

**NPIs, DESIGN  
AND TECHNOLOGY NEWS**



# 23-vii

## Industrial Automation / Industry 4.0



## All-in-one secure MCU module provides controller functionality and verifiable identity

The Microchip WFI32E01PC combines a MIPS32 core-based microcontroller with a 2.4 GHz Wi-Fi® radio and a hardware secure element to enable safe, authenticated connection to IoT cloud services such as Microsoft Azure or AWS.



The WFI32E01PC from Microchip is a highly integrated module which provides industrial-grade microcontroller functionality, robust Wi-Fi connectivity, and hardware security and authentication.

Ideal for industrial IoT applications, the WFI32E01PC contains the PIC32MZW1 Wi-Fi system-on-chip (SoC), which combines a 200 MHz MIPS32® M-Class MCU with a Wi-Fi radio and a rich set of peripheral functions, alongside WFI32E01PC a PCB antenna and a Microchip Trust&GO secure element. The secure element is shipped with provisioning for popular cloud platforms including AWS.

The PIC32MZW1 SoC's 2.4 GHz radio supports Wi-Fi connectivity in IEEE 802.11b/g/n modes. The SoC also features 1 Mbyte of embedded Flash and 256 kbytes of SRAM, giving it the capability to host complex IoT software for wireless networking, a TCP/IP stack, real-time operating system, cloud connectivity, and the application. Application development is supported by the provision of a broad range of peripherals, such as Ethernet, USB, CAN, an ADC, and touch-sensing buttons.

Software development for the WFI32E01 module is supported in Microchip development tools including the MPLAB® X integrated development environment and the MPLAB Harmony v3 software development framework. Microchip also follows a system solution approach which provides ready-to-use software drivers and hardware reference designs, reducing OEMs' project risk and time-to-market.

These reference designs include a project example implementing the Matter wireless protocol for a home automation application.



### FEATURES

- Wi-Fi security protocols supported:
  - WPA/WPA2/WPA3 Personal
  - TLS
  - SSL
- Three UART interfaces
- Two serial peripheral interfaces
- I2C interface
- Operating-temperature range: -40°C to 85°C
- Regulatory compliance:
  - Certified for FCC, IC, RED

### APPLICATIONS

- Home automation:
  - HVAC systems
  - Garage doors
- Building automation
- Computing equipment
- Consumer devices

### FREE DEV BOARD

PIC32 WFI32E Wi-Fi SoC Curiosity Board.

**Orderable Part Number**  
**EV12F11A**

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# 40 V MOSFETs save energy and lower noise in power systems and motors

**STL320N4LF8 and STL325N4LF8AG MOSFETs from STMicroelectronics, based on new STripFET F8 technology, offer low on-resistance and switching losses, while supporting high switching speeds of up to 1 MHz.**



STMicroelectronics has extended its portfolio of low-voltage MOSFETs with the introduction of the STPOWER STripFET F8 oxide-filled trench technology, which cuts both on-resistance and switching losses while optimizing the MOSFET's body-diode properties.

This AEC-Q101 qualified technology will be deployed in MOSFETs with breakdown voltage ratings ranging from 30 V to 150 V to meet all the requirements for very high-power-density solutions.

The advanced STripFET F8 technology supports high switching frequencies thanks to low device capacitance, which minimizes dynamic parameters such as gate-drain charge, boosting system efficiency. Designers can select switching frequencies between 600 kHz and 1 MHz. These high switching speeds permit the use of small capacitive and magnetic components to reduce circuit size and increase the power density of the final application.

The first MOSFETs to benefit from the STripFET F8 technology are the STL320N4LF8 and STL325N4LF8AG 40 V N-channel, enhancement mode MOSFETs. The STL320N4LF8 features maximum on-resistance of 0.8 mΩ at a gate-source voltage of 10 V. The figure for the STL325N4LF8AG is 0.75 mΩ.

These 40 V MOSFETs are also notable for their low EMI output, thanks to an embedded snubber, which prevents spikes in the drain-source voltage, and the body diode's soft-recovery characteristic. In addition, the diode's low reverse-recovery charge minimizes energy losses in hard-switching topologies.

The gate threshold voltage is tightly controlled in the STL320N4LF8 and STL325N4LF8AG to ensure a narrow spread across devices, enabling the parallel connection of multiple MOSFETs to handle increased current.

The MOSFETs are housed in a space-saving and thermally efficient PowerFLAT package with a footprint of 5 mm x 6 mm.



## FEATURES

- Maximum continuous drain current:
  - 360 A for STL320N4LF8
  - 373 A for STL325N4LF8AG
- Withstands 1,000 A/10 μs short-circuit pulses
- 0.8°C junction-to-case thermal resistance
- Operating-temperature range: -55°C to 175°C

## APPLICATIONS

- Automotive
- Computers and computer peripherals
- Data center equipment
- Telecoms equipment
- Solar power generation
- Power supplies and converters
- Battery chargers
- Home and professional appliances
- Gaming equipment
- Drones
- Lighting



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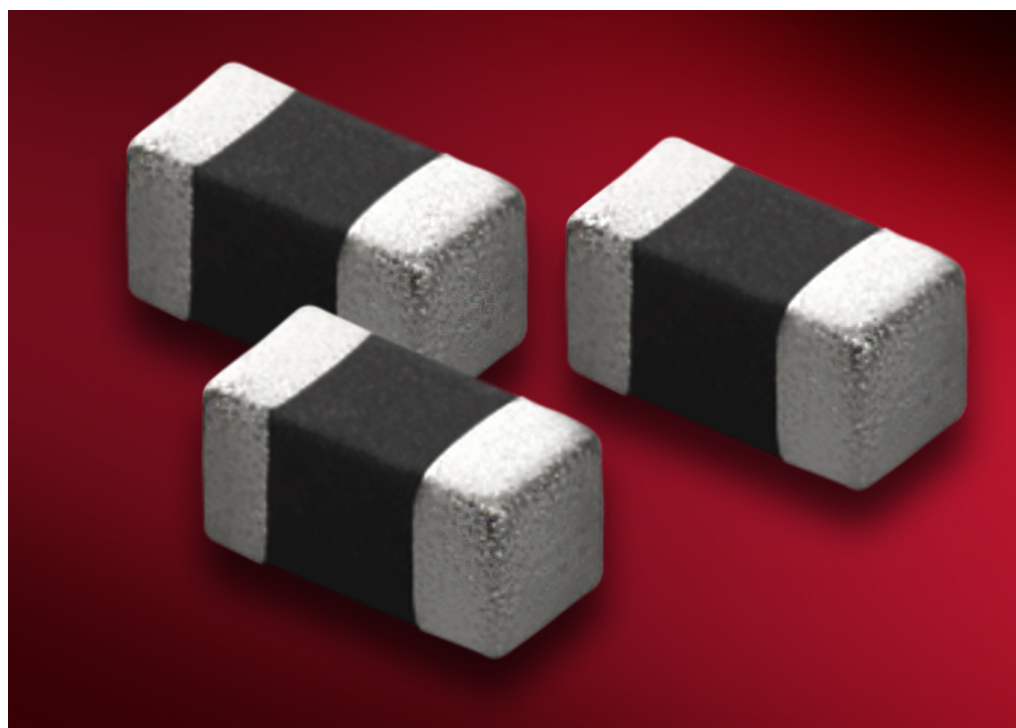


TELECOMS



# PTC thermistor provides resettable short-circuit protection

The surface-mount PRG series from Murata provides a flexible set of trip-current options. Compact dimensions make these thermistors suitable for use in space-constrained products such as smartphones.



**muRata**  
INNOVATOR IN ELECTRONICS

## FEATURES

- Low profile
- Stable characteristics after mounting and energization
- Operating-temperature range: -20°C to 85°C

## APPLICATIONS

- Automotive systems
- Factory automation
- Battery chargers
- USB port protection
  - Smartphones
  - Laptop computers
  - Tablets

The PRG series of positive temperature coefficient (PTC) thermistors operates as a resettable fuse, protecting circuits against the risk of damage caused by short-circuits or other over-current events.

Unlike conventional electrical fuses, the PRG series thermistors return to their normal state after the over-current has abated, and so provide continuous protection without the need for replacement.

Constructed from ceramic material, these thermistors provide a fast and reliable response to over-currents, and are more durable than chip resistors or alternative thermistor types manufactured with organic materials.

The PTC thermistors in the PRG series offer a wide range of trip-current ratings, maximum operating-current ratings up to 37.5 A and voltage ratings up to 30 V dc. The thermistors are available in three case sizes:

- 1.0 mm x 0.5 mm
- 1.6 mm x 0.8 mm
- 2.0 mm x 1.25 mm

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# MOSFET relay family affords design flexibility with choice of more than 150 variants

The GU series of PhotoMOS<sup>®</sup> solid-state relays from Panasonic offers high isolation ratings for use in industrial automation equipment, while providing longer life and a lower failure rate than traditional electromechanical relays.



## Panasonic INDUSTRY

### FEATURES

- Linear output characteristics
- Switches very low analogue signals
- Non-inductive input
- Resistant to shock and vibration

### APPLICATIONS

- Programmable logic controllers
- Industrial PCs
- I/O modules
- Robotic controls
- Smart meters
- Battery management systems
- Automatic circuit breakers
- Smoke detectors
- Intercom systems
- Alarms

The GU series of PhotoMOS solid-state relays from Panasonic Industry gives design engineers a very wide choice of configuration and power options for systems which require a reliable, long-lived alternative to conventional electromechanical relays.

Including more than 150 types, the GU series is suited to many different requirements in industrial automation applications. The relays' photovoltaic coupling technology gives long lifetime, and eliminates the wear and tear to which electromechanical relays are subject.

The GU relays are available in five contact configurations, and in SOP or DIP packages. They support load switching requirements ranging from 40 V/1.6 A to 600 V/50 mA.

Relay options in the GU series include:

- Current limiting
- Short-circuit protection
- Voltage-sensitive types
- High I/O isolation up to 5 kV<sub>rms</sub>

[Download the PhotoMOS product selection app here](#)



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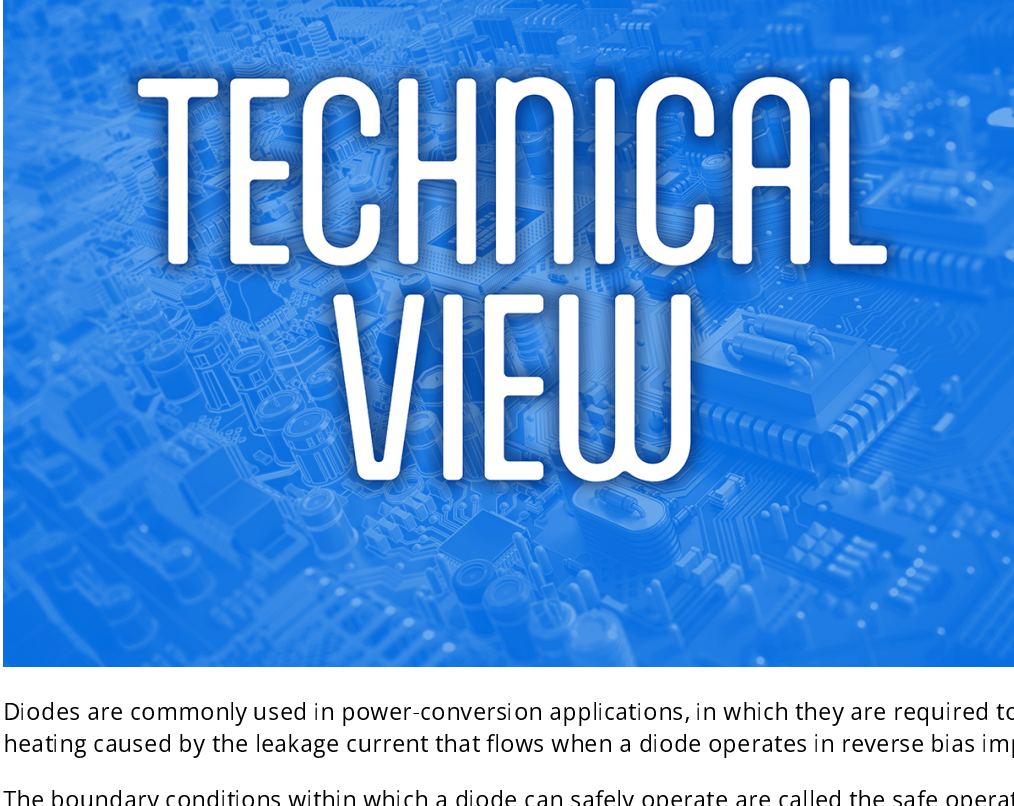
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# Mastering thermal management: how to keep reverse-biased diodes thermally stable

Read this to find out about:

- The risk of thermal runaway when diodes operate in reverse bias
- The factors which affect a diode's susceptibility to thermal runaway
- A comparison of various diode technologies' thermal stability in reverse-bias conditions



nexperia

Diodes are commonly used in power-conversion applications, in which they are required to operate under reverse bias. The self-heating caused by the leakage current that flows when a diode operates in reverse bias impacts its ability to function safely.

The boundary conditions within which a diode can safely operate are called the safe operating area (SOA). When using a diode in an application, the device must stay within its SOA with a sufficient safety margin to ensure robust and reliable operation. This is especially important in high power-density and high-temperature industrial applications such as uninterruptible power supplies, baseband units, and automation equipment, in which the safety of operators is an important concern.

This article examines the thermal stability of reverse-biased diodes, and explores the concept of thermal runaway. It also demonstrates how to calculate the SOA of a diode, before discussing the factors which influence the thermal limits of devices in rectifier applications.

## The diode as a thermal system

Self-heating caused by leakage current is one of the factors that affect the thermal stability of a diode in reverse bias. It also depends on the diode's ability to dissipate this heat, measured as the thermal resistance of the system in which it operates. In thermal equilibrium, the junction temperature of a device can be described using the following equation, in which a fixed ambient temperature,  $T_a$ , is considered thermal 'ground':

$$T_j = R_{th(j-a)} \times P_{dissipated} + T_a$$

Where  $R_{th(j-a)}$  is the thermal resistance between the junction and the ambient environment, and  $P_{dissipated}$  is the amount of power dissipated in the device.

A steady-state condition is reached when the two competing processes shown in Figure 1 are in balance:

1. The capacity of the thermal system to dissipate heat through the thermal resistance, denoted by the dark green line.
2. The self-heating of the device generated by reverse leakage current, and potential switching losses, where the level of leakage current increases in line with junction temperature, denoted by the red line.

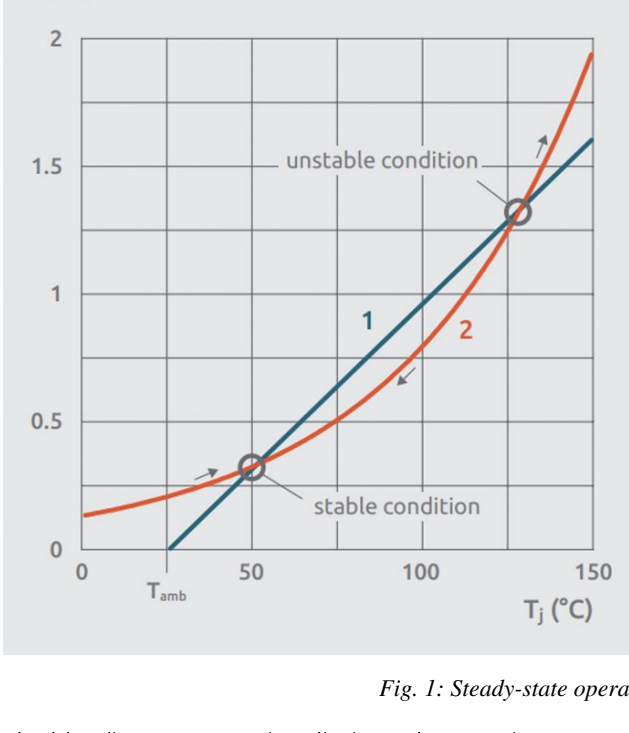


Fig. 1: Steady-state operating conditions that give rise to thermal equilibrium

The blue line, representing dissipated power, intersects the x-axis at the ambient temperature and then rises with a slope proportional to the system's thermal conductance,  $1/R_{th}$ . The power generated by the diode's leakage current, shown by the orange line, rises exponentially with increasing junction temperature. The coordinates of the points of intersection of the two curves mark thermal equilibrium conditions.

The first point of intersection corresponds to a stable thermal equilibrium for the system. Here, as long as the power generated through device self-heating is lower than that dissipated, the junction temperature will decrease and converge toward a thermally stable operating condition.

If more power is generated than can be dissipated however, which is shown at the higher point of intersection in the graph in Figure 1, the device's junction temperature will continue to increase, eventually becoming thermally unstable in a process referred to as thermal runaway. As a result, the device will continue to draw more current until it fails due to thermal overstress. Figure 2 shows an x-ray image of a device that has failed due to thermal runaway.

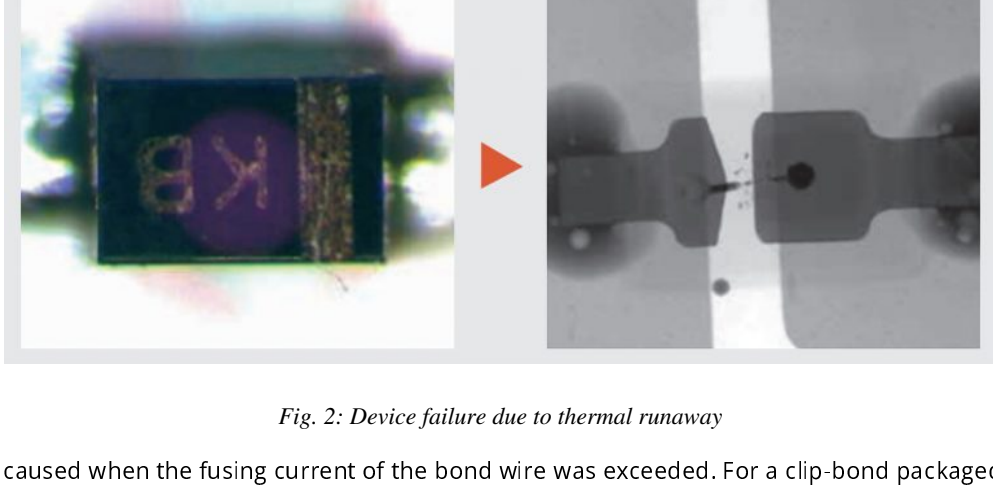


Fig. 2: Device failure due to thermal runaway

Here, the damage was caused when the fusing current of the bond wire was exceeded. For a clip-bond packaged device, however, thermal overstress would destroy the semiconductor die. The apparent discoloration of the epoxy molding compound shows that the device reached a very high temperature.

The system's safety margin is the temperature gap between stable and unstable conditions. As ambient temperature increases, the safety margin shrinks until the stable and unstable equilibrium conditions coincide, at which point the conditions for thermal runaway are satisfied, as shown in Figure 3.

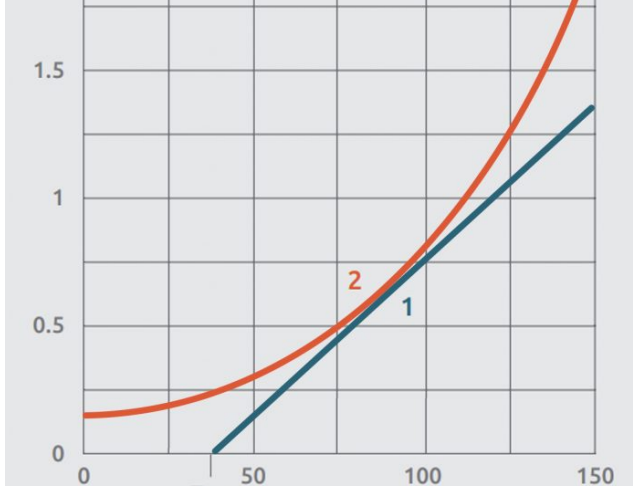


Fig. 3: Continuously rising ambient temperature lowers the thermal safety margin and increases the risk of thermal runaway.

The limits of the thermal runaway condition define the safe operating area of a diode in reverse bias. For a given reverse bias voltage,  $V_R$ , the corresponding leakage current,  $I_R$ , is measured over junction temperature. By applying the formula:

$$\frac{dP_{generated}}{dT} \times R_{th} \geq 1 \text{ (with } P_{generated} = V_R \times I_R \text{)}$$

The temperature limit for thermal runaway can be calculated at each reverse bias point for a given thermal resistance ( $R_{th}$ ). This equation is illustrated in Figure 4, which shows the maximum thermally stable reverse voltage for a diode based on its junction temperature.

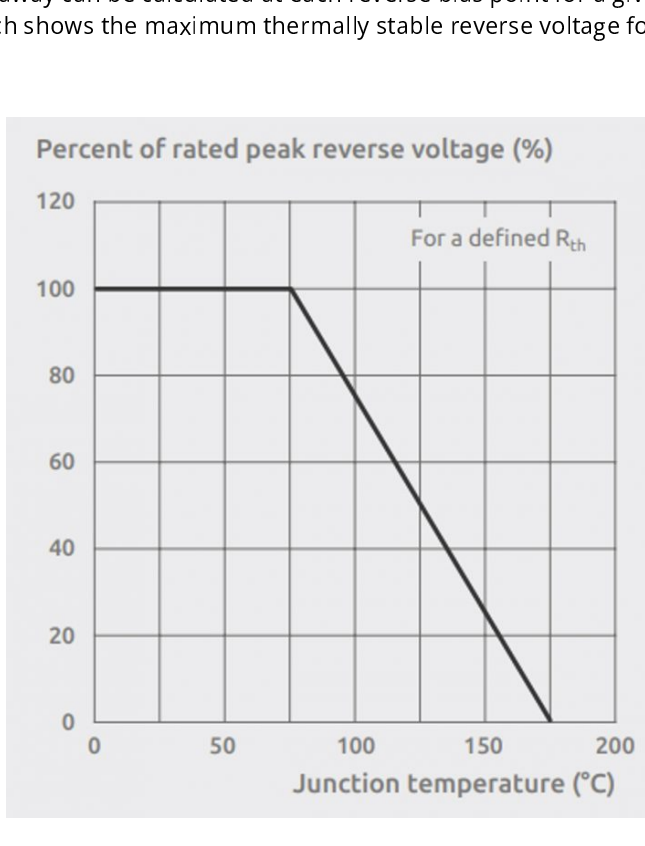


Fig. 4: Relationship between maximum reverse voltage and junction temperature of a diode

In practice, the SOA graph is used as follows. The required maximum reverse voltage can determine the maximum junction temperature for a given application, where a product's  $R_{th(j-a)}$  is known. The generated power can be calculated by taking into account the leakage current of the device at the given reverse voltage and junction temperature, as stated in the device's datasheet. The maximum allowable ambient temperature can be easily calculated with this formula:

$$T_{amb\_max} = T_{j\_max} - P_{generated} \times R_{th(j-a)}$$

## How device technology affects SOA

A diode's SOA is strongly impacted by thermal resistance according to the following formula:

$$\frac{dP_{generated}}{dT} = \frac{1}{R_{th}}$$

Consequently, the SOA can be increased through the use of packages that have a low junction-to-solder-point thermal resistance, or PCBs and substrates with good thermal properties, such as ceramic PCBs.

The semiconductor technology used to construct a diode also impacts its SOA, as the reverse leakage current is responsible for the generated power at a given bias point. When comparing the leakage current of different technologies, it is better to use the current density rather than the actual leakage current. This approach eliminates the impact of die size and enables a like-for-like comparison of different technologies.

Figure 5 shows the relationship between leakage current density and junction temperature for five different diode technologies at a reverse bias voltage of 100 V, including:

- 100 V low leakage-current planar Schottky
- 100 V low forward-voltage planar Schottky
- 200 V hyperfast recovery diode
- 120 V silicon germanium (SiGe) diode
- 100 V Trench Schottky diode

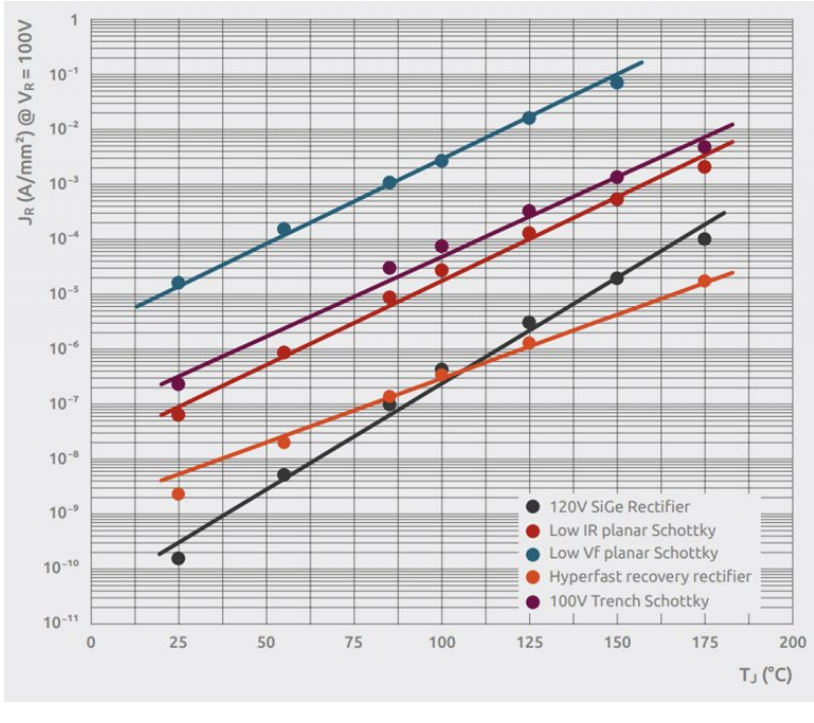


Fig. 5: Leakage current density of five rectifier technologies measured at 100 V

This graph can be interpreted as follows:

- As expected, the Schottky diode with low forward voltage (constructed with a low work function metal) exhibits the highest leakage current.
- In contrast, the leakage current density of the low-leakage planar Schottky device is two orders of magnitude lower, demonstrating the exponential impact of barrier height on the leakage current
- The hyperfast recovery diode also has low leakage-current density
- Interestingly, the leakage-current density for the novel SiGe diode technology is the same as that of the hyperfast recovery diode.
- The Trench Schottky technology exhibits a higher reverse leakage-current density than the low-leakage planar Schottky, due to its trench construction

A decisive factor in determining the thermal stability of a diode in reverse bias is not the actual leakage current but the increase in the rate of leakage current over temperature. To help to understand this better, Figure 6 shows the derivatives of the graphs shown previously in Figure 5 with respect to temperature.

The exponential nature of the reverse leakage-current density over temperature means these derivative graphs are also exponential and, therefore, linear on a logarithmic scale. Nonetheless, the order of the devices remains the same, with SiGe and hyperfast technologies showing the greatest potential for thermal stability, while the planar Schottky with low forward voltage has the least.

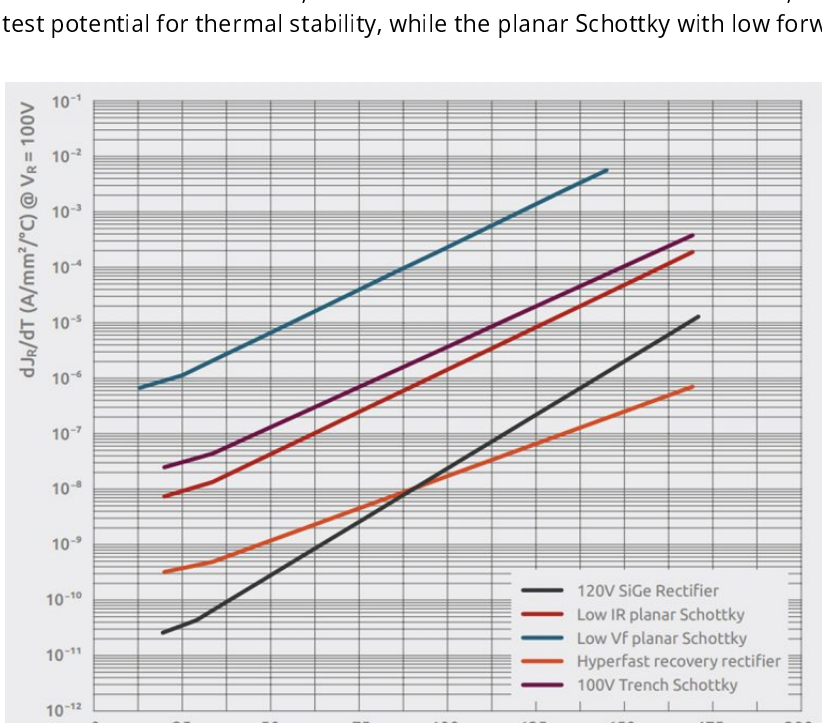


Fig. 6: Derivative of leakage current density at 100 V reverse bias with respect to junction temperature

## Conclusion

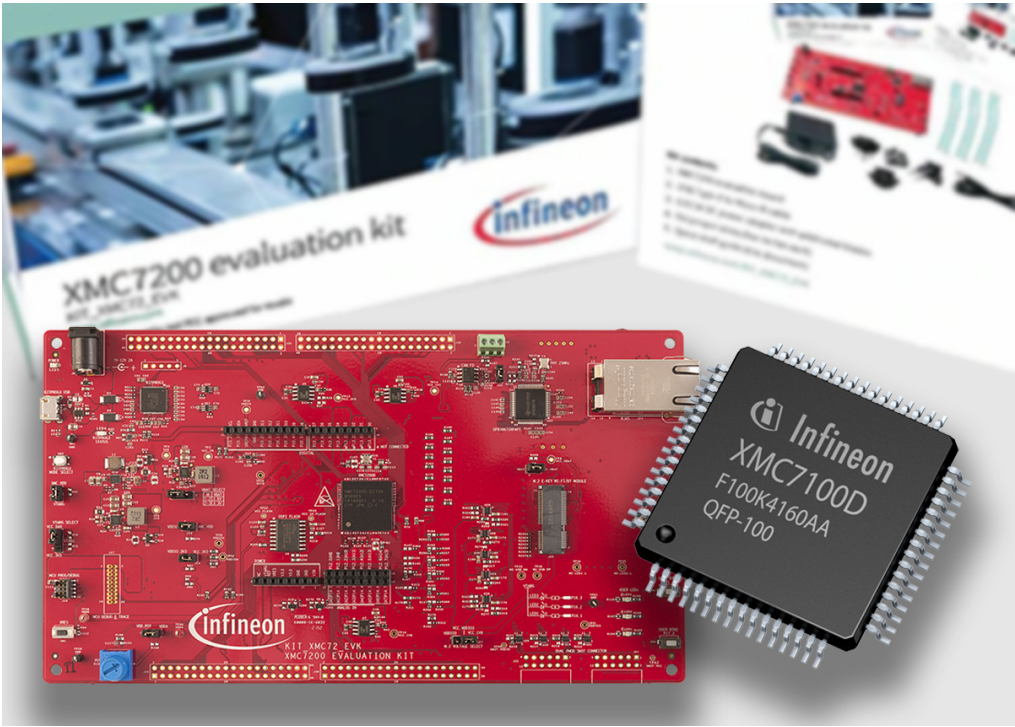
Diodes are commonly used in applications that require them to operate in reverse bias, a condition in which they are sensitive to temperature. Ensuring a diode operates in its SOA requires an understanding of its thermal behavior.

Established methods can be used to calculate the SOA of a diode. Measurements show that SiGe technology bridges the gap between hyperfast and Schottky diodes, showing a better trade-off between the leakage current, corresponding to SOA, and forward-voltage drop. SiGe rectifiers show excellent resistance to the surge currents which can occur in industrial applications.



# New MCUs offer increased performance and more memory for industrial applications

The XMC7000 MCUs from Infineon, with multi-core architecture, provide a rich set of communications interfaces and analog functions. System operation is supported by robust hardware security capabilities.



Infineon provides a new option for developers of high-end industrial applications who require a robust, low-power and high-performance 32-bit microcontroller backed by a comprehensive set of system software and development tools.

The new XMC7000 MCU family includes versions with either a single or dual Arm® Cortex® -M7 core, supported by a 100 MHz Cortex-M0+ processor. The new XMC™ MCUs feature up to 8 Mbytes of Flash memory and 1 Mbyte of on-chip SRAM.

A rich set of peripherals includes a CAN FD interface and 16- and 32-bit timer/counter PWMs in both the XMC7100 and XMC7200. The XMC7200 devices also have a Gigabit Ethernet communications interface. Alongside the advanced peripheral set, the XMC7000 family also offers robust security features. These include a hardware cryptography engine.

The MCUs are able to operate in harsh environments across a temperature range of -40°C to 125°C. Power-saving modes, which bring operating current as low as 8 µA, make these MCUs ideal for power-constrained applications.

The new XMC7000 MCUs are compatible with the latest Infineon ModusToolbox™ 3.0 development platform, which provides a common development experience across Infineon products, including PSoC™ MCUs, AIROC™ Wi-Fi and Bluetooth networking modules, and EZ-PD™ PMG1 MCUs.



### FEATURES

- Supply-voltage range: 2.7 V to 5.5 V
- Read-while-write Flash memory capability
- Three SAR ADCs
- SMIF interface
- SDHC interface

### APPLICATIONS

- Motor control
- Industrial drives
- Electrical vehicle charging equipment
- Two-wheel electric vehicles
- Robotics
- Programmable logic controllers
- Battery management systems
- Power converters

### FREE DEV BOARD

Evaluation kit for Infineon XMC7200D industrial-grade microcontroller.

**Orderable Part Number**  
**KIT\_XMC72\_EVK**

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Series	Flash	RAM	Arm Cortex-M7 Options	Package Options
XMC7100	Up to 4 Mbytes	Up to 768 kbytes	250 MHz single- or dual-core	100-, 144- or 176-pin TQFP 272-pin LFBGA
XMC7200	8 Mbytes	1 Mbyte	350 MHz single- or dual-core	176-pin TQFP 272-pin LFBGA



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# Environmental and motion sensor kit gives complete platform for IoT device development

The STMicroelectronics SensorTile.box PRO kit features motion and pressure sensors and a microphone, supported by a 32-bit microcontroller and Bluetooth® Low Energy radio. ST software libraries and algorithms accelerate application development.



The STMicroelectronics SensorTile.box PRO is a new, ready-to-use programmable wireless kit in a handy box format for developing IoT applications that remotely gather motion, environmental or acoustic sensor data.

The kit provides a complete functional platform for building applications for smart, connected devices. An STM32U585AI microcontroller based on an Arm® Cortex®-M33 core runs application code and performs system control functions, backed by a storage option, a microSD™ card slot for stand-alone data-logging applications.

Wireless connectivity is provided by the BlueNRG-LP Bluetooth® Low Energy 5.2 transceiver, as well as a programmable NFC tag, the ST25DV04K. The board can be easily connected via Bluetooth to the ST BLE Sensor smartphone app.

A rich set of sensor functions is also integrated into the SensorTile.box PRO:

- STTS22H low-voltage local digital temperature sensor
- LSM6DSV16X six-axis inertial measurement unit
- LIS2DU12 three-axis accelerometer
- LIS2MDL three-axis magnetometer
- LPS22DF pressure sensor
- MP23DB01HP digital microphone

ST provides three modes by which designers can interact with the SensorTile.box PRO kit. In Entry mode, the kit runs a wide range of IoT applications supplied with the box. These include:

- Motion sensing: compass, free-fall detection, level sensing, pedometer, quaternion
- Environmental sensing: barometer
- Data logging
- AI and machine learning: baby crying detector, human activity recognition
- User interface: Qtouch sensing
- NFC connectivity

In Expert mode, engineers can build custom applications through the ST BLE Sensor app by selecting input data types and operating parameters, and using built-in functions for evaluating and computing the resulting data.

In Pro mode, designers can quickly develop tailored IoT applications via the STM32 open development environment supported by ST function pack libraries. These include an AI function pack with neural network libraries.

The SensorTile.box PRO board fits into a plastic box measuring 40 mm x 63 mm, and is powered by a 480 mAh rechargeable battery. The kit includes a 5 W wireless charger. The board can also be supplied via a USB Type-C® connector.

The SensorTile.box PRO kit can be ordered using the part number STEVAL-MKBOXPRO.



## FEATURES

- Hardware power switch
- Green and orange system LEDs for displaying the power supply state
- Four programmable status LEDs
- Two programmable push-buttons
- Audio buzzer
- Reset button
- Certifications: CE, FCC, UKCA, IC

## APPLICATIONS

- IoT devices
- Industrial control
- Remote monitoring

## FREE DEV BOARD

SensorTile.box PRO kit offers multiple sensors and wireless connectivity for intelligent IoT nodes.

**Orderable Part Number**  
**STEVAL-MKBOXPRO**

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# IEEE 802.3cg-compliant controller brings Ethernet to the edge of factory networks

The NCN26010 Ethernet controller from onsemi offers high noise immunity, maintaining reliable connectivity over a long range even in noisy industrial environments, and offers multiple node support to reduce the cost of installation.



Factories today commonly use Ethernet networks for supervisory control and station management, but still rely on legacy fieldbus solutions to communicate with field instrumentation. Such legacy protocols need to be replaced and modernized with low-cost, single unshielded-pair Ethernet solutions which will allow factories to run data over Ethernet seamlessly from the cloud to the edge.

The IEEE 802.3cg standard provides a specification for the technology to overcome the gap in industrial Ethernet systems, offering low-cost communication to field devices at a data rate of 10 Mbps/s using two new physical layers:

- 10BASE-T1L for long-range, point-to-point communication over a range of up to 1,000 m
- 10BASE-T1S for multi-point communication over a range up to 25 m

The NCN26010 from onsemi, one of the first 802.3cg-compliant Ethernet controllers, provides a reliable way to take advantage of the benefits of single-pair Ethernet technology.

The NCN26010's noise immunity is far higher than is specified in the 10BASE-T1S standard: a proprietary enhanced noise immunity feature provides robust signal detection in noisy industrial environments, and can extend the network range to up to 50 m.

The NCN26010 also offers very low line capacitance, enabling it to support five times the node requirement of the IEEE 802.3cg standard, up to 40 nodes on a 25 m segment. This helps factory operators to save more on the cost of wiring and installation.

Multi-drop Ethernet offers a way to reduce the wiring and installation costs which typically dominate the networking budget in many factories: a network can be completed with up to 70% fewer cables while reducing installation costs by as much as 80%. 10BASE-T1S also offers the flexibility to repurpose nodes after the initial installation.

## Additional benefits include:

- Eliminates the need for large switches, gateways, or protocol translators, and the additional wiring and power they require
- Lowers software maintenance costs as multiple networking technologies no longer need to be maintained, legacy point-to-point and multi-point standards, such as RS-485, CAN, FlexRay, RS-232, or HART may be replaced by 10BASE-T1S Ethernet
- Enables greater data throughput over existing cables, eliminating the need to run new cables, which is often the highest contributor to costs in a networking installation

onsemi™

## FEATURES

- Best-in-class bit error rate performance
- Collision detection masking
- Physical layer collision avoidance (PLCA)
- Unique PLCA precedence mode
- Supports deterministic real-time performance

## APPLICATIONS

- Industrial automation
- Sensor and control interfaces
- Home automation
- Building control systems
- Security equipment
- Field instrumentation
- Human-machine interfaces

## FREE DEV BOARD

Development platform for IEEE 802.3cg-compliant industrial networking applications.

**Orderable Part Number**  
**NCN26010XMNEVK**

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# Polarized power relays perform energy-efficient switching operations

Panasonic supplies multiple series of polarized power relays to meet the needs of many applications. These relays offer substantially lower power consumption than other types of electromechanical relay, with low self-heating.



Panasonic Industry offers a broad portfolio of polarized power relays for applications including home and building automation, industrial equipment, and smart city automation. Relays supporting three types of operation are available: single-side stable, one-coil latching, and two-coil latching.

Polarized power relays help to reduce energy consumption: the permanent magnet in the coil reduces the energy required to actuate the load circuit. A latching relay also consumes no energy in the switched state. This results in highly efficient operation with no self-heating caused by power loss in the coil.

The Panasonic portfolio of polarized power relays includes the miniature DSP range, which provides the contact rating of a power relay, at 8 A, in a package the size of a signal relay. These power relays offer high contact pressure, a low bounce rate, high energy efficiency, and good resistance to vibration. Highly sensitive, they can be driven directly by transistors, microcontrollers or other types of IC. They require a nominal operating power of around 190 mW with a 3 V coil.

The Panasonic portfolio of polarized power relays also includes the DK, DE, DW and DJ-H series supporting operating current up to 50 A and breakdown voltages up to 277 V ac.

	DSP		DK		DE		DW		DJ-H
Contact Configuration	1A	1A1B, 2A	1A	1A1B, 2A	1A	1A1B, 2A	1A	1A	1A
AC Voltage	250 V	250 V	250 V	250 V	250 V	250 V	250 V	277 V	277 V
AC Current	8 A	5 A	10 A	8 A	16 A	8 A	8 A	16 A	50 A
DC Voltage	30 V	30 V	30 V	30 V	30 V	30 V			
DC Current	5 A	5 A	10 A	8 A	10 A	8 A			
Length x Width x Height (mm)	20.2 x 11 x 10.5		20 x 12.5 x 9.7		25 x 12.5 x 12.5		24 x 10 x 18.8	24 x 10 x 15.8	39 x 15 x 30.2

## Panasonic INDUSTRY

### FEATURES

- Coil-voltage range: 3 V to 24 V dc
- 3.5 mm creepage and clearance
- Standard or reversed polarity
- UL/CSA recognized
- TÜV approved
- Complies with EN 60335 glow-wire test
- Sealed package

### APPLICATIONS

- Office equipment
- Measuring instruments
- Programmable logic controllers
- Computer numerical control machines
- Smart plugs and lighting
- Building automation controls



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# Waterproof circular connectors provide robust performance in industrial applications

**VULCON™ connectors from NorComp give designers a flexible choice of board-mounting options. Systems based on the VULCON circular connectors can keep signal integrity high even in the presence of strong noise sources.**



VULCON™ circular connectors from NorComp offer a robust, waterproof cable-to-panel or cable-to-PCB interface that is ideal for use in demanding industrial applications such as factory- or warehouse-floor robots.

The VULCON circular connectors save space, occupying less room than rectangular connectors that have the same number of contacts. The VULCON product range is available in three sizes, M5, M8, and M12, and with from two to 12 positions.

These connectors offer IP67 or IP68 protection ratings in both the mated and unmated condition. They also feature full metal shells to give excellent shielding against EMI and RF interference, helping systems to maintain high signal integrity.

**NORCOMP**

## FEATURES

- Board-mount configuration options:
  - Solder cup
  - Vertical
  - Right-angle
- Cable-mount available as loose pieces or pre-made cables
- Up to 5 A contact rating
- Operating-temperature range: -40°C to 85°C
- Available in stainless steel

## APPLICATIONS

- Power supplies
- Motors
- Actuators
- Robotics
- Communications equipment
- Sensor systems
- Industrial controls
- Industrial automation
- Gauges
- Data loggers



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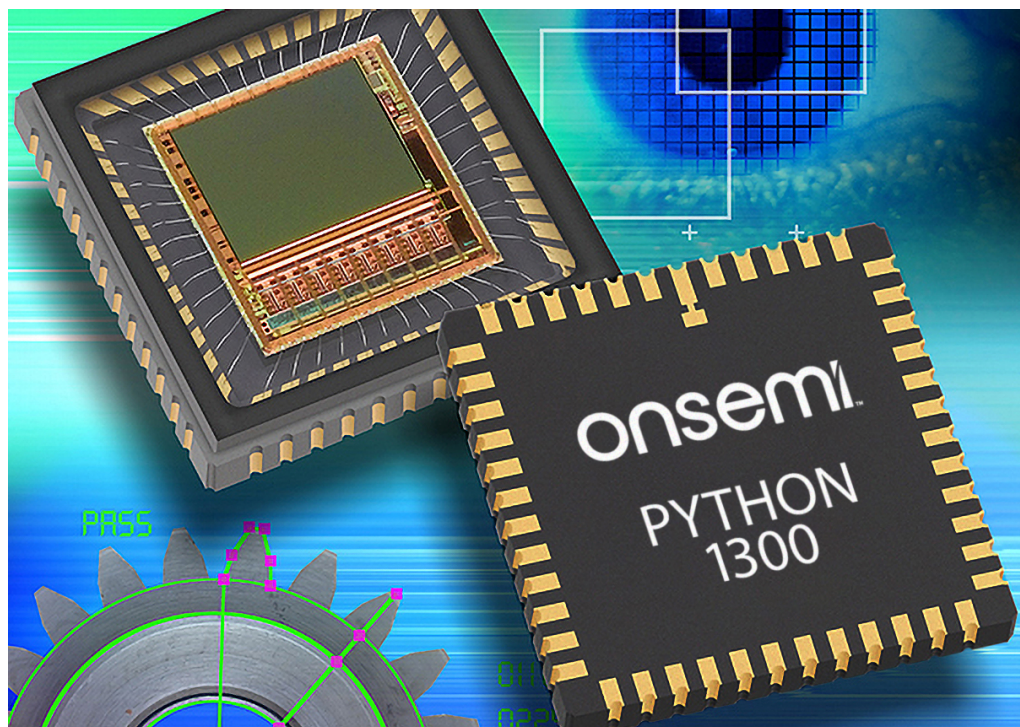


TELECOMS



# Cameras based on onsemi image sensors record descent of Perseverance rover to Mars

High-performance cameras based on PYTHON CMOS image sensors from onsemi, a commercial off-the-shelf product, were selected for their global shutter capability, small optical format, high speed and versatility.



‘Seven minutes of terror’ was NASA’s description of the most challenging phase of the Mars Perseverance Rover’s mission: the entry, descent, and landing (EDL). In these intense seven minutes, the spacecraft enters the Martian atmosphere at 12,500 miles per hour and decelerates to zero for touch-down. Perseverance completes this phase autonomously: its radio signal declaring whether it has succeeded takes longer, some 11 minutes 22 seconds, to reach the Earth.

The Mars Perseverance Rover includes a total of 23 cameras used in the engineering, EDL, and science camera systems. NASA intended the EDL camera systems to capture EDL events in more detail than in previous missions. The camera system took full-color video during the vehicle’s descent through Mars’ atmosphere to the surface. The images captured on the way down help Perseverance’s mission planners to select the rover’s first ventures on the planet.

The EDL camera system itself consists of seven cameras:

- Parachute uplook cameras
- Descent-stage downlook camera
- Rover uplook camera
- Rover downlook camera
- Landing camera (LCAM)

The function of the LCAM was to provide critical image data to the lander vision system (LVS) required for navigation: an onboard computer analyzed the images to compare them with a map so that Perseverance could autonomously choose the safest landing site relative to its position during the descent. It also monitored the deployment of the parachute during the parachute descent phase of EDL.

## NASA’s design challenge

The challenge for the developers of the Mars mission’s EDL and LCAM camera systems was to improve knowledge of EDL and LVS system performance by using a video imaging system to capture key EDL events, including parachute deployment, sky crane deployment, rover touchdown, and lander rocket plume dynamics. Image capture would also help autonomous terrain-relative navigation.

The process for selecting camera technology involved qualification of commercial off-the-shelf hardware, with particular focus on evaluating its cost and ease of system integration.



*Fig. 1: Image acquired during Perseverance’s descent to Mars, using its parachute up-look camera A. (Image Credit: NASA and JPL-Caltech)*

A vital requirement of the EDL camera system was that it should not interfere with the flight system during EDL. The camera system design could also not require changes to the flight hardware or software systems inherited from the Mars Science Library Curiosity rover.

The camera systems’ minimum frame rate requirements were 30 frames/s to capture images of the parachute. The three parachute uplook cameras were to start capturing images at a frame rate of 75 frames/s prior to parachute deployment, and to drop the frame rate to 30 frames/s after 30 s until the backshell separation about 98 s later.

Each parachute uplook camera was expected to take approximately 5,190 images, a total of 15,750 for the system. The rover downlook camera system was to start capturing images just before heatshield separation, continuing through to touchdown on the surface of Mars. This camera system captured images at 30 frames/s for approximately 260 s for a total of around 7,800 images.

The rover uplook camera system was to start capturing images just before the rover separated from the descent stage, continuing through to rover touchdown on the surface of Mars. The rover uplook camera captured data at 30 frames/s for approximately 140 s, capturing around 4,200 images.

## Landing camera

The landing camera requirements include a field of view of 90° by 90°, an array resolution of 1,024 px x 1,024 px, and a global shutter sensor. The camera system solution also needed to have a frame latency of less than 100 ms between the camera image trigger and the last pixel output of the image, a frame rate of up to 2 Hz, and a signal-to-noise ratio of greater than 80:1 with a 1 ms exposure time under the illumination conditions of the Mars environment.

## The solution

The Perseverance mission teams selected cameras from the FLIR Systems Chameleon®3 family of cameras for the EDL systems. The solution chosen for the parachute uplook camera, rover uplook camera, rover downlook camera and landing camera systems includes sensors from the onsemi PYTHON family of CMOS image sensors.

The EDL engineers chose the PYTHON-based cameras from FLIR because of their global shutter operation, small optical format, versatility, and read-out speed: full frame rate, and quadratic speed increase reading out smaller regions of interest. Within the Chameleon3 product family, the PYTHON-based cameras offered the highest frame rates. The correlated double sampling (CDS) support in global shutter mode reduces noise to single digits, and offers increased dynamic range to retain image detail in high-contrast environments.

The parachute uplook camera, rover uplook camera, rover downlook camera systems use PYTHON 1300 image sensors. The landing camera uses a monochrome PYTHON 5000 global shutter CMOS image sensor with a pixel array of 2592 px by 2048 px, and on-chip 8- or 10-bit digitization at up to 100 frames/s.

## Result

The next-generation imaging system of the Perseverance rover improved the operational capabilities of the Mars 2020 mission by providing the first-ever color video of touchdown on the Martian surface. The video footage of crucial entry, descent, and landing events successfully documented the mission systems’ performance. It will serve to instruct the design for EDL systems in the future.

Likewise, the success of the landing camera in capturing Martian surface images to assist terrain-relative navigation will facilitate more targeted landing capabilities for future missions to Mars. More than 1,300 images and video captured by these camera systems are available for viewing on the Mars 2020 mission Perseverance Rover website.


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SAMPLES



# Integrated half-bridge driver simplifies design of heating and cooling systems

The BridgeSwitch™ family of integrated half-bridges from Power Integrations combines power switches and their drivers alongside motor phase current sensing in a single, compact package as an ideal solution for new heat pump designs.



The BridgeSwitch™ family of integrated half-bridges from Power Integrations dramatically simplifies the development and production of high-voltage, inverter-driven, one- or three-phase permanent magnet or brushless dc (BLDC) motor drives.

The functions integrated in BridgeSwitch ICs include motor phase current (IPH) sensing, helping to boost the efficiency and improve the accuracy of motor control in systems with sensorless field-oriented control (FOC).

The BridgeSwitch devices incorporate two 600 V, N-channel power FREDFETs with low- and high-side drivers in a single, small-outline package. The internal power FETs feature ultra-soft and ultra-fast diodes which are ideally suited to hard-switched inverter drives. Both drivers are self-supplied, eliminating the need for an external auxiliary power supply.

The half-bridges' low-profile, surface-mount in SOP-24C package, which has a footprint of 10.8 mm x 9.4 mm, offers extended creepage distances. The package's exposed pads allow for heat-sinking of both power FREDFETs through the PCB.

Internal fault protection functions include a cycle-by-cycle current limit for both FREDFETs, and two-level thermal overload protection. External system-level monitoring includes dc bus sensing with four under-voltage levels and one over-voltage level. The IC can drive external sensors such as an NTC. The bi-directional bussed single-wire status interface reports observed status changes.

Part Numbers	FREDFET Dc Output Current	Continuous Phase RMS Current
BRD1160C/BRD1260C	1.0 A	0.22 A
BRD1161C/BRD1261C	1.7 A	0.50 A
BRD1163C/BRD1263C	3.0 A	0.75 A
BRD1165C/BRD1265C	5.5 A	1.00 A
BRD1167C/BRD1267C	11.5 A	1.33 A

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## Integrated wireless module simplifies Bluetooth Low Energy connectivity

The STM32WB1MMC from STMicroelectronics provides a ready-made implementation of a Bluetooth®-based system, including a 2.4 GHz radio, dual-core MCU, antenna and power circuit, backed by a royalty-free protocol stack.



The STM32WB1MMC from STMicroelectronics is a compact wireless module which provides a quick and easy way to integrate Bluetooth Low Energy networking capability into an end product design. The module is supplied with a royalty-free Bluetooth v5.3 protocol stack.

Based on the STM32WB15 wireless microcontroller, this certified 2.4 GHz module provides excellent RF performance thanks to its good receiver sensitivity and high output power. The module's low-power features extend battery run-time, enabling applications to run on small coin cells or even harvested energy.

The integrated module provides a complete radio system, including a chip antenna, an option for connecting an external antenna, a reliable antenna matching circuit, and a switch-mode power supply.

The STM32WB15 on which the STM32WB1MMC is based is a dual-core wireless MCU which can support comprehensive Bluetooth Low Energy connectivity while also running the host application. The MCU includes a 2.4 GHz radio managed by a dedicated Arm® Cortex®-M0+ processor core. To run the main application, it features a 64 MHz Cortex-M4 core which allows for uninterrupted real-time performance.

A rich selection of analog peripherals includes a 12-bit ADC and low-power comparator. The module also features multiple digital interfaces, and up to 37 fast I/Os, 35 of which are 5 V-tolerant.

The STM32WB1MMC module is supported by the proven STM32Cube software ecosystem, which offers embedded software libraries and tools. The module's 77-lead LGA package has a footprint of 10 mm x 6.5 mm.



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### FEATURES

- High RF performance:
  - Programmable output power up to +5.5 dBm
- -96 dBm sensitivity at 1 Mbit/s data rate
- 2 Mbits/s maximum data rate
- Pending certification for CE, FCC, IC, JRF, SRRC
- Rich security capabilities:
  - Secure firmware installation
  - Hardware encryption
  - Hardware public key authority
  - Secure 96-bit ID
  - True random number generator
- Memory resources:
  - 320 kbytes Flash memory
  - 48 kbytes SRAM

### APPLICATIONS

- Fleet and resource management
- Asset monitoring and tracking
- Large-scale IoT applications



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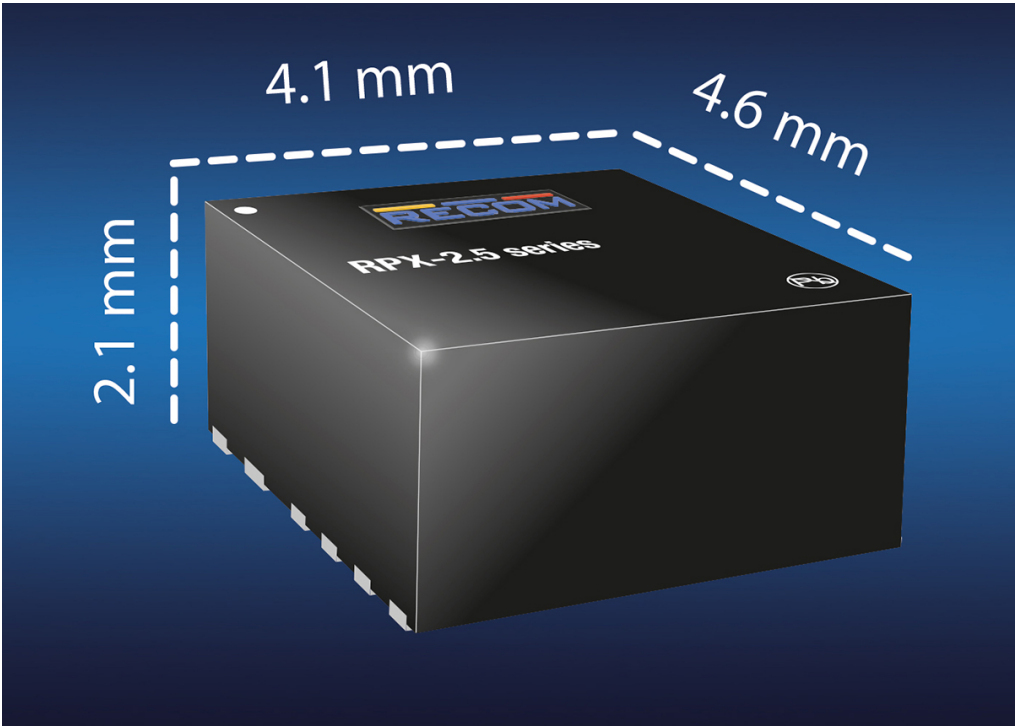
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SAMPLES

# Dc-dc converter modules offer very high power density

RECOM RPX modules’ outstanding thermal performance and innovative 3D Power Package technology enable fanless operation at high ambient temperatures while supplying output currents up to 4.0 A.



The RPX series of dc-dc converter modules from RECOM are complete power modules with integrated power transistors and inductors, requiring only input and output capacitors and voltage-setting resistors to form fully functioning power regulators with various maximum current ratings up to 4 A. The RPX modules’ wide input-voltage ranges mean that they can be used in circuits with a supply voltage of 5 V, 12 V, 15 V or 24 V dc.

The RPX-1.0, RPX-1.5, RPX-2.5 and RPX-4.0 power modules are supplied in thermally-enhanced, surface-mount QFN packages that have a small footprint and offer high power density. The 3D power packaging design developed by RECOM features an integrated inductor and a control IC embedded in the substrate, reducing the system footprint. The excellent thermal performance of the RPX modules means that they can operate at temperatures up to at least 85°C without forced-air cooling.

Built-in protection functions include short-circuit protection, over-current limiting and thermal shutdown. A resistor divider on the input allows an under-voltage lockout voltage to be set to protect battery-powered supplies from over-discharge. A resistor divider on the output controls the setting of the output voltage over a very wide range, while an enable input provides for voltage supply sequencing.

Some products in the RPX series are now also offered as -Q variants, qualified to AEC Q100 Grade 1 for operation up to 125°C. These modules include wettable flanks, which facilitate automated optical inspection of the land-grid array solder joints.

All modules are readily available on short lead times from Future Electronics.

Product Name	Current Rating (A)	Input-voltage Range (V)	Main Output-voltage Range (V)	Package Dimensions
RPX-0.5Q	0.5	4.0 to 36.0	0.8 to 34	3 mm x 5 mm x 1.6 mm
RPX-1.0	1.0	4.0 to 36.0	0.8 to 30	3 mm x 5 mm x 1.6 mm
RPX-1.5	1.5	4.0 to 36.0	0.8 to 30	3 mm x 5 mm x 1.6 mm
RPX-1.5Q	1.5	4.0 to 36.0	0.8 to 30	3 mm x 5 mm x 1.6 mm
RPX-2.5	2.5	4.5 to 28.0	1.2 to 6.0	4 mm x 4.5 mm x 2.0 mm
RPX-4.0	4.0	3.8 to 36.0	1.0 to 7.0	5.0 mm x 5.5 mm x 4.1 mm

RECOM

### FEATURES

- Reliable performance maintained at higher than 110°C ambient temperature
- Minimal filtering required for Class A or B EMC compliance
- Very low power consumption in shut-down mode

### APPLICATIONS

- Industrial control
- Motor control
- Automated test equipment
- Medical and imaging equipment
- On-board power supplies
- Portable devices

### FREE DEV BOARD

Evaluation platform for RPX-4.0 buck regulator module.

Orderable Part Number  
**RPX-4.0-EVM-1**

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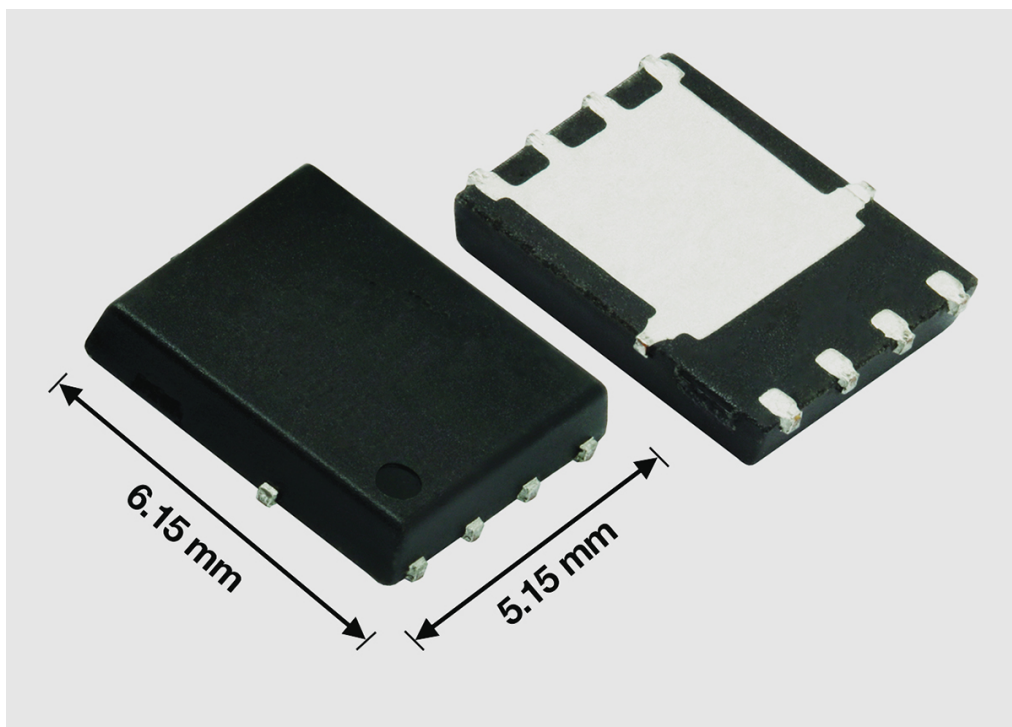


TELECOMS



## Power MOSFETs offer high efficiency in secondary-side converter applications

The SiR5x0DP MOSFETs from Vishay, built with the fifth generation of TrenchFET technology, offer a step-up in performance, reducing both on-resistance and gate charge for lower switching and conduction losses.



### FEATURES

- Low output capacitance
- PowerPAK® SO-8 package
- Operating-temperature range: -55°C to 150°C

### APPLICATIONS

- Servers
- Power tools
- Power adaptors
- Telecoms equipment
- Industrial systems

Products in the latest generation of the Vishay family of TrenchFET® power MOSFETs provide superior performance and efficiency in applications such as the secondary side of dc-dc converters in servers and telecoms infrastructure.

The 150 V SiR570DP, 100 V SiR510DP, and 80 V SiR580DP offer the industry's best figure-of-merit for the product of on-resistance and gate charge. In the case of the SiR510DP, the figure-of-merit is as much as 78% better than typical competing products. This superior performance enables power-system designers to reduce switching and conduction losses, and so to achieve higher conversion efficiency.

The fifth-generation TrenchFET SiR5x0DP MOSFETs are ideal for use in a range of power functions, including:

- Input inrush switches
- O-ring
- Primary-side switching
- Synchronous rectification
- Hot-swap switching
- Motor-drive control



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TELECOMS

# Panasonic power choke coils offer robust performance and cost-saving in demanding automotive applications

The ETQPxMxxxKVx series from Panasonic features a special metal composite core which offers performance advantages over competing power choke products, and saves space when replacing traditional ferrite products.



The ETQPxMxxxKVx series of power choke coils gives automotive design engineers the opportunity to save space and reduce weight while maintaining robust and reliable performance in the next generation of electronic control units (ECUs). Important attributes of these power chokes include non-hard saturation behavior, low core losses, and stability over a wide operating-temperature range of -55°C to 155°C.

ETQPxMxxxKVx family coils are available with inductance values ranging from 0.33 µH to 100 µH. They are ideal for input noise filters in motor drives and in ECUs’ DC-DC converters, as well as for voltage regulators and buck-boost converters.

The AEC-Q200 qualified ETQPxMxxxKVx coils are available in various package sizes with footprints ranging from 5 mm x 5 mm to 10mm x 10 mm. Due to their space-saving metal composite monolithic structure they are up to 70% smaller than other technologies on the market.

In comparison to standard ferrite products, ETQP coils offer various performance advantages including tolerance of high operating temperatures, and vibration resistance up to 30 g.

These inductors also offer high current-bias characteristics without displaying hard saturation behavior. They are rated for currents up to 34.6 A, and meet the EMC compliance requirements of new automotive designs.

Case sizes	From 5 mm x 5 mm to 10 mm x 10 mm, with 3 mm or 4 mm height
Inductance Range	0.33 µH to 47 µH
DC Resistance Range	2.6 mΩ to 206 mΩ
Saturation Current	3 A to 34.6 A
Operating Temperature Range	-55°C to 155°C (including self-temperature rise)

## Panasonic INDUSTRY

### FEATURES

- Land pattern compatibility with similar competitors’ products
- High reliability during lifetime at low cost
- Fully magnetic shielded structure for less EMC noise interference
- High withstanding-voltage characteristics
- Low DCR in 3 mm or 4 mm height

### APPLICATIONS

- Automotive systems:
  - Electric and hybrid electric vehicles
  - Engine ECUs
  - ADAS
  - Power train
  - Motors, pumps and fans
  - Brakes
- Industrial systems:
  - Automation
  - Servers
  - LED drivers
  - Power-supply modules



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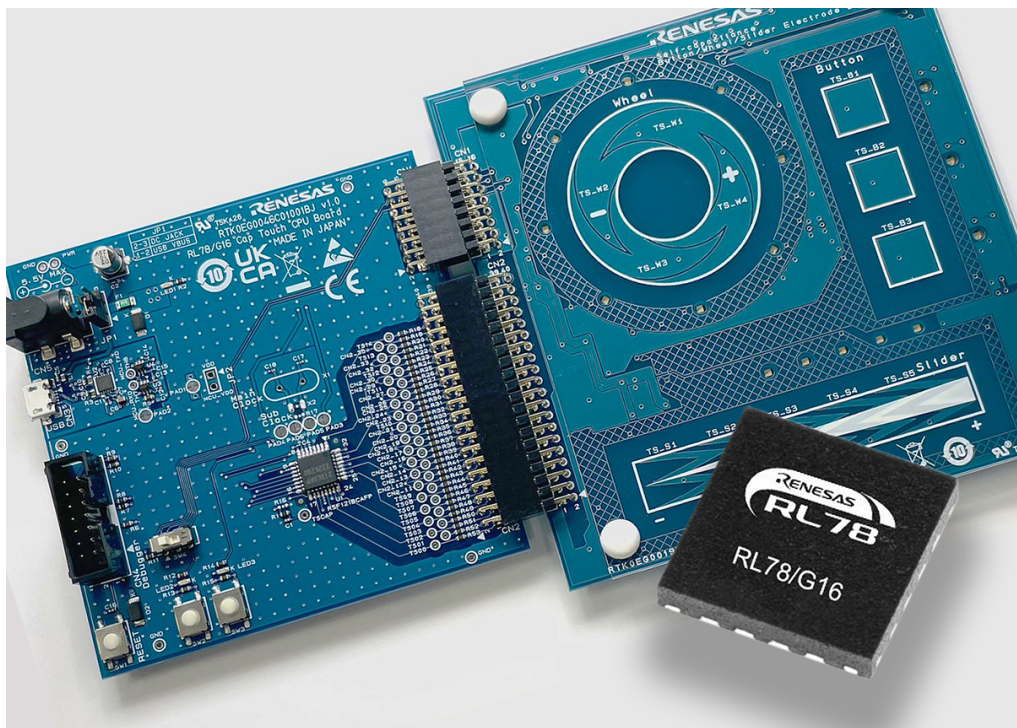


TELECOMS



# New 16-bit MCUs provide space-saving option for touch control

RL78/G16 microcontrollers from Renesas are well suited to home appliances thanks to their high temperature tolerance and high touch sensitivity, supporting placement near to heat and noise generators such as motors.



Renesas has launched the RL78/G16 series of 16-bit microcontrollers which offer a new space-saving option for applications that require touch-sensing capability.

Renesas supplies the 16 MHz RL78/G16 series in a wide choice of package and pin-count options: the smallest 10-pin package, which has a footprint of 3 mm x 3 mm and includes 16 kbytes of Flash memory, offers a three-channel touch-sensing interface.

The RL78/G16 MCUs also provide functional safety hardware to support compliance with IEC/UL 60730, the safety standard for home appliances.

The touch-sensing capability of the RL78/G16, implemented in Renesas CTSUB firmware, is robust enough for placement near to motors and other types of heat-generating equipment thanks to the MCU's tolerance of operating temperatures up to 125°C. The CTSUB firmware enables touch-sensing through acrylic or glass panels more than 10 mm thick, suitable for applications such as household equipment with thick doors or partitions.

Hardware features of the RL78/G16 MCUs include a high-precision, high-speed on-chip oscillator, data Flash, serial communications interfaces, and a comparator.

Provision for development with the RL78/G16 includes a fast prototyping board, which enables the writing/debugging of programs without additional tools simply by connecting a USB cable, a Smart Configurator, which facilitates design with a graphical user interface, a capacitive touch evaluation system, and an Arduino software library.

**RENEASAS**

## FEATURES

- Memory provision:
  - 16 kbytes/32 kbytes of Flash
  - 2 kbytes of SRAM
  - 1 kbyte of data Flash
- Pin-count options from 10 to 32
- Seamless replacement for RL78 devices
- 11-channel 8-/10-bit ADC
- General PWM timer

## APPLICATIONS

- Home appliances
- Industrial equipment
- Consumer devices
- Fans
- Sensor control
- Lighting
- Inverters

## FREE DEV BOARD

Fast prototyping board for RL78/G16 microcontrollers.

**Orderable Part Number**  
**RTK5RLG160C0000BJ**

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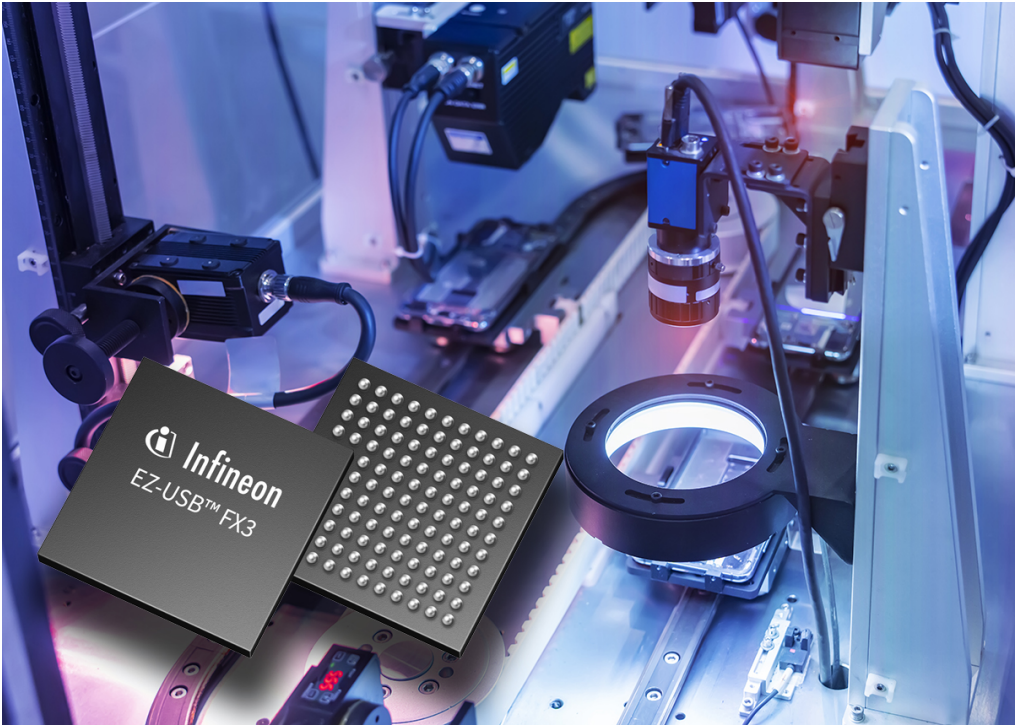
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TELECOMS

# USB 3.0 peripheral controller provides ready-made bridge to high-speed components

The Infineon EZ-USB™ FX3 is a portfolio of USB 5 Gbps peripheral controllers which provides a programmable interface to devices such as processors and image sensors on one side, and a PC on the other.



The EZ-USB™ FX3 series of programmable 5 Gbits/s USB peripheral controllers from Infineon provides a flexible and high-speed bridge to a PC.

Featuring a second-generation general programmable interface (GPIF II), the EZ-USB FX3 can connect to a processor, an image sensor, an FPGA, or an ASIC. Designers can program the GPIF to behave like a FIFO, an asynchronous SRAM, an address/data multiplexed interface, a CompactFlash, or a proprietary interface. This makes it simple to bridge a high-performance component to a PC at a high 5 Gbits/s data rate.

For instance, in an HD video or 3D imaging system, an EZ-USB™ FX3 device can connect directly with a variety of image sensors via the GPIF II interface, and stream uncompressed HD video via USB 3.0 to a PC. Since 5 Gbits/s USB Type-C connectivity is a standard feature in today's PCs, applications such as machine vision and medical imaging can achieve higher image quality at lower cost by using EZ-USB FX3 peripheral controllers.

The EZ-USB FX3 features a fully accessible, 32-bit ARM9 core with up to 512 kbytes of embedded SRAM, providing for easy code development and integration. This is a turnkey solution that includes not only the USB chips, but also a software development kit, applications programming interfaces, the designer graphical user interface, and development kits.

Part Number	Operating-temperature Range	GPIF	SRAM
CYUSB3014-BZXCT	0°C to 70°C	32-bit, 100 MHz	512 kbytes
CYUSB3014-BZXC	0°C to 70°C	32-bit, 100 MHz	512 kbytes
CYUSB3012-BZXC	0°C to 70°C	32-bit, 100 MHz	256 kbytes
CYUSB3014-BZXI	-40°C to 85°C	32-bit, 100 MHz	512 kbytes
CYUSB3013-BZXC	0°C to 70°C	16-bit, 100 MHz	512 kbytes
CYUSB3014-BZXIT	-40°C to 85°C	32-bit, 100 MHz	512 kbytes
CYUSB3011-BZXC	0°C to 70°C	16-bit, 100 MHz	256 kbytes



## FEATURES

- USB 2.0 OTG compliant
- Additional connectivity to peripherals:
  - On-chip I2C, I2S, UART and SPI interfaces and GPIOs
- Improved battery-charging capabilities
  - Complies with USB BC v1.1 standard

## APPLICATIONS

- Factory automation
- Medical and life sciences equipment
- Retail systems
- Security and surveillance

## FREE DEV BOARD

Development platform for EZ-USB™ FX3 USB 3.0 applications.

Orderable Part Number  
**CYUSB3KIT-003**

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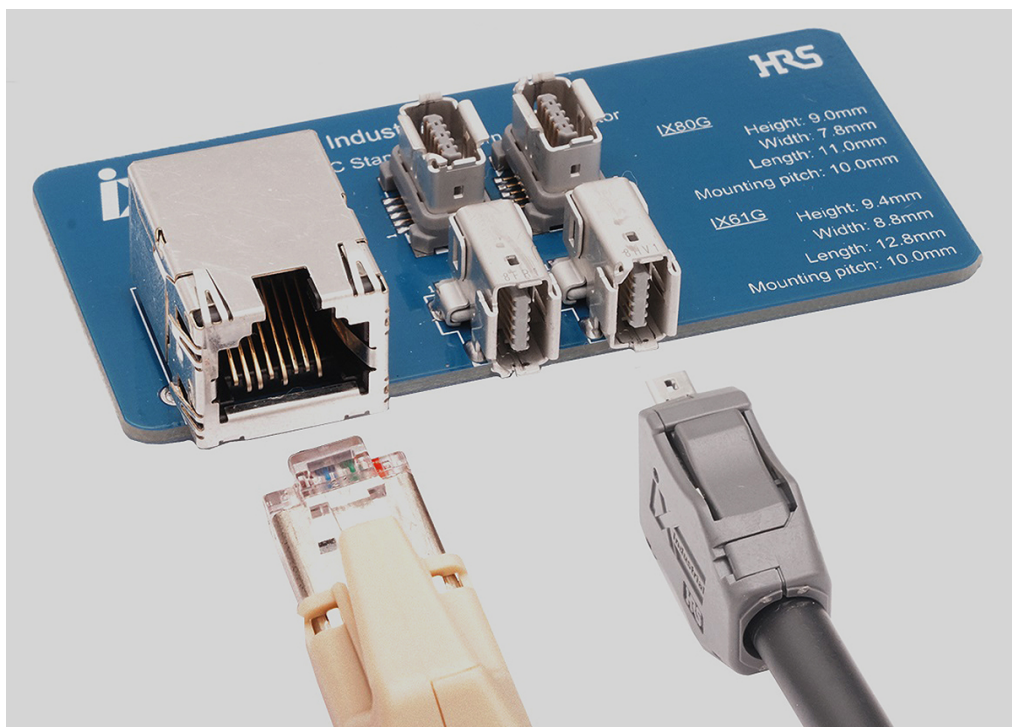


TELECOMS



# Compact industrial Ethernet connectors provide board space savings of up to 75%

ix Industrial™ connectors support data rates up to 10 Gbits/s. Available in a wide range of mounting styles for various cable sizes, the ix Industrial connectors can be positioned closely side-by-side on a single PCB.



**HRS** HIROSE  
ELECTRIC  
EUROPE B.V.

## FEATURES

- Rated current:
  - 1.5 A/pin on all pins
  - 3 A/pin on pins 1, 2, 6, 7
- 50 V ac/60 V dc voltage ratings
- Operating-temperature range: -40°C to 85°C

## APPLICATIONS

- Factory automation controllers
- Industrial robotics
- Programmable logic controllers
- Security systems
- Servo amplifiers
- Servers
- Machine vision cameras
- Automated ground vehicles
- Automated mobile robots

Hirose supplies a rugged Ethernet connector which combines a small, robust design with high-speed data-transmission capabilities. Intended for use in industrial automation and manufacturing environments, the ix Industrial™ connectors combine high-speed performance and a compact design with high reliability and design flexibility.

The connector occupies up to 75% less board space than RJ45 connector systems, and up to 28% less than competing snap-in I/O connectors. Supporting CAT5e and CAT6A cabling, the ix Industrial series connector integrates shielding against EMI and electro-static discharge to provide for safe and secure transmission at data rates up to 10 Gbits/s.

The ix Industrial series is available with two keying codes, one for Ethernet and the other for non-Ethernet applications. The connectors are compliant with the IEC 61076-3-124 standard. The ix Industrial plug is supplied with both solder and insulation displacement contact (IDC) terminations, giving the flexibility to use it with a range of cable sizes. Offered in upright right-angle, horizontal right-angle, vertical, and panel-mount inline versions, the ix Industrial connectors enable designers to save board space, for instance, the dimensions of the upright right-angle receptacle are just 8.8 mm x 9.4 mm x 12.8 mm. The connectors can be mounted in parallel with a pitch distance of only 10 mm. The narrow width of the receptacle is particularly beneficial when multiple connectors are positioned on a single PCB side-by-side.

Featuring a rugged and reliable design, the snap-in I/O connector has a positive metal lock with a pre-load spring mechanism which provides a clear tactile click and ensures complete, secure mating. The pre-loaded springs prevent unintended cable removal, and extend the operating life to more than 5,000 mating/unmating cycles.

The receptacle shell is mounted on the PCB via through-hole solder legs to enhance PCB retention and to resist the wrenching of the cable assembly. The wire-termination unit and cable clamp are integrated into a single plug shell, which prevents the connecting part of the cable assembly from being affected by the load on the cable.



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TELECOMS

# Industry’s first serial page EEPROM marks breakthrough in non-volatile memory

M95P EEPROM products from STMicroelectronics provide an all-in-one solution for ultra low-power systems that require an external non-volatile memory to manage firmware downloaded over-the-air, data logging, or event recording.



STMicroelectronics has introduced the industry’s first family of serial page EEPROM memory products. This family is an extension of the ST EEPROM portfolio, and is available in three density options:

- 8 Mbit M95P08
- 16 Mbit M95P16
- 32 Mbit M95P32

These high-density EEPROM products are page-erasable SPI page memory devices that combine flexibility and high performance with ultra-low power consumption. The bytes are tied together in 512-byte pages, and can be written even if they are not erased. These bytes can be accessed through an 80 MHz SPI bus, with high-performance single-, dual- and quad-SPI outputs.

The innovative page EEPROM architecture gives designers the flexibility to perform firmware management and data logging with the same device, a combination that usually calls for a serial NOR Flash and an EEPROM. This integrated solution reduces bill-of-materials cost and shortens time-to-market. It also enables designers to realize designs for smaller modules with ultra-low power operation, giving longer battery run-time in wearable and portable products.

An entirely new development, serial page EEPROM combines ST’s advanced proprietary non-volatile memory technology with a new smart page architecture, bringing together the benefits of high memory density for firmware management and easy data logging with byte flexibility and high endurance. The technology also features fast read, erase, and program times, reducing manufacturing costs and application downtime by enabling rapid uploads and downloads. Fast power-up and a quad-output read capability allow for faster application wake-up.

Serial page EEPROM offers a non-volatile memory solution that is less expensive than ferroelectric RAM. It also offers lower power consumption as well as more functionality and greater ease of use than serial Flash and dataflash products.



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## FEATURES

- 500,000 cycles write endurance
- 100 years data retention
- 1.5 mA page write current
- 2 ms page write time up to 512 bytes
- 1 ms page program time up to 512 bytes
- 4 ms block erase time
- Error correction code
- Schmitt trigger inputs for noise filtering
- Operating-voltage range: 1.6 V to 3.6 V

## APPLICATIONS

- Industrial IoT modules
- Wearable devices
- Healthcare devices and medical equipment
- Electronic shelf labels
- Smart meters
- 5G optical fiber modules



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# Robust industrial ac-dc power supplies in convenient chassis-mount package

The CUI Inc PSK-10D-T family are encapsulated 10 W ac-dc power supplies that provide the wide temperature range, managed EMI emissions and safety ratings required for use in factory and industrial systems.



## FEATURES

- Up to 85% efficiency measured at 230 V ac input
- 100 mVp-p maximum ripple and noise at full load
- $\pm 2\%$  output-voltage accuracy
- $\pm 0.5\%$  line regulation at full load
- $\pm 1.0\%$  load regulation at any load up to 100%
- Input over-voltage Category III for fixed installations

## APPLICATIONS

- Industrial control systems
- Industrial automation equipment

The PSK-10D-T encapsulated ac-dc power supplies from CUI are housed in a compact chassis-mount package which is easy to install in industrial control and automation applications.

Operating from a wide input-voltage range of 85 V to 305 V ac, the PSK-10D-T modules supply a continuous power output of 10 W at a choice of fixed, single output voltages: 5 V, 9 V, 12 V, 15 V, or 24 V. A version with an output voltage of 3.3 V has a maximum output of 8.6 W. The modules are also rated for an input range of 100 V to 430 V dc.

The PSK-10D-T family's wide operating-temperature range of  $-40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$  makes it ideal for use in harsh industrial conditions. Applications with high requirements for safety or EMC compliance will benefit from the power supplies' Class B EMI emissions rating and certification according to the IEC 62368, IEC 61558, and IEC 60335 safety standards.

The converters provide built-in protection against over-voltage, over-current, and short-circuit events.



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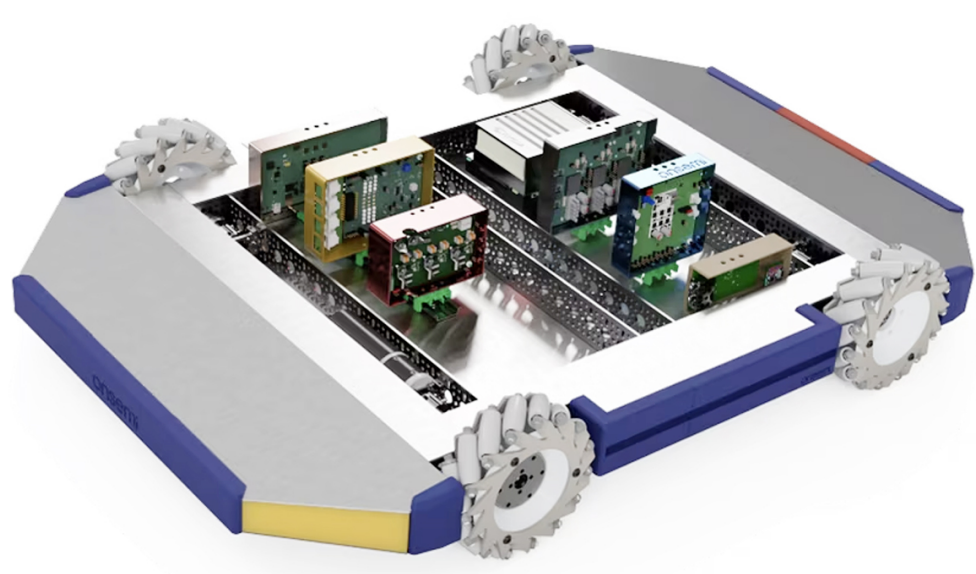


TELECOMS

## Power and motor-control solutions for autonomous mobile robots

**Designs benefit from careful evaluation of components' efficiency, precision and ease of integration. This review of the portfolio of onsemi products suggests ideal components for use in AMRs.**

Autonomous mobile robots (AMRs) offer many benefits including improved safety and higher efficiency compared to vehicles piloted by humans. The safe and independent operation of these complex systems requires the careful integration of many technologies. The design considerations for two vital AMR systems, power management, and motion control, can be implemented with the latest components from onsemi.



onsemi™

Fig. 1: The onsemi demonstration design for an autonomous mobile robot

### Powering AMRs

The design of the power system and the selection of its power components are heavily influenced by the use case's requirement for battery run-time between charges. Important performance characteristics and parameters to consider when designing the power supply for an AMR are shown in Figure 1 and include:

- Energy density
- Voltage and current requirements
- Efficiency
- Size and weight

AMRs commonly use lithium-ion batteries because they offer high energy density and long life. Power management units regulate power flow from the battery to other components. Voltage and current levels are controlled by switching converters and voltage regulators.

Alongside power-conversion circuits, battery management systems (BMS) in an AMR monitor the state of charge, temperature, and current of a battery to ensure the AMR operates safely and efficiently. The onboard battery charger's specifications depend on the battery type, capacity, and voltage.

For the motor-control system, intelligent power modules (IPMs) provide high-power switching for the motor-control system. Inside the IPM, gate drivers provide the appropriate signal to turn on and off the internal power switches.

Power factor correction (PFC) controllers enhance a power system's overall efficiency. Power components from onsemi are ideal for ac-dc power supply topologies such as a totem-pole PFC front end, or an LLC resonant dc-dc converter. They are also ideal for high-voltage dc-dc converter power stages, providing the basis for the efficient and high-density fast battery charger in an AMR, shown in Figure 2.



Fig. 2: Power systems in an AMR

**Motor design for AMR actuators** The choice of motor-driven actuators is important in AMRs since they enable the arms and wheels of the machine to move, as shown in Figure 3. AMRs require high-torque, fast actuators that offer high efficiency while also minimizing size and weight. In designing an actuator, engineers will evaluate components such as brushless dc (BLDC) motors, motor controllers, MOSFETs, universal controller boards, and gate drivers.

BLDC motors offer several advantages over brushed motors. They are used in AMRs due to their high efficiency, low noise, and low maintenance requirements. Their control, however, requires complex algorithms and a suitable driver. Three-phase BLDC motors are widely used in robotics and industrial drives.

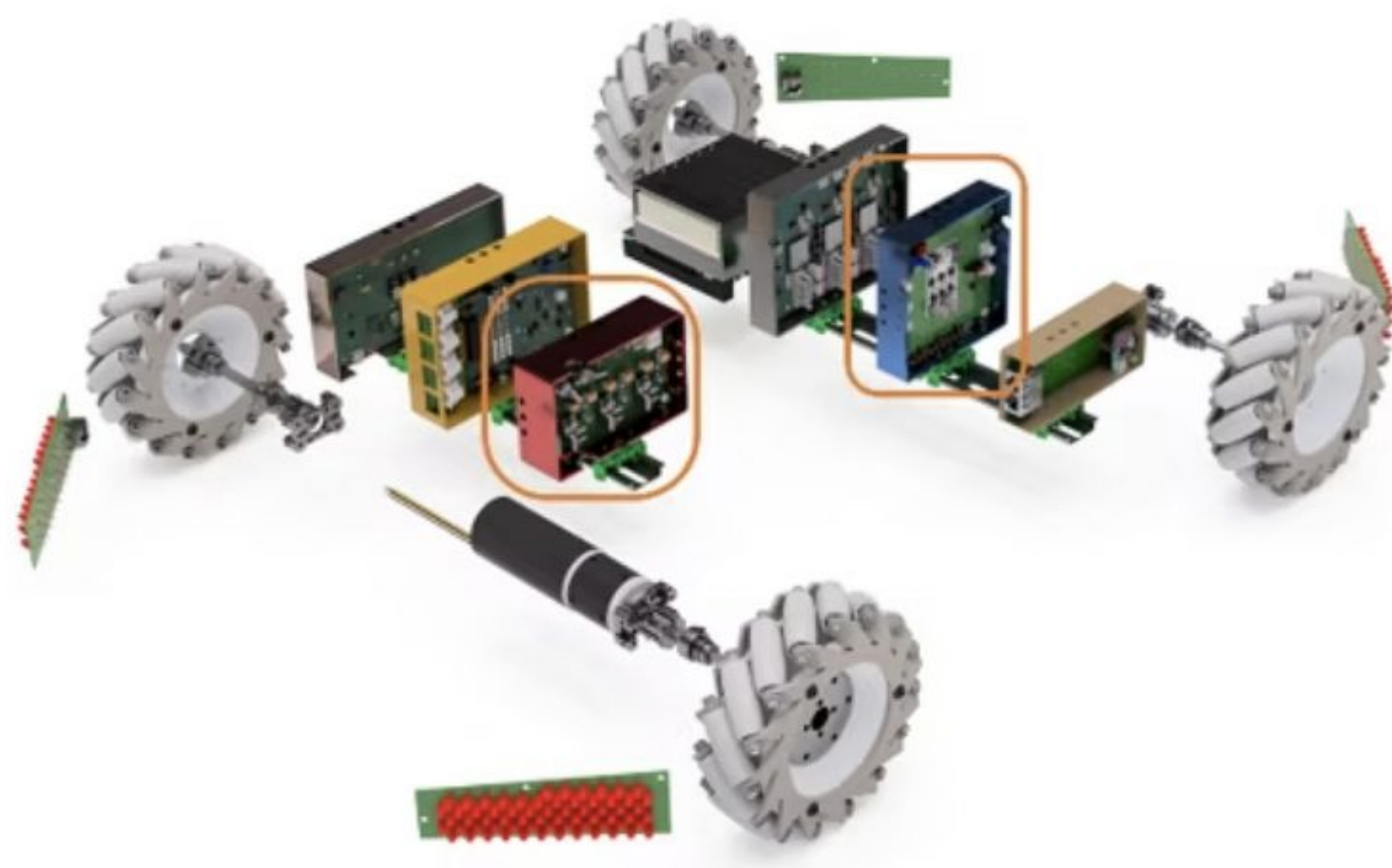


Fig. 3: Motor-control systems in an AMR

Three-phase BLDC motor controllers can be a fully integrated combination of a motor power stage and a controller, backed by an embedded control algorithm. Alternatively, a dedicated microcontroller running a motor-control algorithm can be used alongside a discrete power circuit.

Three-phase motors are driven by power switches that respond to a PWM control signal. These switches can be made from silicon or from a wide bandgap material, either silicon carbide (SiC) or gallium nitride (GaN).

The onsemi portfolio of BLDC motor-control solutions includes the ECS640A ecoSpin™ motor controller, the NCP81075 gate driver, and a power board, which can be used to accelerate AMR actuator development.

Also from onsemi is a universal controller board for motor control, a system-on-module (SoM) based on the Xilinx™ Zynq™ -7000 system-on-chip, which supports precision motion control, and can also be used for advanced artificial intelligence (AI) functions.

onsemi also offers shielded-gate trench MOSFETs that have voltage ratings ranging from 30 V to 150 V, in various package options, and new T10 technology-based 30 V to 40 V and 80 V MOSFETs for low- and medium-voltage applications. T10 devices are divided into two categories for power conversion and motor control.

The T10M devices for motor control offer best-in-class on-resistance, a 10% improvement in unclamped inductive switching capability, and excellent body-diode softness, which lessens susceptibility to voltage spikes and EMI problems.

For three-phase BLDC motors in high-power applications, onsemi recommends PTNG technology-based MOSFETs rated at 80 V, 100 V, 120 V, or 150 V.

The NTMTSC1D6N10MC, NTMTSC4D3N15MC, NTBLS1D5N10MC, and NTBLS4D3N15MC MOSFETs meet the requirements of high-performance applications.



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# Battery charger IC allows ideal current/voltage settings for specific battery types

**ROHM BD71631QWZ battery charger IC's compact package and compatibility with single-cell lithium-ion batteries makes it suitable for popular consumer devices such as earbuds and computer peripherals.**

## Thin, Compact Package Ideal for Low Voltage Rechargeable Batteries Comparison of equivalent products for single-cell li-ion batteries



The BD71631QWZ from ROHM is a linear battery charger IC which is compatible with not only single-cell lithium-ion batteries, but also all solid, semi-solid and other new rechargeable battery types that call for low-voltage charging.

This broad compatibility results from the ability to set the BD71631QWZ's charging voltage between 2.0 V and 4.7 V simply by changing an external resistor. The charge current and termination current can also be set by external resistors. The freedom to configure current and voltage characteristics makes it easy to re-use circuit designs based on the BD71631QWZ across multiple products that use different batteries.

Space saving is another benefit of the BD71631QWZ. The battery charger IC benefits from proprietary package technology to produce a thin, compact 1.8 mm x 2.4 mm x 0.4 mm form factor. This gives a mounting height 60% smaller, and a footprint 50% smaller, than those of standard battery chargers supplied in a 3.0 mm x 3.0 mm x 1.0 mm package. This makes the BD71631QWZ particularly suitable for wearable devices and for IoT devices equipped with ultra-thin sheet-like rechargeable batteries.



## FEATURES

- Adjustable termination-current range: 50  $\mu$ A to 10 mA
- 0  $\mu$ A quiescent battery current
- NTC thermistor input for temperature-adjusted charging
- Fixed 10-hour safety timer
- Protection functions:
  - Thermal shut-down
  - Under-voltage lockout
  - Battery over-voltage

## APPLICATIONS

- Wearable devices:
  - Wireless earbuds
  - Electronic pens
  - E-cigarettes
- IoT devices:
  - Smart displays
  - Smart tags

## FREE DEV BOARD

Evaluation board for low-voltage battery charging IC.

**Orderable Part Number**

**BD71631QWZ-EVK-001**

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# Reflective IR sensor module detects presence of objects at close range

The Vishay VCNT2030 reflective IR sensor module integrates a laser emitter, photodetector and supporting components into a compact, surface-mount package.



## FEATURES

- Package dimensions: 1.85 mm x 1.2 mm x 0.6 mm
- 10  $\mu$ s sensor rise time
- 15  $\mu$ s sensor fall time
- 17° angle of half intensity

## APPLICATIONS

- Position sensor
- Optical switch
- Optical encoder
- Object detection

The VCNT2030 from Vishay is a complete infrared reflective sensor module which can be used to reliably detect objects in close proximity. A typical application is to detect the presence of paper in the feed tray of a desktop printer.

Housed in a miniature surface-mount package, the VCNT2030 includes a high-intensity vertical-cavity surface-emitting laser (VCSEL) and a photodetector arranged in the same plane. The emitter, which offers high optical power and high-speed operation, has its peak wavelength at 940 nm.

The detector is a silicon phototransistor. The sensor's analog output signal at the phototransistor is dependent on the amount of light emitted by the VCSEL and reflected from an object in the sensor's field of view. The useful detection range of the VCNT2030 is from 0.3 mm to 6 mm.



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# High-temperature power Schottky diodes feature low leakage current

The STPSTxH100xx power Schottky diodes from STMicroelectronics are based on trench technology which optimizes the forward voltage/reverse current trade-off for a given silicon die area.



life.augmented

## FEATURES

- Dual or single configurations
- Wide range of package options
- Maximum average rectified current ratings up to 15 A

## APPLICATIONS

- Power converters
- Power supplies

STMicroelectronics supplies a wide range of 100 V high-temperature power Schottky diodes with current ratings ranging from 1 A to 15 A.

The STPSTxH100xx series diodes, which are notable for their very low leakage current, are supplied in flat, space-saving packages. This makes them ideal for use in high-frequency miniature switch-mode power supplies.

All diodes in the high-temperature range have a maximum operating temperature of 175°C. The diodes provide a very wide guard band to protect against thermal runaway in the application.

Designing with the ST power Schottky diodes is supported by the eDesignSuite, a comprehensive set of easy-to-use utilities for streamlining system development. The suite's Rectifier Diodes Simulator enables the designer to:

- Select ratings and application waveforms
- Estimate power losses
- Search and sort suitable devices



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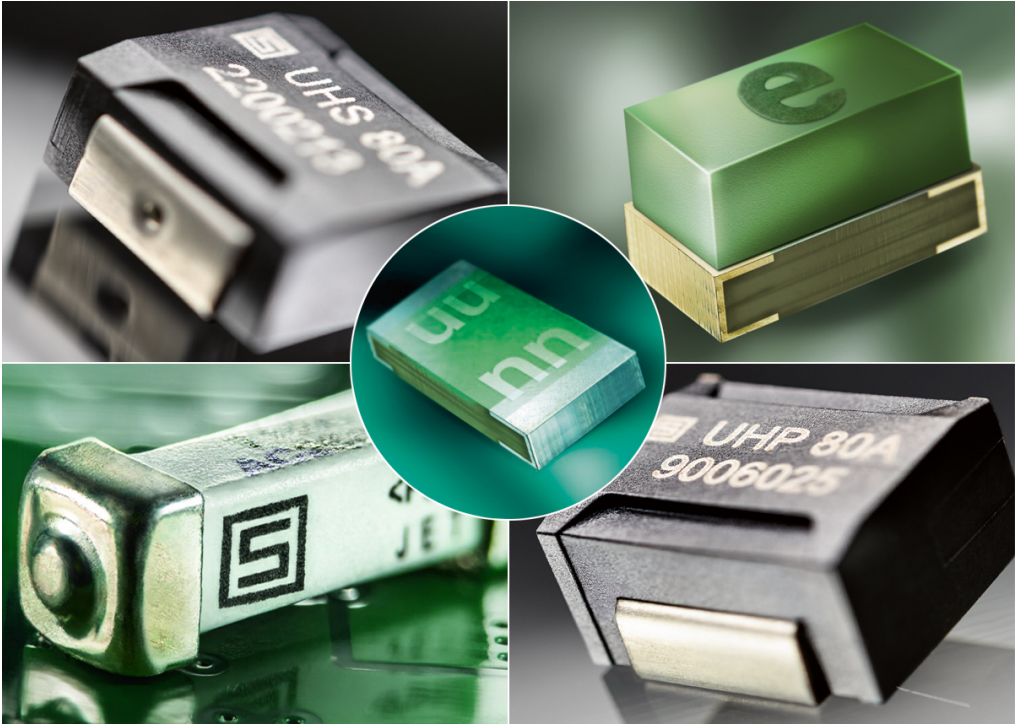
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# Compact fuses for SELV products provide fast protection against short-circuits

The UHS family of fuses from SCHURTER offers a breaking capacity of up to 2 kA, to enable galvanic isolation of low-voltage lithium-ion batteries in safety extra-low voltage (SELV) applications.



 **SCHURTER**  
ELECTRONIC COMPONENTS

### FEATURES

- Safe tripping in 10 s at twice the rated current
- 8.4 mm x 9.4 mm footprint
- 4.7 mm high
- Operating-temperature range: - 55°C to 125°C

### APPLICATIONS

- Automotive
- Telecoms equipment
- Data center servers
- Power tools

SCHURTER UHS fuses, which are available with current ratings up to 100 A, provide protection against short-circuits in products with a safety extra-low voltage (SELV) designation.

In SELV products, very high currents can flow in the event of a short-circuit. The common use of cheap, powerful lithium-ion battery cells has increased the need in PCBs to shut off high currents in a controlled manner.

The compact, surface-mount UHS family of fuses is dedicated to this function, providing a high and fast breaking capacity triggered in the event of a very high over-current. Use of the UHS fuse allows the large store of energy in lithium-ion battery cells to be galvanically isolated in a controlled manner.

Rated Current	Rated Voltage	Package Marking	Breaking Capacity	Typical Cold Resistance
50 A	32 V	UHS 50A	Up to 1.5 kA at 16 V dc	1.82 mΩ
60 A	32 V	UHS 60A	Up to 1.5 kA at 16 V dc	1.5 mΩ
70 A	50 V	UHS 70A	Up to 2 kA at 16 V dc	1.03 mΩ
80 A	50 V	UHS 80A	Up to 2 kA at 16 V dc	0.88 mΩ
90 A	50 V	UHS 90A	Up to 2 kA at 16 V dc	0.77 mΩ
100 A	50 V	UHS 100A	Up to 2 kA at 16 V dc	0.71 mΩ

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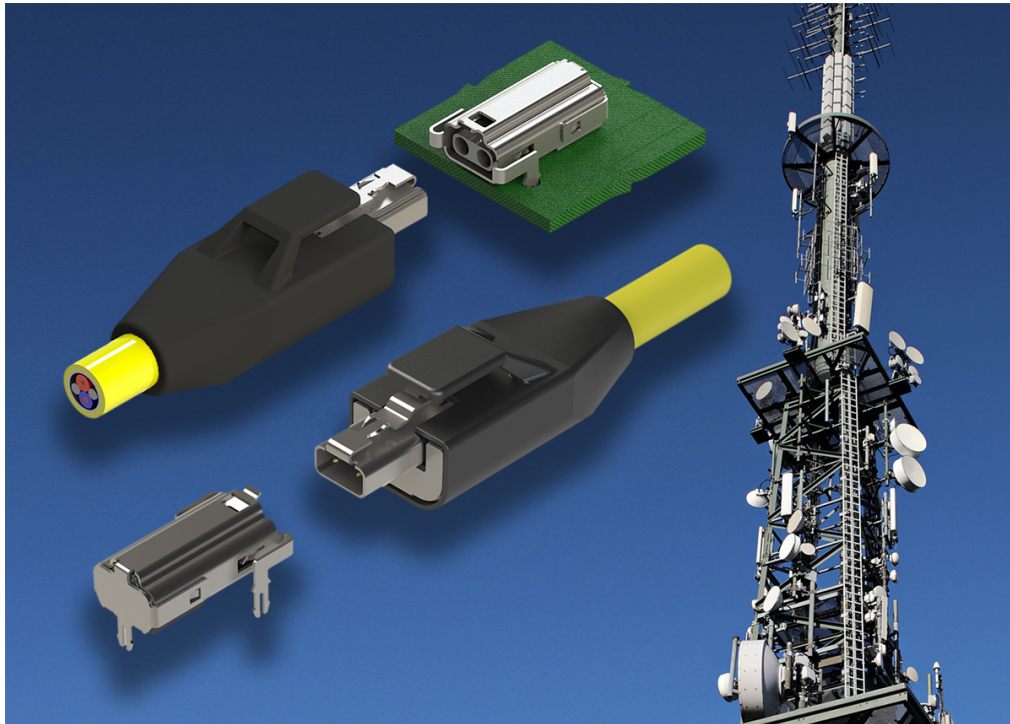
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# New connector range supports space-saving single-pair Ethernet installations

The 6780 series of connectors from KYOCERA AVX provides a standards-compliant way to produce single-pair Ethernet equipment, simplifying network architectures and lowering bill-of-materials and installation costs.



## FEATURES

- Mounting styles:
  - IP20 plug: 2P-K
  - IP20 jack: 2J-L
- Operating temperature up to 85°C
- Cable sizes from 18 AWG to 26 AWG

## APPLICATIONS

- Robots
- Industrial automation
- Sensor and actuator networks
- Control and monitoring cameras
- Smart grid equipment
- Traffic control systems
- Transportation smart monitoring equipment

KYOCERA AVX has launched the 6780 series of connectors for single-pair Ethernet (SPE) equipment.

In SPE, signals are transmitted over only one pair of twisted copper wires. In addition to data transmission via Ethernet, SPE also enables the simultaneous supply of terminal devices via the power over data line (PoDL) protocol. Previously, this required two pairs for Fast Ethernet, with a maximum 100 Mbytes/s data rate, and four pairs for Gigabit Ethernet.

SPE equipment connected via the 6780 series connectors gives OEMs the benefits of space and weight savings using less wire, and offers end users lower installation costs. The 6780 series connectors comply with the IEC 63171-6 and IEEE 802.3 standards governing SPE equipment.

### White paper link

[Passive component advancements for SPE connectors and circuit protection devices](#)



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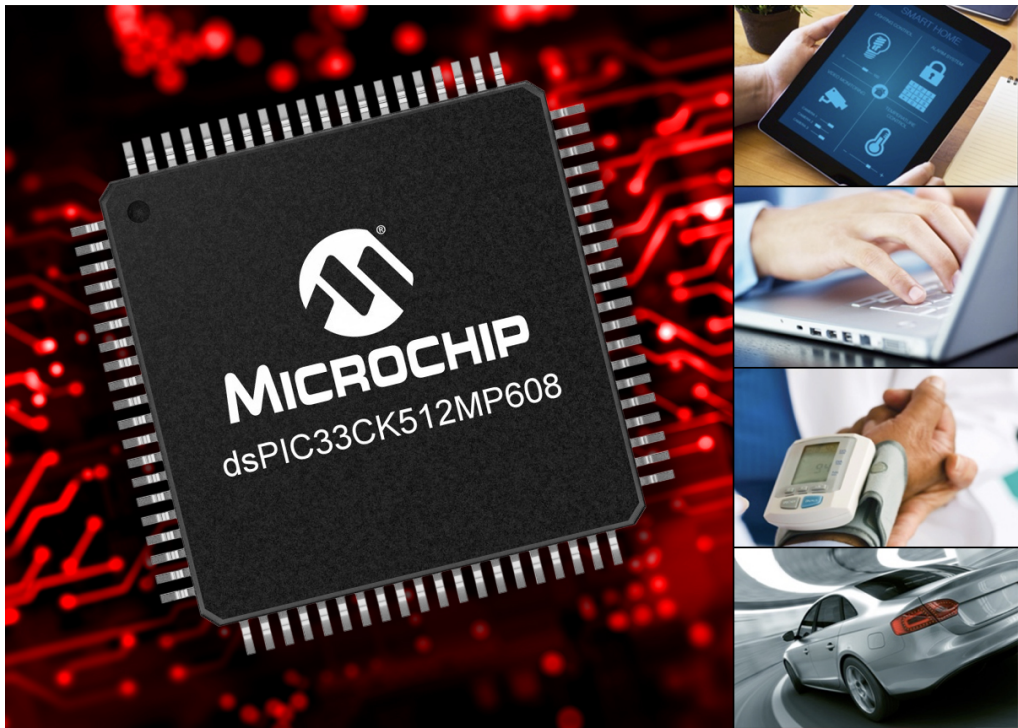
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# Digital signal controllers provide fast and robust platform for motor control or power conversion

The dsPIC33C digital signal controllers from Microchip combine fast DSP functionality with microcontroller features and analog peripherals, to enable implementation of complete motor- or power-system designs with a single chip.



The Microchip dsPIC33C family of digital signal controllers (DSCs) provides an ideal combination of high digital signal processor (DSP) performance with a microcontroller-like peripheral set for use in motor and power-conversion applications that require high performance and robustness.

Offering 100 MIPS performance, the dsPIC33C family of DSCs provides a path for users of dsPIC33E and dsPIC33F DSCs to develop more sophisticated applications. These DSCs feature the dsPIC33 C core with a DSP engine, expanded context-selected registers to reduce interrupt latency, new instructions to accelerate DSP performance, tightly coupled peripherals, and faster execution to enable complex, high-speed control loop implementation.

The dsPIC33C DSCs are ideal for the control of many types of motors, including brushless DC, permanent magnet synchronous motors, ac induction, switched reluctance and stepper motors. The DSCs' high level of peripheral integration enables applications to implement power factor correction and motor control with a single chip.

Loaded with intelligent analog peripherals, the dsPIC33C family also provides easy-to-use smart sensor interfaces for various sensing applications.

The dsPIC33 DSCs feature a DSP engine for the high-speed execution of control loops. Key features include:

Dual, independent cores in the dsPIC33CH series, to enable the system to isolate time-critical control loops from housekeeping functions  
High-speed ADCs, programmable gain amplifiers and a CPU with fast and predictable interrupts  
PWM controllers operating at a resolution of up to 250 ps, giving the flexibility to control numerous power topologies

In addition, the dsPIC33C MPT series features an integrated hardware security module providing various security functions including:

- Immutable secure boot
- Secure firmware upgrade with live update
- Secure on-board communication and message authentication
- Electronic control unit (ECU) authentication



## FEATURES

- 16-bit architecture
- 100 MHz maximum CPU clock speed
- 64 kbytes Flash program memory
- 8 kbytes SRAM
- Analog peripherals:
  - 12-bit, 3.5 Msamples/s ADC
  - Analog comparator
- Eight motor-control PWM outputs
- Quadrature encoder interface
- 150°C maximum operating temperature
- I2C, UART and serial peripheral interfaces
- MPLAB Code Configurator support

## APPLICATIONS

- Motor-control systems
- Digital power supplies
- Automotive systems
- Industrial equipment
- Consumer equipment

## FREE DEV BOARD

dsPIC33CK Curiosity development board for dsPIC33C family of digital signal controllers.

**Orderable Part Number**  
**DM330030**

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# Galvanically isolated high-side switches protect industrial loads

The ISO808 switches from STMicroelectronics provide a wide range of protection functions against electrical and thermal faults. Development boards and configuration software ease integration of the switches into industrial equipment designs.



STMicroelectronics has launched a family of 8-channel high-side switches that combine galvanic isolation for robustness, low on-resistance for energy efficiency, as well as protection and diagnostics functions for reliability and fault recovery.

The ISO808 family of switches drives all types of industrial loads, capacitive, resistive, and inductive, with one side connected to ground. The switches are ideal for industrial machines in which isolation is needed to strengthen the protection of sensitive circuits in smart factory equipment.

The ISO808 and ISO808A have a current limit of 0.7 A, while the ISO808-1 and ISO808A-1 have a limit of 1 A. The ISO808 and ISO808-1 provide a separate Input pin for each channel, and allow either direct control, or synchronous operation in which all outputs are driven simultaneously. The ISO808A and ISO808A-1 have a serial peripheral interface (SPI) input, and feature an open-drain power-good indicator to aid system management. All switches have a dedicated Fault Indicator pin.

Overload protection operates independently on each channel, so non-overloaded channels can continue operating normally. Any overloaded channels are turned off and automatically restarted to permit rapid recovery with minimal intervention on the part of the host. The channel is shut down again if the fault remains: this is detected by monitoring channel and case temperatures.

The ISO808 high-side switches also provide various other protection functions for both the control- and the process-side power rails:

- Ground disconnection protection
- Reverse-polarity protection
- Short-circuit protection
- Thermal case protection
- Under-voltage shut-down

Communication across the isolation barrier is by RF, which gives good noise immunity. Internal logic reports any data errors, and a watchdog ensures the process-stage outputs are safe if the control-side supply voltage is missing.

A graphical design tool, the STSW-IFAPGUI, eases configuration and control.



## FEATURES

- Operating-voltage range on process side: 9.2 V to 36 V
- 0.125  $\Omega$  on-resistance per channel
- Fast demagnetization of inductive loads
- Low process- and control-side supply current
- High common-mode transient immunity
- Standards compliance:
  - IEC 61000-4-2
  - IEC 61000- 4-4
  - IEC 61000-4-5
  - IEC 61000-4-8
- UL1577 and UL508 recognized

## APPLICATIONS

- Programmable logic controllers
- Industrial PCs
- Computer numerical control (CNC) machines

## FREE DEV BOARD

Industrial digital-output expansion board based on ISO808 for STM32 Nucleo microcontroller boards.

**Orderable Part Number**  
**X-NUCLEO-OUT11A1**

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## FREE DEV BOARD

Industrial digital output expansion board based on ISO808A-1 for STM32 Nucleo microcontroller boards.

**Orderable Part Number**  
**X-NUCLEO-OUT14A1**

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# 100 V MOSFET provides wide SOA and low on-resistance for use in PoE applications

The ISZ113N10NM5LF from Infineon provides the robust performance required in power sourcing equipment (PSE) for reliably powering connected powered devices.



## FEATURES

- 11.3 mΩ maximum on-resistance
- 63 A maximum continuous drain current
- 3.1 V gate-source threshold voltage
- 100% avalanche tested

## APPLICATIONS

- PoE systems
- Power supplies
- Power converters

The ISZ113N10NM5LF from Infineon is a 100 V OptiMOS™ 5 linear MOSFET which is ideal for performing the soft-start function in Power-over-Ethernet (PoE) applications.

The design of PoE systems that comply with the IEEE 802.3bt standard stretches the capabilities of the power system, as it calls for high power output per port, power delivery via all four pairs of the Ethernet cable, support for lower standby power, as well as the autoclass function to match power output to the needs of the powered device.

OptiMOS 5 MOSFETs such as the N-channel ISZ113N10NM5LF are suited to PoE systems that have the latest high-power PSE controllers because of their very low on-resistance and wide safe operating area (SOA). A wide SOA is especially important for handling short-circuit conditions and high power dissipation, maintaining safe operation until the PSE controller shuts down the port due to the fault event.

The ISZ113N10NM5LF is available in a space-efficient PG-TSDSON-8-31 (3.3 mm x 3.3 mm PQFN) package, and is fully qualified according to JEDEC standards for industrial applications.



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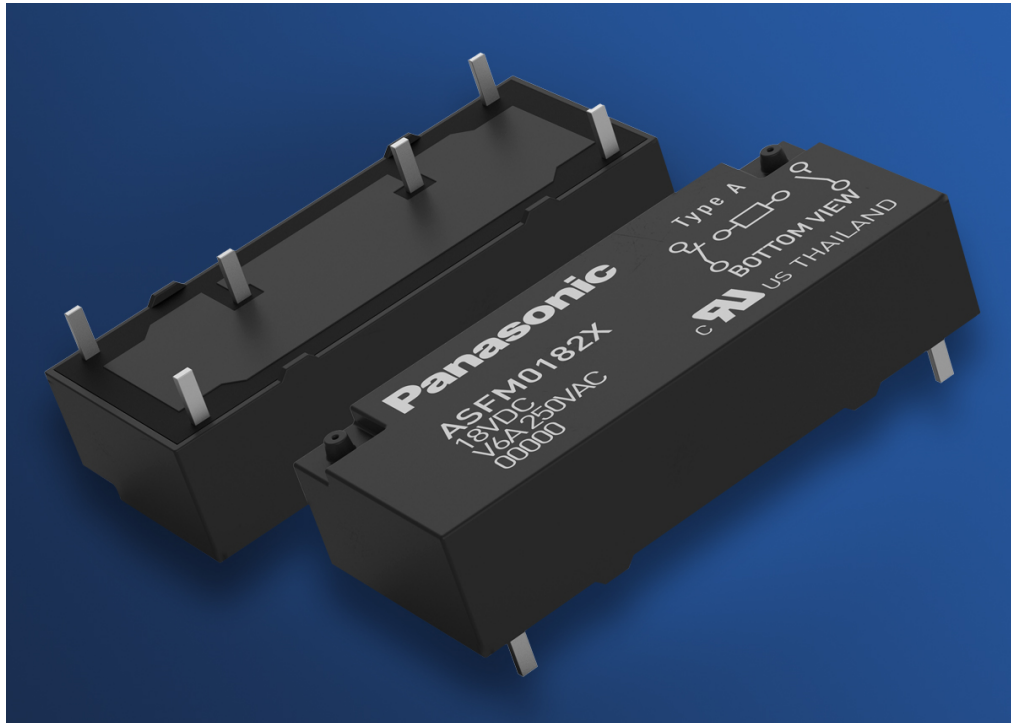


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# Relay with forcibly guided contacts features space-saving flat housing

The SF-M relay from Panasonic offers safety standard compliance, making it ideal for use in industrial and building automation applications that have special safety requirements.



## Panasonic INDUSTRY

### FEATURES

- $\geq 5.5$  mm reinforced insulation on NO side
- Coil voltage from 3 V to 24 V
- Ambient-temperature range:  $-40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$

### APPLICATIONS

- Industrial automation
- Building automation
- Railway signaling equipment

The new Panasonic SF-M series of 2-pole safety relays features forcibly guided contacts specified according to the EN 61810-3 standard for use in any kind of safety control system or safety application.

The new SF-M relays are the first with 1NO and 1NC power contacts to be supplied in a flat housing with a height of only 7.8 mm. Despite the small size, the relays can switch high loads on both contacts: 6 A on the normally open and 4 A on the normally closed side at 250 V ac/30 V dc. This means that the relay can handle loads such as valves directly without the need for any additional relay. On the signal side, the relay's silver alloy contacts can handle loads as small as 10 V/1 mA dc.

The SF-M relays offer very high shock and vibration resistance of more than 20 g, and a low coil holding power of 100 mW.



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# Understanding the methods of trapezoidal control of BLDC motors

onsemi, which supplies a wide range of MOSFETs and power transistors, explains the factors to take into account when designing sensed or sensorless motor-control systems.



onsemi

Trapezoidal control, also called six-step or 120-block commutation, is one of the simplest methods for controlling a brushless dc (BLDC) motor. The basic concept of trapezoidal control is to apply square-wave currents to the motor phases that align with the BLDC motor's trapezoidal back EMF profile, resulting in optimal torque generation.

The six-step name reflects the inverter MOSFETs' assumption of just six on/off state combinations, resulting in six possible stator field orientations within the rotor magnetic field's plane of rotation. The six possible inverter states must follow a specific sequence depending on the desired direction of rotation of the motor, so that the stator and rotor field orientation arrangement produces maximal torque

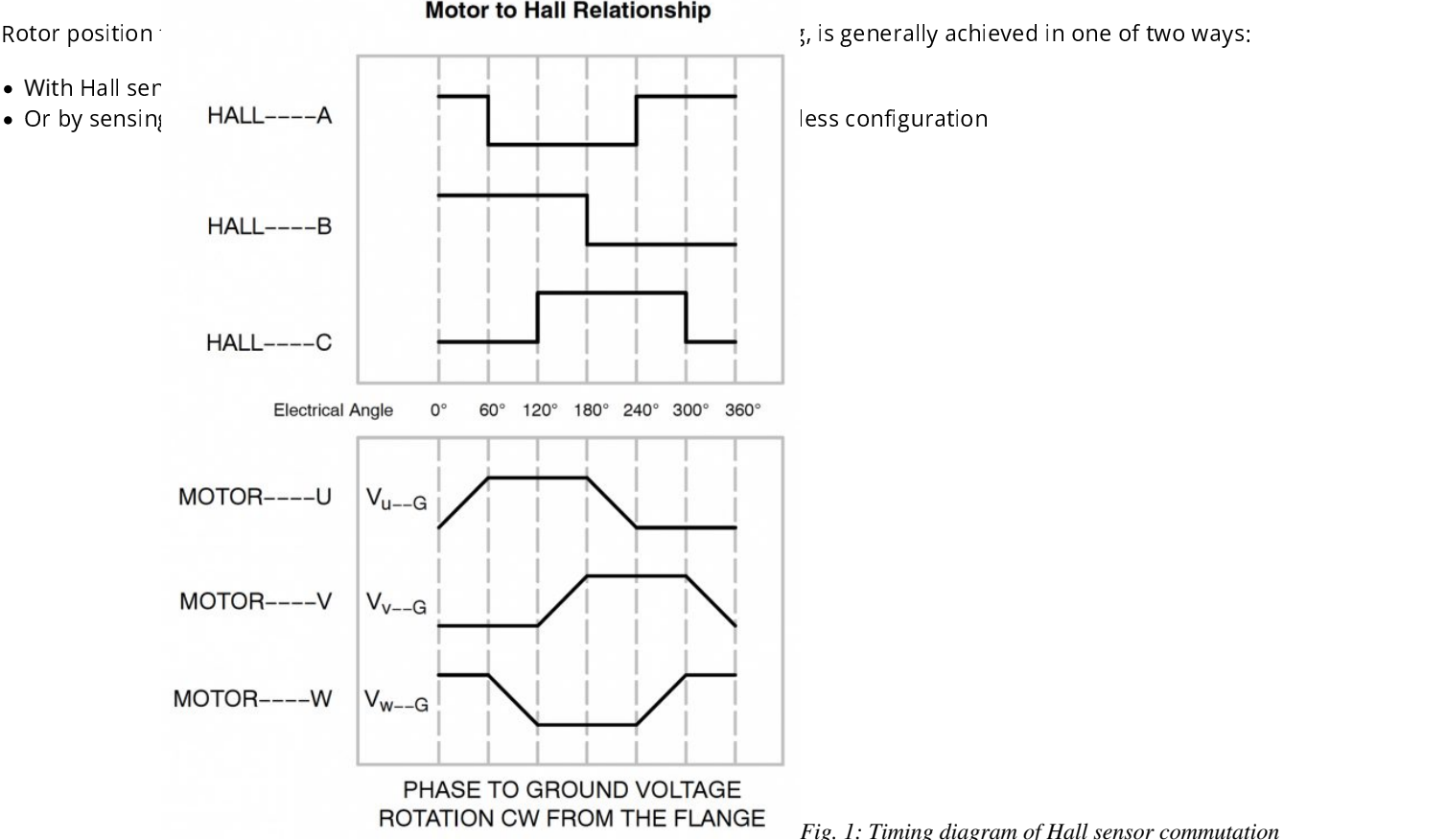


Fig. 1: Timing diagram of Hall sensor commutation

Sensored trapezoidal control does not require any voltage or current feedback signals for operation. Instead, it uses position feedback from Hall sensors to determine the correct sequence for energizing the phases of the motor. Hall sensors are mounted on the motor and sense rotor position through the Hall effect caused by the rotation of the rotor's permanent magnet. Sensored trapezoidal control is generally easier to implement and allows for proper commutation even at start-up, because the rotor position information is present even at zero speed. A typical Hall sensor/phase-voltage commutation timing diagram is shown in Figure 1.

Sensorless trapezoidal control uses the back EMF generated by the motor's rotation to determine the correct motor commutation sequence. For trapezoidal control, only two motor phases are energized at a time. Because no current flows in the non-energized phase, the back EMF of that phase can be directly sensed during that time.

For BLDC motors, the back EMF profile is trapezoidal; during the non-energized time frame, the phase back EMF is either linearly increasing or decreasing. Most back EMF position feedback techniques for trapezoidal control rely on a technique involving back EMF zero-crossing detection (ZCD). The back EMF is monitored to determine the moment when it crosses a reference point, either the neutral motor voltage or half the dc bus voltage.

One important drawback of sensorless control is that, because the magnitude of back EMF is proportional to rotary speed, the motor must rotate at a minimum speed to produce a strong enough back EMF signal for proper rotor position sensing. This means that a start-up mechanism is required to kick-start the motor until it achieves sufficient rotary speed.

While sensed trapezoidal control is easier to implement, it entails a higher bill-of-materials due to the requirement for Hall sensors. It also requires more wiring from the motor, which might not be possible in some environments.

Sensorless control is more complex, must be tuned for specific loads or operating conditions, and might have difficulty starting up under heavy loads. Sensorless control is well suited to applications where the load profile is well known, however, and/or the load profile increases with speed, such as a fan.

Figures 2 and 3 illustrate examples of sensed and sensorless trapezoidal motor-control systems.

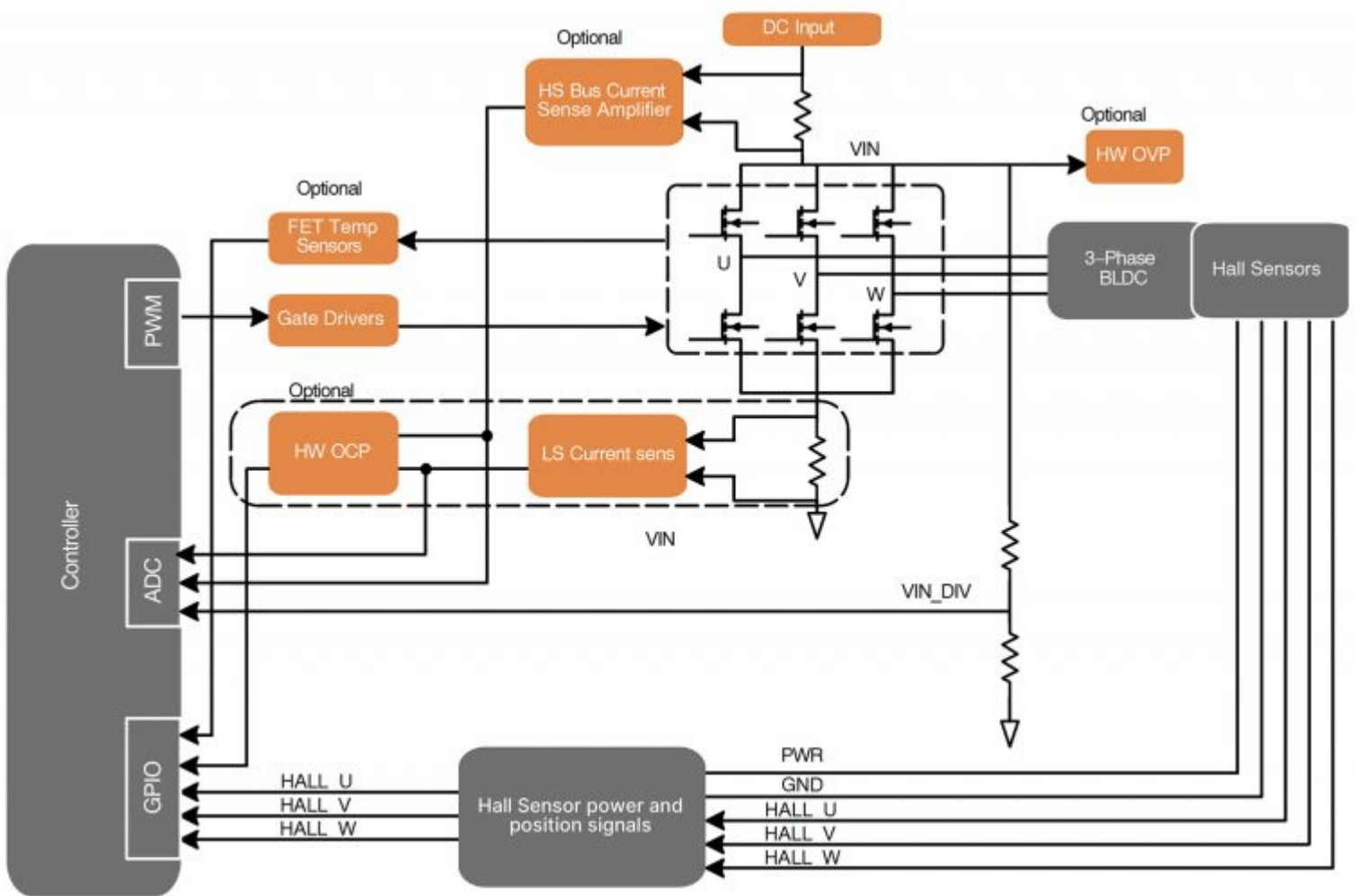


Fig. 2: Block diagram of a sensed trapezoidal motor-control circuit

Figure 2 shows the required signals for sensed trapezoidal control. Hall sensors must be powered externally and are generally open-drain outputs, though they can be push-pull. When placing Hall sensors at 60 or 120 intervals on the motor, determining the correct commutation sequence requires the Hall signal sequences to be decoded differently. It is important to refer to the motor manufacturer's Hall sensor commutation timing diagrams to determine the correct Hall sensor-phase commutation sequence. If no timing diagram is available, the correct commutation sequence can be determined empirically. Hall sensor signals can also be noisy and might benefit from hardware or software filtering.

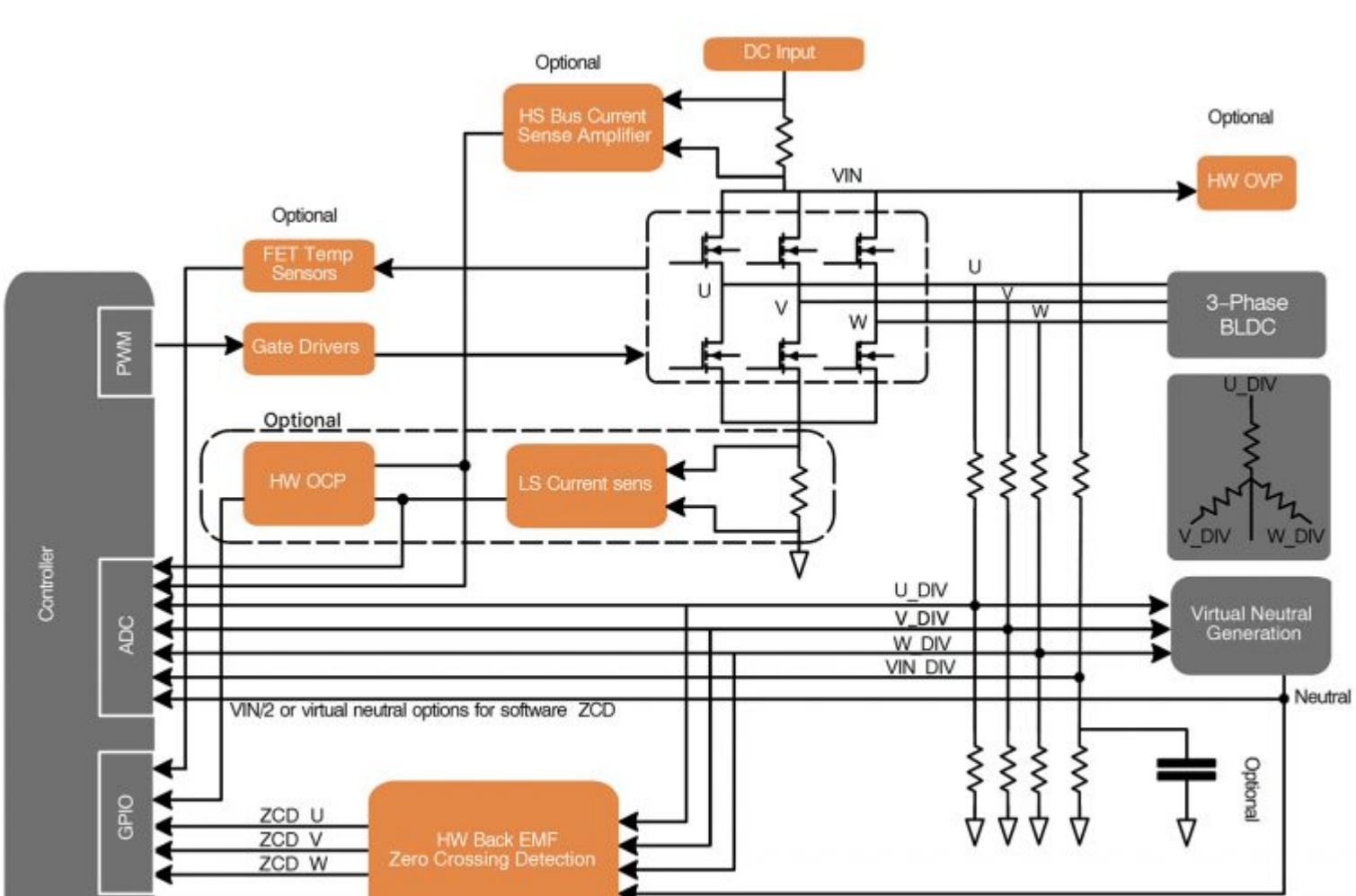


Fig. 3: Block diagram of a sensorless trapezoidal motor-control circuit

Figure 3 shows the signals required for sensorless trapezoidal control. Back EMF ZCD can be performed either in firmware or hardware. For software ZCD, back EMF detection requires an ADC with a minimum of four inputs, 3x phase voltage, Vin/2, or neutral reference, with all voltages divided to adjust to the controller ADC's full-scale range.

Hardware ZCD implements comparators to compare the phase voltages to the reference points and provide the zero-crossing signals directly to the controller via GPIO pins. If using hardware ZCD, the recommendation is to filter the divided phase voltages and implement comparator hysteresis to prevent glitches in the ZCD signals due to non-ideal and noisy back EMF signals. Note, however, that this might limit the maximum rotary speed available due to the delay caused by filtering.

Digital filtering can also be implemented in software ZCD: this is advantageous because motor speed can adjust filtering operation, for instance to implement heavy filtering at lower speeds and reduced filtering at higher speeds.

While using a comparison to half the dc bus voltage is possible, a comparison to the motor neutral (virtual or actual) is preferred as it is more tolerant of phase imbalance. If the motor neutral is not accessible from the motor, a simple Wye-connected resistor network connected to the motor phases can recreate virtual neutral.

## Additional Design Considerations

**Over-current protection (OCP)** can be implemented in hardware, software, or both. Typically, hardware-based OCP will provide faster response, but software-based OCP has more flexibility. Another limitation of software-based OCP is that the full-scale current measurement range of the ADC limits the maximum trigger point.

A combined hardware/software implementation might implement a latching OCP to mitigate catastrophic hard faults quickly, and use software-based OCP for dynamic events such as cycle-by-cycle phase current limiting.

**Over-voltage protection (OVP):** in certain applications, such as when regenerative braking might cause excessive voltages on the dc bus, it might be necessary to implement OVP in hardware by diode-clamping or a crowbar circuit.

Software-based OVP can also be implemented by monitoring the dc bus, and protecting the motor from potentially damaging voltages above the rated voltage of the motor by disabling the inverter output.

**Over-temperature protection (OTP):** it is generally recommended to monitor the inverter MOSFET and board temperature when using any motor-control method, especially when the system is subject to varying ambient temperatures, or in the event of failure of the cooling system failure.

For example, PWM duty cycle limits can be dynamically reduced as temperature increases, and thermal monitoring can also help to determine component degradation over time.

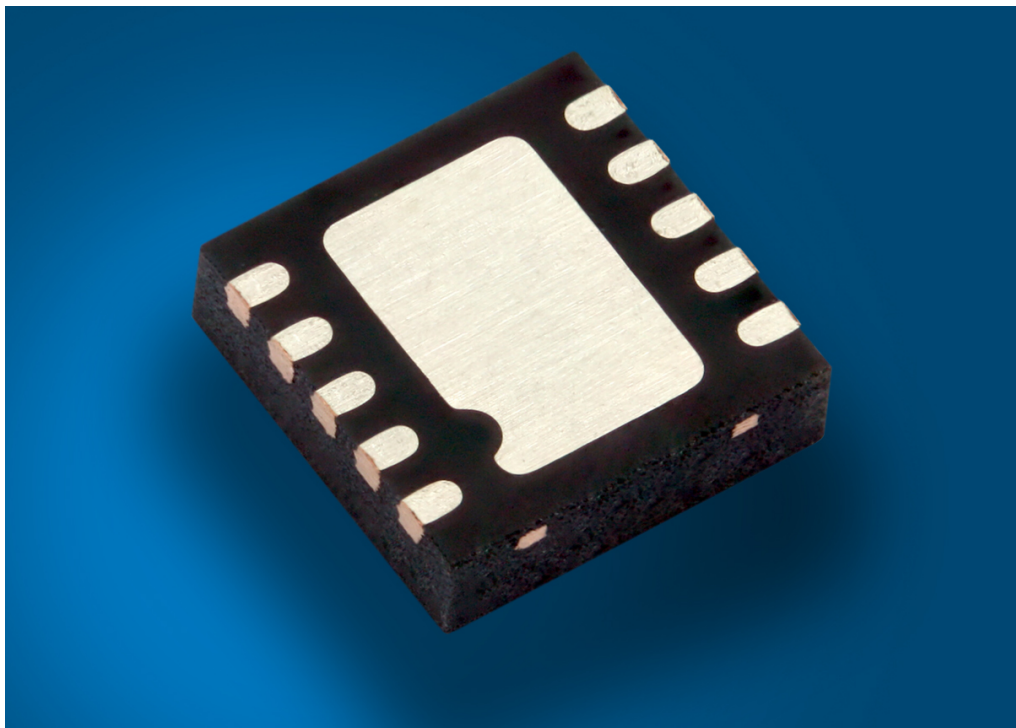
**MOSFET selection:** selecting the best MOSFET or switch is important for any motor-control system and should be specifically tailored to system requirements. The output inverter stage influences the system's overall efficiency, and incorrect MOSFET selection could result in substantial performance degradation and even catastrophic system failure.

It is beyond the scope of this design note to discuss all specific factors related to proper switch selection. onsemi offers a wide variety of highly efficient MOSFETs and transistors for motor-control application, in various voltage ranges.



## Current-limit switches provide comprehensive circuit protection

Vishay SiP32433A/B and SiP32434A/B load switches provide settable limits for over- and under-voltage protection, and block voltage surges and inrush currents over a wide input-voltage range, with either latch off or auto-retry.



The SiP32433A and SiP32433B from Vishay are single-channel load switches which protect both power sources and downstream circuitry connected to the switch from overloads, short-circuits, voltage surges, and excessive inrush currents.

The output-current limit can be set by a single external resistor in a range from 0.3 A to 3.5 A, with an accuracy of  $\pm 8\%$ . The rated input-voltage range is 2.8 V to 23 V.

Vishay also supplies the SiP32434A and SiP32434B switches, which can be set to limit current in a range between 0.5 A and 6 A, with an accuracy of  $\pm 7\%$ . After switching off due to a fault, the SiP32433A and SiP32434A latch the power switch off, while the SiP32433B and SiP32434B auto-retry after a settable period.

The SiP32433 and SiP32434 load switches integrate multiple control and protection features, giving system designers a simple way to control power behavior and maintain reliable operation with only a small number of external components.

Over-voltage protection and under-voltage lockout threshold levels can be set with an external resistor network. Inrush current behavior can be set with a single external soft-start capacitor.

The SiP32433A and SiP32433B feature active reverse blocking, making them ideal for systems with a USB Type-C<sup>®</sup> Power Delivery power supply or with multiple power-source switching.



### FEATURES

- 28 V maximum voltage with 24 V internal over-voltage protection
- 78 m $\Omega$  switch resistance
- Fast response to short-circuits
- Programmable turn-on slew rate
- Junction-temperature range: -40°C to 125°C
- Over-temperature protection

### APPLICATIONS

- Industrial equipment
- IoT devices
- Smart home devices
- Medical and healthcare equipment
- Networking and telecoms equipment
- Data storage
- Computing equipment
- Programmable logic controllers
- Lighting
- Games consoles

### FREE DEV BOARD

Evaluation board for the SiP32433 configurable current-limiting load switch.

**Orderable Part Number**  
**SIP32433AEVB**

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# Synchronous buck converters offer design versatility in PoL applications

AP62500 and AP62800 dc-dc converters from Diodes Incorporated provide the freedom to create the smallest possible point-of-load power supply, or the most efficient. Low EMI and fast transient response ensure excellent performance in consumer applications.



The latest synchronous buck converters from Diodes Incorporated give engineers the flexibility to develop point-of-load (PoL) power supplies that are optimized for either efficiency or size. The AP62500 and AP62800 feature selectable switching frequencies, and a choice of three operating modes that increase efficiency, reduce ripple or eliminate audible noise.

The new dc-dc converters from Diodes require a small number of external components, enabling design engineers to realize compact power-system implementations.

The AP62500 has a continuous output-current rating of 5 A, while the AP62800's rating is 8 A. Both buck converters operate from a wide input-voltage range: 4.5 V to 18 V for the AP62500, and 4.5 V to 17 V for the AP62800. The devices' output voltage can be adjusted down to 0.6 V. This makes the converters ideal for point-of-load power supplies in high-volume consumer products that operate from a 5 V or 12 V distributed power bus. They also provide an efficient solution for FPGA, DSP, and ASIC power supplies.

The selectable switching-frequency options are 400 kHz, 800 kHz, and 1.2 MHz. At a lower frequency, the design achieves higher conversion efficiency, and at a higher frequency the size of the power supply's magnetic components can be reduced.

There are three selectable operating modes:

- Pulse frequency modulation (PFM) for high light-load efficiency
- Pulse width modulation for low output-voltage ripple
- Ultrasonic, to operate outside the audible frequency range and maintain the switching frequency at higher than 20 kHz

The design of these buck converters minimizes EMI problems. A proprietary gate-driver design mitigates switching-node ringing without having to extend MOSFET turn-on/turn-off times, which would otherwise limit the device's ability to switch at high frequency. Constant-on-time control results in fast transient response and low output-voltage ripple, as well as providing for better loop stabilization.



## FEATURES

- High-side MOSFET on-resistance:
  - 47 mΩ for AP62500
  - 22 mΩ for AP62800
- Low-side MOSFET on-resistance
  - 18 mΩ for AP62500
  - 10 mΩ for AP62800
- 195  $\mu$ A quiescent current in PFM mode
- Adjustable soft-start time

## APPLICATIONS

- TVs and monitors
- White goods
- Small home appliances
- Home audio equipment
- Home networking equipment
- Gaming consoles

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# Broad selection of antenna-matching RF integrated passive devices for STM32WL wireless MCUs

The BALFHB-WL-0xD3 integrated passive devices from STMicroelectronics provide a space-saving alternative to antenna-matching circuits built from discrete devices, and are easier and quicker to implement in wireless systems.



life.augmented

## FEATURES

- 50  $\Omega$  nominal input/conjugate matched balun to STM32WL
- 50  $\Omega$  nominal impedance on antenna side
- Low insertion loss

## APPLICATIONS

- Metering
- Smart city management
- Agriculture
- Retail
- Logistics
- Smart buildings
- Environmental management

STMicroelectronics has released nine RF integrated passive devices (IPDs) optimized for STM32WL wireless microcontrollers, which operate at frequencies below 1 GHz.

The BALFHB-WL-0xD3 IPDs combine antenna impedance-matching, balun, and harmonic-filter circuitry in a single compact chip. The IPDs connect the STM32WL MCU to its antenna while providing for the best possible RF performance.

By integrating all the components on one die, the BALFHB-WL-0xD3 IPDs ensure consistent performance, avoiding the process variations that affect conventional matching networks built with discrete components. They also simplify circuit design, reduce bill-of-materials cost, and save space, making them ideal for cost-sensitive and space-constrained IoT devices.

The STM32WL MCUs are ideal for smart, connected devices as they combine application-level processing and wireless communication in a single chip. They integrate an Arm<sup>®</sup> Cortex<sup>®</sup>-M4 MCU core with a sub-GHz long-range radio managed by a Cortex-M0+ core. The radio supports multiple modulation schemes, and comes with LoRaWAN<sup>®</sup> and Sigfox<sup>™</sup> stacks included in the STM32CubeWL software package.

The nine IPDs for the STM32WL MCUs are optimized for various frequencies, power outputs, MCU package types, and PCB configurations. Each integrates the complete receive and transmit signal paths between the MCU and antenna. A filter provides high attenuation of unwanted transmitter harmonics, helping designers to satisfy the requirements of regulations set by licensing authorities worldwide.

The IPDs are supplied in an 8-bump wafer-level chip-scale package with a footprint of 2.13 mm x 1.83 mm.



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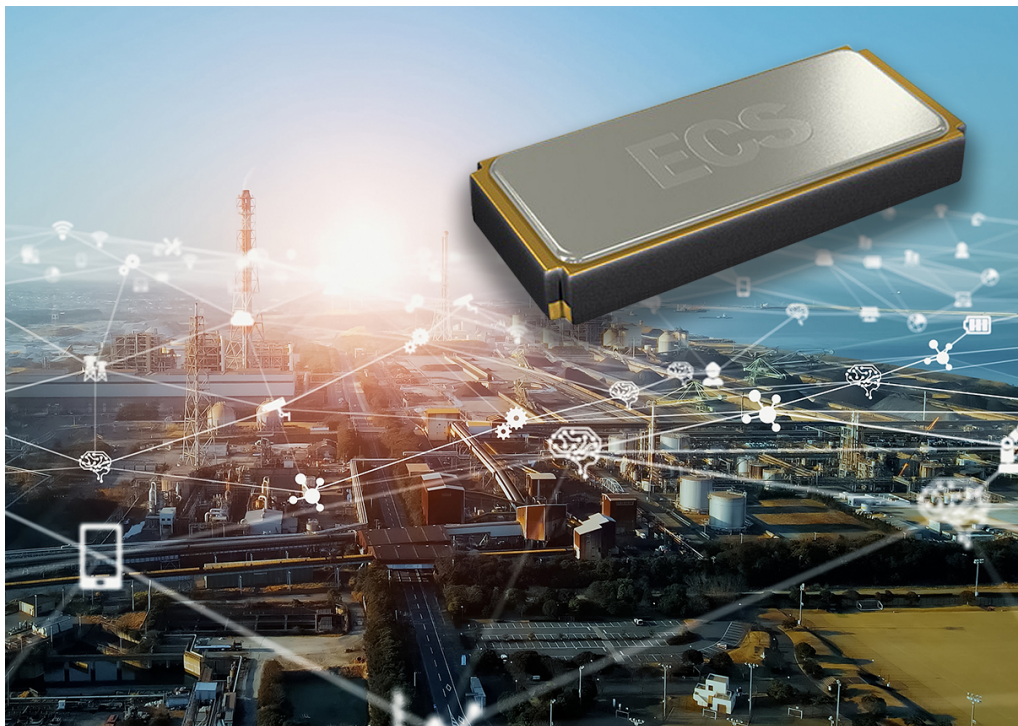
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TELECOMS

# Compact 32.768 kHz tuning fork crystal provides stable output

The surface-mount ECX-31B crystal from ECS Inc. is ideal for industrial applications, and offers various load capacitance options. These crystals are recommended for use in STMicroelectronics microcontroller and microprocessor reference designs.



## FEATURES

- -0.034 ppm/°C temperature coefficient
- 1.05 pF shunt capacitance
- ±3 ppm maximum aging in first year at 25°C

## APPLICATIONS

- Mobile devices
- Industrial equipment
- Automation equipment
- Wireless devices
- Real-time clocks
- Microprocessor circuits
- AI systems

The ECX-31B from ECS Inc. is a series of 32.768 kHz tuning fork crystals which provide a stable output over an industrial operating-temperature range of -40°C to 85°C.

All versions of the ECX-31B are supplied in an industry-standard, surface-mount 3.2 mm x 1.5 mm x 0.9 mm package with a two-pad footprint, offering an equivalent series resistance of 70 kΩ. As standard, these crystals are specified with ±20 ppm frequency tolerance. A ±10 ppm tolerance option is available.

Various part numbers in the ECX-31B series can be specified to choose load capacitance options of 6 pF, 7 pF, 9 pF or 12.5 pF.

STMicroelectronics recommends ECS timing solutions for use with its STM32 families of microcontrollers and microprocessors. Advice about integrating crystals into STM32-based designs may be found in the ST application note AN2867.

### Useful link

[STM32 crystal selection tool](#)



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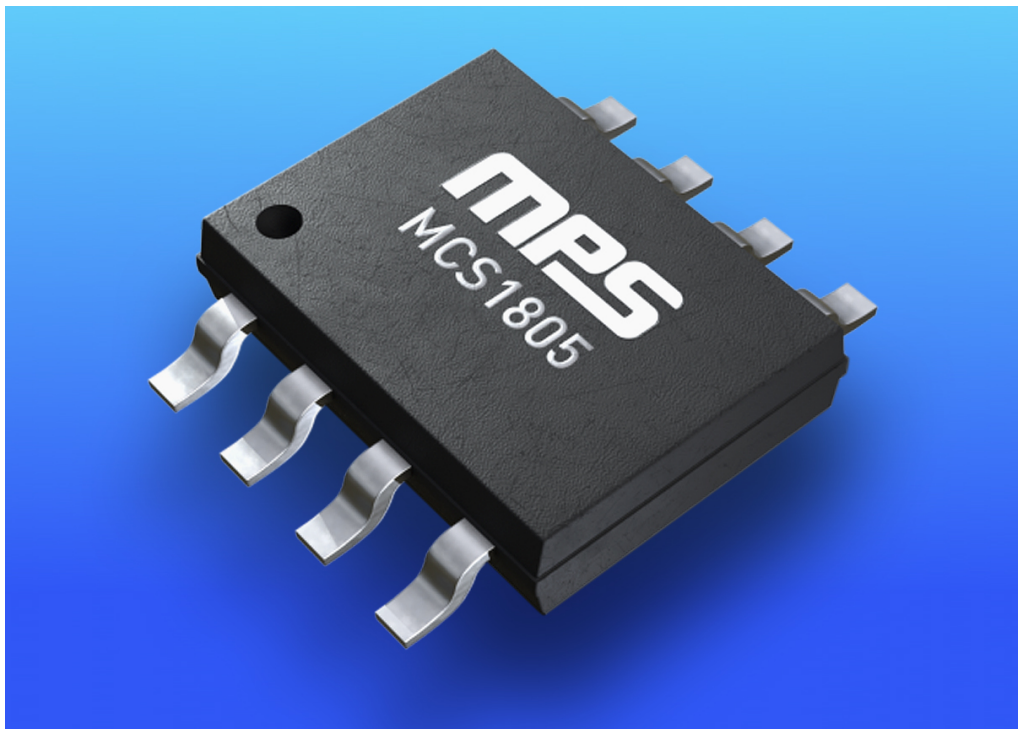


TELECOMS



# Isolated magnetic current sensor provides fast response to over-current events

The MCS1805 from Monolithic Power Systems is a space-saving option for current sensing in motors and power systems. Its SOIC-8 package has a small footprint, and the sensor requires few external components.



The MCS1805 from Monolithic Power Systems is a linear Hall-effect current sensor IC for ac or dc current sensing. The differential Hall array cancels out any stray magnetic field, making the sensor immune to magnetic interference.

The MCS1805 is intended for use in functions such as load detection and management, and over-current fault protection. The sensor integrates fast over-current detection, which makes it simple to monitor the system for events such as short-circuits.

Galvanic isolation between the pins of the primary conductive path and the sensor leads allows the MCS1805 to replace opto-isolators or other isolation devices. The MCS1805 requires few external components. The device is supplied in an SOIC-8 package which has a footprint of 5 mm x 4 mm.

The primary conductor's low resistance allows large currents to flow close to the IC. This current generates a magnetic field, which is sensed at two different points by the integrated Hall transducers. The magnetic field difference between these two points is then converted to a voltage that is proportional to the applied current. A spinning current technique is used for a low, stable offset.

**MPS**

## FEATURES

- Supply-voltage options: 3.3 V or 5 V
- 3 kVrms minimum isolation voltage
- 580 Vrms maximum working voltage
- $\pm 2.5\%$  total current-sensing accuracy
- Bidirectional or unidirectional range: 5 A to 50 A
- 120 kHz bandwidth
- 1  $\mu$ s over-current detection time
- Factory-trimmed for accuracy

## APPLICATIONS

- Motors
- Automotive systems
- Switch-mode power supplies



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