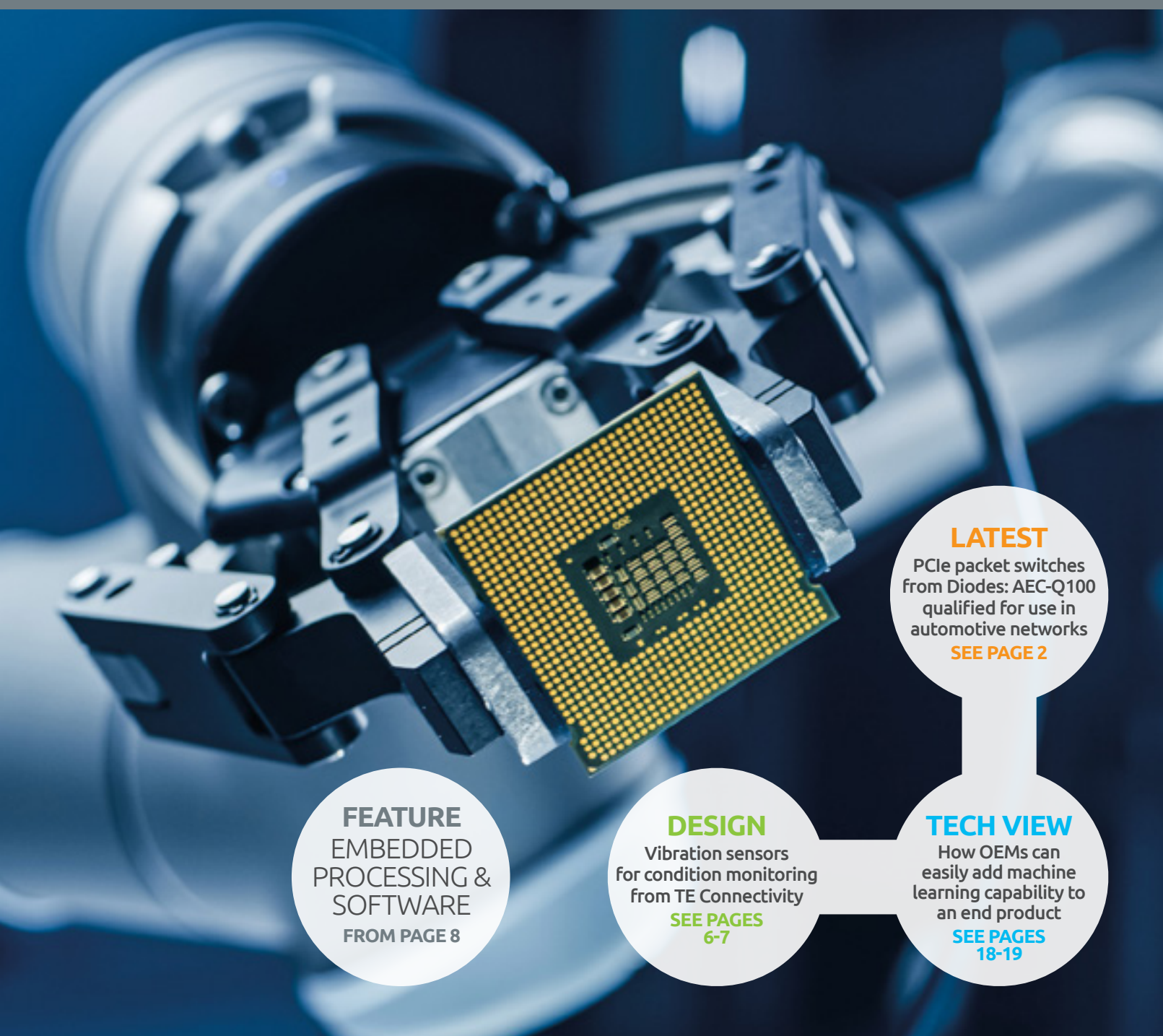


FUTURE TECHNOLOGY MAGAZINE

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PCIe packet switches
from Diodes: AEC-Q100
qualified for use in
automotive networks
SEE PAGE 2

New automotive PCIe packet switches support operation at up to 105°C



Diodes Incorporated's new PI7C9X2G304EVQ and PI7C9X2G404EVQ PCIe 2.0 packet switches offer 3-port/4-lane and 4-port/4-lane capabilities and a maximum operating temperature of 105°C, and they are automotive-qualified to AEC-Q100 Grade 2.





AEC-Q100 qualified for use in automotive networks


Part Number	Ports	Lanes	L0 Power Consumption	AEC-Q100 Qualification Grade	Operating Temperature Range	Package
PI7C9X2G304EVQ	3	4	300mW	Grade 2	-40°C to 105°C	136 aQFN
PI7C9X2G404EVQ	4	4	300mW	Grade 2	-40°C to 105°C	136 aQFN
PI7C9X2G304ELQ	3	4	700mW	Grade 3	-40°C to 85°C	136 aQFN
PI7C9X2G404ELQ	4	4	700mW	Grade 3	-40°C to 85°C	136 aQFN
PI7C9X2G304SLQ	3	4	700mW	Grade 3	-40°C to 85°C	128 LQFP
PI7C9X2G404SLQ	4	4	700mW	Grade 3	-40°C to 85°C	128 LQFP


The parts provide a simple way to fan out more PCIe ports at automotive systems-on-chip, microprocessors and FPGAs. By providing more high-speed data channels, these switches help automotive systems to support more sophisticated features in new vehicle designs. Interoperability at the system level is guaranteed through compliance with the PCI-SIG PCIe Rev 2.1 standard. At the component level, pin-compatibility with other Diodes packet switches which are qualified to AEC-Q100 Grade 3 provides an easy migration path to higher performance for existing system designs.


Latency for a packet passing through the switch without blocking is 150ns, and latency tolerance reporting improves platform power management. While the default mode is cut-through, store and forward modes are also supported. Peer-to-peer traffic is enabled through access control service support.


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CONSUMER

TELECOMS

APPLICATIONS

- Telematics
- In-vehicle wireless router
- V2X communications
- Infotainment
- ADAS
- Navigation systems

FEATURES

- Low power consumption
- Multiple power management modes
- Integrated clock buffer
- Supports peer-to-peer traffic
- PPAP capable
- Manufactured in IATF 16949-certified facilities

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Tantalum capacitors in small case sizes offer new low resistance values



Vishay Intertechnology's T55 and TR3 series of tantalum capacitors provide developers with two options for integrating capacitance with low equivalent series resistance into system designs.

The T55 series of vPolyTan™ surface-mount polymer tantalum chip capacitors has recently been extended to include new devices in the D case size (EIA 7343-31). These new parts offer low ESR values from 9mΩ down to 7mΩ. Previously only found in larger case sizes, the single-digit ESR values of these new capacitors are as much as 5mΩ lower than those typically found in devices housed in a D case. The low ESR of these T55 capacitors results in a lower voltage drop, better frequency response, and

higher ripple-current ratings up to 5.67A_{rms}, cutting the number of capacitors required on the PCB. The T55 series parts range in capacitance from 3.3μF to 1,000μF over voltage ratings from 2.5V to 63V, with a capacitance tolerance of ±20%. The devices are optimized for power management, battery decoupling and energy storage. Vishay's TR3 series of solid tantalum capacitors are available in the A, B, C, D, E and W case sizes. Offered with voltage ratings ranging from 4V to 75V and with capacitance values from as low as 0.47μF to as high as 1,000μF, they feature ESR values as low as 45mΩ. Maximum ripple-current handling capability at 100kHz spans the range from 0.1A to 2.5A. In the C, D and E case size variants, the TR3 capacitors are 100% surge-current tested. The TR3 devices are intended to perform decoupling, smoothing, bulk energy-storage and filtering functions.



T55/TR3 capacitors are available in capacitance values up to 1,000μF

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APPLICATIONS

- Servers
- Telecoms infrastructure equipment
- Solid-state drives
- Wireless transceivers
- Power distribution systems
- Gaming equipment
- Video systems
- Smart meters
- Lighting

FEATURES (T55)

- High ripple-current capability
- Stable capacitance across operating-temperature range
- Good capacitance stability over frequency range
- No wear-out effect
- Operating-temperature range: -55°C to 105°C

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New aluminum electrolytic capacitors tolerate extreme vibration in automotive and industrial applications

Panasonic

Panasonic has added new vibration-resistant parts to ten of its series of proven, surface-mount aluminum electrolytic capacitors.

The new Panasonic products are rated for exposure to vibrations as severe as 30g. In addition, their robust mechanical surface-mount design makes it easy to solder them securely to the board. These capacitors are AEC-Q200 qualified for use in automotive applications, and also offer long lifetime and high performance in industrial equipment.

Anti-vibration parts are now available in these series of aluminum electrolytic capacitors:

The **FK series**: small FK series, medium FK series, high-temperature reflow and **FKS series**. The high-temperature reflow parts offer rated endurance of 5,000 hours, and have a maximum operating temperature of 105°C. They are classed as low-impedance capacitors.

The low-impedance **FP series**: high-temperature reflow parts offer rated endurance of 2,000 hours, and tolerate a maximum operating temperature of 105°C.

The low-impedance **FT series**: high-temperature reflow parts offer rated endurance of up to 5,000 hours, and tolerate a maximum operating temperature of 105°C.

The **TC series**, **TCU series**, **TP series** and **TQ series** are all classed as long-life products, and withstand high-temperature reflow. They are rated for operation at a maximum temperature of 125°C. The endurance ratings are; TCU series 3,000 hours, TP series 2,000 to 4,000 hours, TQ series 2,000 hours and TC series 2,000 to 3,000 hours.

ENERGY

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APPLICATIONS

- Automotive systems
- Industrial equipment
- Power supplies
- Smart meters
- Robotics



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Back-flip FPC/FFC connectors offer board layout flexibility



Hirose's FH34SRJ series of Flexible Printed Circuit (FPC) and Flexible Flat Cable (FFC) connectors provide a way for the PCB designer to gain flexibility in board layout.

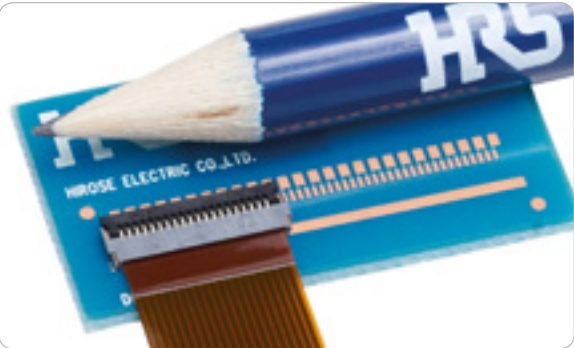
The FH34SRJ connector, which is available in versions offering between four and 50 contacts, accepts FPC and FFC in both top- and bottom-contact formats. A short mounted depth of only 3.2mm is required with a 0.5mm pitch, saving board space.

Despite the FH34SRJ's light weight of just 0.098g, the contact has a unique structure which offers high retention force. The horizontal pull-force for the six-contact version is 3.0N for the top contact and 6.0N for the bottom contact. A retention tab holds the actuator from above to ensure it is securely held when rotated.

Furthermore, the contact has a unique curved shape which supports the actuator axle. The user-friendly actuator lock is supplied in the open position, and only a two-step operation is required: inserting the FPC/FFC, followed by closing the actuator.

A firm tactile lock confirms that the connection is made. Tapers on all four inner walls of the housing opening ensure smooth FPC/FFC insertion.

The FH34SRJ has a fully enclosed, molded design, which means that the contacts are not exposed on the bottom side of the connector. This provides more potential for board patterning.



FH34SRJ: High retention force










APPLICATIONS

- Small medical devices
- Notebook and tablet PCs
- Smartphones
- Portable gaming equipment
- Portable music players


FEATURES

- 1mm height
- Protocol compatibility:
 - USB 3.1
 - eDP 1.3
 - MIPI D-PHY 1.1
- 0.5A maximum rated current
- 50V AC/DC rated voltage
- Operating-temperature range: -55°C to 85°C
- 20 mating cycles


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New space-saving board-level connectors have 2mm centerline



TE Connectivity (TE) has expanded its range of AMPMODU interconnection solutions with the introduction of board connectors which have a 2mm centerline. These new connectors occupy 38% less space than traditional 2.54mm centerline products.



AMPMODU: Surface-mount and through-hole versions









The AMPMODU parts are intended for use in applications in which space constraints are of particular concern.

The new 2mm offerings include breakaway headers and board-to-board receptacles, both supporting automated surface-mount, through-hole reflow (Pin-in-Paste), and traditional through-hole mounting processes.

The 2mm board-to-board receptacles use phosphor bronze contacts with dual cantilever beams which are available in three gold plating thicknesses. The dual-beam design provides for an increased contact surface area between the header pin and the receptacle contact, ensuring reliable signal transfers.

The AMPMODU portfolio includes various top- and dual-entry vertical and horizontal receptacles which offer multiple options for board-to-board stacking of header and receptacle combinations.

The 2mm breakaway headers can be mounted on to boards with thicknesses of 1.6mm and 2.4mm, providing customers with a wide range of options for PCB assembly. They are molded in a flame-retardant, UL 94V0-recognised thermoplastic material which is resistant to reflow soldering temperatures, and provides for safe operation in harsh environments.

APPLICATIONS

- Programmable logic controllers
- Industrial I/O devices
- Servo drives
- Materials handling equipment
- Building and home automation devices
- Industrial robotics
- Instrumentation and test equipment


FEATURES

- Single- and double-row options
 - Up to 25 positions per row
- 2A maximum current rating
- 650V AC dielectric withstanding voltage
- 125V DC operating voltage
- Operating-temperature range: -40°C to 125°C

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New snap-cap connector enhances power and signal transmission in harsh environments



TE Connectivity has extended its DEUTSCH DT range of connectors for use in harsh conditions, introducing a wire-to-wire snap-cap design. This means that the DT 2/3 series now includes three versions: the existing standard version, the welded seal cover, and the new snap-cap design.

The new DT Snap-Cap plugs include an enhanced front seal retention and secondary wedge-lock design.

At the same time, the interface plug's front seal is fully serviceable in the field if a replacement is needed, a key advantage over non-replaceable, molded-in designs.









The new connectors offer interface compatibility with all previous mating connectors and interfaces, enabling a seamless transition from legacy products to future designs.

The DT Snap-Cap series is used for wire-to-wire connections on integrated header modules for low power transmission and signal-level communications. The new connectors share the rugged, circular common contact system found in other DEUTSCH connector products.

The DEUTSCH DT 2/3 position connectors provide for easy contact insertion and removal and uncomplicated mating and unmating.



DEUTSCH DT connectors: Plug's seal can be replaced in the field

APPLICATIONS

- Transportation
- Marine equipment
- Industrial systems
- Aerospace and defense equipment


FEATURES

- 13A maximum continuous current
- 7.5mΩ maximum contact resistance
- Improved wire alignment to maximize seal performance under wire side-load conditions
- IP67 or IP68 protecting ratings
- Operating-temperature range: -55°C to 125°C


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New chip attenuators provide attenuation of up to 10dB from DC to 30GHz



Susumu's new ATS series of chip attenuators is rated for operation up to 30GHz, making it ideal for use in high-frequency communications systems, such as 5G networks.

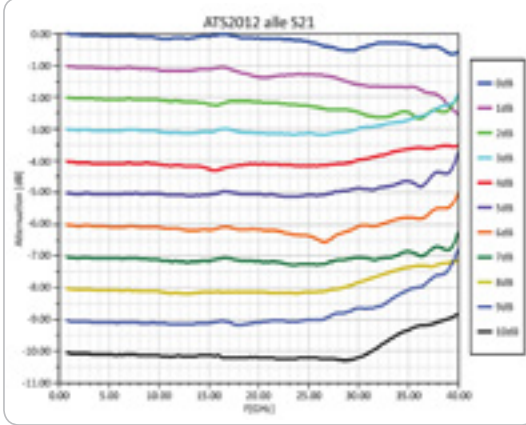










The development of the ATS series drew on Susumu's expertise in the design and production of innovative precision thin-film chip resistors – an attenuator is a resistor

The ATS series attenuators are offered in the 0805-size chip package. ATS series attenuators are available with attenuation values from 0dB to 10dB, in 1dB increments.

The ground terminals surround the signal terminal to reduce interference and crosstalk.

The ATS series attenuators are offered in the 0805-size chip package. ATS series attenuators are available with attenuation values from 0dB to 10dB, in 1dB increments.



APPLICATIONS

- Wireless communications systems and modules
- Base transmitter stations
- Avionics
- Wireless power transmitters
- Drones
- IoT devices

FEATURES

- Operating-frequency range: DC to 30GHz
- Attenuation tolerances:
 - ±0.5dB from DC to 20GHz
 - ±0.75dB from 20GHz to 30GHz
- Voltage standing wave ratio:
 - ≤1.5 from DC to 20GHz
 - ≤1.7 from 20GHz to 30GHz
- 50Ω impedance
- 100mW rated power
- Operating-temperature range: -55°C to 125°C

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Condition monitoring: a comparison of vibration sensor technologies



 By Bjorn Ryden
Global Product Manager, Vibration Sensors,
TE Connectivity

In the past, accelerometers were primarily used for heavy, high-end machinery such as windmills, industrial pumps, compressors and Heating, Ventilation and Air-Conditioning (HVAC) systems. Driven by increased automation, demand is rising for use in smaller systems produced in higher volume, such as machine spindles, conveyor belts, sorting tables and machine tools which require better predictive maintenance.

Machine downtime in these applications has an important effect on the customer experience and on profitability. Digital systems for condition monitoring can help extend operating lifetimes and eliminate unplanned downtime. An accelerometer is a key component of condition monitoring circuits. This Design Note compares the principal accelerometer technologies used today in industrial condition monitoring systems.

Key performance indicators of vibration monitors

For industrial condition monitoring and predictive maintenance applications, a small number of vibration measurement parameters are of critical importance.

Wide frequency response – to detect all possible failure modes of an electric motor, the frequency response of the accelerometer should be 40 to 50 times the motor speed expressed in revolutions per minute (rpm). For fans and gearboxes, the minimum upper limit of the accelerometer should be 4 to 5 times the blade passing frequency.

Resolution and dynamic range – the resolution of the vibration sensor is a function of the amplitude of the output signal to the broadband noise of the onboard electronics. An accelerometer with a superior signal output will allow the measurement of smaller vibrations. A sensor which can measure vibration of a lower amplitude enables the end user to predict a fault earlier than a sensor which has a lower dynamic range. As a general rule, reliable measurement calls for an output signal 10x stronger than the noise generated by the sensor.

Long-term stability – drift is a shift in the sensitivity and/or the measurement output when the input is zero. A shift in the sensitivity of the accelerometer could over time lead a monitoring application to issue a false alarm. A shift in the zero-output measurement will have the same effect. Piezoelectric sensors do not provide a DC response, so they are not susceptible to zero-output drift, only to sensitivity drift. A MEMS accelerometer can suffer from both zero-output drift and sensitivity drift over time.

The two principal types of accelerometer technology

Piezoelectric accelerometers incorporate piezoelectric crystals which supply a signal when stressed by external excitation such as vibration. Most piezoelectric sensors are based on lead Zirconate Titanate (PZT) ceramics which are polarized to align the dipoles and make the crystals piezoelectric. PZT crystals are ideal for condition monitoring applications since they offer a wide operating-temperature range, broad dynamic range, and wide frequency bandwidth of >20kHz.

Variable Capacitance (VC) vibration sensors derive their acceleration measurement from a change in capacitance of a seismic mass moving between two parallel capacitor plates. The change in capacitance is directly proportional to the applied acceleration. VC accelerometers require an IC to be closely coupled to the sensing element to convert the very small capacitance changes into a voltage output. This conversion process can result in a poor signal-to-noise ratio and limited dynamic range.

VC sensors are typically manufactured from silicon wafers and are fabricated into miniature Micro-Electromechanical Systems (MEMS) chips.

Technology comparison

Tests performed by TE Connectivity (TE) reveal the important differences in performance between the two types of accelerometer. The tests were conducted with a piezoelectric and a VC accelerometer which both had a full-scale range of $\pm 50g$.

Frequency response

The frequency response of the two accelerometers was tested on a SPEKTRA CS18 HF high-frequency shaker with a range of 5Hz to 20kHz. The sensors were securely mounted to ensure accurate results over the full test range, as shown in Figure 1. Three sensors of each technology were tested.

A maximum $\pm 1dB$ amplitude deviation is assumed as the usable bandwidth, although a tighter deviation of $\pm 5\%$ is often used for bandwidth tolerance.

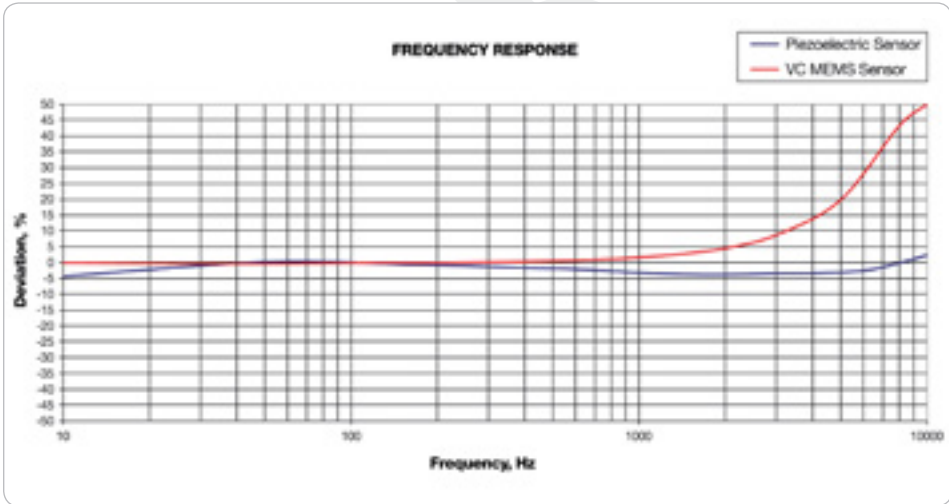


Fig. 1: Comparison of the typical frequency response of piezoelectric and MEMS accelerometers

RESIDUAL NOISE COMPARISON AT VARIOUS BANDWIDTH				
Model	0.03 ~ 300Hz μV_{rms}	0.03 ~ 1KHz μV_{rms}	0.03 ~ 3KHz μV_{rms}	0.03 ~ 10KHz μV_{rms}
Piezoelectric #1	27.2	30.8	39.5	57.6
Piezoelectric #2	25.1	31.7	38.6	56.3
MEMS #1	377.6	405.2	412.7	498.2
MEMS #2	415.7	430.2	453.9	532.1

Fig. 2: Measurements of noise tests on piezoelectric and MEMS accelerometers

MEASUREMENT RESOLUTION COMPARISON					
Model	Resolution mg_{rms}	Residual Noise μV_{rms}	Spectral Noise $\mu g_{rms}/\sqrt{Hz}$	Dynamic Range dB	Resolution Bit
Piezoelectric #1	1.4	57.6	14.4	88	14.6
Piezoelectric #2	1.4	56.3	14.1	88	14.6
MEMS #1	12.5	498.2	124.6	69	11.5
MEMS #2	13.3	532.1	133.0	68	11.4

Fig. 3: Comparison of the resolution of the piezoelectric and MEMS sensor types

The data indicate that the VC MEMS sensor has a usable bandwidth up to 3kHz, while the piezoelectric sensor has a usable bandwidth of >10kHz. It is worth noting that the low frequency cut-off for the piezoelectric sensor was at 2Hz, while the MEMS sensor operates down to 0Hz since it is a DC-response device.

Measurement resolution and dynamic range

To determine the measurement resolution and dynamic range of the piezoelectric and VC MEMS sensors, the samples were tested in a noise-isolated chamber with high-resolution measurement equipment. The units were installed in the same chamber and tested at the same time to eliminate any errors from outside environmental interference.

The measurements were conducted at four distinct bandwidth settings, and the residual noise was measured at each setting, as shown in Figure 2.

The measurement resolution and dynamic range were calculated based on a 0.03 to 10kHz bandwidth, as shown in Figure 3. The resolution of the piezoelectric sensors is around nine times better than that of the VC MEMS sensors. This results in a markedly better dynamic range, which enables the end user to detect potential problems much earlier.

Long-term stability

The long-term stability of piezoelectric sensors is well documented: these devices have been operating in the field for more than 30 years.

Piezoelectric crystals are inherently stable over time. The long-term drift parameters depend on the crystal formulation used, so an actual value is difficult to present. Quartz has the best long-term stability, but it is rarely used in condition monitoring applications because of its limited output and high cost.

PZT crystals are the most commonly used type in piezoelectric accelerometers, and are increasingly becoming the crystal of choice for most other applications.

VC MEMS accelerometers also have wide specification limits for long-term drift depending on the MEMS design structure. A bulk micromachined MEMS sensor will have the best long-term drift but will also be markedly more expensive, and typically only used in inertial applications.

For condition monitoring, MEMS vendors offer surface-micromachined VC MEMS sensors, which are much less expensive, but the end user will sacrifice measurement resolution and long-term stability. The MEMS structure of surface-micromachined designs is less stable than that of bulk-micromachined MEMS sensors.

Sensor output options

Depending on the installation and application, a choice of sensor output-signal options may be necessary. Most current predictive maintenance installations require an analog signal from the sensor, so the end user can decide on which parameters to monitor for a particular type of machinery.

Typically, the signal output is driven by the data acquisition device's or programmable logic controller's interface; an analog output of $\pm 2V$ or $\pm 5V$ is the most common choice. In installations requiring long cable lengths, however, loop-powered 4 to 20mA sensors are also common.

In the digital factory of tomorrow, digital output signals will become more widely required, as will smart sensors with onboard microprocessors which can make immediate maintenance decisions for the end user.

Both these output-signal options are available in piezoelectric and VC MEMS sensors.

Summary of the technology comparison

All or some of the performance parameters discussed above will help the customer make an intelligent decision on the right technology for the condition monitoring installation. Table 1 provides an overview of the factors to consider.

In condition monitoring applications, products from TE Connectivity offer superior performance, high reliability and a long operating lifetime. Examples include:

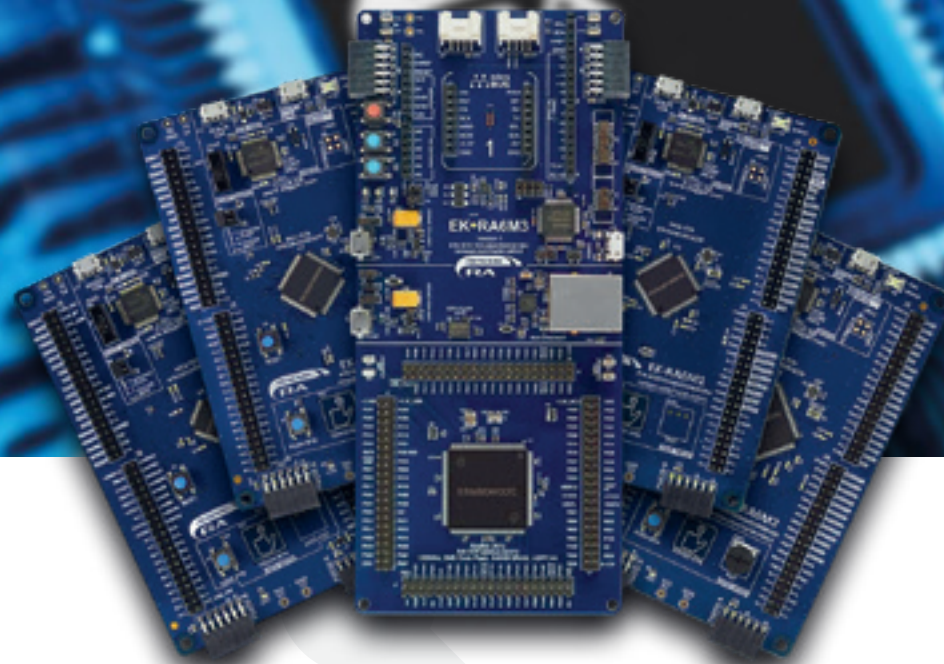
- 820M1, a single-axis, surface-mount piezoelectric accelerometer which has a bandwidth of >10kHz, and which offers a choice of dynamic ranges from $\pm 25g$ to $\pm 500g$
- 830M1, a triaxial, surface-mount piezoelectric accelerometer which has a bandwidth of >10kHz, and which offers a choice of dynamic ranges from $\pm 25g$ to $\pm 500g$

Key Parameter	Piezoelectric	MEMS VC
Wide Frequency Response	●	–
Long-term Signal Stability	●	–
Dynamic Range	●	–
Operating Temperature Range	●	●
Packing Options	●	●
Ease of Installation	●	●
Sensor Output Options	●	●

Table 1: Summary of the benefits of the two vibration sensor

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Broad new family of Arm Cortex-M-based MCUs offers high security and software flexibility

The Renesas RA family is a new range of 32-bit MCUs which is based on the Arm® Cortex®-M core architecture, and which benefits from Renesas' best-in-class technology for embedded system peripherals.

The RA family includes the RA2, RA4 and RA6 series, giving users a wide choice of performance ratings and features. Designers using the Renesas RA family can meet the requirements for scalability, power consumption and performance of almost any embedded end product.

The launch of the RA family offers a new option for designers working in an Arm Cortex-M environment, and who want to retain existing software assets.

It is an alternative to the Renesas Synergy™ family of MCUs, which includes parts based on various Arm Cortex-M cores. Synergy is an excellent solution for customers wanting a complete off-the-shelf software platform solution, giving them very fast time to market.

The RA family is an alternative for customers who want the freedom to choose their own software environment and to be able to reuse their existing software assets.

Now the addition of the RA MCU family gives designers a Renesas option which offers the flexibility to use existing and legacy software for the Arm Cortex-M architecture.

Compared to competing Arm Cortex-M-based MCUs, the RA family provides stronger embedded security, superior CoreMark® performance, and lower-power operation. Certification for Arm's Platform Security Architecture provides customers with the confidence to quickly deploy secure IoT endpoint and edge devices, and smart factory equipment for Industry 4.0 applications.

There is broad feature and pin compatibility across the three series of RA MCUs.

This provides scalability and easy code re-use between one device and another. The RA family includes:

- RA2A1, offering highly integrated, high-accuracy analog capabilities and an Arm Cortex-M23 core

- RA4M1, for control applications which drive a segment LCD panel. It offers low-power operation and high performance thanks to its Arm Cortex-M4 core
- RA6M1, ideal for IoT endpoint devices because of its high-level security features
- RA6M2, suitable for automation applications. Upward-compatible with RA6M1 devices.
- RA6M3, offering the highest performance specifications in the family, with the largest memory options and a rich feature set including TFT LCD controller, 2D graphics engine, Ethernet connectivity and Hi-Speed USB. Like the other RA6 devices, the RA6M3 is based on an Arm Cortex-M4 core.

The RA family MCUs include an integrated capacitive touch-sensing unit for display control.

The Renesas RA Flexible Software Package (FSP) gives a quick and versatile way to build secure connected IoT devices, and provides production-ready peripheral drivers to help users take advantage of the RA FSP ecosystem.

Dev kits provide rich evaluation environment for Renesas RA series microcontrollers

Renesas provides full-featured development kits for each of the series of products in its new Renesas RA family of 32-bit microcontrollers, which are based on the Arm® Cortex®-M core architecture.

The RA family includes the RA2, RA4 and RA6 series, giving users a wide choice of performance ratings and features. Designers using the Renesas RA family can meet the requirements for scalability, power consumption and performance of almost any embedded end product.

The range of RA family evaluation kits includes:

- **EK-RA2A1** (RTK7EKA2A1S00001BU), which features the R7FA2A1AB3CFM, a 48MHz MCU based on an Arm Cortex-M23 core. The MCU includes 256kbytes of code-storage Flash and 32kbytes of RAM.
- **EK-RA4M1** (RTK7EKA4M1S00001BU), which features the R7FA4M1AB3CFP, a 48MHz MCU based on an Arm Cortex-M4 core. This also includes 256kbytes of code-storage Flash and 32kbytes of RAM.
- **EK-RA6M1** (RTK7EKA6M1S00001BU), which features the R7FA6M1AD3CFP, a 120MHz MCU based on an Arm Cortex-M4 core. This includes 512kbytes of code-storage Flash and 256kbytes of RAM.
- **EK-RA6M2** (RTK7EKA6M2S00001BU), which features the R7FA6M2AF3CFB, a 120MHz MCU based on an Arm Cortex-M4 core. It has 1Mbyte of code-storage Flash and 384kbytes of RAM.
- **EK-RA6M3** (RTK7EKA6M3S00001BU), which features the R7FA6M3AH3CFC, a 120MHz MCU based on an Arm Cortex-M4 core. It has 2Mbytes of code-storage Flash and 640kbytes of RAM. It also includes an Ethernet interface and a USB Hi-Speed Host and Device interface.
- **EK-RA6M3G** (RTK7EKA6M3S01001BU), a special version of the EK-RA6M3 development kit which includes extra support for a graphics interface. It has a graphics expansion board featuring a 4.3" TFT color LCD with capacitive touch overlay.

Each board provides native access to the MCU's pins via four 40-pin male headers. It also provides current-measurement points for monitoring the current through the MCU.

All these boards support up to two PMOD connections. The EK-RA6M3 and EK6M3G kits also offer additional expansion options to popular platforms, including Seeed Grove® system (I²C), Digilent Pmod™ (SPI and UART), Arduino™ (Uno R3) or MikroElektronika™ mikroBUS connectors.



APPLICATIONS

- Home automation
- Industrial automation
- Building automation
- Energy management systems
- Healthcare equipment
- Industrial IoT devices

FEATURES

- Supported by open Flexible Software Package (FSP)
 - Based on FreeRTOS
 - Can be replaced by any other RTOS or middleware
- IDE support:
 - Renesas e²studio
 - KEIL® MDK
- Supports GNU Arm Compiler version 6
- Emulator support:
 - Segger J-Link
 - Renesas E2 emulator, E2 Lite emulator
- Renesas PG-FP6 Flash memory programmer or third-party solutions

FTM DEVELOPMENT BOARDS

Orderable Part Numbers:
 RTK7EKA2A1S00001BU, RTK7EKA4M1S00001BU
 RTK7EKA6M1S00001BU, RTK7EKA6M2S00001BU
 RTK7EKA6M3S00001BU, RTK7EKA6M3S01001BU

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Multi-chip dev kit features MCU, dedicated security controller and Wi-Fi module for secure connection to cloud service providers

Infineon has launched a comprehensive IoT device development kit which implements a secure wireless end-to-end connection between the cloud and an end point based on an XTREME 1400 series microcontroller.

The Infineon Digital Security Solutions (DSS) Secure Connectivity Kit includes three boards:

- The XMC1400 XTREME Controller Board features an XMC-1404 MCU, which has a low-power, 48MHz Arm® Cortex®-M0 processor core. The XMC1400 series devices are ideal for performing control functions in electric motors, power-converter circuits, LED lighting and the human-machine interface.
- OPTIGA™ Trust M Security Controller board, which has the part number SLS32AIA010MSUSON10XTMA2. The controller board and the security board are connected via Adafruit Feather Wing headers.
- ESP8266 Wi-Fi® wireless networking module, which connects to the XMC1400 controller board via a MikroBUS header.

The OPTIGA Trust M security controller provides flexible, high-performance secure access for IoT devices to any major cloud provider. Easy to implement in system designs, the OPTIGA Trust M offers zero-touch provisioning, as it can be shipped with customer-specific unique credentials programmed into the chip at Infineon's secure factory. System integration is also supported by the provision of a cryptographic toolbox and a protected I²C interface.

The OPTIGA Trust M supports several security use cases, such as:

- Mutual authentication
- Secure encrypted communication
- Secure over-the-air updates
- Security lifecycle management

An advantage of implementing cloud connectivity via a dedicated security chip is faster performance: routing connection requests via the OPTIGA Trust M, an XMC1400 MCU-based system can connect to the cloud up to ten times faster than a software-only solution.

The OPTIGA Trust M is certified to Common Criteria EAL6+ for high security. It implements advanced asymmetric ECC and RSA cryptography. It also provides AES128-CCM encrypted communication between the host and the security controller.

Open-source OPTIGA Trust M host software and documentation are available on GitHub.

MCU supports mixed-signal applications

The XMC1404 MCU in the DSS Secure Connectivity Kit is an ideal host for low-power devices that connect to the IoT via Wi-Fi or other wireless links.

Operating from a supply of 1.8V to 5.5V, the XMC1404 offers 64kbytes of Flash code-storage memory and 16kbytes of RAM. While the Cortex-M0 core operates at 48MHz, the peripherals are clocked at 96MHz.

For communications and human-machine interface tasks, the XMC1404 provides two CAN nodes, four serial interface channels, a controller for a 3 x 64 LED matrix, and nine-channel LED brightness and color control.

The MCU is similarly well equipped for actuator and sensor control in industrial systems, featuring a 12-bit ADC, four comparators and 16 PWM channels.



APPLICATIONS

- Smart home equipment
- Consumer electronics
- IoT devices
- Industrial I/O modules

FEATURES (XMC1404)

- Math co-processor
- 16 x 16-bit special purpose timers
- Two Hall sensor and encoder interfaces
- Temperature sensor
- Pseudo random number generator
- Real-time clock
- Watchdog timer
- Operating-temperature range: -40°C to 105°C

FTM DEVELOPMENT KIT

Orderable Part Number:
XMC14XTROPTIGATRMTOB01

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Integrated Bluetooth Low Energy radio supports mesh networking

ON Semiconductor®



Mesh networking capability was introduced to the Bluetooth® Low Energy specifications in July 2017 by the Bluetooth Special Interest Group (SIG) as a means of supporting large-scale networks requiring many-to-many node connections.

Designers who wish to take advantage of this capability can use ON Semiconductor's RSL10, a multi-protocol, Bluetooth 5.0-certified radio System-on-Chip (SoC) which offers the lowest power consumption in its class.

The RSL10 is for use in devices which require advanced wireless features such as Bluetooth mesh networking, while occupying a small board footprint and extending battery run-time.

For faster system development, the RSL10 SoC may be supplied integrated into a System-in-Package (SiP). The ready-to-use RSL10 SiP includes an antenna, the RSL10 SoC, and all passive components in a single, miniature package.

ON Semiconductor provides RSL10 software to allow for rapid development of ultra low-power Bluetooth Low Energy mesh networking

applications. Sample code enables easy configuration and deployment of mesh networks with any combination of proxy nodes (to connect a mobile phone), relay nodes, friend nodes and Low-Power Nodes (LPNs), with support for multiple LPNs per friend.

Documentation explains the process of configuring and provisioning an RSL10-based mesh network.

Part Number	Description
NCH-RSL10-101Q48-ABG	RSL10 SoC in QFN
NCH-RSL10-101WC51-ABG	RSL10 SoC in WLCSP
NCH-RSL10-101S51-ACG	RSL10 SiP
BLE-SWITCH001-GEVB	Energy-harvesting BLE switch reference design
RSL10-002GEVB	Radio SoC evaluation board
RSL10-SENSE-DB-GEVK	RSL10 sensor development kit with debugger
RSL10-SENSE-GEVK	RSL10 sensor development kit
RSL10-SIP-001GEVB	RSL10 SiP development board
RSL10-SOLARSENS-GEVK	RSL10 solar cell multi-sensor platform
RSL10-USB001GEVK	RSL10 USB dongle



APPLICATIONS

- Building and home automation
- Sensor networks
- Smart lighting and smart locks
- Automotive systems
- Asset tracking
- Environmental monitoring

FEATURES

- Industry's lowest-power LPN
 - 25nA Sleep current
- Sample application code for friend nodes and LPNs
- Ready-to-use stand-alone node applications
- Source code provided for sample applications
- Full suite of development tools including an Eclipse-based integrated development environment

FTM DEVELOPMENT BOARDS

Orderable Part Number: RSL10-SIP-001GEVB

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2 Design

Engineer • Refine • Document

3 Prototype

Prove • Iterate • Learn

4 Manufacture

Tool • Debug • Support



Integrated module combines high-performance microprocessor with Wi-Fi and Bluetooth connectivity



The SAM5D27 Wireless SOM1 (WLSOM1) is a small, single-sided System-on-Module (SoM) from Microchip which combines a high-performance microprocessor based on the Arm® Cortex®-A5 core with Wi-Fi® and Bluetooth® wireless connectivity.

The SoM form factor and high level of integration provide valuable benefits to designers who need to run applications on the Linux operating system and to transfer data over Wi-Fi and Bluetooth networks:

- Shortens development time
- Reduces development risk and eliminates the need for RF design expertise
- Simplifies wireless certification
- Accelerates integration with cloud services
- Integrated support for AWS Greengrass and Microsoft Azure cloud services
- Pre-provisioned ECC608 Secure Element
- Arm TrustZone® support
- Reduces component count and vendor list, and simplifies inventory and production process

The Cortex-A5 processor core is supported by a 2Gbit LPDDR2 DRAM system-in-package which runs at up to 500MHz. The SoM also includes Microchip's WILC3000 Wi-Fi / Bluetooth dual-mode wireless connectivity module. This connectivity module features a u.FL connector for an antenna. It supports high-speed data transfers at rates up to 72Mbps/s in Wi-Fi mode, and up to 3Mbps/s in Bluetooth mode.

The module's maximum data rate in Bluetooth Low Energy mode is 1Mbit/s.

The module is supplied pre-certified for operation in the US, Canada and Europe. Microchip also supplies a list of qualified antennas for use with the module.

The SoM's MCP16502 Power Management IC (PMIC) provides a space- and feature-optimized power system for the module. Featuring 94 I/Os, the SoM board has a footprint of just 41mm x 41mm and is 3.3mm high.

The ATSAMA5D27-WLSOM1 is supplied with free Linux distribution and bare metal C code examples.

FTM DEVELOPMENT BOARD

The USB-powered ATSAMA5D27-WLSOM1-EK1 features serial debug interfaces and a 20-pin JTAG connector, two USB connectors, one Ethernet port and an SD card slot. It also has two mikroBUS™ connectors and two XPRO PTC connectors, a Wi-Fi/Bluetooth antenna, and may optionally be supplied with a 5" WVGA touchscreen LCD.

Orderable Part Number: ATSAMA5D27-WLSOM1-EK1
Available at FutureElectronics.com



APPLICATIONS

- IoT devices
- Smart appliances
- Healthcare equipment
- Human-machine interfaces
- Access control panels
- Home automation
- Industrial automation

FEATURES

- 10/100 Ethernet PHY
- USB Device and Host interfaces
- Two CAN interfaces
- 64Mbit serial Quad I/O Flash memory
- 128kbytes of SRAM
- Cache memory:
- 32kbytes in L1, 128kbytes in L2
- Graphics controller
- 18-bit graphic LCD controller
- Camera interface
- 51-channel DMA controller
- Operating-temperature range: -40°C to 85°C

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RENESAS
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Renesas' new RX23W is a wireless microcontroller which is based on the high-performance, 54MHz 32-bit RXv2 CPU core, and which offers full Bluetooth® 5.0 networking functionality.

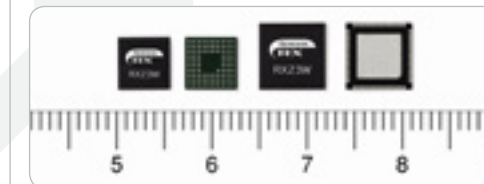
It provides an ideal way for RX family MCU users to add Bluetooth 5.0 connectivity to their designs, and for designers to implement secure wireless point-to-point or mesh networking. The RX23W supports the full set of Bluetooth Low Energy single-mode functions specified in the Bluetooth 5.0 standard: it transfers data at rates up to 2Mbps/s, and over a long range of up to 400m.

The RX23W's RXv2 core provides higher performance than the Arm® Cortex®-M4 processor used in many competing wireless MCUs. The RX23W's powerful core supports the operation of a rich set of peripherals including a USB 2.0 controller and a CAN controller, as well as capacitive touch sensing.

Security is another strong suit of the RX23W: Trusted Secure IP (TSIP) in the RX23W MCU provides strong key management and advanced encryption capability.

The MCU is notable for its excellent power efficiency. It features lower peak power consumption than any competing wireless MCU, with just 3mA in Receive mode. It also offers industry-best sensitivity of -105dBm at 125kbits/s.

Renesas has made the RX23W easy to implement in end-product designs. No external parts are required for the RF antenna line because the RX23W integrates a complete on-chip matching circuit and the RF oscillator adjustment circuit.



RX23W: Available in BGA (left) and QFN (right) packages



APPLICATIONS

- Healthcare equipment
- Home appliances
- Building automation
- IoT devices
- Industrial products

FEATURES

- Memory provision:
 - 512kbytes maximum program Flash
 - 64kbytes maximum SRAM
- 14-channel, 12-bit ADC
- Supply-voltage range: 1.8V to 3.6V
- Operating-temperature range: -40°C to 85°C

FTM DEVELOPMENT BOARD

Renesas supplies target boards for devices in the RX family to provide a means to evaluate the MCU and develop prototypes based on it. The target board incorporates an emulator circuit, and provides through-holes for Arduino®-style pin headers which give access to all the MCU's signal pins.

Orderable Part Number: RTK5RX23W0C00000BJ

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New PMIC provides multiple power rails for safety-critical automotive electronic control units

Infineon has introduced the OPTIREG™ TLF35584, an integrated Power Management IC (PMIC) which provides an efficient, multi-output power supply to a 5V or 3.3V microcontroller, transceivers and sensors in safety-critical automotive Electronic Control Units (ECUs). The PMIC is compatible with the ASIL grade D safety requirements of systems which comply with the ISO 26262 automotive safety standard.

Design flexibility is built into the operation of the TLF35584. For instance, it supports a wide switching-frequency range to enable the design to optimize for efficiency or system size. The PMIC is compatible with Infineon's AURIX™ 32-bit security microcontrollers.

The development of the TLF35584 was conducted in accordance with the requirements of the ISO 26262 standard. The processes which Infineon applied, the safety assessment made of the TLF35584, and documentation including safety manual and a safety analysis summary report reduce the time and effort involved in completing a safety assessment of the complete ECU in which the TLF35584 is embedded.

Safety integrity functions offered by the PMIC include:

- Under- and over-voltage monitoring of all power rails with an independent reference voltage
- A flexible watchdog to detect dependent failures
- Monitoring of the host MCU's safety management unit
- Safe state controller which provides secondary safety paths

A Built-In Self-Test (BIST) system ensures the proper functioning of the relevant safety features. All safety-relevant configurations are locked, and can only be changed by applying a special unlock/lock sequence.

The TLF35584QV parts are supplied in a small, 48-lead QFN package which supports automated optical inspection, and the TLF35584QK parts are in a 64-lead QFP package.

FTM DEVELOPMENT BOARD



This application board is for evaluating the performance of the TLF35584QVVS1 PMIC for the AURIX MCU.

Orderable Part Number: TLF35584QVVS1 BOARD
Available at FutureElectronics.com



APPLICATIONS

- Powertrain
 - Engine management
 - Transmission
 - Transfer case
 - Integrated starter generator
 - Electric motors
- Battery management
 - Inverter
 - DC-DC converter
 - Charger
- Chassis/safety
 - Electric power steering
 - Electric steering column lock
 - Electric parking brake
 - Brakes
 - Active suspension
 - Chassis control
 - Domain control
 - ADAS domain control

FEATURES

- Input-voltage range: 4V to 35V
- Pre-regulator power management block
 - Synchronous buck converter
 - Optional asynchronous boost converter
- Post-regulator power management block
 - LDO supply to MCU
 - LDO supply to communications channels
 - LDO supply to sensors
 - Reference voltage
- LDO for standby power supply
- Flexible state machine
- Serial peripheral interface to host MCU

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Artificial intelligence off-the-shelf: how OEMs can easily build in machine learning capability



By Future Electronics

- The conditions are ripe for embedded developers to create their own Artificial Intelligence (AI) applications:
- Component technology, even a 32-bit microcontroller, supports neural network inferencing at the edge. Tools introduced recently by component manufacturers provide for efficient targeting of trained machine learning tools to their hardware.
 - A broad range of model training frameworks is available for embedded developers to use
 - Third parties can provide large sets of labelled generic data sets such as images, or OEMs can use tools and hardware for collecting and curating their own custom data set

But in such a new and complex field, it is likely that OEMs’ engineering teams will need to undergo an intensive process of education before building an AI-based product. Figure 1 shows the many elements in the process of developing an AI application. A full-custom AI development project starting today could be expected to take a minimum of two years before a finished product gets to market. This time could be considerably longer for an OEM with no previous experience in machine learning techniques and technologies.

Microprocessor, microcontroller and FPGA manufacturers are now introducing sophisticated toolchains to support the development of inference engines and their compilation on their products, in an effort to ease and accelerate the AI development process.

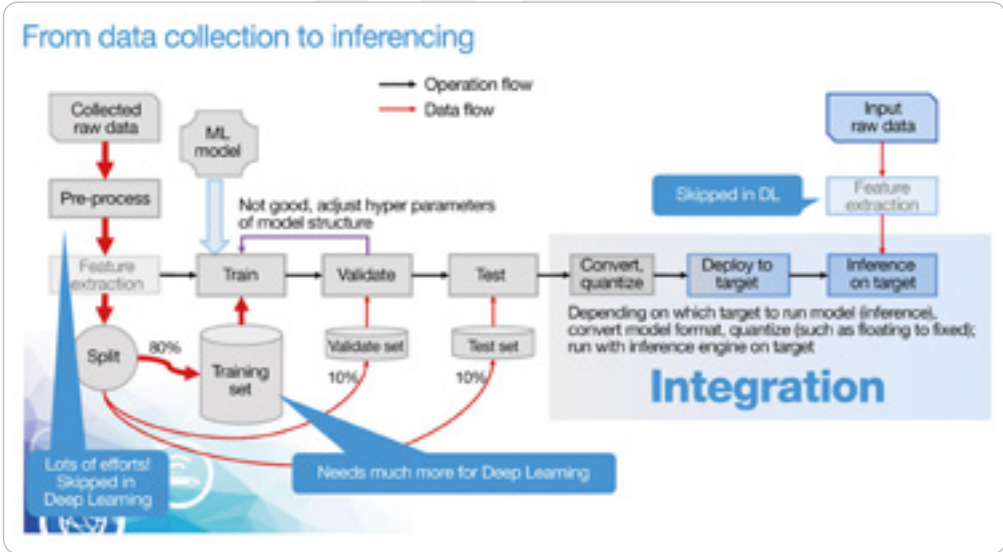


Fig. 1: The process for developing a new machine learning application to run on embedded hardware. (Image credit: NXP Semiconductors)

Read this to find out about:

- The types of generic AI-based applications for which off-the-shelf solutions exist today
- How NXP enables local speech recognition with no cloud connection in its comprehensive reference design solutions
- Two low-power implementations of people counting which run on a Lattice FPGA

But in fact it is possible to embed machine learning capability in a new production-ready design within weeks rather than years, provided your product needs to perform one of a small number of common, generic AI functions.

This is possible because semiconductor suppliers have recognized that many OEMs share a common requirement for AI-enabled applications such as speech recognition, image recognition, and people detection and counting. They have responded to this need by providing ready-made, off-the-shelf reference designs for these applications. As we shall see, some of these designs are production-ready systems that can be dropped into existing product designs with no or little modification.

Machines which hear speech – a hit with consumers

The adoption of technologies such as Amazon’s Alexa Voice Service, Apple’s Siri® voice recognition software and the Google Assistant™ virtual personal assistant shows that consumers are comfortable with speaking their commands to a machine. Speech recognition is a classic field for AI, since it involves distinguishing common patterns of sound that are masked by numerous variations in the pitch and volume of the voice, accent, and enunciation, while filtering out extraneous audible noise.

The conventional development pathway for this application would involve the collation and curation of a large set of voice samples, and then using it to train, validate and test a bespoke learning model.

It would be much easier and quicker to embed a speech-recognition system already developed by a third party and this is exactly what NXP Semiconductors enables with its speech-recognition reference design, the SLN-LOCAL-IOT, featured in this issue, as shown in Figure 2. NXP also provides a similar system, the SLN-ALEXA-IOT, for implementing Amazon’s Alexa Voice Service technology. The reference design boards consist of a production-ready i.MX Voice Solution Board, backed by software for audio signal capture and processing, and for speech recognition, all running on a low-cost i.MX RT1060 family crossover microcontroller.

It enables OEMs to easily and cheaply add local voice control to any end product, with no connection to the internet required. With this NXP reference design, OEMs can quickly add voice controls to home thermostats, washing machines, fridge-freezers, light switches and many other types of device. NXP will support the implementation of custom wake words and commands.



Fig. 2: NXP’s i.MX RT106x Voice Solution Board

The i.MX Voice Solution Board itself is small, and because it requires no SRAM, eMMC storage or Power Management IC (PMIC), it also has a reasonable bill-of-materials cost. According to NXP, the cost is some \$10 lower than that of a typical speech recognition system based on an applications processor.

People detection is a different application for machine learning, but like voice control requires the recognition of a common pattern: the image of a human body in countless variations. Like NXP, Lattice Semiconductor has succeeded in implementing a complex AI application on a highly constrained piece of hardware: a small, ultra-low power iCE40 FPGA.

Lattice provides the reference design as a complete hardware/software kit. The hardware platform is a Himax HM01B0 UPduino Shield, as shown in Figure 3. It is based on the UPduino 2.0 board, a rapid prototyping development board in the Arduino form factor offering the performance and I/O capabilities of the iCE40 UltraPlus FPGA: 5,280 Look-Up Tables (LUTs), 1Mbit of embedded memory, 120kbits of block RAM and eight multiply-accumulate blocks. It also includes the Himax HM01B0 low-power image sensor module and two I²S microphones, supporting AI applications that use either visual or audio inputs or both.

The reference designs are fully supported in the latest version 2.0 of Lattice’s SensAI™ development environment: SensAI provides project files and documentation for human presence detection using Compact Convolutional Neural Networking (CNN) IP for the Lattice FPGA.

The performance of the iCE40-based people detection application is impressive, especially given that it consumes as little as 1mW of power when sampling at a frequency of one or two frames per second. It can detect a person as far as 5m away from the camera, and even if the person’s image occupies as little as 10% of the total frame area.

Helpfully, Lattice supplies with the reference design software its training data set and the input files that it uploaded to the model training framework. This means that the reference design can be used not only as an off-the-shelf solution for people detection, but as the basis for an OEM’s own, custom people detection system: developers can take the Lattice data set and run their own model training process to change the speed, accuracy, range or hardware footprint of the inference engine in the iCE40.

Lattice supplies the same, production-ready hardware and software for people counting, an application that it runs on its larger ECP5-85 FPGA. This FPGA offers much greater hardware capabilities than the iCE40 with 85,000 LUTs and 3.7Mbits of block RAM. This people-counting reference design is hosted on Lattice’s Video Interface Platform, a system which consumes less than 1W and which provides multiple video interfaces such as MIPI CSI-2, eDP, HDMI, GigE Vision and USB 3.0.

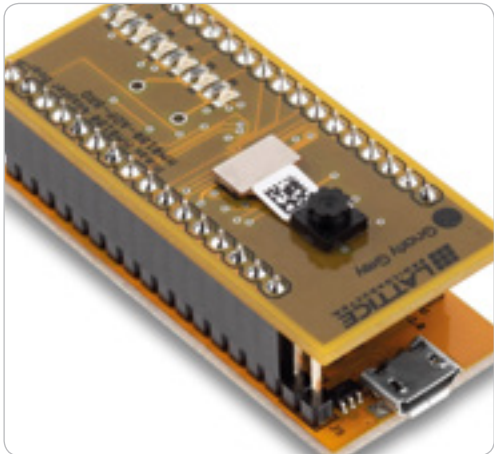


Fig. 3: The Himax HM01B0 UPduino Shield hosts Lattice’s people detection AI application

Lattice’s people counting application can detect and count multiple people in a frame. It can detect the image of a body as small as six pixels, and can detect people as far as 8m away from the camera at various orientations. As with the people detection application on the iCE40, this people counting application is a production-ready design, supplied with the training data set and the input files to the machine learning framework.

A growing range of ready-made solutions

The NXP i.MX RT voice control reference design could be of interest to manufacturers

of home appliances, home automation equipment, consumer electronics devices such as set-top boxes and wireless access points, lighting equipment and many other device types.

Likewise, the people detection and counting applications from Lattice could be useful in building automation, access control, security and surveillance and building automation and control systems.

But these are not the only AI designs that can be applied broadly, and electronics manufacturers can expect to see the emergence of more ready-made implementations of machine learning technology.

For example, demonstrations provided by Lattice for its iCE40 and ECP5 FPGAs include applications for hand gesture recognition, face detection, face tracking, and speed sign detection. And NXP has released a reference design for face recognition in end products such as home appliances, the SLN-VIZN-IOT, which is featured in this issue of FTM.

Running on an i.MX RT1060 family crossover microcontroller, it offers an inference time of <750ms and can recognise more than ten different users’ faces. It is supplied with production-grade face recognition algorithms.

Fastest route to AI implementation

While much of the literature about AI in the embedded world shows the developer how to master the complex process of acquiring training data sets, training a model and implementing the model in an inference engine, some OEMs might choose to completely bypass the long AI development workflow and take advantage of the designs that NXP, Lattice and others have already developed.

The availability of these reference designs is a reminder that the implementation of AI does not have to be difficult, risky or time-consuming.

FTM DEVELOPMENT BOARDS

Orderable Part Numbers:
NXP Semiconductors SLN-ALEXA-IOT
NXP Semiconductors SLN-VIZN-IOT
NXP Semiconductors SLN-LOCAL-IOT
Lattice HM01B0 UPduino Shield

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Smart Lock Example Diagram

