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Bodo´s Power Systems®

Electronics in Motion and Conversion

November 2019

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The Gallery

Happy with **MLCC Downsizing?**

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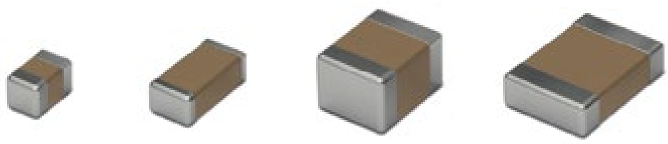
MLCC

Würth Elektronik offers a large portfolio of MLCC sizes up to 2220. While downsizing might be the right choice for some applications, others require larger sizes of MLCCs for keeping the required electrical performance, volumetric capacitance and DC bias behavior. Long term availability ex stock. High quality samples free of charge make Würth Elektronik the perfect long-term partner for your MLCC demands.

For further information, please visit: **www.we-online.com/mlcc**

- Large portfolio from 0402 up to 2220
- Long term availability
- Detailed datasheets with all relevant measurements and product data
- Sophisticated simulations available in online platform **REDEXPERT**



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Traveling by Train

The season of conferences and shows has already begun. I took the auto train to Verona, then drove to Genoa, Italy for EPE ECCE in September. On the way back North, I stopped at Leti, in Grenoble. Here, important work on GaN is carried out and future semiconductors that will operate more efficiently in power electronic systems. Finally, I visited customers in France and Switzerland and arrived home with my car from Lörrach, Germany – again in an auto train. Sleeping overnight is a good way to travel home.

Traveling throughout Europe this year, I recognized that cities such as Genoa, Grenoble, Bern, Zurich, Luzern, Oslo and Bergen are all good examples of where streetcars and trolley busses are used for highly efficient public transportation. Variable speed electric drives make trolley busses and street cars efficient. And wide band gap devices for the next generation's inverter technology will reduce losses even more. SiC devices are taking over at this point from the silicon IGBTs that have been the workhorses for about three decades.

As engineers, we have to work to keep our world attractive for the next generations. Greta and all the young people are right to alert us to stop global warming. Using trains and reducing unnecessary travel will help stop the process.

In December our third Wide Band Gap Conference will take place in Munich, again in cooperation with AspenCore. The program is finalized, and we will see some of the most important leaders in power electronics talking about their progress with these materials. There is still an opportunity to participate as an exhibitor at the tabletop. Our AspenCore friends in Munich will arrange it. If you're interested, just contact us and we will be very happy to forward your request to the

right person ! A high-quality audience is guaranteed. Beside the presentations and the tabletop, the networking will be of great value. Visit www.power-conference.com to book your ticket now. I am looking forward to seeing you in Munich and chatting about your progress.

Bodo's magazine is delivered by postal service to all places in the world. It is the only magazine that spreads technical information on power electronics globally. We have EETech as a partner serving North America efficiently. If you are using any kind of tablet or smart phone, you will find all of our content on the 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 the Month:
Use the train for travel - it is much better for the environment than a flight or a car.

I did and was relaxed, travelling to Italy to the EPE ECCE Conference.

Best Regards

Events

productronica 2019
Munich, Germany, November 12-15
www.productronica.com

SEMICON Europa 2019
Munich, Germany, November 12-15
www.semiconeuropa.org

Thermal Management Innovation 2019
Detroit, MI, USA, November 13-14
www.battery-thermal-management-usa.com

SemIsrael 2019
Tel Aviv, Israel, November 19
www.semisrael-expo.com

SPS 2019
Nuremberg, Germany, November 26-28
www.mesago.de/en/SPS

Intersolar India 2019
Bangalore, India, November 27-29
www.intersolar.in

Power Electronics Conference 2019
Munich, Germany, December 3
www.power-conference.com

Electric Drives E / DPC 2019
Esslingen, Germany, December 3-4
www.edpc.eu

IEEE IEDM 2019
San Francisco, CA, USA, December 7-11
www.ieee-iedm.org

LXS, LXSR, LES, LESR, LKSR, LPSR series

New closed-loop current transducers, based on a custom Hall Effect LEM ASIC, perform at the level of fluxgate transducers, achieving the highest levels of quality and traceability using advanced manufacturing techniques. Offset drift is over four times lower than the previous generation of closed-loop transducers based on Hall cells and very similar to those using fluxgate. There are 6 families and 22 models available with various options, such as an integrated reference (V_{REF}), footprint (3 or 4 primary pins with different layouts), with an aperture and/or with integrated primary conductors and overcurrent detection.

www.lem.com

- **1.5 to 50 A nominal current**
- **PCB mounting**
- **Low offset drift (3 – 14 ppm/°C)**
- **Overcurrent detection output (LPSR models)**
- **-40 to +105°C operation**
- **100 % compatible with previous LEM generation**
- **Multi-range configuration**

LEM

Life Energy Motion

Katja Stolle Takes Over as Exhibition Director

electronica trade fair and conference have a new Exhibition Director. Katja Stolle, who has been with Messe München over 13 years, is now leading the project team. The next electronica will be held in Munich from November 10 to 13, 2020. Katja joined Messe München in 2006 after earning a degree in humanities.
In 2012, she took over the exhibition management of analytica – the leading international trade fair for laboratory technology, analysis and biotechnology. Over the past six years, she has led the LASER World of PHOTONICS and the World of Photonics Congress. She was primarily responsible for the strategic and conceptual enhancement of the world's leading trade fair for photonic components, systems and applications.
Katja Stolle reports to Ms. Barbara Müller, who will continue to oversee the global electronic network at Messe München in her position as Exhibition Group Director. The new position represents both a challenge and motivation for Katja: "electronica is without a doubt the world's most important meeting place for the electronics industry. For this reason, I am really excited about the opportunity to enhance the event with the help of my team and expand the internationally leading role that electronica plays."

https://electronica.de

Power Electronics for Renault-Nissan-Mitsubishi

STMicroelectronics has been chosen to supply high-efficiency silicon-carbide (SiC) power electronics by Renault-Nissan-Mitsubishi (Alliance) for advanced on-board chargers (OBCs) in its upcoming electric vehicles. Renault-Nissan-Mitsubishi plans to use the SiC power technology to build more efficient and compact high-power OBCs that will further increase attractiveness of electric vehicles for the users by cutting battery-charging time and enhancing driving range. As Renault-Nissan-Mitsubishi's chosen partner for advanced SiC technology, ST will provide design-in support to help maximize OBC performance and reliability.

ST is also to supply Renault-Nissan-Mitsubishi with associated components, including standard silicon devices. The OBCs with ST's SiC are scheduled to enter volume production in 2021.
Marco Cassis, President, Sales, Marketing, Communications and Strategy Development, STMicroelectronics, said, "SiC technology can help the world by reducing dependence on fossil fuels and increasing energy efficiency. ST has successfully developed manufacturing processes and established a portfolio of qualified, commercialized SiC products also in automotive-grade version. Building on our long cooperation, we are now working with Renault-Nissan-Mitsubishi to realize the many advantages SiC can bring to EVs. Moreover, this commitment helps ensure success by increasing the economies of scale to deliver superior-performing SiC-based circuits and systems that are also cost-effective and affordable."

www.st.com

The 30th SPS

Despite the challenging economic climate ahead of the SPS anniversary exhibition, the outlook for the trade show is once again very positive and testifies to the importance of the exhibition for smart and digital automation. Some 1,650 automation technology providers from all over the world are expected as exhibitors in Nuremberg from 26 – 28 November 2019. The exhibition will showcase current products and solutions in industrial automation as well as trend-setting technologies of the future.

Exhibition visitors will benefit from the wide range of products and services offered by national and international automation and digitalization providers, and within one day will still be able to gain a complete overview of the market. This explains why 71% of the visitors recorded by exhibition organizer Mesago to the automation trade show are day-visitors. 7% of visitors conduct their technology research over the full three days of the event. Last year, 27.6% (18,154) of the visitors came from outside of Germany. 47,546 of the previous year's visitors came from within the country.
Digitization is having a major impact on the automation industry. Exhibitors will therefore present not only their solutions, but also various products and example applications for digital transformation at the event. IT providers are also increasingly represented at the SPS.

https://sps.mesago.com

Among the Top Sustainable Companies

Infineon Technologies has been again listed in the Dow Jones Sustainability™ World Index. Thus it belongs to the top of the world's most sustainable companies. Out of 47 companies assessed in the semiconductor sector Infineon is part of the six companies included in the World index. This was announced by the Sustainability Investing specialist RobecoSAM.

"It fills us with pride that Infineon has been listed in the Dow Jones Sustainability Index for the tenth time in a row and belongs to the most sustainable companies in the world", says Dr. Sven Schneider, Chief Financial Officer of Infineon. "To be successful in the long run, business excellence has to go hand in hand with strong environmental and social performance. With its innovative solutions Infineon helps to make more out of less and thus actively contributes to address global challenges like climate change."

Created jointly by S&P Dow Jones Indices and RobecoSAM, the DJSI selects the most sustainable companies from across 61 industries. The indices serve as best-in-class benchmarks for investors who integrate sustainability considerations into their portfolios.

Infineon puts a lot of effort into resource-efficient manufacturing globally. Over and above this, the company's sustainable products and solutions enable throughout their lifetimes the reduction of CO_2 emissions by some 56 million tonnes of CO_2 equivalents. This roughly corresponds to the yearly electricity consumption of around 86 million Europeans.

www.infineon.com

Improved Performance of 5G Devices

As 5G devices are entering the market, the industry is looking for further improvements for future device generations. Heraeus' 5G solution portfolio will enable customers to not only reduce costs, but also to improve performance and quality of 5G. Heraeus has identified four top challenges which require innovative solutions:

- Challenge #1: Electromagnetic interference (EMI)
  Heraeus has developed a one-stop-shop solution based on a specially formulated, particle-free silver ink, an ink-jet printer and curing equipment.
- Challenge #2: Miniaturization
  Welco Solder Paste offers superior fine pitch printing performance due to its excellent rheological properties and thus enables smaller consumer devices – including 5G mobile phones.
- Challenge #3: Cost pressure
  AgCoat Prime – a gold coated silver wire – offers a real alternative to gold wire for the memory device packaging in 5G technology.
- Challenge #4: High temperatures
  Classical soldering processes reach their limits with these requirements. An alternative is sintering. Heraeus' mAgic silver sinter pastes increase the lifetime of devices up to ten times.

www.heraeus.com

SiC Device Manufacturing Facility

Cree, Inc. announced plans to establish a silicon carbide corridor on the East Coast of the United States with the creation of the world's largest silicon carbide fabrication facility. The company will build a state-of-the-art, automotive-qualified 200mm power and RF wafer fabrication facility in Marcy, New York, complemented by its mega materials factory expansion currently underway at its Durham headquarters. The fabrication facility, part of a previously announced project to dramatically increase capacity for its Wolfspeed silicon carbide and GaN business, will be a bigger, highly-automated factory with greater output capability. Through a strategic partnership with the office of Governor Andrew M. Cuomo and other state and local agencies and entities, the decision to build in New York will allow for both continued future expansion of capacity and significant net cost savings for Cree. As a result, Cree will continue to drive the transition from silicon to silicon carbide technology to meet the increasing demand for the company's groundbreaking Wolfspeed technology that supports the growing electric vehicle (EV), 4G/5G mobile and industrial markets.

"Silicon carbide is one of the most pivotal technologies of our time, and is at the heart of enabling innovation across a wide range of today's most groundbreaking and revolutionary markets, including the transition from the internal combustion engine to electric vehicles and the rollout of ultra-fast 5G networks," said Gregg Lowe, CEO of Cree.

www.cree.com


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performance is mandatory.
Lunch time?
Scan for short documentary.
… or work time?
Scan for product.
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email pdd@hitachi-eu.com +44 1628 585151

Key to Success of Digital Companies

Alexander Gerfer, CTO of the Würth Elektronik eiSos Group, at one of the most important digital future conferences worldwide, the DLD Tel Aviv, emphasized in his opening speech "when technology meets customer" design support of hardware and the availability of components

can decide on the failure or success of innovation. In his speech, Gerfer stressed the importance of an innovative hardware partner for the success of digital companies: "Würth Elektronik is not just a hardware supplier, we rather see ourselves as our customers' real partner. We know them and their needs thoroughly and focus our product development on them. 'Can't' is not part of our vocabulary. If there is still no solution to a particular challenge, then we'll invent one. This is the reason why Würth Elektronik, as an innovative technology company, is behind many successes, albeit invisibly ... the 'secret ingredient of industry' as it were. There are plenty of examples of customer-driven innovations from Würth Elektronik, including REDEXPERT, an online platform developed in-house that has become known worldwide as the most precise option for AC loss calculation in switch mode power supplies.
Another area to improve the CO2 footprint is 'Horticulture Farming'. Through its cooperation with the Technical University of Munich, Würth Elektronik supports users with practice-relevant data for the selection of the best Horticulture LEDs, adapted to the respective plant species.

www.we-online.com

PSMA Report Addresses Reliability of Power Supply

The Power Sources Manufacturers Association (PSMA) announces publication of its Power Supply Software/Firmware Reliability Improvement Report. This report, the result of a year-long project undertaken by PSMA's Reliability Technical Committee, addresses recommended reliability improvements for power supply digital control software and firmware. This report attempts to present key findings related to the challenges of and solutions to reliability in the digital control of power electronics.
"This is the first report from the work of PSMA's newest committee, which aims to spearhead industry initiatives that identify and attempt to address the pertinent industry challenges related to the reliability performance of power supplies and associated products," noted Brian Zahnstecher, Co-Chair of the PSMA Reliability Committee.

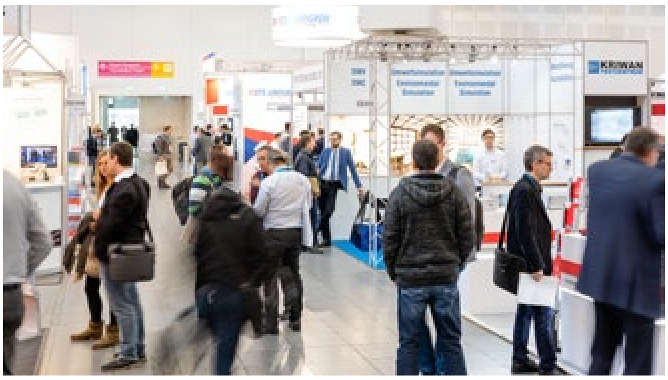
Tony O'Brien, Reliability Committee Co-Chair, added "Moving from power electronics with analog control to power electronics with digital control is a significant transition. Software engineering best practices are being adopted for digital power electronics control for power supplies to ensure that reliability does not suffer with the transition to digital control. Some of the best practices are relatively new, evolving and unfamiliar to the power electronics world"
This 166-page report, divided into nine chapters, examines a wide array of problems and challenges in the field of digitally controlled power supplies, then proceeds to present observed and proposed improvements and best practices.

www.psma.com

EMV 2020 in Cologne

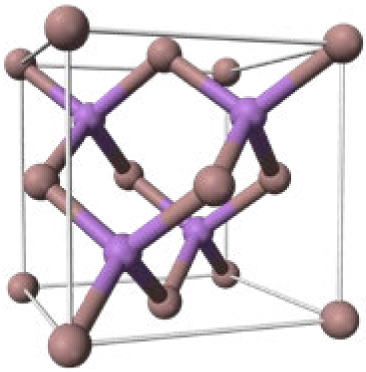
Numerous companies will present their products and services in the field of electromagnetic compatibility at the EMV, which will take place in Cologne from 17 - 19 March 2020. The exhibition and conference are ideal platforms for product developers, users and scientists to network and exchange information on the latest developments in the industry. As from 2020, the EMV with its conference, which previously took place every two years in Dusseldorf will be held in Cologne. The Koelnmesse exhibition grounds will be hosting the event in hall 10.2 and the adjacent Congress Centre East, where all participants will benefit from ideal transport links, a restaurant integrated into the hall and short distances between the conference and the trade fair.

https://emv.mesago.com



High-Performance GaAs Semiconductors

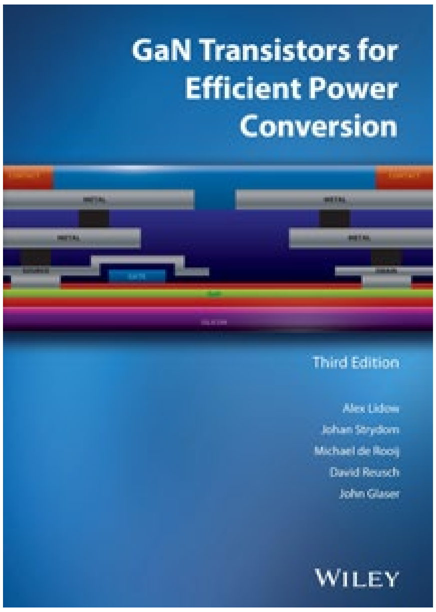
High-performance gallium arsenide (GaAs) based electronics have the potential to help new technologies achieve breakthrough. A study at the Karlsruhe Institute of Technology (KIT) of the development of ultra-fast charging stations for electric vehicles has demonstrated that GaAs diodes from 3-5 Power Electronics GmbH (35PE) Dresden can deliver promising results. "The trials showed that circuits can be laid out much more efficiently than with silicon-carbide-based (SiC) products and that there are close to zero losses," report 35PE Managing Directors Dr. Gerhard Bolenz and Dr. Volker Dudek. A followup project is subjecting the GaAs diodes to practical testing with a charging station manufacturer and a further research partner. These high-performance semiconductors, which operate almost without current or voltage, represent 35PE's first new product family since the start of production in spring 2018. "These 'soft switching' applications are particularly suitable for use in electric mobility and industrial electronics, such as plasma welding. The first samples are already being tested with potential customers in Europe and Asia," explain the managing directors. The product family, which was originally designed for diodes in the 600 volt and 1200 volt range, is being expanded to include the 400 volt range due to demand. The engineers are also working on high-performance semiconductors for hard switching applications. In addition to the automotive and industrial sectors, this will appeal to customers in the renewable energy industry.



www.3-5pe.com

3rd Edition of Gallium Nitride Textbook

Efficient Power Conversion Corporation (EPC) announce the publication of the third edition of "GaN Transistors for Efficient Power Conversion," a textbook written by power conversion industry experts and published by John Wiley and Sons.
This textbook is designed to provide power system design engineering students, as well as practicing engineers, basic technical and application-focused information on how to design more efficient power conversion systems using gallium nitride-based transistors. Gallium nitride (GaN) is leading edge technology that is displacing the venerable silicon MOSFET in power conversion applications. As silicon approaches its performance limits, GaN devices offer superior conductivity and switching characteristics, allowing designers to greatly increase efficiency, and reduce size, weight, and cost.



This timely third edition has been substantially expanded to keep students and practicing power conversion engineers ahead of the learning curve in GaN technology advancements and emerging applications. This book serves as a practical guide for understanding basic GaN transistor construction, characteristics, and a wide range of applications.
Included are
Discussions on the fundamental physics of these power semiconductors
Practical guidance on layout and other circuit design considerations
Application examples employing GaN including lidar for autonomous vehicles, DC-DC power conversion, RF envelope tracking used in 5G communication networks, wireless power, class-D audio, and high radiation environments.

www.epc-co.com

SMSI Call for Papers

The AMA Association for Sensors and Measurement is commencing a Call for Papers for the Sensor and Measurement Science International 2020 (SMSI). This international conference is going to take place parallel to the SENSOR+TEST 2020 trade fair from 22 to 25 June 2020 in Nuremberg, Germany. The submission deadline for contributions and poster presentations is 31 January 2020.
The new conference replaces the previous AMA conferences as of 2020. The former thematic focus on sensors and instrumentation will be complemented in the new format by measuring technology and metrology. The SMSI 2020 links national and international representatives from research, science, and industry. One pillar of the conference, sensor technology, will deal with sensor principles, materials, technology, and application and is to integrate the satellite conference IRS² 2020. Another pillar, measuring technology, is to include its technological foundations, advanced methods, networked systems, and new AI approaches in measuring. The area of metrology deals with

traceability, advanced calibration, and testing methods as well as with new measuring regulations and standards.
The parallel SENSOR+TEST 2020 trade fair, as an information platform for sensor, measuring, and testing technology, also serves to expand the innovation dialog among the conference participants beyond the SMSI 2020 itself.

www.ama-sensorik.de

One-Millionth GaN-Based IC

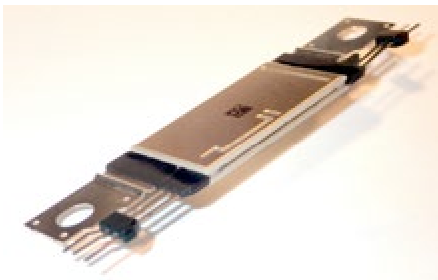
Power Integrations announced the delivery of its one-millionth InnoSwitch™3 switcher IC featuring the company's PowiGaN™ gallium-nitride technology. In an event at the Shenzhen headquarters of Anker Innovations, Power Integrations CEO Balu Balakrishnan presented the one-millionth GaN-based IC to Anker CEO Steven Yang. Anker is a leading manufacturer of chargers and adapters, supplying retailers worldwide with powerful, compact USB PD adapters and a wide range of chargers and adapters for laptops, smart mobile devices, set-top boxes, displays, appliances, networking gear and gaming products. InnoSwitch3 offline CV/CC flyback switcher ICs with PowiGaN technology are up to 95% efficient across the load range. Very low switching and conduction losses of PowiGaN primary switch allows delivery of as much as 100 W from a space saving InSOP 24D surface mount package in enclosed adapter applications without requiring a heatsink. Quasi-resonant InnoSwitch3-CP, InnoSwitch3-EP and InnoSwitch3-Pro ICs combine the primary power switch, primary and secondary control with safety isolated high speed link (FluxLink™) in between, as well as the secondary SR driver and feedback circuits in a single surface-mounted package. The superior switching performance of PowiGaN technology results in substantially higher efficiency, enabling very compact adapter designs.
Commented Mr. Balakrishnan: "Anker is a world leader in compact charger design, and was the first high-volume customer for Inno-

Switch3 products with PowiGaN. I'm pleased to recognize Anker's foresight and technical excellence, and to thank Mr. Yang for his critical contribution to the first successful mass-market deployment of high-voltage GaN technology."

www.power.com/PowiGaN

Partner for Automotive Silicon Carbide Devices

Delphi Technologies PLC and Cree, Inc. announce a partnership to utilize silicon carbide semiconductor device technology to enable faster, smaller, lighter and more powerful electronic systems for future electric vehicles (EV). Cree's silicon carbide-based MOSFET (metal–oxide–semiconductor field-effect transistor) technology coupled with Delphi Technologies' traction drive inverters, DC/DC converters and chargers will extend driving range and deliver faster charging times of EVs, while also lowering weight, conserving space and reducing cost. The Cree silicon carbide MOSFETs will initially be used in Delphi Technologies' 800 Volt inverters for a premium global automaker. Production will ramp in 2022.



"Delphi Technologies is committed to providing pioneering solutions to vehicle manufacturers," said Richard F. (Rick) Dauch, CEO of Delphi Technologies. "Our collaboration with Cree will create a significant benefit to automakers as they work to balance meeting stricter global emissions regulations with consumer appetite for electric vehicles. Overcoming driver anxiety related to electric vehicle range, charging times and cost will be a boon for the industry."
The adoption of silicon carbide-based power solutions is rapidly growing across the automotive market as the industry seeks to accelerate its move from internal combustion engines to EVs. IHS estimates that, by 2030, 30 million high voltage electrified light vehicles will be sold representing 27 percent of all vehicles sold annually. Inverters are one of the highest-value electrification components and their efficiency has an industry-changing impact on many aspects of vehicle performance.

www.delphi.com

ECPE Events

ECPE Tutorial 'Thermal Engineering of Power Electronic Systems
- Part II: Thermal Management and Reliability'
4 - 5 November 2019, Nuremberg, Germany

ECPE Tutorial 'Power Circuits for Clean Switching and Low Losses'
6 - 7 November 2019, Barcelona, Spain

ECPE Tutorial 'Power Semiconductor Devices & Technologies'
20 - 21 November 2019, Rüsselsheim (close to Frankfurt am Main), Germany

ECPE Workshop 'Power Semiconductors in Medium Voltage Applications - SiC vs. Silicon'
3 - 4 December 2019, Freiburg i.B., Germany

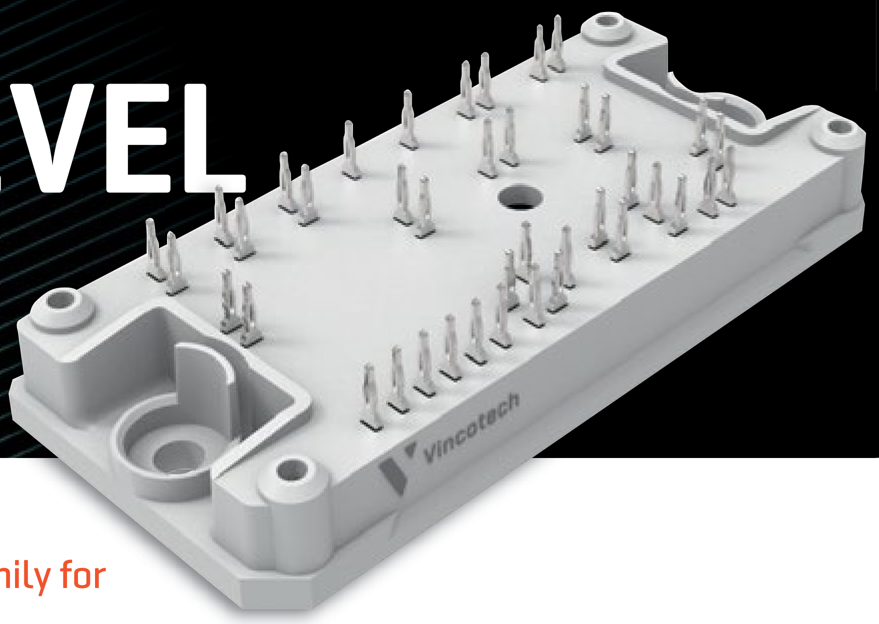
ECPE Workshop 'Power Semiconductor Robustness
- What Kills Power Devices?'
13 January (afternoon) - 14 January 2020, Munich, Germany

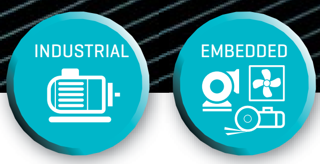
ECPE Workshop 'Magnetic Components in power Electronics'
- further information will be published soon
19 - 20 February 2020, Grenoble, France

www.ecpe.org/events

PERFORMANCE AND INTEGRATION AT THE NEXT LEVEL

Vincotech





New 600 V *flow*PIM 1 + PFC family for power ranges up to 8 kW

Heating pumps and HVAC systems show a high demand for more compact designs and increased power density. Vincotech's new 600 V PIM+PFC family based on the interleaved power factor correction concept (two-leg and three-leg) will ensure your designs easily meet these requirements while drastically improving efficiency and slashing system costs.

Main benefits

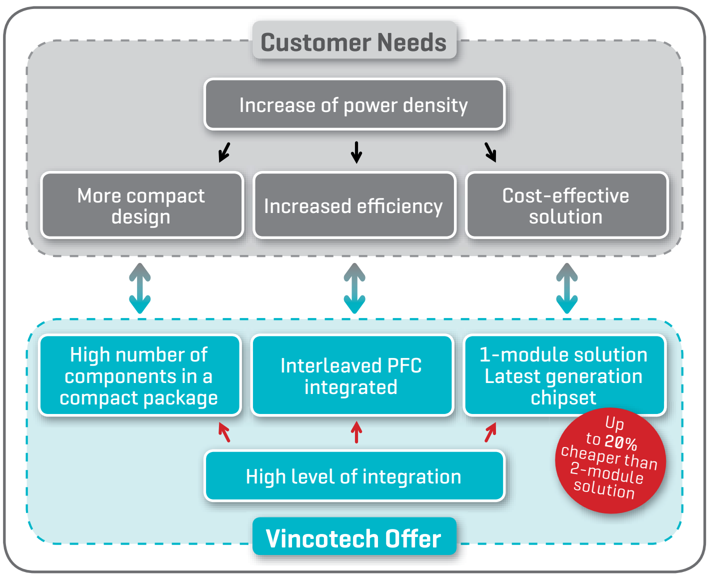
/ New generation 600 V IGBT drives down switching losses

/ Interleaved PFC featuring 650 V high-speed chips dramatically improve thermal performance while cutting costs

/ On-board capacitors and shunts make the PCB design even easier

/ Integrated thermal sensor simplifies temperature measurement

/ Various power module configurations address a wide range of system architectures



www.vincotech.com/*flow*PIM1

EMPOWERING **YOUR IDEAS**

Variable Step Down Micro Modules

The MagI³C-VDMM (Variable Step Down Micro Module) power module family from Würth Elektronik is supplemented by more powerful 1 A and 1.2 A versions. The input voltage range (from 2.5 to 5.5 V) covers the standard 3.3 and 5 V bus voltages, and the adjustable output voltage ranges from 0.8 to 5.5 V. The modules have been designed for high efficiency in the low load range. Integration of the DC-DC converter and coil makes for a very compact solution in an LGA-6EP package.

The MagI³C-VDMM series is particularly suitable as a replacement for linear regulators. Applications include the supply of interfaces, microcontrollers, microprocessors, DSPs and FPGAs. Thanks to their small size and high efficiency (over 96%), they are particularly suitable for use in mobile and battery-powered devices. To save energy, the VDMM can be "put to sleep" using an additional PIN, which extends battery life. The MagI³C VDMM series features excellent electromagnetic compatibility. The modules meet the CISP-32 standard for Class B radiated interference without additional filter elements. The new member of the MagI³C-VDMM family is available from stock. Free samples can be requested.

www.we-online.com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Ultra-low profile
2mm and 3mm thin
Near hermetic seal
No dry-out
Replaces banks of
solid tantalum capacitors
3,000 Hr. life at 85 °C
without voltage derating
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Device Family Reduces Standby Power

CAPZero-3 X-Capacitor Discharge ICs Meet IEC60335

By Roland R. Ackermann, Correspondent Editor Bodo´s Power Systems

Power Integrations announced CAPZero-3, the latest generation of the company's energy-saving X-capacitor discharge ICs. Two-terminal CAPZero-3 ICs (CAP300DG) enable designers to easily meet IEC60335 safety approvals for major appliances, and cover all capacitor values from 100nF to 6μF.

IEC60335 is the discharge safety standard for all appliances. To protect the user from an electrical hazard, it requires the voltage across the input X capacitor to discharge to less than 34 V within less than one second after the AC is removed. CAPZero-3 ICs block current flow through the X-capacitor discharge resistors when the AC voltage is connected, and automatically discharge X capacitors through those resistors when the AC is disconnected. CAPZero-3 ICs simplify EMI filter designs while permitting the use of larger X capacitors, which in turn enables smaller inductive components to be used with no resulting change in power consumption.

CAPZero-3 ICs can be placed before or after a system's input fuse. Devices deliver high common-mode surge immunity so that no external ground connection is necessary, and feature a high differential surge withstand due to 1000V internal MOSFETs. Creepage on the package and PCB is maintained at >4mm. Comments Edward Ong, product manager, Power Integrations: "With the launch of the new CAPZero-3 ICs, designers can use one part to address a large range of applications in small and major appliances that require X capacitor values from 100 nF to 6 μF."

CAPZero-3 devices are safety-certified to CB and Nemko requirements so developers do not need to perform a separate safety test on the X-capacitor discharge circuit of the power supply. Devices are available now, priced at $0.31 in 1,000 piece quantities.

Applications

- All AC-DC converters with X capacitors of 100nF up to 6μF
- Appliances requiring ErP Lot 6 compliance
- Adapters requiring ultra low no-load consumption
- All converters requiring very low standby power
- Lossless generation of zero crossing signal

Description

When AC voltage is applied, CAP300DG blocks current flow in the X capacitor safety discharge resistors, reducing the power loss to less than 5mW, or essentially zero at 230VAC. When AC voltage is disconnected, CAP300DG automatically discharges the X capacitor by connecting the series discharge resistors. This operation allows total flexibility in the choice of the X capacitor to optimize differential mode EMI filtering and reduce inductor costs, with no change in power consumption.

Designing with CAP300DG is simply a matter of selecting the appropriate external resistor values for the X capacitor value being used to achieve the necessary time constant. The simplicity and ruggedness of the two terminal CAP300DG IC makes it an ideal choice in systems designed to meet ErP Lot 6 requirements.

Safety

CAP300DG meets safety requirements even if placed before the system input fuse. If a short-circuit is placed between D1 and D2 terminals of CAP300DG, the system is identical to existing systems where CAP300DG is not used. With regard to open circuit tests, it is not possible to create a fault condition through a single pin fault (for example lifted pin test) since there are two pins connected to each of D1 and D2. If several pins are lifted to create an open circuit, the condition is identical to an open circuit X capacitor discharge resistor in existing systems where CAP300DG is not used. If redundancy against open circuit faults is required, two CAP300DG and R1/R2 configurations can be placed in parallel.

Discharge Operation

To meet the safety regulations of appliances, when the AC supply is disconnected, CAP300DG will discharge the X capacitor to <34V levels according to the above functional description.

Product Highlights

- Meets IEC 60335 X capacitor discharge of <34V in <1sec
- One part to cover X capacitor values from 100nF to 6μF
- Blocks current through X capacitor discharge resistors when AC voltage is connected
- Automatically discharges X capacitors through discharge resistors when AC is disconnected
- Simplifies EMI filter design – larger X capacitor allows smaller inductive components with no change in consumption
- Only two terminals – meets safety standards for use before or after system input fuse
- >4mm creepage on package and PCB
- Self supplied – no external bias required
- High common mode surge immunity – no external ground connection
- High differential surge withstand – 1000V internal MOSFETs
- NEMKO and CB certification pending.

EcoSmart – Energy Efficient

- <5mW consumption at 230VAC for all X capacitor values

www.power.com

Interview on Winning GaN Applications

Ahead of December's Power Conference in Munich, Bodo Arlt took the opportunity to get an insight into Alex Lidow's thoughts on where the GaN market is now and where he sees the potential applications for the future. Dr. Lidow is the CEO and Co-founder of Efficient Power Conversion (EPC).

By Bodo Arlt, Editor, Bodo's Power Systems

Bodo Arlt: Where is GaN winning business now? In which industries are seeing the most adoption?

Alex Lidow: EPC has been in production with GaN-on-Si for power conversion applications for 10 years. The success of these power transistors and integrated circuits initially came from the speed advantage of GaN compared with silicon. GaN-on-Si transistors switch about 10 times faster than MOSFETs and 100 times faster than IGBTs. Applications such as RF Envelope Tracking for 4G/LTE base stations and light detection and ranging (lidar) systems for autonomous cars, robots, drones, and security systems were the first volume applications that took full advantage of GaN's high-speed switching ability.

Not only were GaN transistors faster than Si MOSFETs and IGBTs, they were much smaller – about 5 to 10 times smaller. This opened up many applications in robotics and medical electronics as well as satellites and drones.

As volume built over the years, the cost came down and in about 2015 many of EPC's eGaN® FETs, were priced comparably with power MOSFETs with the same power handling ability.

Smaller, faster, and comparably priced! At this point, there are few reasons not to use eGaN FETs in applications with input voltages of 100 V or less. Today eGaN FETs are being used or designed into the most advanced servers and AI systems that use 48 V bus architectures. There is also a steady migration of more conventional computing systems to eGaN FET or IC-based DC-DC converters for USB-C converters.

Bodo Arlt: What share do automotive applications have in your plans? What trends do you see for GaN in the automotive market? For example, how does the trend to 48V systems influence your developments?

Alex Lidow: We see multiple application areas for GaN in automotive designs. We've already touched on the ubiquitous use of GaN for lidar systems for autonomous cars. The speed of the laser in these systems is critical to getting the incredibly high-resolution images required for safe autonomous transport. Thus, the faster the lidar operates, the higher the image resolution of the surroundings. GaN technology enables the laser signal to be fired at far higher speeds than comparable silicon MOSFET components. GaN-based lidar allows autonomous vehicles to see farther, faster, and better becoming the primary "eyes on the road."

Another automotive application is high-fidelity audio and infotainment systems. In Class-D audio systems, the audio performance is impacted by the FET characteristics.

The low on-resistance and low capacitance of the eGaN® FET enable high efficiency and lower open-loop impedance for low Transient Intermodulation Distortion (T-IMD). The fast switching capability and zero reverse recovery charge enable higher output linearity and low cross over distortion for lower Total Harmonic Distortion (THD). GaN FETs enable higher fidelity Class-D audio amplifiers.

A third automotive application is high-intensity headlamps. eGaN FETs have been powering truck headlamps for over 5 years. eGaN FETs and ICs offer designers lower overall losses, lower heat generation, and improved thermal management. This leads to higher reliability and longer life for the headlamp, compact and lighter assemblies, and lower system costs.

Lastly, but very significantly, the 48 V trend is a sweet spot for GaN. Automotive systems are also becoming challenged with higher and higher electrical loads and are therefore adopting GaN-based 48 V – 14 V bi-directional DC-DC converters to take advantage of the more efficient wiring that comes with higher voltage power distribution.

Bodo Arlt: What have been some of the challenges GaN power devices have to deal with on the road to adoption?

Alex Lidow: EPC manufactures eGaN FETs and ICs in a standard silicon foundry in Taiwan side-by-side Si BCDMOS products. The only exceptional processing for EPC's devices is the growth of the GaN epitaxial layer that sits on top of a standard Si wafer. The added cost of the GaN epitaxial growth is more than offset by the smaller size of the devices, and therefore greater number of devices on each wafer.

Yields are uniformly high, and manufacturing facilities are mature and low cost, so the challenges are in shrinking the devices further to accelerate adoption, improve performance, and open an even more significant cost gap with Silicon. To shrink devices further there needs to be improvements in the GaN crystal to reduce imperfections that lead to electron traps. Another limitation to shrinking eGaN devices is

the need to get power into and out of the parts. High current densities get even higher as devices get smaller and we are already hitting the limits of the solder and copper layers to conduct such high current densities reliably. The only way to improve this situation is to integrate multiple power devices onto the same chip along with drivers, logic, level shifting, and protection circuits. The impact of this integration is to reduce the number of connections between the power system-on-a-chip and the underlying printed circuit board. Current densities can be more than doubled using strategic integration. EPC has introduced many such integrated devices such as our EPC21XX family of monolithic half-bridges, FETs plus drivers, and monolithic power stages that include drivers, level shifters, logic, and a power FETs all on one GaN chip.

Bodo Arlt: What does the future hold for GaN? Where do you see significant opportunities for future expansion in technology and sales?

Alex Lidow: The applications taking advantage of GaN's superior performance continue to expand, and the knowledge base of GaN users continues to broaden. The world has seen in operation the autonomous vehicles that GaN enables. This technology is also increasingly used for autonomous rendezvous and docking in spaceflight as well as for robotics. Digital communications have been vastly improved with the use of GaN FETs and ICs in high speed, energy-saving envelope tracking power supplies. The dream of a wireless world is coming closer to reality with the emergence of large surface area wireless power.

Additionally, power converters used in harsh environments, such as space, high altitude flight, or high-reliability military applications must be resistant to damage or malfunctions caused by radiation. Commercial-off-the-shelf (COTS) eGaN FETs and ICs are smaller, more efficient, and lower cost than aging silicon devices. eGaN FETs and ICs perform 40 times better electrically than the Rad Hard devices typically used in these systems. This enables entirely new architectures for satellite power and data transmission, robotics, drones, and aeronautical power systems.

GaN technology also continues to evolve where EPC's latest generation of FETs and new integrated circuits can outperform, while being cost-competitive with silicon-based products. This combination of superior performance and competitive pricing has provided the incentive for traditionally conservative design engineers to begin using GaN products in applications, such as dc-dc converters, ac-dc converters, and automotive. There has been a wave of new 48 VIN DC-DC power supplies, both isolated and non-isolated, adopting our latest eGaN FETs for high-end computing and automotive applications.

The most significant opportunity for GaN to impact the performance of power conversion systems comes from the intrinsic ability to integrate both power-level and signal-level devices on the same substrate. EPC has been developing customer-specific GaN ICs for the past several years. The general release of more complex monolithic GaN solutions will offer in-circuit performance beyond the capabilities of silicon solutions and enhance the ease of design for power systems engineers. Keep tuned for more developments in this space!

Bodo Arlt: What resources are available for design engineers looking to get started with GaN?

Alex Lidow: Our website is a fantastic resource for engineers. We have application notes covering everything from design basics to full application circuit designs, reliability information, videos, reference designs, and demo boards to start. All reference designs and demo boards are provided with the schematic, gerber files, and bill of materials – everything needed to get designs started quickly. Our Buck Converter Calculator allows designers to input their specific design requirements and select the GaN FET or IC best suited for their conditions. We've also authored a series of textbooks to provide guidance on the use of GaN transistors in widely used power electronics systems. Our seminal text GaN Transistors for Efficient Power Conversion is now in its third edition. Recently released, the third edition has been substantially expanded to keep students and practicing power conversion engineers ahead of the learning curve in GaN technology advancements.

Bodo Arlt: Dear Dr. Lidow Thank you sharing your expertise and knowledge of GaN development and progress with my readers and we look forward to hearing further details during your presentation at the Power Conference next month.

Dr Alex Lidow joined International Rectifier as an R&D engineer and is the co-inventor of the HEXFET power MOSFET, a power transistor that displaced the bipolar transistor and launched modern power conversion. Over the 30 years Dr. Lidow was at IRF, his responsibilities grew from engineer to head of R&D, head of manufacturing, head of sales and marketing, and finally CEO for 12 years. In addition to holding many power MOSFET and GaN FET patents, Alex has authored numerous publications; most recently he co-authored the first textbook on GaN transistors, GaN Transistors for Efficient Power Conversion. In 2004 he was elected to the Engineering Hall of Fame, and in 2005 IRF, under his leadership, International Rectifier was named one of the best managed companies in America by Forbes magazine. Dr. Lidow earned a Bachelor of Science in Applied Physics from the California Institute of Technology and a doctorate in Applied Physics from Stanford University. Since 1998 Alex has been a member of the Board of Trustees of the California Institute of Technology. Alex Lidow - A Lifetime in Power Management

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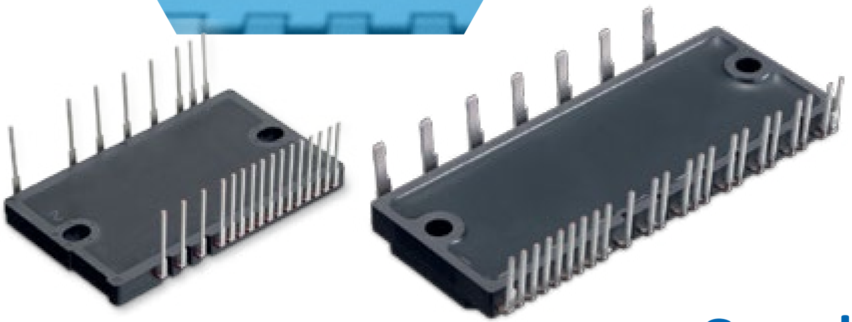

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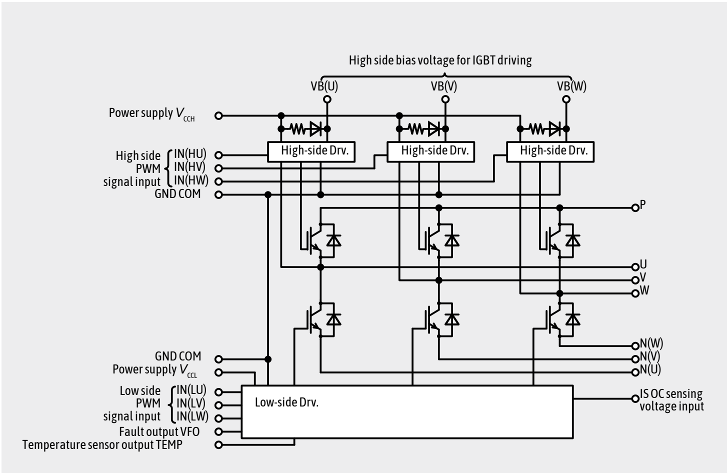

Artificial Intelligence in Power Electronics

Next Generation of Magnetic Components

As an electronics engineer, I don´t work for the earnings but for seeing the circuits working. My name is Dr. Jose Molina and I'm going to explain the story of Frenetic.

By Dr. Jose Molina, Frenetic

Everything has a beginning

A few years ago, I developed a product for accelerating the design process in hardware electronic systems. I was excited to create a company and a product (SpCard, Figure 1) that was used in the European Space Agency. Nevertheless, the space to find an intersection between a product and a disruption in the market has a lot of dimensions and it is important to travel without fear and to listen the signals along the road. During my journey, I found Rafael Jimenez, now a friend of mine, who was the trigger for starting to focus the future of the company on magnetic design. He saw some skills in my team, that I hadn't. Then I called Alfonso Martínez, the Jedi, a friend of mine with a lot of skills in programming from an electronics point of view and without fear of anything.

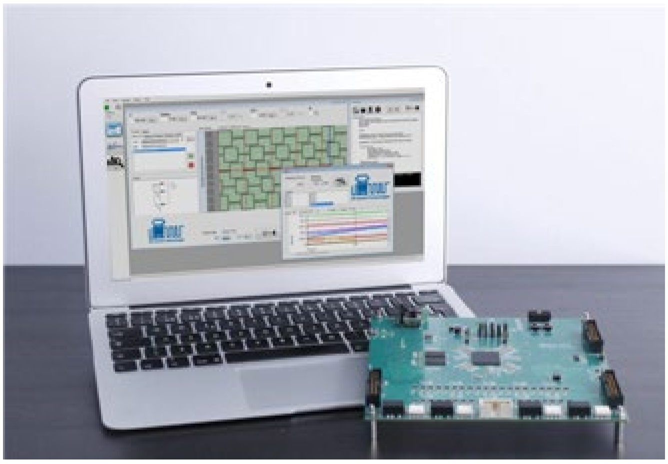

Figure 1: SpCard and Sptool

The discovery

The design of electronic components (especially magnetics) has traditionally been a very manual task.

Engineers have been using analytical software to help them during the process but they still have to decide between several materials, shapes, combinations…

I have always felt a passion for other technologies, especially software technologies that can be applied in my field, electronics. In one of my trips to Silicon Valley, during networking conversations, something clicked in my mind. "Design optimal magnetics, designing the optimal shape" and we patented that idea and we created a software for it. The idea started with the goal of printing the magnetics with a 3D printer and our own materials.

This was the first step, but it wasn't enough, because the designs were expensive, however it was very important for understanding the next step. During the following months, I was focused on a solution for the big market and after some conversations in APEC (Applied Power Electronics Conference), a new idea came to my mind. "Teach a software how to design the best magnetics, using current materials, giving feedback to it" From that point onwards, we started focusing on the idea and reviewing actual technologies. We realized that current materials and shapes have a lot of potential if we could combine them properly. We didn't want a classical software, but rather we wanted something capable of learning from it's results. Therefore, the answer was easy, why don´t we use Artificial Intelligence?

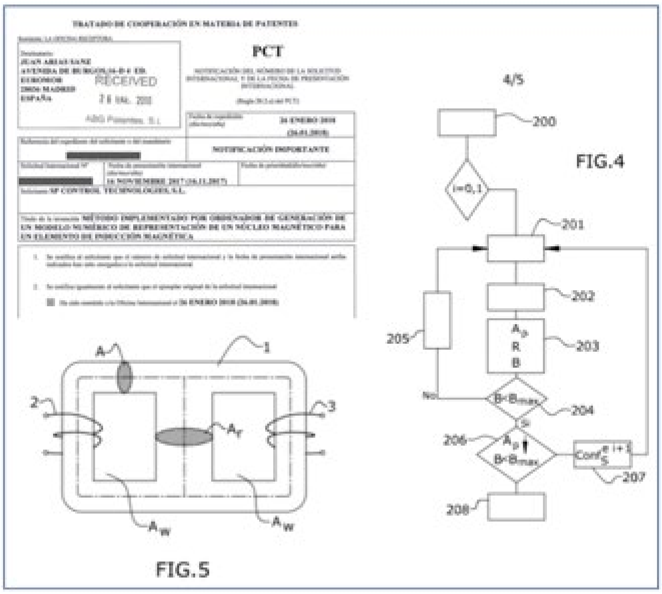

Figure 2: Patent presentation and figures

The main goal of a magnetic company

Before continuing to talk about our road to becoming the most innovative company in magnetics, I think it is important to explain which parameters differentiate the magnetic companies.

The quality of a magnetics manufacturer is a summary of different aspects and skills:

- Accuracy of the design losses predictions
- Manufacturing repeatability
- Cost
- Delivery time
- Capabilities and certifications

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The users of the magnetics are focused on the quality of their products quality and their provider selection often changes from one product to another.

Solving hardware problems with software
Coming back to how we solve the magnetic design problem. The application of Artificial Intelligence techniques for designing an electronic system is the main contribution of Frenetic. Basically, we are “solving hardware problems with software”.

The main problems are:
- Accuracy of the calculation of models developed for general cases
- Materials parameter for different shapes and conditions
- Iterations needed for the appropriate design

The classic design techniques, as been discussed previously, are far from being optimal, since there are too many parameters to be considered by a human brain. However, when we apply AI to this field this is not apparent because of the complexity of getting data with enough quality. There are several sources of data for the Frenetic technology but the main one comes from measurements from the laboratory. Over the last 2 years, Lucas Nicieza, manager of the hardware team, has been creating a Laboratory for acquiring the data needed for the AI.

The lab, located in the center of Madrid (Spain), has been the witness of test products from companies like Porsche, HP, Airbus or Lear, with more than 25 new products alone in 2019. The first year of Frenetic has shown us the main problems with the Frenetic predictions and as a result, we have created the Advanced Magnetic Laboratory, including all the setups we have built before and new experiments which allow Frenetic to learn rapidly. I will come back to the lab later.

Figure 3: Lucas Nicieza in the lab

It should be easy
The next step was; we need to give people a good interface for using our technology without losing information but in a straight forward manner, taking less than 5 minutes of their time. We started working on our web platform (improving it each week), a place where you can interact with Frenetic, obtain your designs in record time and order samples with customized designs. You can also discover the cost of the potential manufacturing and the delivery time estimation. Since Frenetic has evolved very quickly, the web is still one of the main working lines to improve the users experience with the AI.

Sometimes users think we are an online simulator and get disappointed, however Frenetic is much more than that.

Advanced magnetic laboratory
We are now back on at the hardware side. The investment from VCs from Germany, Portugal and Spain has allowed us to create the most Advanced Magnetic Laboratory in the world. This Lab allows Frenetic to increase the accuracy of it’s predictions, achieve higher power ratios and start testing it’s new internal technology, which is still confidential (every year we have an internal confidential project) and will be revealed in the next FreneticCon 2020.

The Lab is a magical place where we work on new ideas of how to estimate losses in magnetics, measure magnetic fields and look at where the dark side of the magnetic fields hide their effects.

Our legacy to science will be this Lab, a place where engineers want to work. A place for dreaming of applied technologies and helping the field of electronics to break down the barriers established over the last 20 years. If I were a young engineer, I would want to work here.

Our obsessions
Every design presents a challenge for our team. The motivation is always the same. The design should be the best, not only with respect to our competitors but with respect to the previous release of Frenetic. But our motivations are not only technical, because is the case with everyone in the race to provide high power density results, we can fail and it is at that moment, where you should show what you are really made of. It is here where our technical team opens a technical investigation together with the customer to evaluate the results and propose a solution as quickly as possible.


Figure 4: First version of the boxes

As I said before, our obsessions are not only technical. Why can´t magnetics be beautiful? We are committed with delivering you the magnetics in very beautiful box along with the technical reports.

Frenetic results
At the beginning of the article I explained what makes a magnetic company better. In the next article, I will publish results on our accuracy, but for today, I will show a comparative example of a design, where the customer already had a design and we improved it.

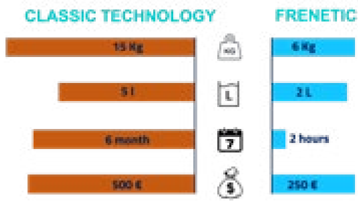


Figure 5: Classic results Vs Frenetic

As it is appreciated in Figure 5, using Frenetic software, we could create a design in 2 hours, easy to manufacturer and decreasing the cost up to 50%. Evidently, this result is not enough for evaluating all the parameters of a magnetic design company, however, in the next article I will try to talk about our results.

Holistic service
Companies with magnetic components in their products have been suffering with the difficulties of getting the right designs in the allotted time due to a lack of communication and understanding. The idea of a Holistic Service for magnetics was developed in Frenetic together with certain TIER1 companies.

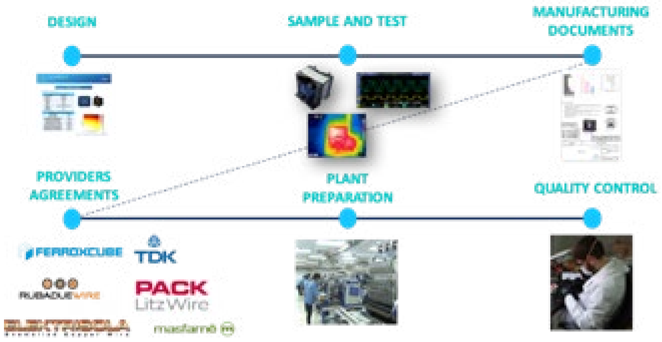


Figure 6: Frenetic holistic process

The holistic process shown in Figure 6 is divided into 6 phases:

- Design: Frenetic provides a solution from electrical specifications.
- Sample and Test: The technical team build and test a sample in the Advanced Magnetics Laboratory under real power conditions. This process is repeated until every spec is achieved.
- Manufacturing documents: Once the sample is validated, manufacturing instructions are described for manufacturing purposes. At this stage an approximated cost could be calculated.
- Providers agreements: With the clear BOM and requirements for manufacturing, the most suitable providers are asked for a quotation and a deliverable estimation.
- ´Plant preparation: The Frenetic team helps in the process of preparing the plant, overseeing the procedures and adjusting the potential gaps for a smooth and repeatable manufacturing process.
- Quality control: To establish the process for evaluating the results automatically and to create the guides for future modifications.

www.spfrenetic.com

Innovative Driver Solutions for all Power Semiconductors

VIP-Interview with Rob Weber, CEO of AgileSwitch LLC, about the company's focus on Industrial and Transportation applications.

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

Henning Wriedt: Your company was founded in 2010. What were your company charter and your market opportunity at that time and how is it today?

Rob Weber: The company charter was simple, bring innovative digital technologies to the world of Analog Power Electronics. Staying true to this charter, we were the first in the market to introduce Digital Monitoring, patented digital communication streams for stacks (AgileStackTM) and Digital Programmable Gate Drivers. The market opportunity has grown significantly to now include SiC MOSFETs in addition to Si IGBTs. Our Digital Programmable Gate Drivers are increasing the rate of adoption of the relatively nascent SiC MOSFETs.

Henning Wriedt: How do you view the different semiconductor technologies in power electronics?

Rob Weber: SiC and GaN are disrupting many markets that can be easily benefit by the more efficient and smaller systems (such as Transportation, String Solar, RF etc). However, Si MOSFETs and Si IGBTs continue to dominate cost sensitive applications. Our goal is to be technology agnostic, providing innovative driver solutions to the whole spectrum of Power Semiconductors.

Figure 1: Rob Weber, CEO of AgileSwitch, LLC.

Henning Wriedt: How is your current product portfolio structured?

Rob Weber: AgileSwitch is currently focused on Industrial and Transportation applications which use Power Semiconductors in the range of 600V – 3300V. We serve these applications with 3 types of products:

* Gate Driver ICs
* Gate Driver Cores
* Plug & Play Gate Drivers.

Henning Wriedt: What are the most important features of your Augmented SwitchingTM technology?

Rob Weber: Our Patented Augmented SwitchingTM (Figure 2) of multi-level switching results in the following primary benefits:

* Better Efficiency
* Reduced EMI
* Rapid Short Circuit Response

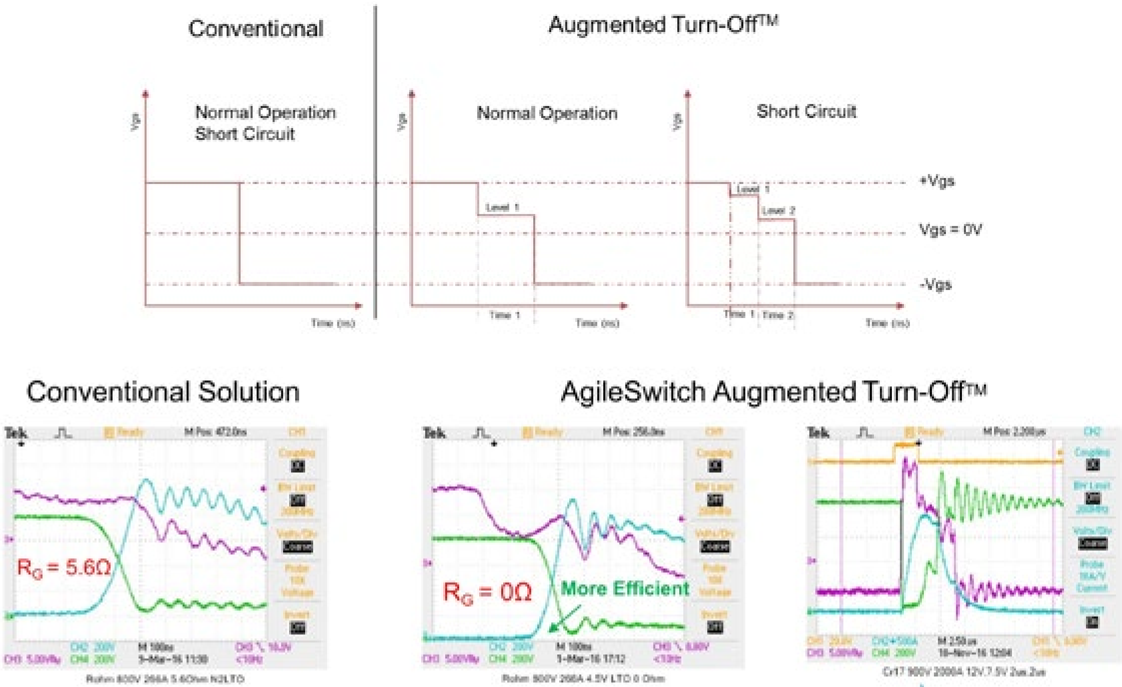


Figure 2: Explanation of Augmented Turn-Off

In addition to greater control over the efficiency vs voltage overshot tradeoff, our customers chose Augmented Switching over a competing technology to overcome issues related to EMI and Over Current Protection.

Henning Wriedt:
Which applications are best suited for your driver cores?

Figure 3: Nitesh Satheesh, General Manager, AgileSwitch India Pvt. Ltd.

Rob Weber: Our fully software configurable Gate Driver Cores are designed for operation in our primary markets of Industrial and Transportation. Specifically, the cores can be used in Motor Drive, Auxiliary Power Supplies. To support this, we have launched a design center in India, led by our General Manager of AgileSwitch India, Nitesh Satheesh, Figure 3, to develop gate driver applications for customers globally. Nitesh has a growing team of experienced development engineers that he is guiding to support a wide range of customer applications.

Henning Wriedt: Can your products be customized?

Rob Weber: Yes, our products are fully software configurable, all the gate driver parameters can be customized using our Intelligent Configuration Tools. The Intelligent Configuration Tool comes with preloaded settings for commonly used SiC Modules. These can be used as a starting point by engineers looking to optimize their designs.

Henning Wriedt: What can your customers expect from AgileSwitch in the near future?

Rob Weber: AgileSwitch is a pioneer in Digital Programmable Gate Drivers. We will release our Gen 2 Gate Driver IC, that features Multi-Level Turn-On. We are also in the process of releasing our qualified 1700V Gate Driver Core for SiC Modules. The holy grail for us is EV, we are in early conversations to design in our Gate Driver ICs.

Rob Weber has focused his entire career around starting and building emerging growth technology businesses. Prior to co-founding AgileSwitch, Rob was President of Intellifit Corporation a provider of guaranteed fit technology for on-line apparel shopping. Prior to Intellifit he served as President of Knoa, an e-learning software company, where he successfully redefined the corporate product strategy and repositioned the company to capitalize on new market opportunities. Prior to Knoa Rob served as President of Elastomeric Technologies, a leading electronic connector manufacturer. Rob is a graduate of the Fisher Program in Management and Technology at the University of Pennsylvania where he earned Bachelor of Science in Economics (B.S.E.) and Bachelor of Applied Science (B.A.S.) degrees from The Wharton School and School of Engineering.

www.agileswitch.com

A Step Forward to Miniaturization for Current Sensing in Power Conversion Systems

Modern power conversion systems must simultaneously become more efficient, smaller and cheaper than previous generation. With this in mind, the Swiss company LEM, global leader in current and voltage sensing, has used its expertise in this field to create a single chip package, the HMSR.

By Damien Leterrier, Thomas Hargé and Stéphane Rollier, LEM

The traditional way to measure current is to use Open Loop Hall effect sensors. The magnetic field created by a current is captured by a magnetic core and measured by a hall element. More recently, dedicated ASICs helped to increase the overall accuracy of the system using advanced compensation techniques.

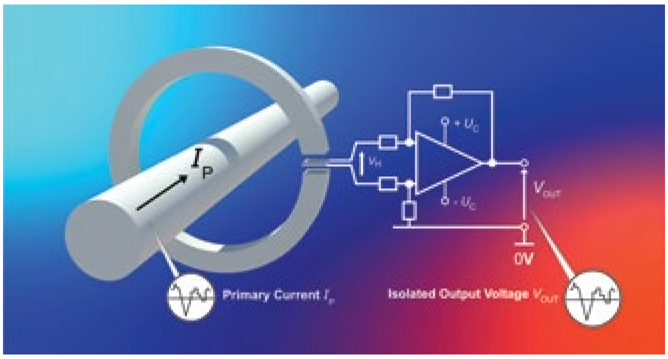


Figure 1: Open Loop technology principle using a traditional Hall effect chip or a dedicated ASIC

LEM first moved into miniaturization with the LTSR product in the previous decade. At that time, the best way to ensure optimum performances was to use Closed Loop Hall effect technology in combination with a special Closed Loop ASIC designed by LEM. The evolution of ASICs technology enabled the development of Open Loop Hall effect sensors that were capable of approaching the level of performance that Closed Loop technology delivered. Not only did Open Loop technology make it easier to reduce the size of components but it also brought the cost improvements that the market demanded, thanks to it having a simpler structure and lower power consumption. This decade has seen the development of the HLSR series which not only delivers high performance in terms of offset and drift but also excellent response time – and all in a package small enough for PCBA-type applications with only a few mm height.

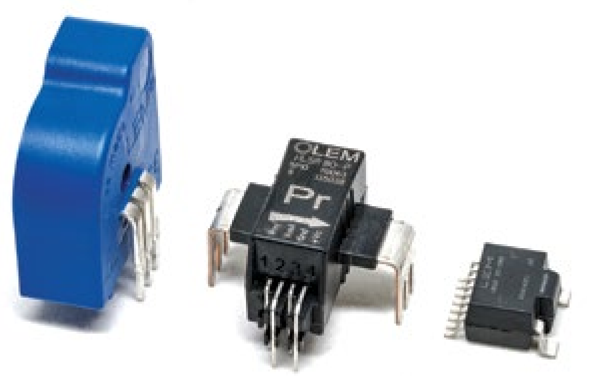


Figure 2: Evolution of the current sensor's size over the decades

LEM has used the extensive know-how and design expertise that it has accumulated over many years to create the HMSR, a state-of-the-art current sensor which satisfies the continuous market requirements of cost reduction, performance improvements and miniaturization.

Figure 3: HMSR current sensor

With this new series, LEM is expanding its miniature, current sensors range for AC and DC isolated current measurement. The new HMSR models are easy to use because they include a low-resistance primary conductor (which minimizes power losses), a miniature ferrite and a proprietary ASIC to allow direct current measurement and consistent insulation performance.

This new product category already includes six different nominal currents – 6A, 8A, 10A, 15A, 20A and 30A – with a measurement span of 2.5 times the nominal current available in a SOIC 16 "like" footprint package. Standard models provide an analogue voltage output with different sensitivity levels available, with 5V power supply versions achieving an output voltage of 800 mV @ I_{PN}.

Built-in are two OCD (over current detection) units which separate the control application path to the safety loop. These OCDs are on two dedicated pins – one set internally at 2.93 x I_{PN} as threshold and one externally whose threshold can be adjusted by the user.

However, HMSR sensors should not be seen as simple Open Loop Hall effect ASIC-based transducers. The HMSR unique primary conductor allows overload punctual currents and a high level of insulation. All this is combined with a ferrite-based magnetic circuit to provide excellent immunity against the external inhomogeneous fields found in power electronics applications. This enables the HMSR to be used in environments with high levels of disturbance.

The ferrite used in the HMSR is also a key factor in achieving a high-frequency bandwidth of 270 kHz (-3dB) and makes it possible to achieve good rejection against external fields.

These dedicated ASIC designs combine field-proven techniques such as spinning, programmable internal temperature compensation (EEPROM) for improved gain and offset drifts. The result is high levels of accuracy across a range of temperatures, from -40°C to +125°C with a typical value of 0.5 % of I_{PN} (the HMSR 20-SMS model). Power conversion applications such as solar inverter or drives demand high efficiency levels and these can be reached only if the control loop is accurate.

The accuracy over temperature figures have been greatly improved on the HMSR in comparison to the previous generation of products. The graph below shows the low level of typical overall error across a measured current with the HMSR 20-SMS, as well as very good linearity on a wide temperature range (-40°C to +125°C).

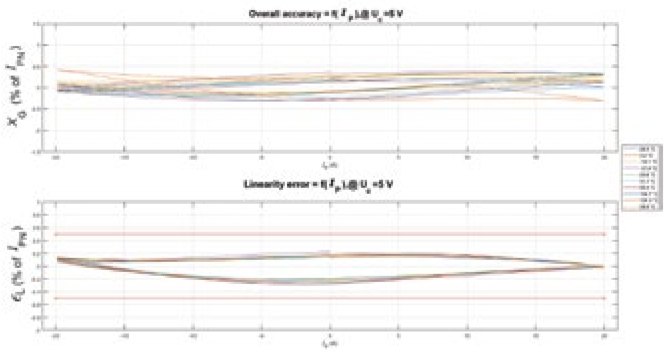


Figure 4: Typical overall accuracy and linearity for HMSR 20-SMS model from -40°C to +125°C)

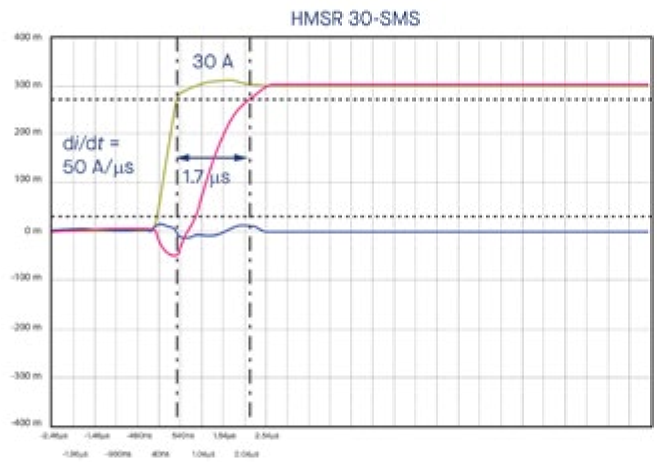


Figure 5: HMSR response time

However, such accuracy is not enough if it isn't backed by a fast response time. To this end, the deployment of a fast IGBT, like SiC-based technology, increases the possibility of working with a faster switching frequency – the HMSR is proven to be ready for such demanding technology with a response time below 2uS (see Figure 5).

In multiple applications, HMSR sensors can be mounted directly onto a printed circuit board as SO16 SMD devices, reducing manufacturing costs and providing much needed space-saving for restricted environments. At just 6mm high, the HMSR offers significant space-saving in applications, making it ideal for placing under the heatsink over intelligent power modules (IPMs) (see figure below).

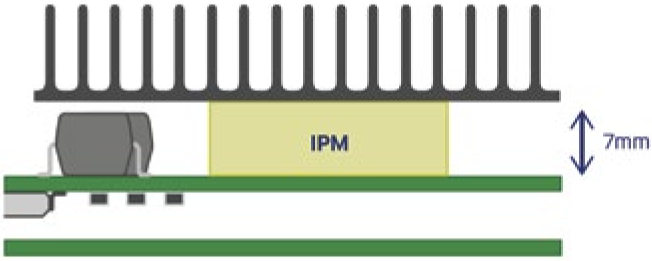


Figure 6: HMSR mounted with IPM

Another area where the HMSR will deliver significant benefits in terms of current measurement is in solar applications.

In particular, the maximum power point tracker (MPPT), an important asset in solar energy conversion, is a collection of components that maximize the power generated from a photovoltaic (PV) panel. It does this by regulating current and voltage depending on temperature, sunshine and total resistance of the system. The control system permanently analyses the system output after injecting a small perturbation (using the perturb and observe method). The MPPT then analyses the resulting power (by sensing voltage and current) and deducts the parameter to change in order to reach the MPP (maximum power point). The MPPT then changes the pulse width modulation (PWM) to adapt the voltage of the DC/DC converter.

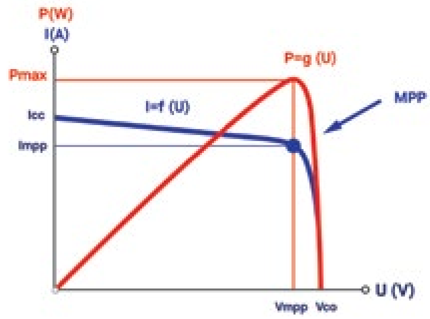


Figure 7: Maximum Power Point

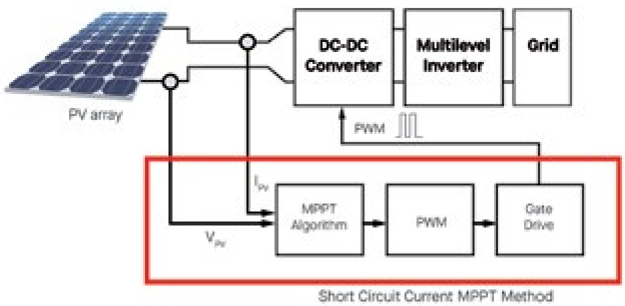
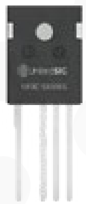


Figure 8: MPPT architecture



The greater the accuracy and lower the noise, the better the performance from the MPPT will be. Using LEM's state-of-the art ASIC, the HMSR provides a highly accurate and very low-noise signal which allows the system to operate to its optimal level.

What's more, string current monitoring makes it possible to compare several strings and to detect issues such as faulty wiring, dirt on the panels and shadows created by growing trees. Here, the excellent accuracy of the HMSR will enable strings to be compared.

In addition, the DC/DC converter used in the MPPT uses high-frequency regulation (around 80kHz), creating high dV/dt which is harmful for electronic components. Thanks to its ruggedized design, the HMSR offers significant resistance to such a noisy environment.

This immunity can easily be checked by applying dV/dt through the sensor and observing the output reaction.

The following graphs (figure 9) show the low disturbance created by applying dV/dt through the sensor. The error generated is only 3% of full scale with a recovery time of 3.8 uS.

HMSR 20-SMS tested with pulsed voltage of +/- 1000 V at 20kV/uS :

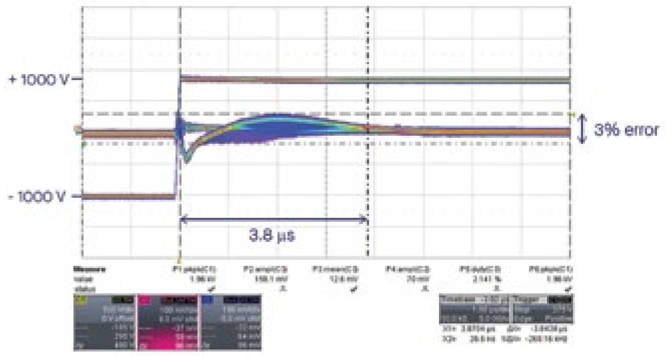


Figure 9: Error generated at the HMSR output after applying dV/dt

The two available built-in OCDs on the HMSR will also protect transistors on the inverter from short-circuiting and overload. This kind of detection and protection is an important feature for multiple applications like HVAC on the DC link or motor drive applications. Most modern variable-frequency drives (VFDs) incorporate a motor overload algorithm and the OCD function on the HMSR will make detection much easier, preventing the overheating of equipment. Having two distinct OCDs provides the opportunity to monitor overload and short-circuit events separately.

Of course, isolation requirements could be an issue for the adoption of IC packages when it comes to choosing a current sensor. For example, in the solar industry power plants are often used with higher DC voltages, up to 1500V in order to increase the DC/AC power ratios. This dramatically increases the isolation needed for a current converter.

The long internal distance between primary and secondary sides helps to isolate the primary bar with the rest of the IC, giving a very high level of isolation guaranteed at 4.95kV_{RMS} (at an AC insulation test voltage of 50 Hz, 1 min). This level will be guaranteed for 100% of the shipped products that are tested during production assembly. The special footprint of the HMSR allows 8mm creepage and clearance distances on the landing pad.

A higher comparative tracking index (CTI) means a lower minimum creepage distance is needed and with a CTI of > 600, according to the IEC 62109-1 (Safety of power converters for use in photovoltaic power systems), the working voltage for the HMSR reaches 1600V, which means it is ideally suited to such high-constraint applications.

Another key requirement in the solar industry is that equipment needs to be surge tolerant up to 20kA to offer effective lightning protection. With the HMSR placed directly on to the string inputs that are subject to lightning, components will be extremely robust against such powerful current surges. Indeed, the HMSR has been designed and tested to this level according to the standard 8/20 uS surge test profile.

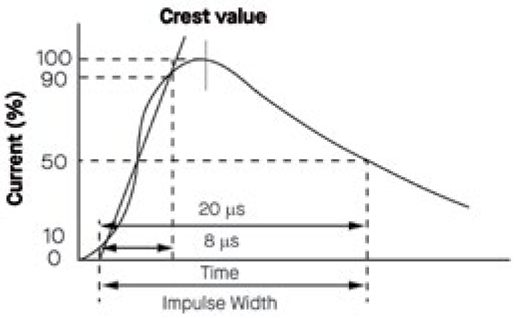


Figure 10: Typical overcurrent surge profile in solar applications

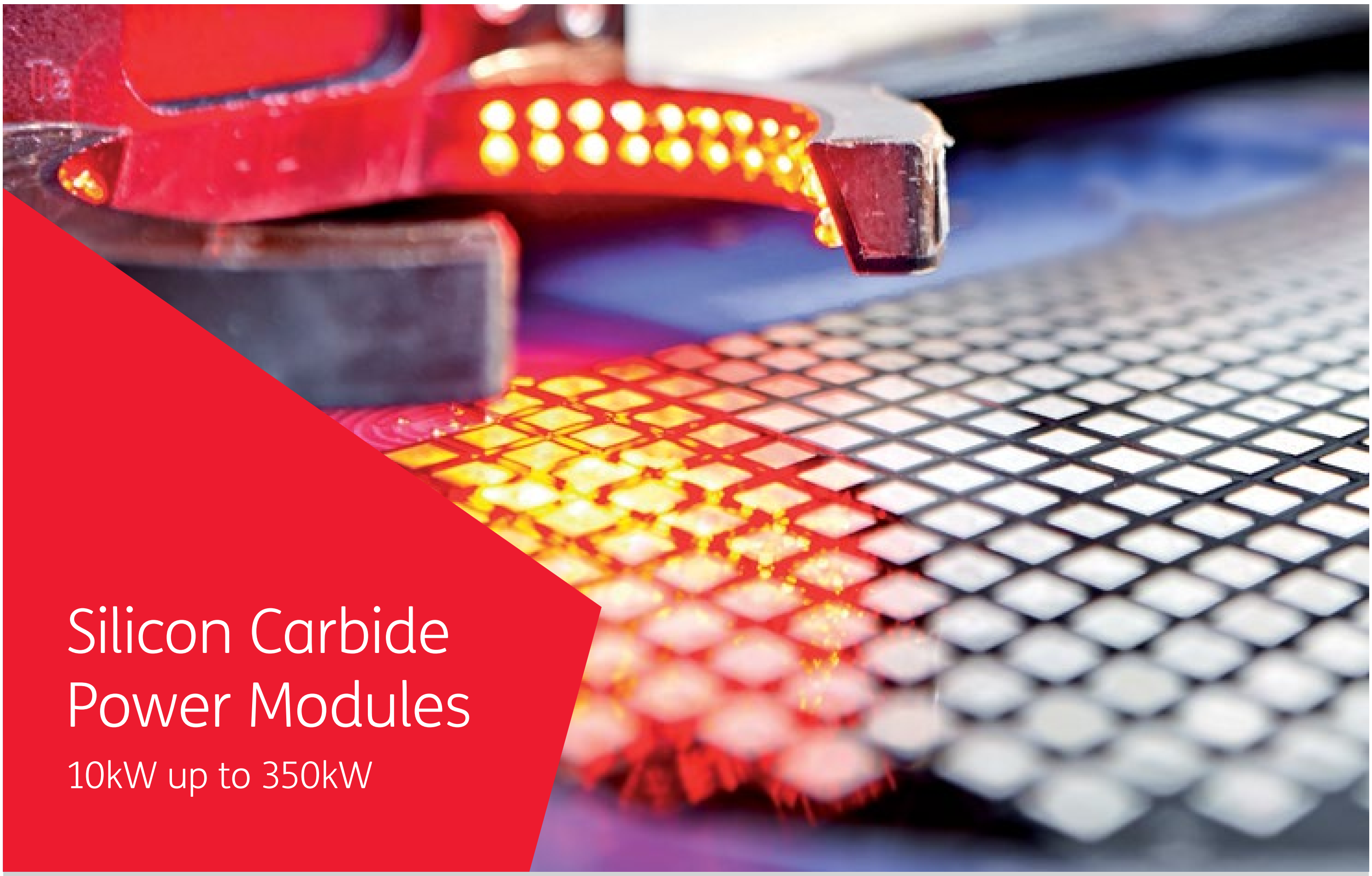
LEM has developed an HMSR evaluation board that makes it possible to prototype and test quickly the extraordinary performances of this new generation of sensors. Available as a sample on request, this new product line will enter mass production in early 2020.

Figure 11: HMSR demo-board available for sampling

HMSR main technical data

I_{PN}	6..30 A
I_{PM} (measuring range)	15..75 A
AC Insulation Test (50 Hz, 1 min)	4.95 kV
Impulse withstand voltage	8 kV
dCp/dCI (mm)	8/8
Operating temperature range	-40°C…+125°C
Supply voltage	5V
Step response time	2uS
Frequency bandwidth	>270 kHz
Over current detection	Yes (x2)

www.lem.com



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WBG Semiconductors to Take Spotlight at Power Conference

The power electronics community will gather in Munich in December to network with peers, learn from experts, and take a deep dive into designing with wide-bandgap power devices.

By Jürgen Hübner

Power electronics is rapidly moving to wide-bandgap (WBG) semiconductors as the gateways to more efficient designs for a host of high-growth applications. WBG materials such as gallium nitride (GaN) and silicon carbide (SiC) enable greater power efficiency while reducing the size, weight, and overall cost of power solutions.

The lineup of technical papers slated to be presented at the Power Electronics Conference, which will convene here early next month, is testament to WBG semiconductors' ascendance. The technical conference will take place on December 3. A half-day networking event is scheduled for December 2.

Market analysts foresee continued growth in the market for power components using WBG materials, namely SiC and GaN. Driven by the demand for power supplies, inverters for photovoltaics, and hybrid and electric vehicles, the market for SiC- and GaN-based power components is expected to exceed US$10 billion in 2027.

The prospects for strong growth in SiC devices are high, stimulated by increasing sales of plug-in hybrid and electric vehicles. Market penetration is widening, with Schottky diodes, MOSFETs, JFETs and other discrete SiC devices already seen in DC/DC automotive converters (where high volumes have already been achieved) and on-board battery chargers.

Network with industry experts

At the networking event on Dec. 2, conference goers will have the opportunity to meet industry experts, gather information, share knowledge, network with peers, and find solutions for their business challenges. The event will start at 2:00 p.m. with presentations on SiC and GaN prospects and challenges for current and future application, followed by a panel discussion on "SiC versus GaN," moderated by Bodo Arlt, editor-in-chief of Bodo's Power Systems. An evening reception and get-together will provide further opportunities for exchanging ideas with others in the power community.

Technical conference

Wide-bandgap semiconductors are transforming power electronics designs across many applications, including data centers, renewable energy, and automotive systems. The full-day technical conference on Dec. 3 will explain why, how, and where this transformation is happening. Conference attendees will gain the knowledge necessary to make informed decisions on which wide-bandgap materials, platforms, and devices can best serve their requirements in current or upcoming designs.

These are among the technical papers that will be presented at the conference:

- SiC Solutions for Industrial and Automotive Applications
- Optimized Power Module Packages for SiC and Its Applications
- Software Configurable Gate Driver Ecosystem — Reducing Time to Market
- Simplify Your Driver — Benefit of the Gate Driver
- GaN — Mature Discrete, Passives and Measurement
- Design Skills of Gapped Ferrite Materials for Inductor and LLC Transformer
- Gallium Nitride in Cars: 48-V – 12-V DC/DC Conversion and LiDAR
- SiC — Mature Discrete, Passives and Measurement
- Optimized for Performance and Price, Let's Go GaNFast
- Test Results for Packaging and Gate Driver Solutions
- Reliable Use of GaN Devices for a Broad Range of Applications
- Enabling and Expanding Broader Power Markets with Silicon Carbide
- Designing an Integrated Motor Drive with GaN
- Introduction of Ultra-Low RDS(on) Devices
- GaN takes its place as the technology of choice for high volume power ICs
- Progress on SiC — Understanding Figure of Merit and Application-Specific Needs
- Modules for Electric Traction
- Higher Voltage, Higher Power, Market Expansion: The Evolution of GaN
- Development of SiC Power Devices Technology
- GaN-on-Silicon: From Switches to Intelligent Power Solutions to Boost Performance
- Control Architecture Unleashes the Full Potential of Silicon Carbide
- High Efficiency, Compact On-Board Chargers for Industrial Electric Vehicles
- Isolated Smart Gate Driver for SiC MOSFET Control
- Analysis of PCB Parasitic Effects in a Vienna Rectifier for an EV Battery Charge

The conference will take place at the Hilton, Munich Airport.

www.power-conference.com

Robust High Voltage IGBT Power Modules Against Humidity and Condensation

Mitsubishi Electric continuously improve the power device robustness even considering different environmental conditions like humidity and condensation.

By Eugen Wiesner, MITSUBISHI ELECTRIC EUROPE B. V.
K. Nakamura, K. Hatori, MITSUBISHI ELECTRIC CORPORATION

Introduction
The power electronics is exposed to extreme environmental conditions during the operation like dust, temperature, humidity, vibrations or chemicals. The mission profile of the temperature and relative humidity has a wide range dependent on application and the location of operation.

In some mining applications the relative humidity level reach even almost 100% with condensation, drip and high pressure water spray for dust control [1].

The IGBT power module as a key components of power electronics is suspended even to such harsh environment. Although the temperature influence on power semiconductor life-time was investigated quite intensively, the humidity was not taken into the account so far due to the missing life-time models or knowledge about failure mechanisms. Especially for case type high voltage IGBT power modules the humidity becomes important parameter due to the non-hermetic package design and the high electric field at semiconductor interfaces, like passivation area. As a result it was necessary to investigate the humidity caused failure mechanisms more deeply and to establish the needed life-time models.

In this article the Mitsubishi Electric investigation results are presented in regards to the humidity and condensation influence on high voltage IGBT power modules durability.

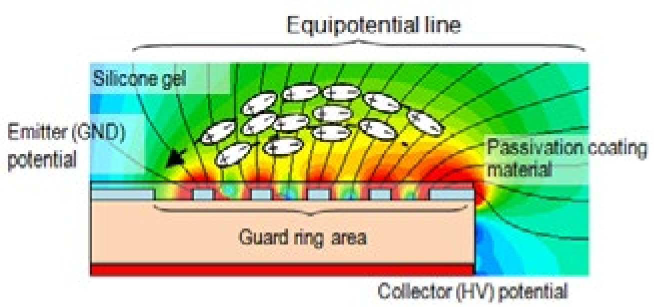

Figure 1: Principle chip guard ring area with gel polarization effect.

Humidity failure mechanisms and life-time model
The electromechanical migration (ECM) and aluminum corrosion are two possible and well described [2] failure mechanisms of power semiconductors caused by humidity. In the first case (ECM) a dendrite grow of Cu or Ag can be detected on the chip passivation area. In the second case the Aluminum metallization is corroded on the guard-ring.

Besides above described two failure mechanisms caused by humidity and requiring a long time influence Mitsubishi Electric found and published one other failure mechanism that may happen even after short humidity or condensation impact [4]. This failure may appear in case of gel polarization and surface charge accumulation at high voltage above guard ring area. In the figure 1 the principle structure of chip guard ring area with the gel polarization effect is shown. The moisture absorption in the module accelerates the polarization. From the polarization resulting surface charge accumulation above the chip's guard ring area causes the blocking capability degradation of the device. This may finally lead to device failure.

This phenomenon can be detected by leakage current increase after condensation event. The leakage current increase happens not immediately. It takes several seconds before the current rises after voltage is applied. In figure 2 the comparison of the leakage current characteristic between dry condition and after condensation is shown.

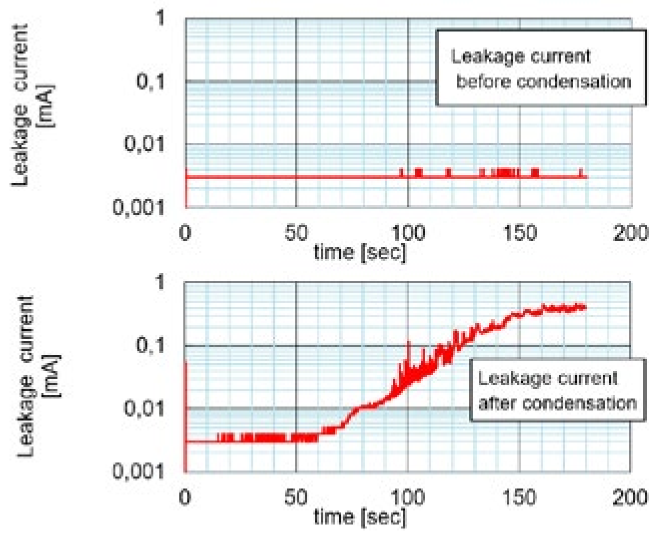

Figure 2: Leakage current increase after condensation event

The knowledge of failure mechanism only is not enough to decide whether the power device will operate the desired time under given conditions. That's why Mitsubishi Electric developed and proposed a life time model considering the humidity as below [2]:

$$LT = \frac{LT_b}{\pi_H \cdot \pi_T \cdot \pi_V}$$

LT is the estimated life time of the power device. The coefficients π_H, π_T and π_V are the acceleration factors proposed by [3]. These factors can be defined by HV-H3TRB measurements at different conditions. The LT_b is the basic life time. It can be calculated from the transformation of different conditions used during the HV-H3TRB evaluation to only one reference condition for example 75%RH, 25°C and 1500V (for 3300V IGBT-Module).

In the following example it is shown how the humidity related parameters can be defined and calculated using 3300V IGBT Module. In the first step the humidity acceleration factor π_H can be calculated using the results from two HV-H3TRB tests. One test (test A) was performed at 85% RH the second test (test B) was performed at 95% RH.

$$\pi_H = \frac{3023\ h_{\ (85\%RH)}}{309\ h_{\ (95\%RH)}} = 9.78$$

For this calculation the 50% Weibull distribution values were used. Other test parameters like temperature and voltage were kept same for both tests. Detailed evaluation result are shown in figure 3 below.

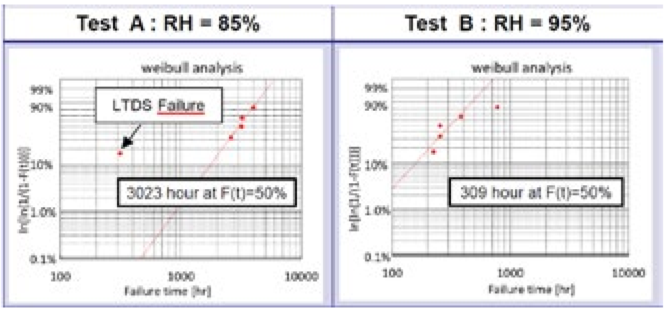

Figure 3: HV-H3TRB evaluation result with 3300V IGBT.

In the second step the empirical factor x using Peck's model can be calculated as below:

$$\pi_H = \left(\frac{RH_{chip}}{RH_u}\right)^x = 9.78$$

$$x = \frac{ln(\pi_H)}{ln\left(\frac{RH_{chip}}{RH_u}\right)} = \frac{ln(9.78)}{ln\left(\frac{95}{85}\right)} = 20.5$$

In the final third step each testing point from HV-H3TRB evaluation can be transformed to the base line at reference conditions (75%RH, 25°C, 1500V) to define the basic life time (LT_b).

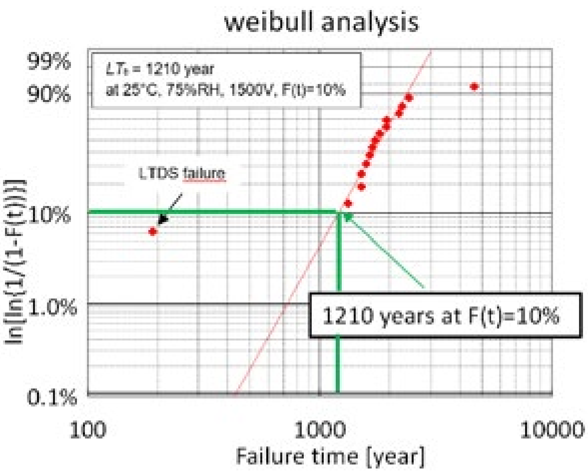

Figure 4: Estimation of basic life-time from HV-H3TRB evaluation test results for 3300V IGBT.

All the transferred testing points from different HV-H3TRB test can be plotted into one Weibull diagram as shown in figure 4. As a result the basic life time can be estimated at the reference conditions for example considering 10% probability value from this Weibull distribution.

From the established humidity life-time model the user can learn a lot. For example the IGBT-Module life-time curves can be drawn in humidity vs. temperature diagram to investigate the impact of temperature increase on the life-time as shown in figure 5. During the operation the absolute humidity is almost constant on the other hand the temperature is fluctuating. The diagram in figure 5 shows that even small increase of temperature by 4 °C at the same absolute humidity can increase the device life time by 30 times. That is why the starting of the inverter should be carefully considered because of low temperature.

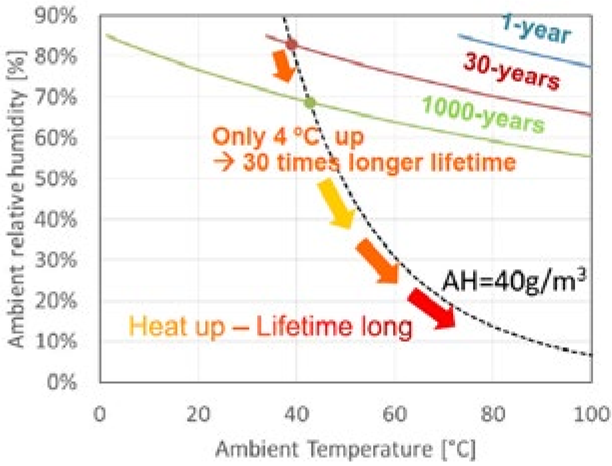

Figure 5: Impact of temperature increase on the module life-time.

IGBT-Module condensation test method

The original condensation test method to check power device robustness against condensation was proposed by Mitsubishi Electric in 2015 [4]. Before condensation event the power module was placed into the humidity chamber at the conditions of 85°C and 85%RH for

36 hours. This time is required to ensure that the humidity reached all parts inside the IGBT module. The power device will be like "saturated" with humidity. After the storage in the humidity chamber the samples will be cooled down rapidly from 85°C to 10°C using a heat sink outside the climate chamber. This rapid cooling event causes the condensation inside the power module. Finally the leakage current will be monitored after the condensation and compared with the characteristic before condensation. The worst case field conditions are usually not so hard as used during the performed condensation testing. According to IEC 60721-3-5 5K2 standard the pre-condition for rapid temperature change is 35°C and 95%RH. The testing with the conventional approach at such conditions would be very time consuming. A new automatic condensation test approach was proposed by Mitsubishi Electric to perform the cycling condensation test more efficient using the humidity chamber [5]. This automatic test is helpful to derive the acceleration factors between the field conditions and the hard qualification tests. The proposed new test sequence for condensation test is shown in figure 6. Instead of cooling down the power module externally using the heatsink the climate chamber is used to generate the condensation. The advantage is that the comparable results to the conventional test can be achieved more efficient and quicker.

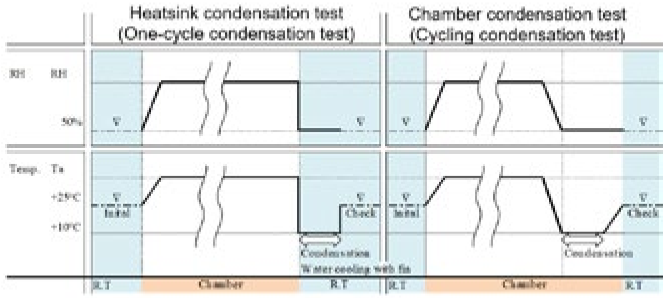

Figure 6: New test sequence for cycling condensation test.

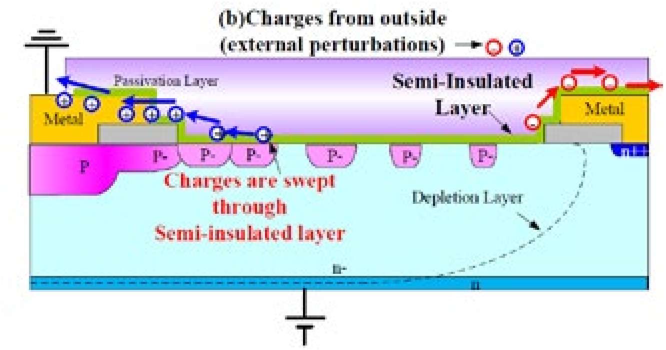

Figure 7: Surface charge control technology

Latest high voltage IGBT module technologies

During the humidity investigation of the existing power modules the most sensitive design components were identified. The big influence on the device robustness against humidity had the selection of the proper silicone gel and the design of the chip passivation structure (guard-ring). Especially the passivation structure improvement leads to an enhancements of the device robustness against humidity. The invented by Mitsubishi Electric surface charge control (SCC) technology of the passivation area is the key factor to improve power device durability. It contains a semi-insulation layer above the Si guard ring structure as shown in figure 7.

This semi-insulation layer avoids the accumulation of surface charges [6]. The latest X-Series high voltage power modules from Mitsubishi Electric use the SCC - technology.

The X-Series power device capability against condensation was tested using the above described cycling condensation test and compared to the conventional module. When evaluating the conventional module an acceleration factor of 80 was found between 85°C/85%RH and 36°C/95%RH. When comparing the new X-series with conventional design at 85°C/85%RH an improvement by more

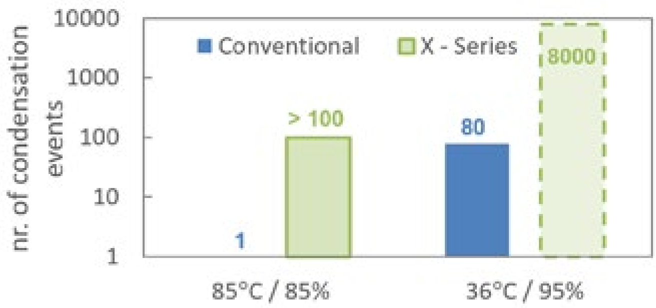

Figure 8: X-Series technology against humidity and condensation in comparison to the conventional product.

than 100 times was confirmed by testing. From these test results an unprecedented robustness against 8000 condensation events under IEC 60721-3-5 5K2 reference conditions can be derived for the new X-series, see Fig.8.

Conclusion

With the latest X-Series high voltage IGBT modules the device capability could be improved against the humidity and condensation. Also the basic approach to define the life time model for the humidity is established providing to the user the confidence of the proper inverter operation. On the other hand the upcoming SiC technology is still challenging especially considering the smaller structures and new materials. The lessons learned in the past with Si IGBT can be partially utilized and used also for SiC high voltage power modules in the future.

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High-Power-Density Adapters and Chargers – Challenges and Solutions

The growing popularity of mobile electronic devices such as laptop, mobile phones, tablets, e-book readers, and smartwatches has led to a wide range of different charger/adapter types.
In order to reduce electronic waste and to simplify the usage, a unification is necessary.

By Dr. Manfred Schlenk, Dr.–Schlenk–Consulting,
Alfredo Medina-Garcia and Christian Wald, Infineon Technologies

There are three topics supporting this need: 1) the USB type-C connector which provides a smaller, thinner and more robust alternative to existing USB interconnection; 2) the so-called USB-PD standard which supports a wide range of output voltages (5 V to 20 V) with power levels up to 60 W for charging different end applications; 3) Smaller form factor charger/adapter to motivate the consumer to use only one for the consumer devices used in daily life.

Smaller form factor at a given power is equivalent to an increase in power density. This market trend demands, therefore, more efficient power converters.

Introduction

The most common power topology for adapters and chargers are flyback converters. They are relatively easy to design and need only one magnetic component. However, in the past, the converter efficiency could not reach values above 90 percent. This limited the possible power density.

Recently developed zero voltage switching methods allow now higher efficiencies and therefore power densities above 15 W/in³. The well-known active clamp topology was reinvented, and different ways of ZVS-techniques were introduced to the market.

Besides the converter topology, worldwide safety standards influence to possible power density too. The temperature of touchable areas of electrical devices must not exceed certain temperatures.

Last but not least, size, shape and usage profile of the adapter also influence the possible heat dissipation and therefore the maximum achievable power density.

Topology selection

Knowing, that a standard flyback converter only allows a certain very low power density, in a very first step the most suitable topology for a high-density USB-PD adapter needs to be investigated. Therefore several topology options have been evaluated by means of multi-objective optimizations. The goal was not to exceed an operating frequency of 200 kHz so that today´s magnetic materials and components could be used easily.

As output power 65 W has been chosen with an output voltage range from 5 VDC - 20 VDC and a universal input voltage from 90 VAC – 264 VAC. The considered topologies included:

- PFC flyback with secondary side power pulsation buffer,
- flyback converter with a fixed (high) output voltage and a subsequent buck converter,
- flyback converter with a wide output voltage range,
- cascaded asymmetrical PWM flyback converter where the primary side consists of two cascaded half-bridges,
- hybrid Flyback converter (asymmetrical PWM flyback converter).

The optimization results are shown in figure 1 for full load operation at the worst case input voltage (Vin = 90 VAC) and the highest output current (Iout = 3.25 A). In addition, the thermal limit line is shown, which defines the minimum efficiency required for a given power density in order to keep the surface temperature of the adapter below 70 °C. Only designs above this line possess the necessary efficiency required to dissipate the generated heat passively (i.e., natural convection and radiation) without exceeding the thermal limit of the case. This clearly shows that the target of the highest power density is inevitably linked to the highest conversion efficiency, underlining the necessity of a comprehensive multi-objective optimization approach.

The optimization results reveal the asymmetrical flyback (see figure 2) as the best-suited topology among the considered candidates for highly compact chargers since it offers the highest efficiency.

The asymmetric flyback topology features ZVS of the primary half-bridge by utilizing the magnetizing current and ZCS of the synchronous rectification switch, and lays the foundation for the highest conversion efficiency. The converter is operated with a fixed turn-on time of the low-side switch of the primary half-bridge, which is determined by the resonance frequency, and a varying turn-on time of the high-side switch, which depends on the input voltage. This results in a varying switching frequency. Because this converter operates in mixed flyback/forward mode, it will be called hybrid flyback from now onwards.

Figure 2 shows the realized demonstrator. The adapter is designed to deliver an output power of 65 W with a peak power capability of 105 W for several milliseconds. The converter is USB-PD compliant;

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it is designed for an input voltage range from 90 VAC to 264 VAC and delivers output voltages from 5 VDC to 20 VDC. Depending on the input voltage, the demonstrator operates from 100 kHz to 200 kHz. The conducted EMI requirements according to FCC Part 15 Class B and EN 55022 Class B are being fulfilled with a 6 dB margin.

The converter efficiency reaches 93.8 percent under worst-case conditions and a peak efficiency of 95 percent. The uncased power density is around 27 W/in³. In reality, the power density of the cased converter will not be higher than 22 W/in³ to avoid a thermal runaway.

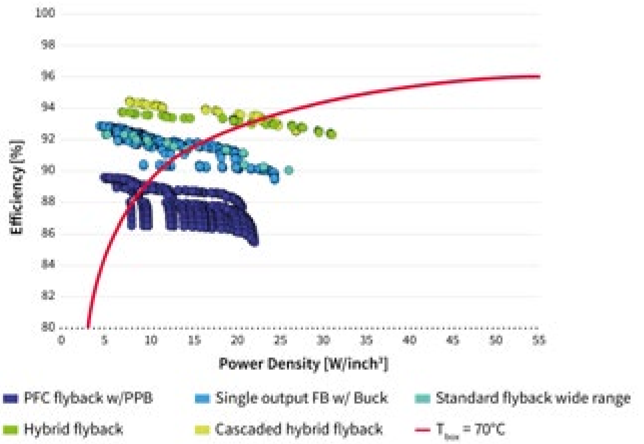


Figure 1: Multi-objective optimization results of several different adapter concepts for full load (Pout = 65 W), Vout = 20 V and low line (Vin = 90 V) operation.

For an optimum operation over input voltage, output voltage and output load the converter operates in a multimode operation which keeps the efficiency as high as possible from low-load to full-load.

Infineon´s XDP™ digital controller family embeds a microprocessor core surrounded by all digital and analog circuits needed to realize a power supply with only a few external components. The controller can be configured by the user in a very flexible way allowing optimization for different application use cases.

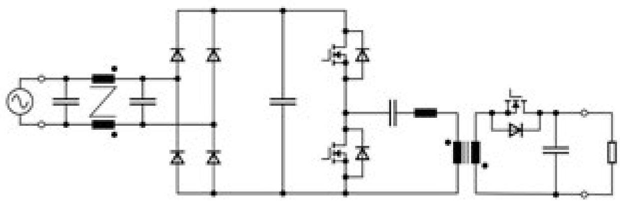
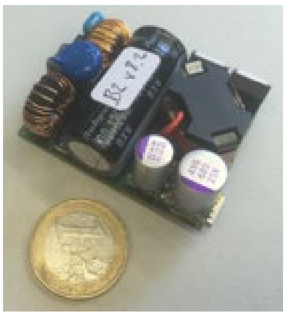


Figure 2: Hybrid flyback converter



Influence of the adapter dimensions

Power density and converter efficiency are closely linked together. A thermal simulation helped to examine the influence of the housing size and the usage profile.

For simplification, the converter was modeled and simulated as a solid copper block with certain power dissipation. Figure 3 shows the used model. As output power again 65 W was chosen, and the maximum allowed case temperature was limited to 70 °C. 1.5 mm thick Plexiglas was used as casing material, and cooling was ensured via heat transfer and heat radiation. It was also assumed that the wall plug has very low heat conduction and heat radiation.

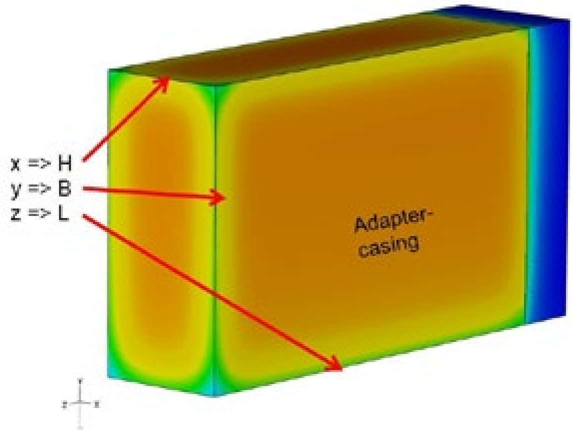


Figure 3: Simulation model

In the first step, the influence of the position of the adapter was evaluated. A 65 W adapter with a density of 15 W/in³ was used as a basis for the simulation. However, the results, shown in figure 4, are also valid for other power densities.

It was found, that the highest amount of heat can be removed by plugging the adapter directly into a wall plug (position 3d). The worst case is given if the adapter is positioned on a desk according to position 1a. Position 3d allows removing around 20% more heat than position 1a.

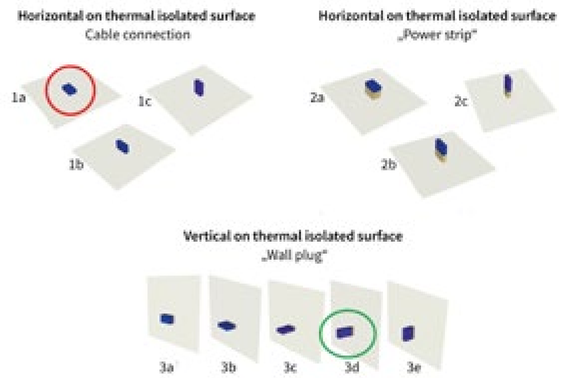


Figure 4: Influence on the position of the adapter

In the next step, the influence of the case size was investigated. The dashed line in figure 1 shows the relation between power density and converter efficiency. For the simulation, a cubical shape with a height of 19 mm was chosen because of a possible direct connection to a wall plug.

It is worth to mention that a thin and flat adapter case would not allow improving the power density. Especially in position 1a around half of the casing cannot contribute for removing the heat.

Requirements and Regulations

Figure 2 shows that the main transformer, electrolytic capacitors as well as EMI filter determine the size of the adapter. A further power density increase would only be achievable by a size reduction of these components.

One possibility is to increase the operating frequency. Theoretically, this allows reducing the size of the transformer as well as of the EMI-filter. One of the key enabling technologies for doing so – GaN power switches – is available nowadays.

The theoretical reduction in size of the transformer is caused by the fact that as an increase in frequency by e.g. a factor of 2 makes it possible to reduce the number of turns of the windings by a factor of 2 under the condition of a constant flux density and the same core geometry. This means less space for the winding is needed, and a smaller core could be used. However, core losses and also copper losses increase with the operating frequency. In order to avoid an unwanted efficiency decrease or to overheat of the component, this may require to reduce the flux density and therefore to increase the number of turns again. The needed space for the windings increases, and the transformer is becoming bigger again.

Besides this, there are requirements from the safety standards regarding creepage and clearance distances as well as the maximum operating temperature of the magnetic component, which also limits the possible size reduction. It is worth to mention, that a general safety regulation (EN 60664-4) is existing, which regulates the creepage distance depending on the operating frequency. According to this regulation, the creepage distances more than double for operating frequencies above 800 kHz.

The size of the primary bulk capacitor is determined mainly by functional requirements, i.e., ripple voltage, minimum input voltage as well as output power. Increasing the operating frequency will not help. Here requirements and capacitor size need to be adjusted.

Last but not least, an increase in the operating frequency may help to reduce the size of the EMI filter. During the filter design, parasitic effects just like stray inductances and magnetic couplings need to be taken into consideration as these could influence the functionality a lot.

Summary

USB-PD adapters are on the way to penetrate the market. New control methods just as digital regulation schemes as well as new highly efficient ZVS/ZCS topologies enhance the behavior of the good old flyback converter.

These new techniques allow to increase the operating frequency and to shrink today's bulky adapters by a factor of 2-3. The influence of the converter efficiency to the maximum possible size reduction of the converter under worst-case conditions needs to be considered. Otherwise, thermal runaway can happen.

However considering all the above-described influences the design of a reliable product with power densities of more than 20W/in³ is feasible, which allows using the same adapter for notebooks, tablets, and mobile phones and other devices.

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Ignition IGBTs: Effect of PCB Design on Ignition IGBTs Thermal Performance

Climate change and environmental concerns are driving the technical demands and technology evolution in the transportation sector. Examples of this are the constant R&D on energy efficiency, vehicles electrification, and use of alternative fuels.

By Dr. Hugo Guzmán and Jose Padilla, Littelfuse

Introduction

Emission regulations aimed at the reduction of greenhouse gases and pollutants imposed by governments around the world are getting stricter [1]. New and demanding limits, and conditions are forcing combustion engine manufacturers to create engines that are smaller in volume, work at higher RPMs and able to work with leaner fuel mixtures. On the overall, these changes in the combustion engine will affect the operating conditions of Ignition IGBTs. Foreseeable, Ignition IGBTs used in these new designs will require higher clamping voltages and energy, while being able to operate at higher frequencies. In this scenario, the thermal performance and the capability of the ignition system to effectively dissipate the generated heat will become more relevant.

In this article, the impact of the use of different thermal PCB PADs on the thermal performance of Ignition IGBTs will be presented. In particular, Littelfuse DPAK packaged Ignition IGBTs will be analyzed using different PCB PAD options considering multiple operating conditions. The provided results will show the reader the benefits of a well thought PCB PAD thermal design and its impact on the temperature evolution of the Ignition IGBTs.

Next generation combustion engines

With the increasing restrictions regarding CO2 emissions (fuel consumption) and pollutant emissions, the challenges for new Spark Ignition (SI) engines are critical. To face the new daring, SI engines are evolving following some strategies and technologies.

Between these trends, it is worth to mention the engine rightsizing and alternative combustion processes that will be mainly based on charge stratification, new fuels and dilution of the homogeneous mixture, either with fresh air or with Exhaust Gas Recirculation (EGR). To achieve the new requirements regarding the air management, changes in the gas exchange strategies are expected and some of them can also provide additional benefits on the fuel consumption thanks to the reduction of the pumping work, one of the main drawbacks of the SI engines in comparison with the more efficient Compression Ignition (CI) engines.

In order to arrange the new trends three main strategies are now of great interest for the close future. On the one hand, the enlargement of the operation range of the engine due to the new test procedure requirements. On the other hand, the trend to dilute the mixture, aimed at reducing the engine fuel consumption and thus CO2 emissions. Finally, new requirements regarding CO2 reduction and public policies are forcing manufacturers to consider hybridization as mandatory in the next future.

Engine rightsizing and hybridization might require the use of smaller cylinders, while maintaining the same throughput power. This will result in higher combustion cycle rates, which require that the ignition system works at higher switching frequencies leading to higher operating temperatures.

Diluted mixtures at low and mid load might require the use of wider gaps to ensure proper heat transfer when the combustion process is initiated. The use of wider gaps requires higher voltage ratings to initiate the arc in the spark gap and consequently, higher voltage ratings are required for the Ignition IGBT and the elements used in the ignition system.

Direct injection during the compression stroke avoids the mixture homogenization and forms a fuel rich zone in the proximities of the spark while keeping the global poor mixture, achieving an additional efficiency improvement. The fuel spray must generate favorable conditions for the combustion development at the time and location of the spark. However, the high local and temporal variation close to the spark compromise the ignition system, that ideally should cover a wide ignition space (larger electrodes gap) and a longer ignition time. These conditions would require a higher breakdown voltage and energy release in the spark.

Overall, it is foreseeable that the Ignition IGBTs used in the coming generation of ignition systems will be required to sustain higher clamping voltages and energy (and consequently higher current), while operating at conditions that inevitably will increase their thermal dissipation. Under these conditions, the Collector to Emitter ON state voltage (Vce(ON)) parameter, which is directly correlated to the ON state losses, will gain higher importance as Ignition IGBTs with lower Vce(ON) will be required in order to reduce power losses and consequently, achieve lower junction temperatures, while maintaining a small system footprint.

In the coming section, a number of experimental test results will be shown in order to demonstrate the effect of a lower Vce(ON) on the steady state temperature and to assess the impact on the thermal performance of DPAK packaged Ignition IGBTs when different thermal PCB PADs are used. A simplified scheme of the test bench setup is shown in Fig. 1, where a load inductance of 0.3 mH was used in order to emulate a common value of the leakage inductance of commer-

cially available Ignition coils. The switching frequency is set to either 33 Hz, 50 Hz, 80 Hz, 100 Hz or 150 Hz. The dwell time, or time that the Ignition IGBT is in the ON state is set to achieve 10 amps of peak current. The Device Under Test (DUT) is then placed in one of the different PCB PADs shown in Fig. 2 and left operating for 10 minutes, ensuring a steady state temperature measurement.

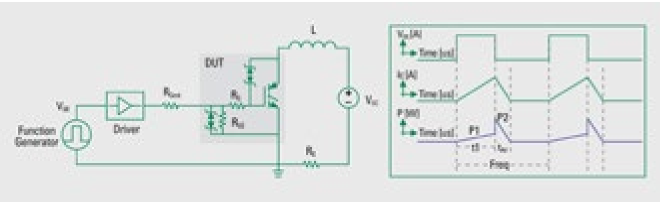

Figure 1: Simplified schematic of the testing circuit and indicative waveforms of the gate voltage, collector current and dissipated power.

Five types of PADs were analyzed considering different thermal conduction paths (Fig. 2). Namely, a PCB cutout (PAD 0) where there is no heat conduction path from the collector of the Ignition IGBT to the PCB, a PAD with the same area as a DPAK packaged IGBT (PAD 1), a PAD with the same area as a DPAK packaged IGBT but including heat spreaders from the top to the bottom of the PCB (PAD 2), and two PADs with the recommended PAD area for a DPAK packaged device (twice the area of the device), without (PAD 3) and with thermal heat spreaders from the top to the bottom of the PCB (PAD 4).

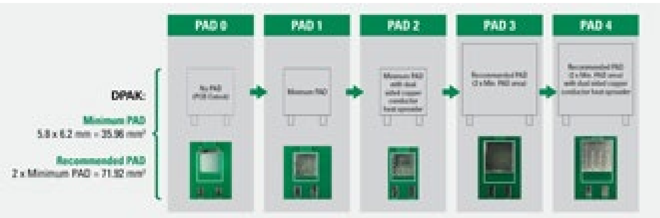

Figure 2: Different PCB pads considered during the thermal analysis.

Let us first quantify the effect of a lower Vce(ON) on the thermal performance. The Ignition IGBTs used in the comparison are Littelfuse DPAK packaged NGD8201A (Vce(ON)typ<1.35V), and a commercially available Ignition IGBT (Vce(ON)typ<1.5V) labeled as "Ignition IGBT A". These devices where chosen, as they possess similar electric and physical die characteristics and equivalent current and energy ratings. Fig. 3 summarizes the measured steady state case temperatures achieved when working under 33 Hz and 150 Hz considering the different PCB PADs. It is possible to see that the slightly higher ON state voltage of "Ignition IGBT A" results in a slightly higher steady state temperature, regardless of the PCB PAD used. As expected this effect is more noticeable at high switching frequencies. Notice also that the use of different PCB PADs results in different steady state case temperatures.

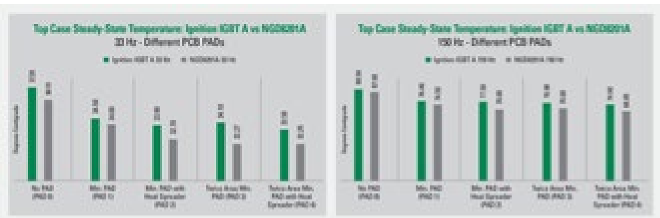

Figure 3: Effect of a lower Vce(ON) in the steady-state temperature.

The effect of the use of the different PCB PADs can be further analyzed in Fig. 4, where the steady state case temperature for the NGD8201A is shown when different switching temperatures and PADs are considered. Once more, the results show that the use of a higher switching frequency results in higher steady state temperatures. However, of special importance is the effect of the PAD on reducing the measured temperature, especially when working at high switching frequencies. For instance, notice how the steady state temperature when working at 150 Hz is reduced from ~90 C to ~70 C when the minimum PAD with heat spreaders between top and bottom layer (PAD 2) or a PAD with the recommended area (twice the area of a DPAK, PAD 3) are used.

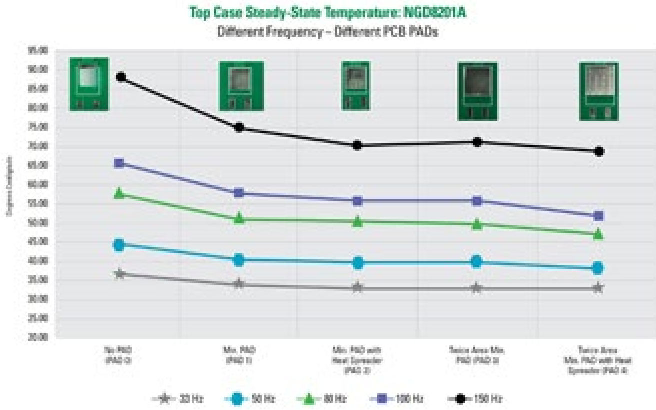

Figure 4: NGD8201A top case steady state temperature obtained under different switching frequencies using different PCB PADs.

For a better comparison, the obtained steady state case temperature under different frequencies are plotted when using the minimum PAD with heat spreaders between top and bottom of the PCB (PAD 2) and the recommended PAD of twice the area of a DPAK (PAD 3). It is shown that regardless of the switching condition, these two PADs can offer the same averaged thermal dissipation capability. This is of special importance in Ignition platforms in which size needs to be considered.

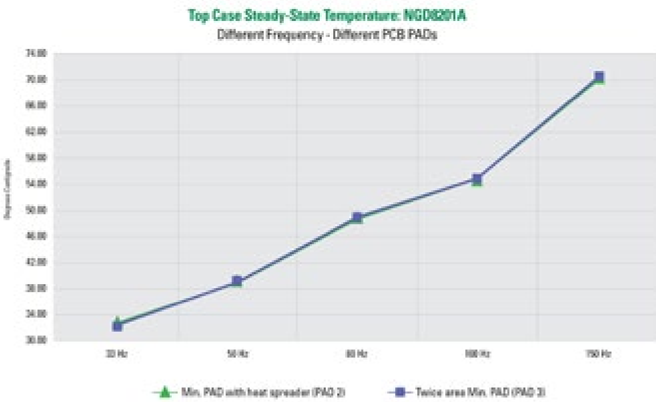

Figure 5: Steady-state case temperature of the NGD8201A using a PCB with the minimum PAD area with heat spreaders between top and bottom layer (PAD 2) and a PAD with the recommended area (PAD 3).

The increasing concern for the development of environmentally friendly transportation systems is leading governments to impose demanding regulations aimed at reducing vehicles CO2 emissions and fuel consumption. To comply with these regulations, the automotive industry has to design engines that ensure combustion efficiency, which in turn require Ignition IGBTs capable of sustaining increased voltage levels while providing low power dissipation at increasing switching frequencies. It has been demonstrated that the use of Littelfuse Ignition IGBTs devices which offer lower Vce(ON) together with an appropriate PCB design that considers an optimum thermal dissipation can ensure safe operation in the harsh working conditions inherent to the automotive industry.

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Jose Padilla joined Littelfuse in October 2016 as Global Product Marketing Manager for Ignition devices, extending his role to all Discrete IGBTs from November 2018. Before joining Littelfuse he was Product Marketing Manager at Fairchild, and application engineer for EVs at Infineon Technologies. From 2007 to 2011 he worked at AICIA, a research institute in Andalusia, Spain, dealing with power electronic converters for grid efficiency improvement. Jose is based in Valencia, Spain, and can be reached at jpadilla2@littelfuse.com.

Flyback Transformer Specification Made Easy with Power Stage Designer

It is widely accepted that the popular isolated topology is the flyback. Technology has developed vast amounts in the last few years, meaning that today modern flyback controllers are able to modulate switching frequency and primary peak current. Historically, this kind of modulation technique needed a custom-made transformer, which often complicates design and development. In this article, Texas Instruments' outlines the key methods that can help speed up and simplify the process.

By Florian Müller, Texas Instruments

Flux
Let's begin with Flux. The current that flows through the windings of a transformer produces a magnetomotive force (MMF) that generates a magnetic flux inside the core, which is invariably limited by the reluctance of the core.

Unfortunately, low core reluctance leads to a high magnetic flux, which can push the transformer into saturation. A minimum number of primary windings is needed to limit the flux, while an air gap can be used to further reduce the flux.

Skin and proximity effect
When AC current flows through a wire, the current flow in the outer regions of the wire's cross section is larger compared to the centre, because eddy currents reduce the current flow in the centre. As the frequency increases, the current is pushed towards the surface of the wire – a phenomenon is called "skin effect." Another similar anomaly is called the proximity effect, which occurs when there are windings side by side. The skin and proximity effects increase the AC resistance of the winding, reducing the AC resistance but increasing the DC resistance.

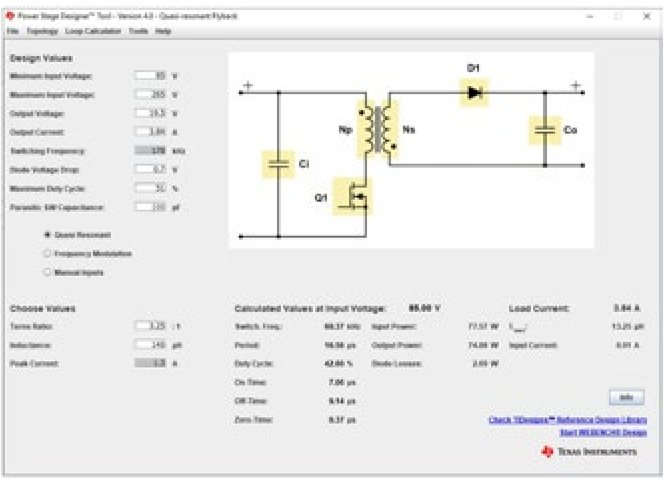

Figure 1: The Power Stage Designer (PSD) tool from Texas Instruments

Leakage inductance
Leakage inductance is caused by magnetic flux that is unable to couple with other windings. Though there are ways to avoid this, it complicates the design process.

Typically, a power supply designer works in collaboration with a transformer manufacturer, meaning the designer doesn't usually need to consider skin, proximity or the parasitic effects of the transformer. The transformer manufacturer has to remedy these concerns with solutions including: fill factor, current density, windows-area product, air gap to provide the best transformer structure, core and bobbin for the application.

Before anything else, the design engineer must provide the manufacturer with a light version of the specification, an outline of which can be found below:
- Turns ratio
- Primary inductance
- Leakage inductance
- Volt second product
- Frequency range
- Rms and peak currents
- Safety, isolation requirements
- Preferred winding structure.

The Power Stage Designer (PSD) tool from Texas Instruments can be used to create mini specs like the one above. The main creation window of the PSD tool displays different topologies. After clicking on the Quasi-resonant flyback picture, a new window displays the schematic with a set of input fields and various output values. The parameters (e.g. input voltage, output voltage, load current) of the power supply specification can be entered here.

Turns ratio
The turns ratio from the primary winding to the secondary winding defines the reflected voltage. It influences the valley of the switchnode resonant ringing, the maximum Mosfet drain-source voltage, and the rms and peak currents.

Choosing the optimal turns-ratio for a specific application is an iterative process. The PSD tool is useful here, as it displays all values when changing the turns ratio. A good turns ratio starting point is to choose a value which results in a flyback voltage that is equal to the minimum input voltage.

Primary inductance
There are two kinds of flyback modulating techniques with variable frequency. The first, a valley switching technique, modulates the switching frequency while simultaneously keeping the primary peak current constant. The controller always operates in discontinuous conduction mode (DCM).

The second, a quasi-resonant technique, modulates the switching frequency and the primary peak current simultaneously in order to switch on the first valley of the resonant ringing, which occurs just after the demagnetising time. The controller operates at the boundary between CCM and DCM, which is sometimes called transition mode.

You can choose both techniques in the PSD Tool (see Figure 1).

A good starting point when specifying the primary inductance is to choose a primary inductance that allows the controller to operate in transition mode for full load and minimum input voltage.

Therefore, you should choose the “Quasi Resonant” operation and select minimum input voltage Vin_min. Typically, the datasheet of a controller shows the Control Law Profile. Figure 2 shows an example of the UCC28742 datasheet.

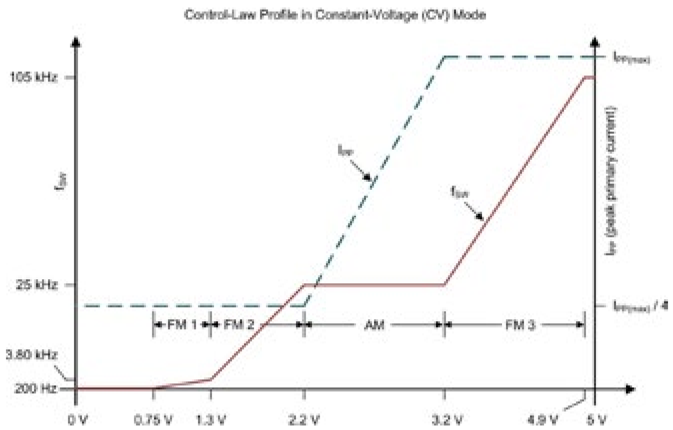

Figure 2: Example of the UCC28742 datasheet

As seen above, the controller is operating with a valley switching technique (from medium to full output power, Vcl > 3.2V), because it varies the switching frequency while keeping the primary peak current (I_pp) constant.

Now select “Frequency Modulation” in the PSD tool and then enter the primary peak current Ipp. Take the value “Ipp_QR” (from Quasi Resonant operation at minimum input voltage), which will typically provide a solid starting point. For fine tuning, the primary inductance and primary peak current can be changed iteratively. Always check that all voltages, currents and the switching frequency are within the limits of the controller and powerstage (for Vin_min and Vin_max).

The next important check is to ensure that the minimum ontime of the controller won’t be violated. Take the primary peak current Ipp_min for light load from the datasheet or the control law (note it’s typically much smaller than Ipp_max) and enter this value in the PSD, checking the minimum on-time for Vin_max. The on-time must be larger than the minimum on-time of the controller. If this isn’t the case, it means the primary inductance must be increased.

Maximum leakage inductance
The energy stored in the leakage inductance is typically dissipated in a snubber network and, therefore, decreases efficiency. Hence, it’s vital the leakage inductance be as small as possible.

Volt-second product and switching frequency range
The next point is the volt-second product. Based on equation 1, the minimum number of primary windings to prevent saturation of the core

$$\text{Primary\_Windings}_{min} = \frac{\text{VoltSeconds\_max}}{A_e \cdot B_s}$$

can be identified. The volt-second product is simply the maximum primary voltage times the maximum on-time of the controller. The maximum primary voltage, on-time and the maximum switching frequency can easily be calculated by the PDS tool.

A typical value for the flux Bs = 300mT if a ferrite core is used. This value can be reduced to 200mT for applications that need a higher margin. The effective core area is defined by the given core.

The switching frequency range shows the PSD tool. Note the values for minimum and maximum input voltage.

Rms and peak currents
The PDS tool provides the maximum peak currents, as well as root mean square currents of the primary and secondary side.

Winding structure
Typically, modern flyback controllers need a good coupling of the auxiliary winding, mainly because the controller gathers information from this winding that’s needed for a stable operation. A recommended winding structure is called the “sandwich” technique. Here, the primary is split with the auxiliary bias and the secondary layer is sandwiched in between, resulting in effective coupling of the windings.

Conclusion
The transformer is the most important component besides the controller and plays a critical role in driving performance. Because the complex specification must be carried out so carefully, the PSD tool is extremely helpful in avoiding mistakes early on in the design stage. It speeds up the process and serves as a quick and effective sanity check.

Power Stage Designer calculates the voltages and currents of 20 other topologies, and it also contains a Bode plotting tool and toolbox with various functions to make a power supply design easier. Texas Instruments provides this tool for free.

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High-Precision Winding Testing with a New Type of Impulse Winding Tester

An Innovative Method for Evaluating Winding Reliability Using Characteristic Distribution of LC and RC

Impulse testing, also known as surge testing, is regarded as one of the most effective ways to evaluate winding reliability. At the same time, because it relies on comparing test waveforms with a reference waveform from a known-good winding, it struggles to test minuscule waveform variations with an acceptably high degree of precision.

By Yuki Maita, HIOKI E.E. CORPORATION

Introduction

With conventional testing methods, impulse testers infer the presence of defects in a winding by applying an impulse voltage across the windings' terminals and observing the waveforms that result. The method offers an exceptional technique for detecting wire breaks, shorts between phases, and variations in inductance in windings.

Recently, the space factor [1] of stator windings has been increasing as manufacturers look to reduce the size of electric motors such as those used to drive electric vehicles. Partial discharge (PD) occurs in such motors when insulation performance between wires is compromised by increasingly high drive voltages and surge voltages caused by inverter control, posing the risk of significantly lower reliability during the motors' use.

Hioki developed the Impulse Winding Tester ST4030A to resolve these issues. This article describes the characteristics of the ST4030A and offers some measurement results obtained using the instrument.

Pass/Fail Decision Based on Characteristic Distribution

The conventional method of identifying windings as either defective or non-defective based on differences in waveform area suffers from a number of problems:

- Difficulty distinguishing between defective and non-defective windings when differences in area are minuscule
- Difficulty assigning physical and quantitative significance to calculation results that consist of differences in area
- Difficulty identifying threshold values
- Difficulty managing enormous volumes of waveform data in applications where it is desirable to retain such data

On the other hand, the ST4030A uses characteristic distribution,[2] a parameter identification technique proposed by Toenec Corporation, as one of its evaluation standards. The characteristic distribution method identifies two parameters of key importance for characterizing attenuating oscillation waveforms obtained from impulse testing (elements of oscillation frequency and attenuation).

In line with previous studies(1), this article will describe the two parameters used in characteristic distribution as LC and RC characteristics. These characteristics are the products of the resistance component R, the capacitance component C, and the inductance component L of the equivalent circuit shown in Figure 1 for the instrument and workpiece under test, in the sense of L × C (LC) and R × C (RC). The former corresponds to oscillation frequency and the latter to attenuation in the attenuating oscillation waveform.

The ST4030A provides functionality for displaying the LC and RC characteristics obtained from test oscillation waveforms as a scatter diagram and for making judgments based on whether the characteristics obtained during testing fall within a user-defined pass area (Figure 2).

Compared to the conventional method of screening windings based on differences in waveform area, evaluation based on characteristic distribution offers the following advantages:

- It allows configuration of a visually clear judgment area.
- It is possible to sort windings in motors already installed with a rotor - a task that is considered difficult to accomplish using the conventional method. This is possible because tested windings can be sorted into defective and non-defective categories by setting a pass area as appropriate relative to a distribution that reflects changes in rotor position.
- It allows the nature of workpiece defects to be inferred based on the characteristic distribution(2).

Another advantage of pass/fail decisions based on characteristics lies in the technique's high sorting capability. Consider an example of the difference between the

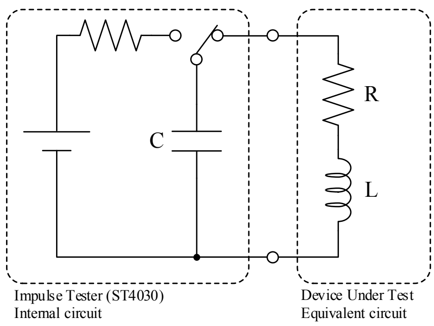


Figure 1: Equivalent circuit model for identifying LC and RC characteristics

1 *The percentage of the coil's cross-sectional area that is occupied by wires*

2 *Patented by Toenec Corporation*

conventional method of waveform comparison and the sorting capability of an approach based on LC and RC characteristics. Fig. 2.3 illustrates the changes in the test voltage waveform and in LC and RC characteristics when a slight change is applied to a workpiece under test. An impulse test was repeated 100 times before the slight change ("Before" in the legend) and after the slight change ("After" in the legend) and variability in measured values was checked under the same conditions using LC and RC characteristic distribution. (The figure includes only voltage oscillation waveform values for 1 cycle before and after the slight change.)

An examination of Figure 3 reveals that although no significant difference can be observed in the outline of the before and after waveforms using the conventional method of waveform comparison, a clear

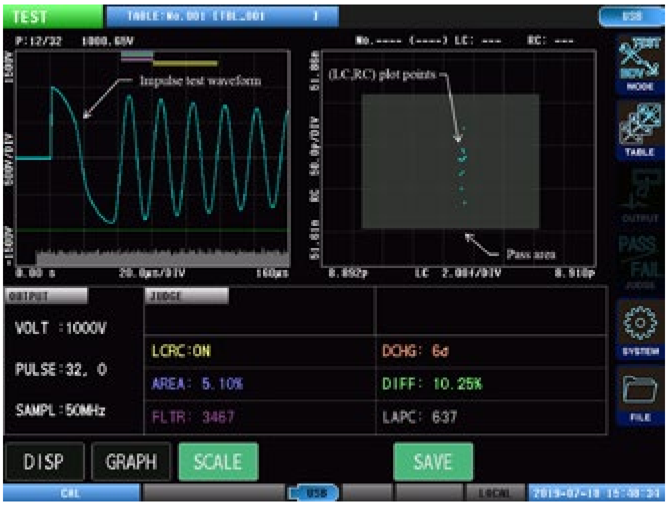


Figure 2: LC and RC characteristic distribution and pass area (shown in gray) on the ST4030A

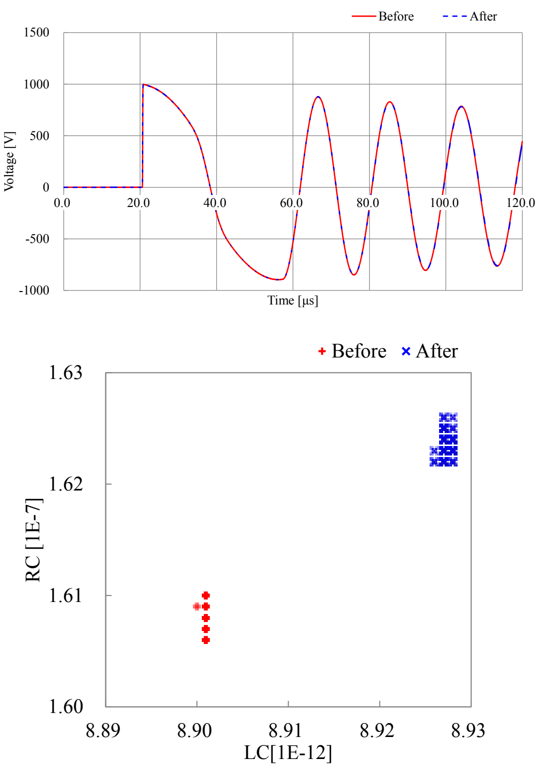


Figure 3: Comparison of waveforms (top) and characteristics (bottom) when slight changes are applied to a winding

difference can be seen in the distribution of LC and RC characteristics before and after the change. Those results indicate the viability of sorting, even when variability in measured values is taken into account. The high sorting capability of LC and RC characteristics offers advantages for detection of minuscule changes such as would be introduced by a single-fault turn in a winding, a defect that would be difficult to identify with conventional waveform comparison.

Partial Discharge Detection Option ST9000

Development Process
Researchers have proposed a number of testing techniques for identifying changes in impulse oscillation waveforms caused by partial discharges. Typical examples of such numerical calculation techniques include Flutter and Laplacian calculation. For convenience' sake, this article will use the abbreviations FLTR and LAPC to refer to the results of those calculations. The ST4030A implements these two calculations as follows:

Both calculations are based on differential calculation as practiced in the field of discrete mathematics. Although they offer the advantage of being simple enough in terms of processing that a single impulse tester can estimate partial discharge magnitude while carrying out impulse testing, they pose the following problems:

- Calculation results take the form of the sum of voltage differential values such as those shown above, making it difficult to assign meaning to threshold values.
- The effects of the noise component contained in the oscillation waveform cannot be ignored.

Hioki addressed the above potential problems with the ST4030A by combining high-precision waveform detection capability—one aspect of the instrument's fundamental performance—with newly developed digital signal processing technology in a sophisticated manner to develop a proprietary solution in the Partial Discharge Function ST9000.

Characteristics of the ST9000
The ST9000's most distinguishing characteristic is its ability to isolate the partial discharge component from the Gaussian noise component that exists to a certain extent in test waveforms. The function uses the following calculation process to detect the partial discharge component:

- It extracts only the noise component from the test voltage waveform using digital signal processing.
- It standardizes the magnitude of the extracted noise component using its standard deviation.
- In the event of a partial discharge, the amount of deviation will exceed that observed in a non-defective winding.

Compared to conventional methods such as Flutter and Laplacian calculation, partial discharge detection processing as implemented by the ST9000 offers the following advantages:

- Since the process yields a discharge waveform that is synchronized with the time axis of the test voltage waveform, locations of waveform fluctuation that correspond to partial discharges can be clearly identified.
- Since calculation results are standardized, there is no need to set judgment levels (although they can be adjusted).

PDIV Testing with the ST9000
Hioki designed the ST4030A with a breakdown voltage (BDV) function to allow operators to take further advantage of the ST9000's partial discharge detection capability. This function evaluates voltages that trigger fail decisions while gradually increasing the voltage applied to the workpiece under test. IEC/TS 61934 defines the partial discharge inception voltage (PDIV) as the voltage at which a partial discharge is first detected while increasing the voltage.

As illustrated in Figure 5, an experimental setup was prepared in which a twisted pair consisting of tinned wire and enameled wire is connected to the terminals of a standard winding while the ST4030A was configured to display the test screen while using the BDV function (Figure 4). The screenshot shows a fail result for partial discharge detection judgment ("DCHG" on the screen) at 700 V, indicating that the PDIV for the workpiece under test is 700 V.

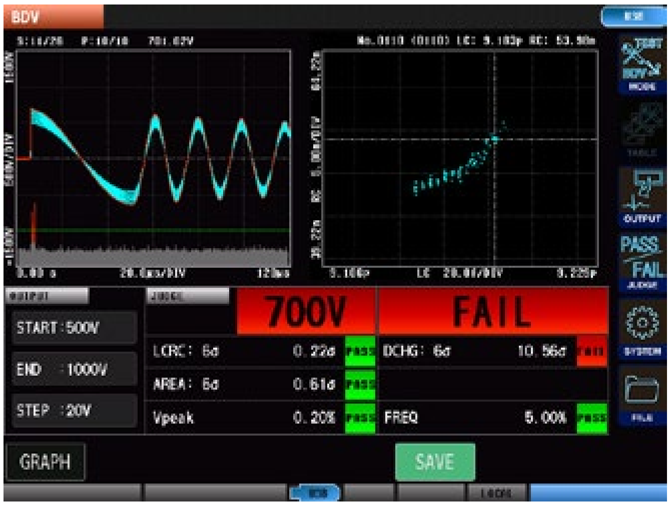


Figure 4: The ST4030A's BDV function

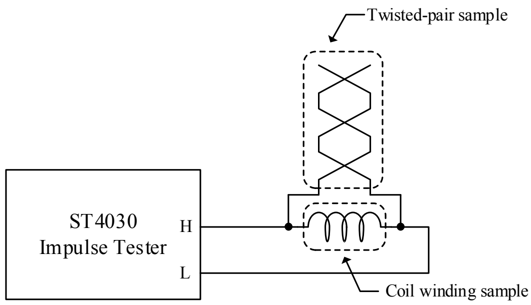


Figure 5: Partial discharge detection experimental setup

ST9000 Decision	FLTR	LAPC
No discharge	1393	872
No discharge	1403	891
No discharge	1397	852
Discharge	1409	890

Table 1 Occurrence of discharge and changes FLTR/LAPC values

Comparison of the ST9000 with Conventional Methods
This section offers an example of how the ST9000 improves partial discharge detection capability. When four impulse tests were conducted after setting the ST4030A's application voltage to 720 V using the setup shown in Figure 5, the ST9000 detected discharge during only one of the tests. The figure above and table below provide FLTR and LAPC values as well as the oscillation waveform obtained during discharge testing. Calculation of FLTR and LAPC values was limited to the interval indicated in Figure 6.

An examination of Table 1 reveals no clear, significant differences in FLTR and LAPC values, regardless of whether discharge occurred, making it difficult to check for partial discharge phenomena based on these results.

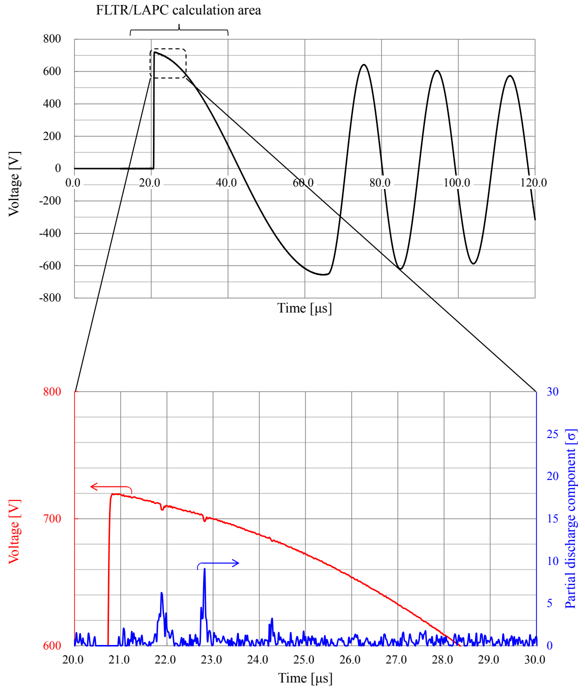


Figure 6: Test oscillation waveform at partial discharge detection and enlarged view of area in question with partial discharge magnitude

By contrast, an examination of the partial discharge detection results from the ST9000 reveals a clear increase in the amount of deviation, which indicates partial discharge, at the same locations as the high-frequency components that can be observed in the oscillation waveform. Furthermore, detection precision can be maintained at approximately the same level even if the calculation interval is set to the entire waveform.

Conclusion

This article has introduced the characteristics of Hioki's Impulse Winding Tester ST4030A along with examples of actual measurement.
It reviewed the many advantages of the characteristic distribution judgment capability provided by the ST4030A compared to the conventional approach of waveform area comparison judgment. It also described how partial discharge components that cannot be detected using conventional numerical calculation methods can be clearly extracted by using the Partial Discharge Function ST9000.
It is the author's hope that this article will prove to be useful in customers' testing of windings and motors.

References

1) Hisahide Nakamura: "Use of Impulse Testing to Diagnose Shorts in Stator Windings in Low-voltage Induction Motors," Transactions on Electrical and Electronic Engineering D, Vol. 132 No. 9 pp.915-921.
2) Hisahide Nakamura and Yukio Mizuno: "Efficient Diagnosis of Shorts and Insulation Degradation in Electric Motor Stator Windings," Transactions on Electrical and Electronic Engineering D, Vol. 132 No. 2 pp.258-267.

www.hioki.com

40 V Input, 3.5 A Silent Switcher µModule Regulator for Automotive and Industrial Applications

Low Noise Silent Switcher Architecture Simplifies EMI Design

Automotive, transportation, and industrial applications are noise sensitive and demand low EMI power solutions. Traditional approaches control EMI with slowed down switching edges or lower switching frequency. Both have undesired effects, such as reducing efficiency, increasing minimum on- and off-times, and requiring a large solution.

By Zhongming Ye, Analog Devices, Inc.

Alternative solutions such as an EMI filter or metal shielding add significant costs in required board space, components, and assembly, while complicating thermal management and testing.

Our low noise µModule® technology offers a breakthrough in switching regulator design. The LTM8003 regulator within the µModule package uses a proprietary Silent Switcher® architecture to minimize EMI emissions while delivering high efficiency at high switching frequencies. The architecture of the regulator and the internal layout of the µModule device are designed so that the input loop of the regulator is minimized. This significantly reduces the switching node ringing and the associated energy stored in the hot loop, even with very fast switching edges. This quiet switching offers excellent EMI performance while minimizing the ac switching losses, allowing the regulator to operate at high switching frequencies without significant efficiency loss.

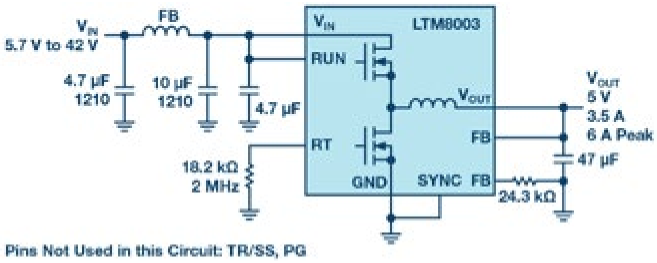


Figure 1: A 5 V converter with a simple EMI filter at the input passes CISPR 25 Class 5.

This architecture, combined with spread spectrum frequency operation, greatly simplifies the EMI filter design and layout, which is ideal for noise sensitive environments. Figure 1 shows a simple EMI filter on the input side, enabling the demo circuit to pass the CISPR 25 Class 5 standard with plenty of margin, as shown in Figure 2.

Continuous 3.5 A with Peak Current Capability 6 A

The internal regulator is capable of safely delivering up to 6 A of peak output current, and no extra thermal management—airflow or heat

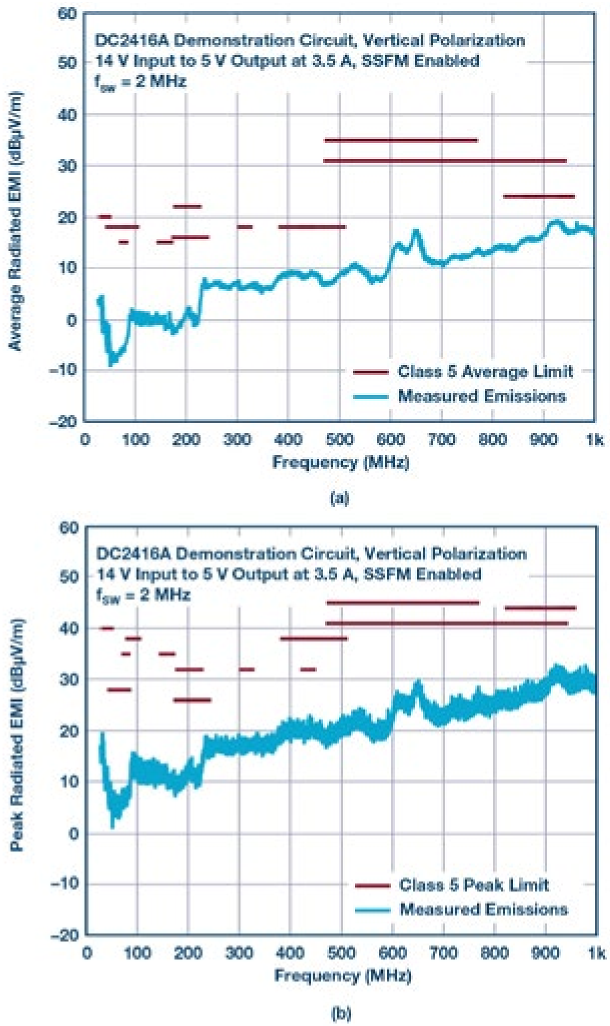


Figure 2: DC2416A demonstration circuit passes radiated EMI spectrum CISPR 25 Class 5.

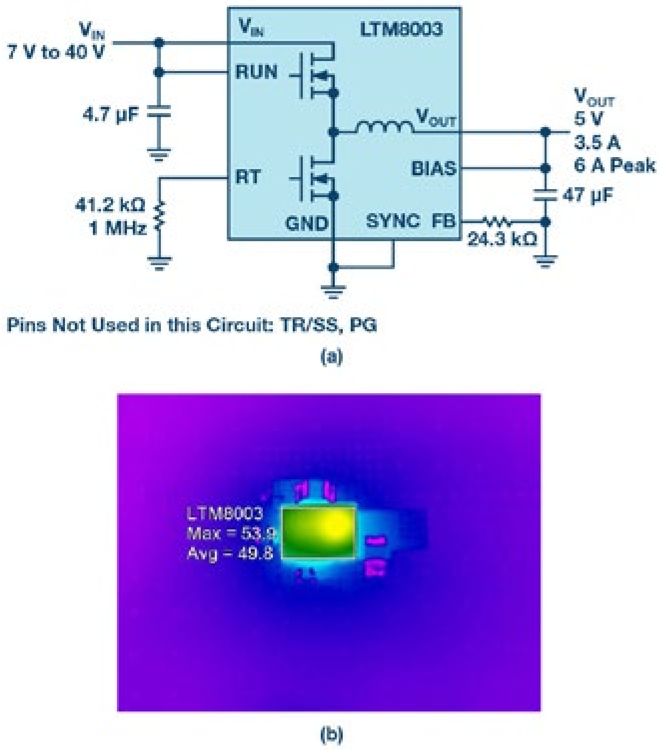


Figure 3: A 5 V, 3.5 A solution for 7 V to 40 V inputs using the H-grade version. Thermal imaging shows no need for bulky heat mitigation components.

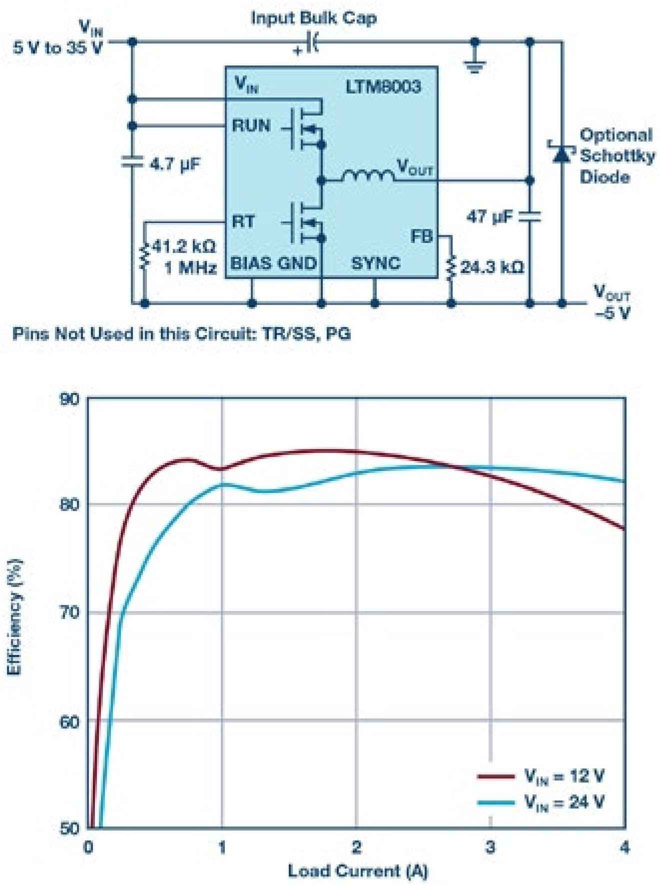


Figure 4: A –5 V supply from a +5 V to +35 V input delivers current up to 4 A

sink—is required for the LTM8003 to continuously support a 3.5 A load at 3.3 V or 5 V from a nominal 12 V input. This meets the needs of the battery-powered applications in industrial robotics, factory automation, and automotive systems.

Wide Operation Temperature Range from –40°C to +150°C
Automotive, industrial, and military applications require power supply circuits to operate continuously and safely in ambient temperatures over 105°C or require significant headroom for a thermal rise. The LTM8003H is designed to meet specifications over a –40°C to +150°C internal operating temperature range. The internal overtemperature protection (OTP) monitors the junction temperature and stops switching when the junction temperature is too hot.

Figure 3a shows a 3.5 A, 5 V solution that operates from a wide-ranging 7 V to 40 V input. The thermal performance at a nominal 12 V input is shown in Figure 3b. The typical efficiency is above 92% with a 12 V input and 2 A load.

Negative Output –5 V from +3.5 V to +35 V Input
Figure 4 shows a solution for a –5 V, 4 A output from a nominal 12 V input, with a maximum of 35 V input. The BIAS pin should be connected to GND.

Conclusion
The LTM8003 is a wide input and output range, low noise, 3.5 A step-down µModule regulator featuring the Silent Switcher architecture. Inputs from 3.4 V to 40 V can produce outputs from 0.97 V to 18 V, eliminating the need for intermediate regulation from batteries or industrial supplies. The pinout is specifically designed to be FMEA compliant, so the output stays at or below the regulation voltage during adjacent pin shorts, single-pin shorts to ground, or pins left floating. Redundant pins enhance electrical connections in the event a solder joint weakens or opens due to vibration, aging, or wide temperature variations, such as in automotive and transportation applications.

A complete solution fits a compact space not much larger than the 6.25 mm × 9 mm × 3.32 mm, BGA footprint of the LTM8003, including the input and output capacitors. The quiescent current of typically 25 µA and wide temperature operation from –40°C to +150°C (H-grade) make it ideal for circumstances where space is tight, the operational environment is harsh, and low quiescent current and high reliability are mandatory. Its features help minimize design effort and meet the stringent standards for industrial robotics, factory automation, avionics, and automotive systems.

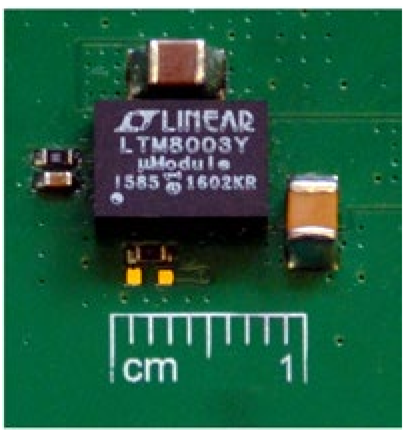


Figure 5: A complete step-down solution is barely larger than the 6.25 mm × 9 mm footprint of the LTM8003 µModule regulator.

www.analog.com

Analytical Model of an LLC Converter with a Constant Power Load

The development of power conversion in the fields of electric vehicle, medical equipment, consumer goods, etc. combined with the need of high efficiency, has pushed the LLC architecture to the top. INFINERGIES, a power electronic design office, started thinking about new analytical models for this architecture.

By Oumar Thiam, Adrien Thurin and Julien Ménagé, INFINERGIES

Introduction

In the domain of power electronic, the LLC converter is becoming more and more popular due to its interesting properties such as high boosting efficiency and low switching losses. But designing of such converter is quite challenging, and most of the time we need a mathematical model which generally uses a resistive load. This model has limitations and one of them is that loads in general aren't only resistive at all time. In fact, the output voltage and current levels are variable depending on the needs. Most of the time the main output characteristic will be the power level because the load could be for example a point of load converter operating as a power load, as it maintains a constant output voltage for a constant-current load regardless of input voltage variation. In other applications, such as battery charger, the control law of the converter can impose a behaviour on the load, in which case it is preferable to deliver a constant power to the battery in order to minimise its charging time. As a consequence, model based on constant power loads seems more suitable when designing LLC converters.

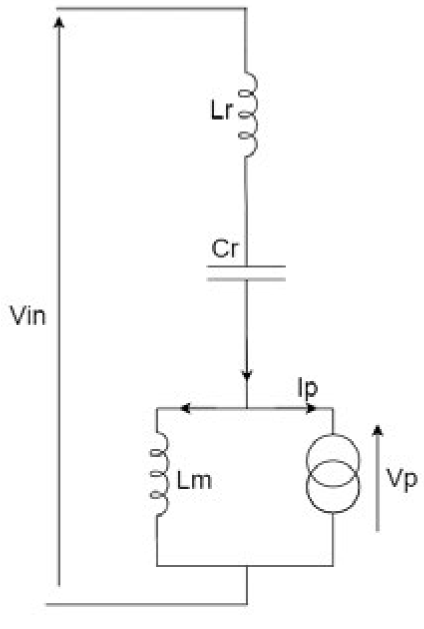


Figure 1: Primary-side model of the LLC converter

The power Model

This model for the LLC converter is focused on the primary side. The rectifier and load on the secondary side are modelled as a primary side current source, whose current is output-voltage dependant. The power used by the current source is equivalent to the power used by the load. The first harmonic approximation is applied both to the input and output voltage. The resulting model is as shown on figure 1.

The first harmonic approximation of the output voltage as seen on the primary side is:

$$V_p = \left(\frac{4 * n}{\pi}\right) * V_{OUT}$$

Where Vout is the output DC voltage, and n the transformer turns ratio Np/Ns. Since both the voltage and current are sine waves in first harmonic approximation, the output power Pout is:

$$P_{OUT} = V_{OUT} * I_{OUT} = \frac{V_p * I_p}{2}$$

Where Ip and Vp are in phase, and therefore, the first harmonic approximation of the current is:

$$I_p = \frac{1}{n} * \frac{\pi}{2} * I_{OUT}$$

Likewise, for a full bridge LLC, the input voltage first harmonic approximation is:

$$V_{in} = \left(\frac{4}{\pi}\right) * V_{dc}$$

Where Vdc is the input DC voltage.

Vout and Iout both depend on the input voltage (Vin), the targeted output power level (Pout), the resonant inductor value (Lr), the resonant capacitor value (Cr), the magnetizing inductor value (Lm), the switching frequency (f) and the transformer turns ratio (n). The Vout curve represent the output voltage that the system should provide for a fixed output power and at a defined switching frequency.

Model verification and limitations

To verify our power model, we needed to compare results such as output voltage curves to ones from a common design which will be our benchmark. We went and used the common method seen is general application notes from semiconductor manufacturers using a resistive load and we calculated values for Lr, Cr, Lm and n using the following specifications given for a battery charger:

- Vin = 400 V
- Vout = 250 - 500 V
- Pout = 7 kW
- Fres = 180 kHz
- Fmin = 100 kHz
- Fmax = 350 kHz

The calculated component values to respect the above specifications are, for instance:

- Lr = 11 µH
- Cr = 73 nF
- Lm = 21 µH
- n = Np/Ns = 1
- Rout = 8.9 Ω (7kW for Vout = 250 V)
- Rout = 21 Ω (7kW for Vout = 380 V)
- Rout = 36 Ω (7kW for Vout = 500 V)

From the application notes data, we deduce a Vout expression (output voltage) for a fixed value of resistor which corresponds to only a single power level at a given frequency. Therefore, the output power level won't be constant through a range of switching frequencies. In fact, it will vary according to the switching frequency. Pout is function of the switching frequency:

$$P_{OUT}(f,R) = \frac{\left(V_{OUT}(f,R)\right)^2}{R}$$

This varying output power will be used in our model to compare to the standard resistive-load-based model. With such a varying power, our power load model should be equivalent to the resistive load model, which will allow for a comparison of the two models. Figure 2 shows the voltage versus frequency curve based on the resistive load model from the application notes (Vout_AN), and the voltage versus frequency curve based on the power load model (Vout_PM), with a power load varying based on the frequency as it would with the resistive model, such that the power used by the load in both models are identical at all frequencies.

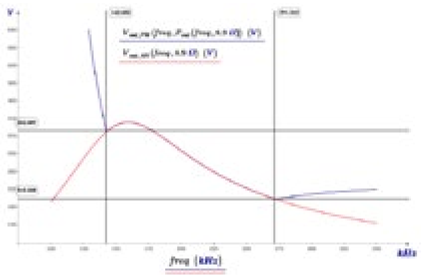


Figure 2: Output voltage of the LLC converter with a resistive load model, and with a constant power load model using a resistive load of 8.9 Ω

As we can see, there is a significant frequency range (143 kHz – 272 kHz) where both curves are superposed. This demonstrates that our model is valid across this frequency range.

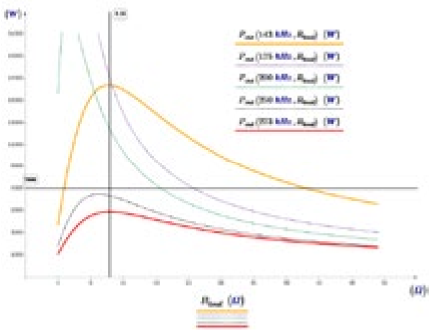


Figure 3: Power delivered by the LLC converter with a resistive load

From 143 kHz to 272 kHz, for Rout = 8.9 Ω, both curves are completely identical. But below 143 kHz and above 272 kHz, they aren't equivalent anymore. Figure 3 shows the output power of the LLC (resistive load mode) for fixed frequency values and Rout ranging from 1 Ω to 50 Ω.

We can see from this set of curves that, at the frequencies where both models stop matching, the power used by the load behaves differently for resistive values above and below the value used in figure 2. For higher resistive values, the power used by the load decreases as the resistive value increases. The condition below, in this case, is respected:

$$\left(\frac{dP_{OUT}(f_{req},R)}{dR}\bigg|_f < 0\right)$$

Additional verifications show that for any resistive load above this threshold value, the power load model and the resistive load model match at this frequency. We can generalise the principle as follows: the constant power model and the constant resistance model are consistent for any load and frequency where the following condition is respected:

$$\frac{d\left(\frac{V_{out\_AN}(f_{req},R)^2}{R}\right)}{dR} < 0$$

The reason for the mismatch between the two models is that there are two different resistive loads for every possible power level that can be reached by the converter. For a constant power load, only one of them is a stable equilibrium. The constant power model only matches the resistive model when the equivalent resistive load is the stable equilibrium setpoint.

It should be noted that simulation results match with the mathematical model, including in conditions where the two models diverge. Such a comparison is too long to be detailed in this article.

Model results

Now that we have verified that the constant power load model is consistent with the literature, we can confidently predict the behaviour of an LLC converter with such a load. Figures 4 shows a comparison of the output voltage of the LLC converter with a constant power load and a resistive load. The plot compares a resistive load model of 11 Ω and a constant power load model of 7000 Watts.

As we can see on these plots, there are 2 points of intersection between the two curves. The first one is at the resonant frequency which is always happening regardless of the power level because for both models, the output voltage is independent of the load at the resonant frequency. The second one is at the frequency where the loads in both models are equivalent, here at 234 kHz: at this frequency, the resistive model predicts a 7000 W output power for an 11 Ω load resistance, and therefore it intersects with the 7000W constant power model curve (see Figure 4).

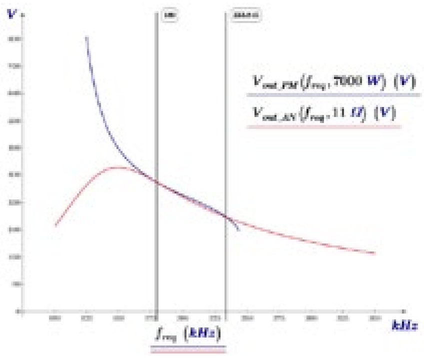


Figure 4: Output voltage of the LLC converter with a resistive load and a constant power load

Figure 4 reveals two significant differences between the two models. The first difference is that there is a limit to the power that can be delivered by the converter at a given frequency, and this maximum power decreases as the frequency increases from a threshold value. The equation of the output voltage as a function of frequency and power doesn't have any real solution above a certain frequency. This means that it is impossible for this converter to deliver 7 kW for frequencies above 243 kHz. Figure 5 shows that lower power levels can be reached at frequencies higher than 243 kHz.

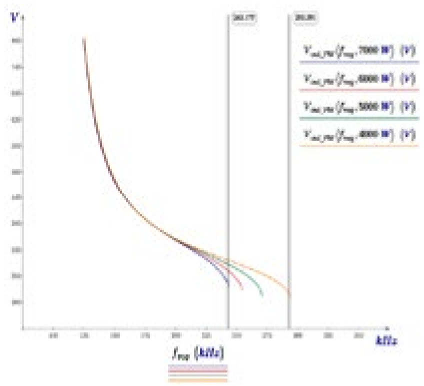


Figure 5: Output voltage of the LLC converter with a constant power load

The second significant difference is that there is no limit to the maximum output voltage. The model diverges (Vout → ∞) at the secondary resonant frequency;

$$F_{R_2} = \frac{1}{2 \cdot \pi \cdot \sqrt{(L_r + L_m) \cdot C_s}}$$

Unlike with a resistive load, an LLC converter with a constant-power load can reach very high voltages. This can be very useful in some applications, such as battery chargers, because the maximum output voltage that needs to be reached is no longer a major constraint on the design. It can also be dangerous for the load or the converter, in case of control loop failure that would set the switching frequency to the minimum frequency. Independent protections should be implemented to avoid such damages.

We should note that the phasing of the resonant current wasn't considered in this study. Although it is possible to reach high voltages at low frequency, it may or may not be possible to achieve zero voltage switching when doing so.

Conclusion

The LLC converter is a difficult topology to model. The resistive load model described in most application notes has many advantages, such as the normalisation of the design parameters. However, it is not representative of many types of loads (POL converters, batteries…), and a new, updated model is required for a better design. First, the constant power load model shows value added information on the LLC design. And secondly, it speeds up the design for all constant power load.

However, some loads may have yet another kind of behaviour. Some loads, such as deeply discharged batteries, can require a constant current source. Another model is then required for the converter. We will present such a model in a future article.

www.infinergies.uk

Coin Cell Style Electric Double-Layer Supercapacitors

The EDC and EDS series of Coin Cell style EDLC capacitors from Cornell Dubilier (CDE) can replace or extend battery life in on-board memory backup. With quick-response and recharge times, these devices offer higher power than batteries and greater energy than typical aluminum electrolytic capacitors without degradation over millions of charge-discharge cycles.
Both series offer values from 0.047 to 1.5 Farad capacity, at voltages up to 6.3 WVDC for the EDC series; and 5.5 WVDC for the EDS series. Operating temperature for the EDS series is from -25 °C to +85 °C, with the EDC series offering -25 °C to +70 °C. Three

case configurations are available for horizontal, vertical and radial-lead PCB mounting. EDC and EDS series capacitors are ready to board mount in such applications as real-time clock (RTC) backup, power failure backup, battery assist and in market segments such as smart metering, HVAC controls, building automation, communication systems, appliances, instruments and other microprocessor-based devices. Because of their high volumetric power density, they can be an effective way to reduce board size and weight. Either series can be used as a drop-in replacement for similar value capacitors recently discontinued by other manufacturers. Lead times are less than 12 weeks with popular values in stock.

www.cde.com

MOSFETs in TO-Leadless Packaging Technology

Alpha and Omega Semiconductor introduced the TO-Leadless (TOLL) package in combination with a 60V and 100V Shield-Gate Technology (SGT) providing the highest current capability in its voltage class. The TOLL package has the highest current capacity due to AOS' innovative technology, which utilizes a clip to achieve the in-rush current. The TOLL packaging technology offers a very low package resistance and inductance due to the clip technology when compared to other TO-Leadless packages. This packaging technology uses a standard wire-bonding technology which enables improved EMI performance. The AOTL66608 (60V), AOTL66610 (60V), and AOTL66912 (100V)

have a 30% smaller footprint compared to a TO-263 (D2PAK) package and has a higher current capability which enables the designer to reduce the number of MOSFETs in parallel. The device's offer a higher power density compared to existing solutions. They are ideally suited for industrial BLDC motor applications and battery management. "Using the AOS TOLL package with clip technology offers performance improvement in a robust package. The AOTL66608, AOTL66610, and AOTL66912 can simplify new designs with the higher current capability to enable savings in overall system cost due to a reduced number of devices in parallel," said Peter H. Wilson, Marketing Director of MOSFET product line at AOS.

www.aosmd.com

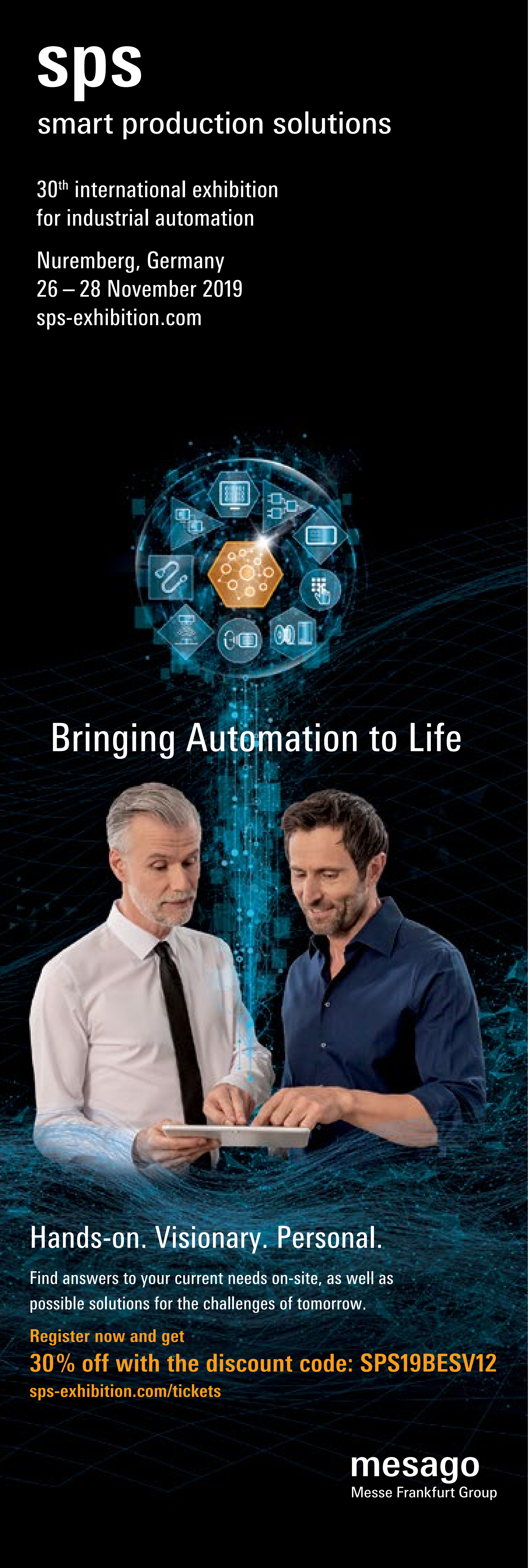
Voltage Surge Protection Modules for Railway

Heraeus Electronics announced the repositioning of its heater technology portfolio. The

company has established product packages and matched material systems of thick film inks addressing the growing needs for heater applications. The updated portfolio offers design flexibility and improved reliability to better suit customer expectations.
The material sets are packaged upon substrate types and focus on the customers' desired operating temperatures, heater specifications, and design requirements – PET and polyimide packages for operating temperatures up to 250°C; aluminum and stainless-steel packages reaching higher temperatures up to 350°C; and packages for oxide and nitride ceramic substrates reliable up to 700°C.
"Matched material systems lead to faster design cycles giving our customers an advantage," says Dean Buzby, Global Product Manager for Thick Film. "We are proud that with our new portfolio, we further improve our customer focus."

Heraeus' heater packages enable significant technology for the automotive industry – especially for electrical vehicle battery thermal management where the products ensure thermal stability, prolonging battery lifespans. Product offerings also enable systems for cabin and comfort heating. Sensors such as Advanced Driver Assistance Systems rely heavily on thick film heaters to ensure proper operating temperatures as well as keeping lenses clear of condensation and frost. Thick film heaters provide high reliability systems with a rapid thermal response even at high operating temperatures. Furthermore, thick film technology enables manufacturers to customize form factors with very thin substrates.

www.heraeus.com



20A 40Vdc MIL-COTS EMI Filters

TDK Corporation announces the introduction of the TDK-Lambda FQA series of EMC filters, with a rating of +/-40Vdc at 20A. The FQA has a rugged encapsulated quarter-brick package with a choice of flanged or non-flanged baseplates. These modules are suitable for use in a wide variety of harsh and demanding environments, including MIL-COTS vehicle and airborne applications.

The FQA series is designed with a high differential and common mode noise attenuation. This simplifies system level compliance to MIL-STD-461G standards. The modules also provide input spike protection to MIL-STD-1275D and RTCA/DO-160G. Qualifying testing is consistent with MIL-STD-883F and MIL-STD-202G.
The PCB mount FQA can be cooled using either an industry standard ¼ brick heatsink, or conduction cooled via a cold plate. The non-flanged package size measures 60.6 x 39 x 12.7mm (L x W x H) and the flanged version 60.6 x 55.9 x 12.7mm. The total DC resistance of the filter is typically 12mΩ, minimizing power losses. The filters are available with standard production screening (-S suffix) and a baseplate temperature rating of -40°C to +115°C, or with enhanced screening (-M suffix) and an extended temperature rating of -55°C to +115°C. Enhanced screening includes functional testing at high and low temperatures and a 96 hour burn-in period with temperature cycling.

www.us.tdk-lambda.com

Broadband Capacitor Series

Exxelia is pleased to announce the launch of its broadband series UBZ, UBL and XBL at the European Microwave Week tradeshow in Paris. Thanks to its strong experience in MLCC manufacturing, Exxelia extends its RF capacitors product offer by developing the three broadband series XBL, UBL and UBZ. Available in standard EIA sizes compatible with SMT pick & place and with any soldering processes thanks to its highly reliable ceramic material, Exxelia new broadband series ensure an ultra-low insertion loss and excellent return loss over a wide bandwidth up to 40GHz.

XBL Series size 0402 UBL Series size 0402 UBZ Series size 0201

www.exxelia.com

High Power TVS Diodes Protect Vulnerable Electronics

Littelfuse, Inc. announced a series of higher surge TVS Diode products in a DO-214AB package. The 8.0SMDJ series is optimized to protect sensitive electronic equipment from transient voltage induced by lightning and other voltage events. Because it combines up to 8000W of peak pulse power dissipation in a compact DO-214AB SMC package, the 8.0SMDJ series offers circuit designers a high-surge, space-saving circuit protection solution that can simplify printed circuit board design and improve reliability significantly.

“Compared to other market solutions currently available, the unidirectional and bidirectional 8.0SMDJ series TVS Diodes deliver higher surge protection in a small DO-214AB SMC package. It is ideal for DC12V, DC24V, and DC48V applications either by using single device or two in a series.” said Meng Wang, Global Product Manager Power TVS at Littelfuse. “The combination of a high power TVS diode in a compact footprint means circuit designers can conserve precious board space for design optimization opportunities including increased power density and higher production efficiency.”

www.littelfuse.com

AC/DC with 1in² Footprint Provides 3W

With the RAC03-K, RECOM introduces the smallest 3 watt solution on the market. This versatile converter can be used in a wide range of applications due to complete certifications for ITE and household standards. In a compact 1in² footprint, these modules deliver an output power of 3 watts from -40°C to 60°C and 2 watts up to 80°C. Despite such a high power density and small footprint, the RAC03-K series is a complete solution supporting Ecodesign Lot 6 standby mode operation for worldwide applications in automation, industry 4.0, IoT, household, and home automation. With an input voltage range from 85 to 264VAC and international safety certifications for industrial, domestic, ITE, and household applications, these are some of the most versatile power modules on the market. Due to their reinforced class II installation rating and their significantly wide margin to class B emissions compliance without external components, these are the easiest to use modular power solutions in the industry. Samples and OEM pricing are available from all authorized distributors or directly from RECOM.

www.recom-power.com

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KEY FACTS

- 30% visitors represent engineering job functions
- 75% involved in purchasing decisions
- 35% are executives and senior managers
- 9,220 visitors from 85 countries registered in 2018

semiconeuropa.org #SEMICONEuropa

Automotive-Grade Backlight LED Driver

ROHM announced the availability of the latest LED driver IC, the BD81A76EFV-M, optimized for LCD backlight in instrument cluster, center information displays and car navigation. Unlike conventional drivers with 4 channels that support LCDs up to 8”, this IC provides 6 channels of output (with 120mA per channel) that can support LCD panels of up to 10-12” class. At the same time original buck-boost control ensures compatibility with both small and large LCDs using a single driver. This makes it possible to develop a common design of LCD control board suitable for conventional panels along with the latest large-size displays.

In recent years, to improve both visibility and design in the automotive field, LCDs are being used in an increasing number of systems including instrument clusters, head-up displays and car navigation. In addition, larger screen sizes are being demanded. They require a greater number of high brightness LEDs for backlight as well as LED drivers featuring multi-channel operation and advanced dimming features that can prevent flicker effects.

In response to this increasing market need, ROHM has leveraged its industry-leading analog design technology and incorporated proprietary technologies into its LED drivers to achieve flicker-free operation and to contribute to a common control board design. The BD81A76EFV-M also allows designers to use larger LCD panels in vehicle applications.

www.rohm.com

Transformer for High Power, High Frequency Applications

Murata has announced a transformer technology for high power, high frequency applications that uses a novel winding technique to allow designers to efficiently reach power and frequency levels that were never possible with conventional winding methods. Murata’s patented pdqb winding technology makes it possible to construct high frequency transformers of up to and over 400 kW that can operate at frequencies as high as 50 kHz. The pdqb winding technique overcomes the skin and proximity effects as well as other high frequency losses associated with conventional construction methods, delivering an efficient (>99.5 %) solution in a compact footprint. There are a number of further benefits to the winding technique including an increased working voltage and

elevated isolation voltage (up to 10 kV). The leakage inductance is highly controllable and interwinding capacitance is low, both of which enhance performance in customer’s designs. Thermal performance is also improved, eliminating the space requirements and cost associated with heatsinking. Each design can be optimized by a combination of Murata’s transformer expertise and their own simulation software. Murata is able to design custom high power, high frequency transformers operating around 4-50 kHz with power ratings from 30 kW to 400 kW.

www.murata.com

Test Tools DC Power Supplies and Electronic Loads for the Bench

Teledyne LeCroy announced the addition of electronic loads and DC power supplies for the electronics test engineering bench to the Teledyne Test Tools (T3) portfolio of test equipment. With these products, the T3 portfolio is extended with offerings of affordable test equipment that engineers, developers and schools can use to assemble a well-equipped test bench.

The test engineer's bench often requires signal and waveform generators, digital multimeters, oscilloscopes and probes, power supplies, loads, spectrum analyzers and, in some cases, time domain reflectometers. Lab managers and engineers want a brand they can count on for the majority of their needs without having to go to multiple vendors. With the addition of switching power supplies, and electronic load solutions, Teledyne Test Tools can supply nearly all bench top equipment requirements.

"With the addition of electronic loads and DC power supplies, which are available in one, two, three and four output configurations, to the Teledyne Test Tools brand of products, customers can choose from an extensive lineup of high-quality, often complimentary test bench solutions", said Roberto Petrillo, GM, Teledyne Test Tools. He continued, "with prices starting from only $444, these product families offer affordable and readily-available test bench equipment that is fully supported by Teledyne LeCroy's world-class technical support experts."

www.teledynelecroy.com

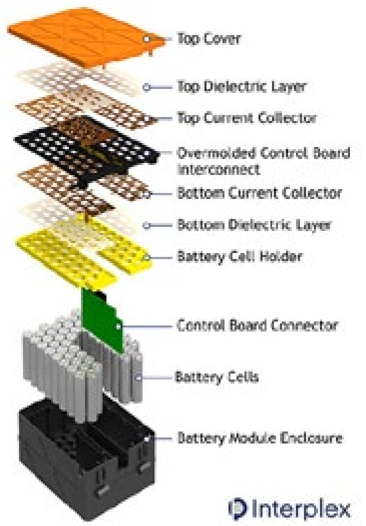
150 Watt Enclosed Switching Power Supply

MORNSUN released an enclosed switching power supply series LMF150-20Bxx with active PFC. The LMF150-20Bxx series features compact size, universal input voltage range of 85-264Vac, accepts AC or DC input and the PF is up to 0.99. The series also meets IEC/EN/UL62368, EN60335, GB4943 standards. Protections including output short circuit, over-current, over-voltage, over-temperature are included. It can be widely used in applications of industrial automation machinery, industrial control system, mechanical and electrical equipment, instrumentation, intelligent building, household appliance, etc.

www.mornsun-power.com

Battery Interconnect Systems Streamline Custom Design and Assembly

Interplex has announced availability of the Cell-PLX™ custom battery interconnect systems. This technology streamlines the design and manufacturing of robust interconnects for battery modules across an extensive range of industries. Battery module designs vary widely by manufacturer and specific application, be it for electric vehicles (EVs) and automotive power applications, land and maritime transportation, or wind energy storage. However, all of them fundamentally require robust mechanical and electrical interconnect systems to integrate and interface with the array of battery module cells. Cell-PLX™ addresses these intricate complexities with a custom battery interconnect system that connects battery cells to current collectors, and a customizable lead frame interface to the battery management system. By tackling the full range of design requirements, it delivers a customized power solution that effectively handles the increasing variety of battery module sizes and configurations.



According to Craig Kennedy, Product Portfolio Director for Battery Interconnect Systems, "as battery applications rapidly advance, flexibility and customization is key to success. Cell-PLX™ is customizable to specific application designs. It supports various current density requirements, with single or multi-layered current collectors and dielectric layers of different thicknesses. With our advanced high-speed manufacturing processes, cell connection terminals on the current collector can be made thinner than the current collector itself. This assures a reliable weld joint to the battery cells while maintaining minimum current density requirements."

www.interplex.com

Aluminium Electrolytic Capacitors for High Ripple Currents

Capacitors with a threaded connection from FTCAP's GW series are designed for optimal cooling: A special stepped base in combination with a Sil-Pad ensure optimal thermal dissipation. The stepped base and use of a ring clamp allow virtually seamless mounting of the capacitors on a heat sink. The low-inductance GW series is therefore suitable for applications with high ripple currents in a broad temperature range from -40 to 105 °C. These aluminium electrolytic capacitors with a threaded connection are insensitive to high ripple currents, such as those that occur in auxiliary power converters of urban rail cars or in welding inverters. As a side effect, however, the high currents also cause increased temperatures in the capacitors. Special winding constructions therefore ensure optimal heat dissipation at the capacitor base. In addition, FTCAP has optimised the GW series with optional base cooling by means of a Sil-Pad that dissipates the heat.

A special feature of the GW series is the patented stepped base: This design ensures that the base of the capacitor is flat despite the adjacent heat shrink tube. Air inclusions are therefore reduced, which would hinder dissipation of heat from the capacitor to the heat sink. Thermal resistance is substantially lower, for processing of high loads despite the compact design.

www.ftcap.de

High-Voltage Dual-Channel Solenoid Driver IC

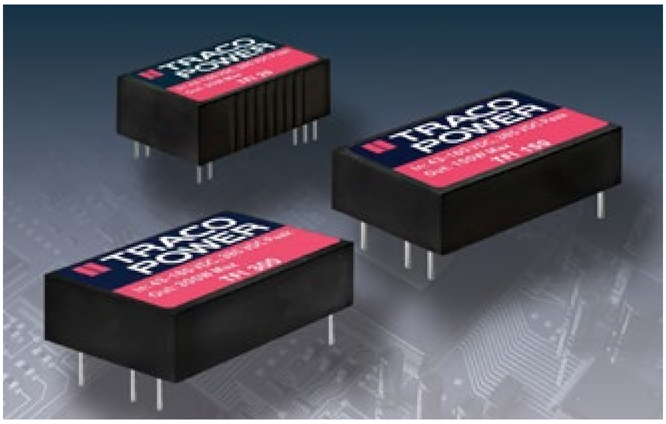
Toshiba Electronics Europe has launched a dual-channel solenoid driver IC that provides a high-voltage drive with low ON resistance. The TB67S112PG driver IC is suited to a wide variety of applications including domestic appliances (air-conditioners and refrigerators), industrial equipment (banking terminals such as ATMs, office automation equipment, and factory automation equipment).

Toshiba's solenoid driver IC lineup currently includes 4- and 8-channel devices (TB67S111PG and TB67S158NG/FTG). The new TB67S112PG completes the lineup, by providing support for dual-channel applications at a lower price point. The device incorporates two channels, each consisting of a low-side MOSFET and a regenerative common diode that can independently drive a solenoid or relay at voltages up to 50V. A low ON resistance of only 0.3Ω allows for a higher output voltage, resulting in higher motor torque, and reducing heat generation during motor operation. Safe operation is enabled through the provision of overcurrent detection (ISD), under voltage lockout (UVLO) detection and thermal shutdown detection (TSD), which, additionally, sets a flag to notify the system controller of a thermal shutdown event.

www.toshiba.semicon-storage.com

Voltage Surge Protection Modules for Railway

TRACO POWER announces the release of their TFI Series of surge filters designed to clamp momentary over-voltage transients up to 385 VDC (20 ms) to protect the DC/DC Converter from being damaged. Input transients defined by EN 50155 (up to 154 VDC) are covered by the wide input range of dedicated railway converters. This level of protection is specifically required in railway applications where high voltage transients are expected and can also be used for 72, 96 and 110 VDC battery systems.



The series consists of 3 wattage models, the TFI 20 (20 Watt in a DIP-24 Package), TFI 150 (150 Watt in a 1.6 x 2.0" footprint) and TFI 300 (300 Watt in a 1.6 x 2.0" footprint). Each TFI filter operates over the 43-160 VDC and is fully encapsulated within a plastic package for MIL-STD-810 Thermal Shock and Vibration protection. Features include an operating temperature range of -40 to +95°C and minimum 36 VDC brownout. During normal operation the output voltage follows the input voltage (Vout = Vin -2 VDC typ.) up to the point of 168 VDC where the voltage is actively clamped. All models are RIA 12 and NF F 01-510 compliant for surge susceptibility protection and are supported by TRACO POWER's 3-year product warranty.
Products are in stock and available through the TRACO POWER global distribution network with manufacturing lead times of 12-14 weeks.

www.tracopower.us

Surface-Mount Isolated DC/DC Converters

Now available from Dengrove Electronic Components, RECOM R2SX 2W isolated DC/DC converters measure only 15.24mm x 10.7mm x 8.0mm, delivering a space-saving solution for bus isolation and general industrial power applications. These open-frame surface-mount modules are available with standard isolation rating of 1kV/second or in a high-voltage 3kV/second version. Customers can choose a nominal input voltage of 5V with unregulated 3.3V or 5V output, or 24V nominal input with 5V, 15V or 24V output. High efficiency is assured from 20% to full load, reaching a maximum of up to 86%. Design-in is easy, with no minimum-load requirement. Only a simple low-cost LC filter is needed for EN55032 Class-B EMC compliance, and guidance is provided to help optimise the component values. The converters operate from -40°C to 75°C at full load and up to 100°C with derating. The usual 3-year manufacturer warranty applies, and certification to the latest safety standards, IEC/EN/UL 62368-1, allows use in new generations of electronic products formerly covered by 60950-1 or 60065 specifications.

www.dengrove.com

Isolation Technology to Maximize Power Efficiency and Minimize Emissions

Analog Devices, Inc. announced a simple power solution that maximizes efficiency and minimizes electromagnetic (EM) emissions of motion systems as customers migrate to higher density automation. The ADuM4122, an isolated, dual-drive strength output driver that uses iCoupler® technology, empowers designers to harness the benefits of higher efficiency power switch technologies.

Electric motor-driven systems account for 40% of global electricity consumption, according to the International Energy Agency, and improvements in motor efficiency can have wide-reaching economic and environmental benefits. With the increased adoption of industrial automation and IoT within smart factories, there is a growing demand for intelligent technology and features within systems to ensure maximum efficiency. The ADuM4122 is the first simple solution that accomplishes this by controlling how fast or slow a MOSFET or IGBT turns on or off by user command, on the fly, thereby controlling motor currents.

"Flexibility and efficiency are two key tenets of a secure, connected enterprise. Previously, the typical solution was to choose a gate driver strength that would enable adherence to EM system regulations at all operating points, meaning systems were often over-engineered and under-utilized," said Mack Lund, Director of Interface and Isolation Technology Group at Analog Devices. "Now, users can dynamically move from a slower to a faster switching transition, thus optimizing EM emissions without sacrificing efficiency."

www.analog.com

Integrated Point-of-Load Regulator

Infineon Technologies introduces the OptiMOS™ IR3826(A)M integrated point-of-load DC-DC voltage regulator. It is a fully integrated and highly efficient device in two versions (IR3826AM for 16 A and IR3826M for 23 A) for applications such as netcom router and switches, datacom, telecom base stations, server and enterprise storage. The voltage regulator can operate from an input voltage of 12 V (5 V to 17 V) and provide up to 16 A or 23 A continuous current. It enables high-switching-frequency operations with enhanced efficiency and reduced power losses compared to previous generations of Infineon's offering. Furthermore, the device supports high switching frequency of up to 1.5 MHz for small PCB size and less capacitors. Both current ratings are offered in PQFN package with 5 mm x 6 mm footprint for easy scalability. Parts are pin-compatible to the previous product offerings to allow risk-free efficiency upgrade with minimum design effort. The IR3826(A)M solves the heat challenge without or with minimum airflow in thermally constrained application designs such us 3.3 V or 5 V supply voltages. Additionally, it supports applications that operate with high ambient temperature, e.g., 85˚C for telecom. The state-of-the-art PWM Gen 3 engine of the devices allows operation with fixed frequency to reduce noise in multi-rail telecom or high-end Netcom applications, like base stations.

The devices are fully RoHS2 compliant without an exemption to accommodate future regulations.

www.infineon.com

Advertising Index