumu engineering breakthroughs in the methods used to design the devices' resistive patterns and terminal materials.

The low-noise RS series resistors are ideal for use in any audio circuits, including digital-to-analog converters.

The RS1005 and RS2012 resistors are available in resistance values ranging from 47 $\Omega$  to 100k $\Omega$ , and with resistance tolerance of  $\pm 0.1\%$  or  $\pm 0.5\%$ . The RS1005 is supplied in a surface-mount 0402 package. The RS2012 is in an 0805 package.

Part Number	Power Rating (regular)	Maximum Voltage
RS1005	1/16W	75V
RS2012	1/8W	150V



RS series resistors produce low noise and signal distortion in audio circuits



#### APPLICATIONS

- Hi-fi audio equipment
- Automotive audio systems
- Mobile audio devices
- Smartphones

#### FEATURES

- $\leq -40$ dB current noise
- $\pm 25$ ppm temperature coefficient of resistance
- Gold terminal available on request



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# Standard tin-plated brass receptacles offer new maximum operating temperature of 125°C

TE CONNECTIVITY

TE Connectivity (TE) has updated its FASTON line of standard terminals to meet the changing trends in the appliance, automotive and other industries.

These trends include the need for lower insertion forces, higher performance and higher temperature ratings.



FASTON terminals: Low insertion force

The new standard line of FASTON terminals includes:

- High-temperature, nickel-plated steel receptacles
- Tin-plated brass receptacles
- Tin-plated brass receptacles using new 2D crimp technology

The standard line of FASTON receptacles is easily identifiable by the dog-bone shaped front end of the receptacle, which allows the mating tab to mate on a rolled edge instead of a sheared edge for reduced insertion force.

The new standard tin-plated brass receptacles are UL rated to 125°C. By contrast, TE's legacy tin-plated brass FASTON receptacles were rated only to 110°C. In addition, the tin-plated brass receptacles are performance-tested on the sixth mating cycle rather than the first, to allow for disconnection and reconnection during service calls without needing to replace the receptacles. All standard FASTON receptacles are backward-compatible with existing FASTON housings.

TE's standard-line 2D crimp FASTON receptacles will allow customers to standardize on four receptacles to cover their full wire range, replacing hundreds of other receptacles, potentially giving better productivity and pricing while reducing change-overs.

The reduced number of receptacles means that users require less application tooling, and benefit from improved inventory handling. The wide-range wire crimps can easily accommodate the under-sized wire being used more often in production today.

Nickel-plated steel receptacles in the standard line of FASTON terminals are intended for high-temperature applications. They are UL rated to 250°C.

APPLICATIONS

- Automotive systems
- Appliances

FEATURES

- Straight, right-hand flag and left-hand flag orientation options
- F crimp or Tab-Lok crimp options
- Low insertion force

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# Humidity and temperature sensors offer consistent, linear outputs

TE CONNECTIVITY

TE Connectivity (TE) provides a range of combined relative humidity and temperature sensors which produce accurate digital or analog outputs.

They include the HTU21D, a digital combined relative humidity and temperature sensor in a low-profile DFN package with a small 3mm x 3mm footprint.

The sensor provides linear measurement outputs in a digital format over an I<sup>2</sup>C interface.

TE's polymer sensor materials combined with an optimized calibration slope and accurate offset give reliable, consistent performance even in the most demanding conditions.

Every unit is individually calibrated and tested: a lot identification mark is printed on the sensor and an electronic identification code is stored on the chip for easy traceability.

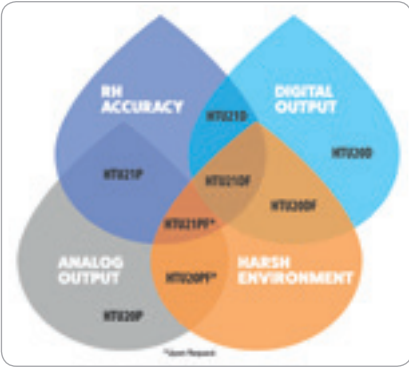
The adjustable resolution of the HTU21D's measurements can be configured by the system

designer, from 8- up to 12-bit resolution for relative humidity, and from 12- to 14-bit resolution for temperature.

The measurement range of the relative humidity sensor is 0-100%. The temperature sensor operates between -40°C and 125°C.

Other relative humidity and temperature sensors

from TE include the analog HTU20P, and a digital part, the HTU20DF, which is suitable for use in harsh environments.



APPLICATIONS

- Heating, Ventilation and Air Conditioning (HVAC) equipment
- Refrigerators and freezers
- Dryers
- Dishwashers
- Printers

FEATURES

- Low power consumption
- Fast response time
- Instantaneous desaturation after long periods in saturation phase

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# Main memory sockets for computing and communications

TE CONNECTIVITY



TE: Solder tail and surface-mount options

TE Connectivity's (TE) main memory connectors are made to JEDEC industry standards for Dual In-line Memory Modules (DIMM) and Small Outline DIMM (SO DIMM). TE also supplies custom memory modules for computing, storage and communications equipment.

The TE memory socket portfolio covers the DDR2, DDR3 and DDR4 generations of sockets. Each product family consists of vertical, right-angle and other angled configurations in solder tail and surface-mount options.

The high-quality contact design in these connectors protects against module stubbing.

APPLICATIONS

- Servers
- High-performance computing equipment
- Workstations
- Mass storage devices
- Communications equipment
- Desktop PCs
- Instrumentation

FEATURES

- Designed to JEDEC industry standards for new and existing DIMM memory modules
- End latches for module retention, ejection and mechanical voltage keying
- SO DIMM sockets offered in several stacking heights

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# DIP sockets for IC connections with 6-48 contacts

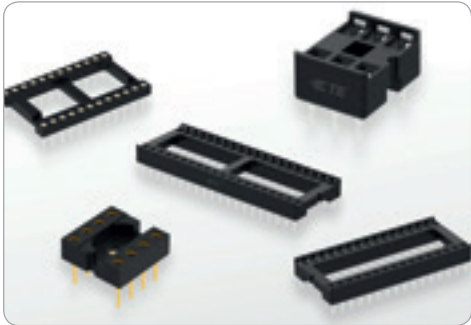
TE CONNECTIVITY

TE Connectivity (TE) supplies a large selection of DIP sockets which are available in variants providing from six to 48 contacts.

They give a highly reliable connection between integrated circuit devices and a PCB. Termination options include through-hole and surface-mount four-finger and dual-leaf contacts. There are also various contact plating options.

Advantages of the TE DIP sockets include:

- Quick IC mating/unmating
- Easy replacement of ICs in the field
- Prevention of IC overheating during soldering
- Facilitates system upgrades



DIP sockets enable IC replacement in the field

APPLICATIONS

- Industrial controls
- Intelligent buildings
- Medical devices
- Military equipment
- Embedded systems

FEATURES

- Open-frame and closed-frame housings
- End-to-end and side-to-side stackable

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# LGA sockets compatible with Intel and AMD microprocessors

TE CONNECTIVITY



LGA sockets: Stainless-steel load plate

LGA sockets are the latest socket technology for Intel or AMD LGA microprocessor packages that range in size up to 3,647 pins. This generation of LGA sockets from TE Connectivity (TE) provides a compressive electrical interface to the microprocessor package. They are solder-ball surface-mounted to the PCB.

The stainless-steel load plate provides a reliable interconnection to the microprocessor package, and includes a single lever handle for package actuation. The contact tip geometry is optimized to reduce risk of contact damage during handling and package installation.

APPLICATIONS

- Servers
- High-performance computing equipment
- Workstations
- Desktop computers

FEATURES

- Socket housing facilitates efficient soldering to the PCB
- Socket is supplied with a cap to facilitate vacuum pick-and-place
- Backplates are available with zinc or nickel plating

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Renesas Synergy™ Platform

## ENHANCED ANALOG FOR SENSING THE WORLD AROUND YOU

Innovate your IoT designs with the latest Renesas Synergy Microcontrollers



The latest device in the S1 MCU Series, the S1JA, boasts some of the highest performing analog circuitry in the Renesas Synergy™ product line. Both a 24-bit delta-sigma and 16-bit SAR ADC are available on the S1JA, as well as three operational amplifiers. Additionally, all the analog componentry is tied together through a programmable switching matrix. This means you can set up and route all the analog inputs and outputs to each other and have the analog componentry operate independently of the MCU core, allowing you to keep the core in a low power state, which helps keep the power consumption to a minimum.

The innovation in the S1JA isn't just in the analog circuitry. The S1JA is powered by the next-generation Arm® microcontroller core, the Cortex®-M23. This latest core, based on the Arm v8m architecture, boasts many updates and improvements over the Cortex-M0+ to help power your next-generation IoT device. New instructions, enhanced debug, and hardware divide capabilities are just some of the enhancements now available on the S1JA.



The power of the Cortex-M23, along with the enhanced analog circuitry, makes the S1JA well-suited for applications such as analog sensors or front-ends, instrumentation amplifiers, or any applications that currently have a standalone ADC and MCU in the signal chain.

### Power for your next-generation connected IoT device



The S5D3 is the latest device in the S5 MCU Series. Powered by an Arm Cortex-M4F processor running at 120 MHz, it has 512 KB of on-board code flash and 256 KB of SRAM, providing enough

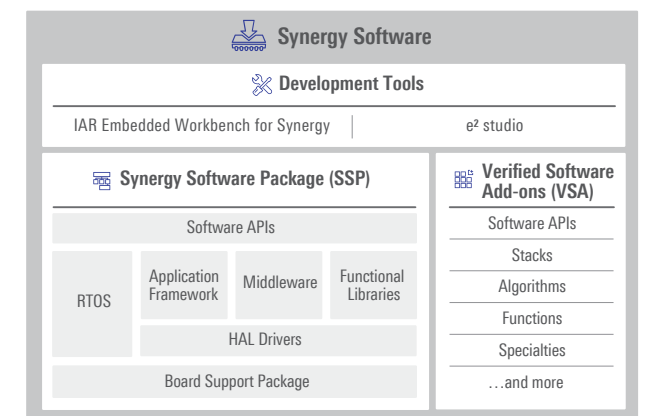
memory to run the most demanding applications. It has been optimized for applications where connectivity is a must, but graphics and Ethernet capability may not be required. The S5D3 has enough processing power, code flash, and SRAM to run multiple connectivity stacks at once, while being cost competitive in terms of features and performance.

The S5D3 boasts six programmable gain amplifiers and many high precision timers. It also hosts multiple SPI, I²C, and UART peripherals. This wealth of peripherals makes the S5D3 ideal for applications like motor control, connectivity or sensor hubs, or wireless communications controllers.

### Get more design power with the updated Synergy Software Package

As with all Synergy MCUs, the S1JA and S5D3 MCUs can fully utilize the Synergy Software Package (SSP), as well as professional commercial grade tools provided in the Synergy Platform. The SSP is powered by the ThreadX® RTOS from Express Logic and contains all the software drivers, middleware, and frameworks to get started on your next design quickly.

On top of that, you can choose from an Eclipse-based IDE in addition to a fully functional IAR Embedded Workbench® for Synergy. All the software and tools are provided free of charge and can be used on any Synergy MCU.



### Get started today with a Renesas Synergy Development Kit

Order your Synergy S1JA (YSTBS1JAE10) or S5D3 (YSTBS5D3E10) development kit today. Visit <http://renessasynergy.com> for more information on these devices, as well as the full lineup of Synergy microcontrollers, software and tools.

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BIG IDEAS FOR EVERY SPACE

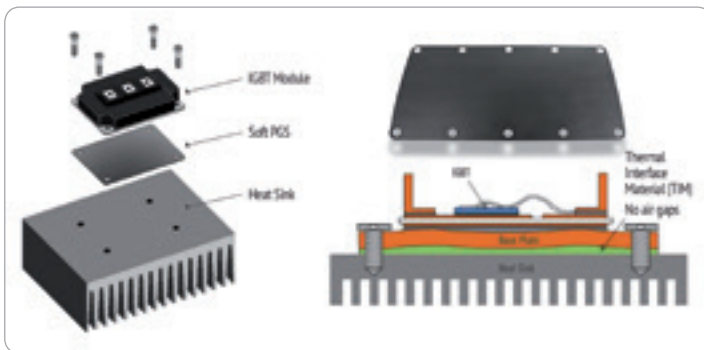


# Graphite-sheet thermal interface material tailored for use with IGBT modules

## PANASONIC

Panasonic's Soft PGS Thermal Interface Material (TIM) is highly compressible, to reduce thermal resistance between rough surfaces in extremely thin spaces. It is custom-cut to IGBT module footprints.

The use of a Soft PGS TIM helps to extend the lifetime of power modules and increase their performance by providing high thermostability and reliability in thermally sensitive areas. Soft PGS is easy to install with a one- or two-step process which entails much lower labor and installation costs than the application of thermal grease.



Panasonic's Soft PGS material fills air gaps between a power module and a heatsink

Soft PGS is much more compressible than standard PGS. This feature of Soft PGS reduces thermal resistance because the thermally conductive material follows the gaps, warpage and distortion in the heat-generating target object or substrate. Soft PGS also offers excellent resistance to high temperatures.



### APPLICATIONS

- Automotive systems
- Power supplies
- Audio/visual equipment
- Medical devices
- Communications systems

### FEATURES

- 0.2K-cm<sup>2</sup>/W thermal resistance
- Thermal conductivity:
  - 400W/m·K in the X-Y direction
  - 28W/m·K in the Z direction
- 40% compressibility at 600kPa pressure
- Operating-temperature range: -55°C to 400°C

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# Deformable thermal material offers high heat conductivity in the Z-direction

## PANASONIC

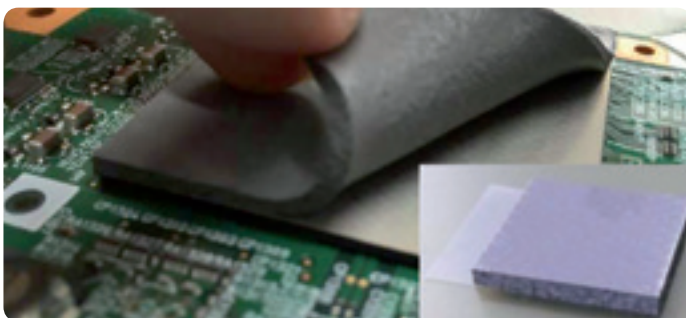
Panasonic's EYG-T series Graphite-PAD, one of its thermal management solutions, is a Thermal Interface Material (TIM) which offers excellent thermal conductivity in the Z-axis (thickness) direction and provides good flexibility. The new Graphite-PAD product's performance is superior to that of most existing TIMs.

The Graphite-PAD product is composed of Pyrolytic Graphite Sheets (PGS) filler in silicone resin. This combination of materials offers high system reliability in designs with high heat dissipation. The PGS inside the resin is oriented in a vertical direction. This oriented structure provides excellent thermal conductivity through the thickness of the sheet.

Mainly composed of silicone resin, the thermal sheet is easily deformable, a property which eases installation.

The Graphite-PAD sheets are ideally suited to use in end products including:

- Micro-inverters
- IGBT modules and power transistors
- Power converters
- Radio devices
- Touch panels
- Cameras
- Automotive LEDs
- Motor-control units
- Optical transceivers



EYG-T series Graphite-PAD: easy to install in PCB assemblies



### APPLICATIONS

- Power supplies
- Audio/visual equipment
- Communications equipment
- Medical equipment

### FEATURES

- 13W/mK thermal conductivity
- Thickness range: 0.5mm to 3.0mm
- Type E 25 hardness
- 50% compressibility in 2mm thickness at 300kPa pressure
- Operating-temperature range: -40°C to 150°C

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# Evaluation kit gives easy connection for XMC4800 MCU to AWS cloud platform via FreeRTOS

## INFINEON

**Infinion has introduced an evaluation kit which provides a ready-made platform for connecting an XMC4800 microcontroller to the cloud service provided by Amazon Web Services (AWS) via the FreeRTOS software.**

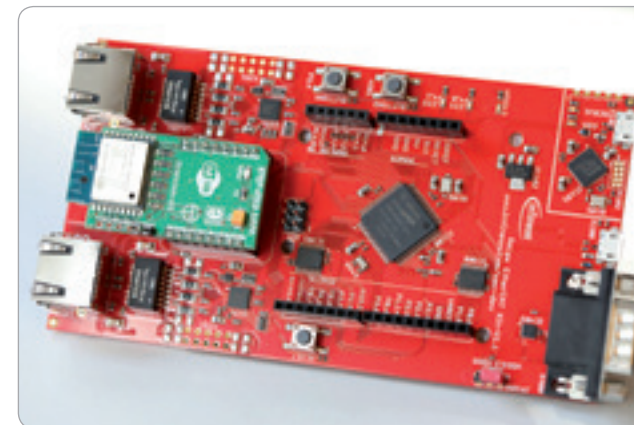
The XMC4800 IoT Amazon FreeRTOS Connectivity Kit, which has the orderable part number KITXMC48IOTAWSWIFITOB01, consists of an MCU baseboard and a Wi-Fi® wireless connectivity board.

The baseboard is an XMC4800 Relax kit, which includes headers compatible with the Arduino® and MikroElektronika click boards™ form factors. The kit's XMC4800 MCU not only runs the AWS FreeRTOS software, but also offers EtherCAT® and CAN networking functionality to support industrial IoT gateway applications.

The Wi-Fi connectivity board is a MikroElektronika Wi-Fi ESP click boards module which supports the mikroBUS™ bus interface.

The Wi-Fi ESP module includes the ESP-WROOM-02, a Wi-Fi radio board based on the Espressif Systems ESP8266EX Wi-Fi system-on-chip. The 3.3V Wi-Fi ESP module can function in both access point and Wi-Fi client mode, and supports the IPv4, TCP, UDP, HTTP and FTP network protocols.

Full support for the XMC4800 IoT Amazon FreeRTOS Connectivity Kit is provided on the AWS website, to enable the user to quickly configure the board for operation on the AWS platform. On the 'Getting started with the Infineon XMC4800 IoT Connectivity Kit' page on the AWS website, users can find information on setting up the operating environment with the Infineon DAVE™ integrated development



XMC4800 IoT kit: Connectivity options include Ethernet, EtherCAT, CAN and Wi-Fi

environment, including instructions for downloading and configuring the Amazon FreeRTOS operating-system software.

The page also offers help on configuring a Wi-Fi wireless connection, and provides a demonstration project.



### APPLICATIONS

- Industrial IoT

### FEATURES XMC4800 RELAX KIT

- XMC4800 MCU
- On-board debugger
- USB power connection
- ESD and reverse-current protection
- Two user buttons and two user LEDs
- Arduino-compatible 3.3V pin-out
- Real-time clock crystal
- Quad SPI Flash interface
- microSD card slot
- Ethernet PHY and RJ45 jack
- CAN node
- EtherCAT node

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# MCU in AWS cloud services kit is first to include integrated EtherCAT node

**The microcontroller featured in the Amazon Web Services FreeRTOS kit is an XMC4800-F100x2048, one of the XMC4800 series of MCUs, which has 2Mbytes of embedded Flash memory. The XMC4800 device is part of the XMC4000 family of MCUs based on the mid-range Arm® Cortex®-M4 processor core, which offers digital signal-processing and floating-point unit capabilities.**

The XMC4800 is the first Flash-based Arm® Cortex®-M MCU series to provide an EtherCAT® slave interface, which has a 100Mbps/s data-transfer rate. It has two MII ports for EtherCAT, eight fieldbus memory management units, eight sync manager units and 64-bit distributed clocks.

Other communications capabilities of the XMC4800 MCU include an Ethernet controller, USB 2.0 On-The-Go controller with integrated PHY, a CAN interface with six nodes, and six configurable serial interface channels.

The XMC4800 also supports analog functions via four 12-bit ADCs, a delta-sigma demodulator and a two-channel, 12-bit DAC.

The XMC4800-F100x2048 on the AWS FreeRTOS board comes in two versions:

- XMC4800F100F2048AAXQMA1 which has an operating-temperature range of -40°C to 85°C
- XMC4800F100K2048AAXQMA1 which has an operating-temperature range of -40°C to 125°C



### APPLICATIONS

- Industrial drives
- I/O modules
- Motor-control systems
- Switch-mode power supplies
- Smart lighting

### FEATURES XMC4800-F100

- 144MHz Arm Cortex-M4 core
- 2Mbytes of Flash
- 353kbytes of RAM
- 100-pin package
- On-board debugger
- LED and touch-sense controller
- SD and Multi-Media Card interface

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# Cypress' Wireless & Compute Portfolio: Powering Tomorrow's IoT Platforms



## PSoC® 6: Industry's Lowest-Power Microcontroller, Purpose-Built for the IoT

PSoC 6 is Cypress' ultra-low-power MCU built on a dual-core architecture integrating an Arm® Cortex®-M4 and Cortex-M0+ onto a single chip. A range of IoT designs requiring low power can benefit from PSoC 6's industry-leading low power consumption of 22 µA/MHz. In addition, PSoC 6 provides the critical security required by connected devices including a hardware-based root-of-trust and hardware-accelerated cryptography. PSoC 6 is in full production with silicon and Bluetooth/Wi-Fi Dev Kits available at Future Electronics. Future also provides the innovative Sequana Dev Kit which features a BLE 5.0 Module based on the PSoC 63 MCU, with support for the Arm® Mbed™ OS.

## Cypress Provides Market-Proven Wi-Fi, Bluetooth & Combo Wireless Connectivity

Get to production faster with Cypress' ecosystem of certified IoT Partner Modules

### Murata 1DX Module

Powered by the Cypress CYW4343W 802.11n Wi-Fi & Dual-Mode Bluetooth Combo chipset

Murata's 1DX certified module (LBEE5KL1DX) is powered by Cypress' CYW4343W chipset which provides developers with wireless connectivity to connect a range of IoT applications with proven 802.11b/g/n 2.4GHz Wi-Fi and dual-mode Bluetooth. The Murata 1DX is designed for space-constrained applications with a form factor smaller than a dime. Engineers can get started with the Murata 1DX by leveraging Future Electronics/Cypress' Nebula IoT Dev Kit.

Learn more at [www.futureelectronics.com/nebula](http://www.futureelectronics.com/nebula).



### Laird Sterling-LWB Modules

Leveraging Cypress' combo and 802.11ac-enabled chipsets

Laird's certified Sterling-LWB Wi-Fi + Bluetooth Combo Module is available with 3 different antenna options and features Cypress' CYW4343W combo chipset. Two different Dev Board options are available – one in an SD Card form-factor as well as a full-on WICED® SDK compatible carrier board. In addition, the Sterling-LWB5 is a pin-compatible upgrade that adds 802.11ac Wi-Fi for higher bandwidth and increased range within IoT applications.



### Inventek Wi-Fi Module

Powered by the Cypress CYW43903 802.11n SoC with integrated Arm Cortex-R4

The Inventek CYW43903-based Wi-Fi module (ISM43903-R48-L54-E/U) provides an integrated or optional external antenna with 1 MB of SRAM available for applications. In addition to WICED support, the module can also run with no operating system while leveraging an integrated TCP/IP stack that requires only a simple AT command set to establish connectivity within your wireless product.



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## New hardware/software platform enables artificial intelligence and cognitive sensing at the edge

### QUICKLOGIC

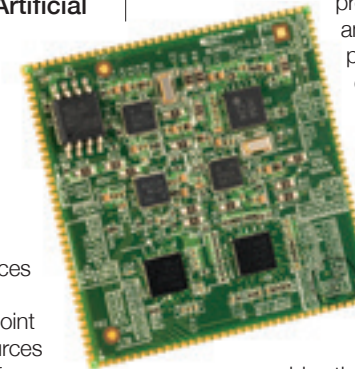
QuickLogic's QuickAI™ platform provides a comprehensive development environment for implementing Artificial Intelligence (AI) and cognitive sensing applications in system end points. It combines feature extraction/ analytics tools from SensiML and System-on-Chip (SoC) silicon from QuickLogic.

Companies developing end-point devices often lack the resources to handle the complexities of cloud-based AI. End-point applications benefit from local AI resources that can react quickly, while providing for low power consumption and lifetime cost. At the same time, the diversity of end-point use cases creates a need for application-specific algorithms and models.

The flexible hardware of the QuickAI platform and the ready-made AI software enable fast, effective development of individual solutions for AI and cognitive sensing implementation. The platform is composed of two elements.

QuickLogic's EOS™ S3 voice- and sensor-processing platform features an Arm® Cortex®-M4F processor core with embedded FPGA fabric and low-power sound detector IP, to make it the ideal host SoC. The FPGA enables the SoC to implement proprietary interfaces, sample IoT sensor data, and perform feature extraction.

The QuickAI platform also provides the SensiML™ Analytics Toolkit. This software enables developers to quickly and easily train data, build models and classifiers, and program the EOS S3 device to implement end-point AI.



### APPLICATIONS

- Industrial IoT
- Predictive maintenance
- Smart agriculture
- Wearable devices

### FEATURES: SENSIML ANALYTICS TOOLKIT

- Application software to make AI scalable
- Collect, segment and label the data
- Conduct both learning and inference
- Perform feature extraction
- Implement scaling across applications and customers
- Generate the classifier and download it to the target QuickAI platform
- Cloud-based

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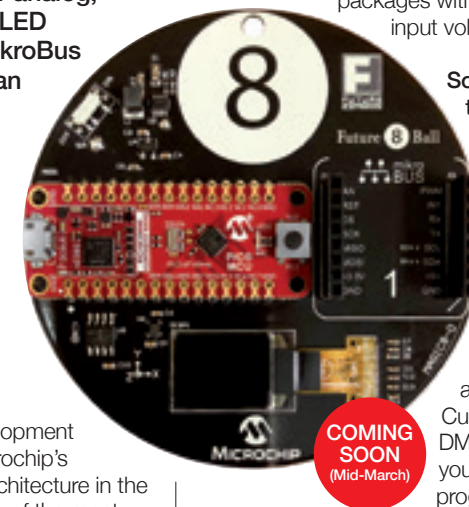
## Future 8 Ball development board offers effortless system design

### FUTURE ELECTRONICS & MICROCHIP

Future 8 Ball brings to life an effortless design solution that promotes 8-bit PIC® microcontrollers, low-power analog, temperature sensors and OLED displays. In addition, the MikroBus interface gives developers an opportunity to select from hundreds of click boards for their applications. The board allows developers of all skill levels to easily bring their ideas to life and Microchip's free MPLAB ecosystem completes the ease of developing with Future 8 Ball.

With more than 45 years of development and commercial experience, Microchip's PIC MCU brand is a dominant architecture in the embedded design world. It is one of the most cost-effective MCUs in the market with long-term availability. Microchip's portfolio of power products are designed to be easy to work with, regardless of experience and offer a complete rapid design, prototype and test, for all aspects of system design.

Microchip's linear Low-Dropout (LDO) regulators feature ultra-low quiescent current, ultra-low dropout voltage, ultra-high ripple rejection, very accurate output, fast transient response, and a broad selection of packages with a wide range of input voltages.



### Some features of the Future 8 Ball board:

- **PIC16F18446:** 8-bit product family features high resolution, intelligent analog and Core Independent Peripherals (CIPs) and the Nano Curiosity board DM164144 will allow you the ability to program and debug your development journey through the MPLAB® ecosystem.

- **MCP16251/2:** is a compact, high-efficiency, fixed frequency, synchronous step-up DC-DC converter, providing an easy-to-use power supply solution for battery powered applications.

- **MCP1812:** is a 300mA LDO linear regulator that provides high-current and low-output voltages while maintaining an ultra-low 250nA of quiescent current during device operation.

- **AT30TSE754A:** temperature sensor is capable of measuring and converting temperatures from -55°C to 125°C to a digital word and provides a typical accuracy of ±0.5°C over the operating temperature range of 0°C to 85°C.

- **E92VP:** Energizer battery AAA Alkaline Zinc Manganese Dioxide 1.5V



### APPLICATIONS

- IoT sensor end nodes
- Motor control
- Industrial processing control
- Medical
- Home appliances
- Touch sensing
- Automotive systems
- Long-life, battery-powered devices
- Wearable electronics

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## Two-channel time-to-digital converter for LiDAR and medical imaging

AMS

The AS6501 is a high performance, two-channel Time-to-Digital Converter (TDC) front end. It offers very high measurement performance and data throughput. High-speed operation is supported by the provision of LVDS stop inputs and LVDS serial outputs for each channel.

The AS6501 calculates all timing measurements internally via a reference clock.

Performance ratings include single-shot resolution of 10ps, and pulse-to-pulse spacing of 5ns. The maximum data output rate is 70Msamples/s.

The very high-resolution timings provided by the AS6501 support applications in distance and ranging measurement such as automotive LiDAR.

- 2 to 12.5MHz differential reference clock input
- Automatic calibration to reference clock
- Up to 450mW power dissipation
- 60µA standby current
- 0 to 16s measurement range
- LVDS inputs and outputs
- 3.3V supply voltage



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## Battery fuel-gauge ICs with low operating current maximize battery run-times

MAXIM INTEGRATED



The MAX17262 and MAX17263 from Maxim Integrated combine traditional coulomb counting with the novel ModelGauge™ m5 EZ algorithm to produce very accurate measurements of a battery's State of Charge (SOC) without requiring battery characterization.

Drawing low quiescent current, these fuel-gauge ICs minimize power loss during long periods of device standby time, extending battery life.

The MAX17262 is a single-cell fuel gauge with integrated current sensor. Quiescent current is 5.2µA, the lowest in its class.

The MAX17263 is a single-/multi-cell fuel gauge which drives 3 to 12 LEDs to indicate battery or system status. This feature is useful in devices with no display. Quiescent current is 8.2µA.

- Low operating current
- Supports Li+ chemistry and variants including LiFePO4
- Supplies power capacity estimates during discharge
- Predicts remaining capacity under forecast load
- Alert indicator for voltage, SOC, temperature, current and 1% SOC change
- Time-to-empty and time-to-full estimation
- No calibration required

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## 500mA single-cell li-ion battery charger with power path management

MONOLITHIC POWER SYSTEMS

The MP2663 from Monolithic Power Systems is a highly integrated, single-cell lithium-ion/li-polymer battery charger with power path management for space-limited, portable applications.

The MP2663 uses input power from either an AC adapter or a USB port to supply the system load and charge the battery independently. The charger features pre-charge, Constant Current (CC) and Constant Voltage (CV) regulation, charge termination, and charge status. The power path management function provides continuous power to the system by automatically selecting the input, the battery or both to power the system.



- ±0.5% charging voltage accuracy
- I²C interface for setting charging parameters and status reporting
- Robust charging protection including battery temperature monitoring and programmable timer
- Thermal limiting regulation
- 13V maximum input voltage
- Battery disconnection function

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## 14-channel li-ion battery cell controller IC

NXP SEMICONDUCTORS

The MC33771B from NXP Semiconductors is a SMARTMOS lithium-ion battery cell controller IC designed for automotive applications, such as hybrid electric and fully electric vehicles. It is also suitable for industrial applications, such as energy storage systems and uninterruptible power supplies.

The device performs analog-to-digital conversion of the differential cell voltages and current, as well as battery coulomb counting and battery temperature measurements. The information is digitally transmitted through a serial peripheral interface or transformer isolation to a host microcontroller for processing.

- Operating-voltage range: 9.6V to 61.6V
- 0.8mV maximum total voltage measurement error
- Total stack voltage measurement
- Addressable on initialization
- Synchronized cell voltage/current measurement with coulomb counting
- Seven GPIO/temperature sensor inputs
- Supports ISO 26262 compliance up to ASIL D safety grade
- AEC-Q100 qualified



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## High-side power switches for USB ports

DIODES INCORPORATED



The AP22815 and AP22615 from Diodes Inc., are single-channel high-side power switches which provide protection for any sensitive electronic equipment that is used in a hot-swap situation, such as USB peripherals, portable electronics, or external storage devices.

The power switches feature a wide input-voltage

range of 3.0 to 5.0V and an adjustable limited load current of up to 3.0A for the AP22815, and 4.0A for the AP22615.

- 40mΩ on-resistance
- 2kV ESD protection on the human body model
- Built-in soft-start
- Active Low or active High enable
- Fault report flag with blanking time of 7ms
- Over-voltage, over-current and over-temperature protection functions

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## LDOs feature ultra-low quiescent current

MICROCHIP

Microchip's MCP1811 and MCP1812 are LDO linear regulators which draw an ultra-low quiescent current of 250nA. In shut-down mode, the LDOs draw a 5nA supply current.

Maximum output current is 150mA for the MCP1811, and 300mA for the MCP1812.

The MCP1811/12 family comes in nine standard fixed output-voltage versions: 1V, 1.2V, 1.8V, 2.0V, 2.5V, 2.8V, 3.0V, 3.3V, and 4.0V.

- 400mV dropout voltage
- Over-current protection with foldback
- Input-voltage range: 1.8V to 5.5V
- Stable with 1.0µF ceramic output capacitor
- SOT-23, SC70 and UDFN packages



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## Narrow-angle Grid-EYE infrared array sensor

PANASONIC

The AMG8854M01 is a new Grid-EYE thermal sensor array from Panasonic which offers a narrow field of view of 35.6° (±3°). This allows the Grid-EYE infrared sensor to focus on close objects with enough pixels to be able to identify and measure those objects.

The sensor operates in a temperature range of -20°C to 100°C, and draws a maximum current of 6mA.

- 8x8 IR pixel matrix
- I²C interface
- Normal, sleep and standby modes
- 5.0V operating voltage
- 0.25°C temperature measurement resolution
- Frame rates: 10 or 1 frames/s



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## Multi-channel low-voltage remote diode sensor

MICROCHIP

Microchip's EMC1812/13/14/15/33 devices are accurate temperature sensors which provide their measurement outputs via a two-wire I²C interface. The devices monitor up to five temperature channels.

Advanced features, such as resistance error correction, beta compensation and rate-of-temperature-change measurement combine to provide a robust solution for complex environmental monitoring applications.

- Temperature-measurement range: -40°C to 125°C
- 0.125°C measurement resolution
- ±1°C maximum accuracy
- Programmable or fixed address options
- Operating-voltage range: 1.62V to 3.6V
- Configurable Alert pins



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# How Arm TrustZone security technology has made the transition from mobile phones to small, resource-constrained embedded systems

By John Robins  
EMEA Vertical Segment Manager (Embedded Systems), Future Electronics

**TrustZone® technology for Arm® CPUs is a successful security system IP which is today used in hundreds of millions of mobile phones. Its adoption by mobile phone manufacturers has been driven by the need to provide an isolated, secure space in which the online financial transactions performed by banks and online payment systems can run. This security IP removes the risk that a user's secure data may be obtained, allowing a hacker to make unauthorised payments or money transfers.**

An online financial transaction is a complex software process, and the value at risk in internet transactions is colossal. That TrustZone technology is approved by giants of the financial world is testament to the high security that it provides to mobile devices.

But the importance of security in the mobile phone and financial ecosystems has tended to overshadow its relevance to the embedded world as well. On mobile phones, the Arm TrustZone technology is implemented in the Cortex®-A class of larger, high-performance application processors. In the embedded world, devices are more commonly based on a microcontroller platform, which offers a far more constrained computing environment appropriate to the system's more limited functional requirements and lower power and cost budgets.

Whether in an MCU or a processor, the TrustZone technology provides a secure platform for the execution of software in a Trusted Execution Environment (TEE). Arm has worked with the GlobalPlatform organisation to provide Application Programming Interfaces (APIs), compliance processes and certification for a TEE.

The TEE consists of three parts: hardware-based isolation technology (such as Arm TrustZone), trusted boot, and a small trusted Operating System (OS). The TEE can be used to run multiple, isolated trusted applications which may be provisioned over the air. Compared to other security technologies, a TEE provides higher performance and access to larger amounts of memory. A TEE, which may be home grown or supplied by a third party, provides the important security functions of:

- Trusted boot
- Integrity management
- Authentication
- Payment
- Content protection
- Cryptography
- Mobile device management

Now, following the introduction by Arm of its new Cortex® M-23 and M-33 cores, microcontroller-based embedded systems can implement software securely in a TEE running on a TrustZone platform, enabling embedded system designers to emulate many of the security capabilities of today's smartphones.

## The role of secure software isolation in embedded systems

It is true to say that criminal hackers focus their effort on breaking systems from which they have most to gain. A mobile phone which can make withdrawals from the user's bank account is clearly a valuable criminal target. It would be easy to assume that an embedded device has much less appeal to hackers.

## READ THIS ARTICLE TO FIND OUT ABOUT:

- The security capabilities of Arm's TrustZone technology
- How the introduction of Arm Cortex-M cores has enabled implementation of TrustZone technology on microcontrollers
- New microcontroller products which support TrustZone technology

But imagine a device as simple as a smart home heating thermostat, connected to the internet to provide access to cloud computing applications. A hacking attack might be executed via a spoof Over-The-Air (OTA) firmware update. The result, flashed up on the thermostat's display screen: 'Pay 1 Bitcoin now or your heating is permanently disabled.' Such an attack, played out globally over a population of millions of thermostats, could yield enough to make the hacker's investment of time and risk worthwhile.

Some embedded systems use a secure authentication device, a typical example is the A1006 from NXP Semiconductors, which provides a unique encrypted identity to protect against attacks via an OTA process. A remote update, for instance, might be required to recognise the device's identity before the device allows the update to run. Authentication provides some 'connection security' and is one of the functions of TrustZone technology.

But TrustZone does more than securely verify the CPU's identity: it provides system-wide, hardware-level isolation of functions and resources into 'trusted' and 'non-trusted' elements. As Arm says, 'TrustZone is a System-on-Chip (SoC) and CPU system-wide approach to security, helping to isolate and protect secure hardware, software and resources. TrustZone is hardware-based security built into SoCs by semiconductor chip designers, then used by software developers.'

It goes on: 'The new TrustZone for Cortex-M [MCU cores] may be used to protect firmware, peripherals and I/Os, as well as to provide isolation for secure boot, trusted update and root-of-trust implementations without compromising the deterministic real-time response expected in embedded systems. The non-secure software is blocked from accessing secure resources directly, and this isolation extends beyond the processor to encompass memory, software, bus transactions, interrupts and peripherals within an SoC.'

This provides 'run-time security' on top of the partial connection security offered by a discrete authentication chip. In a system such as a wireless keypad-enabled smart door lock, for instance, TrustZone technology enables the embedded developer to implement not only the secure elements of the application software running on the CPU in trusted space: operations involving the keypad and camera I/Os can also be executed in trusted space, thus blocking any attack based on spoof keypad inputs, as shown in Figure 1.

The concept of hardware-separated trusted and non-trusted worlds is at the heart of the TrustZone approach.

Non-trusted software is blocked from accessing trusted resources directly. Instead, access to trusted resources is via Application Programming Interfaces (APIs) provided by trusted software, as shown in Figure 2. These APIs implement authentication processes to decide whether access to the trusted service is permitted. This means that, even if there are vulnerabilities in the non-trusted applications, hackers cannot compromise the whole chip.

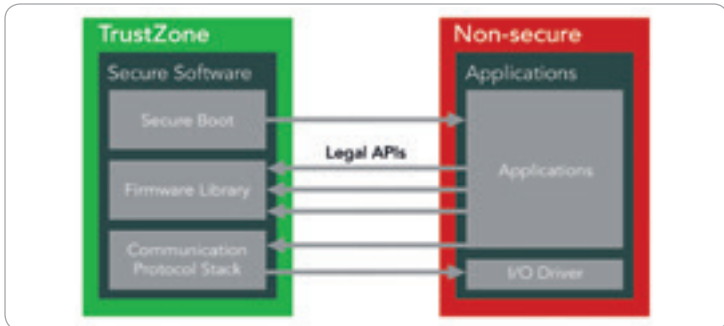


Fig. 2: APIs provided by trusted software allow non-trusted software to access trusted resources – but only if properly authenticated. (Image credit: Arm)

The reason that the TrustZone technology's security is so highly rated by third parties is that it is built into the hardware architecture of the chip: the trusted and non-trusted resources are physically isolated from one another in the silicon.

Developers of embedded systems might worry that this dual architecture creates a complex environment in which to implement applications, particularly those that require real-time, deterministic responses. In fact, the physical separation of trusted and non-trusted resources in the silicon is masked in the programming environment. A system developer working with a Cortex-M33 or M23 core – the first Cortex-M cores to support TrustZone technology – will see the same programming interface in a familiar tool such as Arm's Keil® Integrated Development Environment (IDE) as for any other Cortex-M core. The main difference is that the IDE adds a configuration setting for the developer to dictate whether a process or resource should be allocated to trusted or non-trusted space.

The IDE will also provide a means for the developer to generate the authentication process by which a trusted-world API gives permission to non-trusted software to access trusted resources. In either the Cortex-M23 or M33, this will be backed by security keys stored in trusted memory, and by dedicated hardware, such as an encryption engine, which also run in trusted space.

To support the need for real-time operation, the TrustZone implementation in the Cortex-M processors is different from that of the Cortex-A class processors in one important respect: it uses a hardware Secure Attribution Unit (SAU) to switch almost instantaneously between the trusted and non-trusted states, in contrast to the Secure Monitor Call software instruction in A-class processors.

## Microcontroller products with TrustZone technology

This development ecosystem can now be used in new system designs including TrustZone technology following the launch of compatible microcontroller products, including the SAM L11 from Microchip and the LPC5500 family from NXP Semiconductors.

The SAM L11 and the SAM L10, launched at the same time, are based on the Arm Cortex-M23 core: of the two Cortex-M cores which support TrustZone technology, the Cortex-M23 is 75% smaller than the Cortex-M33 core, and uses around half as much power.

NXP has based its LPC5500 MCUs on the Cortex-M33 core to provide a wider range of security features: these include SRAM Physically Unclonable Function (PUF)-based root-of-trust and provisioning, real-time execution from encrypted files, and asset protection.

As a rough guide, it is fair to say that the processing capability and the power consumption of the Cortex-M23 core are on a par with those of the popular Cortex-M0+ core. This means that users can now embed a proven hardware and software platform for high security into even very small and resource-constrained embedded systems. And they can do so without in any way compromising the real-time and deterministic characteristics of the typical embedded product.

Both the SAM L10 and SAM L11 include chip-level tamper resistance, secure boot and secure key storage. When combined with TrustZone technology, these capabilities enable the OEM to establish a hardware root-of-trust, and provide protection from both remote and physical attacks, as shown in Figure 3.



Fig. 3: The SAM L11 MCU's comprehensive security features protect against various forms of attack. (Image credit: Microchip)

The SAM L11 MCU also embeds Trustonic's root-of-trust during silicon manufacturing to work with Kinibi-M software, as shown in Figure 4. The Kinibi-M abstracts away the lower-level details of the SAM L11's hardware security to provide a modular approach through a Graphical User Interface.

Partnerships with Secure Thingz and Data I/O Corporation offer secure key-provisioning services for customers that have a proven security framework. These processors are fully supported in both Arm's Keil® development platform and the IAR Embedded Workbench IDE.



Fig. 4: The security architecture of the SAM L11 MCU includes Arm's TrustZone technology and the Kinibi-M GUI. (Image credit: Microchip)

## No impediment to embedding security in embedded systems

Smartphones are today thought to set the gold standard in online security, because billions of users safely use them to make contactless payments at stores and in public transit systems, and to transfer money online via banking apps. Arm's TrustZone technology embedded in the smartphone's Arm Cortex-A-based application processor provides the hardware basis for this very high security.

Now the same hardware security technology is available in the Cortex-M33 and M23 MCU cores, enabling designers of embedded devices for the Internet of Things to provide a proven hardware basis which is secure against many kinds of online and physical attack.

## Appendix: references

1. From [www.arm.com/solutions/security](http://www.arm.com/solutions/security)
2. From [www.arm.com/why-arm/technologies/trustzone-for-cortex-m](http://www.arm.com/why-arm/technologies/trustzone-for-cortex-m)

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