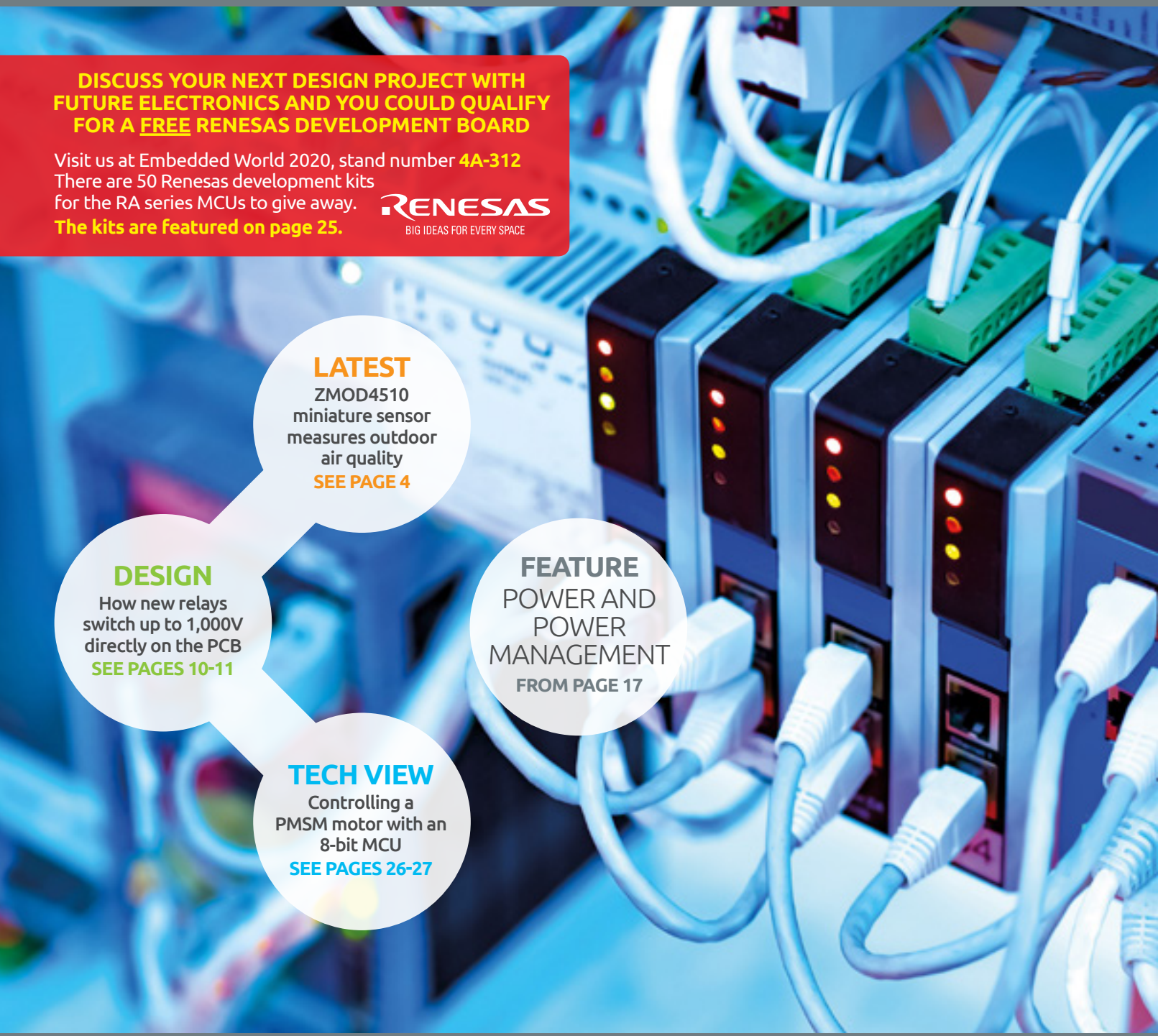
# FTM

FUTURE TECHNOLOGY MAGAZINE

FUTURE ELECTRONICS

20-i **EMEA**





# Family of automotive TVS diodes now available in SMA, SMB and SMC packages

**Diodes Incorporated has introduced 84 new automotive-qualified Transient Voltage Suppression (TVS) diodes packaged in a choice of SMA, SMB or SMC packages.**

These devices are intended for use in a wide range of automotive applications, in which they protect sensitive circuits such as Electronic Control Units (ECUs) from powerline transients generated by inductive switching at the alternator or at an electric motor.

Automotive diodes: Supplied in unidirectional and bidirectional versions

The reverse stand-off voltage values available in the new TVS products range from 14V to 36V. They are supplied as both unidirectional and bidirectional devices. Power dissipation ratings, tested for 10/1,000µs pulses, are 400W for the SMA package, 600W for the SMB and 3,000W for the SMC.

All parts conform to the specifications of the ISO 7637-2 automotive standard for load dumps, pulses 1, 2a, 2b and 3. The diodes are also compatible with the ISO 10605 ESD standard.

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

APPLICATIONS
- Automotive systems:
  - ADAS
  - Infotainment systems
  - Navigation systems
  - Heating, ventilation and air conditioning
  - Body control modules

FEATURES
- AEC-Q101 qualified
- PPAP support
- High forward surge current capability
- Excellent clamping capability

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# New MCU kits and firmware accelerate development of digital-power and motor-control projects

**STMicroelectronics has extended the applications support for its STM32G4 microcontrollers, supplying digital-power and motor-control Discovery kits and adding new firmware examples in the latest v1.1.0 of its STM32CubeG4 software package.**

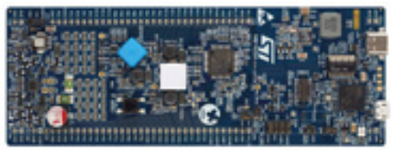
The new B-G474E-DPOW1 Discovery kit is a complete digital-power platform containing the STM32G474RE MCU, a buck-boost converter with on-board resistive loads, a high-brightness RGB LED controller for lighting-power designs, user LEDs and buttons, flexible power and data connections, and debugging support.

Designers can use the kit to explore the capability of the MCU's Filter-Math Accelerator (FMAC) to handle functions such as 3p/3z compensation and to ensure high efficiency across the load range. It can also perform digital slope compensation, freeing CPU cycles for other functions.

ST has also introduced the B-G431B-ESC1 Discovery kit, a complete reference design for Electronic Speed Control (ESC) of three-phase Brushless (BLDC) and permanent magnet synchronous motors drawing up to 40A. Containing the STM32G431CB MCU and a three-phase motor-driver stage based on ST's STripFET F7 power MOSFETs, it can implement either sensorless Field-Oriented Control (FOC) or six-step commutation. On-board features include electrical and thermal protection, interlocking high-side/low-side drivers, and support for motor sensors and three-shunt current sensing.

ST has also extended the STM32G4 series, adding a new 14mm x 14mm, 128-pin LQFP package. The STM32G4 MCUs offer rich analog features as well as high-resolution timers, dual-bank Flash for secure live firmware upgrades, low power consumption in dynamic mode, and a 125°C maximum ambient temperature option.

**FREE DEVELOPMENT BOARDS**
**Orderable Part Numbers:**
**B-G474E-DPOW1 and B-G431B-ESC1 Discovery kits**
**Apply at: www.my-boardclub.com**


Digital power kit includes a buck-boost power converter and resistive loads

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APPLICATIONS
- Drones
- Small electric vehicles
- Radio-controlled vehicles

FEATURES (B-G474E-DPOW1)
- STM32G474RET6 Arm® Cortex®-M4 core-based MCU
- Reset push-button
- Board connectors:
  - USB Type-C™
  - USB micro-B
  - 2 x 32-pin header, 2.54mm pitch, daughterboard extension connector for breadboard connections
- On-board STLINK-V3E debugger/programmer with USB re-enumeration capability
- Four-direction joystick with Selection button
- Comprehensive free software libraries and examples
- Supports IAR™, Keil® and GCC-based IDEs
- Handled by STM32CubeMonitor-UCPD software tool

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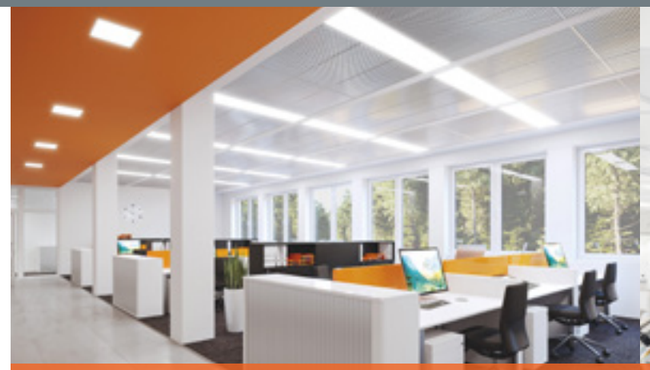


# NFC-enabled drivers provide smart data for easy commissioning of LED luminaires

*Advanced DALI interface also supports predictive maintenance of systems using OPTOTRONIC LED drivers*

**OSRAM has introduced OPTOTRONIC LED drivers which include an NFC transceiver to accelerate luminaire manufacturing and commissioning, and to provide a simple wireless interface for maintenance technicians to download operating data.**

The drivers' NFC interface enables luminaire manufacturers to eliminate the common practice of setting the output current with resistors. This practice is outdated, as the assembly of resistors on to a luminaire's PCB requires manual labor, and resistors are more expensive, less accurate and less flexible than software programming. Users are increasingly demanding customized settings in modern LED luminaires, and software programming also provides more features to enable manufacturers to meet their requirements.

Standard NFC readers support a quick, wireless process for configuring drivers in the factory, without needing a connection to mains power: the connection is made simply by placing the LED driver on top of the NFC interface. In most cases, it is possible to read out the driver's configuration even after it has failed.

The new OTi DALI NFC LED drivers not only support advanced manufacturing operations, they also enable luminaire users to prepare their lighting installations for the IoT, thanks to their provision of luminaire information and monitoring data based on a standard DALI interface which conforms to the latest DiiA specifications, parts 251, 252 and 253.

### Data for smart lighting systems

When integrated into a suitable lighting management system, the OTi DALI NFC LED drivers can supply valuable luminaire data via the DALI interface, including operational data such as lumen output, CRI and color temperature. In addition, energy consumption data provided by the LED drivers can serve as a basis for optimizing energy efficiency.

Luminaire- and driver-related data, such as operating hours and switching cycles, also provide valuable inputs for maintenance and diagnostic functions. In production, the luminaire manufacturer can store data such as model, power and service life in the LED driver; a lighting management system can retrieve these data once the luminaire is installed.

Whenever a luminaire fails, all the relevant data can be read out, so that a replacement luminaire with the correct configuration can be ordered immediately and quickly installed. Diagnostic data also support building operators' preventive maintenance programs.

OSRAM's NFC LED drivers offer additional operation and status information beyond the data sets specified in the DALI standard, such as energy consumption, power and operating time. By using these data, it is possible to perform predictive maintenance for more reliable lighting operation.

These data can also be presented graphically in OSRAM's Tuner4TRONIC software.

### In-field reprogramming

To speed up the installation and maintenance of LED luminaires on the field, smartphones with integrated NFC antennas can be used to program selected OSRAM indoor compact NFC LED drivers. Typical examples could be the adjustment of light output or changing the dimming times or levels. Using the copy and paste functionality of the Tuner4TRONIC-Field app, the settings of one luminaire can be transferred to a new one in a matter of seconds.

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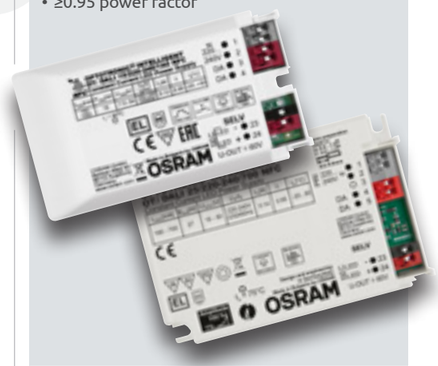
APPLICATIONS
- Variable-current luminaires
- Indoor lighting installations
- Luminaires in protection classes I and II
- Downlights
- Spotlights
- LED panels

FEATURES
- Maximum output power: 10W, 15W, 25W, 35W or 50W
- Range of programmable features:
  - Constant lumen output
  - Soft switch off
  - Dim-2-Dark
  - TouchDIM
- Low ripple current for high quality of light
- Input-voltage range: 198V to 264V AC
- ≥0.95 power factor

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# Launch of first digital outdoor air-quality sensor for high-volume products

RENESAS
BIG IDEAS FOR EVERY SPACE

**Integrated Device Technology, a Renesas company, has launched the first software-upgradeable, digital outdoor air-quality sensor for high-volume applications.**


The IDT® ZMOD4510 sensor can detect Ozone ($O_3$) and Nitrogen Oxide (NOx) gases, two common causes of poor outdoor air quality. The ZMOD4510 is highly sensitive: it can measure combined $O_3$ and NOx in concentrations as low as 20 parts per billion (ppb). The air-quality ratings from the ZMOD4510 are correlated with the US Environmental Protection Agency's (EPA) air quality index for measuring $O_3$ and NOx.

Small and flexible, it is ideal for use in industrial and consumer devices. In heating, ventilation and air-conditioning systems, industrial cameras, home automation and smart air purifiers, the ZMOD4510 can perform highly sensitive and reliable measurement of outdoor air quality over a long lifetime.

The ZMOD4510 is also easily integrated into end-product designs thanks to IDT's provision of compiled firmware. All ZMOD4510 sensors are also supplied factory-calibrated, which lowers the customer's production costs. The sensor is calibrated electrically and with gas to ensure consistency from lot to lot, an important advantage for manufacturers with long production runs. ZMOD4510 devices are also highly resistant to siloxanes for high reliability when used in harsh environments.

The ZMOD4510 is the newest member of IDT's ZMOD™ family of gas sensors. The ZMOD4510 should be used for measuring outdoor air quality, while the ZMOD4410 should be used to measure indoor pollutants such as volatile organic compounds. When used together, they support a smart systems approach in heating, ventilation and air-conditioning equipment, and help to ensure healthy air quality.

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## APPLICATIONS

- Personal air-quality monitors
- Weather stations
- Smart city equipment
- Industrial monitoring systems
- Smart HVAC systems

## FEATURES

- Small 3mm x 3mm x 0.7mm package
- $I^2C$ interface to host microcontroller
- Software-upgradeable
- Adjustable resolution for optimizing speed and resolution
  - 16-bit maximum resolution

**FREE DEVELOPMENT BOARD**

**The ZMOD4510-EVK-HC board may be connected to a PC via a bi-directional USB connection, and the sensor tested with the evaluation software which Renesas supplies. The output is shown as a raw resistance signal, as the measured concentration for $O_3$ and NOx combined, and as an outdoor air-quality rating consistent with the EPA's standard.**

**Orderable Part Number: ZMOD4510-EVK-HC**

**Apply at: www.my-boardclub.com**

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# New IR sensor modules perform presence detection at a range of up to 30m

VISHAY

**Vishay Intertechnology's latest series of Infrared (IR) sensor modules for use in proximity sensing and presence detection offer improved immunity to optical interference and more stable performance over their temperature range.**

The new Vishay TSSP9xxx AGC 0 devices perform presence and proximity sensing at a distance of up to 2m. When used in light-curtain and perimeter-guard applications, their range extends up to 30m.

Compared to earlier devices, the new fixed-gain sensors provide higher resistance to interference without generating spurious signals. In addition, they offer an almost constant detection threshold over their operating-temperature range of -25°C to 85°C. They can also detect a valid IR signal at a higher DC illuminance.

The TSSP9xxx AGC 0 modules, which integrate a PIN photodiode and sensor IC into a single package, are well suited to fast proximity applications which must detect an object within around 15ms. Emitting a burst pattern of variable intensity, they offer a reaction time of just 300µs.

The devices are ideal for use in toys, drones, robots and vicinity switches to sense the distance to objects. They may also be used as reflective sensors in hand dryers, towel or soap dispensers, water taps, toilets, vending machine fall detectors, and security and pet gates.

The modules operate over a supply voltage range of 2.0V to 3.6V, feature a low supply current of 0.8mA, and offer carrier frequencies of 38kHz and 56kHz. The sensors are designed to receive IR pulses from an emitter with a peak wavelength of 940nm.

The TSSP9xxx devices are insensitive to supply-voltage and ripple noise, and provide shielding against EMI, while an IR filter suppresses visible light.

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## APPLICATIONS

- Toys • Drones • Robots • Vicinity switches
- Sanitary equipment
- Vending machines
- Security equipment and barriers

## FEATURES

- Choice of five package types:
  TSSP930xx in Minimold, TSSP940xx in Mold
  TSSP950xx in Heimdall, TSSP960x in Panhead
  TSSP980xx in Minicast

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# Conductive polymer-aluminum capacitors feature low ESR and high capacitance values

*High-temperature endurance makes devices ideal for demanding applications*

Panasonic INDUSTRY

**Panasonic Industry Europe has added a new series of long-life, surface-mount products to its OS-CON line of conductive polymer-aluminum solid capacitors.**

Available with a rated voltage of 2.5V, 6.3V or 16V DC, the new SVPT products feature high capacitance ratings ranging from 100µF to 560µF, and low ESR.

The components are able to withstand operation at 105°C for up to 20,000 hours, making them ideal for use in demanding power-system applications. The capacitors have a long rated lifespan.

Like all OS-CON capacitors, the SVPT series devices feature excellent noise-reduction capability and frequency characteristics. Their ESR values are also very stable over their operating-temperature range of -55°C to 105°C, since their electrolyte is solid.

There are three parts in the SVPT series. All are supplied in a C65-sized cylindrical case which is 6.4mm long and has a diameter of 6.3mm.

| Part Number | Rated Voltage (V DC) | Rated Capacitance (µF) | Equivalent Series Resistance (mΩ) | Rated Ripple Current ($mA_{rms}$) | Leakage Current (µA) |
|---|---|---|---|---|---|
| 16SVPT100M | 16 | 100 | 24 | 2,490 | 300 |
| 2R5SVPT560M | 2.5 | 560 | 16 | 3,500 | 300 |
| 6SVPT330M | 6.3 | 330 | 15 | 3,390 | 415 |

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## APPLICATIONS

- Servers
- Base transmitter stations
- Smart meters
- Power management systems

## FEATURES

- 20% capacitance tolerance at 20°C/120Hz
- 1,000h endurance in damp heat test at 60°C
- 0.32g in weight

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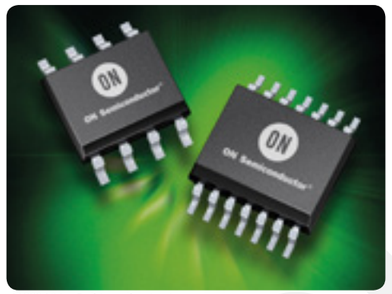
# Precision op amps feature low noise and low drift

ON Semiconductor®

**ON Semiconductor's NCS2191x family of high-precision operational amplifiers combine a low maximum input-offset voltage of just 25µV with low-noise operation to provide for accurate signal-conditioning in demanding sensing applications.**



NCS2191x: Rail-to-rail output

The NCS2191x devices' noise performance is specified as 22nV/√Hz, ensuring minimal distortion of the input signal. The clean operation of the op amps is also very stable: maximum input-offset drift is just 0.085µV/°C.

The op amps' rail-to-rail output swings to within 10mV of the rails. Gain-bandwidth product is 2MHz.

The NCS2191x family is available in three versions and in various package styles: the single-channel NCS21911, the dual-channel NCS21912 and the quad-channel NCS21914. The NCV2191x parts are automotive-qualified versions of these op amps.

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## APPLICATIONS

- Temperature monitoring
- Transducer systems
- Electronic scales
- Medical instrumentation
- Current sensing
- Automotive systems

## FEATURES

- Supply-voltage range: 4V to 36V
- 570µA maximum quiescent current
- 3pF input capacitance
- 1.6V/µs slew rate
- 3kV ESD rating on the human body model
- Operating-temperature range: –40°C to 125°C

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# Certified Wi-Fi module ideal for IoT devices and industrial systems

WIZnet

**WIZnet's WizFi360 is a complete Wi-Fi® networking module with a built-in microcontroller core, for use in IoT devices and industrial applications.**

The WizFi360 includes a 2.4GHz transceiver and supports the IEEE 802.11b/g/n versions of the Wi-Fi networking standard. Its maximum UART baud rate is 2Mbits/s. It is supplied with FCC, CE, KC and J-MIC certificates.

The Wi-Fi module supports the TCP, UDP, MQTT and DHCP communications protocols using AT commands. Featuring an Arm® Cortex®-M3 core, it works as a serial interface-to-Wi-Fi bridge.

The WizFi360 is available in two versions:

- WizFi360-PA has an on-board PCB antenna. It measures 24mm x 16mm x 3mm.
- WizFi360-CON has an IPEX connector for an external antenna. Its dimensions are 17mm x 16mm x 3mm.

The WizFi360's hardware and software can be customized to meet user-specific requirements. Custom variants available to order include the WizFi360io-H, an XBee header-compatible module, and the WizFi360io-C, which features a 5V UART interface.

WizFi360 is also certified for the Microsoft Azure cloud computing platform, enhancing interoperability and allowing for faster time to production.

WizFi360-EVB: Compatible with the Arduino board standard

**FREE DEVELOPMENT BOARDS**

**WizFi360-EVB-Mini is a compact evaluation board which can be easily integrated and programmed to reduce development time and cost.**

**Orderable Part Number: WizFi360-EVB-Mini**

**The WizFi360-EVB-Shield is an industrial-grade development board for testing and verification of the WizFi360 Wi-Fi module, and can be used as an Arduino shield.**

**Orderable Part Number: WizFi360-EVB-Shield**

**Apply at: www.my-boardclub.com**

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## APPLICATIONS

- IoT devices
- Air/water purifiers
- Smart devices
- Industrial systems

## FEATURES

- Firmware may be upgraded over-the-air or via UART interface
- Station, SoftAP and SoftAP+Station operating modes
- Supports AirKiss with app
- WPA-PSK or WPA2-PSK encryption
- Operating-temperature range: -40°C to 85°C


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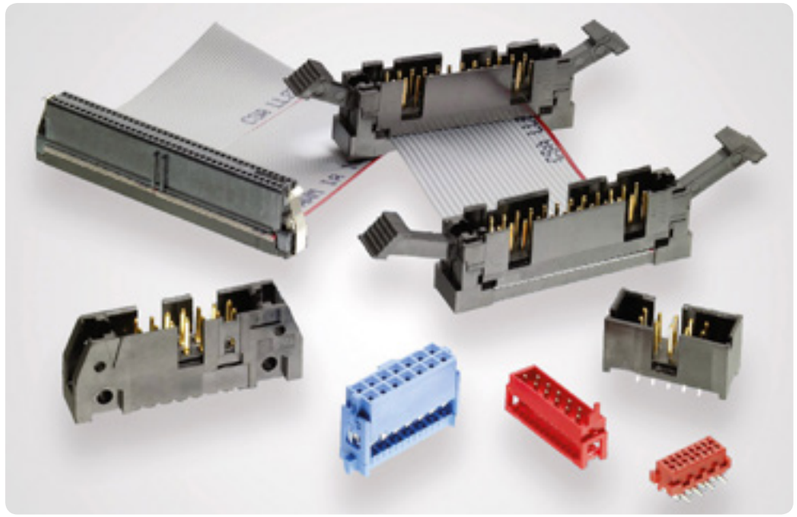
# Ribbon cable connectors enable board-to-board connections

TE connectivity

**AMP-LATCH connectors from TE Connectivity (TE) are ribbon cable-to-board devices used to make a connection between ribbon cable and PCB circuits. Embedded in electronics equipment, the AMP-LATCH connectors may be used to connect one board to another, or one subsystem to another.**



AMP-LATCH connectors: No need to strip or prepare wire on the assembly line

The most commonly used AMP-LATCH products terminate to a 0.050" (1.27mm) ribbon cable pitch. TE also supplies AMP-LATCH connectors which terminate to 0.025" (0.64mm) and 0.39" (1.0mm) ribbon cable.

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## APPLICATIONS

- Computers
- Business equipment
- Medical equipment

## FEATURES

- Mass termination capabilities
- No need to strip or prepare wire
- Labor savings
- 1A current rating
- Operating-temperature range: -65°C to 105°C
- UL 94V-0 flammability rating
- Contact materials: phosphor bronze or brass

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# Connector provides ready-made interface for sensors in lighting systems

TE connectivity

**TE Connectivity's LUMAWISE Endurance S Connector System is an ecosystem of products designed for sensor- and other control-system applications. Now, the Endurance S ecosystem has been expanded to enable additional use cases.**

The sensor-ready components offer all the original Endurance S benefits, and now also feature extended electrical ratings, plus alternate key combinations for protected mating.

The compact design of the LUMAWISE connectors is UV-resistant and attractive. It may be mounted facing upwards, downwards or sideways. The keyed mating combinations are flexible, and enable lighting-system designers to create differentiated product designs.

The sealing cap or base and receptacle may be securely mated with a low-torque action. An optional vent gives the user the ability to minimize condensation.

LUMAWISE Endurance S: UV-resistant for use in applications exposed to sunlight

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## APPLICATIONS

- Street lighting
- Area lighting
- Sensor-ready control applications
- Outdoor luminaires
  - Wall packs
  - Parking lots
  - Walkways
- Photo-controls
- Central management systems
- City management systems

## FEATURES

- Contact rating: 1.5A, 30V
- 10kV dielectric withstand voltage to mounting surface
- Four-pole contacts

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# Waterproof circular connector offers high current capacity in harsh applications

HIROSE ELECTRIC EUROPE B.V.

**Hirose has introduced the HR41 series of high-current circular connectors for outdoor, harsh environments.**

The lightweight circular housing is robust and resistant to harsh environmental conditions. Tests verify its reliability in:

- Sunlight: tested for 2,000-hour operation
- Salt spray: tested for 1,500-hour operation
- Water intrusion: IP68 rating

In addition, the HR41 connectors withstand 15kV lightning surges.

The connector range consists of bayonet-locking, cable-mount plugs, and panel-mount receptacles which can handle currents up to 24A.

The HR41 provides for easy field assembly with a standard crimp tool. A visual and tactile raised mating indicator on the plug and receptacle aids the mating operation in dark conditions.

The cable can be clamped and the waterproof gasket sealed in one simultaneous step without additional tooling. The anti-loosening mechanism ensures that the tightening ring securing the cable will not come loose during operation.

The innovative connector design incorporates a sequential contact structure. The contacts are arranged in sequence to ensure the ground contact is connected before the power contacts during the mating process to ensure safe connection. In addition, housing walls protect the contacts and ensure a long creepage distance.

A contact removal tool is available to quickly remove the contact from the housing.

HR41 connector: Ground contact connects before power contacts

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## APPLICATIONS

- LED lighting
- Tunnel lighting
- Construction lighting
- Marine lighting
- Offshore lighting
- Robots
- Electronic toll systems
- Industrial equipment

## FEATURES

- Contact positions: 3, 5
- Cable size: AWG 10 to 18
- Voltage rating: 1,000V AC/DC
- Operating-temperature range: -40°C to 105°C
- UL and TÜV recognised

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# USB connectors support data-transfer rates up to 480Mbits/s

**TE Connectivity (TE), a standing member of the USB Implementers Forum (USB-IF) industry consortium, offers a wide range of connectors which conform to the specifications of USB standards.**

TE's products accommodate the two differentially-driven data wires which provide bidirectional, simultaneous signals in USB 2.0 connections operating at data-transfer rates up to 480Mbits/s. The connectors are also compatible with USB 1 interfaces operating at rates of 1.5Mbits/s or 12Mbits/s.

TE provides USB connectors in the various USB form factors: standard A and B, mini B, and micro A/B and micro B sizes.

TE's standard USB connectors are also available in locking versions, and its standard and micro USB connectors are available in latching versions.

TE USB connectors: Locking and latching versions available

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## APPLICATIONS

- Desktop and laptop computers
- Keyboards/mice/joysticks
- Printers/scanners
- Game ports
- Digital audio
- Modems
- Portable storage devices.
- Mobile phones
- GPS devices
- MP3 players

## FEATURES

- Cable-mount overmold plug kits for all USB sizes and types
- Consolidates serial parallel, keyboard, mouse and game ports
- Compatible with asynchronous and isochronous data-transfer methods
- Polarized for proper orientation
- Plug-and-play capability
- Hot pluggable
- Supports battery charging

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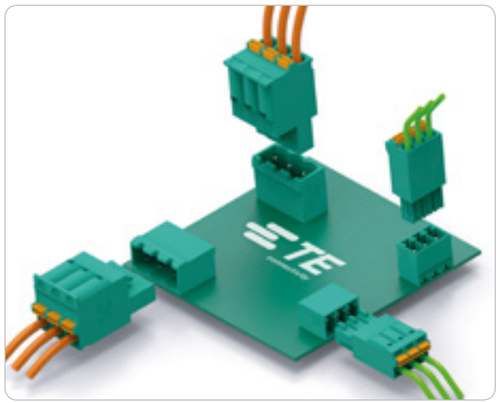
# Push-in clamp connectors give 80% reduction in installation time

**TE Connectivity (TE) is expanding its Buchanan portfolio with new push-in clamp termination PCB connectors which enable tool-less insertion of ferruled and unferruled wires. This reduces the labor time in installation by as much as 80% compared to the installation of traditional screw-clamp terminations.**



TE push-in PCB connectors: 3.5mm or 5.0mm pitch

The design of the PCB connectors in a 3.5mm or 5.0mm pitch consists of two-piece plug connectors with straight and right-angled shrouded headers. The wide range of options for pitch and number of positions gives considerable design flexibility.

TE's Buchanan clamp connectors are intended for use in high-density signal and power applications. The maintenance-free push-in clamp technology gives higher reliability and longer uptime in manufacturing process equipment and control devices.

Products with Buchanan push-in clamp technology are also suitable for use in harsh environments.

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## APPLICATIONS

- Servo/inverter drives
- Industrial controls
- Programmable logic controllers
- Safety controls and modules
- Power-supply units
- Heating, ventilation and air-conditioning units

## FEATURES

- 2 to 16 poles
- Solid or stranded wire
- Operating-temperature range: -40°C to 105°C
- >2,000MΩ insulation resistance
- UL recognized

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# Launch of smallest automotive-grade inductors for under-the-hood applications

**Vishay Intertechnology has released its smallest automotive-grade IHLP® high-current inductors.**

Supplied in a 3.3mm x 3.3mm (1212) case, these inductors enable system designers to save space in next-generation ADAS and sensor applications.

The IHLP-1212AB-5A is rated for operation at a temperature of up to 155°C, and has a low 1.2mm profile. Vishay is also introducing the IHLP-1212AZ-A1 and IHLP-1212AB-A1, which have a lower 1.0mm profile, and offer a maximum operating temperature of 125°C.

The AEC-Q200-qualified devices are optimized for energy storage in DC-DC converters operating at switching frequencies up to 5MHz. They also provide excellent attenuation of noise in high-current filtering applications.

IHLP inductors support switching frequencies up to 5MHz

| Part Number | IHLP-1212AZ-A1 | IHLP-1212AB-A1 | IHLP-1212AB-5A |
|---|---|---|---|
| Inductance Range (µH) | 0.10 to 1.0 | 0.10 to 1.2 | 0.10 to 1.2 |
| Typical DC Resistance (mΩ) | 8.60 to 63.61 | 8.98 to 60.16 | 7.01 to 53.49 |
| Maximum DC Resistance (mΩ) | 9.20 to 66.38 | 9.61 to 62.79 | 7.50 to 57.65 |
| Heat Rating Current (A) | 3.47 to 10.50 | 3.81 to 10.48 | 3.98 to 11.50 |
| Saturation Current (A) | 5.23 to 19.21 | 5.61 to 18.92 | 3.84 to 11.79 |
| Self-resonant Frequency (MHz) | 95 to 475 | 79 to 419 | 82 to 455 |

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

## APPLICATIONS

- Noise suppression for motors
  - Windshield wipers
  - Power seats and mirrors
  - Heating and ventilation fans
- High-intensity discharge lighting
- Engine- and transmission-control units
- Diesel injection drivers
- DC-DC converters for entertainment and navigation systems
- LED drivers

## FEATURES

- Very low buzz noise
- ±20% inductance tolerance
- Handles high transient-current spikes without saturation

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DESIGN NOTE FUTURE ELECTRONICS

# High-power relays:

## the easy way to switch high loads directly on the PCB

Panasonic INDUSTRY

**As global awareness about ecological and energy concerns broadens, newly developed relays that meet the changing needs of the energy and automotive sectors have been in increasing demand. Energy generation from wind and solar panels is becoming more prevalent, as private households install their own photovoltaic systems and connect them with battery storage systems. At the same time, electromobility is promising to usher in a new age of transportation.**

These technologies create a need for new switching solutions: relays used in these applications need to provide higher switching capacities and smaller dimensions. Now Panasonic Industry offers a solution which switches high loads directly on the PCB: the HE series for high-power applications.

### Switching high loads on the circuit board

The HE-N series can withstand loads up to 120A, and the HE-V handles loads up to 1,000V DC in ambient temperatures of up to 85°C. These relays are no longer responsible just for controlling a secondary contactor, switching between 500mA and a few amperes; they become the central load-carrying element, in many cases eliminating the need for other contactors. This makes it easier than ever to switch high currents on the PCB, and helps the power-system designer to:

- Save space
- Simplify assembly and installation
- Reduce energy consumption
- Extend service life
- Reduce cost

The HE series was designed for applications which demand electrical separation, carry high currents or require an emergency cut-off. All the HE relays can switch currents between 20A and 120A, at voltages ranging from 277V AC to 1,000V DC, as shown in Figure 1. The following application examples show how the HE series high-power relays can be integrated into high-performance board designs.

### Solar inverters

Wall-mounted solar inverters are becoming smaller and lighter, while at the same time higher ratings of between 60kW and 100kW are becoming more common. This means the relays in these inverters need to offer higher switching capacities.

Inside the converter, very high currents flow during the charging of the capacitor. This component is used to prevent voltage fluctuations on the input side when a large load is connected to the output side. To limit the inrush current, a pre-resistor is used to pre-charge the capacitor with approximately 10A for 0.5s. While the inverter usually switches currents via a semiconductor, a relay is used to bypass it during the pre-charging process. As soon as the current settles, the relay closes and the current flows through the closed contacts.

| Series | HE-V | HE-S | HE-Y5 | HE-Y6 | HE-N |
|---|---|---|---|---|---|
| Switching Current | 20A | 35A | 48A | 90A | 120A |
| Dimensions | 41 x 50 x 39.4mm | 30 x 36 x 40mm | 38 x 33 x 36.3mm | 38 x 33 x 38.8mm | 50 x 40 x 43mm |
| Holding Power | 210mW | 170mW | 310mW | 310mW | 400mW |
| Contact Gap | 3.8mm | 3.2mm | 2.5mm | 3.0mm | 3.6mm |
| Ambient Temperature | -40°C to 85°C | -40°C to 85°C | -40°C to 85°C | -40°C to 85°C | -40°C to 85°C |
| Contact Arrangement | 2FormA | 2FormA 2FormA1FormB | 1FormA | 1FormA | 1FormA |
| Maximum Switching Voltage | 1,000VDC | 480VAC | 277VAC | 277VAC | 800VAC |

Fig. 1: Key features of the HE series relays from Panasonic

The reasons for using a relay in this instance are simple: electromechanical relays such as the HE-Y5, shown in Figure 2, have a much lower and more stable contact resistance than high-power semiconductors. Use of a relay in this case keeps unwanted effects such as power dissipation and heat generation to a minimum.

For switching currents above 60A, inverter designers have generally used industrial contactors. As the IEC 62109-1 solar industry standard requires single-fault protection when inverters are connected to the mains power grid, two separately controlled contacts per phase must be connected in series. This ensures that, if one contact is welded, the second contact can still open safely.

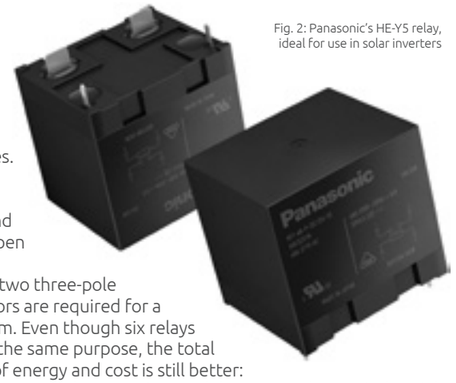

Fig. 2: Panasonic's HE-Y5 relay, ideal for use in solar inverters

This means that two three-pole industrial contactors are required for a three-phase system. Even though six relays are necessary for the same purpose, the total balance in terms of energy and cost is still better: this is because the HE-Y5 relay occupies much less space than an industrial contactor, dissipates much less power and costs much less. While the energy savings at each single relay might be small, the total energy saved is considerable across a large population of installed inverters.

This justifies the choice of a high-quality relay in place of a secondary contactor.

### Vehicle charging stations

The electric vehicle market has seen rapid growth since governments worldwide have committed to reducing $CO_2$ emissions. This has led to a new focus on the need to build out vehicle charging infrastructure, both public charging points and household systems.

An array of mains isolating relays is currently required for safe recharging. The specification of the isolation depends on the charging system and on national standards. For instance, the IEC 61851-1 standard distinguishes between charging modes on the basis of their installation and system components. All however require a switching device with power ratings ranging from 16A/250V AC to 63A/380V AC. This is used to connect and disconnect the electricity supply system to and from the vehicle. The latter is usually the case when a fault occurs, such as when a creepage current is detected.

Panasonic's HE-S power relay has been approved for many charging stations; it is especially suited to wall-mounted systems with charging capacities of up to 22kW or 43kW. It can carry high charging currents at ambient temperatures of 85°C for several hours, even under direct sunlight.

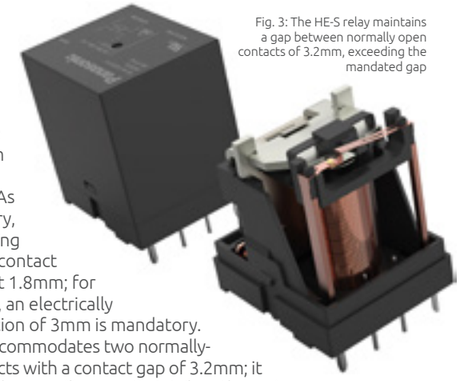

Fig. 3: The HE-S relay maintains a gap between normally open contacts of 3.2mm, exceeding the mandated gap

The relay's lowest holding power is 170mW. It also features a clearance and creepage distance of more than 8mm between the coil and the contacts. As in the solar industry, automotive charging systems require a contact distance of at least 1.8mm; for many applications, an electrically protective separation of 3mm is mandatory.

The HE-S relay accommodates two normally-open bridge contacts with a contact gap of 3.2mm; it is also available with an auxiliary contact. When the main contacts are welded, this auxiliary contact retains an opening of at least 0.5mm and can switch 1A at 230V AC.

This configuration is certified for mirror contacts by the VDE in accordance with the IEC 60947-4-1 standard. As the auxiliary contact is switched via a separate actuator, it is electrically isolated from the contact set, its connections are routed outwards, parallel to the coil terminals. This, combined with a large contact gap, makes the HE-S perfectly suited for automotive charging stations.

### Battery storage

Given the rate at which solar panels are being installed in homes around the world, it is hardly surprising that sales of battery-based fixed energy-storage systems are growing.

Relays which are used for charging and discharging batteries must carry high currents for a long time. Even more important, however, is that the relay be able to cut off even a high current safely and reliably. An emergency cut-off occurs when equipment fails or a malfunction occurs. When lightning strikes a solar panel which is connected to a battery storage system, the resulting overcharge can cause damage and poses a safety hazard. DC cut-off is therefore required for all major solar and battery storage systems.

Power relays such as the HE-V can be used for cutting off both positive and negative lines on the DC side rated for up to a maximum of 1,000V DC. The relay uses a blow-out magnet mechanism and serial contact connection to maintain the required arc and gap length for high DC voltage cut-off. If a problem occurs in a photovoltaic system, the relay can short the connection between the panel and junction box.

The same principle can also be applied to increase energy efficiency when a panel is in the shade. Furthermore, the HE-V power relay prevents inrush currents to the battery, and supports power cut-off operation effected by the push of an emergency button.

The HE-S relay may be used for AC safety cut-off.

### Conclusion

With an improved internal architecture and compact design, the HE series relays from Panasonic are able to control high currents directly on the circuit board. They offer system manufacturers new opportunities to improve product designs and increase energy efficiency. By replacing secondary connectors with power relays mounted on the PCB, they can save space, energy and cost, without compromising on quality or performance.

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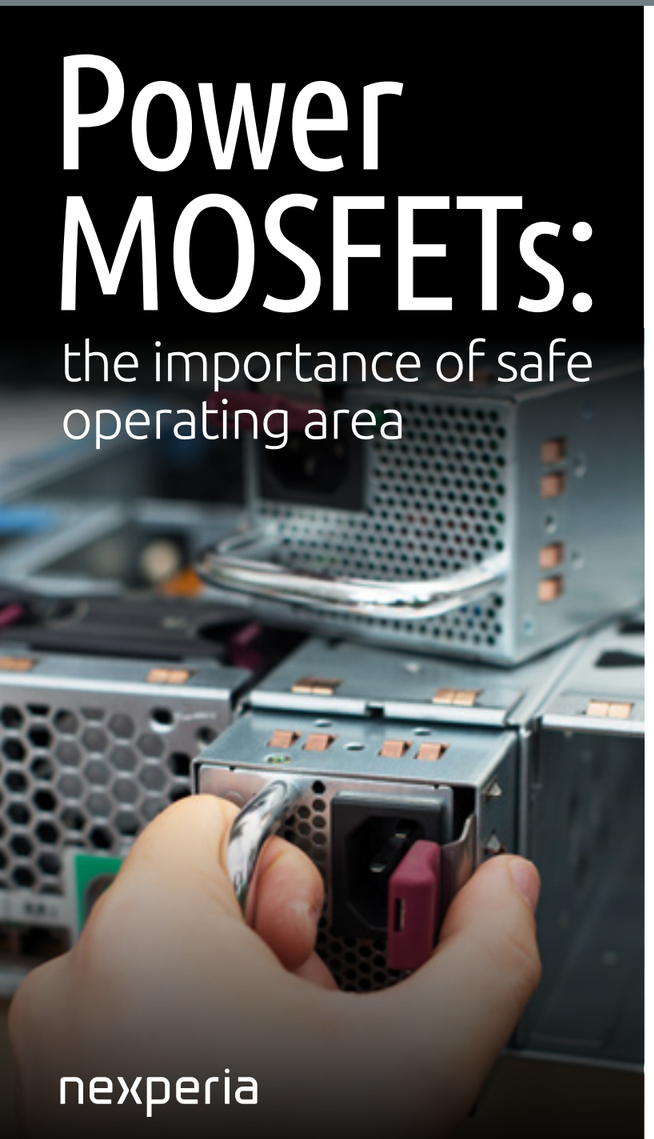
# Power MOSFETs:

## the importance of safe operating area



nexperia

**When MOSFETs are being evaluated for a high-power design, engineers often make their choice based on the parameter of on-resistance. Lower on-resistance means that the MOSFET will have a lower power loss, which in turn means it will generate less heat and provide for safer operation.**

However, a MOSFET's ability to handle a large current is not determined by its on-resistance alone, but also by its Safe Operating Area (SOA) rating. SOA, a characteristic specified in most MOSFET datasheets, is the amount of power which the device can handle for a period of time before failing. A strong SOA capability can make a power design more robust and reliable; conversely, a weak SOA rating indicates that a MOSFET is prone to failure under some expected fault conditions.

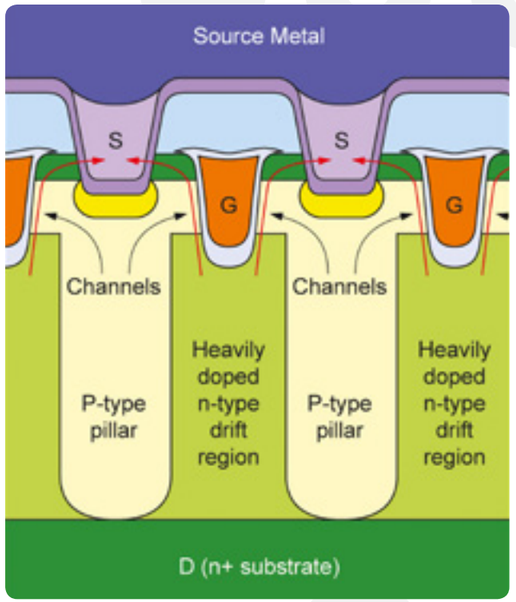



Fig. 1: Trench structure of a superjunction MOSFET

Some applications rely on a good SOA rating. For example, hot-swap power supplies will hold the MOSFET in linear mode at start-up to limit the in-rush current. Here, the MOSFET must handle a large amount of power for a short period of time to protect the load circuit: this calls for strong SOA performance.

Circuits which can encounter faults, such as power ORing or e-fuses, might be exposed to large fault currents for short periods of time: here too, the SOA rating is important. A MOSFET might fail if it cannot handle the power in the time needed to switch it off. In other words, during the fault and switch-off time, a MOSFET with a smaller SOA can fail, as it is incapable of handling the energy driven through it.

### What determines a MOSFET's on-resistance and SOA?

Most modern power MOSFET manufacturers use a variant of the trench design shown in Figure 1. To turn the device on, the gate has a voltage applied to it: this creates current carriers in the channel which connects the Drain and Source of the device. Each gate trench has two channels carrying current, one on each side of the trench. Applying a larger gate voltage creates more charge carriers in the channels, which in turn reduces on-resistance.

Another way to reduce on-resistance is to put more trenches in parallel. The effect is the same as when resistors are inserted in parallel in a circuit: adding trenches in parallel decreases on-resistance. To reduce on-resistance even more, trenches can be placed closer together to allow for more paralleling.

The trench itself acts as a heat-sink, allowing heat to pass through to the device's package. Narrowing the trenches impairs thermal performance, and this reduces the SOA. This creates an inverse correlation between these two aspects of MOSFET performance: improving on-resistance tends to impair SOA.

### What happens if SOA capability is exceeded?

A MOSFET's SOA dictates the amount of power the device can tolerate over a period of time before failure. There are two failure modes: it can fail either because the entire MOSFET overheats, or because a part, or so-called 'hot spot', overheats.

As the temperature of the device rises, the value of its threshold voltage falls, which dictates when the device turns on and off. This has the effect of lowering the device's on-resistance. This effect is usually negated by a general increase in the MOSFET's on-resistance as temperature increases.

When a hot spot is created, however, the device turns on more in that region, allowing for more current to flow through it. This in turn heats the area up further, reducing the threshold voltage and increasing current until the device fails. This effect is called thermal run-away: the device will fail under this condition.

When the MOSFET manufacturer puts channels closer together to reduce on-resistance, it increases the risk of hot spots, since the narrower structure reduces the current-carrying capability and thermal performance of each trench. Overheating and thermal run-away are the signs of failure caused when a MOSFET operates outside its SOA.

During excessive heating or thermal run-away, the device may also suffer from a short-circuit failure. The device will then act as a three-terminal short-circuit, with the Gate, Source and Drain pins shorted together, until the large current causes it to burn.

### Avoiding the SOA/on-resistance trade-off

Nexperia has created superjunction MOSFET technology which avoids the trade-off between on-resistance and SOA to which competing MOSFETs are susceptible. The Nexperia superjunction structure extends SOA performance by adding extra p-doped trenches between the gate trenches, to provide more charge carriers in the channel. This reduces on-resistance without affecting the SOA.

Another method used is 'Super SOA', which extends SOA performance. This allows Nexperia MOSFETs to offer competitive on-resistance while providing up to ten times higher SOA performance than competitors' parts.

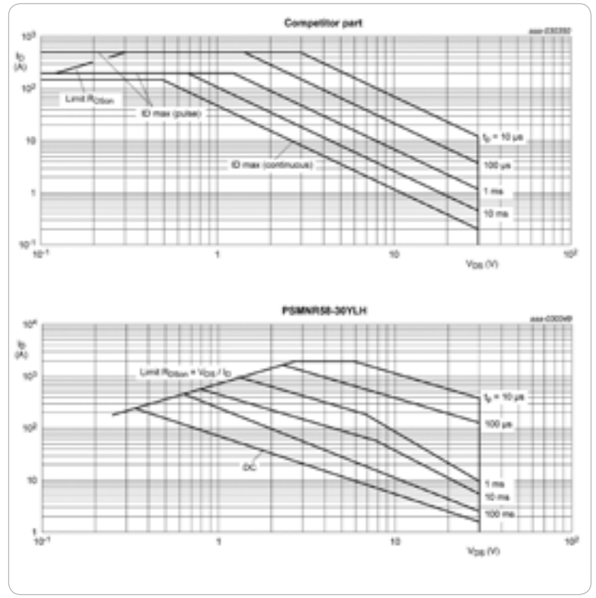



Fig. 2: SOA comparision of similar $R_{DS(ON)}$ devices

### Understanding SOA graphs

Figure 2 shows a comparison between a 0.67mΩ Nexperia MOSFET and a competing device with slightly lower on-resistance of 0.60mΩ. On the drain current, $I_D$, axis, the difference between the two devices is of an order of magnitude. Each curve on the graph shows the time for which the device can safely handle a specific voltage at a specific current before failing.

For example, for a duration of 10ms when the voltage over the device is limited to 12V, the Nexperia device can handle a current of 30A; the competing device can only handle 2A.

This indicates the strength of Nexperia's SOA performance. A wide range of applications might benefit from this characteristic. A good SOA capability gives the MOSFET a greater chance of surviving faults and unexpected transients which might damage or break another device.

Nexperia's range of NextPower Live MOSFETs, which have superior SOA capability, are listed in the table to the left.

| LFPAK56 Packaged Parts | Part Number | On-resistance at a Gate-source Voltage of 10V (mΩ) | Maximum Drain Current (A) |
|---|---|---|---|
| 25V | PSMNR51-25YLH | 0.47 | 380 |
| | PSMNR60-25YLH | 0.59 | 300 |
| | PSMN0R7-25YLD | 0.57 | 300 |
| | PSMN0R9-25YLD | 0.72 | 300 |
| | PSMN1R0-25YLD | 0.89 | 100 |
| 30V | PSMNR58-30YLH | 0.54 | 380 |
| | PSMNR70-30YLH | 0.66 | 300 |
| | PSMN0R9-30YLD | 0.65 | 300 |
| | PSMN1R0-30YLD | 0.79 | 300 |
| **$D^2PAK$ Packaged Parts** | **Part Number** | **On-resistance at a Gate-source Voltage of 10V (mΩ)** | **Maximum Drain Current (A)** |
| 100V | PSMN3R7-100BSE | 3.36 | 120 |
| | PSMN4R8-100BSE | 4.1 | 120 |
| | PSMN7R6-100BSE | 6.5 | 75 |

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DESIGN NOTE FUTURE ELECTRONICS

# Understanding transient voltage suppression in automotive systems

By Isaac Sibson
Automotive Applications Engineer,
Diodes Incorporated

**In automotive applications, it is essential to protect sensitive semiconductor components against power surges, transients and ESD events. A single transient voltage spike could easily damage a component or disrupt its operation, while even moderate electrical noise energy can interrupt digital communications.**

Transients can occur as momentary or continuous surges wherever high voltages are present, and can propagate through PCB tracks and cables. Momentary surges can easily reach a voltage of 3kV, and can often occur when inductive loads are switched, for example when a motor stops. As most modern ICs operate from low DC voltages, transients are a common threat both to these components and to the digital signals that they handle.

To stop these transients, a common solution is the Transient Voltage Suppressor (TVS). This article explains the characteristics of TVS devices, and discusses the way they may be used in automotive applications.

## TVS explained

The TVS is a solid-state device which provides a low-impedance path to earth for a transient voltage surge, but a high-impedance path at all other times. This allows supply voltages and signals to operate as intended, with no current routed via the TVS, but almost instantly clamps any high voltages safely, protecting sensitive components and routing the excess surge to earth.

A TVS is effectively a PN junction diode designed to enter avalanche mode, in which it can pass very high currents, when the potential on its cathode exceeds a preset level. This level will depend on the application, but the important characteristic is that the junction should break down quickly - in less than 1ns - so that the transient surge is handled rapidly enough to avoid damage. The TVS would normally be placed either in parallel with the load across the 0V and supply rail, between ground and a single-ended signal, or across a differential pair of signals.

A TVS resembles a Zener diode, but is designed to operate slightly differently. Instead of handling a steady voltage for a sustained period of time, a TVS is designed to break down quickly and absorb a high amount of energy for a short time.

## TVS in automotive applications

In most cars, the main voltage rail is at 12V DC, supplied by the rectified and regulated output of an alternator, as well as from the battery. The alternator is inductive, and therefore a potential source of transient voltages.

In addition, car manufacturers are adding more automatic features to their products. This means that new car designs include more electrical motors, for powering functions such as mirrors, windows and seats. The electrification of the drivetrain also means that mechanical systems such as water and oil pumps are driven by electric motors. These motors impose an inductive load on the system. They are therefore potential sources of transient voltages when loads are connected and disconnected.

Industry standards apply to the implementation of surge protection in the automotive environment, including ISO 7637-2 and ISO 16750. Figure 1 shows the shape of the test pulses on the 12V power rail specified by these two standards. Separately, national standards are also applied in some countries.

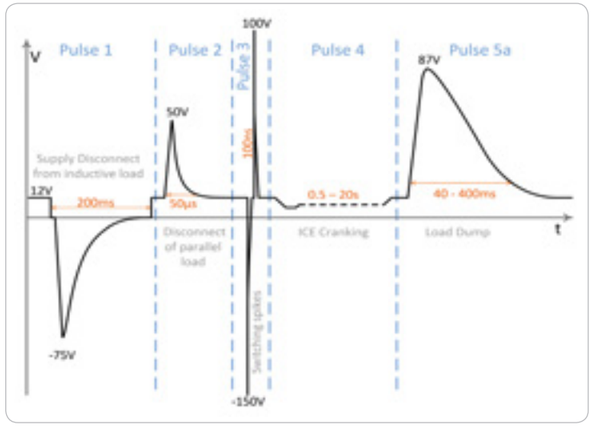


Fig. 1: TVS test pulses used in the automotive industry

The circuit protection system must be able to handle each of the pulses shown in Figure 1. This may call for several TVS devices to be distributed around the circuit. For example, there is likely to be a large main load-dump TVS located close to the alternator, as shown in Figure 2. The remaining energy would need to be dissipated by supplementary TVS protection devices at each module, and a system-level approach should be used to define the requirements for this.

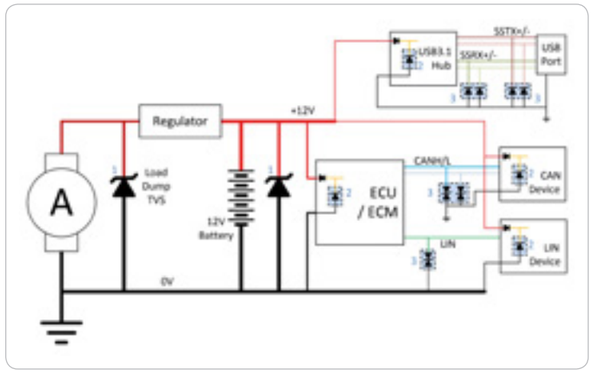


Fig. 2: A typical automotive application using large devices around alternator and regulator; TVS and reverse-polarity protection around modules; and protection around data buses

In harsh environments there will be a markedly larger area under the curve of the pulse, corresponding to more energy to be dissipated, compared to other use cases.

This holds true for automotive applications. In fact, large vehicles such as trucks and vans might operate from a 24V supply rail, which means that the protection must be able to deal with much larger amounts of energy.

## Protecting safety-critical signals with TVS devices

As modern vehicles include more and more data communications, the use of automotive-qualified TVS devices for CAN, FlexRay™ and LIN networks is becoming more common.

These networks are used to carry safety-critical communications between automotive modules. Their signals might be interrupted by noise at a lower energy than transient surges. The signals and modules must therefore be protected while avoiding any impact on signal bandwidth. As CAN and FlexRay are differential buses, they require a dual bidirectional TVS to protect both lines.

The simplest type of TVS is unidirectional, and is used when the area of the circuit to be protected is always positive, for example 0V to 5V. The unidirectional TVS is still able to protect against both positive and negative transients.

In contrast, a bidirectional TVS provides protection from transients across a split-rail system or differential signaling scheme, to protect against transients that are both positive and negative with respect to the signal. These devices can be either symmetrical, when the breakdown voltage is the same in both directions, or asymmetrical, when the reverse breakdown voltage is higher in one direction than in the other. A LIN bus, for example, would employ an asymmetrical bidirectional TVS because the signal line can easily fluctuate between -15V and 24V due to ground variance.

A vehicle might also include high-speed data buses such as USB and HDMI, which require low-capacitance TVS protection to preserve data integrity.

## The electrical characteristics of a TVS device

A TVS is specified based on the nominal working voltage. To protect a microcontroller operating at 3.3V, for example, a TVS of 3.3V could be used.

The actual parameter specified in this case is the reverse working voltage, $V_{RWM}$, defined as the voltage at which the device is guaranteed not to pass more than a minimal specified leakage current, $I_R$. This means that the reverse working voltage is the voltage at which the TVS has a negligible influence on the rest of the circuit.

The related breakdown voltage parameter, $V_{BR}$, is the point at which the device will conduct at least a specified minimum current IT. Figure 3 shows that this is measured at the value of IT at which the TVS starts to conduct strongly.

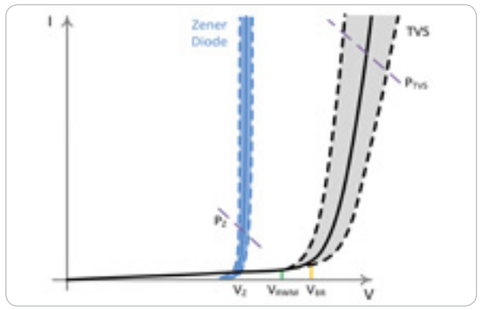


Fig. 3: A TVS operates over a shorter period than a Zener diode

As shown by the dotted lines in Figure 3, the breakdown voltage can vary over a wide range, so it is important to consider this variation with respect to the circuit being protected. The device's peak pulse power limit, $P_{PK}$, can be found on the transfer characteristic of a TVS, as shown in Figure 4. The point at which the transfer curve intersects with the peak pulse power curve denotes the maximum clamping voltage, $V_C$, and the maximum peak current, $I_{PP}$, for the device.

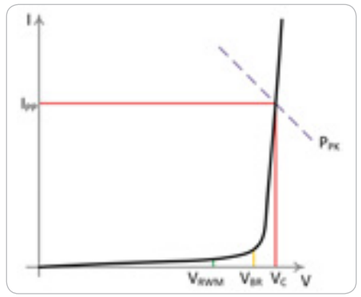


Fig. 4: The transfer characteristics of a typical TVS diode

The length of the pulse determines the amount of energy that can be absorbed. Standard duration and magnitude pulses are defined in international standards. These include IEC 61000, which covers fast surges such as those caused by by electro-static discharges and lightning strikes, and defines two relevant points on the power curve: 8µs (t1) and 20µs (t2) which are commonly referred to as 8/20. Another relevant standard is IEC 6164, which deals with slower surges with higher energy levels, such as those that would occur from inductive loads. The time intervals for this standard are 10/1000, which equals 10µs (t1) and 1,000µs (t2). These figures are used to define TVS performance, as shown in Figure 5. Note that t2 is total elapsed time from 0.

## Conclusion

Transient voltages are an ever-present threat to sensitive ICs, and in automotive applications they are unavoidable. The TVS is the right component, in many cases, to provide protection against surges, spikes and transients.

Diodes Incorporated offers a wide range of TVS protection products, enabling every part of a vehicle's electronic systems to be protected from hazardous transients, and providing for higher reliability and safety.

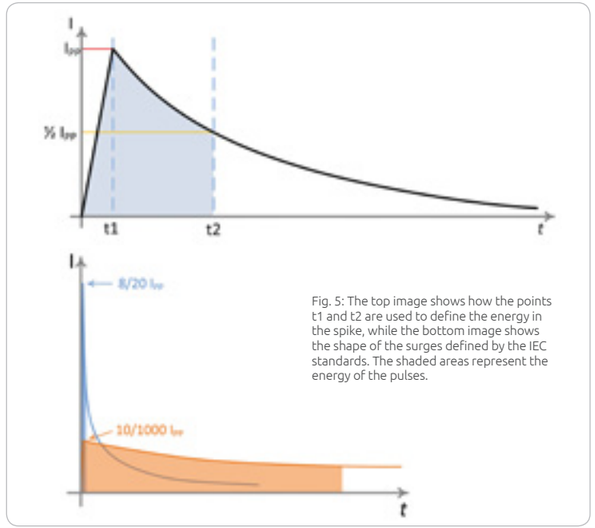


Fig. 5: The top image shows how the points t1 and t2 are used to define the energy in the spike, while the bottom image shows the shape of the surges defined by the IEC standards. The shaded areas represent the energy of the pulses.

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# How new absolute magnetic encoders perform robust rotary position sensing in industrial applications

By Emmanuel Lemelle
Product Marketing Manager, Vishay

**The positioning-system function in devices such as the arm joints in industrial robots and collaborative robots (cobots), and the steering wheels of automatic guided vehicles, needs a position sensor which offers a combination of high accuracy, repeatability and resolution. The sensor also needs to perform reliably in any environmental conditions.**

Vishay supplies a range of magnetic encoders which meets these requirements. This Design Note gives an overview of this range of Rotational Absolute Magnetic Kit (RAMK) products, and explains its advantages over other position sensing technologies.

## Absolute magnetic encoder: principle of operation

The purpose of the RAMK encoder is the same as that of any position sensor: to represent a mechanical angular position as an electrical signal. In Vishay's case, this is achieved through the implementation of magnetic technology which addresses a wide range of operating requirements.

The RAMK's rotor is composed of a combination of several magnetic tracks. These magnetic fields are read by Hall-effect cells mounted on the stator. The output from the magnetic cells enables the absolute position of the rotor to be determined, as shown in Figure 1.

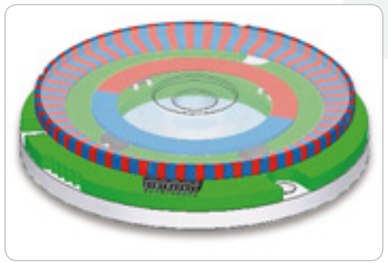

Fig. 1: The magnetic tracks and Hall-effect cells in Vishay's patented RAMK design

The precision rating of each RAMK sensor is a 'real' resolution: it is not the result of calculation. The repeatability is higher than 16 bits. Figure 2 illustrates the accuracy and resolution that Vishay's magnetic technology enables the RAMK encoders to achieve.

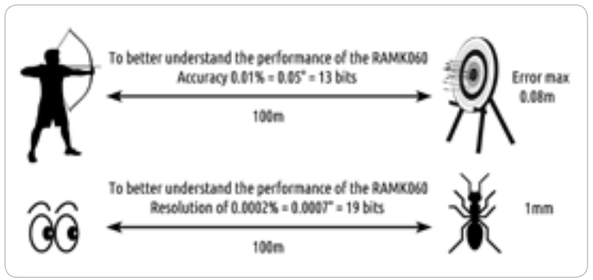


Fig. 2: Illustration of the accuracy and resolution of the RAMK encoders

Because the resolution is real, the mathematical function in the RAMK encoders is monotonic. This is important for all applications that call for high repeatability.

## Benefits of the RAMK encoders

The RAMK encoder module is ideal for space-limited applications in which precise feedback on angular position is required. This is due to:

- Compact dimensions, including low profile of 6.5mm
- Potential for off-axis mounting, which maintains access to the end of the shaft
- Light weight of <55g

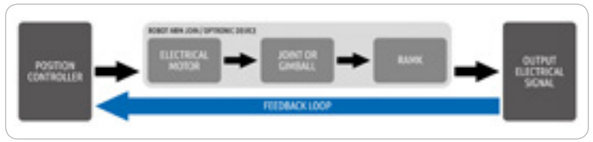


Fig. 3: RAMK encoder in a typical system architecture

There are numerous benefits of the RAMK products:

- Repeatability: the high accuracy and resolution make such position sensors ideal for embedded devices in harsh environments that require high repeatability
- Safety: with built-in self-monitoring, this technology supports compliance with safety standards
- Accuracy: the sensors offer 12- or 13-bit accuracy at rotation speeds higher than 220rpm
- Plug-and-play: no calibration is required after mounting in the application
- Reliability: the encoder is not sensitive to moisture, grease, dust or other contaminants common in industrial environments. By contrast, users of an optical encoder have to keep the codewheel perfectly clean for correct operation.
- Magnetic technology is not sensitive to temperature, a major advantage over capacitive technology, in which the dielectric permittivity varies over temperature and humidity. The patented architecture of the Vishay encoders is immune to external magnetic fields, unlike other magnetic position sensors.
- The RAMK encoders offer excellent resistance to shock and vibration, matching standards applied to military products

A large product range is available on demand: customers have a choice of output signal types, SPI, SSI or Biss-C, and can also specify multi-turn variants, full redundancy, custom housings, and a memory to store the last position before power-off for multi-turn versions. The encoders are also available in multiple diameter options, as shown in Table 1.

| Part Number | Diameter |
|---|---|
| RAMK027 | 27.3mm |
| RAMK033 | 34.3mm |
| RAMK040 HP | 40.57mm |
| RAMK060 | 59.9mm |
| RAMK090 | 90mm |

Table. 1: The RAMK encoder family consists of five product variants

## Applications for the RAMK encoders

The high accuracy, repeatability and resolution of the RAMK encoders make them suitable for use in the control of arm joints in robots, and for determining the position of the steering wheel in automatic guided vehicles. In these industrial applications, the RAMK encoders' resistance to contamination by dust, moisture or grease is valuable.

With its excellent resistance to shock and vibration, the RAMK encoder is also ideal for the gimbals mounted in optronic devices and in missile-guidance systems. Other fields of application include wind turbines and solar panels, in which the accuracy of conventional encoders is not sufficiently high.





# Efficient 400mA step-down converter offers digital output-voltage selection

**The ST1PS01 from STMicroelectronics is a synchronous step-down converter IC which provides a maximum output current of 400mA from an input at a voltage between 1.8V and 5.5V.**

It is notable for its ultra-low quiescent current, when not switching, it draws just 500nA at an input voltage of 3.6V.

Housed in an 8-ball flip-chip package measuring 1.14mm x 1.44mm, it is intended for use in product designs that require a small and thin PCB, and which benefit from the device's high conversion efficiency.

Using an enhanced peak-current control topology, the ST1PS01 achieves very high efficiency using an inductor of just 2.2µH and two small capacitors. It reaches 94% efficiency when supplying a 1mA load, and stepping a 3.6V input down to an output of 3.3V.

The output voltage can be set dynamically using two digital-control inputs. ST supplies the converter in three versions, each providing a different set of output-voltage selection options:

- ST1PS01AJR provides a selectable output voltage of 1.9V, 2.0V, 2.1V or 2.8V
- ST1PS01DJR provides a selectable output voltage of 1.8V, 2.3V, 2.5V or 2.8V
- ST1PS01EJR provides a selectable output voltage of 1.8V, 2.7V, 3.0V or 3.3V


ST1PS01: Maximum conversion efficiency reaches 94%

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### APPLICATIONS

- Wearable devices
- Personal tracking monitors
- Smart watches and sport bands
- Energy harvesting
- Wireless sensors
- Single-cell lithium-ion battery applications

### FEATURES

- 1.57V under-voltage lock-out threshold
- Embedded soft-start circuit
- Output voltage Power Good signal
- ±1.5% output-voltage accuracy

**FREE DEVELOPMENT BOARD**

**The STEVAL-1PS01EJR evaluation board features the ST1PS01 series synchronous step-down converters for applications in which high efficiency and PCB size and thickness are important.**

**Orderable Part Number: ST1PS01EJR**

**Apply at: www.my-boardclub.com**



# High-frequency AC-DC power controller implements efficient active clamp flyback topology

**ON Semiconductor's NCP1568 is a highly integrated AC-DC power controller which implements an active clamp flyback topology to produce high conversion efficiency.**

The NCP1568 uses a proprietary variable-frequency algorithm to enable it to perform Zero-Voltage Switching (ZVS) of a converter's MOSFETs across all line and load conditions. Because of the ZVS capability, the NCP1568 can operate at high switching frequencies up to 1MHz.

This enables the use of small magnetic components for high power density, while also achieving high efficiency.

The NCP1568's high level of integration means that a complete AC-DC converter circuit can be implemented with a small number of external components. The controller includes a high-voltage start-up circuit, a low-side driver and a 5V logic-level driver for the active clamp transistor. It is compatible with both silicon superjunction MOSFETs and Gallium Nitride (GaN) FETs.


NCP1568: High switching frequency for compact power-system designs

**FREE DEVELOPMENT BOARD**

**The NCP1568PDUHD90WGEVB evaluation board is a design for an efficient, high-density 90W USB Type-C®, USB Power Delivery 3.0 and Quick Charge 4 power adapter design featuring the NCP1568, the NCP1622 PFC controller, the NCP51530 half-bridge driver and the NCP4306 synchronous rectifier driver.**

**Orderable Part Number: NCP1568PDUHD90WGEVB**

**Apply at: www.my-boardclub.com**

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### APPLICATIONS

- AC-DC power converters
- Battery pack chargers
- High-density USB Power Delivery adapters
- Notebook computer adapters
- Industrial power supplies
- Telecoms power supplies
- Lighting

### FEATURES

- No audible noise
- Frequency foldback with 31kHz minimum frequency
- Frequency jittering
- Programmable optional transition to discontinuous mode
- Quiet-Skip technology
- Short-circuit protection

# 22W wireless power transmitter design conforms to latest Qi specifications

**NXP Semiconductors has introduced the WCT-15W1CFFPD, a complete reference design platform for 22W wireless charging transmitters which conforms to the latest specifications of the Qi® standard for smart devices.**

Based on NXP's MWCT101x wireless charging transmitter IC, the reference design uses the MP-A11 topology which was defined and developed by NXP. Supporting the latest Extended Power Profile (EPP) provisions of the Qi specification, the WCT-15W1CFFPD is one of the first design platforms to enable fast wireless charging of devices such as smartphones and tablets.

The design is compatible with the iPhone® mobile digital device, and supports other popular devices' fast charging schemes.

This fully certified Qi hardware reference design includes professional-grade Qi-certified application software libraries.

NXP also provides example project firmware with a certified library which contains all the necessary wireless-charging control blocks. Users link to the library via an application programming interface which lets the user modify parameters and settings contained in the firmware. Customers can apply a ready-to-use binary file from NXP or build an application on the firmware library.

WCT-15W1CFFPD: Supports fast wireless charging of smartphones

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APPLICATIONS

- Qi mobile phone charging
- Home appliances
- Medical devices

FEATURES

- >75% power-transfer efficiency
- Low-power object detection technology
- Low standby power
- Accurate fixed-frequency control
- Integrated digital demodulation
- Integrated USB Power Delivery stack
- Input-power range: 5V to 19V DC

**FREE DEVELOPMENT BOARD**

**Orderable Part Number: WCT-15W1CFFPD**

**Apply at: www.my-boardclub.com**

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# New ultra-fast 200V rectifiers in MicroSMP package boost power density and efficiency

**Vishay Intertechnology has introduced new, smaller versions of its 200V Fred Pt® Ultrafast recovery rectifiers, enabling power-system designers to achieve higher power density. In addition, the devices' low forward-voltage drop reduces power losses and improves efficiency.**

The new 1A- and 2A-rated devices are housed in an eSMP® series MicroSMP (DO-219AD) package. The series includes the industry's first such device to offer a current rating of 2A. These rectifiers are intended for use in high-frequency inverters, DC-DC converters, freewheeling diodes and power factor correction circuits.

Measuring 2.5mm x 1.3mm with a low 0.65mm profile, the 1A VS-1EQH02xM3 and 2A VS-2EQH02xM3 products provide space-saving alternatives to rectifiers housed in an SMA package.

For excellent thermal performance, the eSMP rectifiers feature an asymmetric design with a large metal pad for heat dissipation, while their FRED Pt technology enables ultra-fast reverse-recovery times of as little as 13ns.

The parts are available in automotive-grade and commercial versions.

| Part Number | Forward Current | Breakdown Voltage | Forward Voltage | Reverse-recovery Time | Reverse-recovery Charge | AEC-Q101 Qualified |
|---|---|---|---|---|---|---|
| VS-1EQH01HM3 | 1A | 100V | 0.72V at 1A | 13ns | 11nC | Yes |
| VS-1EQH02HM3 | 1A | 200V | 0.72V at 1A | 13ns | 11nC | Yes |
| VS-2EQH01HM3 | 2A | 100V | 0.82V at 2A | 19ns | 15nC | Yes |
| VS-2EQH02HM3 | 2A | 200V | 0.82V at 2A | 19ns | 15nC | Yes |
| VS-1EQH01-M3 | 1A | 100V | 0.72V at 1A | 13ns | 11nC | No |
| VS-1EQH02-M3 | 1A | 200V | 0.72V at 1A | 13ns | 11nC | No |
| VS-2EQH01-M3 | 2A | 100V | 0.82V at 2A | 19ns | 15nC | No |
| VS-2EQH02-M3 | 2A | 200V | 0.82V at 2A | 19ns | 15nC | No |

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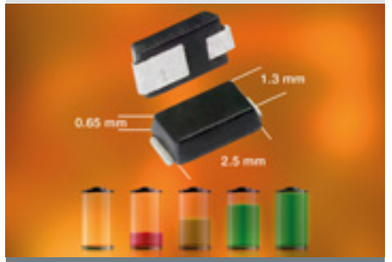
APPLICATIONS

- Automotive ECUs
- Anti-lock braking systems
- High-intensity discharge and LED lighting
- Telecoms and industrial power supplies

FEATURES

- Soft-recovery features over entire operating-temperature range
- Automotive-grade parts operate at up to 175°C

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# 3A switching regulator provides robust operation in industrial systems

**STMicroelectronics' A7987 is a step-down monolithic switching regulator which can supply up to 3A DC to a load at an adjustable output voltage ranging between 0.8V and the input-voltage value.**

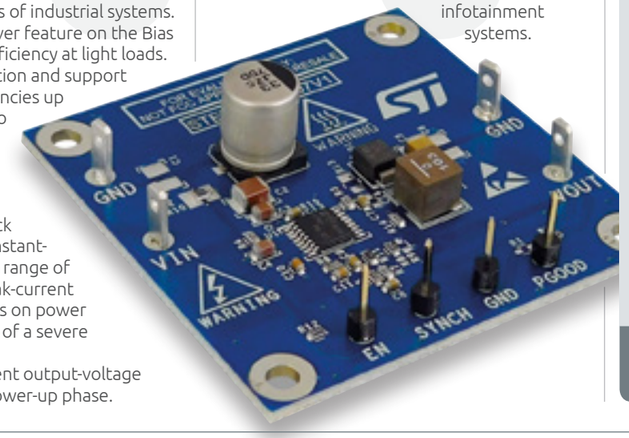
Operating from a wide input-voltage range of 4.5V to 61V, and capable of supporting a duty cycle of close to 100%, the A7987 conforms to the fail-safe specifications of industrial systems.

An embedded switch-over feature on the Bias Voltage pin maximizes efficiency at light loads. Adjustable current limitation and support for high switching frequencies up to 1.5MHz enable users to realize a compact power circuit.

Pulse-by-pulse current sensing with digital frequency fold-back implements effective constant-current protection over a range of operating conditions. Peak-current fold-back minimizes stress on power components in the event of a severe short-circuit.

The device can implement output-voltage sequencing during the power-up phase.

Multiple devices can be synchronized on the shared Synch pin to prevent beating noise - ideal when low noise is required, as in infotainment systems.

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APPLICATIONS

- 24V automotive battery systems
- Industrial and commercial vehicles

FEATURES

- 250mΩ on-resistance
- 11µA shut-down current
- 1mA quiescent current
- Adjustable soft-start time
- Low-dropout operation
- Auto-recovery thermal shut-down

**FREE DEVELOPMENT BOARD**

**The STEVAL-ISA207V1 evaluation board is a step-down switching power supply based on the A7987 regulator in an HTSSOP16 package. It is designed for automotive battery-powered applications.**

**Orderable Part Number: STEVAL-ISA207V1**

**Apply at: www.my-boardclub.com**

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# 1,200V SiC MOSFET features very low switching and conduction losses

**The NTHL080N120SC1 from ON Semiconductor is a 1,200V N-channel MOSFET fabricated in the wide bandgap Silicon Carbide (SiC) material to give superior switching performance and higher reliability than equivalent silicon devices.**


1,200V NTHL080N120SC1: Maximum on-resistance is just 110mΩ

SiC transistors are notable for their very low reverse-recovery charge and on-resistance, characteristics which minimize both switching and conduction losses and produce very high conversion efficiency.

In the NTHL080N120SC1, maximum on-resistance is rated at 110mΩ at a gate-source voltage of 20V and a drain current of 20A. Low total gate charge of 56nC also contributes to the device's high efficiency.

The NTHL080N120SC1 can support high-frequency switching circuits: it features short rise and fall times of 6ns and 8ns, and short turn-on and turn-off delays of 6ns and 28ns.

This SiC MOSFET is ideal for use in power factor correction circuits, boost inverters and charger circuits. Easy to drive, its gate-source threshold voltage is just 2.5V.

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APPLICATIONS

- Solar inverters
- Networking equipment power supplies
- Server power supplies
- Industrial motor drives
- Uninterruptible power supplies

FEATURES

- 44A maximum drain current
- Operating junction-temperature range: -55°C to 175°C
- 80pF output capacitance
- 100% UIL tested
- Three-lead through-hole TO247 package

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# Integrated motor driver chip ideal for three-phase applications

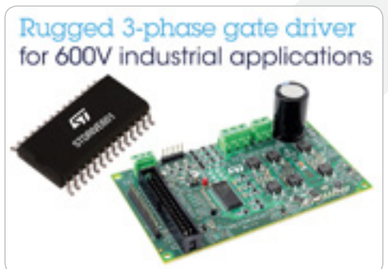
**The STDRIVE601 from STMicroelectronics is a single chip containing three half-bridge gate drivers for N-channel power MOSFETs or IGBTs. It is intended for use in three-phase motors or inverters.**

Offering integrated bootstrap diodes as well as a full set of protection functions, the STDRIVE601 simplifies the design of motor-drive circuits, and helps developers to reduce the size of the PCB and cut bill-of-materials cost.

The STDRIVE601, a high-voltage device manufactured with ST's BCD6s offline technology, can sink 350mA and source 200mA at all outputs. Interlocking and dead-time functions prevent cross-conduction.

The device has dedicated Input pins for each output, and a Shut-down pin. The logic inputs are CMOS/TTL-compatible at levels down to 3.3V, to provide for easy interfacing with control devices.

Matched delays between low-side and high-side sections guarantee freedom from distortion and allow for high-frequency operation.




STDRIVE601: Integrated motor driver IC reduces component count

**FREE DEVELOPMENT BOARD**

**The EVALSTDRIVE601 demonstration board is a complete three-phase inverter. Its power stage features STGD6M65DF2 IGBTs. The board supports a three-shunt or single-shunt current-sensing topology.**

**Orderable Part Number: EVALSTDRIVE601**

**Apply at: www.my-boardclub.com**

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APPLICATIONS

- Three-phase motor drives
- Inverters

FEATURES

- High-voltage rail up to 600V
- ±50V/ns dV/dt transient immunity
- Gate-drive voltage range: 9V to 20V
- 85ns overall input-output propagation delay
- Matched propagation delay for all channels
- Comparator for fast over-current and over-temperature protection
- Smart shut-down function
- Interlocking and dead-time function
- Under-voltage lock-out function on low- and high-sides

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# Half-bridge gate driver supports GaN transistors' fast switching operations

ON Semiconductor®

**The NCP51820 from ON Semiconductor is a high-speed gate driver which is ideal for driving Gallium Nitride (GaN) power transistors in offline, half-bridge power circuits. It is suitable for use with the High Electron Mobility Transistor (HEMT) and Gate Injection Transistor (GIT) types of GaN power switch.**

Use of the 650V NCP51820 to drive GaN transistors is especially beneficial in offline topologies including:

- Half-bridge
- Bridgeless PFC
- Single-ended, active clamp

The power stages in these circuits often perform zero-voltage switching, but can also operate under hard-switching conditions at voltages of around 400V. When driven by the NCP51820, GaN transistors can switch at frequencies of 1MHz or higher, with drain-source edge rates as high as 100V/ns.

The NCP51820 offers short and matched propagation delays with advanced level-shift technology providing a -3.5V to 650V common-mode voltage range for the high-side drive circuit, and -3.5V to 3.5V common-mode voltage range for the low-side drive.

In addition, the device provides stable operation rated for up to 200V/ns for both driver-output stages in high-speed switching applications.

To protect the gate of the GaN power transistor against excessive voltage stress, both drive stages employ a dedicated 5.2V voltage regulator to accurately maintain the gate-source drive signal's amplitude. The circuit actively regulates the driver's bias rails and thus protects against potential gate-source over-voltage events under various operating conditions. The device's leadless, 4mm x 4mm package offers low parasitic inductance.


NCP51820: Low-inductance 4mm x 4mm package

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APPLICATIONS

- Power supplys for OLED TVs and servers
- High-power gaming adapter
- Mobile phone/notebook travel power adapter
- Industrial inverter
- Motor drive

FEATURES

- 50ns maximum propagation delay
- Separate Source and Sink output pins
- Independent under-voltage lock-out protection
- Thermal shut-down protection
- Programmable dead-time control

**FREE DEVELOPMENT BOARD**

**The NCP51820 half-bridge Gallium Nitride (GaN) driver evaluation board replaces the driver and power MOSFETs used in existing half-bridge or full-bridge power supplies.**

**The board demonstrates the performance of a GaN-based power circuit, and the small number of components required to efficiently and reliably drive two enhancement-mode HEMT power switches in a high-voltage, totem pole configuration.**

**Intended applications for this driver board include various offline power-converter topologies: LLC, Phase-shifted full-bridge, Totem pole PFC, Active clamp flyback, Forward dual active-bridge, Phi-2, High-voltage synchronous buck**

**Orderable Part Number: NCP51820GAN1GEVB**

**Apply at: www.my-boardclub.com**

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# SiC Schottky diodes feature zero recovery current and high thermal performance

ON Semiconductor®

**ON Semiconductor's Silicon Carbide (SiC) Schottky diodes benefit from the superior characteristics of this wide bandgap material to provide better switching performance and higher reliability than comparable silicon devices.**


These characteristics include zero reverse- and forward-recovery current, temperature-independent switching behavior and excellent thermal performance. Use of ON Semiconductor's SiC diodes enables power-system designers to gain benefits including higher efficiency, faster switching, increased power density, reduced EMI and reduced system size and cost.

The diodes are rated for a maximum junction temperature of 175°C. They enable easy implementation of paralleled power circuits. They are also notable for their high surge-current capacitance.

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APPLICATIONS

- Automotive DC-DC converters
- Electric vehicle on-board chargers
- Industrial power supplies
- Power factor correction
- Solar inverters
- Uninterruptible power supplies
- Welding equipment

FEATURES

- Low forward voltage
- Positive temperature coefficient
- AEC-Q101 qualified
- PPAP support

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# New DC-DC converter modules give high power efficiency

VICOR

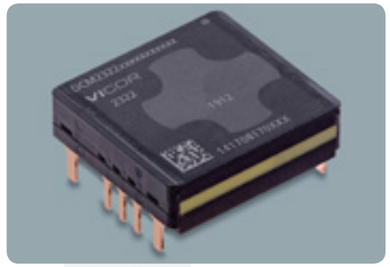
**Vicor has launched a new, lower-power variant of its DCM3623 series of isolated, regulated DC-DC converter modules. The new DCM2322 ChiP family of easy-to-use power modules offers improved power density which is five times greater than that of competing DC-DC converters.**

Packaged in a 22mm x 23mm x 7mm package, the new modules use a high-frequency zero-voltage switching topology to achieve high thermal and electrical performance at conversion efficiencies up to 90.8%.

The DCM2322 converters support two modes of operation:

- Array mode for up to eight units powering loads up to 960W. No power derating is needed. The sharing strategy permits dissimilar line voltages across an array.
- Enhanced output-voltage regulation mode. In this stand-alone mode, the module supports loads up to 120W.

Modular DCM converters used independently or with downstream point-of-load products support efficient power distribution, providing superior power-system performance and connectivity from a variety of unregulated power sources.



DCM3623: Package offers low thermal impedance

The DCM2322 converters are available in versions which support one of three input-voltage ranges:

- 43 to 154V input
  - 3.3V output at 40W
  - 5V output at 60W
  - 12V, 15V, 24V, 28V and 48V outputs at 120W
- 14 to 72V input
  - 3.3V output at 35W
  - 5V output at 50W
  - 12V, 15V, 24V, 28V and 48V outputs at 100W
- 9 to 50V input
  - 12V, 15V, 24V, 28V and 48V outputs at 60W

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APPLICATIONS

- Robotics
- Unmanned aerial vehicles
- Rail transportation
- Communications equipment
- Military equipment
- Aerospace
- Industrial systems
- Process control

FEATURES

- Low top- and bottom-surface thermal impedance
- Fully operational current limit
- Protection functions:
  - Over-voltage
  - Over-current
  - Under-voltage
  - Short-circuit
  - Thermal

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# Miniature automotive MOSFETs offer higher power density

DIODES INCORPORATED

**Diodes Incorporated has introduced new 40V-rated DMTH4008LFDFWQ and 60V-rated DMTH6016LFDFWQ automotive-compliant MOSFETs housed in a miniature DFN2020 package.**

These 2.1mm x 2.1mm MOSFETs give a 90% saving in board footprint over MOSFETs supplied in larger packages such as the SOT223 type. This means that designers of DC-DC converter circuits in automotive applications can achieve higher power density.


Diodes automotive MOSFETs: 175°C maximum operating temperature

The 40V DMTH4008LFDFWQ has a typical on-resistance of 11.5mΩ at a gate-source voltage of 10V, while gate charge is just 14.2nC. For the 60V DMTH6016LFDFWQ, these values are 13.8mΩ and 15.2nC.

Both devices are qualified for operation at up to 175°C. The sidewall-plated DFN2020 package makes them suitable for use in the high ambient temperatures found under the hood in vehicle systems.

When used in an application such as a 12V/5A buck converter, the DMTH4008LFDFWQ dissipates 20% less power than competing MOSFETs. This marked improvement in efficiency provides automotive designers with greater flexibility and the freedom to increase power density in new or existing automotive applications.

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APPLICATIONS

- Power-management systems
- DC-DC converters
- LED backlights
- ADAS

FEATURES

- AEC-Q101 qualified
- PPAP support
- 0.6mm profile
- 3V maximum threshold voltage
- 100% unclamped inductive switching

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# Gate driver supplies high-speed input to 1,200V power switches

ON Semiconductor®

**ON Semiconductor's FAN73912, a half-bridge gate-drive IC, provides a high-voltage and high-speed drive input to MOSFETs and IGBTs which operate at up to 1,200V.**

The gate driver offers various features which provide protection against operating faults, and give flexibility to the power-system designer.

For instance, the FAN73912 includes an advanced input filter at the high-side Input pin which protects against short-pulsed input signals caused by noise.

In addition, an advanced level-shift circuit supports high-side gate-driver operation at a high-side floating offset voltage of up to -9.8V, while providing a total high-side floating supply voltage of 15V.

The FAN73912 can drive both channels with 2A of sourcing current and 3A of sinking current.


FAN73912 gate driver is suitable for use with MOSFETs or IGBTs

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APPLICATIONS

- AC-DC power supplies
- Server power supplies
- Consumer devices
- Industrial motors
- Medical electronics
- Home appliances

FEATURES

- Floating channel for bootstrap operation at up to +1,200V
- Built-in shoot-through protection logic
- Common-mode noise-canceling circuit
- Under-voltage lock-out protection on both channels
- Matched propagation delay below 50ns
- Outputs in phase with input signal

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# Offline converter provides integrated option for high-voltage power circuits

**The VIPer26K from STMicroelectronics is a high-voltage offline converter which combines both a PWM current-mode control block and a 1,050V avalanche-rugged power stage.**


Integrating a high-voltage start-up circuit, sense transistor, error amplifier with 3.3V reference, and oscillator with jitter into a single converter chip, the VIPer26K enables the designer to realize a complete high-voltage converter operating from an AC or DC input with a small number of components. Support for jittered switching reduces the cost of EMI filtering and helps achieve compliance with the requirements of EMC standards.

The VIPer26K supports the most common topologies for switch-mode power supplies, including:

- Isolated flyback with optocoupler
- Isolated flyback with primary-side regulation
- Non-isolated flyback with resistive feedback
- Buck
- Buck-boost

The high 1,050V breakdown voltage offered by the VIPer26K's power MOSFET enables the device to handle an extended input-voltage range, and to reduce the size of the drain snubber circuit.

The device features low power consumption and operates in burst mode when supplying light loads, helping designers to comply with strict energy-saving regulations.

**FREE DEVELOPMENT BOARD**

**The STEVAL-VP26K01B reference design implements a 15V, 1.5W buck converter for auxiliary power supplies operating over a very wide input-voltage range of 60V to 870V DC, or 90V to 600V AC. The highly compact design offers tight line and load regulation over the entire input and output range**

**Orderable Part Number: STEVAL-VP26K01B**

**Apply at: www.my-boardclub.com**

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APPLICATIONS

- Energy metering
- Auxiliary power supplies for industrial systems with a three-phase input
- LED lighting
- Air-conditioning units

FEATURES

- Drain-current limit protection:
  - -500mA for the VIPER265K
  - -700mA for the VIPER267K
- <30mW standby power at 230V AC
- Safe auto-restart after a fault condition
- Hysteretic thermal shut-down protection
- Built-in soft-start for improved system reliability

**FREE DEVELOPMENT BOARD**

**The STEVAL-VP26K01F evaluation board implements a three-output isolated flyback converter. It is intended for use in supplying the STCOMET smart meter and powerline communication system. The board uses a VIPER267KDTR offline high-voltage converter.**

**Orderable Part Number: STEVAL-VP26K01F**

**Apply at: www.my-boardclub.com**

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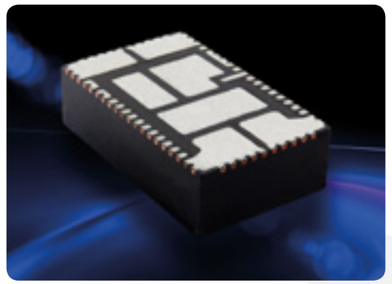
# 20A DC-DC regulator module in new space-saving package design

**Vishay's new SiC931, a synchronous buck regulator module which is capable of supplying a continuous 20A output, features an innovative microBRICK™ package design which is less than half the volume of equivalent competing modules. Its board footprint is also 30% smaller than that of competitors.**

Intended as a power supply for microprocessors, DSPs, FGPAs or ASICs, the SiC931 is a complete power system including power MOSFETs and inductor. Its power stage is capable of supplying a continuous current of 20A at a switching frequency of up to 2MHz.



SiC931: Power supply for board-level components such as a DSP or FPGA

Requiring few peripheral components, it is easy to design into an end product's power system.

The SiC931 module produces an adjustable output voltage of 0.6V to 5.5V from a 4.5V to 18V input range. Its architecture supports an ultra-fast transient response with minimal output capacitance and tight ripple regulation at light loads. The device is internally compensated, and no external ESR network is required to maintain loop stability.

The SiC931 gives the user a choice of four programmable switching frequencies: 600kHz, 1MHz, 1.5MHz and 2MHz. Its mode of operation is also programmable, between continuous-conduction and power-saving modes.

The module implements an adjustable soft-start process, and applies an adjustable cycle-by-cycle current limit. It also incorporates a power-saving scheme which increases light-load efficiency.

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## APPLICATIONS

- FPGA power supplies
- Point-of-load power supplies
- Industrial equipment
- Automation

## FEATURES

- Output-voltage tracking and sequencing with pre-bias start-up
- ±1% output voltage accuracy from -40°C to 125°C
- Package dimensions: 10.6mm x 6.5mm x 3mm
- Output over-voltage protection
- Output under-voltage and short-circuit protection
- Power Good flag
- Over-temperature protection

**FREE DEVELOPMENT BOARD**

**Orderable Part Number: SIC931EVB-A**

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# Digital PFC controller for applications consuming >600W

**STMicroelectronics' STNRGPF12 is a digital controller for interleaved Power Factor Correction (PFC) boost topologies, and intended for use in high-power applications consuming more than 600W.**

It provides a digital form of inrush-current control based on a silicon-controlled rectifier. The STNRGPF12 can drive one or two interleaved channels.

The device works in continuous-conduction mode at a fixed frequency, with average current-mode control in applications based on a mixed-signal architecture.

The controller can be configured through a dedicated software tool, ST's eDesignSuite. The tool generates a full schematic including a complete bill-of-materials and the final binary object code to be downloaded to the IC.


STNRGPF12: Fixed-frequency operation

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## APPLICATIONS

- AC-DC power supplies
- Welding equipment
- Air-conditioning units
- Industrial motors
- Uninterruptible power supplies
- Chargers

## FEATURES

- 32kbytes Flash program memory
- UART interface for bootloader support and system monitoring
- Soft start-up management
- Burst-mode support
- Load feed-forward
- Input-voltage feed-forward
- Channel current-balance function
- Programmable phase shedding
- Programmable, fast over-current and thermal protection
- Operating-temperature range: -40°C to 105°C

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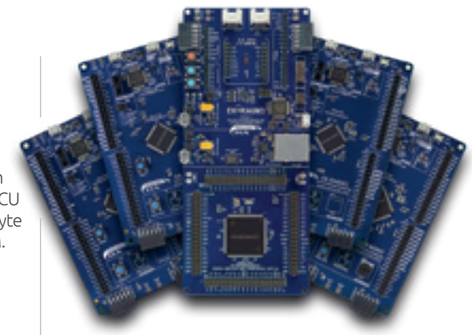
# Dev kits provide rich evaluation environment for Renesas RA series microcontrollers

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



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

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

The range of RA family evaluation kits includes:

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

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

## RA series microcontrollers support re-use of Arm Cortex-M software

**The Renesas RA family of microcontrollers offers a new option for designers who work in an Arm Cortex-M environment, and who want to retain existing software assets. It is an alternative to the Renesas Synergy™ family of MCUs, which includes parts based on various Arm Cortex-M cores. These parts enable re-use of software created in the Synergy environment when migrating from one MCU to another, to reduce PCB layout effort and increase manufacturing efficiency.**

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

There is broad feature and pin compatibility across the three series of RA MCUs. This provides scalability and easy code re-use between one device and another. The RA family includes:

- RA2A1, offering highly integrated, high-accuracy analog capabilities and an Arm Cortex-M23 core
- RA4M1, for control applications which drive a segment LCD panel. It offers low-power operation and high performance thanks to its Arm Cortex-M4 core
- RA6M1, ideal for for IoT endpoint devices because of its high-level security features
- RA6M2, suitable for automation applications. Upward-compatible with RA6M1 devices.
- RA6M3, offering the highest performance specifications in the family - the largest memory options and a rich feature set including TFT LCD controller, 2D graphics engine, Ethernet connectivity and Hi-Speed USB. Like the other RA6 devices, the RA6M3 is based on an Arm Cortex-M4 core.

The RA family MCUs include an integrated capacitive touch-sensing unit for display control. Some parts also offer an embedded TFT display controller backed by a 2D drawing engine and JPEG image compression engine.

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## APPLICATIONS

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

## FEATURES

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

**FREE DEVELOPMENT BOARDS**

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

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TECHNICAL VIEW FUTURE ELECTRONICS

# How new motor-drive software enables an 8-bit MCU to control a PMSM

By Steffen Hering
Business Development Manager, Future Electronics

**Read this to find out about:**

- The efficiency, noise and reliability advantages of the PMSM motor type
- Future Electronics' innovative implementation of field-oriented control for an 8-bit MCU
- The operation of the SPINnaker motor-drive reference design board based on an STM8S MCU

**Industrial, automotive and medical equipment manufacturers which want to replace legacy brushed DC electric motors or block-commutated Brushless DC (BLDC) electric motors with a superior Permanent Magnet Synchronous Motor (PMSM) have in the past faced an unattractive trade-off. In return for the superior efficiency, longer lifetime and higher reliability offered by the brushless PMSM, the designer had to accept a higher Bill-of-Materials (BoM) cost. This was because the complex mathematical calculations required to control an electronically commutated PMSM called for the high-speed data-processing capability of a sophisticated 32-bit microcontroller in most cases, and at the very least a 16-bit MCU.**

This cost disadvantage put PMSMs out of reach of high-volume, low-margin applications. Now, however, Future Electronics has developed a form of Field-Oriented Control (FOC) for electronically commutating a PMSM which is hosted on a simple, low-cost 8-bit MCU. Suitable for motors rotating at a constant speed and subject to small load variations, the new SPINnaker motor-control reference system offers all the benefits of a PMSM of high efficiency, low noise and high reliability, at a BoM cost around half that of a 32-bit MCU-based implementation.

Now for the first time it is possible to implement a PMSM design running FOC commutation software in cost-constrained applications.

## Commutation options

It is in fact already possible to implement electronic commutation of a brushless motor on an 8-bit MCU. Block commutation, the simplest way of driving electronically commutated motors, has a low mathematical complexity and can be implemented on a relatively low-speed CPU, and is today commonly used to control BLDC motors. A BLDC motor has a different winding arrangement from that of a PMSM and is better suited to block commutation. But block commutation has several drawbacks which reduce its appeal to motor-system designers, as shown in Figure 1:

- Relatively high torque ripple
- Reduced efficiency
- Acoustic noise

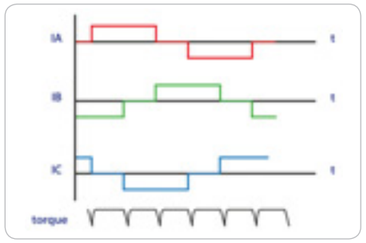


Fig. 1: A typical block commutation pattern showing the sequential switching of the three phases of a BLDC motor, and the torque ripple produced by the switching operations.

FOC is a more sophisticated method for controlling a motor drive which offers more attractive operating characteristics. Because the driver waveform is sinusoidal, the motor-drive system is quieter, more efficient, and produces no torque ripple.

This means that a PMSM is the best motor type to use when the application calls for precise control of a continuously spinning rotor, and when the motor needs to operate almost silently. Typical use cases will include a fan drive in the cabin of a car, in which the passengers value low acoustic noise; industrial production equipment, in which very precise control of position is essential; and when reliability is essential, such as in zero-maintenance or unrepairable pump drives, for instance in mining equipment.

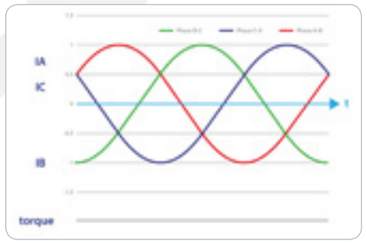


Fig. 2: Sinusoidal commutation, in which the motor drive's three phases are modulated for maximum torque and a flat torque profile at any rotor angle.

Attractive as the sinusoidal FOC method shown in Figure 2 is, it is computationally intensive. FOC software typically occupies a Flash memory footprint of between 24kbytes and 60kbytes. It is normally realised through a complex control algorithm which requires the use of floating-point operations, trigonometrical functions, complex numbers and matrix operations.

This would normally be the domain of a 32-bit MCU, yet Future Electronics, with the release of its SPINnaker motor-control reference design board, has developed a form of FOC software, operating on the Space Vector Modulation (SVM) principle, which runs on an 8-bit MCU.

The SPINnaker reference design system comprises a full-featured three-phase motor-driver daughterboard connected via a standard header to an STMicroelectronics STM8S-DISCOVERY development board for the STM8S family of 8-bit MCUs, as shown in Figure 3. Users can alternatively connect the motor-driver board to an STM8A-DISCOVERY board for the STM8AF and STM8AL families of automotive 8-bit MCUs, which are rated for a maximum junction temperature of 150°C.

In fact, the architecture of the SPINnaker software is MCU-agnostic and can be ported on request to other manufacturers' 8-bit MCUs as well.


Fig. 3: The SPINnaker motor-driver daughterboard.

The unique SVM algorithm developed by Future Electronics controls the rotor speed, the current (flux), and the angle between the rotor and stator. Implementing proportional-integral control emulation, it requires no divider or other complex mathematical functions and is as a result a very small body of code: it occupies only around 7kbytes of Flash memory and 1.2kbytes of RAM.

Maximum resolution is 384 steps per revolution; the user can configure the software to offer lower resolution at higher rotation speeds. The standard software uses a UART interface to communicate configuration and system-monitoring data, although it can also transfer data via an $I^2C$, SPI or LIN interface. The commutation software operates with a position indicator or sensor. Sensor-less operation is possible, but needs additional circuitry.

Of course, shrinking a complex control algorithm to fit constrained resources inevitably entails some trade-offs. Compared to a 32-bit MCU implementation, the SPINnaker FOC software responds more slowly to changes in the load and maintains less precise control when the rotor's speed changes rapidly. In addition, the system only provides data outputs once per revolution, not at every step as in a standard FOC system.

Nevertheless, as the performance test results below show, the SPINnaker control system maintains impressive speed control and stability when driving a motor at a constant speed and with little change in the load.

And the promise of BoM cost reduction is real: a Future Electronics comparison of a standard 32-bit MCU implementation with the SPINnaker system indicates that SPINnaker offers around a 50% cost saving.

## Simple user configuration

The SPINnaker motor-control software is backed by a PC configuration tool which makes it easy for the system developer to configure the motor's operation, as shown in Figure 4. The GUI also displays graphs for monitoring the performance of the motor in real time.

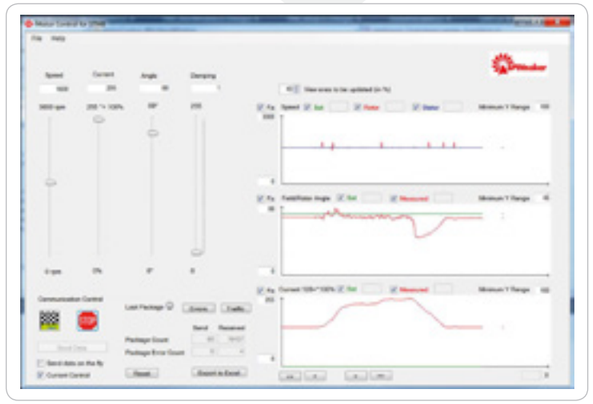

Fig. 4: The configuration tool GUI provided by Future Electronics with the SPINnaker system.

The GUI includes sliders for selecting the required speed in rpm, the current in 256 steps/revolution, and the angle between the rotor and stator. 'Damping' is a feature which will be enabled in future versions of the SPINnaker software. The graphs on the right of the screen show the speed, angle and current relative to their maximum values.

Figure 4 shows the operation of the SPINnaker system under test conditions. A mechanical load increase induces a rise in the current value (1). After a brief and small variation in the field/rotor angle, the algorithm quickly brings it back to equilibrium (2). When the mechanical load is decoupled from the motor, the algorithm lowers the current (3), causing the angle between the rotor and stator to briefly diverge from its specified value before returning to equilibrium.

As well as supporting system monitoring, the SPINnaker configuration GUI enables the user to configure various motor characteristics, as shown in Figure 5. The control software also provides safety and protection features, such as automatic stall detection and overload shut-down, which generate user alerts in the configuration tool when active.

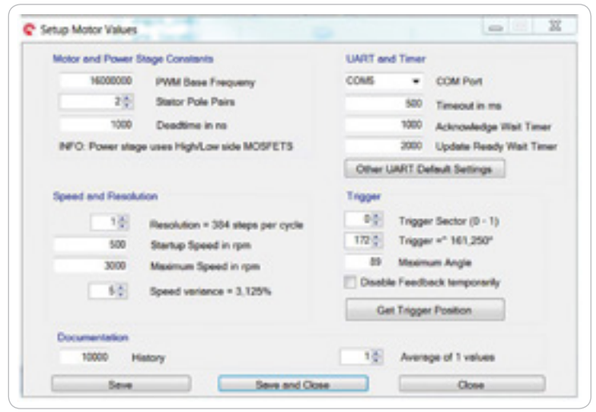


Fig. 5: The configuration tool provides many options for the user to modify the characteristics of the motor.

The SPINnaker system also provides for user monitoring of the data traffic between the control board and the motor-driver daughterboard, as shown in Figure 6. Detailed analysis of the data enables the developer to optimize the control sequences for specific operating conditions.

## New opportunity to embed PMSMs in low-cost end products

The introduction of the SPINnaker system from Future Electronics makes it possible for the first time for a PMSM to be used in cost-sensitive and high-volume applications that previously were limited to the use of a brushed DC motor or block-commutated BLDC motor. Replacing these motor types with a PMSM enables the OEM to benefit from its attractive attributes: higher reliability, higher efficiency, lower EMI and lower acoustic noise.


Fig. 6: Data traffic between the STM8S MCU control board (in red) and the motor-driver daughterboard (in black).

Design engineers may apply to receive the SPINnaker board and software at Future Electronics' **www.my-boardclub.com** website for developers.

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