FTM

FUTURE TECHNOLOGY MAGAZINE

FUTURE ELECTRONICS

ISSUE 1809

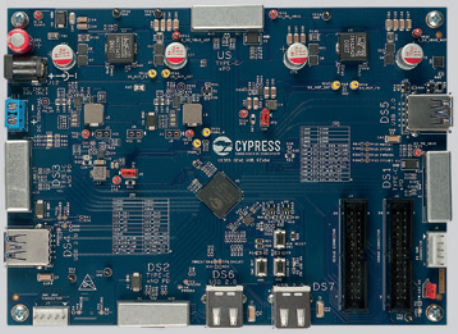
AMERICAS EDITION

Application Spotlight on:

Signal Chain

Industry's first seven-port USB-C hub controller with USB Power Delivery

Cypress Semiconductor has introduced the programmable EZ-USB® HX3PD, the industry's first seven-port USB Type-C™ hub controller with USB Power Delivery (PD). The hub controller simplifies USB Type-C dock system design by integrating the functionality of five chips into one, lowering bill-of-materials cost and reducing board size by as much as 50%.



HX3PD evaluation board

Upgrade to VOC sensors cuts initialization time

ams has upgraded the functionality of its CCS8xx family of gas sensor ICs to reduce initialization time and improve performance in indoor air-quality monitoring applications.

Software changes to the CCS801 analog Volatile Organic Compound (VOC) sensor IC and CCS811 digital VOC sensor have reduced the initialization period from more than 48 hours to 60 minutes. This means that an indication of indoor air quality via a relative value for total VOC or equivalent CO_2 can be used almost immediately after initial power-on in the end-product.

Compact IP20 LED drivers perform accurate dimming

Inventronics has released a new programmable IP20 LED driver series for indoor lighting applications such as panel lighting, troffers and downlights.

The new LUG-040SxxxDTE provides full power at almost any output current range from 800mA to 1,500mA, and from 40W down to 28W. The drivers offer flicker-free, smooth dimming down to 10% of full power, resulting in consistent light quality.

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Precision, accuracy and flexibility: new products bring the best of digital and analog to the signal chain

A properly functioning signal chain is essential to any interaction between electronics and the real world. The design of a high-performance signal chain presents engineering challenges which differ from application to application. For all, however, the goal is broadly the same: to process signals accurately and precisely enough to enable the correct monitoring or control of an electronic system.

A typical signal chain will consist of a sensor network, a signal conditioning element, often known as the Analog Front End (AFE) plus filters, an Analog to Digital Converter (ADC), ending with signal processing in the digital domain. Before processing, a sensor's small signals need amplification to take full advantage of the ADC's full dynamic range, a role for an operational amplifier.

A vast choice of op amps is available via Future Electronics from manufacturers such as ON Semiconductor and STMicroelectronics. The range is constantly expanding, however, to take advantage of technical improvements and to meet new customer requirements. This issue of FTM introduces the NCS21xR series of op amps for industrial applications, and the related NCV21xR parts for automotive applications. These devices feature an extremely low input-offset voltage, and gain error of just 1%. This means that they can be used to amplify the very low-voltage signal produced by a current-sense resistor in applications such as automotive battery management systems.

After digitization by a suitable ADC, this precision signal enters the digital domain. As this digital data streams into a microcontroller, the signal-to-noise ratio can be enhanced by filtering. A filter is a function that has traditionally been implemented in the analog domain. Today, however, it is possible to use filtering algorithms running in software. The ability to create filters digitally allows for some relaxation of the requirements of the analog signal chain.

This shift, implementing filtering in the digital domain rather than using more complex analog filtering components, can give the designer greater flexibility and can reduce the cost and complexity of analog components.

The introduction of microcontrollers with advanced on-board analog capabilities provides designers with the opportunity to integrate this kind of digital signal processing in an MCU alongside analog functions. This is the promise of the STM32F373 series from ST, a device which contains an ADC, DACs, comparators and other analog components, while also providing high digital performance with an Arm® Cortex®-M4 RISC core.

This issue of FTM gives a flavor of the signal chain capabilities available in the Future Electronics product range. Help with analog and mixed-signal designs and guidance on the complete range of components is available from the engineers at each of Future Electronics' branches. Please get in touch with your nearest, or call 1.800.FUTURE.1 for help.

Amar Abid-Ali
Vertical Segment Director
Future Electronics

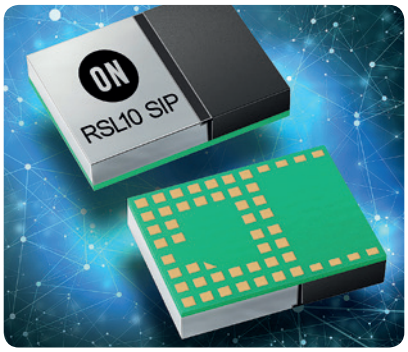
FUTURE ELECTRONICS

Bluetooth Low Energy system-in-package includes radio transceiver and antenna

ON SEMICONDUCTOR

ON Semiconductor's RSL10 SIP is a complete Bluetooth® Low Energy wireless system-in-package including a 2.4GHz radio transceiver, antenna and passive components. It provides the easiest way to implement low-power Bluetooth Low Energy technology in wireless communication applications.

The RSL10 SIP, which has the part number NCH-RSL10-101S51-ACG, supports both Bluetooth Low Energy and proprietary 2.4GHz radio protocols. Featuring ON Semiconductor's RSL10 2.4GHz system-on-chip, the RSL10 SIP offers very high radio performance, including Receive sensitivity of -94dBM and Transmit power of up to +6dBm. It supports Firmware Over The Air (FOTA) updating.



RSL10 SIP: Outstanding deep-sleep power consumption

The RSL10 SIP is intended for use in applications which need to take advantage of the low-power characteristics of the Bluetooth Low Energy protocol. Its power consumption in deep sleep mode is the industry's best at 62.5nW, as is its Receive power consumption of 7mW.

The RSL10 SIP provides a complete radio system for devices connecting to a Bluetooth Low Energy network. It includes two processor cores, an Arm® Cortex®-M3 controller core and an LPDSP32 for intensive signal-processing functions. It also features built-in power management, 384kbytes of Flash memory and configurable analog and digital sensor interfaces. Both the RSL10 and RSL10 SIP feature an AES-128 encryption engine to protect data transmitted over the air.

The RSL10 SIP is housed in an 8mm x 6mm package.

ENERGY INDUSTRIAL LIGHTING MEDICAL AUTOMOTIVE SECURITY CONSUMER TELECOMS

APPLICATIONS

- Fitness and wellness monitors
- Smart watches
- Smart locks
- Home appliances
- Lighting equipment

FEATURES

- Certified to worldwide wireless standards including FCC, CE, IC, KCC and MIC
- Supply-voltage range: 1.1V to 3.3V
- I²C and serial peripheral interfaces
- Pulse code modulation interface

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FTM Boards

Orderable Part Number: RSL10-SIP-001GEVB

To buy development boards go to:
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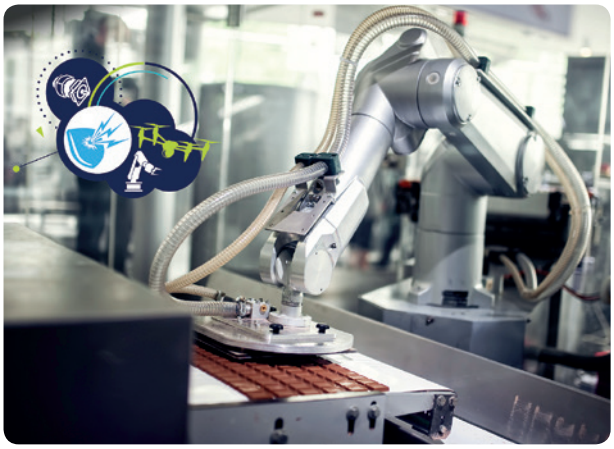
TVS diodes in space-saving thin package feature 400W and 600W peak pulse power ratings

STMICROELECTRONICS

The SMA4F and SMA6F unidirectional Transient Voltage Suppression (TVS) diodes introduced by STMicroelectronics are packaged in a thin SMA Flat package to provide space savings in circuits which require protection from high peak-power pulses. The SMAxF devices are footprint-compatible with their sister SMAJ and SMBJ families.

At just 1mm high, the SMA4F and SMA6F series of TVS protection devices are ideal for designs in which space is an important constraint. Their planar technology is well suited to circuits that require low leakage current and a high maximum junction temperature of 175°C, providing long-term reliability and stability. The TVS diodes maintain a high power rating even at the maximum operating junction temperature.

The devices in the SMA4F series have a peak pulse power rating of 400W for a 10/1000µs waveform. For the SMA6F series, this power rating is 600W. Each of the SMA4F and SMA6F series consists of 32 parts featuring stand-off voltage ratings ranging from 5.0V to 188V.


SMAxF TVS diodes: 175°C maximum junction temperature

ENERGY INDUSTRIAL LIGHTING MEDICAL AUTOMOTIVE SECURITY CONSUMER TELECOMS

APPLICATIONS

- Industrial power supplies
- Factory automation
- Motor control
- Battery chargers
- Air-conditioning units
- Home appliances
- Uninterruptible power supplies
- DC-DC converters
- Switch-mode power supplies
- Smart metering equipment
- Building automation

FEATURES

- Peak pulse power:
  - SMA6F series: 4kW for 8/20µs waveform
  - SMA4F series: 2.5kW for 8/20µs waveform
- 1µA leakage current at 85°C
- UL94-V0 compliant
- 25kV contact discharge rating according to IEC 61000-4-2

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Innovative Peltier modules provide higher reliability and longer cycle life

CUI INC

CUI's line of high-performance thermoelectric cooling modules features an innovative arcTEC™ structure which delivers superior cooling performance and a longer cycle life.

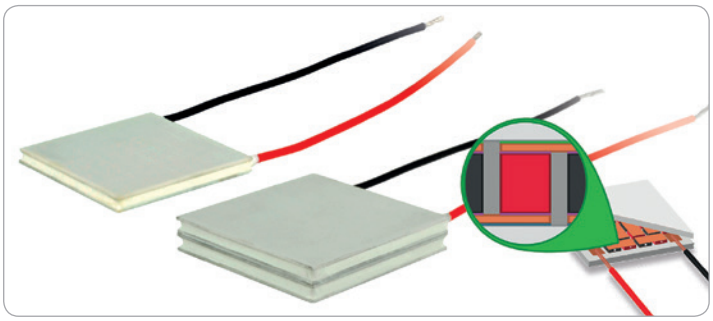
CUI's high-performance Peltier modules are available in a wide range of sizes and current ratings to meet the needs of various applications. They range in footprint size from the smallest at 20mm x 40mm to the largest at 50mm x 50mm, and have a profile as low as 3.15mm. The modules' superior performance enables them to achieve a maximum temperature differential of up to 95°C.

The reliable solid-state construction, precise temperature control and quiet operation of these thermoelectric modules make them ideal for medical and industrial applications, and designs in which forced-air cooling is not possible.

The superior characteristics of these high-performance Peltier modules is due to CUI's arcTEC structure, which combats the effects of thermal fatigue found in conventional thermoelectric modules by incorporating:

- A thermally conductive resin between the electrical interconnect and ceramic on the cold side of the module
- High-temperature solder
- Larger P/N semiconductor elements made from premium silicon ingot

The combination of these three enhancements greatly improves reliability, performance and cycle life.



CUI Peltier modules: Maximum temperature differential of up to 95°C

ENERGY INDUSTRIAL LIGHTING MEDICAL AUTOMOTIVE SECURITY CONSUMER TELECOMS

APPLICATIONS

- Industrial machinery
- Medical equipment
- Refrigeration equipment
- Fanless designs

FEATURES

- Current-rating range: 2.0A to 12.5A
- Supplied with 22 AWG wire leads

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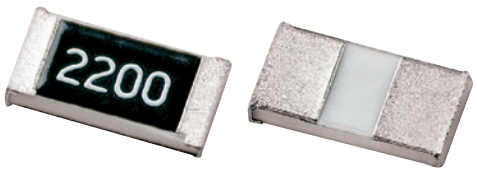
Precision chip resistors handle high power loads up to 1W

SUSUMU

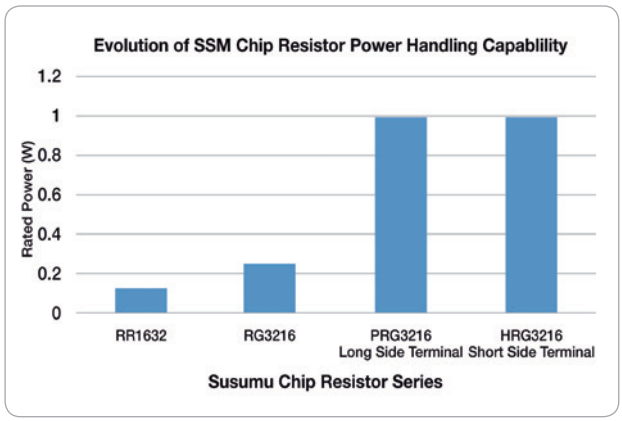


terminals mean that the HRG resistors are able to handle high power loads of up to 1W in a standard EIA 3216 case size, or 1206 in inches.

The Susumu HRG series is notable for its precise electrical characteristics and high reliability. The resistors are available with absolute resistor tolerances of 0.1% or 0.5%. The temperature coefficient of resistance is ±25ppm/°C or 50ppm/°C.

Susumu has introduced the HRG series of high-power chip resistors which offer precise and stable resistance over a wide temperature range and numerous temperature cycles.

The HRG series features conventional short-side wrap-around terminals, in contrast to Susumu's PRG series resistors, which have long-side terminals. The proprietary thin-film resistor construction and enlarged bottom



HRG series: Same power rating as PRG series, which has long-side terminals

ENERGY INDUSTRIAL LIGHTING MEDICAL AUTOMOTIVE SECURITY CONSUMER TELECOMS

APPLICATIONS

- Power supplies
- Power switching
- Automotive braking systems
- Test and measurement equipment
- Motor deflection circuits
- Sensor circuits
- Batteries
- Electric car chargers

FEATURES

- Low noise
- Excellent high-frequency performance
- Maximum drift after 1,000 hours
  - ±0.25% at rated power at 70°C
  - ±0.1% at 85% relative humidity at 85°C
  - ±0.1% after 1,000 temperature cycles between -55°C and 125°C
  - ±0.1% at 155°C
- AEC-Q200 qualified

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We Accelerate Time to Revenue by Providing

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- Design Support Services
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Triad's 50/60Hz World Se

With more than 70 years of transformer design and manufacturing experience, Triad now offers over 500 different power transformers that are available off-the-shelf from the industry's leading distributor network. In today's shrinking world and global market, it is essential to design products that can be delivered worldwide. For this reason, Triad has designed one of the industry's most complete

-C2 PC Mount Split Pack Class 2/3

With dual primaries, -C2 Split Pack™ Transformers are the only device of their type with TÜV approval and are UL 5085-1 and 3 recognized. They utilize a Class F 155°C insulation system and can be used in myriad applications requiring inherently/non-inherently limited transformers.

FEATURES

- Split bobbin design
- No electrostatic shielding required
- Use in series, parallel or separate circuits
- High isolation between secondaries

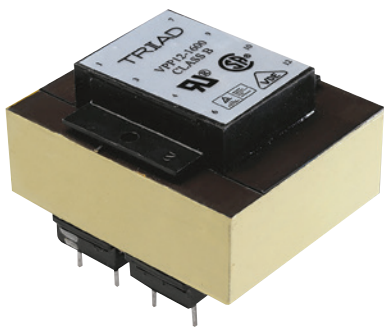
SPECIFICATIONS

- Frequency: 50/60Hz
- Electrical rating: 1.1 to 36VA
- Nominal secondary voltage: 5 to 56V
- HIPOT dielectric: 4200V AC

APPLICATIONS

- Commercial food and beverage equipment
- Motor speed controls
- Industrial controls
- Timers

VPP PC Mount Transformers



Triad's VPP PC Mount World Series™ Transformers are an advanced line of more than 40 quality transformers. They are perfect for board-level applications requiring the added safety and security of insulating shrouds over the windings. They are also UL 5085-1 and 2/3 recognized.

FEATURES

- Dual bobbin construction
- Insulating shroud meets UL V0 flammability specs
- No electrostatic shielding needed

SPECIFICATIONS

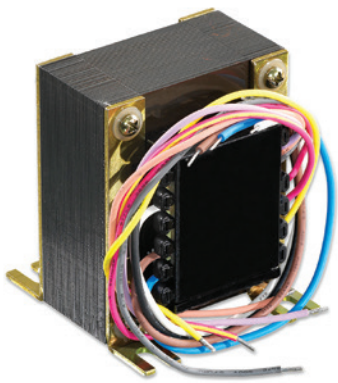
- Frequency: 50/60Hz
- Electrical rating: 2.5 to 56VA
- Secondary voltage range between 5 to 36V

APPLICATIONS

- Battery charging
- Spa controls
- Soft drink machines
- Security access and control

VPL Chassis Mount Transformer

Triad's VPL Series is similar to the VPP Series, but with chassis mounting and leads. The VPL sets the industry standard with European-style split bobbins. These leaded devices meet all international safety agency standards.



FEATURES

- Low inter-winding capacitance requires no electrostatic shielding
- 3500V isolation between primary and secondary
- Compact footprint

SPECIFICATIONS

- Frequency: 50/60Hz
- Electrical rating: 5 to 56VA
- Secondary voltage between 5 to 36V

APPLICATIONS

- Building and plant equipment
- Lighting
- Temperature controls
- Material handling

ries Transformers

TRIAD MAGNETICS

offerings of international power transformers. Triad's World Series Transformers range in power from 1.1VA to 10kVA. Most have configurable 120/240V primaries with output voltages that range from 5.0 to 240V AC. They are UL recognised and TÜV tested to IEC global safety standards. They can be customised to your requirements and are backed by our world-class service.

VPM Medical Toroidal Mount

Triad's VPM Series offers output power up to 10kVA and are UL recognized and CE certified for medical applications. They feature toroidal construction with dual secondaries, allowing for both series or parallel connections. Faraday and flux band shield maintains low leakage current and low stray fields, respectively.

FEATURES

- Dual secondary windings for series or parallel connections
- Low leakage current and low stray fields.
- Low temp rise: 25°C to 55°C

SPECIFICATIONS

- Frequency: 50/60Hz
- Primary: 100, 120, 220 or 240V AC
- Electrical rating: 25 to 10,000VA
- Insulation Class F: 155°C

APPLICATIONS

- Hospital equipment
- Biomedical equipment
- Test equipment
- Audio equipment

VPT Toroidal Mount

Triad's VPT Series features a compact toroidal design, which is cost effective and efficient with higher power density and reduced magnetic fields. They are approved to UL 5085-1 and 2, CE IEC 61558-1, and CE IEC 61558-2-6 with Class B insulation for use up to 130°C.

FEATURES

- Isolated dual primary and secondary coils
- Class B (130°C) rated insulation
- High efficiency

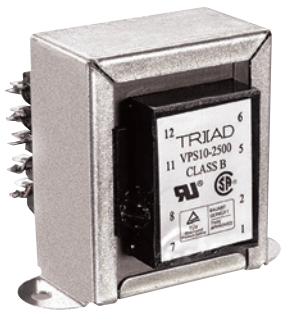
SPECIFICATIONS

- Frequency: 50/60Hz
- Electrical rating: 25 to 2500VA
- Secondary voltage from 6 to 230V

APPLICATIONS

- Sound reproduction
- Power system equipment
- Production equipment

VPS Chassis Mount Quick Connect



Triad's VPS Chassis Mount Transformers are chassis-mount devices requiring higher power up to 175VA. They meet major U.S. and global standards (CSA, IEC and UL). They are among the industry's most versatile transformers.

FEATURES

- Dual bobbin design with insulating shroud
- Meets global safety standards
- Quick disconnect connection

SPECIFICATIONS

- Frequency: 50/60Hz
- Electrical rating: 25 to 175VA
- Secondary voltage range between 5 to 230V

APPLICATIONS

- Oil/gas equipment
- Conveyor ovens
- Heat exchangers
- Music equipment

How to protect buck regula

RENESAS

A synchronous buck regulator will often be used in an industrial application to step down 12V rails to point-of-load inputs, sometimes supplying a voltage as low as 0.6V to a microcontroller, FPGA, memory IC or peripheral I/O. In these cases, Over-Current Protection (OCP) is necessary to protect the switching regulators from damage caused by excessive currents.

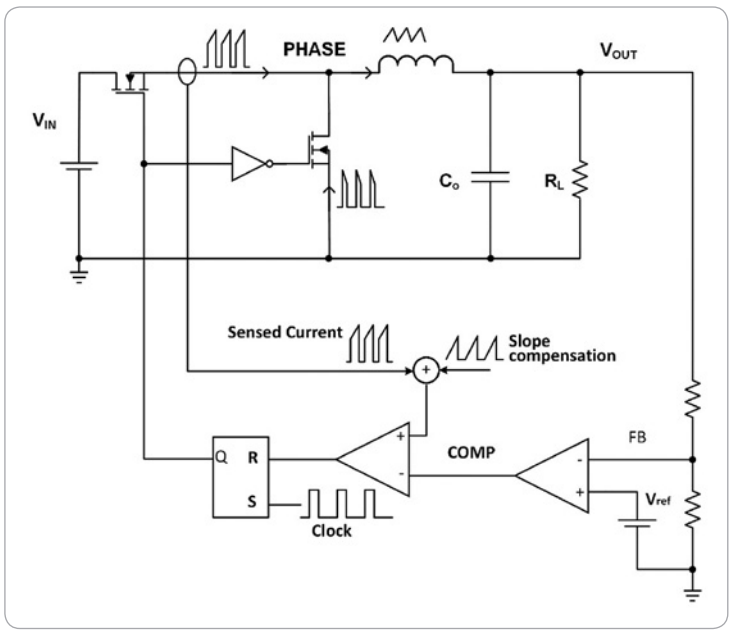


Fig. 1: Block diagram of a peak current-mode control buck converter

The fast response offered by cycle-by-cycle current limiting enables a switching regulator to operate continuously at its maximum load current. It can, however, generate excessive heat, and this can potentially reduce system reliability. To mitigate the risk to system reliability and to extend the host system's mean time before failure, a secondary-level protection scheme, such as hiccup-mode or latch-off mode protection, may be used.

Over-current protection with cycle-by-cycle current limiting

The current-mode control buck converter has many advantage: the first is the ability to perform cycle-by-cycle current limiting merely by clamping the COMP voltage, as shown in Figure 1, the block diagram of a peak current-mode control buck converter.

Current limiting calls for information about the current through the inductor. The most commonly used current sensing schemes include resistor current sensing, inductor DC resistance current sensing, power MOSFET on-resistance current sensing, and SenseFET current sensing. Due to its high accuracy and negligible power loss, the SenseFET current sensing scheme is widely integrated in switching regulators, such as Renesas' ISL85005 and ISL85014 synchronous buck regulators.

SenseFET current sensing is based on the matched devices principle, according to which the current is split into power FET and senseFET inversely with respect to their resistances. A very high ratio of power FET resistance to SenseFET is often adopted because the current flowing in the SenseFET is only a small fraction of the power FET. This means that a signal-level resistor with a very low resistance value can be used to sense the current without giving rise to a large power loss.

The first level of OCP with cycle-by-cycle current limiting that power-system designers can implement is peak current limiting, followed by reverse current limiting. Later this article will describe how to implement second-level protections for sustained fault events.

Peak current limiting

In a buck converter that implements peak current-mode control, the clock signal initiates the switching cycle. Then the high-side switch turns on and the inductor current ramps up. The inductor current is sensed and compared to the control signal (V_{COMP}). When the inductor current reaches V_{COMP}, the high-side switch is turned off and the inductor current decreases until the next switching period begins. By clamping V_{COMP}, the peak inductor current can be limited at a suitable level. Figure 2 shows the current waveforms operating in normal and current-limiting modes.

tors from over-current damage

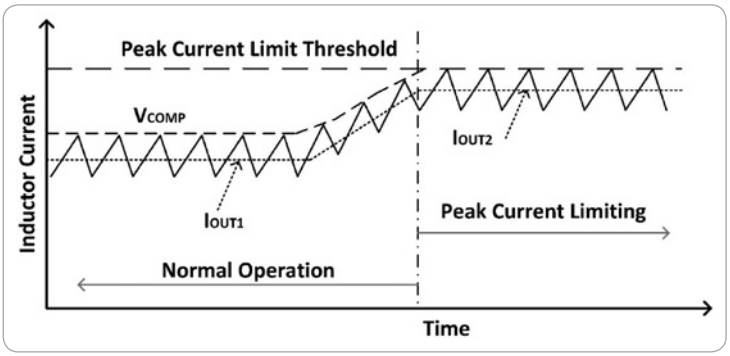


Fig. 2: Normal and peak current-limiting modes of operation of a synchronous buck converter

Valley current limiting

This provides an additional level of protection. Valley current limiting can be implemented by sensing the inductor current when the low-side switch is on. If the sensed current at the end of the switching cycle exceeds the valley current limiting threshold, the high-side switch will skip the next cycle and remain off until the current decays below the valley current limiting threshold. Thus, the previously discussed current runaway situation, caused by the control scheme's minimum on-time, can be avoided. Figure 3 illustrates this protection mechanism.

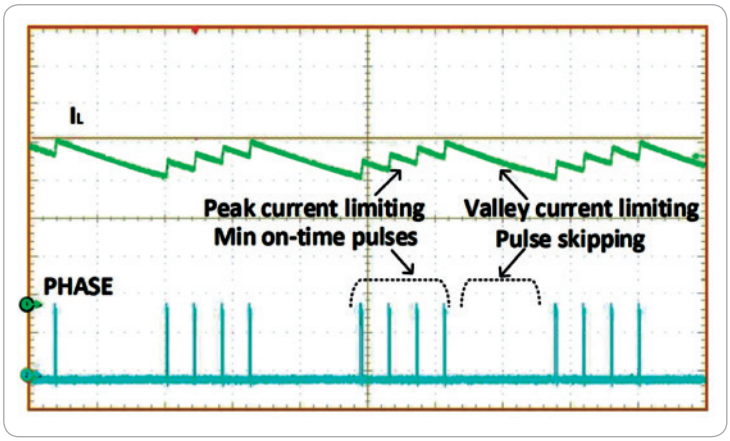


Fig. 3: Peak current limiting with valley current limiting

Switching frequency foldback

This provides another effective approach to eliminating the risk in a short-circuit fault event of current runaway caused by minimum on-time. When an over-current event is detected, the peak current-limiting circuit limits the duty cycle and thus decreases the output voltage. When the feedback voltage and/or on-time is lower than the programmed threshold, the frequency foldback function reduces the switching frequency. A lower frequency for a demanding duty cycle will produce a longer on-time.

Reverse current limiting

In a non-synchronous buck converter with diode rectification, inductor current is always positive. In contrast, inductor current in a synchronous buck converter can flow in either direction through the low-side MOSFET when it operates in forced continuous conduction mode. If the output voltage is accidentally lifted above the output setting point, a large negative current will flow from V_{OUT} to the PHASE node and through the low-side MOSFET to ground, as shown in Figure 1. Excessive reverse current can also lead to regulator failure.

Both peak current limiting and valley current limiting can only limit the forward current, but not the reverse current. An additional reverse current-limit circuit is required. It will force the low-side MOSFET off in response to the reverse current flowing through it, thereby exceeding a preset reverse current-limiting threshold.

Secondary-level OCP schemes

Cycle-by-cycle current limiting provides prompt first-level protection by limiting the maximum current at a preset level. But a switching regulator operating at its continuous maximum current will experience a steep rise in temperature, and might even reach the thermal shut-down threshold in some scenarios. A thermal shut-down protection circuit will shut off the switching regulator to prevent damage and enable it to cool.

Once cooled, the regulator will automatically recover from a thermal shut-down event. In a sustained fault, the regulator oscillates between peak current limiting and thermal shut-down, impairing its long-term reliability. Consideration should be given to implementing the two secondary-level protection mechanisms below to avoid this problem.

- Hiccup-mode protection: this is usually implemented with cycle-by-cycle peak current limiting along with a cycle count circuit. Hiccup operation is initiated when an over-current event is detected, as the cycle-by-cycle limiting circuit acts to limit the peak current. Then the cycle count circuit counts the switching cycles. After a certain number of consecutive cycles, the switching regulator is turned off for a given time, and then attempts to start up again. If the over-current condition has been removed, the switching regulator will start up and return to normal operation.
- Latch-off mode protection: like cycle-by-cycle current limiting schemes, hiccup-mode OCP also enables the regulator to restart after the fault is removed. Latch-off mode protection might be preferred in some applications, such as battery power systems, to eliminate unnecessary battery drain in sustained fault conditions. The latch-off mode protection shuts down the regulator and latches it off when an over-current event is detected. The system will need to toggle off ENABLE or V_{IN} to restart the regulator.

Many advanced integrated switching regulators have built-in OCP circuits to protect themselves from excessive current and power dissipation. The ISL85003, ISL85005 and ISL85005A synchronous buck regulators from Renesas have internal peak current limiting, valley current limiting and reverse current limiting functions to provide comprehensive protection.

The ISL85009, ISL85012, and ISL85014 synchronous switching regulators also have these current limiting functions. In addition, they offer a frequency foldback function, and hiccup mode and latch-off mode protection options to fully protect the switching regulators and to enhance system reliability.

Understanding hybrid a

PANASONIC

Specifying capacitors might seem a simple task, but it has actually become more complicated in recent years. The reason is growing freedom of choice. The universe of capacitors has expanded greatly over the past few years, in large part because of the new capacitor technologies which have provided many advances in conductive polymer solutions.

These advanced capacitors sometimes use conductive polymers to form the entire electrolyte. Or the conductive polymers can be used in conjunction with a liquid electrolyte in a design known as a hybrid capacitor. Either way, these polymer-based capacitors offer a performance edge over conventional electrolytic and ceramic capacitors in the parameters of:

- Electrical characteristics
- Stability
- Longevity
- Reliability
- Safety
- Lifetime cost

The various polymer and hybrid capacitors have different sweet spots in terms of voltage, frequency characteristics, environmental conditions and other application requirements. This Design Note describes the best uses for each type of advanced capacitor. It also highlights specific applications in which a polymer or hybrid capacitor will outperform traditional electrolytic or ceramic capacitors.

The varieties of polymer capacitor

Polymer capacitors come in four main varieties, including hybrid aluminum capacitors. Each type has different electrolytic and electrode materials, packaging and application targets.

Layered polymer aluminum capacitors use conductive polymer as the electrolyte and have an aluminum cathode. These capacitors cover a voltage range from 2V to 35V, and offer capacitances between 2.2µF and 560µF. The distinguishing electrical characteristic of these polymer capacitors is their extremely low Equivalent Series Resistance (ESR). For example, some Panasonic SP-Cap™ polymer capacitors have ESR values as low as 3mΩ. They are suitable for use in handheld electronic devices or other applications requiring a low-profile capacitor that will not interfere with a nearby heat-sink.

Wound polymer aluminum capacitors are also based on conductive polymers and aluminum, but they have a wound foil structure, as shown in Figure 1. The wound polymer capacitors cover a wider range of voltages and capacitance values than other types of polymer capacitors. Voltages extend from 2.5V to 100V, while capacitances run from 3.3µF to 2,700µF.

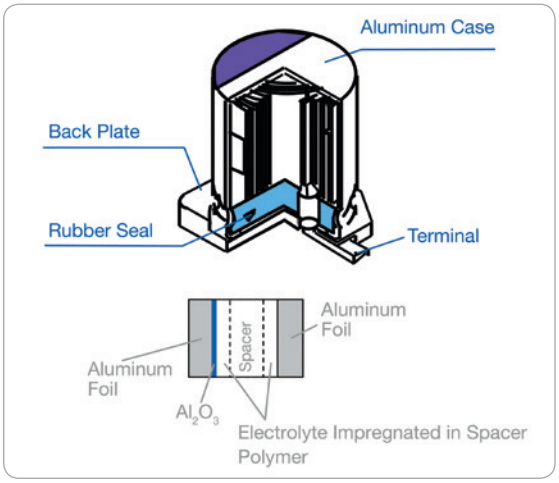


Fig. 1: The construction of a wound polymer aluminum capacitor

Like the layered polymer capacitors, the wound style has very low ESR values. Panasonic OS-CON™ capacitors, for instance, have ESR values below 5mΩ. The wound style can be surface mounted, but they are not as small as layered capacitors.

Polymer tantalum capacitors employ a conductive polymer as the electrolyte and have a tantalum cathode, as shown in Figure 2. They span voltages from 2V to 35V and capacitances from 3.9µF to 1,500µF. They, too, have low ESR values.

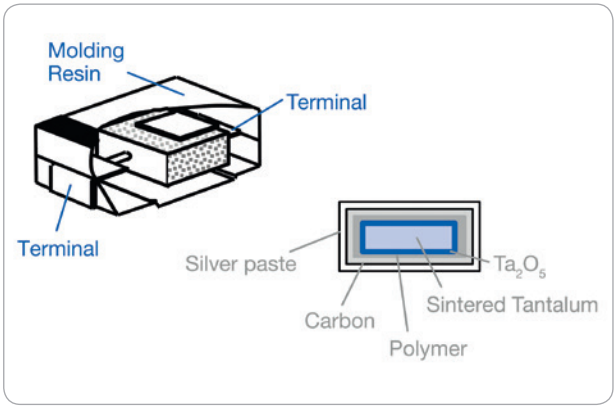


Fig. 2: The construction of a polymer tantalum capacitor

POSCAP™ capacitors from Panasonic feature ESR values as low as 5mΩ. Packaged in a molded resin case, the tantalum polymer capacitors are among the most compact on the market. The Panasonic POSCAP M size, for example, measures just 2.0mm x 1.25mm.

Polymer hybrid aluminum capacitors use a combination of a liquid and conductive polymer as the electrolyte, and aluminum as the cathode. The polymer offers high conductivity, and a correspondingly low ESR. The liquid portion of the electrolyte, meanwhile, can withstand high voltages and provides higher capacitance ratings due to its large surface area.

The hybrid capacitors offer a voltage range from 25V to 80V and capacitances between 10µF and 330µF. At 20mΩ to 120mΩ, ESR values for hybrids are higher than for other types of polymer capacitors, but still very low considering that they are suitable for use in relatively high-power applications.

nd polymer capacitors

The advantages of polymer capacitors

Despite differences in their materials and construction, the four types of polymer capacitors share desirable electrical properties.

Good frequency characteristics. Thanks to their low ESR values, polymer capacitors have a low impedance near their resonance point, and lower impedance reduces AC ripple in power circuits by as much as five times by comparison with conventional low-ESR tantalum capacitors, as shown in Figure 3.

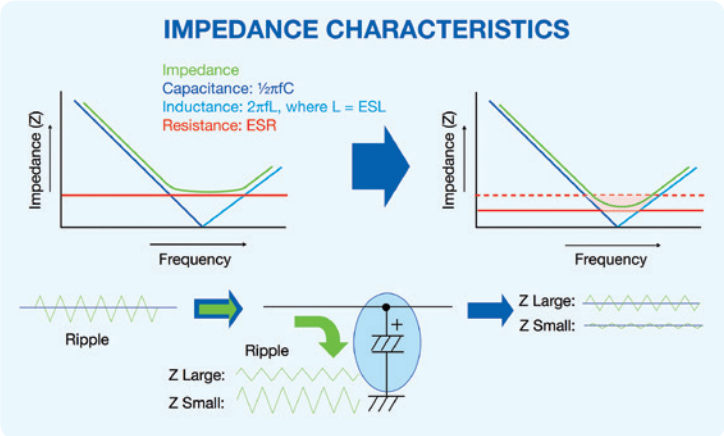


Fig. 3: Lower ESR reduces AC ripple in high-frequency switching power converters

Stable capacitance. Unlike ceramic capacitors which suffer from capacitance drift in response to temperature changes and DC bias, polymer capacitors remain stable over time. This stability is particularly important in industrial and automotive applications, which tend to experience fluctuations in operating temperatures.

Hybrid capacitors add another dimension to capacitance stability. They keep a stable capacitance in the face of common operating conditions, such as high frequencies and low temperatures, which reduce the capacitance of conventional liquid electrolytic capacitors, as shown in Figure 4.

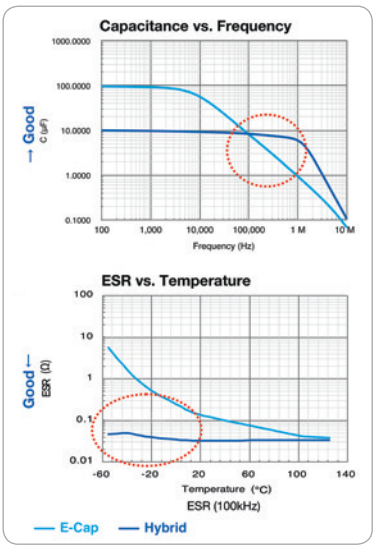


Fig. 4: Hybrid capacitors offer stable capacitance at high frequencies and stable ESR, even at temperatures as low as -55°C

Greater safety. Conventional electrolytic capacitors can suffer from electrical or mechanical stresses which produce defects or discontinuities in the oxide dielectric film. Polymer capacitors have a self-healing capability which eliminates this failure mode.

Typical tantalum capacitors are normally de-rated in use by 30-50% of their labeled voltage to ensure that they operate safely. This de-rating, while a common and accepted engineering practice, increases cost because a higher capacitance value has to be specified. By contrast, Panasonic guarantees the operation of its polymer capacitors at 90% of the full rated voltage.

Robust capacitors for industrial use

The increased use of electronics in industrial applications has created a need for more robust capacitor solutions. These demanding applications often have unforgiving operating environments which are not friendly to conventional capacitor types such as aluminum electrolytic.

Capacitors using polymer technology, such as Panasonic's OS-CON and hybrid models, are ideally suited for these applications because they offer a combination of:

- Long life
- Low ESR
- High ripple current
- High-temperature operation
- High voltage
- High capacitance

Industrial applications that can benefit from advanced polymer and hybrid capacitors include motor drives, power inverters and specialty lighting. Controller applications can take advantage of polymer-based capacitors as well. POSCAP polymer tantalum and SP-Cap models from Panasonic offer similar electrical characteristics to the OS-CON and hybrid models, but also have compact form factors which make it easy to integrate them into industrial control systems.

Hybrid capacitor performance advantages

Driven by the miniaturization of electrical components and the rise in switching frequencies in many electrical devices, hybrid capacitors are becoming increasingly popular. Hybrids are known for their stable electrical characteristics at high frequencies. These robust capacitors also have other strong advantages in applications such as computer servers, back-up devices and networking gear as well as industrial motors, automotive engine control units, security cameras and LED lighting.

Among the advantages are:

Small size. Surface-mount hybrid capacitors measuring just 6.3mm x 5.8mm can handle 35V and offer a capacitance of 47µF. The small size can save a significant amount of board space. In a 48V power-supply design, hybrid capacitors from Panasonic occupied just 13% of the board space required by aluminum electrolytic capacitors.

Reliability. By nearly every measure, hybrid capacitors outperform equivalent aluminum electrolytic and polymer capacitors in reliability. For instance, hybrid capacitors have markedly better endurance and humidity resistance than either their electrolytic or polymer counterparts. Hybrids also have significantly higher tolerance for large ripple currents, in-rush currents and high temperature.

In combination, the size and reliability advantages of hybrid capacitors result in a strong cost benefit, in spite of the higher purchase price of hybrid capacitors. The higher ripple current specification alone can result in a 20% reduction in cost by increasing the lifetime of the capacitor.

In a 48V power-supply design, the use of hybrid capacitors can cut cost in half compared to the use of equivalent aluminum electrolytic capacitors. The savings come from reductions in board cost and warranty cost, combined with the ability to withstand high ripple currents.

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74LV1T00 - 74LV1T02 - 74LV1T04 - 74LV1T08 - 74LV1T32 - 74LV1T34 - 74LV1T86 - 74LV1T87 - 74LV1T125 - 74LV1T126

Single supply logic gates with voltage translation

Our 74LV1Txxx logic family provides solutions that integrate voltage level translation with a Boolean function. 74LV1Txxx types are single 1.6 V to 5.5 V supply general-purpose voltage translating devices. Our 74LV1Txxx family is currently composed of ten logic functions including buffers, inverters and gates (AND, OR, NAND, NOR, EXCLUSIVE-OR, EXCLUSIVE-NOR).

Our 74LV1Txxx family provides single-supply translation using overvoltage-tolerant, low-threshold inputs. The output level is always referenced to V_{cc} which can range from 1.6 V to 5.5 V. For V_{cc} = 3.3 V, input logic signals from systems at 1.8 V to 5.5 V are valid. This wide V_{cc} range allows interconnection between systems at most of the different logic signal levels. 74LV1Txxx has a low-noise balanced output drive capability of 8 mA reducing line reflections, overshoot and undershoot.

Key Features

- Wide supply voltage range 1.6 V to 5.5 V
- Up and down translation possible
- Overvoltage tolerant inputs
- Up to 50 MHz operation at 3.3 V

Applications

- Portable devices
- Industrial controllers
- Servers, PC & Notebooks
- Automotive

Benefits

- No external pull-up or pull down resistors required
- Integration of logic function with translation saves device count and PCB space
- Footprint-compatible with existing non-translating devices
- Low dynamic power consumption increasing battery longevity
- Available in smallest package for use without step-down mask (X2SON5)

nexperia

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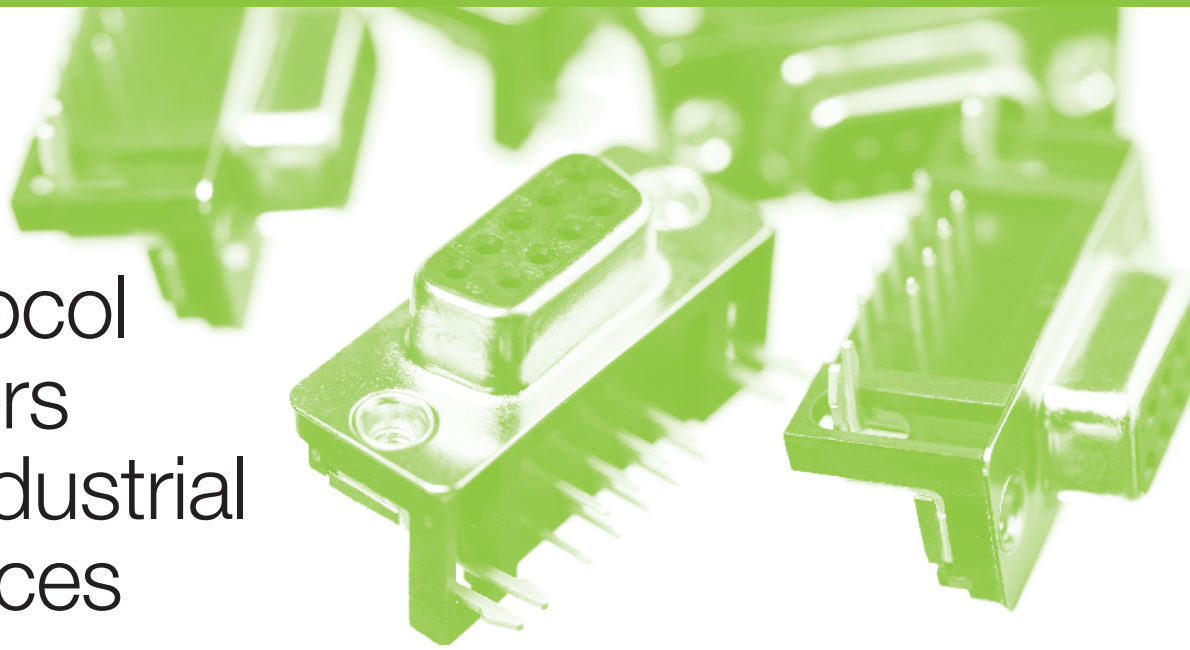


Dual-protocol transceivers simplify industrial PC interfaces

RENESAS

The trend in industrial PC designs towards smaller form factors and more communication versatility is driving the development of modern bus transceivers. New transceivers are favored over legacy designs because of their high level of integration, dual-protocol capability supporting the RS-232 and RS-485 standards, and ample configuration features.

Developed in the early 1980s, the RS-485 protocol is now greatly improved, providing for robust data transmission in noisy environments and across long distances. The protocol uses differential signaling across a signal pair of two conductors, A and B. It specifies a differential bus voltage swing between the two conductors of 1.5V minimum when loaded with a 54Ω differential load.

RS-485 supports networking of up to 32 unit-loads via a multipoint bus topology. Bus nodes are daisy-chained to one another via twisted-pair cable, as shown in Figure 1. The recommended characteristic cable impedance of 120Ω requires termination resistors at both cable ends, the values of which should match the cable impedance.

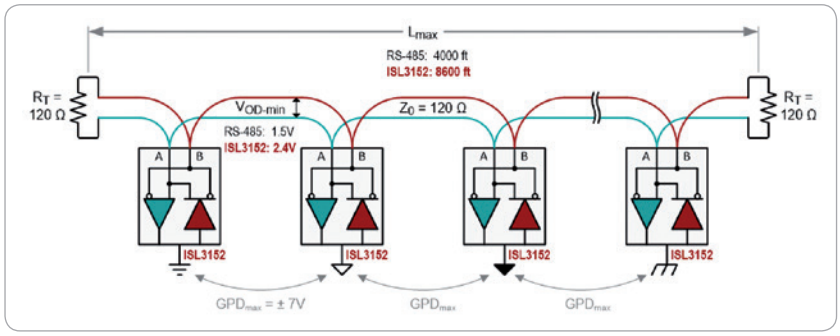


Fig. 1: Typical RS-485 network with daisy-chained bus nodes and terminated cable ends

As the receiver inputs are internally referenced to ground, a separate ground connection between drivers and receivers is not required. This is true, as long as the receiver input voltages do not exceed the specified common-mode voltage range of -7V to +12V.

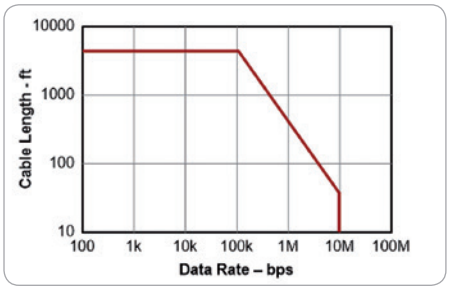


Fig. 2: RS-485 cable length versus data-rate characteristic

RS-485 supports cable lengths up to 4,000ft (1,200m), and data rates up to 10Mbits/s, but not simultaneously. The maximum applicable cable length for a given data rate is shown in Figure 2.

RS-485 supports multipoint topologies in which each bus node can either transmit or receive data. Two types of multipoint buses exist: half-duplex and full-duplex, as shown in Figure 3. A half-duplex bus uses two wires to connect nodes: one node may transmit data while another node receives data.

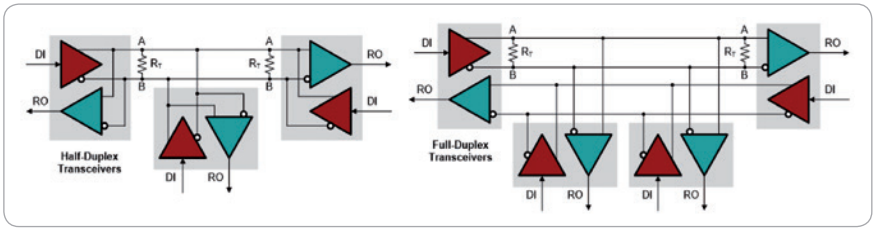


Fig. 3: Half-duplex and full-duplex multipoint bus topologies in RS-485

In a full-duplex bus, two signal pairs (four wires) are used. One pair connects the driver of the master node to the receivers of multiple slave nodes, and the other pair connects the drivers of the slave nodes to the receiver of the master node. This topology allows the master to either broadcast data to all slaves or address a specific slave node, while simultaneously receiving data from the slave nodes, one slave at a time. A full-duplex bus increases data throughput but is substantially more expensive than a half-duplex bus due to the higher wiring effort.

Dual-protocol transceivers

Modern transceivers are capable of supporting the designs of new industrial PCs and the designs of RS-232 to RS-485/RS-422 interface converters. The latter is needed in existing RS-232 equipment, such as legacy PCs, instrumentation equipment, and industrial machinery, in which interfaces must either be connected to a single network, or be extended over long distances.

Continued over…

Figure 4 shows the block diagram of a dual-protocol transceiver. The device incorporates two RS-232 Transmit and Receive channels, and one full-duplex RS-485 transceiver. Notice the transceiver's flow-through pin-out with bus pins on one side and logic pins on the other. This allows for easy routing of signal traces to the local controller and provides a great advantage over legacy transceivers, as shown in Figure 1, the pin-outs of which require the crossing of signal traces from the bus to the controller side and vice versa.

When operating the bus systems independently, each RS-232 port can support data rates of up to 400kbits/s without exceeding the specified maximum slew rate.

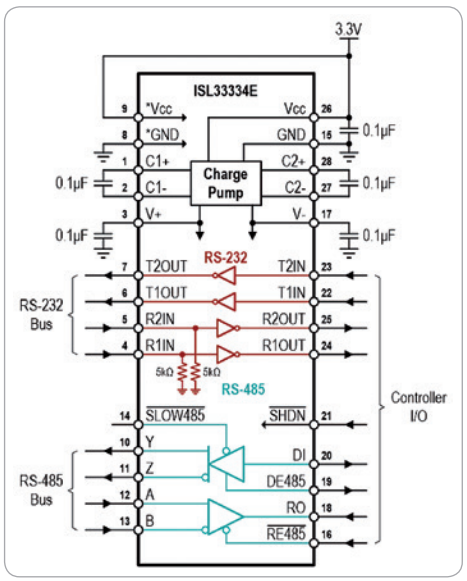


Fig. 4: Dual-protocol transceiver incorporating one RS-485 and two RS-232 transceivers

Multi-protocol applications

The integration of one RS-485 and two RS-232 transceivers into one IC makes the interface design of an industrial PC versatile, as the local controller can either drive the various bus systems independently, or act as an interface converter, as shown in Figure 5. When operated as an RS-232-to-RS-485 converter, the RS-232 signals of either channel 1 or channel 2 or both can be converted to logic levels, and then transmitted via the RS-485 bus. Using address coding, the controllers on both sides of the RS-485 link can distinguish between two RS-232 data streams.

To extend the data link between two RS-232 interfaces via a point-to-point link over long distance, the dual-protocol transceiver is configured as a standalone RS-232-to-RS-485 converter. Two converters are needed, one at each cable end to convert RS-485 bus signals into RS-232 data and vice versa. The configuration is simple, as the Enable inputs for driver and receiver can be wired to their respective voltage rails to keep the transceiver constantly active, as shown in Figure 6a.

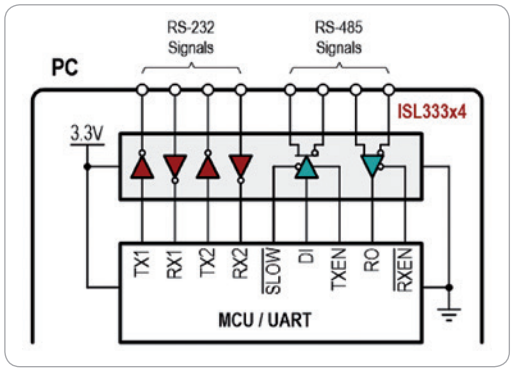


Fig. 5: Networking multiple pieces of RS-232 equipment via RS-232-to-RS-485 converters

Networking multiple pieces of RS-232 equipment over a full-duplex RS-485 bus requires a minor configuration change for the converters in slave nodes. The driver and receiver in the master node (PC) can remain active all the time, and so can the receivers in the slave nodes. The drivers in the slave nodes, however, must be closely controlled to prevent two or more slaves from accessing the bus at the same time.

For this purpose, the driver of the second RS-232 channel is used to enable and disable the RS-485 driver with the RTS flow control signal, as shown in Figure 6b. Note that, within the converter, the RTS must be looped back to the CTS input of the controller. This is known as a null-modem configuration.

Networking multiple pieces of RS-232 equipment over a half-duplex RS-485 bus requires the configuration shown in Figure 7a. Here the RTS signal controls the Enable functions of both driver and receiver. This configuration is required in all nodes, master and slaves, because a half-duplex bus can only pass data in one direction at a time.

In some equipment the RTS and CTS control signals can be up to 10ms out of synchronization with the data to be transmitted. In this case it is best to make the Enable signals data-driven. This is accomplished by implementing an inverter function between the Driver Input (DI) and the Enable pins (DE485 and RE485).

This puts the transceiver in transmit mode when DI = low, and in receive mode when DI = high. In receive mode the driver outputs are high-impedance, and the low-impedance termination resistors reduce the bus voltage to 0V. Since the RS-485 receiver is a full fail-safe device, all dual-protocol transceivers on the bus will indicate a zero bus voltage as a logic high at the receiver output, RO. Thus toggling a driver output between active low and high impedance will still generate a low-to-high transition at another receiver's output.

Conclusion

Modern dual-protocol transceivers simplify the design of industrial interfaces due to their high level of integration, combined support of RS-232 and RS-485 protocols, programmable data rates, and power-saving configuration features. A wide range of fixed and programmable, single- and dual-channel, multi-protocol transceivers from Renesas may be used in the applications described in this Design Note.

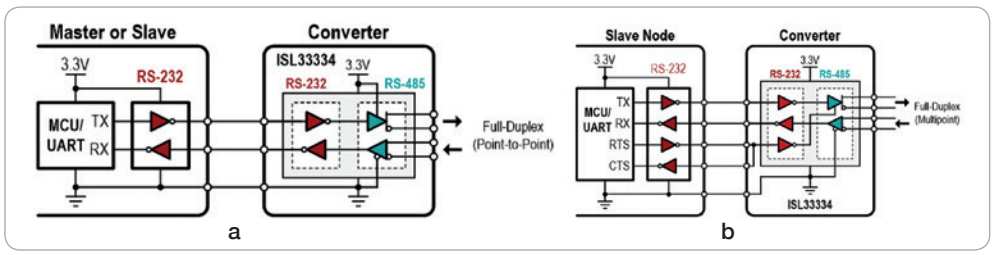


Fig. 6a/b: Networking multiple pieces of RS-232 equipment via RS-232-to-RS-485 converters

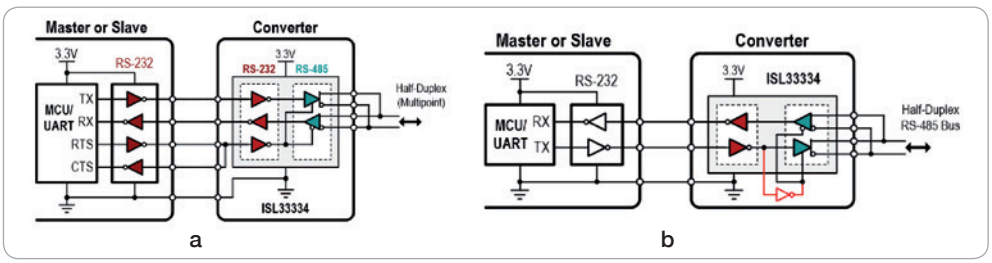


Fig. 7a/b: Networking multiple pieces of RS-232 equipment via RS-232-to-RS-485 converters over a half-duplex RS-485 bus

Distance2Go
XENSIV™ Radar 24GHz development board

24GHz sensor development kit utilizing Infineon BGT24MTR11 RF transceiver and XMC4200 32-bit ARM® Cortex®-M4 MCU series

This development kit allows the user to implement and test several sensing applications at the 24GHz ISM band such as FMCW distance measurement, Doppler based movement detection, Doppler based direction of movement detection, and Doppler based speed measurements of targets.

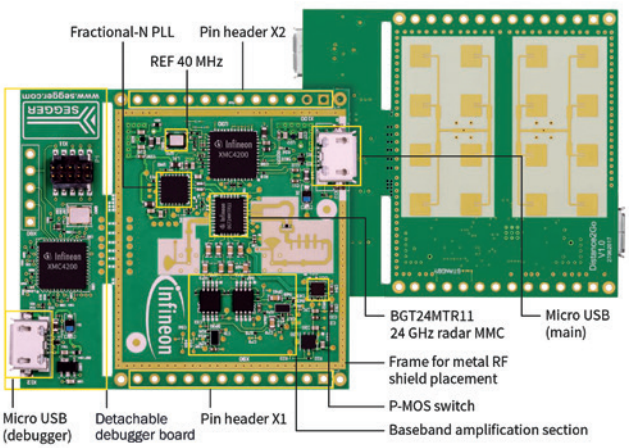
Applications
- Drone soft landing
- Drone obstacle avoidance
- Robotics obstacle avoidance
- Tank level sensing
- Intelligent switches
- Intelligent door opener

Key Features
- Capability to detect distance of multiple targets
- Capability to detect motion, speed and direction of movement (approaching or retreating)
- Very small form factor (4.5 × 3.6cm) 24GHz ISM band module that can be used as a development kit or mounted as a daughter board in a system
- BGT24MTR11 – 24GHz highly integrated RF MMIC
- XMC4200 ARM® Cortex®-M4 – 32-bit industrial microcontroller
- Debug over cortex 10-pin debug connector
- Integrated multiple element patch antennas

Kit Contents
- 24GHz demonstration board
- User's manual
- SW GUI to operate kit
- FMCW FW and SW (1) (also available as source code)
- Doppler FW and SW (1) (also available as source code)
- Schematic and bill-of-materials of module

The kit consists of the BGT24MTR11 transceiver MMIC and a XMC4200 32-bit ARM® Cortex®-M4 for signal processing and communication via USB.

The demonstrator board is shown in the figure below highlighting all main board components. The board is already preprogrammed using Infineon's DAVE™ development tool. The module features a phased locked loop that is controlled with the XMC4200 to generate the FMCW ramps required for distance measurement. The MCU samples up to 2 IF channels of the transceiver chipset and communicates via USB interface to a connected PC.



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Apples to apples? Considerations tantalum capacitors for MLCCs

By Craig Hunter, Senior Director, Global Marketing Communications and Dave Richardson, Senior Manager of Field Applications, Vishay Intertechnology

VISHAY

OEMs are today suffering from shortages of Multi-Layer Ceramic Capacitors (MLCCs), especially for devices in large case sizes and in high capacitance values. This has led them to evaluate the polymer tantalum capacitor as an alternative for functions such as filtering and in applications such as voltage stabilization and buffering. This Design Note describes some tips to help streamline the evaluation and testing process necessary for a successful substitution of a polymer tantalum capacitor for an MLCC.

These two capacitor types are commonly used surface-mount devices, and are ideal for many applications. To ensure a substitution is successful, it is necessary to look at the main differences in performance that result from the different materials and construction in each type. The designer then needs to consider different values of the main parameters by which a capacitor is specified to see whether the polymer tantalum alternative is compatible with the circuit's performance requirement.

Capacitance

The MLCC devices most likely to be replaced use a Class II dielectric material. This Class II ceramic, typically X7R or X5R, has a capacitance value which will vary over the operating-temperature range. This characteristic is called the Temperature Coefficient of Capacitance, or TCC, as shown in Figure 1.

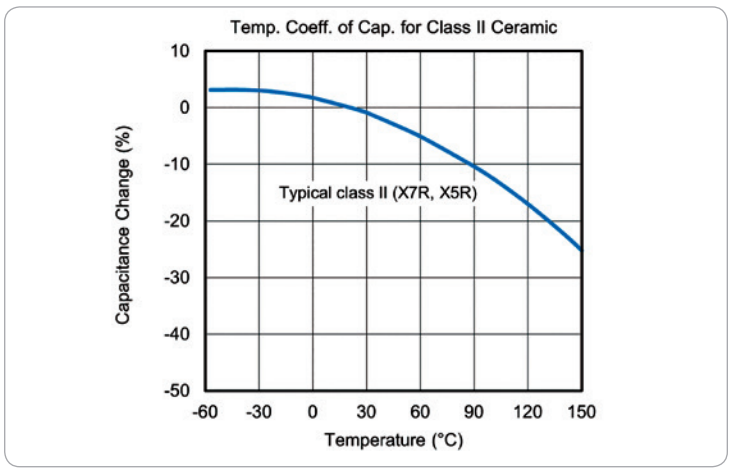


Fig. 1: TCC for Class II MLCC

For a typical X5R device the TCC is ±15% over a temperature range of -55°C to 85°C. Devices with a Class II dielectric also have a Voltage Coefficient of Capacitance, or VCC, as shown in Figure 2. As the voltage applied to the MLCC approaches the rated voltage, capacitance will drop markedly. These TCC and VCC characteristics are additive. So for a Class II device operating at 85°C and near its rated voltage, the capacitance could be as little as 30% of the specified datasheet value.

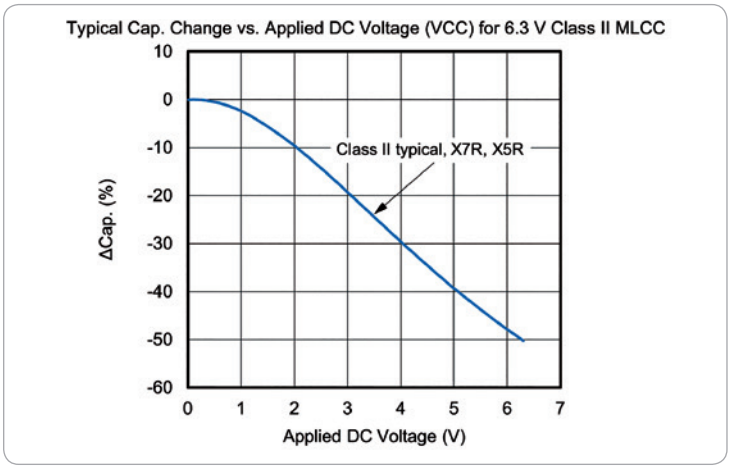


Fig. 2: VCC for Class II MLCC

By comparison, polymer tantalum capacitors have no material VCC effect, and therefore the capacitance value under applied voltage conditions remains fairly stable. In addition, the capacitance of these devices actually increases slightly as temperature increases, as shown in Figure 3.

Overall then, for surface-mount applications that require high capacitance values, such as bulk energy storage or power filtering, polymer tantalum capacitors provide superior capacitance performance over MLCCs with similar ratings. In fact, if capacitance is the driving factor in the application, it might be possible to replace multiple MLCCs with a single polymer tantalum capacitor.

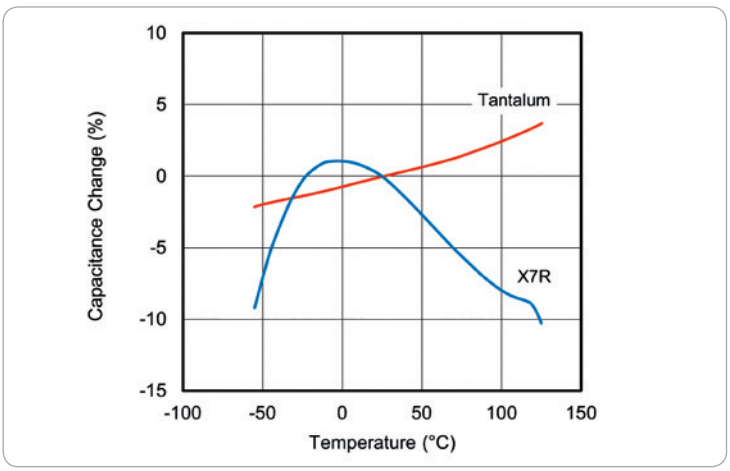


Fig. 3: Comparison of the TCC of a polymer tantalum capacitor with that of an X7R MLCC

when substituting polymer and

Rated voltage, de-rating and polarity
It is generally considered safe to run MLCCs at up to their full rated voltage. In practice, many designers de-rate by around 20% to provide for the VCC effect, which yields lower effective capacitance values in the circuit.

However, it is mandatory for designers to de-rate a polymer tantalum capacitor by 20% for 10V ratings and above, and by 10% for products below 10V. By comparison, traditional tantalum (MnO_2) parts must be de-rated by 50%. These parts can, however, be better from a cost point of view if they meet the technical requirements of the application.

While polarity is immaterial for MLCCs, it must be maintained for polymer and tantalum devices. This precludes the use of polymer and tantalum devices in switching applications in which reverse voltage spikes can occur.

Equivalent Series Resistance (ESR)
ESR is the real part of the impedance (Z) value. It represents all of the resistive losses in the capacitor. When a signal is passed through a capacitor, energy is lost in the form of waste heat, a function of ESR.

An MLCC has a lower ESR than a polymer tantalum capacitor of the same voltage and capacitance rating. Devices with a lower ESR more efficiently decouple noise to ground, can handle higher average ripple current, and more effectively provide momentary high currents.

It is also worth noting that parts with a low ESR meet pulse-current demand while avoiding voltage drops during discharge, and enable the specification of a lower input voltage. On the other hand, the use of capacitors with very low ESR can sometimes lead to instability in feedback-loop circuits.

Equivalent Series Inductance (ESL)
A capacitor's ESL is primarily determined by its physical dimensions. The reason that MLCCs are often designed with long side terminations is to decrease inductance in high-speed applications. But overall, for similarly sized devices of normal construction, there is unlikely to be an important difference in performance due to the inductive component.

High-speed circuits are an exception, however: inductive loads may delay the delivery of the required current from the capacitor, and this can have an impact on the performance of the circuit. The effects on impedance vary with case size and can be seen in Figure 4.

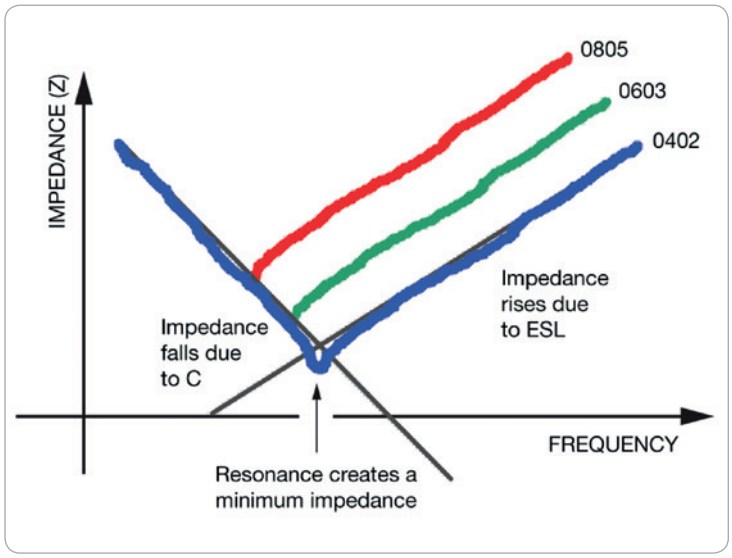


Fig. 4: The correlation of impedance and case size

DC leakage current
This value is specified differently depending on capacitor type. In short, MLCCs have a lower leakage current and outperform polymer tantalums by a factor of around five.

Scorecard and other relevant information
MLCCs offer superior ESR and DC leakage current characteristics, and are also non-polarized. So if polymer tantalum capacitors are selected, polarity must be maintained on the PCB. Mechanically, MLCCs are more susceptible to cracking when using larger case sizes on boards during the pick-and-place and assembly processes.

High-capacitance MLCCs tend to suffer from interference by high-frequency signals. This is perceived in the form of audible noise, such as whistling, and the piezo effect, making them a poor choice in some DC-DC conversion and audio applications.

Polymer tantalum capacitors provide high and stable capacitance values, which remain almost unaffected by the application of voltage. But they have higher ESR and DC leakage current values than Class II MLCCs. Their materials and construction make them less susceptible to mechanical damage caused by board flexing or high-temperature reflow processes.

Substituting devices
When substituting one capacitor type for another, designers should consider:

- The effect of TCC and VCC on capacitance values
- Case size, especially height
- Voltage rating and de-rating
- Polarization, for polymer and tantalum capacitors
- The dynamic parameters of ESR, ESL and DC leakage current

Figure 5 provides a reference table which may be used as a starting point in the evaluation process when replacing MLCCs with polymer and tantalum MnO_2 capacitors.

Range of Case Sizes	Capacitance	Voltage	Vishay Polymer Tantalum	Vishay Tantalum MnO_2
1608 / 0603	0.68µF to 22µF	2.5V to 50V	T55 standard range T58 extended range	TMCJ 298D
2012 / 0805	0.1µF to 47µF	2.5V to 50V		TMCP
3216 / 1206	0.1µF to 220µF	4V to 75V		TMCS 293D

Fig. 5: Capacitor replacement reference table

32-bit MCU features rich set of analog functions for signal-chain applications

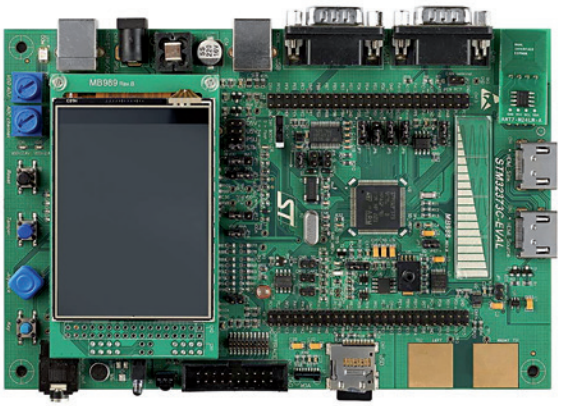
STMICROELECTRONICS

The STM32F373 family of 32-bit MCUs from STMicroelectronics offers a rich set of analog peripherals for use in applications that need to provide a low-noise, accurate interface to sensor signals.

Based on the high-performance Arm® Cortex®-M4 RISC core operating at a frequency of up to 72MHz, the STM32F373 features up to 256kbytes of Flash memory, up to 32kbytes of SRAM and an extensive range of enhanced I/Os and peripherals.

The analog peripherals supporting signal-chain functions include a 12-bit ADC with class-leading 5Msamples/s performance, three true 16-bit sigma-delta ADCs, fast comparators, a two-channel DAC and a single-channel DAC, and an uncommitted programmable gain amplifier.

The MCU also features a low-power real-time clock, nine general-purpose 16-bit timers, two general-purpose 32-bit timers and three basic timers.



The board includes a 240x320px color display and touch-sensing slider

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- CAN 2.0B interface

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FTM Boards

The STM32373C-EVAL evaluation board features a touch-sensing slider, joystick and 240x320px TFT color display connected to a serial peripheral interface on the STM32F373 MCU.

Orderable Part Number: STM32373C-EVAL

To buy development boards go to:
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Buck regulator ICs operate over wide input-voltage range up to 65V

ON SEMICONDUCTOR

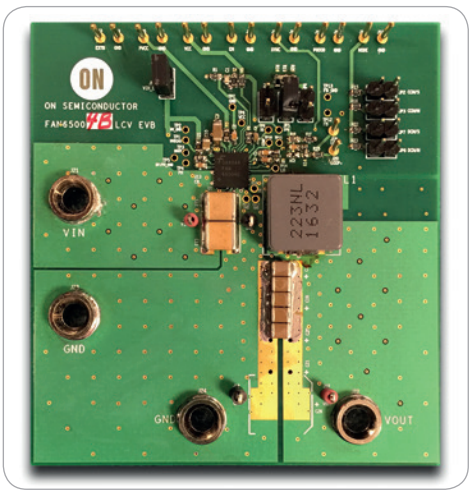
ON Semiconductor supplies a family of synchronous PWM buck regulator ICs which share a common footprint, and which are notable for their high efficiency and thermal performance.

The FAN65004B, rated for a maximum continuous current of 6A, the 8A FAN65005A and 10A FAN65008B products operate over a wide input-voltage range of 4.5V to 65V, stepping down the output in a range from 0.6V to 55V. Conversion efficiency is more than 95% over a wide load range.

Based on a constant-frequency voltage-mode controller, the FAN6500xx regulators also include a driver, power MOSFETs and LDOs in a thermally-enhanced 6mm × 6mm QFN package. The devices' control technique produces low ripple current and is easy to compensate.

The controller's switching frequency is programmable in a range from 100kHz to 1MHz, and the regulator supports frequency synchronization in either master or slave mode.

To improve efficiency when supplying light loads, the FAN6500xx devices can be set to operate in discontinuous conduction mode with pulse skipping. The integrated MOSFETs benefit from ON Semiconductor's high-performance PowerTrench® technology, which reduces ringing in converter applications.



FAN6500xx buck regulator: Low ripple current

The FAN6500xx regulators offer a complete set of protection features including thermal shut-down, under-voltage lock-out, over-voltage protection and hiccup-mode short-circuit protection.

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APPLICATIONS
- High-voltage point-of-load modules
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FEATURES
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- Power-good indication

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CAN transceivers offer proven quality in industrial applications

INFINEON TECHNOLOGIES

CAN transceivers from Infineon provide proven quality, a track record of reliability, and high robustness for use in automation applications.

Features include excellent electromagnetic performance and low levels of EMI. They also offer compliance with the ISO 11898 standard for CAN communication.

The IFX1050G, IFX1050GVIO and IFX1040SJ devices are CAN transceivers supporting a maximum data rate of 1Mbit/s. Infineon also supplies two parts, the IFX1051LE and IFX1051SJ, which support the CAN Flexible Data-rate (CAN FD) standard and operate at data rates up to 2Mbits/s.

The IFX1050 and IFC1040 parts support high speed differential-mode data transmission in industrial applications. The transceiver works as an interface between the CAN protocol controller and the physical differential, two-wire bus in CAN applications.

The IFX1050 has three operating modes: normal mode, stand-by mode and receive-only mode, which is useful when performing diagnostic investigations. The IFX1040 has a normal mode and a stand-by mode. In stand-by mode, the part remains in a low-power state drawing a low quiescent current, and wakes up when CAN messages are detected. The mode selection for both parts is controlled by logical input pins.

The products are based on Infineon's SPT® Smart Power Technology, which allows bipolar and CMOS control circuitry to co-exist with DMOS power devices on the same monolithic circuit.

The IFX1051 parts offer guaranteed loop-delay symmetry to support CAN FD data frames at rates up to 2Mbits/s. Additional fail-safe features such as TxD time-out and optimized output slew rates on the CAN High and CAN Low signals make the IFX1051 an ideal choice for large High-Speed CAN networks which call for operation at high data-transmission rates.

Product Part Number	Package	Transceiver Type	Maximum Transmission Rate	Maximum Quiescent Current	Bus Wake-up cCapability	Wake-up Inputs
IFX1050G	PG-DSO-8 (SOIC-8)	High-speed CAN ISO11898-2	1Mbit/s	10µA at 5V stand-by	No	No
IFX1050GVIO	PG-DSO-8 (SOIC-8)	High-speed CAN ISO11898-2	1Mbit/s	10µA at 5V stand-by	No	No
IFX1040SJ	PG-DSO-8 (SOIC-8)	High-speed CAN ISO11898-2 ISO11898-5	1Mbit/s	30µA at 5V stand-by	Yes	Yes in stand-by
IFX1051LE	PG-TSON-8	High-speed CAN FD ISO11898-2	Up to 2Mbits/s	3mA in receive-only mode	No	No
IFX1051SJ	PG-DSO8 (SOIC-8)	High-speed CAN FD ISO11898-2	Up to 2Mbits/s	3mA in receive-only mode	No	No

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- Industrial equipment
- Lighting
- Motor control and drives
- Motorcycles, e-bikes and small electric vehicles
- Power-management systems
- Renewable energy
- Smart grid equipment

FEATURES

- Low CAN bus leakage current in power-down state
- Over-temperature protection
- Protected against transient voltage spikes
- Pin-to-pin replacements for industry-standard parts

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FTM Boards

The DEMOBOARD IFX1050SJ is a basic control unit for use in a system to generate High-Speed CAN data streams. It provides a ready-to-use system for building a complete CAN network. Software examples are provided to enable timing measurements and to verify signal integrity.

Orderable Part Number:
DEMOBOARDIFX1040SJTOBO1

Infineon also supplies the DEMOBOARD IFX1050G, and an evaluation board for the IFX1050G High-Speed CAN transceiver, and the DEMOBOARD IFX1050GVIO for evaluating the IFX1050GVIO transceiver.

To buy development boards go to:
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Current sense amplifier offers industry's widest dynamic range

MAXIM INTEGRATED

The MAX40016 from Maxim Integrated is a Current Sense Amplifier (CSA) with an internal sense element which senses current over a four-decade range from less than 300µA to higher than 3A.

The four-decade current sensor functions with 1% gain error and offers three, multiplexed programmable output ranges for interfacing with 12-bit ADCs.

It accepts a power-supply current through an active on-chip transistor. A low voltage drop of 35mV to 60mV across the transistor sensing element means that the MAX40016 is ideal for portable designs.

The integrated sense element allows the entire current measuring path to be factory-trimmed, relieving the user of the need to calibrate discrete sense resistors and CSAs.

For guidance on implementing the MAX40016 in current-sensing applications, readers may view online the Maxim Application Note 6565, 'Current sensing devices used in battery management of portable applications', at maximintegrated.com.

MAX40016: Low voltage drop ideal for battery-powered devices

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APPLICATIONS
- Mobile devices
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- Portable instruments

FEATURES
- High accuracy over full four-decade measurement range
- Integrated current-sense element saves the space and cost of a discrete precision sense resistor
- 10µA supply current in low-power mode

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Precise current-sense amplifiers feature low gain error and offset voltage

ON SEMICONDUCTOR

The NCV21xR series from ON Semiconductor are automotive voltage-output current-sense amplifiers which can measure voltage across shunt resistors at common-mode voltages ranging from -0.3V to 26V, independent of the supply voltage. The NCV21xR amplifiers are AEC-Q100 qualified for use in automotive systems. ON Semiconductor also supplies the NCS21xR series for use in industrial applications.

Offering a choice of fixed gain values, the NCV21xR and NCS21xR series amplifiers are notable for their low offset voltage and zero-drift architecture. These enable the implementation of accurate and stable current-sensing circuits with maximum full-scale drops across the shunt resistor as low as 10mV.

The NCV21xR amplifiers can operate from a single 2.2V to 26V power supply, compatible with the safe 2.5V voltage reference typically used in a measurement circuit, and can handle an absolute maximum input of 30V. They draw a maximum supply current of 80µA.

ON Semiconductor also supplies the NCS199AxR industrial current-sense amplifiers, which offer the flexibility of operating from a wide supply-voltage range of 2.2V to 26V, and which are rated for an absolute maximum voltage of 30V.

NCS21xR: Zero-drift architecture

	NCS210R	NCS211R	NCS213R	NCS214R
Gain (V/V)	200	500	50	100
Gain error (%)	1	1	1	1
Offset voltage (µV)	35	35	100	60

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APPLICATIONS
- Power-supply adaptors
- Wireless chargers
- Power supplies for telecoms equipment
- Hybrid and electric vehicles
- Automotive systems

FEATURES
- 0.5V/°C offset drift
- 10ppm/°C maximum gain error drift
- Rail-to-rail output capability

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FTM Boards

The PCB comes populated with the amplifier, six test points and one 0.1µF capacitor. The user can mount their own custom shunt resistor for quick prototyping.

Orderable Part Number: NCS210RMUTAGEVB

To buy development boards go to:
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Precision resistor's low current noise and temperature drift ensure accurate signal transmission

YAGEO

Yageo's RT series of thin-film resistors provides for accurate signal transmission because of high precision, high stability and low current noise.

In the RT series thin-film resistors, advanced sputtering technology is used to form a fine nichrome resistive layer on the ceramic substrate. This produces attractive performance characteristics for applications that require high signal integrity, including a low Temperature Coefficient of Resistance (TCR) of ±5ppm/°C, and tight tolerance of ±0.01%. A low TCR minimizes drift in resistance value as the operating temperature in the application rises. Tight tolerance provides excellent overall stability and high reliability.

The RT series is also notable for its low current noise, a result of the special composition of the resistive layer. Metal granules are stacked together to form a fine metal film from the micro-structure of the resistive layer of a thin-film resistor. The electrons pass through one or more metal granules to another in a straight current flow, which inhibits noise generation. The low-noise feature of thin-film chip resistors is ideal for applications that require low distortion to achieve accurate signal transmission. In addition, the noise level of the resistor is consistent over a wide frequency range.

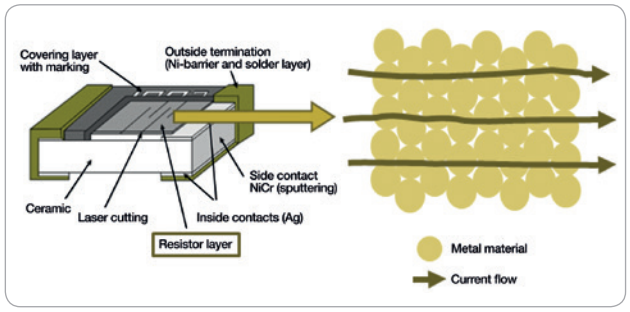

Fig. 1: Structure of an RT series resistor, and the micro-structure of its resistive layer

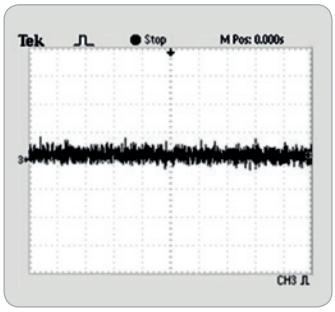

Fig. 2: Consistent noise over the operating-frequency range of its resistive layer

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Maximizing the efficiency of DC-DC converters: how to

By Robert Gabrysiak
Applications Engineer, Future Electronics (Poland)

READ THIS ARTICLE TO FIND OUT ABOUT:

- The main characteristics of the most widely used DC-DC converter topologies
- The performance benefits of zero-voltage switching and synchronous rectification
- Components which enable designers to achieve efficient conversion of a rectified mains input to a point-of-load output as low as 2.5V in only two stages

For some years, the designers of medium- and high-power electronics systems have been under intense pressure to improve efficiency at full and light load, in order both to ensure compliance with increasingly tight limits to power consumption imposed by governments, and to help end users to reduce energy costs.

The industry's responses to this pressure have included efforts to reduce or eliminate power losses in high-power DC-DC converters; and at the same time to extend the use of high-voltage DC in place of AC in power distribution systems, with the effect of reducing distribution losses.

Electronics OEMs in sectors such as telecoms and networking servers, battery-charging systems and renewable energy generation are also looking to improve efficiency by implementing direct conversion from a 48V DC distribution bus to Points-of-Load (PoL) operating at a voltage as low as 2.5V.

This article explains important power-conversion breakthroughs which have enabled the development of more efficient DC-DC converters, both for stepping down 400V inputs to a 48V output, and also for converting the 48V distribution bus to a PoL voltage. It also introduces two new off-the-shelf solutions that an OEM designer can implement quickly and easily.

The choice of DC-DC converter topologies

The most common DC-DC converter types can be divided into two categories depending on how they transfer power: energy can go from the input through the magnetics to the load simultaneously, or the energy can be stored in the magnetics for later release to the load. These types are shown in Figure 1.

Topology	Power Range	Transformer Utilisation	Number of Active Switches	Voltage Stress on Active Switches	Type of Power Transfer
Buck (multi-phase)	>1kW	Single ended	1	V_{IN}	Energy flow
Flyback	<150W	Single ended	1	$>V_{IN} + n^*V_{OUT}$	Energy storage
Forward	50W – 200W	Single ended	1	$>V_{IN}$ x 2 (D_{MAX} = 0.5)	Energy flow
Active Clamp Forward (ACF)	50W – 300W	Double ended	2	$V_{IN}/(1-D)$	Energy flow
Push-Pull (P-P)	100W-500W	Double ended	2	$>V_{IN}$ x 2	Energy flow
Half-Bridge	100W – 1kW	Double ended	2	$\geq V_{IN}/2$	Energy flow
Full-Bridge	>1kW	Double ended	4	$\geq V_{IN}$	Energy flow

Fig. 1: Common DC-DC converter topologies and the power ranges to which they are suited

Multi-phase buck controllers offer higher efficiency than single-phase converters because of their low transitional losses. They also feature a lower output-ripple voltage, better transient performance, and a lower ripple-current rating at the input capacitor.

A full-bridge converter configuration retains the voltage properties of the half-bridge topology, and the current properties of the push-pull topology. The push-pull, half-bridge and full-bridge configurations use smaller input filter and output inductors than single-ended converters use. They also provide up to 40% better transformer utilization, and balanced semiconductor power dissipation over the input-voltage range.

Different application requirements, then, will call for the use of different converter topologies. But across the board, the realisation of high-efficiency DC-DC converter designs has been made possible by the development of two important techniques: Zero-Voltage Switching (ZVS), and synchronous rectification.

Benefits of implementing zero-voltage switching

ZVS is an extreme form of 'soft switching'. In a hard-switching system during turn-on, each primary-side MOSFET in turn is exposed to a voltage equal to at least the supply voltage, and current tends to flow from drain to source, resulting in high turn-on losses.

In soft switching, the current at the turn-on point is oriented from source to drain, which discharges the MOSFET's output capacitance before turning the device on, thus eliminating turn-on losses. It should be noted that ZVS operation affects turn-on losses only; the converter will still suffer from switching losses at turn-off, both due to current overlap and to charging of the output capacitor.

Why synchronous rectifiers are replacing diode rectifiers

Alongside ZVS, synchronous rectification on the secondary side is also helping to improve converter performance in important ways. As shown in Figure 2, synchronous rectifiers may be used to replace diode rectifiers, with the drivers of the synchronous rectifiers behaving as diode rectifiers. This approach is more efficient because the product of the average current and on-resistance is much lower than the forward voltage of the diode. In a design using synchronous rectification, however, the MOSFET must be carefully controlled so that the timing of the MOSFET's turn-on and operation is synchronized with the diode's turn-on period.

New digital implementation of phase-shifted full bridge

For high-power converter applications, as Figure 1 shows, the Phase-Shifted Full Bridge (PSFB) topology is the most suitable. When the PSFB topology is implemented with both ZVS and synchronous rectification, power-system designers can achieve excellent power density and efficiency. This is particularly important in DC power distribution applications, for instance when stepping down 400V DC to 48V to supply a distribution bus.

In the past, the implementation of such a circuit would have called for deep power-design expertise and the ability to create complex PWM waveforms and manage tight timing constraints. More recently, however, microcontroller manufacturers have introduced solutions which provide an easy-to-use platform for a fully digital implementation. Here, MCUs control the gate drivers of the MOSFETs in the full bridge, and for synchronous rectification. Digital control offers advantages such as programming flexibility, high integration, and the ability to program in-rush controls and soft-start operations.

take advantage of the latest topologies and techniques

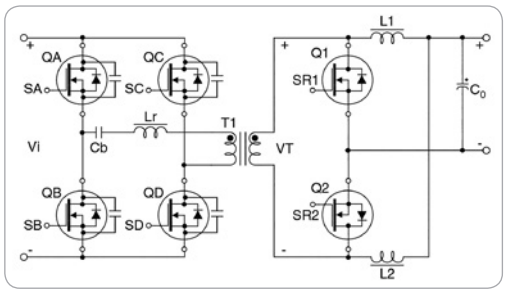

Fig. 2: Simplified circuit diagram of a phase-shifted full-bridge converter with synchronous rectification on the secondary side. (Image credit: Vishay Application Note 833)

Such an approach is demonstrated by STMicroelectronics in its STEVAL-ISA172V2 board, which implements a 2kW AC-DC converter with one STM32F334 MCU for the AC-DC converter and power factor correction, and another to perform the power-control functions in a PSFB DC-DC converter providing an output of 48V or 52V, as shown in Figure 3. The STM32F334 MCU features a high-resolution timer (217ps maximum resolution) which enables very accurate current regulation in the PSFB circuit.

The control algorithm is based on a simple voltage loop realized with a traditional Proportional Integral (PI) regulator, see Figure 3. The algorithms used in the STM32F334 are explained in detail in Application Note 4856 from ST, which supports the STEVAL-ISA172V2 demonstration board.

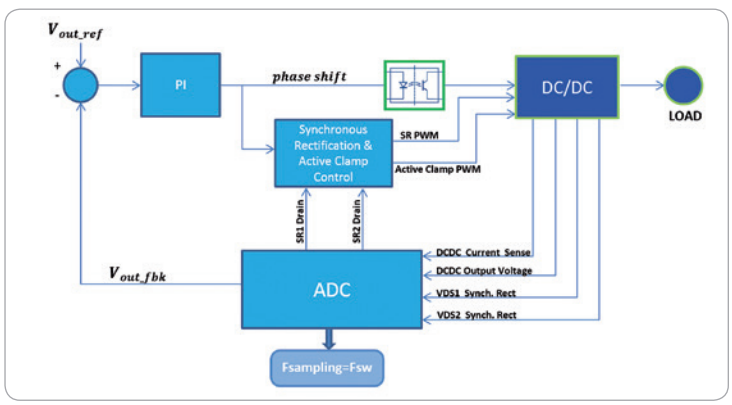

Fig. 3: The control loop in the STEVAL-ISA172V2 PSFB converter circuit. (Image credit: STMicroelectronics from AN4856)

Easy 48V-to-PoL conversion

The STEVAL-ISA172V2 steps a rectified mains input of 400V DC to a distribution bus voltage of 48V. Typically, this distribution bus would be stepped down to an intermediate voltage of 12V or lower, before being stepped down again to PoL voltages of 5V or less. This reflects the ready availability of existing buck converter ICs, which work well over a narrow input-to-output voltage ratio of up to 6:1. But the performance of conventional hard-switching converter ICs falls below acceptable limits, in terms of both efficiency and output power, at step-down ratios above around 12:1. Direct conversion from 48V to a PoL voltage, which involves much wider ratios up to 36:1, is made possible through the use of a ZVS topology.

And looked at logically, it makes sense to eliminate one of the intermediate conversion stages, normally the 48V-to-12V step: in a typical two-stage conversion when both converters offer efficiency of 90%, the overall efficiency is 81% (0.9 x 0.9). So a single-stage conversion, 48V to the PoL voltage, which can achieve average efficiency higher than 81% is better than two stages each with high 90% efficiency.

A particularly efficient implementation of ZVS is enabled by a new buck-conversion topology developed by Vicor in its Cool-Power® ZVS series of regulator modules, as shown in Figure 4. The ZVS technique cuts turn-on switching losses and gate-driver losses, as well as eliminating FET body-diode conduction.

Part number	Input voltage [V]	Output Voltage [V]	Maximum Current [A]
PI3525-00-LGIZ	48 (30 – 60)	5.0 (4.0 – 6.5)	20
PI3542-00-LGIZ	48 (36 – 60)	2.5 (2.2 – 3.0)	10
PI3543-00-LGIZ	48 (36 – 60)	3.3 (2.6 – 3.6)	10
PI3545-00-LGIZ	48 (36 – 60)	5.0 (4.0 – 5.5)	10
PI3546-00-LGIZ	48 (36 – 60)	12 (6.5 – 14.0)	9

Fig. 4: Specifications of the Vicor Cool-Power ZVS regulators for 48V-to-PoL conversion

The Vicor ZVS buck topology is in fact the same as a conventional synchronous buck regulator, except for the addition of a clamp switch across the output inductor, as shown in Figure 5: energy stored in the output inductor is directed so as to ensure that switching takes place under nominally zero-voltage conditions.

The high-side power MOSFET in the Vicor PI35xx parts always turns on at zero current and at nearly zero drain-source voltage. Power wastage and heat still arise from conduction losses, but switching losses are reduced by almost eliminating turn-on losses thanks to the ZVS operation.

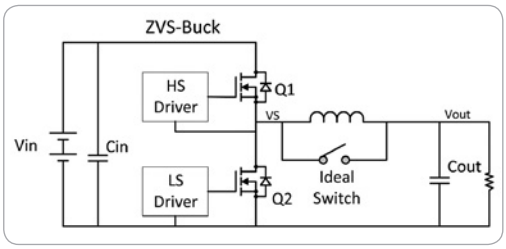

Fig. 5: The Vicor ZVS buck-converter topology, showing the clamp switch across the output inductor. (Image credit: Vicor, ZVS white paper)

With the addition of the clamp phase, there is no body diode conduction in the low-side MOSFET, hence the high reverse-recovery current prior to turning on the high-side MOSFET, a feature of conventional synchronous buck regulators, is not a feature of these Vicor parts. Each power MOSFET thus produces much less heat, eliminating the need for expensive and bulky heat-sinks, and helping to reduce the size and weight of the system, and its bill-of-materials cost. Peak efficiency is typically higher than 95% for all of the devices in the range.

Conclusion

This Vicor solution is provided as a fully integrated surface-mount module, making it quick and easy for the power-system designer to implement. Together with new, high-efficiency approaches to 400V-to-48V conversion such as that demonstrated in the STEVAL-ISA172V2 board, system designers can now more quickly and easily than ever before achieve two-stage conversion from the rectified mains to a PoL voltage.

This approach enables high voltage and low current to be distributed throughout a system, minimizing distribution losses while providing a low-voltage and high-current supply directly from a 48V input in a highly efficient manner. A space-saving solution, this approach also reduces development time since it eliminates one entire power stage from the power-system design.

Distribution at 48V DC requires less cabling, and reduces crowding, cost, weight and conduction losses, typically offering a 16x reduction in power losses and a 4x reduction in capacitor volume.

This combination of benefits suggests that 48V power distribution will rapidly spread from its stronghold today in telecoms and networking equipment to other market sectors including industrial and automotive systems.

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