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Electronics in Motion and Conversion

October 2017

Smart appliances need a smart power supply with clever standby power management

The Gallery

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Nature is Teaching Us

We have seen the increasing power of hurricanes in Florida. It is clear that global warming is influencing weather around the globe. Those who have not understood the lesson before now need to get back to school to learn the basics of climate change and the facts involved, especially those in control of public policy. Damages to the infrastructure, to buildings, loss of life, evacuations, etc. - all are happening more frequently. Leaders in the world must start to work at the core subjects and not just sightsee and promise help. Global warming must be stopped.

In our field, Wide Band Gap semiconductors will make their contribution in system designs with significantly reduced losses. To design with SiC and GaN is the future. For all Design Engineers that desire a more efficient future, I recommend attending the following event in Munich Germany:

Wide Band Gap Conference, 5th of Dec 2017, Munich-Airport
Wide Band Gap semiconductors have become mature during the last decade. The trend is to replace silicon power switches with SiC and GaN. It is important that system design engineers get involved in advanced design work using wide band gap devices for their next project. Experts from semiconductor manufacturers and the early users will describe their experience and ease the transition to the new technology. Particulars of the conference are listed at: http://www.Power-Conference.com

A great set of experts will be presenting, and discussing your WBG application subjects. Get your seat booked to stay at the frontier of technology for your next project.

I personally remember in the mid 80's introducing the new device called the COMFET, seeking to convince designers to use these devices instead of MOSFETS and Bipolar Transistors.

After the first successful designs were running, gradually the field lost their hesitation and started to accept and use the COMFET. The name changed to the IGBT, and it changed our world. WBG devices have started on a similar track. We see the same kind of spirit today. My role has changed to publishing, but always to promote progress. I'd love to see as many as possible in Munich at the WBG event.

Bodo's Power Systems reaches readers across the globe. If you are using any kind of tablet or smart phone, you will find all of our content on the new website www.eepower.com. If you speak the language, or just want to have a look, don't miss our Chinese version: www.bodospowerchina.com

My Green Power Tip for October:
Go out and pick wild berries in the forest and open fields. When farm grown, they are sprayed against insects and to reduce spoilage, they are packed to travel long distance, some fly in by airplane. Help to avoid traveling fruit. Pick your own from your neighborhood.

Best Regards

Bodo´s Power Systems®

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Events

ECCE 2017
Cincinnati OH, USA, October 1-5
www.ieee-ecce.org/2017

CWIEME Chicago 2017
Chicago IL, USA, October 3-5
www.coilwindingexpo.com/chicago

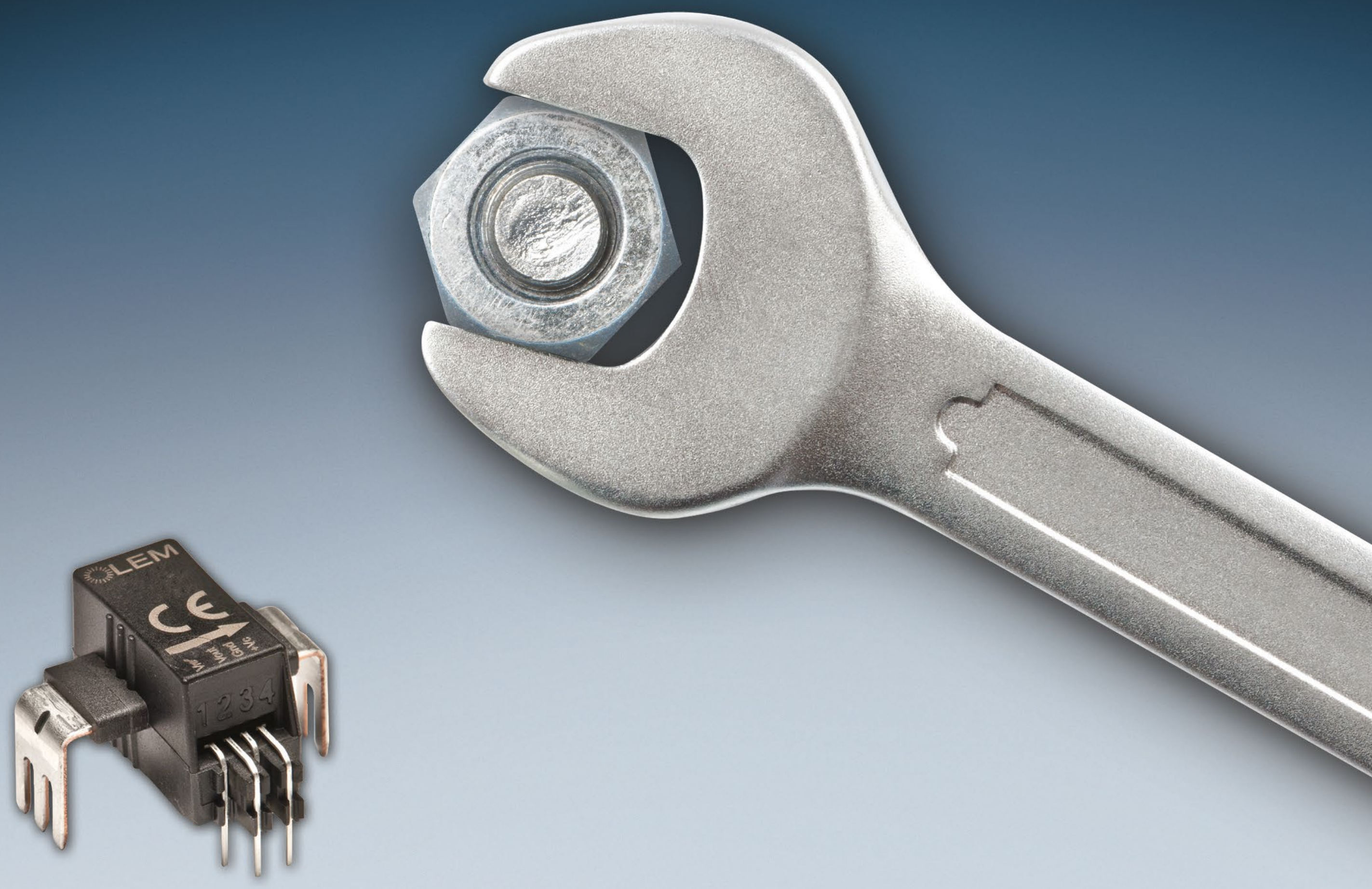
INTELEC 2017
Gold Coast, Australia, October 22-26,
www.intelec.org

Power Electronics 2017
Moscow, Russia, October 24-26
www.expoelectronica.primexpo.ru/en

CWIEME Istanbul 2017
Istanbul, Turkey, November 2-4
www.coilwindingexpo.com/istanbul

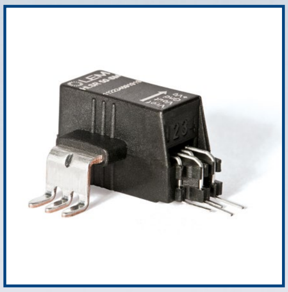
SPS/IPC/ Drives
Hall 3A.400

The Perfect Fit



HLSR

The perfect fit for your design: a cost-effective current transducer that out-performs shunts in every way. The compact package of the HLSR requires only 387mm^2, less board area than many shunt solutions. Large clearance/creepage distances ensure safety, and high performance produces accurate measurements across a wide temperature range of -40°C to +105°C. The LEM HLSR – a single compact device that eliminates complexity in your design.



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- Through-hole and SMT packages

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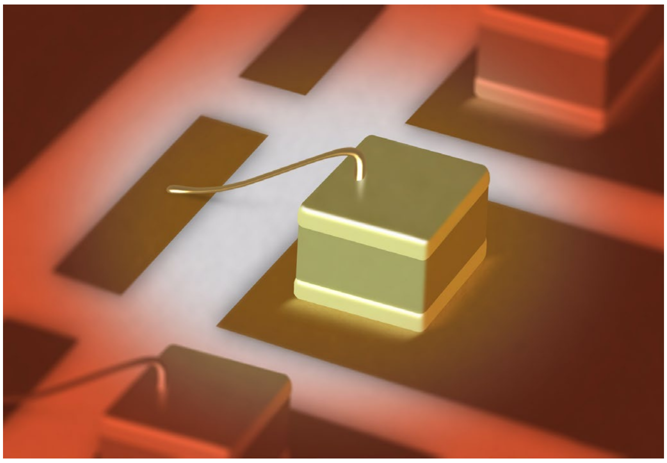
The 20th European Microwave Week (EuMW 2017) Oct 8th – 13th

The show will provide an unrivalled opportunity for visitors to see products, components and materials – especially from Knowles Capacitors and their brands DLI, Novacap, Syfer, Voltronics and Johanson MFG.

EuMW 2017 brings together a host of products from Knowles Capacitor brands Stand No: 177



Recently launched by DLI is the V Series, Single Layer Capacitor (SLC). This series was designed to provide higher capacitance in a smaller footprint. The wire bondable range is ideal for power applications where excellent high frequency response is a prerequisite. This, together with the small footprint of just 0.03”/0.77mm square, allow for high density mounting. Excellent in high frequency characteristics compared with general purpose MLCC’s, the impedance of this product becomes lower at high frequencies. High capacitance, X7R dielectric temperature stability, and gold termination, completes the spec for DC Blocking, RF Bypassing, Filtering, Tuning and Coupling applications. RoHS compliancy is standard.

DLI’s application of precision thin film fabrication with integrated resistors, coupled with high permittivity ceramic materials, lead to a host of components for RF and Microwave applications to provide a high performance and repeatable design solution. The company has a lineup of cataloged and bespoke products such as Power Dividers, Couplers, Bandpass/Lowpass Filters and Xtreme Broadband Blocks. Stand 177 will have specialized staff on hand to discuss specific products and applications that engineers may care to bring along.

www.knowlescapacitors.com

Elektronik Motorcycle Team Driven to Set a Land Speed Record

The University of Nottingham’s Wurth Elektronik Motorcycle Team is poised to ride into the record books when it attempts to break the British electric motorcycle land speed record on Sunday 17th September at Elvington Airfield. The team will be aiming to improve on their last attempt where they achieved a top speed of 165.8mph in test runs which were carried out to hone the bike.

Talan Skeels-Piggins, the UK’s first paralysed motorbike racer and World Champion (600cc category), will put the University’s race bike through its paces.

The Team, comprising of members from the Faculty of Engineering, has spent time developing the bike in a controlled environment and completing fine design work. Significant modifications have been made to the aerodynamics of the bike, lowering the drag coefficient. The most important change however, has been made to the bike’s converter. The team has significantly increased the power that the bike can deliver and ensured that the converter does not trip at high speeds. In order to achieve this, they carried out several dyno runs in collaboration with Sevcon, a manufacturer and supplier of electric drives.

When asked about the team’s chances, Team General Manager and Assistant Professor in Mechanical and Electrical Engineering, Dr Miquel Gimeno-Fabra said confidently, ‘We will break the old record – no doubt about that. Talan is a very experienced rider and he will push the bike to its limits. I wish him the very best of luck. I am sure we will see speeds in excess of 190mph. This will position us as the fastest electric vehicle in the UK, securing an official record that will be hard

to break for electric bikes to come. From an engineering perspective, it will clearly demonstrate that the electric bike is able to exceed expectations and this will place it on a par with petrol superbikes.’

More information is available from Miquel Gimeno-Fabra, Assistant Professor in Mechanical and Electrical Engineering on +44 (0) 115 7484847, M.Gimeno-Fabra@nottingham.ac.uk or Shirlene Campbell Ritchie, Media Relations Manager at The University of Nottingham, on +44 (0)115 846 7156, shirlene.campbellritchie@nottingham.ac.uk

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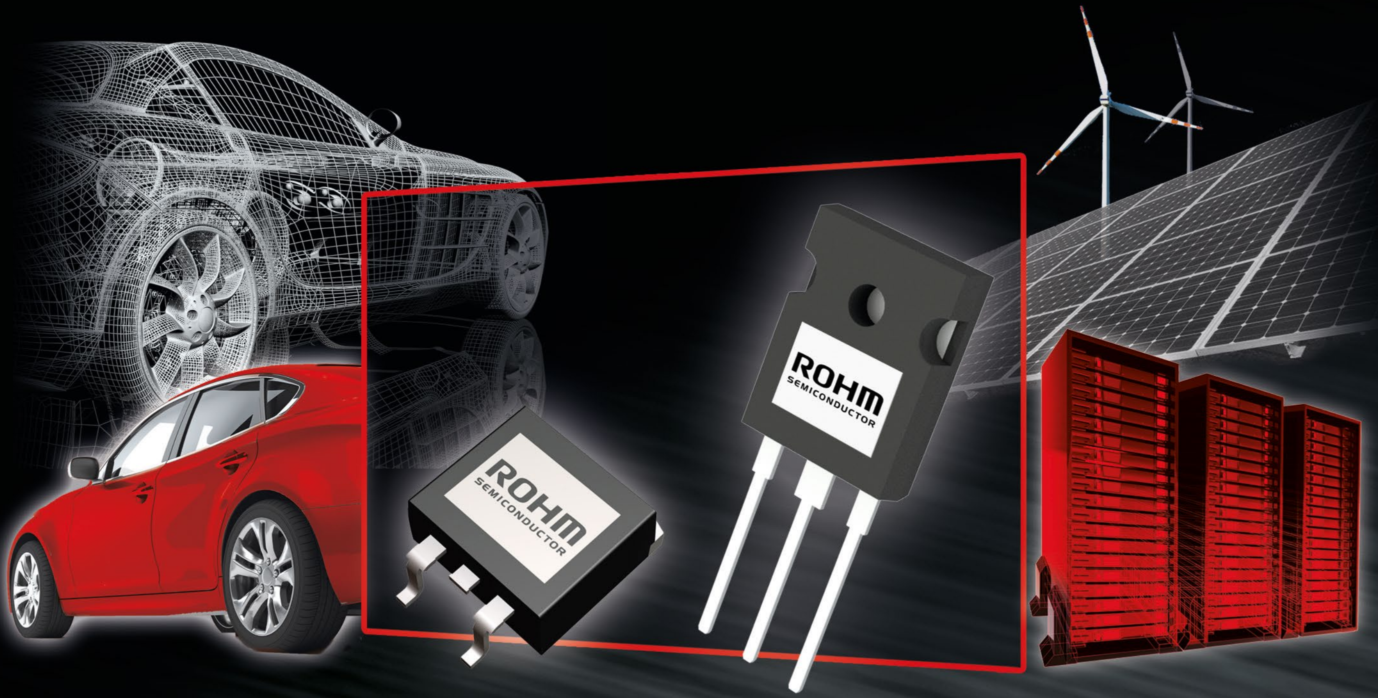

RGS Series (Automotive)

- Package: TO-247N
- 650V, 1200V
- Short circuit withstand time: 8-10 µs
- Low switching noise
- Built-in very fast & soft recovery FRD
- Based upon AEC-Q101

RGP Series (Ignition)

- Package: TO-252 (DPAK), TO-263S (D2PAK)
- BV_{CES} = 360V to 560V
- Low saturation voltage typ. 1.6V
- Avalanche energy 250 mJ to 500 mJ (Tj=25°C)
- Built-in ESD protection diode for gate
- Built-in resistor between gate and emitter (Opt.)
- Based upon AEC-Q101

RGTV / RGW Series (Industrial)

- ***High efficiency***
- ***Smooth and oscillation-free turn-off***
- ***Soft co-packaged diode***

- Light punch through & thin wafer technologies
- Package: TO-247N & isolated TO-3PFM
- 650V / 30, 50, 80A : RGTV @ Tc = 100°C
- 650V / 30, 40, 50A : RGW @ Tc = 100°C
- Low saturation voltage typ. 1,5V (Tj=25°C)
- Short circuit withstand time 2 µs (RGTV)

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IVT-S Measures Current in the Fraunhofer Development Platform foxBMS

IVT-S Measures Current in the Fraunhofer Development Platform foxBMS

The Fraunhofer Institute for Integrated Systems and Device Technology (IISB), Erlangen, is using Isabellenhütte's shunt-based management system IVT-S for precision current measurement in battery management systems in its foxBMS development platform.

The Isabellenhütte IVT series offers precise, temperature-compensated current and voltage measurement in a single component. Isabellenhütte's IVT systems are mainly used in the rapidly growing market for lithium-ion traction batteries and can be found in electric cars, electric trucks, electric buses and electric aircraft as well as in materials handling.

Fraunhofer IISB foxBMS – a gateway for researchers and developers

foxBMS is a research and development platform for battery management systems, which was developed by the Fraunhofer IISB based in Erlangen. foxBMS is an open-source platform, meaning that any companies or research institutes are free to use it to develop or test their own products – such as electric vehicles or applications with similar requirements.

Integrated system for precision measurements: IVT-S in the foxBMS

Fraunhofer IISB uses Isabellenhütte's IVT-S measurement system to achieve high-precision current measurements in the foxBMS platform. "We opted for the IVT-S from Isabellenhütte because this current sensor offers precision current measurement in combination with coulomb counting to determine state of charge in automotive battery systems up to 1,000 V," explains Dr.-Ing. Vincent Lorentz, Group Manager Battery Systems at Fraunhofer IISB.

The IVT-S from Isabellenhütte has a galvanically isolated CAN interface. The integrated, three-channel HV sensor measures the voltage of the battery and monitors high-voltage protection and fuses.

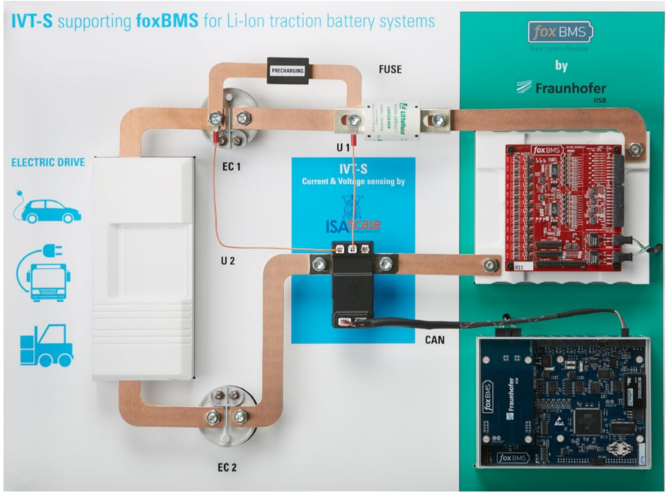

Image: The IVT-S current measurement system from isabellenhütte has an integrated CAN bus interface, which ensures the smooth transfer of data between the measurement device and the application. Photo: © Isabellenhütte Heusler GmbH & Co. KG

The IVT-S is often used in the power distribution unit, the battery junction box or the HV box. This area is isolated from the battery cells and the BMS and often contains the circuit breaker on the plus/minus side of the battery and the pre-charging circuit required for traction batteries. The sensor is placed in the battery's minus pole, as the current measurement always takes place in relation to the voltage of the shunt ground. This enables the overall battery voltage to be monitored. In addition, voltage measurement can also be used to monitor the pre-charging circuit or the circuit breaker.

www.isabellenhuette.de

New JEDEC Committee to Set Standards for Wide Band Gap Power Semiconductors

JEDEC Solid State Technology Association, the global leader in standards development for the microelectronics industry, announced the formation of a new JEDEC committee: JC-70 Wide Bandgap Power Electronic Conversion Semiconductors. Led by interim chairs from Infineon, Texas Instruments, and Wolfspeed, a Cree Company, the new JC-70 committee will initially have two subcommittees: Gallium Nitride (GaN) and Silicon Carbide (SiC) and focus on Reliability and Qualification Procedures; Datasheet Elements and Parameters; and Test and Characterization Methods. JC-70's first committee meeting will be co-located with the 5th IEEE Workshop on Wide Bandgap Power Devices and Applications (WiPDA), on October 30, 2017 in Albuquerque, NM. JEDEC meetings are open to committee members and invited guests only, and interested companies worldwide are welcome to join JEDEC to participate in this important standardization effort. Contact Emily Desjardins (emilyd@jedec.org) for more information.

Silicon carbide (SiC) and gallium nitride (GaN) are the most mature wide bandgap (WBG) power semiconductor materials and offer immense potential for enabling higher performance, more compact, and energy efficient power systems. "WBG GaN and SiC technologies are poised to benefit from the development of standards focused on quality and reliability, datasheets, and test methods," said Tim McDonald, Senior Director, GaN Applications and Marketing at Infineon Technologies.

During an industry conference in the spring of 2016, a working group of industry experts was formed. Designated as GaNSPEC DWG, it began laying the necessary groundwork for the development of standards for GaN. JEDEC began providing logistical support to the group shortly thereafter.

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Launch of Emulator Service for European Chipmakers

Leti, a technology research institute of CEA Tech, and Mentor®, a Siemens business,, announced Leti will provide access to the Mentor Veloce® emulator to SMEs and startups and will introduce emulation technology to global companies beginning Q3 2017. The Veloce emulator is Mentor's high-capacity, high-speed, multi-application tool for emulation of system-on chip (SoC) designs that was installed at Leti in 2013.

Emulation is a vital process for more efficient development of complex digital circuits that includes debugging the design at early stages and validating the upstream, onboard software operation.
The Veloce emulator accelerates block and full SoC register-transfer level (RTL) simulations during all phases of the design process, ending the long delay between starting simulations and getting results. It enables pre-silicon testing and debug, can use real-world data, while both hardware and software designs are still fluid.

www.leti.fr/en

www.mentor.com

Cutting-Edge Technologies From the Automation Industry

In 2017, SPS IPC Drives will once again be demonstrating why it is the leading exhibition in electrical automation technology. 1,700 exhibitors from all across the globe will be in Nuremberg on 28-30 November to cover all the aspects of industrial automation, from simple sensors to intelligent digital solutions. With the exhibits and studies on Industrie 4.0 and digital transformation expected to be back among the most popular highlights for this year's attendees, Industrie 4.0 will also be definitive topic of focus at SPS IPC Drives 2017.
Now that the age of digital transformation has arrived, the IT and automation industries are growing more intertwined than ever. In addition to the various products and example applications that will be on display, SPS IPC Drives will reflect this trend in topic-specific showcases and presentations in a series of different forums.
In the automation industry, more and more attention is being paid to digital transformation. As a result, the organizers behind SPS IPC Drives have decided to reconfigure the topics covered in the exhibition's halls. Starting this year, Hall 6 will be entirely dedicated to Software and IT in manufacturing. Microsoft Germany, SAP Germany, and other renowned IT providers will be exhibiting on subjects such as industrial web services, virtual product development and design, digital business platforms, IT/OT-technologies, fog-/edge- and cloud computing.

www.mesago.de/de/SPS/home.htm

50V GaN HEMT Family with 3GHz Unmatched 250W Device

Wolfspeed, A Cree Company and a leading global supplier of GaN-on-SiC high electron mobility transistors (HEMTs) and monolithic microwave integrated circuits (MMICs) with best-in-class reliability, has extended its family of 50V unmatched GaN HEMT RF power devices by adding a 250W part with a frequency range up to 3.0GHz and the highest efficiency of any comparably-rated GaN device available, enabling RF design engineers to use fewer components to design smaller and lighter linear amplifier circuits for commercial and military wireless communications and S-band radar applications.
The new 50V GaN HEMT devices provide a combination of high power and high gain with high efficiency operation, making it possible for RF design engineers to replace several lower-power GaN HEMTs or multiple silicon LDMOS devices with a single device in their power amplifier designs. Packaged in a four-leaded metal-flanged ceramic “Gemini” package, the new 250W GaN HEMTs operate efficiently at full rated power, reducing the need for complex thermal management systems.
Their higher power and efficiency rating, combined with a frequency range up to 3.0GHz, makes these devices ideal for a wide range of RF linear and compressed amplifier circuits.

www.wolfspeed.com/cghv40200pp

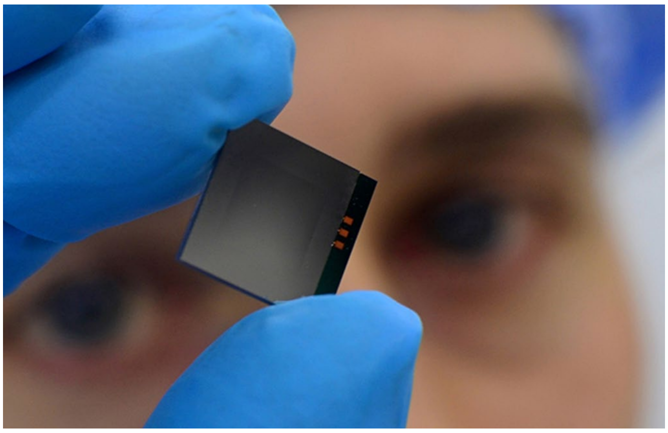
High Density Power Amplifier IC

The PA164 and PA165 from Apex Microtechnology establish benchmarks for power amplifier performance in a single chip design. By driving advances in packaging technology and utilizing Apex's proprietary MOSFET silicon design, the PA164 and PA165 can deliver enhanced amplifier features and combinations of continuous and PEAK output current currently not available in an IC form factor that is also rated to operate on voltage supplies up to 220 volts.
The PA164 provides 1 amp continuous and 4 amps PEAK of output current, while the PA165 can deliver 10 amps PEAK. At these levels of performance, thermal management for a very compact package must be managed very carefully. The design of this IC utilizes separate supplies for the amplifier core and the output stage to help optimize the overall power dissipation capabilities. In addition, both devices are housed in an QFP style package with a heat slug on top to facilitate for mounting of a heat sink over a single device or on an “arrow” pattern of these devices. As a result, the devices are capable of dissipating up to 28 watts.
“With the increased in miniaturization of circuitry designs, board space has become a highly valuable commodity. The exceptional performance potential for these ICs make them an attractive solution across a wide number of potential applications requiring high power across multiple channels when board real estate is very tight,” explains Apex Strategic Marketing Director Jens Eltze. “Both the PA164 and PA165 can offer designers the opportunity to reduce the size of their overall circuity while saving valuable design time in achieving a final layout.”

www.apexanalog.com

Full Program for Semiconductors

Modern industrial societies are inconceivable without semiconductors. Regardless of whether smartphones, cars or medical devices, almost no technical product is without this “core element” of electronics manufacturing.



productronica is the largest microelectronics event in Europe together with SEMICON Europe, taking place parallel for the first time, on the grounds of Messe München from November 14 to 17, 2017.

Another important industry network for microelectronics is represented by Silicon Saxony (Hall B1 Booth 416) at SEMICON Europe. The joint booth bundles a considerable number of companies, research institutes and universities, which show the specific application areas of semiconductor technology such as automotive, the Internet of Things (IoT), 3D-packaging and hybrid electronics.

www.productronica.com

Completion of 150mm SiC n-type Wafer Development

Norstel AB, Sweden, announced the successful development of low defect density 150mm Silicon Carbide (SiC) n-type substrates.

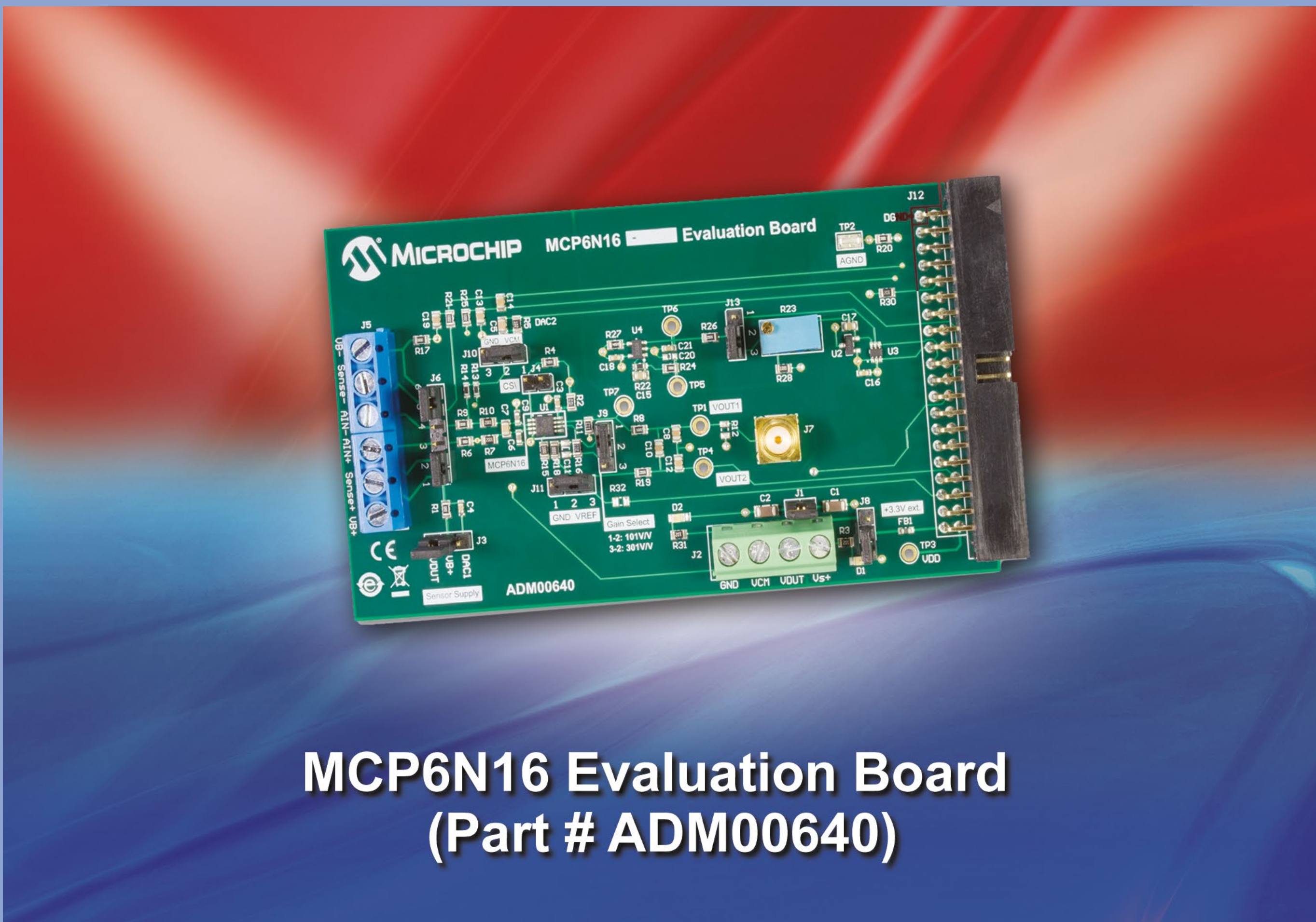
“With a micropipe density (MPD) below 0,2 cm-2 and a Threading Screw Dislocation (TSD) density below 500 cm-2, our first 150mm conductive 4H SiC substrates demonstrate our commitment to quality as an enabler for high yield device processing” says Dr. Alexandre Ellison, CTO of Norstel AB.

The company states that it has prioritized wafer quality over time to get to the next wafer size. As a result, emphasis was given in R&D to first decrease the dislocation density in the SiC wafers prior to diameter expansion from 100mm to 150mm.

First 150mm customer samples will be available by 1st quarter 2018.

www.norstel.com

Win an MCP6N16 Evaluation Board



Win a Microchip MCP6N16 Evaluation Board (ADM00640) from Bodo's Power.

The MCP6N16 evaluation board is designed to provide an easy and flexible platform when evaluating the performance of the MCP6N16, a Zero-Drift instrumentation amplifier designed for low-voltage operation featuring rail-to-rail input and output performance.

The evaluation board is populated with the MCP6N16-100, which is optimized for gains of 100V/V or higher. If one of the other gain option models is desired (e.g. MCP6N16-001 for gain of ≥1V/V, or the MCP6N16-010 for gain of ≥10V/V), exchanging the DUT and adjusting the gain setting resistors can easily be accomplished with standard soldering tools.

The fully assembled evaluation board includes differential input filtering, two jumper selectable gain settings and output filtering, in addition to an external voltage reference circuit to allow for an adjustable output common-mode level shifting.

The MCP6N16 instrumentation amp is ideal for applications that require a combination of high performance and precision, low power consumption, and low-voltage operation. Examples include sensor interfaces, signal conditioning, and stationary and portable instrumentation, for the medical, consumer and industrial markets.

The MCP6N16's low-power CMOS process technology enables low power consumption whilst still providing 500 kHz bandwidth, and it features a hardware-enable pin for even more power savings. This low-power operation and shutdown capability requires less current for the given speed and performance, which extends battery life and leads to less self-heating. In addition, the amplifier's low, 1.8V operation allows two dry-cell, 1.5V batteries to be drained well beyond typical use, and its rail-to-rail input and output operation enables full-range use, even in low-supply conditions. This provides better performance across the entire operating-voltage range.

For your chance to win a Microchip MCP6N16 Evaluation Board, visit the website below and enter your details in the online entry form.

www.microchip-comps.com/bodo-mcp6n

Targeting all Power Applications from PCs to Industrial Equipments

VIP-Interview with Satya Dixit, Senior Director, Systems and Applications Engineering at Rohm Semiconductor about his company's current and future plans in Power Electronics

By Henning Wriedt, US-Correspondent Bodo's Power Systems

Henning Wriedt: Rohm was founded in 1958 and renamed in Rohm Semiconductor in 2009. How would you describe the company's status in the electronics industry today?

Satya Dixit: You have notice it, Henning. It started the journey as a Resistor company and it was producing Discrete Semiconductor initially. From there, Rohm has come a long way and the currently only 37% of the revenue comes from Discrete Semiconductor and over 46% from Integrated Circuits.
Rohm Semiconductor has become a major player in multiple verticals, like, Consumer and smart devices, Industrial and IoT, and Automotive. The recent acquisition of Powervation, a Digital Power Controller company, broadens our portfolio in power electronics.
As one of the most respected semiconductor companies in Japan and top supplier of semiconductors in some categories of power electronics in the world, Rohm is increasing its footprint in the Sensors and Power Electronics for the Industrial, Smart Devices, Automotive segments.
As per the IHS report on Semiconductor Ranking, Rohm ranks #25 in total semiconductors, #8 in the discrete segment and #2 in the small signals device segment in the world.

Henning Wriedt: How does power electronics rank within your company?

Satya Dixit: Power Electronics, including power management ICs, is the major segment of the company, addressing very low quiescent current devices for wearables and smart phones to mid power solutions for PCs, servers and high power for industrial and automotive segments. Synthetically providing by combining ICs and discretes as solutions is one of our company's advantages.

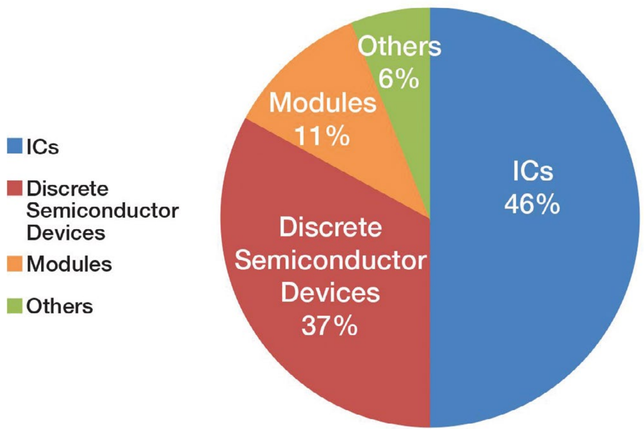


Figure 1: Product segments of Rohm Semiconductor

Henning Wriedt: Which regions in the global market are of special interest to you?

Satya Dixit: We divided our sales ratio into four markets: Japan, Asia (including China), US, and Europe. In Europe, the automotive and industry markets account for around 80% of the semiconductor demand, perfectly matching our mid-term strategy. Looking ahead, Europe will grow increasingly important to us, so we will further focus our efforts there. The US is important because they are constantly creating new technologies and solutions. This creative edge makes America a great place for R&D. Furthermore, we all know the automotive capability of America, both in terms of innovation and production, which further enhances our interest. In Asia, we are targeting our efforts on China. With its rising middle class, China is showing an increased demand for smartphones and sophisticated consumer electronics, markets that are important to us.

Henning Wriedt: Your product portfolio runs from MOSFETs and IGBTs to SiC components and Intelligent Power Modules. Are you targeting every power application?

Satya Dixit: Rohm is targeting all power applications from PCs to industrial equipment. We supply Si for up to 600V applications and SiC for up to 1700V. To expand the adaptable applications, we continue to develop higher power devices in the future.

Henning Wriedt: Which products did you introduce during the PCIM 2017? Briefly, what are their highlights?

Satya Dixit: We are getting recognized as a leading company of SiC, then this PCIM we showed gated driver for SiC drives and new products of Silicon IGBT to appeal to total Power Device Solution Companies. And application examples were shown like Zaptec charger for Electric vehicles and customer modules in Europe.
Rohm is able to offer customers not only a full line-up of efficient and compact products for their applications, but also a complete solution for the power channel. We showed power semiconductor solutions with five categories as 'SiC', 'Power IC', 'Automotive', 'Industrial' and 'Motor Drive'. Our new series of Isolated Gate Driver ICs for power MOSFETs expands the existing portfolio and improves the design of industrial and automotive power systems.
The first released product of this series is a gate driver device. It has an output current of 4A, a built-in active miller clamping to prevent parasitic turn on effects and integrates an under-voltage lock-out (UVLO) optimized to drive our SiC MOSFETs. The optimized UVLO improves the reliability of the system – a very sensitive topic in Automotive and Industrial applications.

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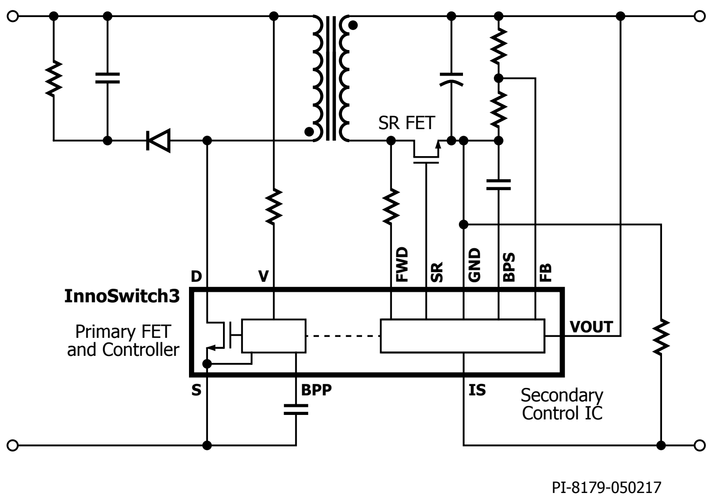

- Up to 94% efficient across line and load
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Moreover, the new 1200V/400A and 600A full SiC power modules include latest SiC SBDs and MOSFETs with a new low inductance structure. The provided function allows reducing the thermal resistance value between module-case and heatsink which enables a smaller size of the cooling system. These properties make them ideal replacements for 400, 600A and even 1000A Si IGBT-based Power Modules, depending on the customers' switching frequency.
We also showed our new 650V IGBTs which are overcoming the trade-off between saturation voltage and turn-off loss characteristics. Measurement results show low noise performance while keeping a higher switching speed.

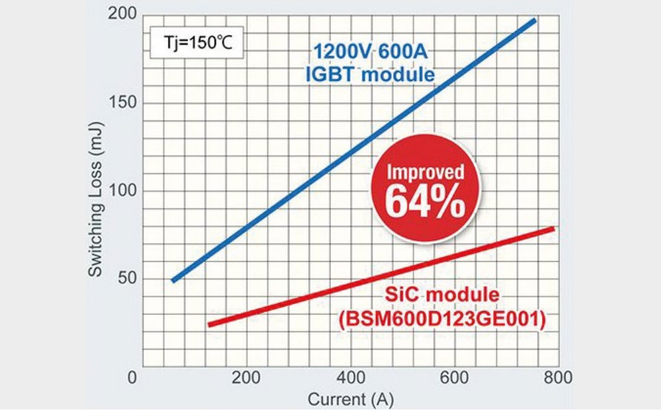

Figure 2: Switching Loss Comparison SiCs vs IGBTs. Rohm has developed 1200V 400A/600A rated full SiC power modules (BSM400D12P3G002/ BSM600D12P3G001) optimized for inverters and converters in solar power conditioners, UPS, and power supplies for industrial equipment.

Henning Wriedt: Regarding power products: What trends do you see in the market for electric and hybrid electric vehicles?

Satya Dixit: I see HEV/EV related applications (Inverter, DC/DC converter, On-board charger) ISO26262 compliant devices, primary Boost, Buck-boost products for Start-stop design, and ADAS related applications. Furthermore:
- Radar, Camera module and Control board ECU with PMIC and discrete regulator solutions,
- SoC PMIC solution activities aiming at future autonomous driving in 2025.

Henning Wriedt: Which materials are the foundation for power electronics today and maybe in three to five years from now?

Satya Dixit: There are few technologies that are suited to handle new requirements: Silicon IGBT, Super Junction MOSFETs, GaN and SiC devices. However, SiC remains hot, as more resources are put on this by many companies and it is advancing and maturing faster for the HEV/EV and Industrial markets. GaN has still not gained enough traction and this will still be the target for many companies and applications. Wide Band Gap materials will continue to thrive in the power electronics industry.

Henning Wriedt: Which role plays your subsidiary SiCrystal AG?

Satya Dixit: SiCrystal produces SiC wafers from crystal growth, external polishing, flat formation, slicing, sanding, edge polishing and cleaning and supplies to the Rohm factories where photo masking, chip design, wafer process and assembly is done. This is the main source of SiC wafers for our SiC devices that are designed and manufactured.

Henning Wriedt: How are your customers adapting the SiC MOSFET/IGBT Discrete Evaluation Board and other design aids?

Satya Dixit: Rohm delivers SiC MOSFET/IGBT Discrete Evaluation Boards for customers to evaluate in their designs. In some cases, we also make the reference designs that are closer to customer's applications and hence making it easy for customers to evaluate our devices in their applications. We also provide the device characterization data, circuit simulations, schematics, layout guidelines and external component selection. This helps the customer to adapt our solutions easily into their designs.

Henning Wriedt: What kind of feedback are you getting from your Tech Web? Any major technical or communication trends?

Satya Dixit: Rohm receives requests for simulation models for our industrial solutions, self-help documents and material with all the technical answers are some of the trends that we have seen.
In recent years, the number of electronics engineers, who look for many kinds of information online, is increasing. Rohm picks up technology focusing contents from basic to advance in our own media TechWeb. For example, the design and evaluation method of power management and power devices such as Si and SiC.
Many engineers use this site to gain knowledge of power management and to get the latest product or technology information. This site is supported by our engineers, who have the deep knowledge of both analog and power products. It will increase the Rohm's brand awareness, the number of fans for our company and leads to a steady business in the future.

Henning Wriedt: Regarding power electronics - what can our readers expect from Rohm Semiconductor in the near future?

Satya Dixit: Rohm continues to develop and deliver solutions in Industrial and Automotive segments. Digital Power is another area the readers can expect solutions for datacenter and high power applications. Most of the solutions we have in SiC are the most reliable ones compared to any solutions out there. SiC, IGBT, DigiBuck, PMICs and very low quiescent current devices are the focus of our power electronics products coming in the future.

Henning Wriedt: Mr. Dixit, thank you for this interview!

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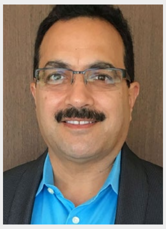

Satya Dixit is the Senior Director, Systems and Applications Engineering at ROHM Semiconductor. His team defines and develops new products, customer solutions, and system architectures. They also perform IC validation and help introduce new products. Satya addresses the needs of multiple markets, including mobile, consumer, PC, automotive, and industrial segments.

In 1958 Rohm was established in Kyoto, Japan, as a manufacturer of small electronic components. In 1967 the production was expanded to include transistors and diodes, followed in 1969 by ICs and other semiconductor products. Two years later Rohm established a sales office and an IC design center in the Silicon Valley - the first step into the worldwide semiconductor market.

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Smart Appliances Need a Smart Power Supply with Clever Standby Power Management

How to Minimize Standby Power Consumption in Household Appliances

You know that most electrical and electronic household and office equipment consume electric power when switched off or not performing their primary function. This standby power is mostly wasted.

By Mirko Sciortino, Senior Application Engineer STMicroelectronics

Introduction

Worldwide, standby losses are a significant part of total electricity use. Recognizing this, since the beginning of the twenty-first century many voluntary and mandatory programs have taken aim at reducing standby power (and its associated CO_2 emissions).

Household periodical appliances that users turn on and off, such as washing machines, coffee machines, and the new robotic vacuum cleaners, typically have two phases for power loss when idle:

- The "left-ON mode," is when the appliance has finished its working cycle and remains switched on; this phase may persist for an indefinite time after the completion of the cycle without further intervention of the user.
- The "OFF-mode," is, as you might guess, when the appliance is turned off, automatically or by the user.

To achieve the highest labelling grade, it makes sense to limit the duration of the left-ON mode and force the appliance to enter the OFF-mode automatically when it completes its working cycle. In fact, IEC62301 Clause 4.5 for energy-consumption calculation labelling, allows that if the consumption of the appliance is lower than 5 mW in the "OFF-mode," no contribution at all to energy consumption needs to be considered while the device is not performing its primary function.

Other household continuous appliances, such as a refrigerator, always stay ON and must be highly efficient in light-load condition that is where they operate for the major portion of their life.

This paper presents an approach to minimize the overall standby power for a household appliance using advanced technologies and clever power architectures, which enable SMPS designs to meet the most demanding energy-saving regulations, thanks to:

- Advanced light-load management that allows the appliance to reach the lowest overall input power consumption under light-load and no-load conditions.
- Zero-power mode (ZPM) function that enables the appliance to shut down automatically at the end of the working cycle, consuming zero power from the power line.

Examples of the implementation of such techniques are presented with reference to two VIPerPlus high-voltage converters.

Advanced light-load management

VIPer01 is a high-voltage converter smartly integrating an 800 V avalanche-rugged power MOSFET with fixed-frequency PWM current-mode control. The integrated HV startup, sense-FET, error amplifier and oscillator with frequency jitter allow you to design a complete application (flyback, buck, buck-boost) with minimum component count.

Main features of VIPer01 to meet the most stringent energy-saving standards under light-load are:

- Low threshold of both power MOSFET and internal logic circuitry that allows to supply the IC starting from a 4.5 V supply voltage.
- Reduced gate charge of the power MOSFET and low-consumption of the internal logic circuitry allow the circuit to reach an extremely low quiescent current.
- "Pulse Frequency Modulation" (PFM) decreases the switching frequency under light-load, which minimizes all the frequency-related losses.

Light-load standby performance

The measurements reported here refer to the evaluation kit STEVAL-ISA177V1, a wide-range flyback converter based on VIPer01, which delivers 4.25 W to a 5 V single output.

In no-load conditions the overall application consumes less than 10 mW at 230 VAC and its efficiency @ 250 mW output load is higher than 60%.

	P_{IN} [mW]	
P_{OUT} [mW]	**@V_{IN} = 115 V_{AC}**	**@V_{IN} = 230 V_{AC}**
0	4.4	8.6
25	48.6	57.4
50	89.0	100.1
250	361.2	398.5

Table 1: STEVAL-ISA177V1 no-load and light-load performances

Best standby performance in the market

A benchmark with the most popular high-voltage converters shows that a 5 V output converter in buck topology based on VIPer01 has better performance than the average standby available in the market.

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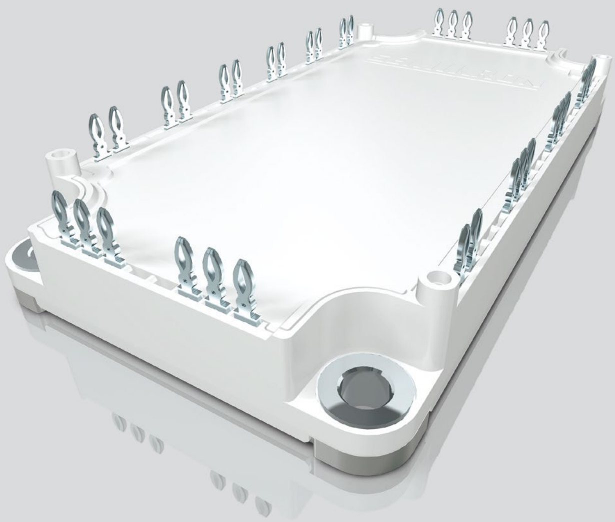

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To ensure realistic comparisons, all measurements were performed using the same base board, which was equipped with: diode bridge rectification, input filter, freewheeling diode, power inductor and output capacitor.

Each sample to be tested has been placed on a separate module containing all the circuitry needed to bias and run that particular SMPS driver. Then, the modules were separately plugged into the base board.

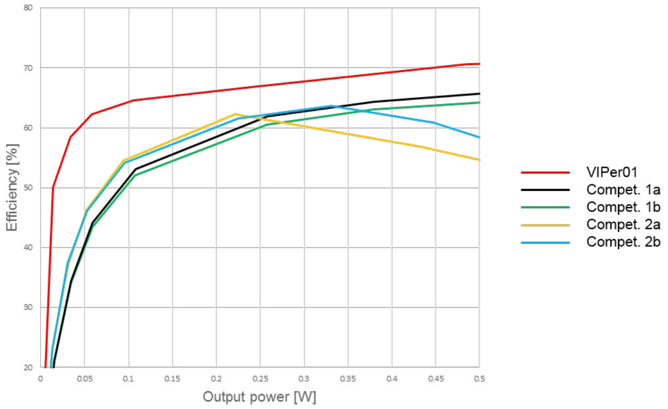


Figure 1: Efficiency at Vout = 5 V, light-load

Light-load efficiency comparison

The above charts show that VIPer01 has the best performance in terms of efficiency under light-load relative to all the considered devices.

Standby consumption comparison

We measured the standby power consumption by connecting a Zener diode across the output. A 15 V Zener diode has been used for 5 V output voltage, 20 V Zener diode for 12 V output and 28 V Zener diode for 24 V output voltage version. The following table summarizes standby measurements taken under different conditions.

	Input power consumption (mW)		
	5 V	12 V	24 V
VIPer01	10.1	14.4	39.4
Compet. 1a	60.1	44.2	61.1
Compet. 1b	61.4	20.2	45.6
Compet. 2a	39.2	31.8	53.6
Compet. 2b	37.2	30.8	53.1

Table 2: Standby power measured with Zener diode on the output

Advanced architecture for zero-power consumption

This section shows that VIPer0P allows designing an SMPS for periodical household equipment that automatically enters the OFF-mode at the end of the working cycle, while consuming less than 5 mW in this OFF-mode state, getting rid of the commonly used bi-stable electromechanical switches, increasing the overall reliability, and reducing the cost of the system. In fact:

- The SMPS can be shut down by a microcontroller (MCU) supervising the operation of the appliance and enter a special state where it delivers no power at its output terminals.
- Once in this state, the SMPS is ready to be manually restarted by the user while consuming less than 5 mW from the power line at 230 Vac.

This capability is a "zero-power function", an innovative feature of VIPer0P which is described hereafter and defined by IEC62301 Clause 4.5.

Zero-power function

In addition to the features for advanced light-load management listed in above for VIPer01, the key feature of the VIPer0P is the "zero-power function," whose principle schematic is shown in Figure 2. It consists of a special idle state (Zero-Power Mode, ZPM) where the control IC is totally shut down - except for the circuitry necessary for exiting ZPM - and the high-voltage start-up cell does not perform its usual function. The high-voltage start-up cell is the current generator used to start-up the device from the rectified power line directly by charging its Vcc capacitor Cs above the start-up threshold.

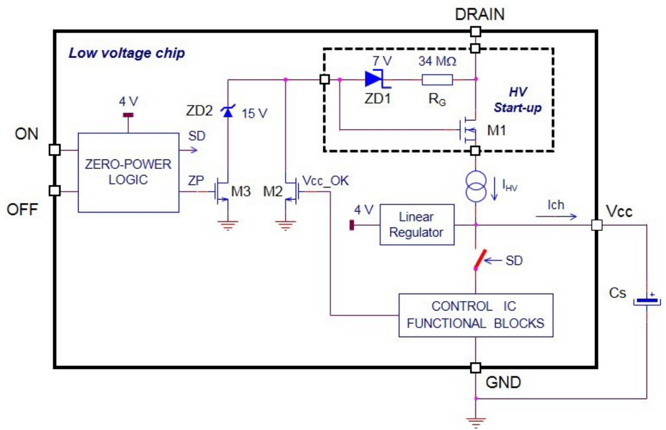


Figure 2: Principle schematic of the zero-power function of VIPer0P

Assuming that the device is operating normally, when the OFF pin voltage is pulled to GND for more than 10 ms (debounce time for immunity to disturbances), the "zero-power logic" block asserts the signals SD and ZP high. SD asserted high disconnects nearly all the blocks of the control chip from the Vcc supply line, so that it is shut down with the gate of the main MOSFET pulled low. This stops the SMPS. The only parts of the control IC that remain alive are the "zero-power logic" block and the 4 V regulator that provides the bias voltage to it.

ZP signal asserted high turns M3 on and fixes the voltage of the gate terminal of M1 at about 15 V through the Zener diode ZD2. In this way, the Vcc voltage is set at about 13 V. The 4 V linear regulator supplied from Vcc provides those few µA needed to operate and keep the "zero-power logic" block alive. Both pins ON and OFF are internally connected to this 4 V supply line via 50 kΩ pull-up resistors, so either of them can be used to provide a small current to some external circuit.

Figure 3: STEVAL-ISA174V1 (64 x 29 mm)

The overall consumption in ZPM consists of two components: that on the branch ZD1, RG, ZD2, M3 and that due to the quiescent current Iq (≈ 1.5 µA) absorbed by the 4 V regulator and the "zero-power logic" block plus the current Iext delivered to an external circuit.

This consumption may be estimated as follows:

$$P_{ZPM} = Vin_{pk}\left(\frac{Vin_{pk} - V_{ZD1} - V_{ZD2}}{R_G} + I_q + I_{ext}\right)$$

with obvious symbolism. At *Vin* = 230 Vac and with worst-case values (*RG* = 28 MΩ, *VZD*1 + *VZD2* = 20 V, *Iq* = 2 µA) it is *PZPM* = 4.2 mW + 0.325 mW/ µA of *Iext*.

To exit ZPM, the ON pin voltage must be pulled to GND for more than a 20 µs debounce time. By doing so, the "zero-power logic" block asserts the signals SD and ZP low. ZP asserted low turns M3 off and releases the gate terminal of M1, while SD asserted low reconnects the blocks of the control chip to the Vcc supply line, held at 13 V by the Vcc capacitor Cs. This voltage is well above the start-up threshold of the IC (8 V), so the high-voltage start-up cell is disabled by M2 turned on and switching activity restarts immediately.

A practical example on zero-power architecture

The demonstration board STEVAL-ISA174V1 is a wide-range input, 6.8 W two-output non-isolated flyback converter designed with the VIPer0P.

It delivers 4 W on a - 5 V output tightly regulated through a voltage divider connected to the non-inverting input of the error amplifier available at the FB pin; and 2.8 W to a + 7 V output, semi-regulated by magnetic coupling through the turn ratio of the two output windings.

The demonstration board has been completely characterized and is described in AN4836, here only the results related to energy saving requirements are reported. In particular, this application complies with the tightest references for energy-conscious designs, such as European CoC ver. 5 requirements for external power supplies.

The data in Table 3 show that the application, when in zero-power mode (ZPM), is ratified to have zero-power input consumption as per IEC62301 Clause 4.5 and is Five-star energy efficient when operating with no load.

Vin	ZPM input power consumption [mW]	No-load input power consumption [mW]
115 Vac	0.8	6.5
230 Vac	3.5	9.1
Conditions	- Power line connected - IC not switching, most internal blocks disabled - $Iout_1$ = $Iout_2$ = 0 - $Vout_1$ = $Vout_2$ = 0	- Power line connected - IC switching (burst-mode) -$Iout_1$ = $Iout_2$ = 0 - $Vout_1$ and $Vout_2$ regulated at their nominal values

Table 3: ZPM input power and no-load input power of STEVAL-ISA174V1

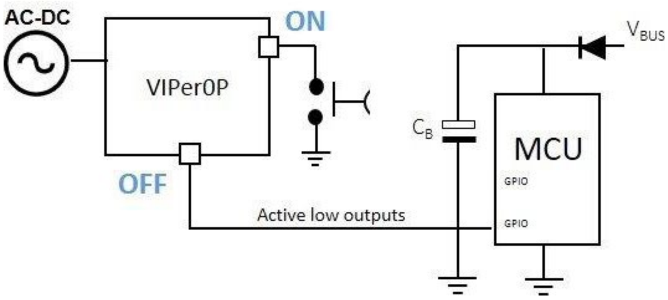
The data in Table 4 show that the equivalent 12 V / 6.8 W SMPS (simply obtained connecting the load across the Vout1 and Vout2 lines) is compliant with the ErP Lot 6 Tier 2 requirements in off-mode (same as ER 1275/2008) and the 10% load efficiency target envisaged by the European CoC ver. 5.

Vin [V_{AC}]	Eff [%]			
	@ P_{OUT} = 25 mW	@ P_{OUT} = 50 mW	@ P_{OUT} = 250 mW	@ P_{OUT} = 680 mW
115	55.6	60.8	72.2	78.0
230	51.3	57.0	66.3	71.4

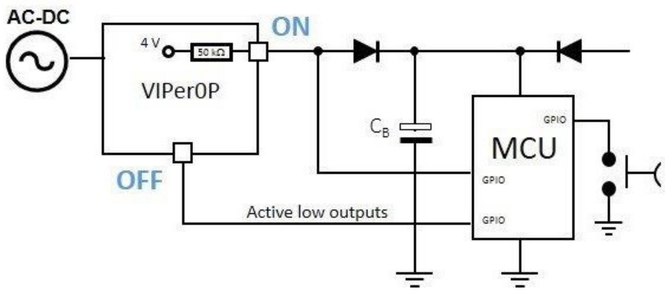
Table 4: Light-load performances of STEVAL-ISA174V1

STEVAL-ISA174V1 is a demonstration board and does not include MCU, thus ON and OFF pin are activated by the user through push buttons. Other evaluation kits that include the MCU are STEVAL-ISA181V1 and STEVAL-ISA192V1.

Figure 4 shows two examples of ways the pins ON and OFF can be operated.



(a) Automatic ZPM with manual turn ON



(b) ZPM fully managed by MCU

Figure 4: Examples of ZPM management with a MCU and a touch button

With the arrangement (a), the MCU supervising the operation of the appliance shuts down the SMPS by pulling low OFF pin voltage through one of its GPIO pins, cutting also its own supply voltage. The restart is commanded by a pushbutton or a tactile switch pressed by the user that directly operates pin ON. The MCU wakes up after the SMPS is again up and running. This arrangement provides the minimum consumption from the power line.

With the arrangement (b), the MCU shuts down the SMPS by pulling low OFF pin voltage and wakes it up as well by pulling low ON pin voltage. Two of its GPIO pins are used. The MCU (rated for 3.3 V supply voltage) is powered also during ZPM, so it must be equipped with advanced features of power management such as an ultra-low consumption standby mode with fast wake-up. This arrangement is implemented in the evaluation kit STEVAL-ISA192V1.

Conclusions

Today power supply units require more sophisticated methods for improving performance to meet the energy-saving regulations' push for greater efficiency.

ST's VIPerPlus high-voltage converters combine an 800 V avalanche rugged power section, a state-of the art PWM control circuitry, with advanced technologies and clever power architectures to meet the need for increasingly efficient electrical power in smart household appliances that have to be connected with an advanced user interface.

VIPer01 applications demonstrate how easy it can be to meet the most stringent energy regulations for continuous household appliances. On the other hand, VIPer0P applications demonstrate how to build a clever standby architecture with easy interaction with the MCU to reduce the bill of materials cost of a power supply for a periodical household appliance.

The result is an SMPS design that meets the most demanding energy-saving regulations and more: high reliability, flexibility, and minimal component count.

More information on VIPerPlus products, demonstration boards, technical documentation and online design simulator can be found at

www.st.com/viperplus

Advanced Si-IGBT Chip Design for Maximum Overall System Performance

The overall system performance is undoubtedly influenced to a significant extent by the choice of the power semiconductor technology employed. For conventional IGBT modules, the recent improvements in the VCEsat vs. Eoff trade-off shows a tendency towards saturation and hence the performance improvement of upcoming IGBT chip generations do not indicate a significant step in efficiency improvements anymore. With the new G1-IPM series it is possible to obtain substantial system efficiency improvement by utilizing an advanced Si-IGBT chip and implementing an adaptive gate control.

By Narender Lakshmanan and Thomas Radke, Mitsubishi Electric Europe B.V.

Introduction:

Mitsubishi Electric has introduced the new G1 series Intelligent Power Modules (IPM) with an advanced Si-IGBT design to address several key performance parameters and enable the end-user to achieve high system performance. The advancements in the G1 IPM chip technology are aimed at resolving some inherent drawback of the Si-IGBT especially when it is employed for motor control applications. The G1 IPM device has been developed by implementing some key advancements in the latest 7th generation IGBT. It can be noticed (refer Figure 1) that in comparison to the 7th generation conventional Si-IGBT, the advanced G1 IPM chip technology offers significant benefits although it belongs to the same chip generation.

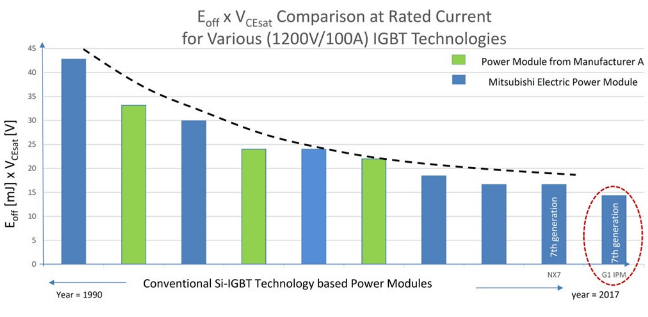


Figure 1 : A comparison of the V_{CEsat} x E_{OFF} index for different Si-IGBT technologies

Short Circuit Capability and Electrical Performance:

Short circuit protection for a conventional Si-IGBT has been implemented using a 'desaturation detection' based system where the V_{CE} across the IGBT is observed to ascertain the occurrence of a short circuit event. To facilitate a successful detection, the conventional Si-IGBT devices are designed such that several gate cells in the chip are left unconnected [6][2]. While this ensures that the IGBT enters into the desaturation mode beyond a particular value of I_C, it also means that several electrical parameters are compromised to a certain extent [6][2][3]. The G1 IPM possess a Si-IGBT chip with a monolithically integrated current sense emitter (refer figure 2). The sense emitter feature facilitates an assessment of the IGBT collector current via direct measurement. Based on the input from the sense emitter, trip levels can be assigned and an SC turn-off can be initiated before the chip desaturates. This approach to directly determine the instantaneous I_C renders the V_{CE} based desaturation detection system obsolete. Thus, it is no longer necessary to ensure that the IGBT enters into the desaturation mode. As a direct consequence, all available gate cells in the Si-IGBT chip can be connected transforming the chip into a 'full gate IGBT' and the subsequent electrical benefits can be harvested due to the enhanced utilization of the Si-IGBT chip [1]. Additionally, the IGBT chip is provided with an on-chip temperature sensing diode in the center of the chip in order to ascertain the IGBT junction temperature with maximum effectiveness (refer figure 2).

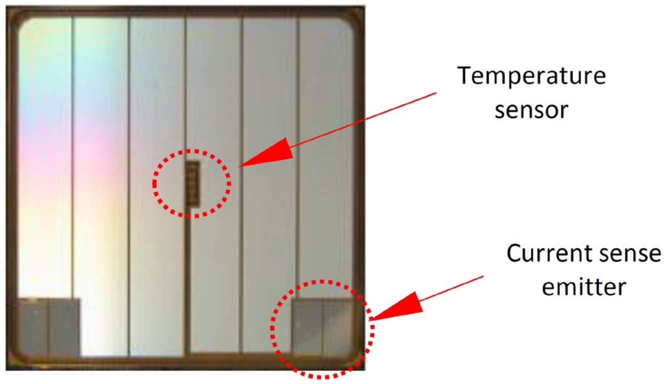


Figure 2 : The temperature sensor and the current sense emitter components of the IGBT chip in the G1-IPM

Switching dv/dt as a Performance Limiting Factor:

One factor that negatively influences the lifetime of the insulation layers in the system (motor winding insulation or cable insulation) is the exposure to high speed transient voltages (dv/dt). The IGBT switching event is capable of generating high dv/dt at the terminals of the power module (especially during a turn-on event). A conventional solution to address this issue is to restrict the switching speed of the IGBT by employing a gate impedance such that the switching dv/dt is maintained below a particular level. The dv/dt versus I_C characteristics is such that the highest dv/dt (worst case dv/dt) is experienced during turn-on of low I_C and the turn-on dv/dt reduces with an increase in I_C.

Although the worst case dv/dt would be generated only during turn-on of low I_C, a conventional gate driver with fixed turn-on gate resistances will force a restriction of switching speed for all values of I_C. This approach will generate significant turn-on losses while operating at high I_C even though the switching dv/dt is not the worst case during high I_C operation. It is therefore clear that for conventional Si-IGBT technology, there is a trade-off between controlling the worst-case dv/dt and efficiency.

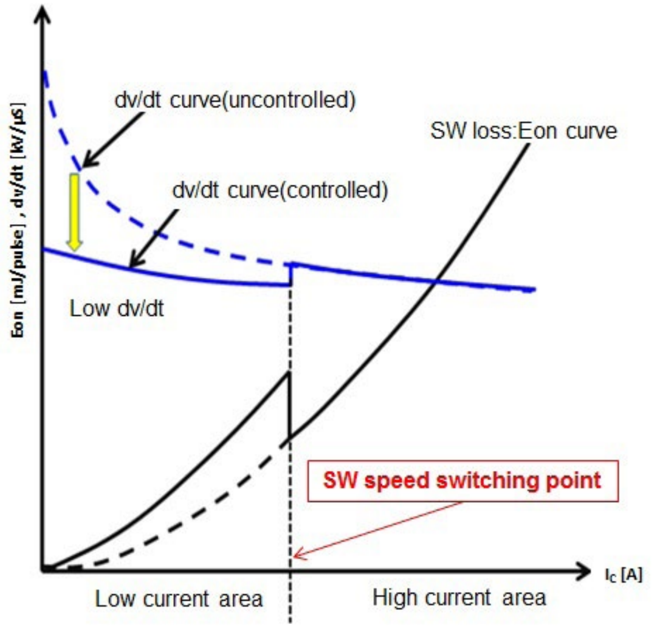


Figure 3 : Utilization of the sense emitter to implement a switching speed control in the G1 IPM

Utilizing Sense Emitter to Control dv/dt Without Sacrificing Efficiency:

The sense emitter provision in the advanced full gate Si-IGBT open up the possibility to ascertain the I_C. Based on the dv/dt vs I_C dependency, it is clear that to address the worst case dv/dt, it is appropriate to implement a switching speed restriction only during the switching of low I_C. Considering this key point, a switching technique has been implement in the G1 IPM Si-IGBT devices where the turn-on switching speed in regulated based on the I_C. If the I_C (from the sense emitter data) is ascertained to be below a particular threshold, the gate drive unit will be informed to apply a switching speed restriction such that the worst case dv/dt is avoided. When the switching I_C exceeds the pre-set threshold value, the gate drive unit will be informed to turn the IGBT ON with a higher switching speed, such that the turn-on losses can be optimized. With this approach, the worst case dv/dt is avoided during switching, while simultaneously ensuring that the system efficiency is not compromised (refer Figure 3).

Full Gate IGBT with Sense Emitter - Analysis of Overall Performance:

The G1 IPM module utilizes the full gate 7th generation Si-IGBT which is equipped with the monolithically integrated sense emitter. This approach is aimed at combining the benefits of the full gate Si-IGBT along with the advantages of the sense emitter component. The target is to ensure maximum efficiency, high reliability (instantaneous I_C based SC protection) and an acceptable EMI profile (dv/dt control). Figure 4 shows a comparison of the overall power loss performance of the full gate device with the conventional Si-IGBT (under same turn-on dv/dt condition). As evident from Figure 4, the full gate IGBT device generates approximately 18% less overall losses than the conventional Si-IGBT device under the mentioned working conditions.

Under the conditions mentioned in Figure 4, the switching speed control technique allows for a 48% reduction in the turn-on losses. The full gate IGBT (with sense emitter) clearly generates significantly lower switching loss versus its convention counterpart. Figure 5 shows the overall power loss versus f_C (switching frequency) of the full gate (with sense emitter) IGBT and the conventional Si-IGBT device. The gap in performance between the full gate IGBT (with sense emitter) and the conventional Si-IGBT increases with an increase in the f_C.

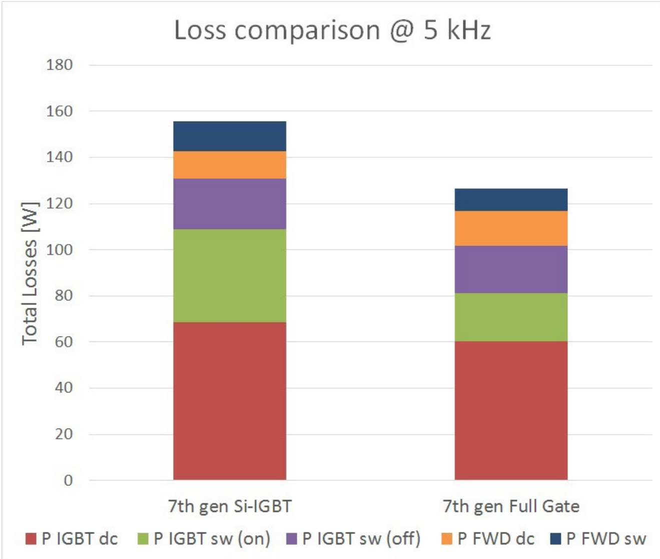


Figure 4 : The comparison of the total power loss generated by a single IGBT + Diode combination in the 100A/1200V 7th gen Full Gate device and the 7th gen Si-IGBT (100A/1200V) for the conditions: VCC = 600V, Iout = 100 A rms, f_C = 5 kHz, m = 1, cos(φ) = 0.8, TS = 80°C, fo = 50 Hz

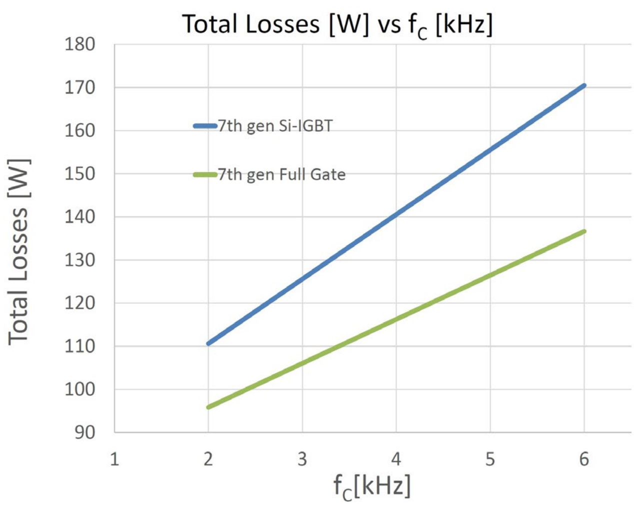


Figure 5: The Comparison of total losses generated in a single IGBT + Diode combination in the 100A/1200V 7th gen Full Gate device and the 7th gen Si-IGBT (100A/1200V) for several switching frequencies. Conditions: VCC= 600V, Iout = 100 Arms, m = 1, cos (φ) = 0.8, Ts = 80°C, fo = 50 Hz

For applications which require an operation at low levels of audible noise (high switching frequencies are necessary), the 7th generation full gate IGBT (with sense emitter) promises enormous system level benefits. Certain overload operation points exist for motor control applications. During the stand-still (locked rotor) condition - the load current is not symmetrically distributed among the inverter IGBTs, and during extremely low output frequencies - the inverter IGBTs can experience a high current ripple. Under such overload conditions, it is crucial to determine the IGBT junction temperatures of each chip to avoid an over-temperature failure event. The IGBT junction temperature can be effectively monitored using the on-chip temperature sensor integrated on each chip.

It can thus be concluded that the full gate Si-IGBT equipped with the sense emitter feature and the on-chip temperature sensor address several key challenges which were inherent to the conventional Si-IGBT approach thereby allowing the inverter developer to achieve significantly higher system performance.

References:

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Combining Excellent Performance and Ease-of-Use with a Cost-Effective Package Choice for Low Power Applications – Compatible Solutions in SOT-223

Everywhere you look, you will find electrical devices and products. These devices all need to be powered or charged whether they are the latest mobile phone, the television in a living room, or the light over a desk at work. Consumer demand is driving the development of power supplies for these devices that are more efficient, smaller, and less costly than ever before.

By Stefan Preimel, Infineon Technologies AG

The need for increased efficiency, improved power density, and lower cost without negatively impacting other key requirements is pushing designers to find new and innovative alternatives to the traditional design choices.

There are many solutions that can be explored. Some require product redesigns, and others fit well into the existing layout. One area where significant cost savings can be found is in the design and packaging choice for high-voltage and high-ohmic Metal Oxide Semiconductor Field Effect Transistors (MOSFETs). Here, there are alternative and new devices that can easily keep the design or redesign costs to a minimum and maintain or improve the thermal performance of existing solutions.

The CoolMOS™ P7 in SOT-223

In 1999, Infineon introduced the CoolMOS™, a MOSFET drain structure design that was based on the innovative Superjunction concept. The construction of the Superjunction transistor allows a reduction in area-specific resistance, and this in turn provides conduction loss benefits. The dramatic reduction in chip area for the first generation of CoolMOS™ technology lowered capacitance and dynamic losses as well.

Over several generations, the original CoolMOS™ design was refined and improved. In 2016, the CoolMOS™ CE series was released in a SOT-223 package. SOT-223 package was selected because it directly addressed the need for cost reduction in price sensitive applications while maintaining similar thermal performance and one-to-one footprint compatibility with the long established DPAK packages.

The current CoolMOS™ in SOT-223 portfolio has been expanded and now includes the CoolMOS™ P7 family, combining all the benefits of the very latest Superjunction MOSFET technology with the cost and size advantages of using a SOT-223 package. The result is a highly cost-effective space saving device choice for low-power applications.

Figure 1 shows a comparison of the dimensions of the DPAK and SOT-223 packages. As you can see, the leads of the SOT-223 package will fit directly on the DPAK footprint. This common footprint means that the SOT-223 can easily be used as a direct replacement in existing PCB designs. The SOT-223 comes with a size advantage as well because it has a 25 percent lower package height and 35 percent shorter package length than the DPAK package.

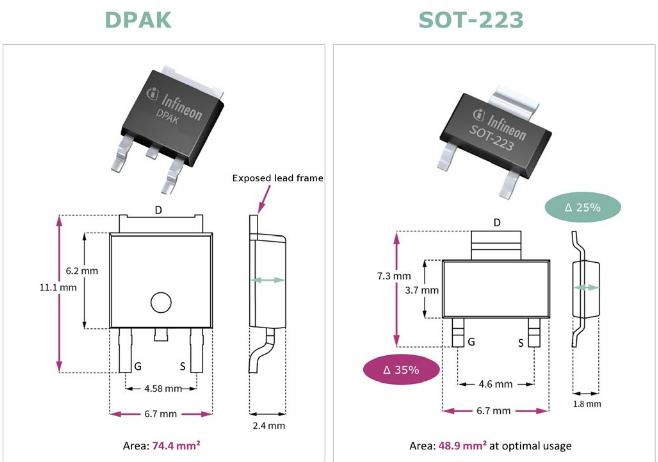

Figure 1: Size comparison of the CoolMOS in DPAK and SOT-223

One of the most noticeable differences between the DPAK and the SOT-223 packages is clearly visible when the devices are compared side-by-side; DPAK has an exposed lead frame, and SOT-223 does not. This may cause designers and engineers to conclude that there are thermal limitations on this design and a MOSFET in SOT-223 can only be used as a plug and play replacement for DPAK if they accept a higher operating and case temperature, or if the application design has a low overall power loss. Extensive testing has shown otherwise, although there are a few limitations.

If the power losses are greater than 250 mW, additional copper around the drain pad must be included in the PCB design layout in order to help keep the device cool. Figure 2 shows a direct comparison of the device temperature with respect to the copper around the drain pad in DPAK and SOT-223 based on thermal simulations. The standard DPAK package on a standard DPAK footprint with recommended copper area will operate at 85 °C (point A in Figure 2).

If the DPAK package is replaced one-to-one with a SOT-223 package you will observe a 4 °C to 5 °C temperature increase (point C in Figure 2). If you increase the copper area by at least 20 mm2 to 40 mm2, the operating temperature of the SOT-223 device will drop to the same level as the DPAK device (point D in Figure 2).

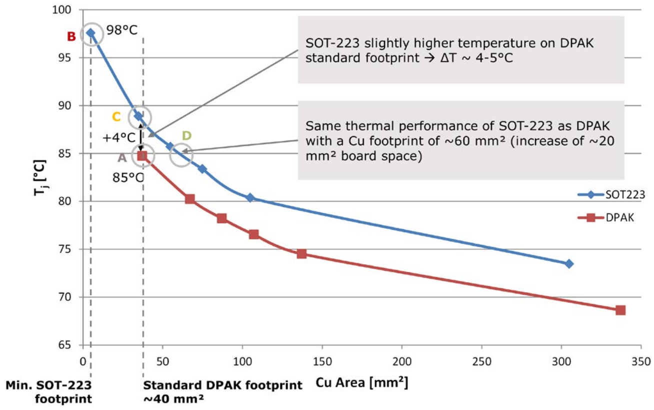

Figure 2: Thermal simulation of junction temperature @ 250 mW (Tj vs. Copper area)

Thermal performance in real-world applications

The best way to demonstrate the interchangeability of the DPAK and the new SOT-223 packages is to look at a real-world example. A plug-and-play comparison was done on a commercially available 52 W LED driver board (see Figure 3). The original design used an 800 V CoolMOS™ C3 in DPAK. Table 1 shows the basic specifications of the selected LED driver board.

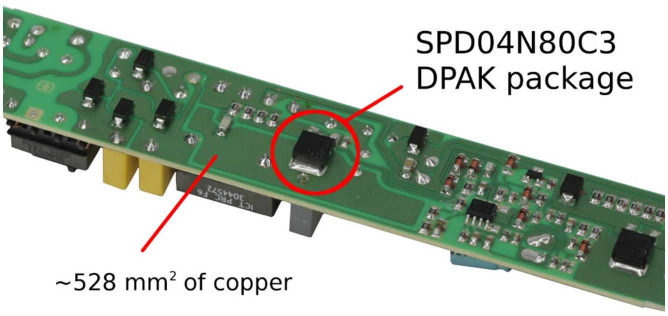

Figure 3: LED driver board used for testing thermal performance

Table 1: LED driver specifications

Description	Specification
Input	220 V / 50 Hz
Output	55 – 150 V / 0.35 A / 52 W
Topology	SEPIC
Original device	SPD04N80C3
PCB dimensions L x W x H	210 mm x 30 mm x 21 mm
Lifetime requirement	100,000 hours

Testing was done with a 230 V AC input voltage, at a stabilized ambient temperature of 25 °C, and with a normal device enclosure. No additional design changes or modifications were made other than changing the MOSFET. The MOSFET temperature was measured with thermocouples attached to the MOSFET. The device efficiency was measured at three operating points with the following setup:

- Pin was measured with a Yokogawa digital power analyzer
- Vout was measured with an Agilent 34980 data logger
- Iout was measured via a 200Ω shunt resistor and an Agilent 34980A data logger

In the original layout of the LED driver board, approximately 530 mm2 of copper around the drain pad is used to help dissipate the heat generated by the original DPAK package. The application test was done with a closed case and with the same thermal-gap pad that was used in the production version of the product. The thermal-gap pads help to reduce the MOSFET operating temperature by connecting the copper area and the device to the device enclosure.

Figure 4 shows the results of the testing. The original CoolMOS™ C3 (SPD04N80C3) is shown as a baseline in orange. When the CoolMOS™ P7 in DPAK (IPD80R1K4P7) is used, there is a notable efficiency improvement at full load of around 0.25 percent. This means that the CoolMOS™ P7 in DPAK is operating around 3 °C cooler than with the original CoolMOS™ C3 in DPAK. When the CoolMOS™ C3 DPAK is replaced with a CoolMOS™ P7 in SOT-223 (IPN80R1K4P7), the improvement over the baseline is around 0.15 percent and the operating temperature is between 1 °C and 2 °C cooler than the original CoolMOS™ C3 in DPAK.

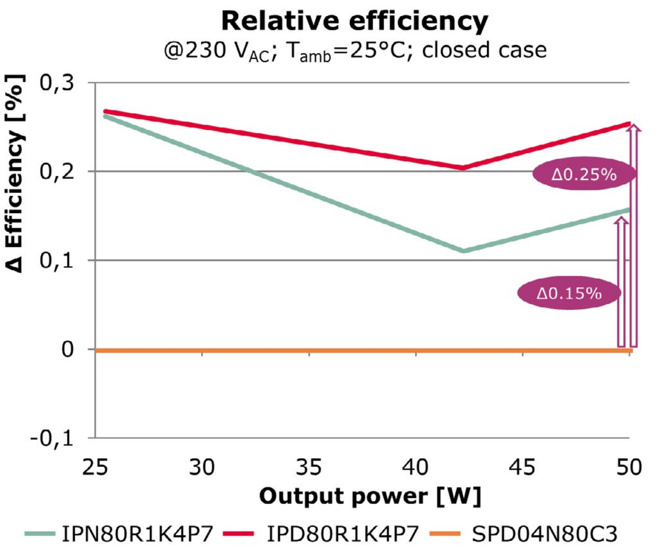

Figure 4: Efficiency and temperature test results

The real world application test clearly shows that the smaller SOT-223 functions perfectly as a drop-in replacement for DPAK. It is smaller, more efficient, and comes with significant cost savings as well.

The CoolMOS™ P7 in SOT-223

The CoolMOS™ P7 in SOT-223 is currently available in three voltage classes, 600 V, 700 V, and 800V. The 600 V and 700 V devices are standard grade products and the 800 V devices are fully qualified as industrial grade. The 600 V devices are a perfect fit for PFC, flyback and LLC stages in half-bridge or full-bridge configurations. The 700 V and 800 V devices are only suitable for PFC or flyback topologies where there is no hard commutation of the body diode. The full portfolio will be available by the end of 2017 and will cover an RDS(on) range from 360 mΩ up to 4500 mΩ.

Conclusion

The desirable combination of a high performance MOSFET that is cost effective is sometimes difficult to find. The compromises are often in areas that are a challenge to deal with in the application designs. A larger device for example can have great thermal characteristics, but then it is hard to fit it into the end product when the consumers are demanding smaller and smaller products. This is where the strength of CoolMOS™ P7 in SOT-223 lie: high efficiency of the Superjunction MOSFET technology combined with a low-cost package that fits into existing DPAK-based designs.

The thermal characteristics are within an acceptable range if you use the minimum DPAK copper area requirements, which is often within thermal allowances in the design. If space allows, adding an extra 20 mm2 of copper improves the thermal performance to a point where it comes close to a traditional DPAK-based solution.

The CoolMOS™ P7 provides ease-of-use and fast design-in supported by a low ringing tendency and can be used across PFC and PWM stages. Excellent efficiency FoMs, in particular, the low switching and conduction losses, and improved driving losses guarantees the highest efficiency and help to manage the thermal load of low power supply solutions.

The unique ease-of-use properties of the CoolMOS™ P7 device family are the result of carefully selected and integrated gate resistors where needed. In addition, the CoolMOS™ P7 600V has an outstanding body diode ruggedness which makes it the perfect fit not only for hard but also for soft switching applications (LLC). The excellent ESD robustness of greater than 2 kV (HBM) over a large portion of the portfolio supports high assembly yields.

Almost two decades of Superjunction technology innovation has brought us to the CoolMOS™ P7, and with it now available in a SOT-223 package, designers and engineers have a MOSFET choice that provides an excellent balance between performance, ease-of-use, small application footprint, and price. Additional information on CoolMOS™ P7 in SOT-223 can be found at

www.infineon.com/sot-223

Pack More Power in Your Cool, Small Smart-Home Hub

By Jia Hu, Nazzareno (Reno) Rossetti and Sami Nijim, Maxim Integrated

Introduction

Smart hubs are fast becoming a common household item. Used to wirelessly control door locks, lights, thermostats, audio and electric appliances, they are also equipped to send notifications to the homeowner (Figure 1). These wall-powered, soap-sized gadgets are packed with electronics and often include backup batteries in case of power outage. To fit in such a small space while minimizing heat generation, the on-board power management system must be small and efficient. This article reviews a typical approach for powering a smart hub. It then presents a new solution that delivers more efficient power in a smaller space, enabling longer backup battery run-times and smaller form factors to accommodate today's smarter homes.

Figure 1: Smart-home Hub Illustration

Typical Power Management Implementation

As an example, a typical smart hub system (illustrated in Figure 2) wirelessly communicates with a smart vacuum cleaner. The smart hub is powered by a wall adapter and has a backup battery in case of a power outage.

In the event of a power outage, the backup battery should provide operation for up to 10 hours. In a typical implementation, four AA

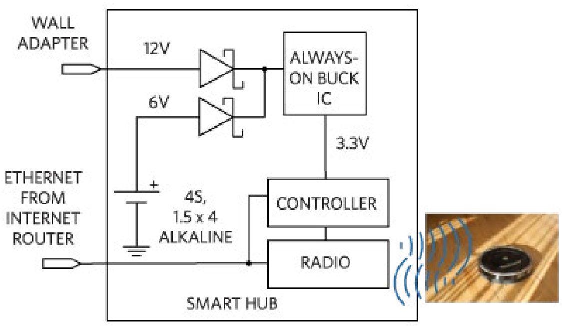

Figure 2: Typical Smart Hub System

alkaline batteries in series provide 6V and a 2Ah charge. Accordingly, the smart hub must consume less than 200mA on average to last for 10 hours during a power outage.

The power management circuit includes an always-on buck converter and two diodes that multiplex the two input power sources. The footprint of the smart hub's power circuit, including active and passive components, is shown in Figure 3.

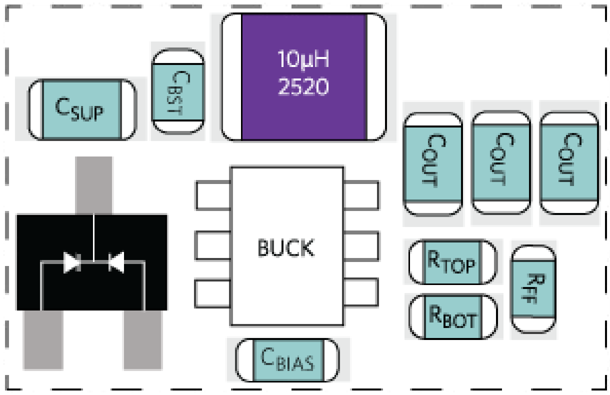

Figure 3: Typical Smart Hub Power Section Footprint (46mm^2)

This typical smart hub power solution, which requires two chips (represented with their SOT23-3 and TSOT-6L packages in Figure 3) and several passives, results in a board area footprint of about 46mm^2.

Integrated Power Management Solution

In Figure 4, the two ICs containing the buck converter and the dual diodes are integrated into a single chip leading to a much more compact solution. In addition, the two diodes, actively implemented with low RDS-ON MOSFETs, have virtually ideal performances.

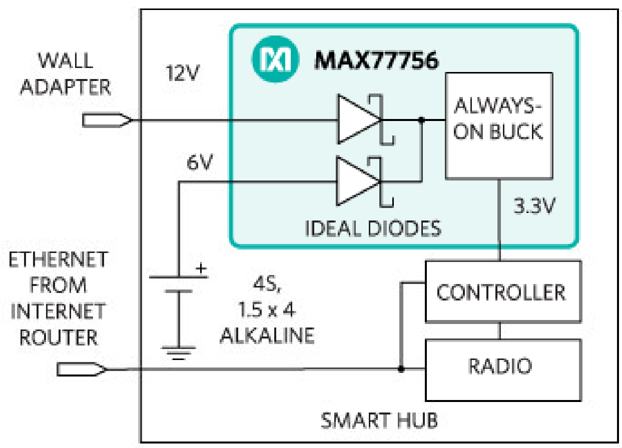

Figure 4: Integrated Power Solution

Integrated Buck Converter and Power MUX
An example of the integrated implementation can be found in the MAX77756 (Figure 5), a synchronous 500mA step-down converter with integrated dual-input power multiplexer (MUX). The MOSFET-based multiplexer minimizes the power losses associated with the diode implementation.

If the smart hub consumes an average of 200mA with 6V input (backup mode), then the current delivered by the buck converter at the output, while neglecting efficiency losses, will be 364mA on average.

The MAX77756 500mA current capability can handle an average load with room to spare for peak current demand, making it an ideal choice for this application.

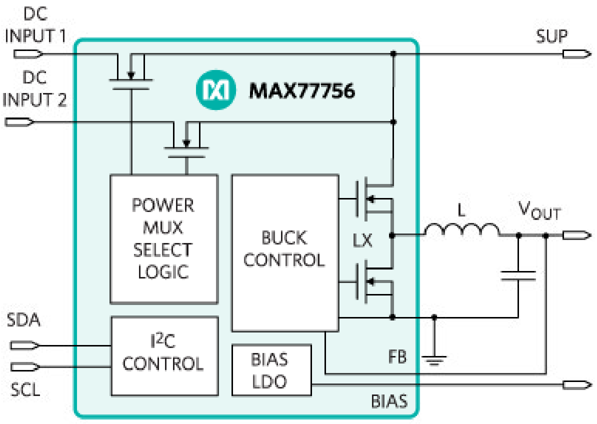

Figure 5: MAX77756 Block Diagram

The MAX77756 operates from an input supply as low as 3.0V and as high as 24V. Default output voltage is factory-programmed to either 1.8V, 3.3V, or 5.0V. Output voltage is further adjustable through external resistors or an I^2C serial interface.

Size Advantage
The MAX77756 application footprint in Figure 6, highlights the passive components and the single MAX77756 in a tiny 2.33mm x 1.42mm (0.7mm max height), 15-bump wafer-level package (WLP).

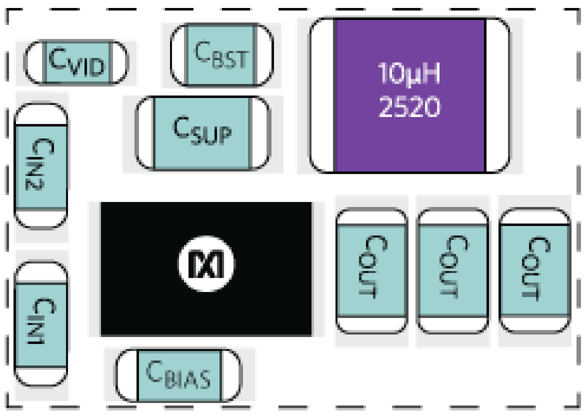

Figure 6: Integrated Smart Hub Power Solution with MAX77756 ($33mm^2$)

The high level of integration leads to a footprint of only $33mm^2$ or 28% smaller than the typical implementation.

Efficiency Advantage
Figure 7 shows the MAX77756 efficiency curve for a 12V input (DC INPUT 1 or 2 in Figure 5) and a 3.3V output. The superb 87% peak efficiency, which includes the buck converter and MUX MOSFET losses, makes this device the best in class. The buck converter has

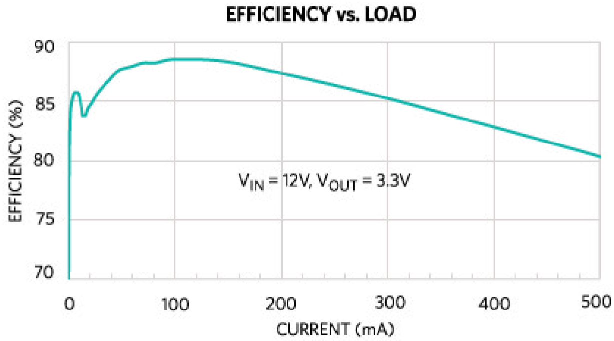

Figure 7: MAX77756 Efficiency Curve

the advantage of several efficiency points compared to alternative solutions.

High efficiency and small footprint go hand in hand. Less heat generation helps in designing a smaller, cooler smart hub, easing the concerns for device overheating. Higher efficiency is also important in case of power outage. For example, a 5% efficiency advantage will translate directly into an equal extension of the backup battery run time of 5%.

Conclusion
Smart hubs are small, cool gadgets that require space and power-efficient solutions. By integrating an always-on buck converter and a MOSFET-based input MUX into a single chip, it's possible to achieve a 28% reduction in the power management footprint and have best-in-class efficiency as shown by the MAX77756.

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About the Authors
Jia Hu is an Executive Business Manager in the Mobile Power group at Maxim Integrated. He has 20 years of experience in the semiconductor industry. Jia holds a master's degree in Electrical Engineering from the University of Washington, and bachelor's degrees in Electrical Engineering and Economics from the University of California, Berkeley.

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MPM38222 – A Simple, Compact Power Solution for Optical Modules

High efficiency, excellent thermal performances, small footprint, and low emissions become challenges for power solutions in high-speed, high-density optical modules. This article introduces the MPM38222, a high-performance, 6V input, dual 2A power module, which is suitable for optical modules and other space-limited applications. The total solution for a dual 2A resides in a 9mmx7mm area with 90% efficiency and can meet EN55022 Class B emissions. The Module is available in a small QFN-14 (4mmx4mmx1.6mm) package.

By Yi Sun and Jinqian Yu, Monolithic Power Systems Inc.

Introduction

High-speed, high-density optical modules are widely adopted as interfaces that connect fibers to copper networks, data centers, and most end points in optical networks. As more components are integrated into the modules, higher efficiency, better thermal performances, smaller footprint, and low emissions become challenges for the power solutions. MPS has created an easy and high-performance solution for optical modules and other space-limited power supplies. The proprietary packaging technology of MPS's power modules has given them an edge over other competitors. For space-limited power designs, the smallest solution size possible is often desirable with no performance compromise. With this in mind, MPS is proud to present their MPM38222 dual 2A module to the industry.

Small Package with Dual Outputs

Space matters in optical modules and similar products. The MPM38222 is a dual-channel DC/DC module in a compact 4x4x1.6mm package. It has two output channels, and each channel can supply up to 2A of current. Just two or three devices can cover most power rails in an optical module.

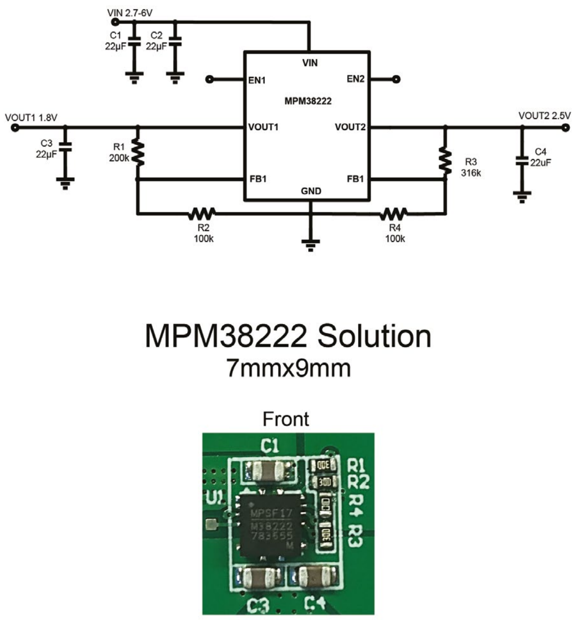


Figure 2: Typical Application and Layout

Two chip inductors and the entire power stage are integrated inside the module (see Figure 1). As a result, compared to a discrete design solution, the Module only needs a minimal number of external components and functions as a full power system. Figure 2 shows the typical application circuit and layout for a 2.7V to 6V input, 1.2V/2A, and 1.8V/2A output applications. Only a few external ceramic capacitors and feedback resistors are required for each channel. The total solution size is only 9x7=63mm2 of PCB area. It provides a simple power system that's easy to use, especially in space-limited applications.

The MPM38222 operates from a 2.7V to 6V input, generates an output voltage as low as 0.608V, and has a 45µA quiescent current, making it ideal for powering portable equipment that runs on battery cells.

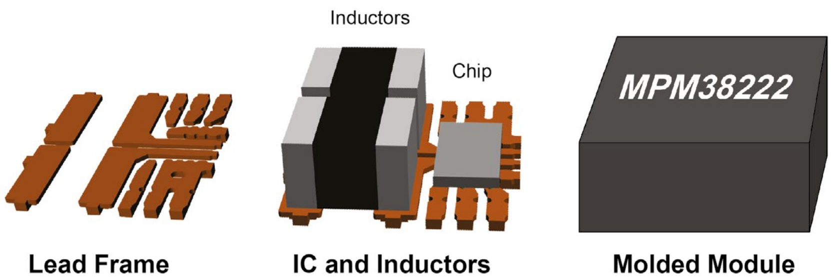


Figure 1: Assembly Process

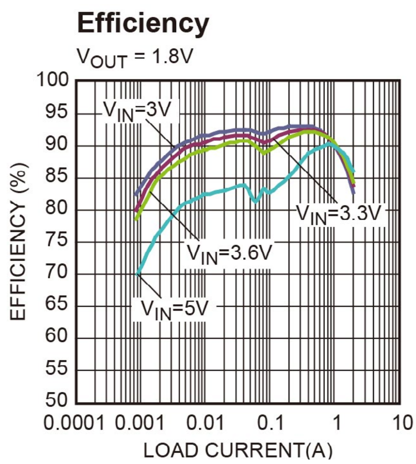


Figure 3: Efficiency vs. Load Current

High Efficiency at Light Load

Optical modules usually operate at loads of hundreds of mA. The device can achieve at least 90% efficiency between 10mA to 1A (see Figure 3).

In this load range, the MPM38222 uses a proprietary control scheme to save power and improve efficiency. The low-side switch is turned off when the inductor current starts to reverse and works in discontinuous conduction mode (DCM) operation. This helps skip pulses and reduce the switching frequency, minimizing switching loss.

Low-Noise Design

In addition to being small in size, the MPM38222 also has minimal EMI noise to its surroundings. Thanks to its high switching frequency, it can provide a clean output with peak-to-peak voltage ripple less than 20mV using only one 22µF 0603 ceramic capacitor. For the input side, the device employs a 180° phase shift between the two channels, which minimizes the input voltage ripple. It is also engineered to meet low EMI standards. Figure 4 shows its radiated EMI performance (EN55022 Class B).

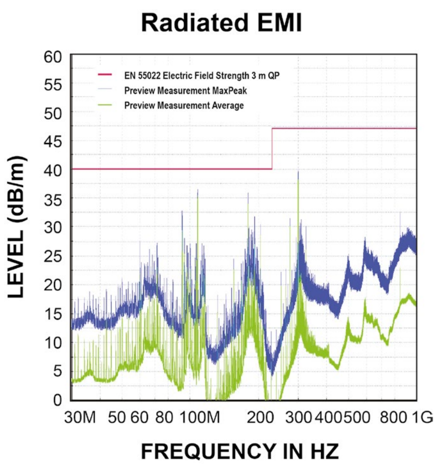


Figure 4: Radiated EMI Test

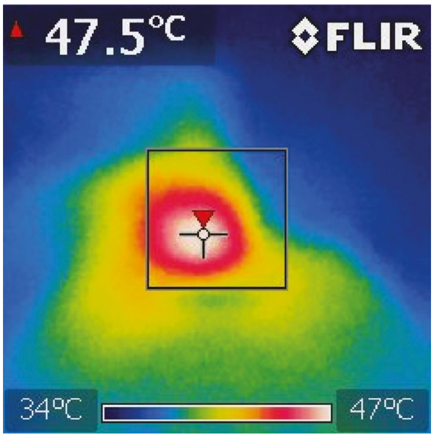
Good Thermal Performances

Figure 5a shows the thermal image for 5V input, 1.8V@1A, and 1.2A@1A, while Figure 5b shows the same voltage @ 2A load current for both channels. For 1A load conduction, the temperature rise is only 22°C above the ambient 25°C without heatsink or forced air flow. For a 2A condition, the temperature rise is only 45°C. This excellent thermal performance enables the Module to work stably in a constraint space environment with high ambient temperature.

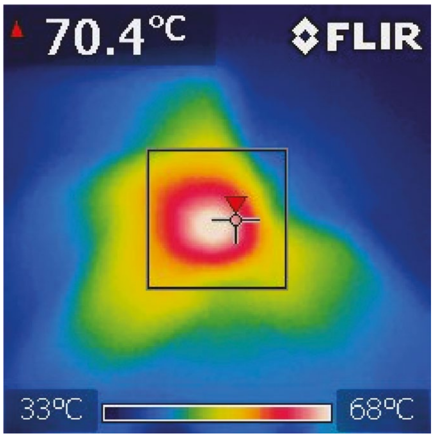
Protection Features

The MPM38222 includes various protection features to ensure a reliable and safe design.

1. Soft start: A soft start with a controlled slew rate helps prevent input current overshoot during power-up.
2. Over-current protection and hiccup: The Module limits the peak-current limit on a cycle-by-cycle basis. The device enters hiccup mode when the output is shorted to ground.
3. Thermal shutdown: It shuts down the device when its junction temperature reaches 160°C.



a. 5V Input, 1.8V@1A, 1.2A@1A



b. 5V Input, 1.8V@2A, 1.2A@2A

Figure 5: MPM38222 Thermal Image

For more detailed protection features, please refer to the datasheet.

Conclusion

The MPM38222's high efficiency, low noise, and small size make it a great candidate for optical modules and other space-limited designs. The highly integrated module helps ease the design and shortens the time to market. For more design support, please visit

www.monolithicpower.com

Optimising the Thermal Performance of Power Electronics

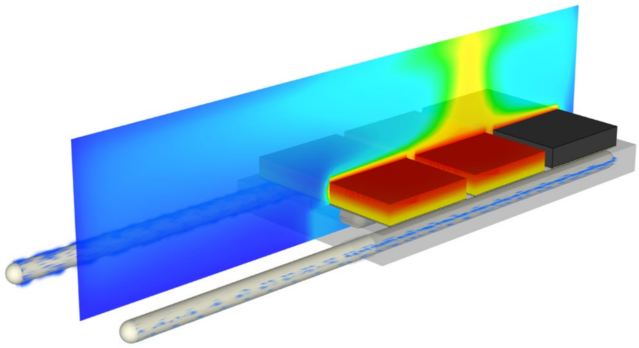
While designers have always strived for efficiency within the field of power electronics, over the last five years, a combination of budgetary pressures, changing device lifecycles and corporate social responsibilities (CSR) concerns have helped drive demand for increasingly low-cost, light weight and energy efficient components and end devices.

By Tom Gregory, Product Manager at 6SigmaET

However, this poses a significant problem for device designers and electronics engineers. Despite these rising demands there is no avoiding the fact that power electronics are designed for extremely high power loads; power which, in turn, generates a lot of heat. The thermal design of power electronics device and systems must be considered from the outset.

More power, more problems

Power electronics systems put some uniquely demanding strains on semiconductors devices. Although we have seen significant improvements in the efficiency levels of power electronics devices, with some conversion and switching products reaching efficiency levels of 98%, the fact is that the very high power loads involved still generate significant amounts of heat loss. Even when a 98% efficiency is achieved, the remaining 2% of wasted energy -represents a significant amount of heat, often hundreds of watts, which has to go somewhere. As such, managing the heat dissipation from components and from the wider system is absolutely critical to the design of power electronics.



End users typically demand very high reliability and longevity, which is essential in a wide range of industries, from renewable energy and electric vehicles right through to the rail industry. High temperatures can reduce the reliability of components. To take the example of aluminium electrolytic capacitors - used for energy storage and filtering – these electrochemical devices are often the life-limiting components within power systems. According to some estimates, the average aluminium electrolytic capacitor will have its operating lifespan halved with every 10°C rise in temperature.

The load on power electronics devices will typically be transient in nature. The variation over time has an impact on both the immediate performance of a semiconductor, and on its lifespan. Power cycling – where a device rapidly switches between high and low power loads causing large swings in temperature – can stress the solder and bonding of semiconductor devices, resulting in device failure.

If the operating temperature of a device is not managed the operating conditions of the power electronics device might change leading to a further temperature rise, a phenomenon known as thermal runaway. As the junction temperature of a power transistor increases, the on-resistance of transistors increases, which in turn creates more heating of the junction, in a positive feedback loop. Ultimately this can cause the electronic devices to effectively burn themselves out.

Keeping cool: key design decisions

The nature of these thermal behaviours means that designers are faced with a number of vital decisions in the design process in order to optimise heat transfer away from critical semiconductors and other components.
At the chip level, appropriate materials for substrates, bonding, die attaches and interface materials need to be selected. At the system level there are equally important decisions to be made regarding PCB materials, heat sinks and whether to incorporate liquid cooling or thermoelectric coolers.

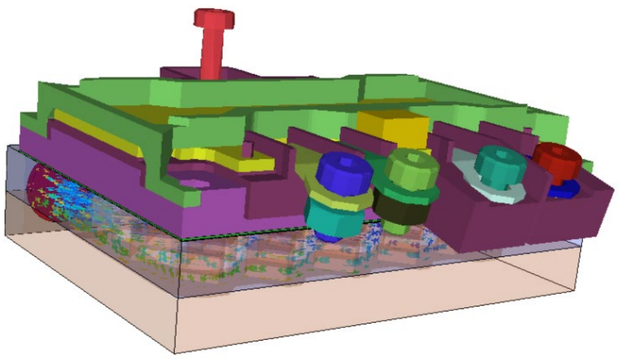
The more robust materials used in power electronics also brings their own challenges. Compared to typical FR4 PCBs, materials like ceramic or copper have high thermal conductivity, which can be advantageous in thermal management, but at the same time these materials can also add significant cost and weight to a design if not used optimally.

Design engineers must also be careful to consider the real-world environments in which their devices are likely to operate. In a controlled setting, engineers may be confident in their product's ability to dissipate the heat generated. However, those capabilities may not translate to the real-world environment in which it will ultimately be deployed.

To deliver a fully optimised product these decisions need to be tackled as early as possible in the design process. Unfortunately, it is still the case that many designers rely on 'rules of thumb' to deal with thermal complications, which leads to 'over-engineering' products or trying to 'manage out' thermal complications at the back end of their projects. Indeed, according to research from 6SigmaET, only 25% of design engineers test any thermal operation early on in their designs, while 27% wait until after a design is complete.

By not dealing with thermal considerations early in the design process, engineers are fundamentally compromising their designs – either by adding unnecessary cost, compromising ultimate efficiency and performance, or by failing to hit other important requirements such as weight.

There is no one-size-fits-all material that engineers should use for their designs. However, by simply altering one of their materials design engineers can make efficiency savings or thermal performance gains. So what's the key to making the right design decisions at both the chip level and the system level? Thermal simulation.



Using simulation to solve at all levels
Through the use of thermal simulation, engineers can test the thermal performance of semiconductors – both the precise detail of heat sources in an IC at the micron scale, and also in terms of how they interact as part of an overall system.

By creating a thermal simulation model in advance, engineers can test their designs using a wide variety of different materials – for example, switching from copper to aluminium at the click of a button. Simulation also enables designs to be tested in a massive array of different environments, temperatures and use states. This will not only help to identify potential inefficiencies, but also reduces the need for multiple real-world prototypes (further helping to reduce overall costs).

As thermal simulation packages start to bundle pre-designed component types, templates and materials as standard, this process is becoming easier than ever before. As one example, 6SigmaET now includes an in-built "Package Builder". This allows users to automatically generate individual IC component models at the system level simply by defining a list of parameters. Through this interface, users can create detailed integrated circuits and thermal models for inclusion within their product designs – allowing them to factor in internal temperatures of complex ICs.

Tools like this are making it increasingly easy for engineers to precisely understand the thermal challenges of their designs. In turn this means that thermal considerations can be dealt with far earlier in the design process, enabling the thermal performance of power electronics semiconductors and systems to be fully optimised, reducing reliance on expensive late-stage 'fixes', and avoiding unnecessary over-engineering.

Put simply, the ease of use and capabilities of today's thermal simulation tools means there is no longer any excuse to rely on 'rules of thumb' when it comes to the thermal performance of semiconductors in power electronics products.

www.6sigmaet.info

Tom Gregory,
Product Manager at 6SigmaET

1200V Hyperfast Diodes and their Applications

In our modern society, electricity is becoming an ever more important resource of energy. Common examples of energy users and producers are computing equipment (desktop computer, tablets, but also server farms including un-interruptible power supplies), communication equipment (mobile phones, base stations), electric vehicles (traction and battery charging), PV energy harvesting equipment (solar energy farms) and wind turbines (wind farms). Handling the electric energy efficiently has become essential; 1200V diodes can help.

By Nick Koper, Chaochao Shi and Terry Liu, WeEn Semiconductors

High voltage

It is a well-known fact in electric energy transfer that Ohmic losses in low voltage systems have a larger impact on efficiency than in high voltage systems. It is for that reason that new standards for mobile phone and tablet charging have been developed (USB-PD) that allow these devices to be charged from 9V, 12V or even 20V sources, where in the early days 5V was the standard.

Of course, mobile phones and tablets are more or less low power systems (in the order of 1 to 10 Watts), but a similar tendency can be observed in higher power systems (1 kW and above).

High power electric power conversion systems like UPS, PV inverters and EV chargers are commonly built using DC/DC converter building blocks like Boost/Flyback Converters, Buck/Forward Converters and Resonant Converters. Flyback and Forward Converters are basically the isolated counterparts of the Boost and the Buck Converter respectively.

Traditionally the highest DC voltage levels in this kind of systems used to be around 400V. In many new high power systems an internal DC voltage of 700V or above is used in order to benefit from efficiency advantages that can more easily be realized by using higher voltage. Basically for the same reason why many modern mobile phones use USB-PD voltage levels of in the order of 12V and not the traditional 5V USB level.

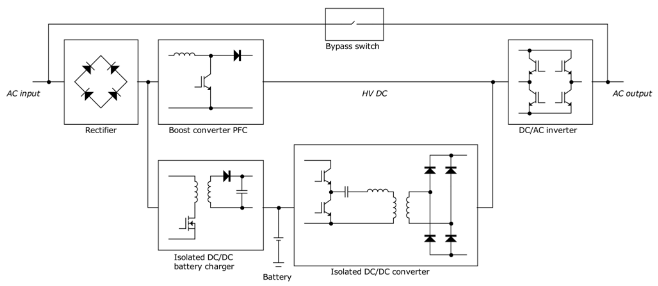


Figure 1: Block diagram of a UPS system with various DC/DC building blocks

Hard switching, soft switching and power loss resulting from diode behavior

When it comes to the switching behavior of DC/DC converters, there's essentially just hard switching and soft switching. Bipolar pn-junction diodes behave differently under hard switching and soft switching circumstances. This can be illustrated by examining the operation of a boost converter in continuous conduction mode (CCM) and of an LLC resonant converter. The CCM boost converter is essentially hard switching, the LLC resonant converter is essentially soft switching.

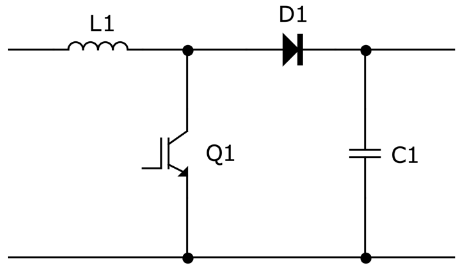


Figure 2: Principle diagram of a boost converter

Hard switching

A CCM boost converter is often used as the power factor correction (PFC) circuit in a power converter system.

When, at time t_1, switch Q1 is closed the current in inductor L1 (I_{L1}) builds up while the current in diode D1 (I_{D1}) stops to flow. When Q1 is opened at time t_2, the current starts to flow through the diode. At the moment that D1 must start to conduct the current (at time t_2) only a low concentration of charge carriers (electrons and holes) is present in the drift region of the diode. That makes the initial impedance of the diode relatively high, which results in a high voltage drop (V_{fr}) across the diode. After a certain time (t_{fr} – mostly in the order of 10 to 100 ns) sufficient charge carriers have been injected into the drift region, the impedance of the diode drops dramatically and the voltage drop across the diode is reduced to the static V_F level for the specific forward current. The energy loss due to diode switch-on (switch-on loss) can be approximated by:

$$E_{sw-on} = \tfrac{1}{2} \cdot I_F(t_2) \cdot V_{fr} \cdot t_{fr} \qquad (1)$$

The energy E_{sw-on} is completely dissipated in the diode itself.

After switching on, the current through the diode continues to flow and ramps down. Ramp down continues until switch Q1 is closed again. The energy dissipation during the diode conduction period is:

$$E_{cond} = \int_{t_2}^{t_1} V_F(I_F) \cdot I_F(t) \cdot dt \qquad (2)$$

Which can be estimated to be approximately equal to:

$$E_{cond} = \overline{V_F} \cdot \overline{I_F} \cdot (t_1 - t_2) \qquad (2a)$$

Where $\overline{V_F}$ and $\overline{I_F}$ are the average V_F and I_F levels respectively. All conduction loss is dissipated in the diode.

At the moment Q1 is closed the sequence repeats.

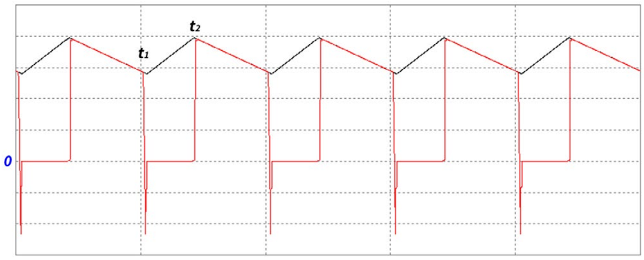


Figure 3: Current waveform in the diode of a CCM boost converter (simulated); black = I_{L1}, red = I_{D1}

The current that flows in diode D1 at the moment it's being switched off (t_1) significantly deviates from zero. Under that circumstance a bipolar diode cannot block the current instantaneously. In a bipolar diode the stored charge in the drift region must be removed before the diode can block the current flow. The reverse current associated with the extraction of the stored charge can clearly be recognized in figure 3. Removal of the stored charge (Q_s) leads to power loss: switch-off loss ($E_{sw\text{-}off}$). The power loss associated with switching off is proportional to the voltage trajectory that the stored charge need to travel; in a normal boost converter that voltage trajectory is equal to the output voltage of the boost converter (V_{out}); namely the stored charge was initially at V_{out} level and is 'transported' to ground potential (0 V) because Q1 is closed.

$$E_{sw-off} = V_{out} \cdot Q_s \qquad (3)$$

The stored charge Qs is the product of the current flowing in the diode (IF) and the (ambipolar) charge carrier lifetime τ_a.

$$Q_s = I_F \cdot \tau_a \qquad (4)$$

Combining equations (3) and (4), and knowing that switch-off occurs at t_1, the expression for the switch-off loss is:

$$E_{sw-off} = V_{out} \cdot I_F(t_1) \cdot \tau_a \qquad (5)$$

The energy $E_{sw\text{-}off}$ is normally only partially dissipated in the diode itself; generally a lot of the energy will be dissipated in switch Q1.

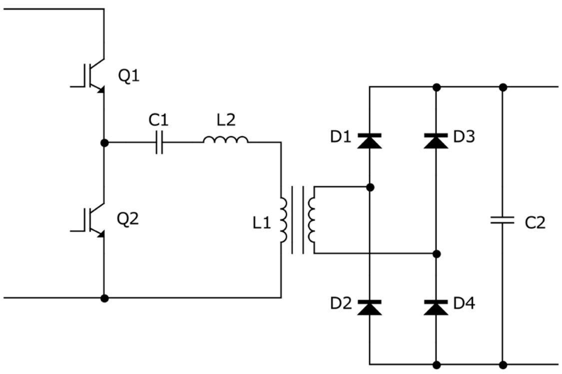


Figure 4: Principle diagram of an LLC resonant converter

The ambipolar charge carrier lifetime τ_a is not a constant; lifetime decreases with current density in the silicon device. That makes it interesting to consider to use a smaller diode in order to reduce power loss in the system as a whole, especially when switching loss happens to be already dominant over conduction loss. Although the conduction loss will increase when a smaller diode is applied in an application, that loss may be more than compensated by the reduction of switching loss. See also the text box "Conduction loss versus switching loss".

Charge carrier lifetime increases with temperature. Therefore it makes sense to try to keep the operating temperature of a bipolar diode low in order to keep switching loss low.

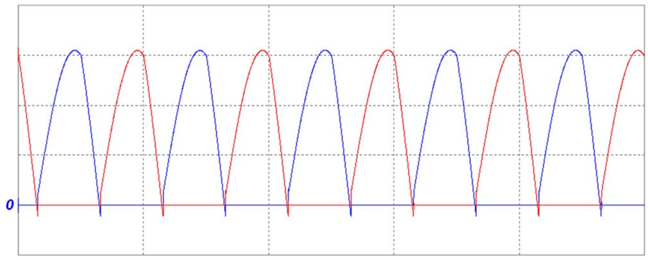


Figure 5: Current waveforms in the diodes of an LLC resonant converter (simulated); blue = I_{D1} and I_{D4}, red = I_{D2} and I_{D3}

Soft switching

An LLC resonant converter can often be found as a building block in a UPS or PV inverter. The switches Q1 and Q2, together with L1 (the magnetization inductance of the transformer), L2 (the leakage inductance of the transformer) and C1 (the series capacitance of resonating circuit) create a sinusoidal (or piecewise sinusoidal) current flowing out of the secondary side of the transformer. That sinusoidal current is rectified by the diode bridge (D1, D2, D3, D4), causing a DC voltage to result across the output buffer capacitor C2. The current that flows in diode pair D1 and D4 (and in the pair D2 and D3) is essentially zero when the diodes are switching on and switching off. Because the diodes switch on at zero-crossing, diode turn-on losses are much lower than in a hard switching topology – the V_{fr} voltage overshoot is much lower and sometimes not even detectable. For switch-on power loss the same equation (1) applies as for a hard switching topology, but in a soft switching topology I_F is close to zero, so the switch-on losses are nearly zero.

Conduction loss versus switching loss

In semiconductor switches (diodes, BJTs, MOSFETs, etc.) two aspects generally, determine the power loss: current conduction and switching. Conduction loss (on-state loss) can be reduced by making the semiconductor switch lager. Switching loss occurs because of change in the 'charged state' of a semiconductor switch: the most charge is involved in the transition, the higher the switching loss. Switching losses can be reduced by:

- Making the semiconductor switch smaller,
- Adapt the internal operation of the device in such a way that less Charge is involved in a switching transition. As a side effect this Adaption usually leads to higher conduction loss.

Switching loss is proportional to the switching frequency. When the switching frequency is low, conduction loss will nearly always de dominant; selecting the biggest device generally gives the lowest power loss. A high switching frequency, a trade-off must be made between conduction loss and switching loss arrive at minimum total power loss. In that case the optimum device will either be (1) a smaller switch or (2) a switch with adapted characteristics, or a combination of the two. Higher conduction loss must be tolerated to arrive at minimum total power loss.

Diode switch-off losses are also much lower because the forward current level is approaching zero when the diode needs to turn off. Again the same equation (3 or 5) applies, but I_F is substantially lower than in a hard switching topology. So that makes switch-off losses much lower as well, which can easily be recognized in the diode's reverse recovery current magnitude in figure 5 – the reverse recovery current only slightly drops below zero.

The main requirement for the diode is that it must be fast enough to keep pace with the switching frequency of the (LLC resonant) power converter.

One component in the energy loss cannot be avoided: conduction loss. Also in soft switching topologies the conduction loss is given by equation (2).

Because switching losses play a less significant role in soft switching topologies the same (ultrafast/hyperfast) bipolar diodes can be used up to much higher switching frequencies in soft switching topologies than in hard switching topologies.

1200V diodes

Hyperfast bipolar diodes need lifetime control in order to make them switch fast (see also the text box "Lifetime control") – in principle there's no fundamental difference between 600V diodes and 1200V diodes. But, compared to 600V diodes, 1200V diodes require a wider drift region/depletion region in order to cope with the 1200V reverse voltage. The consequence of that wider region is that stored charge extraction (at the moment that the diode should turn off) takes longer. In order to make a 1200V diode just as fast as a 600V diode, it needs the lifetime of the charge carriers to be reduced even further. This additional carrier lifetime reduction unfortunately also affects the forward voltage drop of the diode: V_F will rise and consequently conduction loss will be higher. It is for this reason that 600V Hyperfast diodes have t_{rr} values specified in the order of 20 ns where 1200V Hyperfast diodes have t_{rr} values in the order of 60 ns.

Where picking the right balance between conduction loss and switching loss in 600V diodes was already a challenge, it is even more challenging for 1200V diodes.

Lifetime control

Semiconductor switches are either unipolar switches (like Schottky diodes and MOSFETs) or bipolar switches (like pn-junction diodes and BJTs). In a unipolar device only electrons or holes conduct the current, in a bipolar switch both electrons and holes conduct the current. One advantage of unipolar switches is that they can switch very quickly while the main advantage of bipolar devices is that they are better current conductors.

Through the so-called conductivity modulation phenomenon, a bipolar switch conducts the current much better than a unipolar switch for the same amount of silicon used.

However, conductivity modulation also has a disadvantage. When a bipolar device conducts, a high concentration of charge carriers (electrons and holes) is injected into the drift layer of the device (that's what makes the device conduct so well). But, when the bipolar device needs to switch off, the excess charge carriers must first be removed before the device can start blocking the current: bipolar devices cannot switch-off instantaneously. Either one will have to wait until the excess electrons and holes In the drift layer have recombined spontaneously or one will have to extract the charge carriers actively. When extracted actively, a so-called reverse recovery current flows in a bipolar diode before the device actually blocks the current flow.

The charge concentration that can be injected into the drift layer depends on the lifetime of the charge carriers. In 'normal' silicon the effective lifetime of charge carriers is in the order of several microseconds. For standard 50 or 60 Hz rectifier diodes that charge

carrier lifetime is no limitation for the diode’s operation. However, in bipolar diodes that need to switch at much higher frequency, lifetime control must be used to reduce the effective lifetime of the charge carriers.
Reduced charge carrier lifetime reduces the charge concentration in the drift layer of the diode. That makes the diode less well conducting in the on-state (higher V_F), but it also makes it easier to extract the excess stored charge and it speeds-up spontaneous electron-hole recombination: the diode switches faster (lower t_{rr}).
Charge carrier lifetime can be controlled by diffusing a low concentration of gold (Au-kill) or platinum (Pt-kill) into the silicon. The Au or Pt atoms will operate as recombination centers: they speed-up the recombination of electrons and holes.
Unfortunately, recombination centers operate as generation centers when the diode is in the off-state. This causes a fast Au-killed or Pt-killed diode to have a much higher leakage current than a slow “un-killed” diode; the faster the diode, the higher the leakage current. Furthermore, the leakage current increases with rising temperature which can lead to thermal runaway. A substantial difference between Au-killed and Pt-killed diodes, is that the Au-killed diodes have much higher leakage current than Ptkilled diodes at the same operating temperature. Where most Au-killed diodes cannot be used at an operating temperature above 150°C, Pt-killed diodes are able to operate at a temperature of 175°C or higher and are therefore a more reliable solution.

Leakage and high operating temperature capability

High reverse voltages across a bipolar diode’s terminals will cause a leakage current to flow. Hyperfast diodes need a high concentration of recombination centers (see also the text box “Lifetime control”) in order to give the device its fast switching properties, but unfortunately these recombination centers do also operate as generation centers that contribute to a higher leakage current. Furthermore, when the operating temperature of a Hyperfast diode rises the activity of the generation centers increases, which leads to higher leakage current. When a Hyperfast diode must be able to operate reliably at high temperature, it is essential that the leakage current does not rise to a level where the dissipation because of leakage could result in thermal runaway of the device. In order to achieve that a lifetime control method should be used that gives the Hyperfast diode these desired properties. The traditional so-called “Gold-kill” process does usually not allow the resulting Hyperfast diodes to be used above an operating temperature of 150 °C. An enhanced so-called “Platinum-kill” process delivers Hyperfast diodes that can be used up to temperatures of 175 °C and is therefore preferred for manufacturing Hyperfast low-leakage diodes that are capable of operating at high temperature. Using the right lifetime control and choosing the right balance between conduction losses and switching losses results in 1200V Hyperfast diodes that enables cost effective and efficient high power/high voltage switched mode power conversion systems.

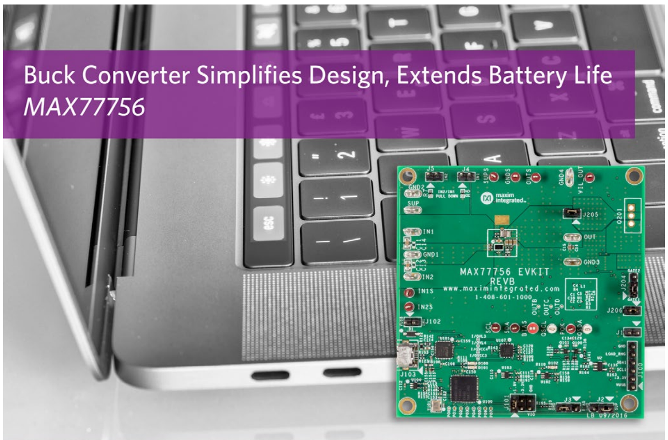
www.ween-semi.com

About WeEn Semiconductors

WeEn Semiconductors was established in 2016 as the continuation of NXP’s Bipolar Power Business Line. WeEn Semiconductors Co., Ltd, is the global joint venture between NXP Semiconductors N.V. and Beijing JianGuang Asset Management Co. Ltd (JAC Capital). WeEn Semiconductors’ business and operations center is located in Shanghai, China.

Extend Battery Life of USB Type-C™ Devices with Flexible Buck Converter

Developers of multi-cell, USB Type-C products that need higher current, dual input, and I²C support now have a flexible option with the MAX77756 24V, 500mA, low quiescent current (Iq) buck converter from Maxim Integrated Products, Inc. (NASDAQ: MXIM).



USB Type-C products must generate an always-on 3.3V rail to detect USB insertions. Products utilizing the Power Delivery (PD) voltage range (5V to 20V) can generate an always-on (1.8V/3.3V/5.0V) digital supply rail for the port controller using the MAX77756 step-down converter. In addition, the MAX77756 has a 20µA quiescent current that extends battery life by reducing idle power consumption. To simplify the system design, the MAX77756 has a dual input ideal diode ORing circuit that allows the chip to power from the external USB source if the battery is empty.
Multi-cell battery-operated devices—such as ultrabooks, laptops, tablets, drones, and home automation appliances—can easily evolve to Type-C with PD using the flexible MAX77756 power supply. The MAX77756 has a unique combination of wide input voltage range, low quiescent current, higher current load, dual input, and I²C for flexibility and programmability. There is also a default power mode if customers do not want to use the I²C bus. The MAX77756 is a robust IC with short-circuit and thermal protection, 8ms internal soft-start to minimize inrush current, proven current-mode control architecture, and up to 26V input voltage standoff.

www.maximintegrated.com

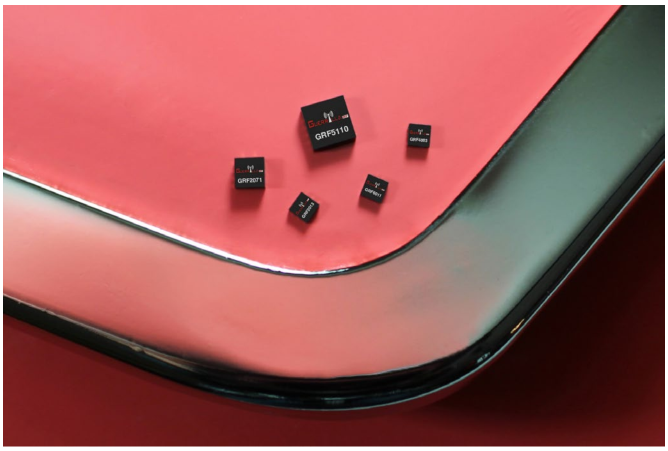
First Silicon Carbide Power Devices

Ascatron provides next generation Silicon Carbide (SiC) power semiconductors using its proprietary 3DSiC® technology with a quality and performance unattainable through current methods. SiC radically reduce losses in electrical power converters and lowers system costs, making it key for electric vehicles and renewable energy. The global impact will thus be large.
Ascatron, with background in producing advanced SiC epi material for global customers, has recently transformed from a service provider to a device product company. The first products available for customer testing are diodes rated to 1200V, 1700V and 10kV. MOSFET switches are under development and will be introduced 2018.
“We have developed a unique material technology that makes it possible to fully use the potential of SiC to handle very high power with minimal losses, while maintaining the reliability of silicon”, says Adolf Schöner, CTO of Ascatron. “We call it 3DSiC® and is based on our expertise in producing advanced SiC epitaxy material. The technology has the potential to lower the losses up to 30% compared to conventional solutions”.
The 3DSiC® technology enables a modular design of Ascatron product line. Each device is divided in a high voltage module related to the desired voltage class, and a low voltage part for each type of component. Combination of different modules gives a wide range of products.
“Our business target is to be highly trusted and innovative supplier of SiC semiconductors for power electronics in industry, automotive and energy”, says Christian Vieider, CEO of Ascatron. “We foresee a period of technology change when shifting from silicon to SiC and target to take part in such industry consolidation”.

www.ascatron.com

MMICs Covered with Extensive Range

Guerrilla RF Inc., represented by Aspen Electronics in the UK, is a leading provider of high performance MMICs to wireless infrastructure OEMs in multiple market segments, including enterprise/carrier-class WiFi access points, small cells, wireless backhaul and cellular repeaters. Their high performance RF and Microwave IC products enable new levels of range and coverage area in wireless systems.



Recently announced is a failsafe SPDT switch for cellular boosters, cellular infrastructure and
L-band Satellite Communications – the GRF6011. This linear, ultra-low loss switch has been designed with failsafe characteristics when all voltage inputs are removed. In switching mode, the device delivers IP1dB levels greater than 1 Watt along with >49 dBm IIP3 levels for both RF paths. When powered down (Failsafe Mode), RFC to RF1 defaults to a high insertion loss while RFC to RF2 defaults to a low insertion loss state that retains high linearity.

www.aspen-electronics.com

Wide-Range Bench Top DC Power Supply

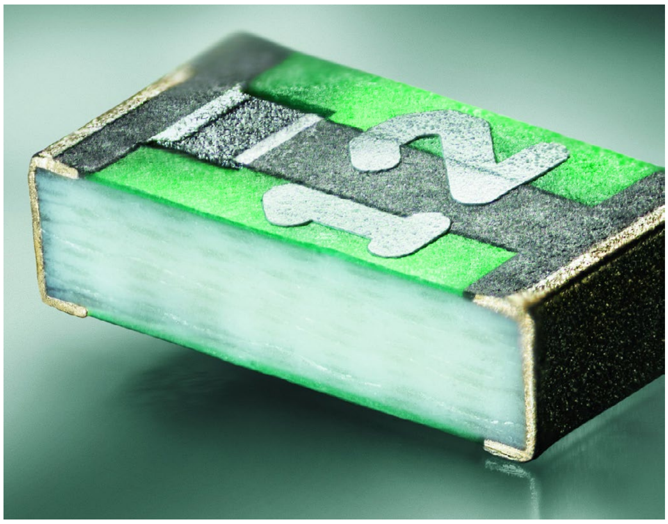
The PWR-01 series from Kikusui Electronics is a new wide-range bench top DC power supply that provides unrivaled testing performance in a compact, user-friendly package.

The PWR-01 is a versatile instrument with models ranging from 400W, 800W and 1200W rated power output and maximum rated voltage up to 650V. Equipped with a 4 times voltage and current variable ratio as well as a 30% increase in power density compared to our previous model, the PWR-01 is guaranteed to satisfy the need for flexible current and voltage in a wide variety of applications. Variable internal impedance is a unique new feature that allows for various types of simulations ideal for automotive, solar panel evaluation, and other battery driven applications. The PWR-01 is also equipped with a soft start function that limits the inrush current, minimizing any harmful effects on DUTs such as DC motors. The user interface has been updated with ergonomic power setting knobs that allow the operator to control voltage and current independently as well as front facing banana plugs designed for optimal safety and comfort. The PWR-01 programmable internal memory feature lets the operator save custom sequences onto the device, eliminating the need to access a PC every time a test is conducted. Synchronized operation allows for more complex sequences over multiple channels for accurate testing of DC-DC converters, simulation of control circuit board start up tests, etc. LAN (LXI), USB, and RS232 interfaces are included as a standard so that the PWR can be operated in almost any testing environment via SCPI commands, LabView, Labwindows/CVI, etc., ideal for system integration. For more information on the PWR-01 series, please consult the Kikusui company website at:
www.kikusui.co.jp/en/product/detail.php?IdFamily=0143

www.kikusui.co.jp

Protection Against Excessive Temperature and Overcurrent

Schurters's USN 1206 offers a temperature-sensitive SMD fuse suitable for both overcurrent protection and protection against excessive ambient temperatures.



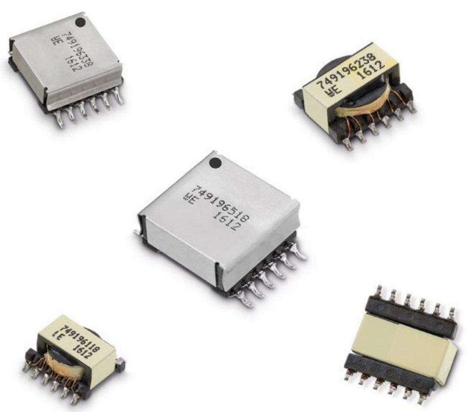
Due to the ever-increasing packing density in power electronics, it is becoming ever challenging to deal with the tighter and hotter board real-estate. Automobile manufacturers increasingly use control units in their products, including power electronics (e.g. ABS modules, annealing time control units, actuators, etc.). The trend is to integrate as many functions as possible into the smallest possible space in a single module. The fact that such modules must be protected against overcurrent is self-evident. However, the increasing power density also entails thermal problems. For this purpose, new approaches are needed to avoid a creeping risk of overheating.

thermal-protection.schurter.com

www.schurter.com/en

Flexible Transformer for Switched-Mode Power Supplies

Würth Elektronik eiSos, one of the leading manufacturers of electronic and electromechanical components, presents a new line of transformers for SMT assembly - WE-FLEX HV (Flexible Transformer High Voltage). Like the WE-FLEX



series of transformers, these excel because of their flexible capabilities in various applications making them ideally suited for fast prototyping. Different circuit configurations enable over 375 transformer solutions and around 125 choke solutions with WE-FLEX HV. Applications include flyback converters, forward converters, push-pull converters, step-up and step-down converters or single-ended primary-inductor converters (SEPIC). With their isolation voltage of 1.5 kVAC, these transformers are currently unrivaled on the market. The newly developed MnZn core material reduces core losses by up to 30 percent as compared with classical products and makes the new SMD transformer an attractive solution for all types of isolated DC-DC converters in industrial and telecommunications applications. WE-FLEX HV is available in four sizes, each with five different air gap lengths.

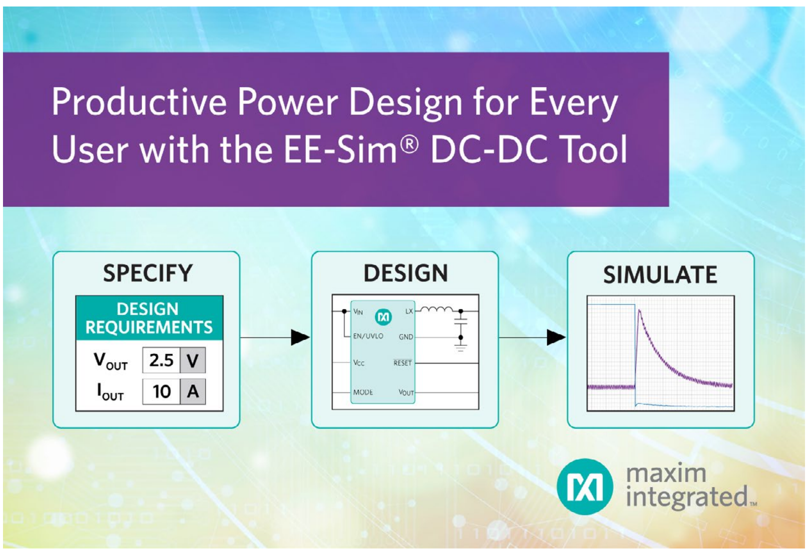
The working temperature is specified as -40°C to +125°C. Given suitable circuitry, the large package types of the series have a basic isolation for working voltages up to 250VRMS.

Free samples from the new SMD transformer series are now available. WE-FLEX HV is now available from stock.

www.we-online.com

EE-Sim® DC-DC Converter Tool

Power novices can now create custom designs with speed and confidence, while power experts can develop finely crafted circuits using the free EE-Sim® DC-DC Converter design and simulation tool from Maxim Integrated Products, Inc.. Try the EE-Sim DC-DC Converter tool: http://bit.ly/EE-Sim
EE-Sim DC-DC Converter Tool Overview video: http://bit.ly/EE-Sim_DC-DC_tool_video



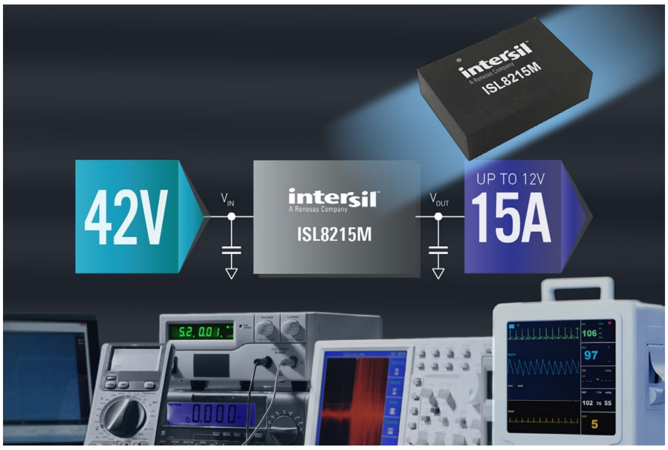
Without a robust development tool, power design can use up valuable time and resources. With Maxim's re-engineered EE-Sim DC-DC Converter tool, power designers can create and simulate complex circuits with more confidence. Novices can create designs in just a few minutes, while experts wield a high degree of control over simulation parameters and visualizations with the user-friendly EE-Sim DC-DC Converter tool.

"With Maxim's EE-Sim DC-DC Converter tool, it's easy to create and simulate circuits online by simply populating some basic design requirements—once generated, components can easily be swapped out to suit your needs," said Ross Murgatroyd, Global Senior Product Manager at Premier Farnell. "This kind of robust DC-DC Converter design and simulation tool will be invaluable for engineers in helping them speed time to market," said Raymond Yin, Director of Technical Content for Mouser Electronics. "Saving time and resources is key and Maxim's EE-Sim DC-DC Converter tool offers many great features for power design."

www.maximintegrated.com

Industry's First 15A, 42V Analog Power Module

Intersil, a subsidiary of Renesas Electronics Corporation (TSE: 6723), announced the first 42V single-channel DC/DC step-down power module that delivers up to 15A of continuous current. The ISL8215M operates from a single wide input voltage range that includes industry standard 12V, 18V, and 24V intermediate bus power rails. The module offers adjustable output voltages from 0.6V to 12V, and provides the highest power density of 60mA/mm2 in a 13mm x 19mm package. Its 96.5% peak efficiency drives point-of-load (POL) conversions for FPGAs, DSPs and MCUs in industrial, medical, RF communications, after-market automotive, and portable equipment that use Li-ion batteries.



The ISL8215M is a complete DC-to-DC power supply that includes a controller, MOSFETs, inductor and passive components inside a single encapsulated package to simplify system design and speed time to market. The module's proprietary High Density Array (HDA) package offers unmatched electrical and thermal performance through a single-layer conductive package substrate that reduces lead inductance and dissipates heat primarily through the system board. The ISL8215M's components are mounted to a copper lead-frame structure that allows the module to operate at full load over a wide temperature range with no airflow or heatsinks, further reducing size and cost.

www.intersil.com/products/isl8215m

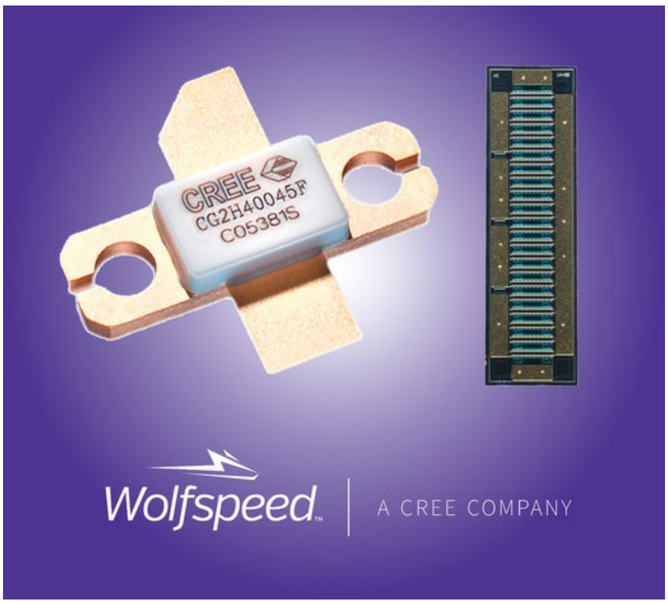
Conductive Polymer Aluminium Solid Capacitors

Panasonic Automotive & Industrial Systems Europe recently announced a series of eight new conductive polymer aluminium solid capacitors with super high voltage capabilities of up to 100VDC max for industrial, digitalisation, control system, noise filtering, and power supply applications. The products benefit from low ESR values and high ripple current and offer very stable characteristics.

Both radial lead type SXE series components and surface mount type SXV series products are fully REACH and RoHS compliant as well as halogen-free. The components have been designed for an operating temperature range from -55°C up to +125°C, benefit from a voltage range from 63VDC up to 100VDC, a rated capacitance range of 6.8µF up to 68µF, and a capacitance tolerance of ±20% (120Hz / +20°C). The endurance is up to 1000h at +125°C.
https://na.industrial.panasonic.com/whats-new/sxe-series-and-sxv-series-os-con%E2%84%A2-conductive-aluminum-polymer-solid-capacitors

https://na.industrial.panasonic.com/

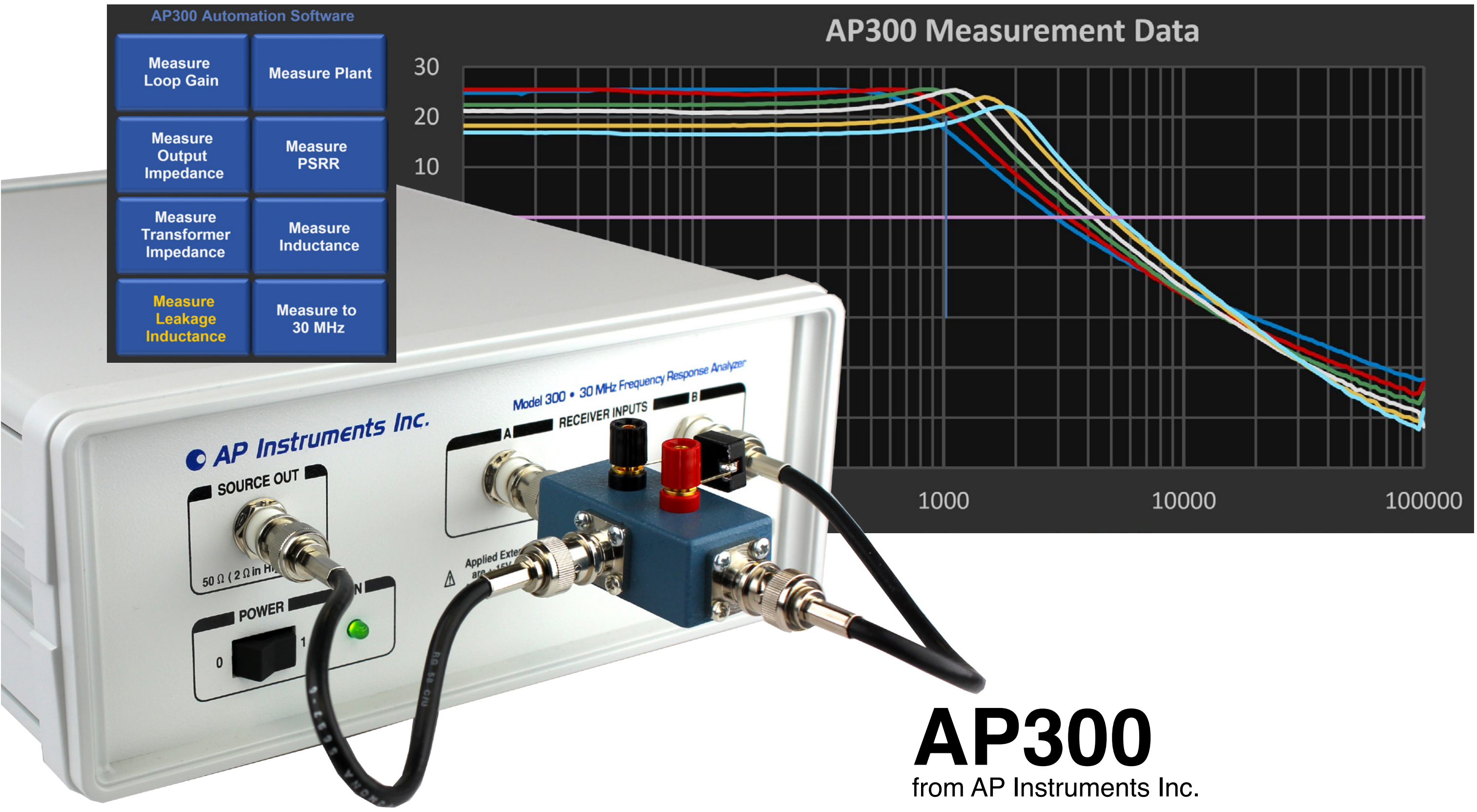
Next Generation GaN HEMTs Deliver Unmatched Efficiency



Wolfspeed, A Cree Company and a leading global supplier of GaN-on-SiC high electron mobility transistors (HEMTs) and monolithic microwave integrated circuits (MMICs), has introduced a new series of 28V GaN HEMT RF power devices. These new devices are capable of higher frequency operation to 8GHz with increased efficiency and higher gain as well as best-in-class reliability. RF design engineers are now able to build more efficient broadband power amplifiers for commercial and military wireless communications and radar applications.

The new 28V GaN HEMT devices are developed using Wolfspeed's proven 0.25µm GaN-on-SiC process, and are designed with the same package footprint as the previous generation of 0.4µm devices, making it possible for RF design engineers to use them as drop-in replacements for the earlier devices in existing designs. Available as both packaged devices (CG2H400 Series) and bare die (CG2H800 Series), the new GaN HEMTs deliver 33% higher frequency operation to 8GHz (from 6GHz), an additional 1.5-2.0dB of gain, as well as a 5-10% boost in operating efficiency compared to Wolfspeed's earlier generation devices.

www.wolfspeed.com/rf



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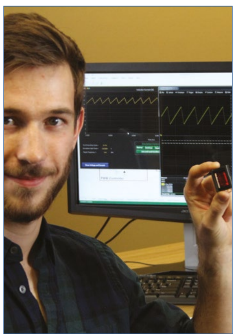

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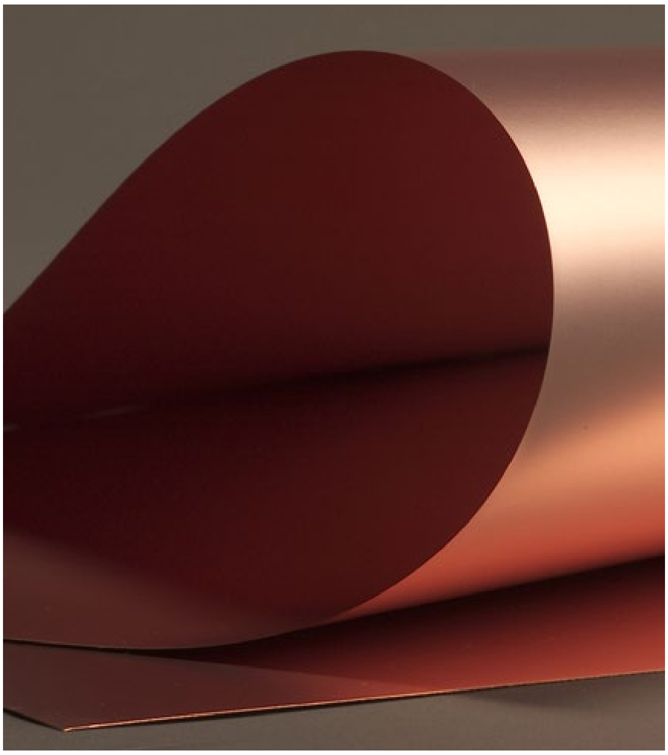
CLTE-MW™ Laminates for 5G and other Millimeter Wave Applications

Rogers Corporation (NYSE:ROG) is pleased to introduce CLTE-MW™ laminates. These laminates are ceramic filled, woven glass reinforced PTFE composites. CLTE-MW laminates were developed to provide a cost effective, high performance material for the circuit designer. This unique laminate system is well suited for applications that have limitations in thickness due to either physical or electrical constraints.

The seven available thickness options from 3 mils to 10 mils ensure that ideal signal to ground spacing exists for today's 5G and other millimeter wave designs. In addition, a variety of copper foil options are available including rolled, reverse treated ED, and standard ED. Resistive foil and metal plate options are also available upon request. CLTE-MW laminates are reinforced with spread glass, which along with a high filler loading help minimize the high frequency glass weave effects on electromagnetic wave propagation. Their woven glass reinforcement also provides excellent dimensional stability. Other key features of the laminate include low z-axis CTE (30ppm/°C) for excellent plated through hole reliability, a low loss tangent of 0.0015 at 10 GHz to enable low loss designs, and low moisture absorption of 0.03% to ensure stable performance in a range of operating environments.

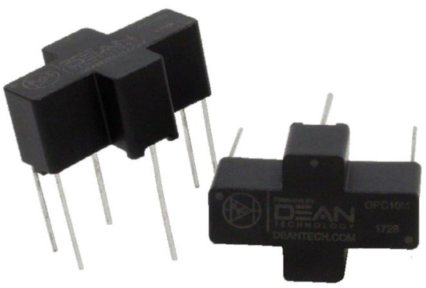
www.rogerscorp.com



OPC10M – Optocoupler / Optical Switch

Dean Technology, Inc., announced the introduction of a high voltage optocoupler, the OPC10M. This 10 kV optical switch is able to variably control a high voltage output up to 10,000 volts by adjusting a reference low voltage input, and is the first product in a set of optical devices that DTI will be introducing in its HVCA line of products over the coming months.

Dean Technology's optical switch products consist of a central diode and two or more LED drivers in a fully encapsulated and light-tight package. It is exceptionally space efficient, and the tight control of production methods will allow DTI to offer these parts at prices far better than competitive solutions.



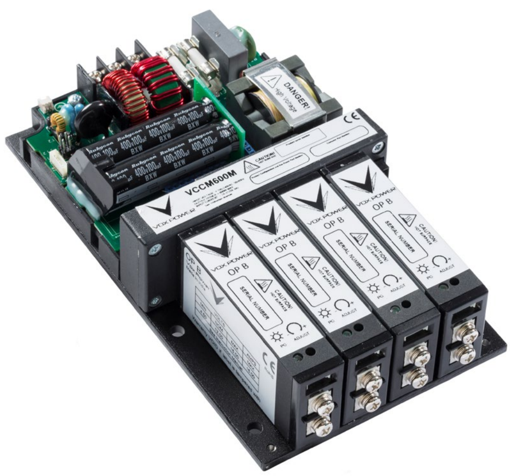
"We're starting off our optical switch line with a 10 kV part that should provide a perfect solution for many of the applications where this kind of device can be used," said Lynn Roszel, Engineering Manager for Dean Technology. "For a long time, we've built custom solutions for customers using this technology and we've put all of that learning into the OPC10M. It is a very useful and stable optical switch that we're very excited to have gotten into production."

Dean Technology intends to release a wide range of new optical devices, starting with the OPC10M. A range of optical switches with higher voltages and power levels is planned, and a full line of optical diodes with clear encapsulation is already in the works. Custom parts for both of these types of products are being produced now and DTI has engineering resources ready to help with custom development for any customer's needs. Full product details for the OPC10M, with example test circuits, are on the company's website and the part is in stock and ready for purchase directly from Dean Technology or through any approved sales channel.

www.deantechnology.com

World's First Conduction Cooled Modular Power Platform

Vox Power Ltd., announces the release of their VCCM600 series of conduction, convection or forced air cooled configurable power platforms. The new VCCM600 series, released by the designers oft he world's smallest configurable power solutions, offers customers 600 watts of conduction cooled power with up to 750 watts of peak power in a small 177.8mm x 101.6mm x 40mm (7 x 4 x 1.61 Inches) footprint.



Each configured VCCM600 conduction cooled solution can consist of up to 4 isolated 150 Watt DC output modules, which can be serially or parallel connected to scale the output voltage and current as required. In 2017 the range of outputs will be extended to include a series of digitally controlled, high power single output modules. Those will enable customers and channels to create multiple output or high power single output conduction cooled solutions within a few minutes.

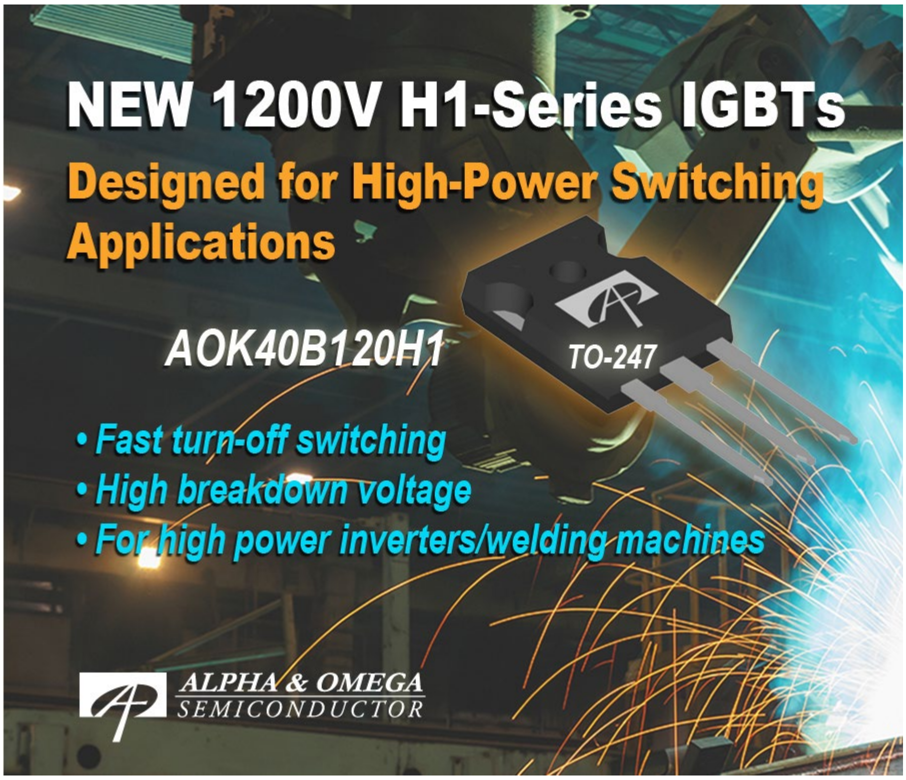
www.vox-power.com

1200V, 40A H1 IGBT for High Switching Applications

Alpha and Omega Semiconductor Limited (AOS), a designer, developer and global supplier of a broad range of power semiconductors and power ICs, is expanding its recently launched fast turn-off switched 650V H-series IGBT family with a 1200V rating. The new AOK40B120H1 has been developed to address needs of industrial welding and high-frequency converters with 3-phase ac or high voltage dc input. The device offers excellent performance in high switching frequency applications, which can be a perfect fit for high voltage industrial welding machines.

The AOK40B120H1 has been designed with AOS' patent pending AlphaIGBT™ technology platform and features industry-leading fast turn-off as well as low VCE(SAT) of 1.8V, which reduces power losses incurred during conduction and switching. Also, the 1200V minimum BVCES rating and high latch-up ruggedness enable a larger safety application design.

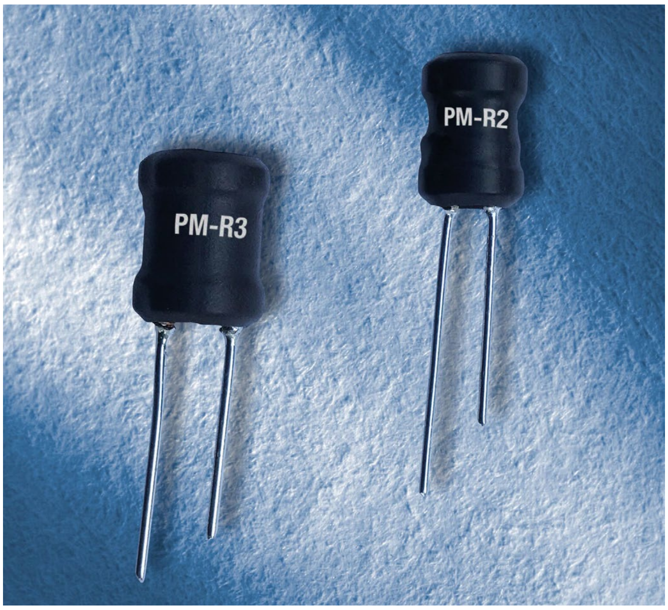
www.aosmd.com



Drum Cores for EMI Filtering and Switch Mode Power Supplies

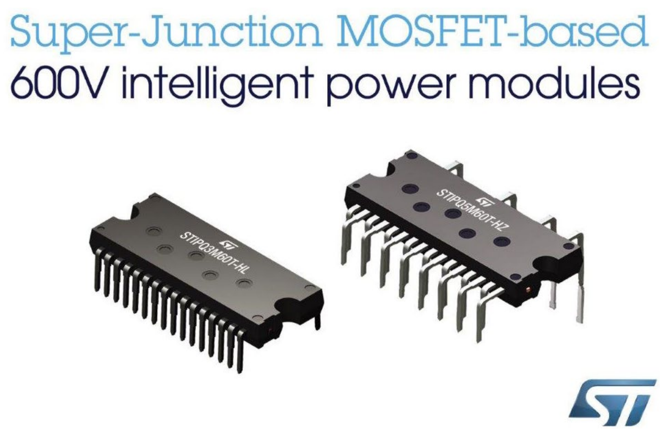
Premier Magnetics, global producer of high-quality magnetic components, introduces its new line of low-cost, high-performance drum core inductors designed for EMI filtering and switch mode power supply applications. With a product offering of over two dozen models with inductance values from 100 to 10,000 µH, the new PM-R Series boasts low dc resistance (DCR), providing low temperature rise at high peak currents. Their combination of high peak current and high self-resonant frequency (SRF) make the PM-R Series inductors an ideal drop-in replacement for lower-performing drum core devices. And in applications where the devices' maximum height of 10.0 to11.5 mm is acceptable, the PM-R Series offers a cost-effective alternative to surface-mount inductors.
Premier Magnetics' PM-R drum core inductors are offered in two series, PM-R2 (7.5 mm, dia. x 10.0 high, max) and PM-R3 (9.5 mm, dia. x 11.5 high, max), each offering models with a range of 100 µH to10 mH. Both series of inductors are available with sleeving (+125°C); and without sleeving (+155°C). Standard operating temperature range is -40C to 130C, with higher temperatures available. The radial-leaded components are RoHS compliant.

www.premiermag.com



600 V Super-Junction MOSFET-based IPMs

ST has extended its portfolio of intelligent power modules with the introduction of the second series of SLLIMM-nano devices based on super-junction MOSFETs (5 A and 3 A current rating at 25 °C, with 600 V breakdown voltage).
ST's SLLIMM™ family of small low-loss intelligent molded modules enhances the efficiency of home appliance motor drives working up to 20 kHz in hard-switching circuitries and of applications with a power range up to 3 kW.



ST's intelligent power modules (IPMs) provide a direct connection between a low-voltage microcontroller and a mains-powered electric motor. They greatly reduce costs by simplifying design and significantly reducing component count while saving space, improving reliability and lowering EMI.
Available in different package options (fully molded and DBC) , lead options (through-hole and SMD), discrete technologies (IGBT and MOSFET), current ratings and driving options, they feature the best compromise between conduction and switching losses for high efficiency, along with outstanding robustness and EMI behavior.
The low MOSFET on-resistance (1.0 Ω or 1.6 Ω max, in 5 A and 3 A variants, respectively), combined with low capacitances and gate charge minimize both conduction and switching losses, enhancing the efficiency of compressors, pumps, fans and any low-power motor working up to 20 kHz in hard-switching circuitries for an application range up to 300 W. The devices are available in both zig-zag lead and line-lead form giving designers extra design flexibility.

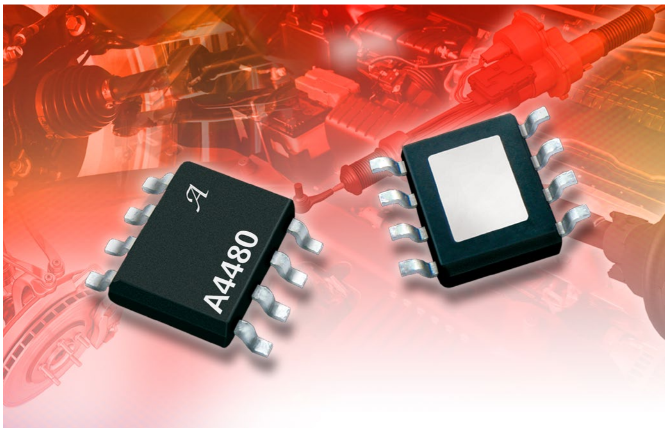
www.st.com/ipm

Introduction of the IXRFD615 Ultrafast RF MOSFET Driver

IIXYS Corporation announced the introduction of the IXRFD615 ultrafast low-side RF MOSFET gate driver by its IXYS Colorado division. The IXRFD615 is a CMOS high-speed, high-current gate driver specifically designed to drive MOSFETs in Class D and E RF applications as well as other applications requiring ultrafast rise and fall times or short minimum pulse widths.
The IXRFD615 can source and sink 15 Amperes of peak current while producing voltage rise and fall times of less than 5 nanoseconds and minimum pulse widths of 8 nanoseconds. The input of the driver is compatible with TTL or CMOS and is fully immune to latch up over the entire operating range.
The IXRFD615 is packaged in a low-inductance surface mount RF package incorporating advanced layout techniques to minimize stray lead inductances for optimum switching performance.
Designed with small internal delays, cross conduction or current shoot-through is virtually eliminated. The features and wide safety margin in operating voltage and power make the IXRFD615 unmatched in performance and value.

www.ixyscolorado.com

Wide Input Voltage Inductorless Buck-Boost Regulator



Allegro MicroSystems Europe has announced the release of a new wide input 5 V output regulator designed to power automotive sensors and low power uControllers. It can also be used for non-automotive applications where the input voltage could be above or below 5 V. Allegro's A4480 incorporates a unique multi-mode charge pump pre-regulator, followed by a 5V LDO. This enables operation with input voltages from 3.5 to 28 V (with 40V protection), while maintaining a 5 V output voltage. Compared to traditional LDO solutions, the efficiency across input range is improved, and VIN < VOUT operation is enabled. Furthermore, as opposed to traditional switching solutions no inductor, diode, or external switching element is required in this simple, low component-count optimised solution.

www.allegromicro.com

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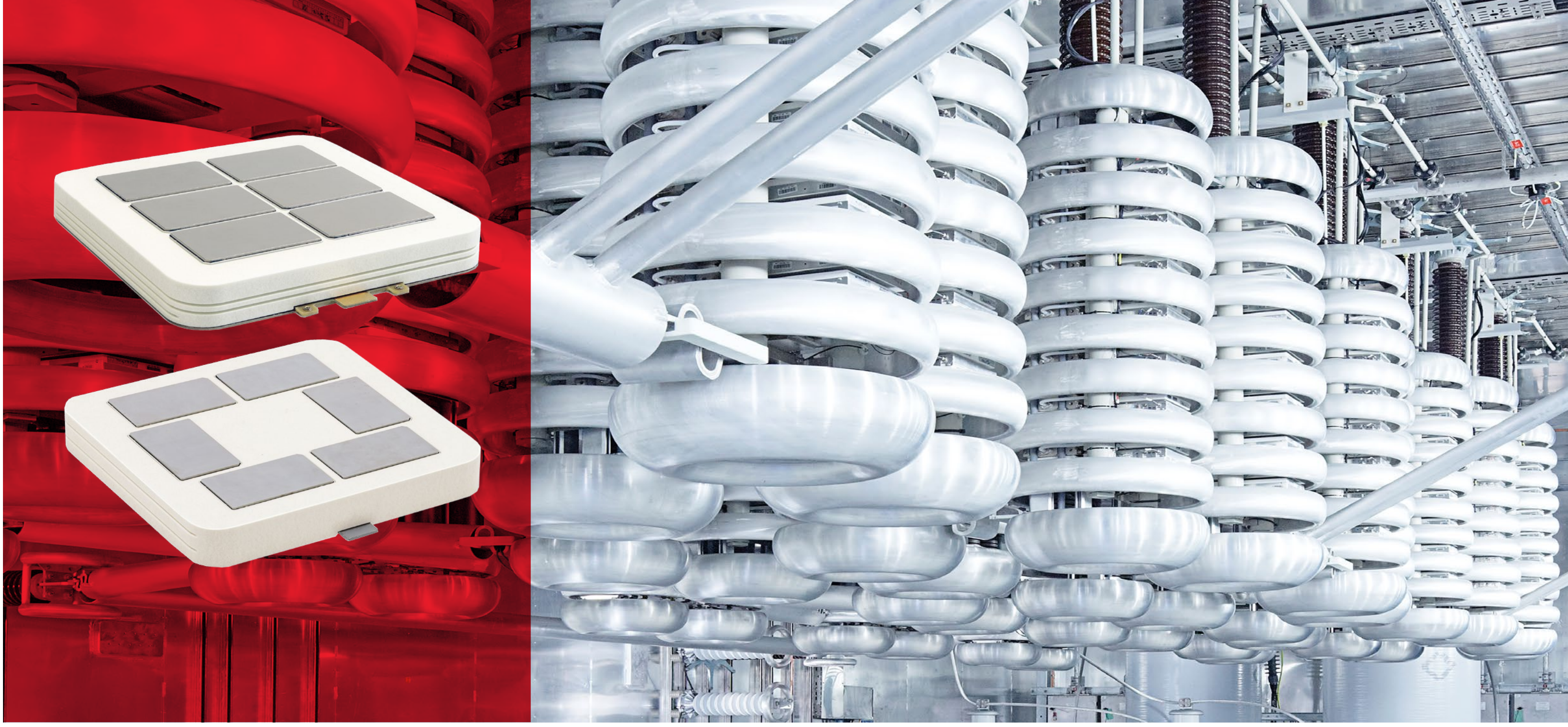

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