FTM

FUTURE TECHNOLOGY MAGAZINE

FUTURE ELECTRONICS

20-vii **EMEA**

LATEST
Lumileds: boost to IR LEDs' drive current lifts radiant power output
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The role of ESD protection in the all-IP car
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Ultra low-power MCUs give longer battery life in IoT sensor systems

RENESAS
BIG IDEAS FOR EVERY SPACE

Renesas has expanded its RE family of embedded controllers by adding new RE01 ultra low-power microcontrollers based on Renesas' breakthrough Silicon-On-Thin-Buried-oxide (SOTB™) process technology, and built around the Arm® Cortex®-M0+ processor core.

The new RE01 MCUs feature a Flash memory provision of 256kbytes. RE01 MCUs with 1.5Mbytes of Flash are already in mass production. Available in a WLBGA package as small as 3.16mm x 2.88mm, the new 256kbyte RE01 MCUs are intended for use in sensor control in compact IoT devices.

Independent testing verifies the low-power performance of the latest RE01 MCUs. Tested according to the parameters of the EEMBC® ULPMark™-CoreProfile benchmark, the 256kbyte RE01 MCU achieved a high score of 705.

Implementation of Renesas' proprietary SOTB process technology enables marked reductions in both active and standby current: in normal operation, current is as low as 25µA/MHz, and 400nA in standby mode. Operating current can be reduced even further, to 12µA/MHz, by using Renesas' ISL9123, which draws ultra-low quiescent current, as an external step-down regulator.

Despite the new MCUs' ultra-low power consumption, they are capable of high-speed operation in applications which require real-time data processing from multiple sensors, even when powered by small batteries or by energy-harvesting devices. The Cortex-M0+ core can run at a maximum operating frequency of 64MHz, and the device features an on-chip 14-bit ADC for digitizing sensor inputs at high speed and resolution.

Development tools compatible with the RE01 MCUs' evaluation kit include IAR Embedded Workbench® for Arm, which supports the IAR C/C++ compiler, and e2 studio, which supports the GNU compiler.

Driver software supporting Arm's Cortex Microcontroller Software Interface Standard (CMSIS) is available. Renesas also supplies low-level sample code for use in low-power applications which cannot permit the power loss caused by the operation of driver software.

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APPLICATIONS

- Smart home and smart building systems
- Environmental sensing
- Structure monitoring
- Trackers
- Wearable devices

FEATURES

- 128kbytes SRAM
- Operating-voltage range: 1.62V to 3.6V
- On-chip energy-harvesting control circuit
- 0.6mA current to program on-chip Flash memory
- Trusted Secure IP security core

FREE DEVELOPMENT BOARD

Part supported: 256kbyte R7F0E01182CFM in a 64-pin LFQFP package.

Orderable Part Number: RTK70E0118S00000BJ

Apply at: my-boardclub.com

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Precision op amp features ultra-low input-offset voltage and low noise

DIODES INCORPORATED

Diodes Incorporated has introduced its first precision operational amplifier, the dual-channel AS2333, which offers highly stable and linear outputs.

The AS2333 uses chopper stabilization to achieve an ultra-low input-offset voltage of 8µV. Near-zero drift over time and temperature, of just 0.02µV/°C, means that system designers can rely on the stability of sensor signals in applications requiring high precision and accuracy. The AS2333 is ideal for amplifying the small signals from sensors which measure parameters such as pressure, sound, light, temperature, voltage or current. Chopper stabilization also minimizes low-frequency 1/f noise and offset-voltage crossover distortion.

AS2333: Amplifies small sensor signals with low noise and low distortion

The op amp also features high-impedance inputs with a common-mode range 100mV beyond the supplies. Output swing is within 50mV of the rails. Features well suited to use in battery-operated applications include a typical quiescent current of 12µA, and support for supplies as low as 1.8V ±0.9V.

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APPLICATIONS

- Transducers
- Medical equipment
- Chemical detectors
- Handheld test instruments

FEATURES

- 120dB common mode rejection ratio
- 130dB open loop gain
- 350kHz bandwidth
- 12µA quiescent current per channel
- 0.12V/µs slew rate
- Operating-temperature range: -40°C to 125°C

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LDO combines low quiescent current with wide input-voltage range

ON Semiconductor®

The NCP730 from ON Semiconductor is a CMOS Low Dropout (LDO) voltage regulator which draws a very low quiescent current, helping to prolong run-times in battery-powered, always-on systems or IoT applications.

The LDO operates from a wide input-voltage range of 2.7V to 38V. There are various fixed output-voltage options. The NCP730 is also available with an adjustable output voltage in the range 1.2V to 24V.

The LDO is capable of supplying a maximum 150mA continuous output current, and 200mA peak current. It includes a built-in soft-start circuit and thermal shut-down protection.

The dropout voltage, rated at 290mV at 150mA and a 3.3V output, keeps conversion power loss to a minimum, while regulation is maintained at a consistently high level. Output-voltage accuracy is ±1% over an operating-temperature range of -40°C to 85°C.

Parts which include a Power Good (PG) circuit indicate that output voltage is in regulation. This signal may be used for power sequencing, or as a microcontroller reset.

The NCP730 integrates an innovative fast transient-response amplifier to limit under- and over-shoot, as well as short-circuit and over-temperature protection functions.

Part Number	Voltage Option	Version	Package
NCP730ASNADJT1G	Adjustable	Without power good	TSOP-5
NCP730ASN250T1G	2.5V		
NCP730ASN280T1G	2.8V		
NCP730ASN300T1G	3.0V		
NCP730ASN330T1G	3.3V		
NCP730ASN500T1G	5.0V		
NCP730BMTADJTBG	Adjustable	With power good	2mm x 2mm WDFN6
NCP730BMT250TBG	2.5V		
NCP730BMT280TBG	2.8V		
NCP730BMT300TBG	3.0V		
NCP730BMT330TBG	3.3V		
NCP730BMT500TBG	5.0V		
NCP730BMT1500TBG	15.0V		

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APPLICATIONS

- Battery-powered tools
- Home automation
- Metering
- Remote controlled devices
- White goods
- Combination arc-fault circuit breakers

FEATURES

- 1µA quiescent current
- 100nA shut-down current
- Stable with small 1µF ceramic capacitors
- Power-supply ripple rejection: 80dB at 10Hz and 70dB at 10kHz

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New dual DC-DC converters provide independently isolated asymmetrical outputs

CUI INC®

CUI Inc has introduced a family of isolated DC-DC converters which supply dual regulated outputs for rated loads up to 3W, 10W or 20W. Supplied in SIP or DIP packages, these converter modules operate from a wide input-voltage range of 18V to 75V DC.

CUI DC-DC converters: Wide 18V to 75V input range

The **PRQ3W-S series** supplies up to 3W of continuous power. Operating over a wide temperature range of -40°C to 85°C and supplied in a SIP package, these low-power DC-DC converters provide a rugged solution for sensitive power systems.

The **PQD10W-D series** supplies up to 10W of continuous power. Housed in an industry-standard 1" x 1" DIP package, the PQD10W-D modules also operate over a temperature range of -40°C to 85°C. These DC-DC converters are suitable for convection-cooled equipment and industrial power circuits.

The **PQF20W-D series** supplies up to 20W of continuous power. Featuring an extended -40°C to 105°C operating-temperature range, these modules are housed in 2" x 1" DIP package.

The PRQ3W-S, PQD10W-D and PQF20W-D all offer asymmetrical outputs. These independently isolated outputs make the converters ideal for space-constrained applications which supply two loads, such as motor-control circuits, distributed power supplies and hybrid module systems.

CUI also supplies the **PRF30W-D series**, which provides up to 30W of continuous power.

ENERGY INDUSTRIAL LIGHTING MEDICAL TRANSPORT SECURITY CONSUMER TELECOMS

APPLICATIONS

- Motor-control circuits
- Distributed power supplies
- Hybrid module systems
- Medical equipment
- Telecoms and network equipment
- Remote control systems

FEATURES

- Dual output-voltage options:
  - 5V/5V
  - 5V/12V
  - 5V/24V
- 3kV DC isolation
- Protection functions:
  - Short-circuit
  - Over-current
  - Input under-voltage
- UL/EN/IEC 62368 certified

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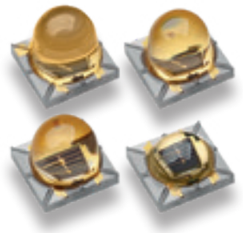
Boost in radiant power of domed IR LEDs to improve performance of motion-tracking and surveillance cameras

IR INFRARED

LUMILEDS

Lumileds has introduced additions to its LUXEON IR Domed Line of infrared LED emitters, offering a marked increase in DC drive-current capability up to 1.5A, and pulse current up to 5.0A.



These higher drive currents produce increased maximum radiant power output of 1,350mW at the slightly visible 850nm wavelength, or 1,450mW at 940nm for invisible or covert IR emission.

The higher power capability of these new IR LEDs enables clearer 3D imaging with fewer LEDs in multi-emitter applications, such as the 3D scanning or time-of-flight systems used for face recognition.

The higher optical power output of the new LUXEON IR Domed Line of LEDs is particularly useful in the latest generation of small, high-resolution surveillance cameras, which have smaller lens apertures, and smaller pixels in the image sensor. These systems need more light to function properly.

The new LUXEON IR Domed Line parts may be used as drop-in replacements for lower-power IR LEDs in existing designs, as they have a standard 3.7mm x 3.7mm footprint.

The new LUXEON IR Domed Line emitters also now include a narrow-beam 50° LED, complementing the existing 60°, 90°and 150° emitters. The range of optical outputs provided by the LUXEON IR Domed Line gives IR camera designers the ability to optimize for high punch, long range or wide scanning.

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APPLICATIONS

- Biometric identification
- Virtual reality and augmented reality headsets
- Machine vision
- Surveillance cameras
- Security and access-control equipment
- User interface controls

FEATURES

- Forward voltage:
  - 3.2V for 850nm emitters
  - 2.9V for 940nm emitters
- Full-width half-maximum spectrum
  - 35nm for 850nm emitters
  - 50nm for 940nm emitters
- 2.5W/°C thermal resistance
- 145°C maximum junction temperature

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Miniature IR emitters offer high optical power density

The LUXEON IR Compact Line is a series of high-power, efficient infrared emitters which are suitable for mounting in small spaces.

The LEDs' compact and well-defined light-source geometry allows them to be easily coupled into secondary optics for tight beam control. The package has a footprint of 1.9mm x 1.37mm and a two-pad configuration, providing high power density and supporting a new generation of miniaturized designs.

Featuring best-in-class thermal conductivity, the LUXEON IR Compact Line LEDs maintain excellent performance in real-world operating conditions.

Features:

- Available in 850nm and 940nm wavelengths
- Radiant power output:
  - 1,050mW for 850nm emitter
  - 1,150mW for 940nm emitter
- 2.8°C/W thermal resistance

Applications:

- Surveillance/CCTV cameras
- Machine vision
- 3D scanning
- Time-of-flight sensing systems
- Biometric identification
- User interface control
- Augmented and virtual reality

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Broadband IR emitter ideal for spectroscopy and hyperspectral imaging

The LUXEON IR ONYX LED module from Lumileds provides continuous broadband infrared emission over a spectral bandwidth of 650nm to 1,100nm. Offering superior light-output characteristics, the product comes in an industry-standard 2720 package and footprint for easy integration in existing designs.

The LUXEON IR ONYX, which has the orderable part number L1IG-0750100000000, gives new scope to equipment manufacturers to miniaturize spectroscopy and hyperspectral imaging applications in handheld devices for mobile, industrial, and medical applications.

Features:

- Minimum radiant power output:
  - 40mW over 600nm to 1,050nm spectrum
  - >80µW/nm over 750nm to 1,000nm spectrum
- Robust, long-life phosphors
- Flat spectrum allows for ease of calibration

Applications:

- Spectroscopy
- Machine vision
- Healthcare equipment
- Hyperspectral imaging

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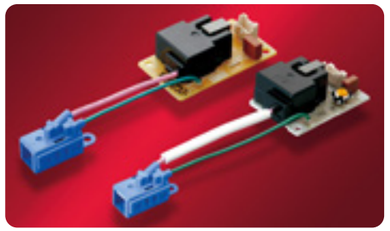
Ionizer and ozonizer modules offer higher ion output and better control of ozone output in air-cleaning equipment

muRata INNOVATOR IN ELECTRONICS

The Ionissimo® family of modules produced by Murata uses high-voltage discharges to ionize or ozonize air molecules. They are widely used in air purification, bacteria removal, deodorization, static charge elimination and electrostatic charging.



Ionissimo: Module comprised of ion generator and power supply

Medical research indicates that ionizers and ozonizers may also be able to play a part in new forms of air-cleaning equipment intended to destroy particles of the SARS-CoV-2 virus in indoor air.

Murata's compact Ionissimo modules are capable of generating a large number of ions, and concurrently producing ozone. Without affecting ionization, the quantity of ozone generated can be controlled to the optimum level for a specific application, such as disinfection of air.

Benefiting from unique high-voltage technology and an innovative structural ion element design, these ionizers are smaller and more efficient than conventional ionizers. An Ionissimo module comprises an ion generator connected to a dedicated power supply, providing a complete system which is easy to integrate into end product designs.

Murata also supplies the **MHM500 series of ozonizers** for humidifier applications. The MHM500's ozone generator section is highly reliable: it includes an internal heater to keep the surface of its substrate dry. It is also one of the smallest creeping-discharge types in the industry.

IONISSIMO FEATURES

Specifications	MHM305	MHM306	MHM314	MHM400	MHM402	MHM501	MHM502
Input Voltage	10.8V to 13.2V DC	10.8V to 13.2V DC	10.8V to 13.2V DC	10.8V to 13.2V DC	10.8V to 13.2V DC	10.8V to 13.2V DC	11.0V to 13.2V DC
Generated Ions	Negative ion	Negative ion	Negative ion	Negative ion	Positive ion	–	–
Power Consumption	0.4W	0.6W	0.6W	0.6W	0.6W	0.9W	1.0W
Ion Output	>20 million ions/cc	>20 million ions/cc	>60 million pcs/cc	>60 million pcs/cc	>20 million pcs/cc	–	–
Ozone Output	≤0.04mg/H	<0.6mg/H	≤0.1mg/H	≤0.1mg/H	≤0.1mg/H	≤2.5mg/H	≤50mg/H
Operating Temperature Range	-10°C to 50°C	-10°C to 50°C	-10°C to 50°C	-10°C to 50°C	-10°C to 50°C	-10°C to 50°C	-10°C to 50°C
Operating Relative Humidity Range	20% to 80% (without dew)	20% to 80% (without dew)	20% to 80% (without dew)	20% to 80% (without dew)	20% to 80% (without dew)	20% to 95% (without dew)	20% to 95% (without dew)

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APPLICATIONS

- Medical equipment
- Air-conditioning units
- Air purifiers
- Refrigerators
- Washing machines
- Dishwashers

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Development kit supports rapid prototyping with the PolarFire SoC FPGA

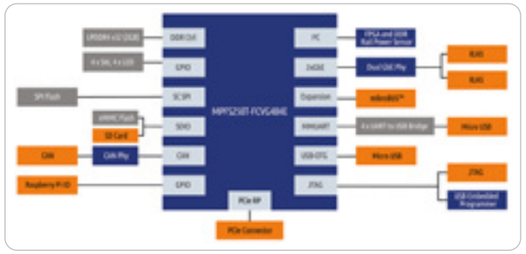
Microchip has introduced a development kit which provides a rich application environment for evaluation of the features of its PolarFire® SoC FPGA.

The Icicle kit, which has the orderable part number MPFS-ICICLE-KIT-ES, enables evaluation of the PolarFire SoC FPGA's five-core RISC-V microprocessor sub-system, innovative Linux® operating environment, real-time, low-power capabilities and its rich set of peripherals. These sophisticated features make the PolarFire SoC ideally suited to secure, reliable and power-efficient computing functions across a wide range of applications, including imaging and vision functions which use artificial intelligence.

The Icicle main board includes LPDDR4 DRAM, SPI Flash non-volatile memory and eMMC storage to enable the PolarFire FPGA to run the Linux operating system off-the-shelf. The kit is also supplied with a multi-rail power sensor to monitor multiple power domains. A PCIe root port and Raspberry Pi and mikroBUS expansion ports, alongside a number of wired connectivity options, support quick system prototyping using a wide choice of peripheral function boards.

The PolarFire SoC Icicle kit is supplied with:

- MPFS250T-FCVG484EES PolarFire SoC
- USB cable
- QuickStart card
- 12V/5A AC power adapter and cord
- Ethernet cable



Microchip's MPFS-ICICLE-KIT-ES: Multiple interfaces to expansion boards and serial data connections

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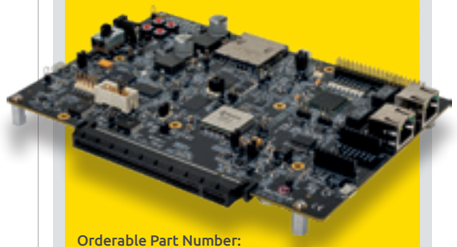
APPLICATIONS

- Imaging
- Artificial intelligence and machine learning
- Industrial automation
- IoT devices
- Wireline access networks
- Aerospace
- Defense equipment
- Automotive systems

FEATURES

- Secure boot
- 4 x 12.7Gbits/s SERDES interfaces
- PCIe interface
- USB 2.0 interface
- UART/SPI/I²C interface
- CAN interface
- Power sensor

FREE DEVELOPMENT BOARD



Orderable Part Number: MPFS-ICICLE-KIT-ES

Apply at: my-boardclub.com

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PolarFire SoC: the low-power, high-security, multi-core FPGA

The PolarFire® SoC FPGA family offers a combination of low power consumption, thermal efficiency and defense-grade security for smart, connected systems. It is the first system-on-chip FPGA to feature a deterministic, coherent RISC-V CPU cluster and a deterministic L2 memory sub-system, enabling the execution of real-time functions on a Linux® operating platform.

Built on the mid-range, low-power PolarFire FPGA architecture, the PolarFire SoC devices can consume 50% less power than alternative FPGAs. They are available in versions featuring between 25,000 and 460,000 logic elements and include 12.7Gbits/s transceivers.

Security features in the PolarFire SoC FPGA include:

- Secure hardware
  - Secure wafer sort and packaging
  - Spectre- and Meltdown-immune CPUs
- Design security
  - DPA-resistant bitstream programming
  - Anti-tamper
  - DPA-resistant secure boot
- Data security
  - CRI DPA countermeasures pass-through license
  - DPA-resistant cryptography co-processor
- RISC-V Physical Memory Protection (PMP)

High-speed comparators handle wide input-voltage range

ON Semiconductor®

The NCS2250 and NCS2252 from ON Semiconductor are low-voltage comparators suitable for use in complex applications that require a fast response time and flexible implementation. They may be used to implement functions such as logic-level shifting and translation, clock and data signal restoration, and the voltage-level trigger in power converters.

The NCS2250 and NCS2252 families achieve fast response for operation in high-speed sampling circuits thanks to their short propagation delay of just 50ns with 100mV overdrive.

Featuring an extended common-mode input-voltage range, the comparators handle input signals 200mV above and below the rails, supporting voltage detection at ground or on the supply rail. The low quiescent supply current, just 150µA with a 5V supply, makes these devices suitable for use in battery-powered systems.

The NCS2250 parts provide a complementary push-pull output, and the NCS2252 parts an open drain output. The comparators are available in pin-compatible SC70-5 or SOT23-5 packages.

NCS2250: Complementary push-pull output

Part Number	Output Type	AEC-Q100 Qualified	Package
NCS2250SQ2T2G	Complementary	No	SC70-5
NCS2250SN2T1G	Complementary	No	SOT23-5
NCS2252SQ2T2G	Open drain	No	SC70-5
NCS2252SN2T1G	Open drain	No	SOT23-5
NCV2250SQ2T2G	Complementary	Yes	SC70-5
NCV2250SN2T1G	Complementary	Yes	SOT23-5

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APPLICATIONS

- Automotive lighting
- Industrial lighting
- Mobile phones
- Power supplies
- Portable and battery-powered systems

FEATURES

- 88dB power-supply rejection ratio
- 81dB common-mode rejection ratio
- 6mV maximum input-offset voltage
- 3.8pF input capacitance
- Supply-voltage range: 1.8V to 5.5V
- Operating-temperature range: -40°C to 125°C

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Buck-boost DC-DC converter features ultra-low quiescent current for use in wireless devices

RENESAS
BIG IDEAS FOR EVERY SPACE

Renesas has introduced the ISL9122, a family of flexible buck-boost switching regulators which draws ultra-low quiescent current. This makes them ideal for use in powering sensors, microcontrollers, wireless devices and other system components which normally operate intermittently, with long periods in standby mode.

Quiescent current is rated at <1.3µA. In shut-down mode, the ISL9122 draws just 7nA. Operating over an input-voltage range of 1.8V to 5.5V, the ISL9122 is suitable for use in systems powered by coin cells, lithium-ion rechargeable batteries or multiple alkaline primary batteries in series.

The ISL9122 regulator implements dynamic voltage scaling in I²C-programmable 25mV steps to optimize system power consumption. In addition, its ability to boost output power up to 5.375V maximizes the RF transmission capabilities of IoT devices across their battery range.

Switching frequency control is implemented by either pulse-frequency or Pulse-Width Modulation (PWM), depending on the load. In forced PWM mode, the regulator always switches at 2.5MHz, which improves the system's EMI performance.

Like the ISL9123 buck regulator, the new ISL9122 is ideal for powering the Renesas RL78 family of 8-/16-bit ultra low-energy MCUs, the RA family of 32-bit MCUs with Arm® Cortex®-M cores, or the RE family of embedded controllers for wearable devices and energy-harvesting applications.

ISL9122: Dynamic voltage scaling adapts power usage to application conditions

ENERGY INDUSTRIAL LIGHTING MEDICAL TRANSPORT SECURITY CONSUMER TELECOMS

APPLICATIONS

- Wireless earbuds
- Fitness bands
- Smart watches
- Water or gas meters
- Portable medical devices
- Battery-operated smart IoT devices

FEATURES

- High efficiency:
  - 84% at light load of 10µA
  - 97% peak efficiency at full load
- Automatic and selectable forced bypass power-saving mode
- Adjustable output-voltage range: 1.8V to 5.375V in 25mV increments
- 500mA maximum output current
- Only requires three external components: one inductor, and input and output capacitors
- Protection functions:
  - Over-current
  - Short-circuit
  - Over-temperature

FREE DEVELOPMENT BOARD
Orderable Part Number: ISL9122AIIN-EVZ
Apply at: my-boardclub.com

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80V MOSFET offers energy savings in power-converter applications

VISHAY

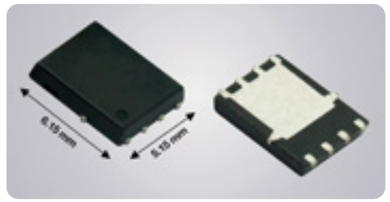
Vishay Intertechnology's SiR680ADP 80V TrenchFET® fourth-generation N-channel power MOSFET offers an outstanding combination of low gate charge and low on-resistance, enabling power-system developers to realize energy savings in new switching power-converter designs.

The SiR680ADP's on-resistance is as little as 2.35mΩ at 10V. Gate charge is 55nC, and output capacitance is just 614pF. These specifications are fine-tuned to reduce the power losses from switching, channel conduction and diode conduction, resulting in increased efficiency in power-conversion systems.

The MOSFET's product of on-resistance and gate charge, which is a key figure of merit for MOSFETs used in power-conversion applications, is a best-in-class 129 (mΩ x nC). This is 12.2% lower than the closest competing product, and 22.5% lower than Vishay's third-generation TrenchFET device. It is well suited to use in DC-DC converters which step a 48V input down to a 12V output.

The SiR680ADP provides a highly efficient building block in DC-DC and AC-DC conversion functions such as synchronous rectification, primary-side switching, buck-boost converters, resonant tank-switching converters, and the ORing function in power supplies.

The SiR680ADP is supplied in a 6.15mm x 5.15mm PowerPAK® SO-8 package.



SiR680ADP MOSFET: Ideal for step-down converters with 12V output

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APPLICATIONS

- Power supplies
- Motor drives
- Battery and load switches
- Telecoms equipment
- Servers
- Solar micro-inverters
- Power tools
- Industrial equipment
- Energy harvesting

FEATURES

- 100A maximum drain current at a case temperature of 70°C
- 3.5V maximum gate-source threshold voltage
- 100nA maximum gate-source leakage current
- 0.9°C/W junction-to-case thermal resistance
- Junction-temperature range: -55°C to 150°C

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Solid-state relays save space and weight in healthcare devices

Modern medical and healthcare devices, such as endoscopes, blood pressure gauges and ultrasonic diagnostic equipment, are required to be as light and portable as possible. Medical equipment designers are therefore looking for components in miniature packages which enable them to save board space, without compromising their performance, quality or reliability.

In the domain of relays, Panasonic Industry's miniature, long-life PhotoMOS® relays are an ideal choice for medical equipment. Solid-state relays with a MOSFET output, the PhotoMOS products are notable for their low off-state leakage current and stable on-resistance over their lifetime.

The compact **AQY210S** and **AQY280** PhotoMOS relays are ideal components for signal control and sensor input transmission in next-generation blood pressure gauges thanks to the provision of an unlimited number of contact operations and reliable, non-aging contact resistance value. These models are also suitable for I/O signal switching in diagnostic endoscope systems.

For signal control and the scanner circuit inside ultrasonic devices, the **AQY22xRx** are the preferred PhotoMOS parts, as they support a continuously high operating speed and high-frequency signal switching, and are supplied in a compact housing. X-ray and CT scanners will also benefit from these relays' low capacitance x resistance values and high optical isolation between input and output, providing for safe switching.

PhotoMOS relays: Low leakage current and reliable operation

High accuracy and reliability and compact designs make the PhotoMOS family of relays an appropriate choice not only for complex, stationary diagnostic equipment, but also for next-generation mobile assets in modern healthcare settings.

ENERGY INDUSTRIAL LIGHTING MEDICAL TRANSPORT SECURITY CONSUMER TELECOMS

APPLICATIONS

- Medical diagnostic equipment
- Portable healthcare devices

FEATURES

- Low offset voltage
- Low leakage current
- 1.5kV AC I/O isolation voltage for AQY210S
- Operating-temperature range: -40°C to 85°C

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REFERENCE NUMBER 20-vii 15

Integrated dual-output regulator operates from universal mains input

ON Semiconductor®

The NCP10970 from ON Semiconductor combines a switching buck converter, a Low Drop-out (LDO) linear regulator and a comparator in a single chip to provide dual outputs of 16V and 3.3V or 5.0V from a universal mains input.

The switching regulator stage, which includes a 670V-rated MOSFET, steps the mains input down to a 16V output, adjustable by a resistor divider on the Feedback pin.

This output is protected against short-circuits. Internal circuitry which prevents the converter from operating in continuous conduction mode improves the circuit's resistance to current surges, improves efficiency and reduces EMI.

The integrated linear regulator provides either a 3.3V or 5.0V low-noise output, depending on which option is chosen. Operating from a raw 16V DC voltage supplied by the high-voltage switching regulator, high efficiency is maintained while drawing low quiescent current.

In no- or light-load conditions, the NCP10970 goes into skip-cycle mode for low standby power consumption.

NCP10970: Low standby current for use in battery-powered devices

ENERGY INDUSTRIAL LIGHTING MEDICAL TRANSPORT SECURITY CONSUMER TELECOMS

APPLICATIONS

- Smart lighting
- White goods
- IoT devices
- Metering

FEATURES

- Input-voltage range: 30V to 440V AC
- High-voltage start-up current source
- Fixed-frequency discontinuous current-mode control scheme
- Demagnetization detection
- 4ms soft-start
- Thermal shut-down protection

FREE DEVELOPMENT BOARD

The NCP10970AGEVB is a high-efficiency, non-isolated buck converter circuit which complies with the CoC5 Tier 2 specifications and has low EMI emissions.

Orderable Part Number: NCP10970AGEVB

Apply at: my-boardclub.com

FOR PRICING AND SAMPLES E-MAIL: INFO@MY-FTM.COM

REFERENCE NUMBER 20-vii 16

Extended choice of medical-qualified sounders includes new 100dB loudspeaker

MALLORY

Mallory Sound Products has extended its line of IEC 60601-1-8 qualified medical sounders, introducing new, louder alarms, and compact transducers which offer power savings in battery-powered and portable medical equipment.

Mallory's medical alarms are recognized by UL and CUL for compliance with all the requirements of the IEC60601-1-8 standard.

They may easily be integrated into medical electronic system designs.

For medical applications requiring a high sound level such as in operating theaters, Mallory's 45mm-diameter SBS series speaker models are ideal: they produce 100dB at a distance of 0.1m from the speaker, and operate from a voltage between 9V and 12V. They are available with or without circuitry.

Mallory's 45mm-diameter SBT series power-saving transducer models are suitable for battery-powered applications. They are also available with or without circuitry.

Mallory has added over 150 new part numbers to the miniature 23mm MSS series. The MSS series includes sounders which can produce three tones.

Mallory medical sounders: Choice of tones and standard alarms

ENERGY INDUSTRIAL LIGHTING MEDICAL TRANSPORT SECURITY CONSUMER TELECOMS

APPLICATIONS

- Medical equipment

FEATURES

- MSS5G: three priority sounds, low, medium and high
- MSS5GLHCT: three different sounds, low and high with a continuous tone option
- MSS5GLMCT: three different sounds, low and medium with a continuous tone option
- MSS5GMHCT: three different sounds, medium and high with a continuous tone option
- MSS5GL: one tone type, low priority
- MSS5GM: one tone type, medium priority
- MSS5GH: one tone type, high priority

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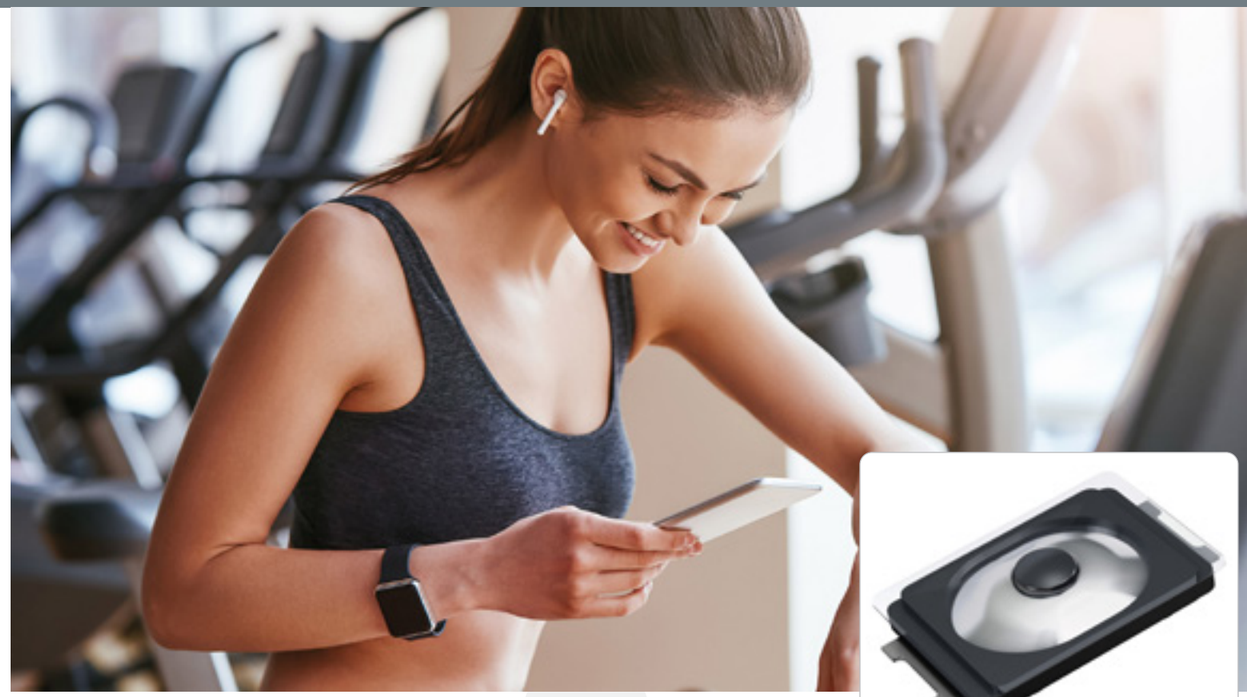
REFERENCE NUMBER 20-vii 17



EVPAW series: Laser-welded nylon overlay

IP67-rated tactile switches for reliable smart wearable devices

Panasonic INDUSTRY

Panasonic Industry supplies a series of Light Touch switches for wearable and personal electronic devices which can maintain high operating performance over a long lifetime in the presence of sweat, condensation and other sources of moisture and contamination. The IP67-rated EVPAW series switches are therefore ideal for use in smart watches, wireless earphones and other devices which are worn for long periods of time and in harsh operating conditions.

An electro-mechanical switch, the EVPAW gives direct tactile feedback to the user, and can withstand abusive operating events such as accidental knocks and bumps, as well as exposure to sweat.

Many wearable devices, whether in the user's hands, on their feet or on their heads, are exposed to sweat, which contains salt. When wearing a Bluetooth® wireless headset, for instance, during a workout at the gym, sweat will drip down the cable into the mechanism which operates the volume control and the microphone. If this mechanism is not waterproof as specified by an IP67 rating, sweat will get into the switch.

When dry, the salt from the sweat remains inside the device and can cause the switch to malfunction. The same applies to water, damp, moisture and dust penetration. To withstand these harsh operating conditions, the housing of the switch requires an IP67 protection rating.

To make the EVPAW switches, Panasonic Industry uses a patented laser-welding process in which the switch is sealed with a thin nylon layer applied over the switch actuator. Superior to adhesively bonded and short-lived silicone membranes, the EVPAW's nylon sealing safeguards the haptics of the switch and protects it from developing any sign of wear.

Part Number	Operating Force	Minimum Lifetime
EVPAWBD4A	1.6N	500,000 cycles
EVPAWCD4A	2.4N	500,000 cycles
EVPAWED4A	3.3N	300,000 cycles

ENERGY INDUSTRIAL LIGHTING MEDICAL TRANSPORT SECURITY CONSUMER TELECOMS

APPLICATIONS

- Mobile phones
- Portable audio players
- Wearable devices
- Portable electronic devices

FEATURES

- External dimensions: 3.0mm × 2.0mm, height 0.6mm
- Push-plate actuator
- 10ms maximum bounce time
- 500mΩ maximum contact resistance
- Operating-temperature range: -40°C to 85°C

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REFERENCE NUMBER 20-vii 18

INTERCONNECT • PASSIVE • ELECTROMECHANICAL COMPONENT FOCUS FUTURE ELECTRONICS

Floating connectors cut risk of mounting failure caused by misalignment

HIROSE ELECTRIC EUROPE B.V.

Hirose's FX22 series of floating connectors can absorb mounting misalignment in applications involving the use of multiple connectors.

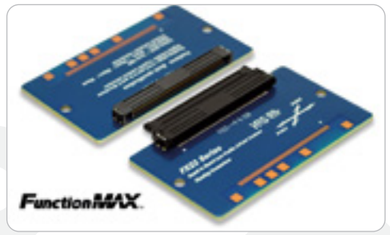
The header has a unique floating structure embedded inside the housing. This provides an alignment adjustment in the x and z dimensions of ±0.6mm, absorbing misalignments and reducing the risk of mounting failure.

Large mating guides on each side of the connector also allow for an alignment movement of ±1.2mm in the x and z dimensions to simplify the mating operation and to prevent incorrect insertion.

The connector range consists of low-profile headers and receptacles which form a co-planar board-to-board connection.

The receptacle features double beam contacts. Each beam has a different contact force to give dissimilar vibration characteristics and different resonant frequencies. This minimizes the risk of damage caused by movement between the contacts, and gives high resistance to vibration. The first beam contact also has a self-cleaning function which eliminates dust from the contact path of the second beam contact to increase contact reliability.

Because of the floating function of the FX22 connectors, the high-speed FX18 series board-to-board connectors can be combined with them on the same board. In addition, the FX20 series can be added to provide a vertical or parallel connection.



FX22: Self-cleaning function on contacts

The FX22 series is part of the FunctionMAX product family of board-to-board connectors designed to meet the requirements of the industrial market with maximum functionality.

ENERGY INDUSTRIAL LIGHTING MEDICAL TRANSPORT SECURITY CONSUMER TELECOMS

APPLICATIONS

- Industrial equipment
- Broadcast equipment
- Smart meters
- Medical devices
- Base transmitter stations
- Measurement instruments
- Projectors

FEATURES

- 0.5mm contact pitch
- 0.7A rated current
- 50V AC rated voltage
- Number of contacts: 40, 50, 60 or 80
- 50 mating cycles
- Operating-temperature range: -55°C to 85°C

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Proximity and ambient light sensor offers design flexibility in gesture applications

VISHAY

Vishay Intertechnology's VCNL4035X01 is an automotive-grade proximity and ambient light sensor which gives designers a flexible way to implement 2D or 3D gesture-recognition functions.

VCNL4035X01: Resists interference from background light sources

Featuring Filtron™ technology, the VCNL4035X01 combines photo-detectors for proximity and ambient light, a signal-conditioning IC, a 16-bit ADC and a driver for up to three external IR emitters in a 4.0mm x 2.4mm x 0.8mm surface-mount package.

The sensor can be used to enable various functions:

- Gesture recognition
- Presence detection
- Collision avoidance in toys and robots

The support for external IR emitters for gesture applications gives the designer flexibility to locate the emitters in the optimal position, in contrast to fully integrated gesture-sensing modules, in which the emitters are located next to the sensor.

The device includes a programmable interrupt function, which allows both high and low thresholds to be set to reduce overall power consumption. The function can be programmed to trigger both the ambient light and proximity sensor.

The sensor's Filtron technology provides spectral sensitivity similar to that of the human eye, while offering excellent cancellation of interference from background light sources. The device's high sensitivity means that the sensor can detect objects as far as 500mm away. This range depends on the choice of external IR emitter.

The VCNL4035X01's ambient light photodiode has a detection range of 0.004lux to 4.2klux, which means that it can operate in applications with a dark or a transparent lens.

The proximity sensor uses intelligent cancellation to eliminate cross-talk, while a smart persistence scheme ensures fast response time when an object is detected.

ENERGY INDUSTRIAL LIGHTING MEDICAL TRANSPORT SECURITY CONSUMER TELECOMS

APPLICATIONS

- Consumer electronics
- Display activation
- Lighting controls
- Industrial equipment

FEATURES

- Immune to fluorescent light flicker
- Excellent temperature compensation from -40°C to 105°C
- Supply-voltage range: 2.5V to 3.6V
- AEC-Q101 qualified
- I²C interface

FREE DEVELOPMENT BOARD
Orderable Part Number: VCNL4035X01-GES-SB
Apply at: my-boardclub.com

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M8/M12 cable assemblies provide robust performance in Fieldbus networks

TE connectivity

TE Connectivity (TE) has introduced M8/M12 cable-assembly solutions for Fieldbus data communications, complementing its sensor/actuator cable assemblies for industrial networks.

The new A- and B-coded M8/M12 cable assemblies conform to the specifications of the Profibus, DeviceNet and CC-link protocols, offering multiple options for a variety of needs. They feature 360° shielding against EMI for complete protection of signal and data transmissions, and are rated IP67 for resistance to dust and water.

The assemblies are overmolded in either PVC or halogen-free polyurethane cables, suitable for drag chain applications or torsional stress, depending on the requirements of the application. They come in standard cable-length options from 0.5m to 15m.

Assemblies can be produced in many customer-specific plug-and-play configurations to provide design flexibility and enable quick installation in most industrial environments.

Fieldbus is the most widely used network technology in industrial automation and process control: it accounts for 42% of the industrial network market, and continues to grow at around 6% per year. Most of the growth is from installations of Profibus technology.

Particularly useful in applications around the base of the automation pyramid, Fieldbus is a critical element of the Industrial Internet of Things, for devices which do not require large bandwidth but which benefit from having power and signals in the same cable.

ENERGY INDUSTRIAL LIGHTING MEDICAL TRANSPORT SECURITY CONSUMER TELECOMS

APPLICATIONS

- Industrial communications
- Industrial machinery
- Industrial automation
- Machine tools
- Robotics
- Material handling
- Process control systems

FEATURES

- Rated for 100 mating cycles
- Voltage and current ratings:
  - 250V/4A for 2- and 4-pole assemblies
  - 60V/4A for 5-pole assemblies
- Cable length options: 0.5m, 1m, 2m, 4m, 6m, 8m, 10m, 15m

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New M12 industrial Ethernet cable assemblies

TE has extended its line of industrial Ethernet cable assemblies to include M12 assemblies as well as its existing M8 Ethernet cabling. The TE assemblies are compatible with the Profinet, EtherCAT®, Ethernet/IP & SERCOS-III industrial Ethernet protocols.

In the TE range are Ethernet assemblies which can withstand up to 1 million flexes, or which resist machine oils, abrasion and UV radiation. A compact full-metal housing with crimp flange/crimp sleeve provides 360° shielding against EMI.

The hexagonal crimp of the sleeve gives a vibration-resistant and torsion-proof cable strain relief, in accordance with IEC 61373, Category 1, Class B, as well as safe shield termination.

- 100Mbits/s maximum data-transfer rate
- Cable length options from 0.5m to 30m

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M8/M12 cable assemblies for sensors and actuators used in harsh environments

TE offers M8/M12 cable assemblies for applications such as sensors, robotics and production equipment, to be used in extreme temperatures and harsh environments.

The TE cable assemblies can be installed quickly, helping to reduce downtime and maintain continuous operation in critical areas.

The M8/M12 sensor cable assemblies have a protection rating of IP67, which means they are dustproof, and waterproof to a depth of 1m. They also protect against EMI, chemicals and mechanical stress.

Designers can choose between single- and double-ended cable assemblies, including M8/M12 versions. M12 configurations are available with two, three, four, five or eight poles, while M8 configurations have three or four poles.

Options include straight or angled connectors and shielded and non-shielded variants.

ENERGY INDUSTRIAL LIGHTING MEDICAL TRANSPORT SECURITY CONSUMER TELECOMS

APPLICATIONS

- Industrial communications
- Machinery
- Automation
- Machine tools
- Process control systems
- Vision systems
- Factory equipment

FEATURES

- Standard cable lengths: 0.5m, 1m, 1.5m, 3m, 5m, 7m and 10m
- Compatible with TE's male/female connectors and I/O modules

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DESIGN NOTE FUTURE ELECTRONICS

Silicon Germanium (SiGe) rectifiers offer superior efficiency and thermal stability

nexperia

Silicon Germanium (SiGe) rectifiers combine the efficiency of silicon Schottky rectifiers with the thermal stability of Fast Recovery rectifiers, enabling engineers to optimize 100V to 200V power designs for high efficiency.

SiGe rectifiers now available from Nexperia are intended for use in applications in vehicles, servers and communications infrastructure. By offering an extended safe-operating area with no thermal runaway at up to 175°C, these AEC-Q101 qualified SiGe rectifiers are particularly suitable for use in applications exposed to high ambient temperatures.

When designing rectifier circuits in the 100V to 200V range previously, engineers had to compromise between efficiency and operating temperature. While Schottky rectifiers offer very high efficiency, they suffer from thermal runaway above a certain temperature threshold. This means that use is limited in power circuits in automotive Electronic Control Units (ECUs) or fuel-injection systems for example, which routinely operate in temperatures above 150°C.

The alternative is to use a Fast Recovery rectifier. These are very thermally stable, but they have a very high forward voltage, and this compromises efficiency.

SiGe and the ideal rectifier performance

The characteristics of SiGe technology include a smaller bandgap, a faster switching frequency and higher intrinsic charge-carrier density than silicon. These features confer an advantage in high-frequency switching behavior: this is why SiGe devices are employed in radio-frequency transistors. Before now, SiGe diodes have only been discussed theoretically in academic literature, and not available for practical implementation.

Nexperia has been developing SiGe rectifier technology in recent years, and already has several patents for the process which address the apparently conflicting demands for high efficiency and high-temperature operation.

Figure 1 shows a simplified diagram of the internal structure of Nexperia's new SiGe rectifiers. To enhance performance, the rectifiers are housed in two-pin Clip-bonded FlatPower (CFP) packages (CFP3 and CFP5), which offer excellent thermal dissipation. This package design is pin-compatible with that of Schottky and Fast Recovery rectifiers.

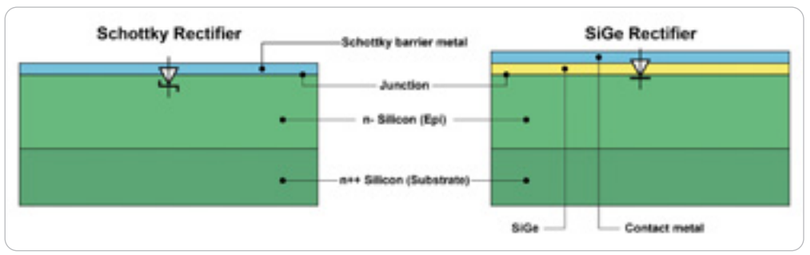


Fig. 1: Structural comparison of a Schottky and SiGe rectifier

As Figure 2 shows, the new devices maintain high thermal stability, extending the Safe Operating Area, in this example from 140°C, the temperature at which Schottky rectifiers begin thermal runaway. The SiGe rectifiers remain stable up to and beyond 175°C, the specified limit of the CFP package. Thermal runaway occurs when the reverse power generated within the chip exceeds the power which can be dissipated by the package. At this point the increase in leakage current becomes super-exponential.

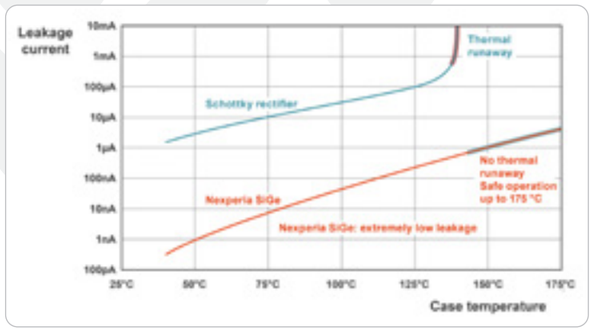


Fig. 2: Leakage current vs case temperature for a Schottky and a SiGe rectifier

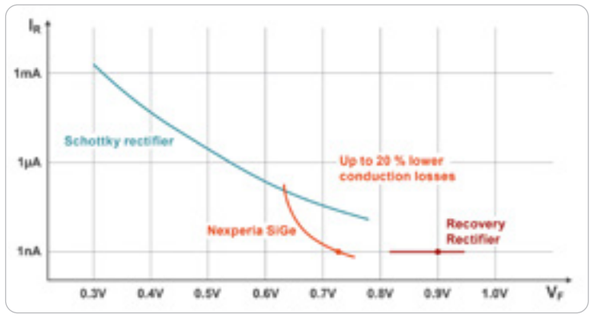


Fig. 3: Trade-off in forward voltage vs. leakage current for Schottky, SiGe, and Fast Recovery rectifiers. The SiGe rectifier shows around two orders of magnitude lower leakage current than a Schottky rectifier, and around 20% lower forward voltage drop than a Fast Recovery rectifier.

As Figure 3 shows, a Fast Recovery rectifier typically has a forward voltage of about 0.9V. Nexperia's first SiGe diode, by contrast, has low leakage current of 1nA, which, as the curve shows, equates to a forward voltage of around 0.75V, some 150mV better than the Fast Recovery rectifier.

The result is a reduction in conduction losses of around 20%. How this translates into efficiency is dependent on multiple factors, most importantly the duty cycle of the application.

As a rough estimate, an improvement in efficiency of 5-10% could be expected with the same thermal stability as the best Fast Recovery diodes.

SiGe advantages in high-temperature switching applications

In addition to these benefits, SiGe rectifiers show improved switching performance in comparison to Schottky rectifiers, for example in a 48V/12V DC-DC converter. The SiGe rectifier has a lower reverse-recovery charge and lower reverse-recovery current than a comparable Schottky rectifier, resulting in lower switching losses, in combination with a lower snappiness.

These benefits directly improve the efficiency of the DC-DC converter, as shown in Figure 4. At high frequencies, the switching losses become a major contributor to overall losses: here, the SiGe rectifier is more efficient than the Schottky rectifier.

In summary, SiGe rectifiers are a suitable choice for switch-mode power supplies even when operating in high-temperature environments. They combine the high efficiency of a Schottky rectifier with the thermal stability and safe operation of a Fast Recovery rectifier.

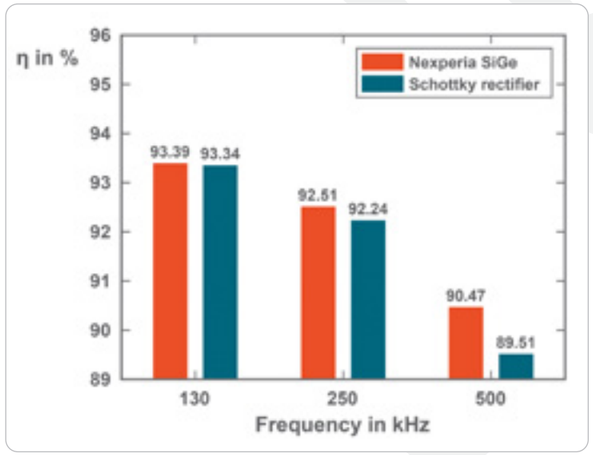


Fig. 4: Efficiency of a 48V/12V DC-DC converter at switching frequencies between 130kHz and 500kHz. A 3A SiGe rectifier is compared to a 3A Schottky rectifier. The increased efficiency of the SiGe rectifier at high frequencies is because of lower switching losses.

FOR MORE DETAILS AND DATA E-MAIL: INFO@MY-FTM.COM | REFERENCE NUMBER 20-vii 24

1A/2A/3A SiGe rectifiers in space-saving CFP packages

Nexperia has released a new range of Silicon Germanium (SiGe) rectifiers featuring 120V, 150V and 200V reverse-voltage ratings.

The new 1A to 3A SiGe rectifiers are particularly suitable for automotive applications that operate at high temperature, such as LED lighting, engine control units or fuel-injection systems. Design engineers using these low-leakage devices can now rely on an extended safe-operating area with no thermal runaway up to 175°C. At the same time, the design can be opimized for power efficiency, which is not possible with the Fast Recovery rectifiers commonly used in high-temperature designs.

Compared to Fast Recovery rectifiers, Nexperia's SiGe rectifiers offer conduction losses which are lower by some 10% to 20% thanks to the low forward voltage. The devices' low reverse-recovery charge results in low switching losses.

The PMEG120Gx, PMEG150Gx and PMEG200Gx SiGe devices are housed in compact, thermally-efficient CFP3 and CFP5 packages.

An extension of the portfolio to higher currents up to 15A is planned for 2021.

Features:

- Maximum forward-current ratings: 1A, 2A or 3A
- 1nA typical leakage current
- Fast and smooth switching
- Low parasitic capacitance
- AEC-Q101 qualified

Applications:

- Automotive systems including:
  - LED lighting
  - Engine control units
- 5G base stations
- Communications infrastructure
- Server power supplies

INDUSTRIAL AUTOMATION / INDUSTRY 4.0

NXP Semiconductors: meeting the next-generation industrial IoT challenges

NXP's product portfolio and its industrial partner ecosystem help to enable the design of next-generation automation applications to meet the challenges of the fourth industrial revolution. The Industrial Internet of Things (IIoT) aims overall to build distributed autonomous systems in order to bring more agility to the manufacturing systems and meet demand while adjusting to environmental condition changes in real time.

These systems bring four main levels of sub-challenges.

1. Flexibility

Designing flexible factories organized in distributed, modular units (automation cells).

2. Connectivity

Connecting a production line from edge to cloud while properly managing real-time critical data and ensuring proper bandwidth for heavy traffic users such as vision systems.

3. Functional Safety

Improved factors including availability, efficiency, speed; cannot take higher risks with operators and machines.

4. Security

As the factory floor becomes more fully connected and widely spread, it also becomes much more vulnerable to:

Physical attacks: as the production site is wider it might, for example, be more vulnerable to intruders with a USB key

Remote attacks: with all devices connected to the cloud, more opportunities exist for a hacker to penetrate the system

From embedded hardware to software solutions, NXP's industrial automation expertise and innovative spirit address those challenges and help to enable designers to meet the highest expectations of industry 4.0 and industrial IoT markets. Our industrial solutions are usually made available to our customers for at least 15 years after market introduction.

NXP enables secure connections and industrial applications in every layer of factory automation:

- **Manufacturing:** production lines are complex systems of devices which achieve perfect synchronization thanks to real-time processing and deterministic communication
- **Logistics:** once the product is fully manufactured, new generations of factories rely on intelligent devices able to autonomously organize storage or shipping
- **Operations Management:** management of factories located around the world requires systems enabled with secure connections to monitor logistics and manufacturing operations
- **Edge-to-cloud:** the cloud enables innovative solutions for factories. Information from all layers of factory automation must be securely transferred from edge to cloud.

Join the NXP on-demand webinar to get an overview of NXP's solutions for factory automation:
www.nxp.com/design/training/nxp-solutions-for-secure-connected-smart-factories

Get connected with NXP's on-demand IIoT webinars

Industrial Networks

For proper control, a PLC and all the different elements of the automation cell need to connect to a network in order to transmit and receive data, inquiries, commands, updates and more.

Join the on-demand webinar to learn more about NXP's industrial networks solutions
www.nxp.com/design/training/factory-automation-nxp-solutions-for-industrial-networks

Industrial Control

Industrial control is a key element in any factory automation process. It may vary from a simple panel-mounted controller to large interconnected and interactive distributed control systems. It can also be the head of an automated cell managing slice I/O clusters or drives, for example.

Join the on-demand webinar to learn more about NXP's security and moving AI to the edge solutions
www.nxp.com/design/training/factory-automation-nxp-security-solutions

www.nxp.com/design/training/factory-automation-moving-ai-to-the-edge

HMI and Vision Solutions

A Human-Machine Interface (HMI), a key component of any industrial system, can offer a variety of user interface choices, from simple LCD displays to high-definition systems on the supervision side. Furthermore, HMIs can be coupled with some vision systems to enable a tighter control of the production line or to enable user-specific security policies such as face recognition.

Join the on-demand webinar to learn more about NXP's HMI solutions
www.nxp.com/design/training/factory-automation-nxp-hmi-solutions

Motion Control and Drives

NXP's motion control and robotics solution provides computing performance, embedded connectivity, low latency and a real-time open-source operating system to address the requirements for multi-axis motion control and robotics applications. Motor drives are used in several applications, including automation, consumer, industrial, medical, and automotive. The type of motors vary from stepper motors to brushless DC, permanent magnet motors to brushed DC motors.

Join the on-demand webinar to learn more about NXP's motor control solutions
www.nxp.com/design/training/factory-automation-nxp-motor-control-solutions

Follow the link below to learn more on NXP solutions and discover the portfolio for factory automation:
www.nxp.com/applications/solutions/industrial/factory-automation

Second-generation SiC MOSFETs offer lower switching losses for highly efficient power conversion

STMicroelectronics has introduced the second generation of its Silicon Carbide (SiC) power MOSFETs, offering very low on-resistance per unit area and excellent switching performance. Switching loss hardly varies at all across the junction-temperature range.

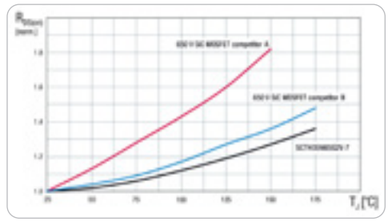
ST supplies a wide range of second-generation SiC MOSFETs: breakdown voltage ratings range from 650V in the SCTxN65G2 parts, to 1,200V in the SCTxN120G2 products, and extending up to 1,700V.

The use of SiC MOSFETs in automotive applications such as electric vehicle traction motors or charging stations, and in industrial applications such as solar power generators and motor drives, enables designers to gain various benefits including:

- Reducing the size and weight of the power stage
- Achieving higher power density
- Reducing the size and cost of the power circuit's passive components
- Achieving higher system efficiency
- Easing thermal design constraints and eliminating or reducing the size and cost of the heat-sink

Laboratory tests by ST compared the switching losses of the second-generation 650V SCTH35N65G2V-7 SiC MOSFET with a trench field-stop silicon IGBT of the same voltage rating and equivalent on-state resistance. The SiC MOSFET had much lower switching losses, even at high temperature.

This enables a converter or inverter power stage to operate at very high switching frequencies, reducing the size of its passive components. In addition, the SiC MOSFET's variation of on-state and off-stage energy over a temperature range from 25°C to 175°C is very small, while the off-state energy of the IGBT increases by 89%. The resistance of the SiC MOSFET also changes very little as temperature rises.



Normalized on-state resistance vs temperature

ENERGY **INDUSTRIAL** LIGHTING MEDICAL TRANSPORT SECURITY CONSUMER TELECOMS

APPLICATIONS

- Traction motor
- Charging station
- Solar inverter
- Factory automation
- Motor drive
- Data center power supply
- Industrial battery chargers
- Uninterruptible power supplies

FEATURES

- Operating junction temperature up to 200°C
- Very low switching losses
- No recovery losses in body diode
- Low power losses at high temperature
- Easy to drive

FREE DEVELOPMENT BOARD

Orderable Part Number: STDES-PFCBIDIR

Apply at: my-boardclub.com

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Robust digital isolator supports high-speed communication at up to 100Mbits/s

ON Semiconductor®

The NCID9211 from ON Semiconductor is a high-speed, dual-channel isolator which enables digital signals to be transferred between systems without exposing them to conducting ground loops or hazardous voltages.

Supporting full-duplex, bi-directional communication, the NCID9211 is based on ON Semiconductor's patented galvanic isolation technology, which uses an off-chip capacitor. It is the only digital isolator to provide insulation reliability which matches that of an optocoupler.

The NCID9211's thick ceramic substrate yields capacitors which are around 25 times thicker than thin-film on-chip capacitors and coreless transformers. This gives a Distance Through Insulation (DTI) greater than 0.5mm - similar to the typical DTI of an optocoupler.

This DTI guarantees working voltages up to 1,500V without relying on the dielectric insulation material.

At the same time, the isolator provides outstanding electrical performance, including a maximum propagation delay of 25ns and maximum pulse distortion of 10ns. This enables the regulator to support a data transfer rate up to 100Mbits/s.

A related part, the NCIV9211, has AEC-Q100 qualification pending.

NCID9211: Insulation reliability matches that of an optocoupler

ENERGY **INDUSTRIAL** LIGHTING MEDICAL TRANSPORT SECURITY CONSUMER TELECOMS

APPLICATIONS

- Power supplies
- Industrial control systems
- Data acquisition equipment
- Fieldbus communications

FEATURES

- 2kV peak insulation
- 8mm creepage and clearance distance
- Supply-voltage range: 2.5V to 5.5V
- 100kV/µs minimum common-mode rejection
- Safety and regulatory approvals pending:
  - UL1577 recognition
  - DIN VDE V 0884–11
- Operating-temperature range: -40°C to 125°C

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Non-volatile MRAM products offer high-speed alternative to battery-backed SRAM

RENESAS
BIG IDEAS FOR EVERY SPACE

Renesas has extended its range of Magnetoresistive Random-Access Memory (MRAM) products with the M3000 and M1000 series, offering non-volatile memory densities of 4Mbits, 8Mbits or 16Mbits.

Renesas fabricates the MRAM devices with a new, proprietary technology called perpendicular magnetic-tunnel-junction Spin-Transfer Torque (STT), achieving best-in-class non-volatile memory performance including long data retention and fast Read and Write speeds. The Renesas MRAM products have configurable single, dual or quad serial peripheral interfaces which can operate in single or double data-rate modes at up to 108MHz.

MRAM offers various performance advantages over other non-volatile memory technologies such as Flash. These include high memory density, long endurance, and low-voltage operation.

MRAM is ideal as a replacement for battery-backed SRAM: while SRAM also offers high Read and Write speeds, the non-volatile nature of MRAM means that it needs no dedicated battery power supply in case of system power failure.

The elimination of the back-up battery in MRAM-based data logging systems saves not only the cost of the battery itself, but also the pain of replacement, implementation of power-management firmware, and space.

Ferroelectric RAM (FRAM) is also often considered as a replacement for battery-backed SRAM, and offers similar performance to MRAM. But Renesas' MRAM devices offer higher density and longer endurance than FRAM products.

Part Number	Density (kbytes)	I/O Voltage	I/O Frequency
M1004204	4,096	1.8V	54MHz, 108MHz
M1008204	8,192	1.8V	54MHz, 108MHz
M1016204	16,384	1.8V	54MHz, 108MHz
M3004204	4,096	3V	54MHz, 108MHz
M3008204	8,192	3V	54MHz, 108MHz
M3016204	16,384	3V	54MHz, 108MHz

ENERGY **INDUSTRIAL** LIGHTING **MEDICAL** TRANSPORT SECURITY **CONSUMER** TELECOMS

APPLICATIONS

- Industrial control and monitoring
- Multi-function printers
- Robotics
- Data switches and routers
- Hearing aids
- Solid-State Drives (SSDs) for data storage

FEATURES

- Low active Write and Read current
- Supply-voltage range: 1.71V to 3.6V
- Operating-temperature range: -40°C to 105°C

FREE DEVELOPMENT BOARD

The M3016 evaluation kit contains a 16Mbit MRAM, and features an Arduino host board and terminal emulator software which communicate with a PC via a USB interface.

Test programs supplied with the kit enable the user to quickly evaluate the functionality of the MRAM device.

Orderable Part Number: M3016-EVK

Apply at: my-boardclub.com

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600V drivers with embedded controller offer ready-made solution for BLDC motors

STMicroelectronics offers two 600V-rated motor drive solutions which are ideal for use in Brushless DC (BLDC) motors operating from a 250V AC mains power supply.

The STSPIN32F0601 and STSPIN32F0602 combine three-phase gate drivers and an STM32F0 Arm® Cortex®-M0 microcontroller in a single 10mm x 10mm TQFP package.

Providing a simple and highly integrated solution for the implementation of high-voltage BLDC motor-drive designs, these STSPIN32F0 parts are supplied with popular control algorithms and application examples. This embedded software includes single- and three-shunt Field-oriented Control (FOC) schemes, as well as traditional sensored single-shunt and six-step sensorless control.

The gate drivers integrate zero-drop bootstrap diodes and protection circuitry, including cross-conduction prevention and dead-time insertion. In addition, under-voltage lock-out protection on both the lower and upper driving sections prevents the power switches from operating in low-efficiency or dangerous conditions. There is also a patented fast-acting smart ShutDown (smartSD) function for overload and over-current protection.

The integrated 48MHz STM32F0 MCU gives designers the freedom to use the rich STM32 development ecosystem when building applications. The MCU features 4kbytes of SRAM, and 32kbytes of Flash memory for data and code storage. The analog and digital peripherals on the STSPIN32F0601 and STSPIN32F0602 include a 12-bit ADC with up to ten channels, six general-purpose timers, 21 general-purpose I/O pins, and I²C, UART and SPI ports.

An integrated bootloader provides for flexible device lifecycle management, allowing firmware updates to be applied in the field.

The STSPIN32F0601 and STSPIN32F0602 are pin-compatible with ST's 250V-rated STSPIN32F0251 and STSPIN32F0252, allowing hardware and firmware to be re-used in products for operation on either 110V or 250V AC mains supplies.

FREE DEVELOPMENT BOARD

The motor control boards are fully compatible with ST's X-CUBE-MCSDK (motor-control software development kit). These tools simplify development of drives which implement single- or three-shunt control.

The boards also contain a power-supply stage and a populated MOSFET output stage which has a dual footprint. This allows the user to replace the devices provided with alternative MOSFETs or IGBTs in DPAK or PowerFlat packages.

A detachable STLINK debugger provides for configuration and firmware debugging using standard STM32 tools. Single-wire debug and UART connectors are also available.

Orderable Part Numbers: EVSPIN32F0601S3 and EVSPIN32F0602S1

Apply at: my-boardclub.com

ENERGY INDUSTRIAL LIGHTING MEDICAL TRANSPORT SECURITY CONSUMER TELECOMS

APPLICATIONS

- Corded power tools
- Motor drives
- Pumps
- Fans
- Compressors

FEATURES

- Low-power standby mode
- Matched propagation delay for all channels
- Integrated bootstrap diodes
- On-chip debug support
- Operating-temperature range: -40°C to 125°C

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REFERENCE NUMBER **20-vii 28**

New 650V IGBTs maximize efficiency in power factor correction applications

STMicroelectronics has introduced a new series of 650V IGBTs based on trench field-stop technology, and optimized for applications working at a switching frequency between 16kHz and 60kHz.

HB2 series IGBTs: Low saturation voltage and gate charge

An upgrade on the earlier HB products, the new HB2 series features a lower saturation voltage, between 1.55V and 1.65V, and lower total gate charge than the earlier generation of IGBTs. This lowers the overshoot voltage during turn-off, even with a small gate resistance, and reduces turn-off energy.

The HB2 series IGBTs are ideal for use in power circuits performing single-phase or interleaved Power Factor Correction (PFC), or in two-switch forward converters.

The HB2 series IGBTs are available with current ratings ranging from 15A to 100A, and with three different diode options: protection diode, half-rated diode, and full-rated diode.

ENERGY INDUSTRIAL LIGHTING MEDICAL TRANSPORT SECURITY CONSUMER TELECOMS

APPLICATIONS

- Welding machines
- PFC converters
- Uninterruptible power supplies
- Solar inverters
- DC chargers

FEATURES

- Low thermal resistance
- Maximum junction temperature: 175°C
- Low tail current
- Tight parameter distribution
- Positive temperature coefficient of saturation voltage

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REFERENCE NUMBER **20-vii 29**

MICROCHIP

Integrated Ethernet controller provides SPI link to host MCU

Microchip's ENC28J60 is a stand-alone Ethernet controller with integrated media access controller and physical layer which can serve as an Ethernet network interface for any microcontroller equipped with a Serial Peripheral Interface (SPI).

The ENC28J60 conforms to all of the specifications of the IEEE 802.3 Ethernet standard, and is fully compatible with 10/100/1000Base-T networks.

The controller incorporates a number of programmable packet-filtering schemes. An internal Direct Memory Access (DMA) module provides for fast data throughput and hardware-assisted checksum calculation, which is used in various network protocols. Communication with the host MCU is implemented via an interrupt pin and the SPI at a clock rate of up to 20MHz.

In a circuit design based on the ENC28J60, only two pulse transformers and a few passive components are required to connect a microcontroller to an Ethernet network.

The ENC28J60 Ethernet controller consists of seven main functional blocks:

- SPI communication channel between the host controller and the ENC28J60
- Control registers for controlling and monitoring the ENC28J60
- Dual-port RAM buffer for received and transmitted data packets
- Arbiter to control access to the RAM buffer when requests are made from the DMA, transmit or receive blocks
- Bus interface which interprets data and commands received via the SPI
- Medium Access Control (MAC) module
- 10Base-T Physical layer (PHY) module which encodes and decodes the analog data on the twisted-pair interface

The device also contains other support blocks, such as an oscillator, on-chip voltage regulator, level translators to provide 5V-tolerant I/Os, and system control logic.

The ENC28J60 is supplied in 28-pin SPDIP, SSOP, SOIC and QFN packages.

FREE DEVELOPMENT BOARD

The Ethernet PICtail™ Daughter Board can be plugged into various demonstration boards, including the PIC18 Explorer (part number DM183032). The board is populated with the 28-pin ENC28J60 Ethernet controller which interfaces to an RJ-45 female connector. Featuring a standard 28-pin PICtail pin-out, the board is easily interfaced to Microchip's 8-bit MCU demonstration boards.

Orderable Part Number: AC164121

Apply at: my-boardclub.com

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APPLICATIONS

- VoIP systems
- Industrial, building and home automation
- Security equipment
- Instrumentation

FEATURES

- Supports full and half-duplex modes
- Supports unicast, multicast and broadcast packets
- Six interrupt sources and one Interrupt Output pin
- 3.3V operating voltage
- Operating-temperature ranges:
  - Industrial, -40°C to 85°C
  - Commercial, 0°C to 70°C in SSOP package only

FOR PRICING AND SAMPLES E-MAIL: INFO@MY-FTM.COM

REFERENCE NUMBER **20-vii 30**

Digital vibration sensor ideal for monitoring the condition of industrial machinery

The IIS3DWB from STMicroelectronics is a three-axis digital vibration sensor system-in-package which provides low-noise, stable and repeatable sensitivity over a wide frequency bandwidth.

The IIS3DWB has a selectable full-scale acceleration range of ±2g/±4g/±8g/±16g. The sensor can measure acceleration over a bandwidth of up to 6kHz at an output data rate of 26.7kHz.

Operating over an extended temperature range up to 105°C, the IIS3DWB is well suited to vibration monitoring in industrial applications.

IIS3DWB: Based on proven MEMS production technology

It combines this high performance with low power consumption and digital features such as a FIFO and interrupts, which help developers to realise successful designs for battery-operated industrial wireless sensor nodes.

Like other MEMS sensors from ST, the IIS3DWB takes advantage of the robust and mature manufacturing processes already used for the production of micromachined accelerometers and gyroscopes. The sensing elements are manufactured using ST's proprietary micromachining process, while the embedded IC interfaces are fabricated in a CMOS process.

The IIS3DWB is supplied in a 14-lead plastic LGA package measuring 2.5mm x 3.0mm x 0.9mm.

FREE DEVELOPMENT BOARD
Orderable Part Number: STEVAL-STWINKT1
Apply at: my-boardclub.com

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APPLICATIONS
- Vibration monitoring
- Condition monitoring
- Predictive maintenance
- Test and measurement

FEATURES
- 75µg/√Hz noise density in three-axis mode
- 1.1mA operating current in three-axis mode
- Low- or high-pass filter with selectable cut-off frequency
- Embedded temperature sensor
- Embedded self-test
- Serial peripheral interface
- Supply-voltage range: 2.1V to 3.6V

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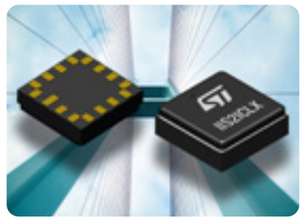
Two-axis digital inclinometer offers high temperature stability and low power consumption

The new IIS2ICLX from STMicroelectronics is an accurate, low-power, two-axis digital inclinometer for applications such as industrial automation and structural health monitoring. It features a programmable machine-learning core and 16 independent programmable finite state machines which help edge devices to save power and reduce the size and frequency of data transfers to the cloud.

Based on MEMS accelerometer technology, the IIS2ICLX inclinometer has a selectable full scale of ±0.5g/±1g/±2g/±3g and provides outputs over an I²C or serial peripheral interface. Embedded compensation maintains stability over temperature to within 0.075mg/°C, ensuring high accuracy and repeatability even in fluctuating ambient temperatures. The IIS2ICLX's programmable machine learning core integrates artificial intelligence algorithms to reduce power consumption at the system level.

Low noise density of 15µg/√Hz enables high-resolution tilt sensing as well as sensing of low-level, low-frequency vibration, as required when monitoring the health of large structures such as wind turbines, bridges and skyscrapers.



IIS2ICLX: Monitors large structures such as bridges

Affordable, battery-powered MEMS tilt sensors containing the IIS2ICLX enable many more structures to be monitored for safety than has been economically viable using earlier, more expensive technologies.

Many competing precision inclinometers are single-axis devices. The two-axis IIS2ICLX can sense tilt with respect to a horizontal plane along two axes (pitch and roll) or, by combining the two axes, can measure tilt with high and repeatable accuracy and resolution with respect to a single direction in the horizontal plane over a range of ±180°. The sensor's digital output simplifies system design and reduces bill-of-materials cost by eliminating the need for external digital-to-analog conversion or filtering.

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APPLICATIONS
- Industrial vehicles
- Robotics
- Industrial IoT devices
- Structural health monitoring
- Levelling instruments

FEATURES
- 0.42mA operating current for full two-axis measurement
- Sensor hub feature to efficiently collect data from external sensors
- Up to 3kbyte embedded FIFO
- Programmable high- and low-pass digital filters
- High shock survivability
- Operating-temperature range: -40°C to 105°C

FREE DEVELOPMENT BOARD
Orderable Part Number: STEVAL-MKI209V1K
Apply at: my-boardclub.com

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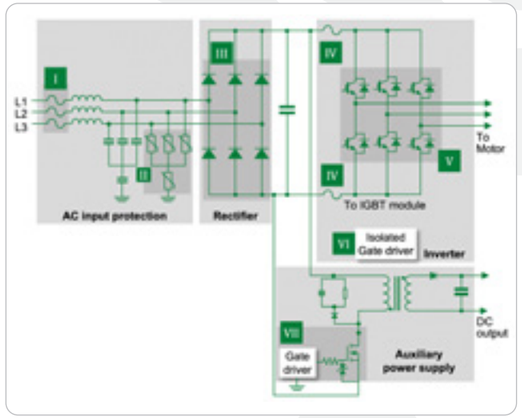
Broad choice of power components used in high-power inverters

Littelfuse
Expertise Applied | Answers Delivered

Littelfuse supplies a wide range of components used in the high-power inverters found in industrial applications such as motor drives or auxiliary power supplies. Littelfuse products can be applied in a motor's main functional blocks, including AC input protection, the rectifier stage and the inverter stage, as well as in a motor's auxiliary power supply.

The Littelfuse product lines for inverter circuits and the functions of each are shown in the table.



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	Product Lines	Technology	Function in Application	Features	Benefits
I	JLS, JLLS, LDC, L70QS 606, 504, 505	Fuses	AC line fuses for over-current or short-circuit protection.	200kA interrupting rating. Compact design, smallest available package.	Reduces damage from heating and magnetic effects of short-circuit currents.
	LFT, LFJ	Fuse holder	Supports fuse protection.	Low-resistance connection.	DIN rail mountable.
II	TMOV UltraMOV	MOV (Metal Oxide Varistor)	Protects against damage due to lightning-induced surges or harmonic voltage disruptions from the power line.	UL recognized Type 4 surge protection device.	Integrated thermal disconnect enhances safety.
III	DMA10P1200UZ DMA10P1600HR DMA80IM1600HB	Rectifier diode	Converts AC line voltage supplied to the drive to DC.	Planar passivated chips. Very low leakage current and forward voltage drop Good thermal behavior. High commutation robustness.	Small footprint. Multiple package options.
IV	PSR	Semi-conductor fuse	Protects power semiconductor components against over-current.	Bus bar mount.	Best-in-class DC performance.
V	MIXA30W1200TED MIXA60W1200TED MIXA80W1200TED	IGBT module	Switching power supplies.	Rugged XPT design with thin wafer technology.	Short-circuit rated for 10µs. Low gate charge, low EMI and low saturation voltage.
VI	SMBJ P6SMB	TVS diode	Protects IGBTs from transient overloads.	600W peak pulse power capability. Excellent clamping capability. Small footprint.	Improves system reliability by clamping the voltage at safe levels during transients.
VII	LSIC1MO170E1000	SiC MOSFET	High-frequency switching.	Optimized for high-frequency applications. Extremely low gate charge and output capacitance. Low on-resistance.	High switching frequency. High efficiency. More robust. Small die size.
	IX4351NE	Gate driver	Drives SiC MOSFETs or high-power IGBTs.	Separate 9A peak source and sink outputs. Internal negative charge pump regulator for selectable negative gate-drive bias.	Eliminates the need for separate negative supply. Quick turn-on and turn-off.
	SMF	TVS diode	Protects SiC MOSFET from voltage transient.	200W peak pulse power capability. Excellent clamping capability. Low profile.	Improves system reliability by clamping the voltage at safe levels during transients.

INDUSTRIAL AUTOMATION / INDUSTRY 4.0 FUTURE ELECTRONICS

Motion and pressure sensors offer minimum 10-year longevity for industrial applications

BOSCH
Invented for life

Bosch Sensortec supplies a range of motion and environmental sensors which have guaranteed longevity, making them suitable for use in industrial equipment designs which are expected to be available to the market for many years.

The six-axis **BMI090L** Inertial Measurement Unit (IMU) combines a 16-bit, three-axis closed-loop gyroscope and a 16-bit, three-axis accelerometer in a 3mm x 4.5mm x 0.95mm LGA package. The BMI090L features a built-in filter to suppress mechanical vibrations above 350Hz, thus enabling precise orientation and motion tracking in harsh and demanding industrial environments.

The **BMA490L** is a unique accelerometer for home appliances, power tools and other industrial products in which high performance and long availability are crucial.

The **BMP390L** pressure sensor is ideally suited to industrial applications which require very high performance and low power consumption. This barometric pressure sensor offers high temperature stability over the whole temperature and pressure range, as well as low short- and long-term drift. This makes the sensor's performance robust in demanding industrial use cases. The sensor is available in a 2mm x 2mm x 0.75mm LGA package with a metal lid.

The **Bosch Sensortec longevity program** supplies products for a minimum period of ten years from the product's date of introduction, including the notification period. All products in the program are marked with an 'L' at the end of the part number.

The longevity program offers various benefits:

- High degree of reliability and peace of mind
- High-performance sensors developed for industrial use cases
- Increased flexibility in purchasing due to the availability of smaller reel sizes

Bosch modules: Integrated sensor systems

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APPLICATIONS

- White goods
- Home appliances
- Robots
- Drones
- Precision agriculture
- Logistics and asset tracking
- Industrial IoT devices
- Power tools

FEATURES

- Resolution:
  - Accelerometer 0.09mg
  - Gyroscope 0.004°/s
- Zero offset:
  - Accelerometer ±20mg
  - Gyroscope ±1°/s
- Temperature coefficient:
  - Accelerometer ±0.2mg/K
  - Gyroscope ±0.015°/s/K
- Maximum output data rate: 2kHz
- 5.15mA operating current in full measurement mode

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650V SiC Schottky diode performs ultra-efficient high-frequency switching

STMicroelectronics' STPSC10H065DLF is a 10A, 650V Schottky power diode fabricated on a Silicon Carbide (SiC) substrate which supports very fast and efficient switching. It is ideal for use in power-conversion and inversion functions such as boost power factor correction, bootstrap diode and LLC clamping.

The wide-bandgap SiC material permits the design of a Schottky diode structure which combines a low forward voltage, for reduced power loss and higher efficiency, with the robustness to handle a 650V repetitive peak reverse voltage.

Because of the diode's Schottky construction, it draws little or no reverse-recovery current at turn-off, and ringing patterns are negligible. The diode's negligible turn-off capacitance characteristic is stable across the operating-temperature range.

The STPSC10H065DLF offers an excellent trade-off between forward voltage and surge-current tolerance. Maximum surge current is 90A for a 10ms sinusoidal pulse at room temperature. At the same time, forward voltage drop is typically 1.38V at a forward current of 10A and a junction temperature of 25°C, a market leading value which is highly reproducible over all production units.

The STPSC10H065DLF is supplied in an 8mm x 8mm PowerFLAT HV package which is less than 1mm high.

STPSC10H065DLF: Low 1.38V forward voltage drop

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APPLICATIONS

- Telecoms and network equipment
- Industrial power supplies
- Renewable energy systems
- High-frequency inverters

FEATURES

- 100µA maximum reverse leakage current at a junction temperature of 25°C
- Switching behavior stable over operating-temperature range
- 32nC total capacitive charge at a reverse voltage of 400V
- 175°C maximum junction temperature

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Ready-to-use industrial Ethernet module includes certified hardware and software

RENESAS
BIG IDEAS FOR EVERY SPACE

Renesas has introduced a complete, ready-to-use Ethernet module for use in industrial applications which is based on its R-IN32M3 multi-protocol communication IC.

Both the module hardware and the Ethernet protocol software which Renesas supplies are certified for compliance with the Ethernet standard for interoperability.

This dramatically reduces the total cost of ownership as well as lifting barriers to the use of new network technology in industrial equipment.

R-IN32M3 module: SPI control link to host processor

The module supports multiple real-time data networking protocols including PROFINET RT, EtherNet/IP™ and EtherCAT®. It includes Ethernet ports supporting data transfers at rates of 10Mbits/s or 100Mbits/s with auto-negotiation. It also features a two-port Ethernet switch for bus and ring network topologies.

Control and configuration are provided via a high-speed serial peripheral interface and power pins to connect the module to a host processor.

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APPLICATIONS

- Industrial automation equipment
- Protocol conversion gateways
- Portable industrial devices
- Industrial human-machine interfaces

FEATURES

- No additional license fees payable
- Source code for application examples
- Extensive tool chain supports development and test process

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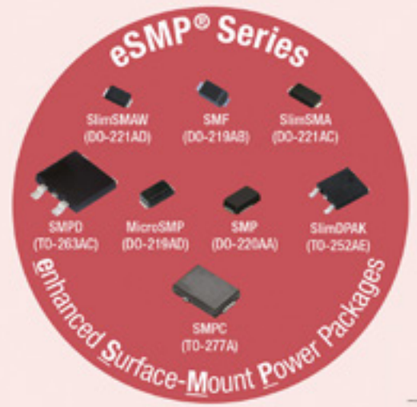
VISHAY.

FRED Pt® RECTIFIERS IN eSMP® SERIES PACKAGES

Space-Saving Footprints and Low Profile Package Solutions for All Major Applications

FRED Pt® (Fast Recovery Epitaxial Diodes) products are based on a Pt doping technology that allows **maximum operating junction temperature** Up to 175 °C

- Current range from 1A to 30A
- Reverse voltage: 100V, 200V, and 600V
- Fast and soft recovery characteristics
- Low leakage currents
- Low forward voltage drop
- Reduce switching losses



FRED Pt® rectifiers are available in the following packages:

Standard Products	AEC-Q101 Qualified Products
MicroSMP (DO-219AD)	MicroSMP (DO-219AD)
SMF (DO-219AB)	SMP (DO-220AA)
SMP (DO-220AA)	SMF (DO-219AB)
SlimSMAW (DO-221AD)	SlimSMAW (DO-221AD)
SlimSMA (DO-221AC)	SlimSMA (DO-221AC)
SMPC (TO-277A)	SMPC (TO-277A)
SlimDPAK (TO-252AE)	SlimDPAK (TO-252AE)
SMPD (TO-263AC)	SMPD (TO-213AC)

APPLICATIONS

DC/DC CONVERTERS · PFC POWER FACTOR CORRECTION · AUTOMOTIVE · TELECOM

FRED Pt® **AEC-Q101 qualified** products have undergone **part average testing (PAT)** and **statistical yield limit (SYL)** analysis to ensure their electrical parameters meet the **highest quality** level for **automotive** applications

FRED Pt® PAT SYL
AEC-Q101 Qualified

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TECHNICAL VIEW FUTURE ELECTRONICS

The role of ESD protection in the all-IP car

How Ethernet and new architectures require new ESD protection concepts to provide the highest system reliability

nexperia

It was Henry Ford who said, 'You can have it in any color you want, as long as it is black.' This statement might have been valid decades ago, but customer expectations have grown dramatically, and now the modern automotive world is currently dominated by three major trends: electrification, autonomous driving, and connectivity. While the first has a massive impact on the power train and the high-voltage part of the wiring harness, the last two are driving a paradigm change in the way Electronic Control Units (ECUs) communicate in the car.

Trends and concepts drawn from consumer electronics, communications infrastructure and the IoT are being adopted in the vehicle. Autonomous driving and in-vehicle connectivity in particular are creating demand for higher data-transfer rates and a zonal architecture.

The topology of today's in-vehicle networks can only be understood by reference to signaling technologies used in the past. The first electrical control interfaces in vehicles connected the controller and actuator via a single wire. As demand for functionality increased, bus networks were introduced. The buses connected the control units which managed discrete functional blocks, such as the power train or body control.

This scheme can still be found in today's cars, even though it has expanded due to the increased demand for bandwidth and interconnections. The implementation of physically separate buses to meet security requirements makes the topology even more complex.

If a designer were to devise an in-vehicle network from scratch today, the approach would be different. Modern techniques, such as the decoupling of physical and software addresses, plug-and-play configurability, and end-to-end encryption would be readily available. Today's in-vehicle networks do not provide these features, however, and retrofitting is expensive and does not work properly in many cases.

In contrast to the old way of connecting ECUs which talk to each other directly, a zonal architecture aims to form a network by which, in principle, any ECU can talk to any other. To do so, every ECU is connected to a domain or zone controller directly via a short CAN, LIN or 10BASE-T1S interface. The domain or zone controllers are connected using a high-speed backbone network technology such as 1000BASE-T1, as shown in Figure 1.

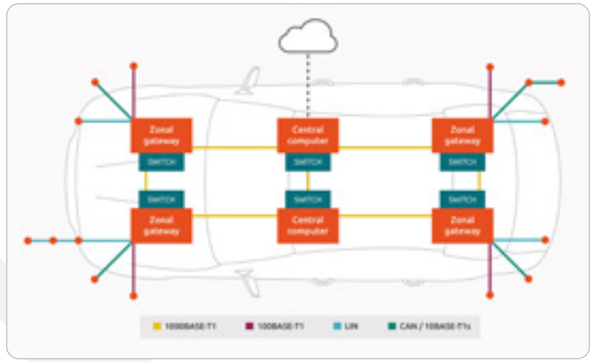

Fig. 1: Modern in-vehicle network with zonal architecture and Ethernet as the backbone

Software makes the system very versatile: virtual CAN/LIN networks can be implemented, so that legacy ECUs can operate as though via an old-fashioned CAN-/LIN-only topology. As every ECU has a dynamic Internet Protocol (IP) address, plug-and-play operation as well as reconfigurability, for instance supporting over-the-air updating, are possible. When based on software, secure sub-networks can be formed to ensure compliance with safety standards in safety-critical applications and to protect sensitive data.

Automotive Ethernet is the system of choice for such a topology, as it inherently provides the desired flexibility. Furthermore, it is easy for engineers to implement, as it is the standard technology in today's communications infrastructure.

The different speed classes suit the three different stages of the zonal architecture: 1000BASE-T1 and multi-gigabit Ethernet for the connection of the zone controllers; 100BASE-T1 for the direct connection of ECUs to the zone controller; and 10BASE-T1S to connect ECUs with a limited demand for bandwidth to a zone controller.

This enables the concept 'all-IP car' connected solely via automotive Ethernet. The expert community is split on the question of whether this idea will be realized in future, or even whether it is desirable. The general consensus is that legacy protocols such as LIN, CAN and FlexRay will remain in zonal architectures for cost and legacy reasons. The exception to the zonal architecture, according to the experts, can be found in the high-speed connection of driver-assistance system sensors to the respective control units. Here, no flexibility is required, and a mostly unidirectional, high-bandwidth data stream needs to be transmitted. The technology of choice, SerDes interfaces, fulfills this need.

Faced with the mega-trends discussed above, hardware engineers must handle a specific problem in network communications design: ESD robustness. As the feature size of ICs shrinks, engineers can no longer sacrifice design space for internal ESD protection. This means that new concepts of external ESD protection come into play. This is necessary, since the robustness of device-level ESD protection might be sufficient, but at the system level the protection is inadequate. In the light of the security threats prevalent in highly connected architectures, and especially when implementing autonomous driving technologies, the danger posed by potential system failures caused by ESD events is severe and must be prevented.

In the system implementation specification for 100BASE-T1, the OPEN Alliance proposes two possible external ESD protection devices. As shown in Figure 2, one can be placed at the connector (ESD_1) and one at the PHY (ESD_2). The specification allows the use of none, one or both devices to achieve the desired ESD robustness.

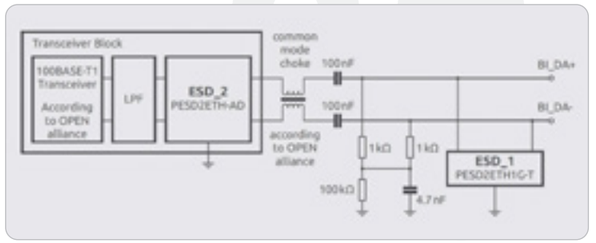

Fig. 2: Interface topology for 100BASE-T1 according to the OPEN Alliance. ESD protection is located at the connector and as part of the transceiver block.

External ESD protection at the PHY is considered a part of the PHY from the point of view of the Ethernet specification. Hence the PHY in combination with external protection needs to pass all requirements that apply to the PHY alone. The protection at the connector must comply with the OPEN Alliance specification for external ESD protection devices. Besides having maximum capacitance of 3pF, the ESD protection device should feature a minimum trigger voltage of 100V, due to the placement at the connector.

From a system perspective, external ESD protection at the connector is superior, and offers the best way to design a robust interface. This can be observed when using an EMI scanner during an ESD event, as shown in Figure 3: here, the color scale reflects the current amplitude from blue (0A) to red (maximum current). Three cases of ESD protection placements are compared.

Scenario 1 shows current amplitude during an ESD event for the Medium-Dependent Interface (MDI) without external ESD protection: high current flows throughout the PCB from the connector to the PHY.

In scenario 2, an ESD protection device is positioned between the Common-Mode Choke (CMC) and the PHY. Though the current at the PHY is lower, high current still flows through the PCB, weakening the passive and active components.

In scenario 3, the ESD protection is placed at the connector before the CMC and PHY as recommended. Very little electrical stress can be observed throughout the MDI, providing the best system-level robustness and reliability.

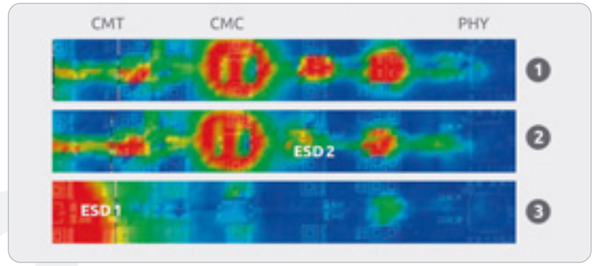

Fig. 3: Current amplitude during an ESD event for the MDI without [1] and with external ESD protection at the PHY [2] and at the connector [3]. The color scale reflects the current amplitude from blue (0A) to red (maximum current).

Technical differences between ESD protection devices can have a marked impact on the result of this measurement and thus on the ESD robustness of the interface. The interplay of the saturation characteristic of the CMC and the clamping behavior of the external ESD protection are the most important factors. Clamping needs to be as low as possible, to prevent the CMC from going into saturation. The requirements of a trigger voltage, however, and the 'unwanted clamping' test need to be met as well.

There are currently three main technologies which might be applicable to ESD protection: Zener diodes, advanced silicon technologies (such as silicon-controlled rectifiers, open-base transistors and other snap-back technologies), and varistors.

Considering the RF requirements of the interface, it is clear that a Zener diode is not an option; only silicon-based or varistor technology can be used. Silicon technology can make use of the snap-back effect, resulting in very low clamping voltages while meeting the other requirements of the norm. Varistors may also offer suitable RF behavior and high trigger voltages. The clamping voltage however is substantially higher. This can be seen in the Transmission Line Pulse (TLP) graph in Figure 4, together with the resulting discharge currents at 6kV. The snap-back and resulting very low clamping of the Nexperia PESD2ETH1G-T provides better protection than the varistor-based solution.

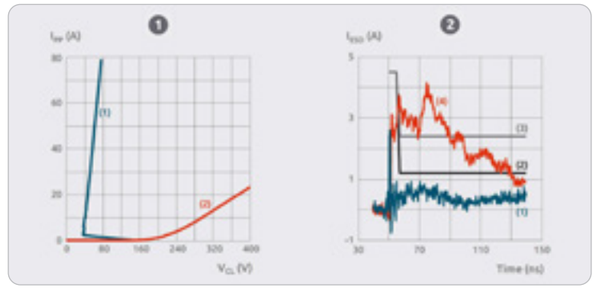

Fig. 4: TLP graph (left) of a silicon based ESD protection device, Nexperia's PESD2ETH1G-T (1) and of a varistor (2) and the corresponding ESD discharge current measurements (right)

The evolution of the wiring harness in vehicles offers great opportunities for new functionality, but also confronts design engineers with new design problems. New ESD protection concepts help to achieve high system-level robustness while offering more PCB design flexibility.

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