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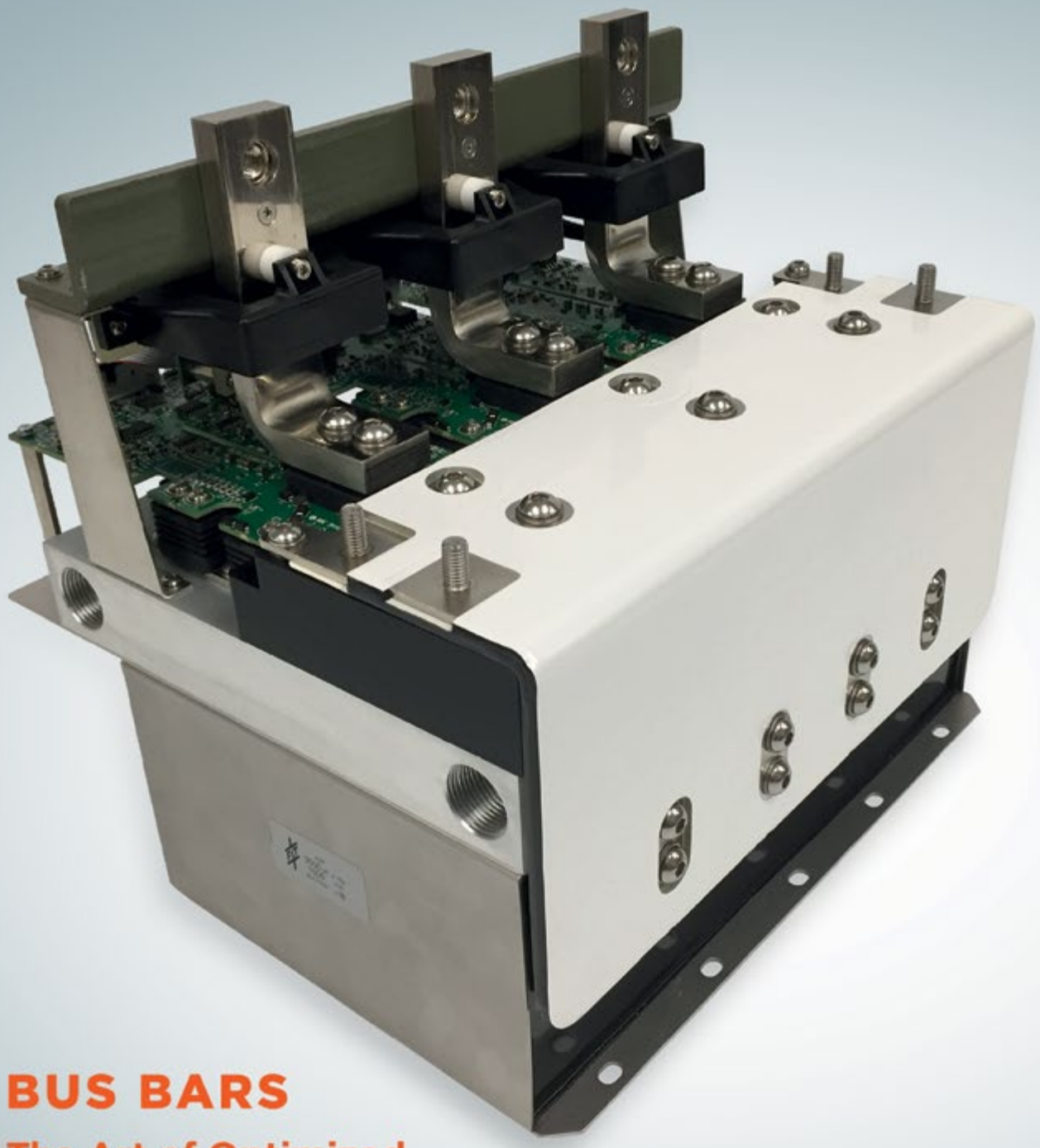
Electronics in Motion and Conversion

February 2018



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Events

IEW 2018
Bengalore, India, February 7-9
www.indiaelectronicsweek.com

EMC 2018
Düsseldorf, Germany, February 20-22
www.mesago.de/en/EMV/For_visitors/Welcome/index.htm

APEX 2018
San Diego CA, USA, Feb 24 – Mar 01
www.ipcapexexpo.org

Embedded world 2018
Nuremburg, Germany, Feb 27- Mar 1
www.embedded-world.de/en

Battery Experts Forum 2018
Aschaffenburg, Germany, Feb 27 – Mar 1
www.battery-experts-forum.com

Looking Forward

I'm back at my desk and so happy that Holger has produced the January issue – a milestone, the first one not under my control. My last activity was at the Wide Band Power Conference on 5th of December in Munich. I am pleased with the great feedback from both presenters and attendees. They all enjoyed sharing their information towards progress in design. The presentations will be covered by articles in the upcoming issues - Bs&T Frankfurt and AgileSwitch contributions are in the current issue.

We look forward to an exciting year in 2018. APEC in St. Antonio, Texas, will start to get the power family together, we look forward to meeting again. Power electronics is the heart beat of electronics. I have stated that a long time ago. Now the focus is to make power electronics as efficient as possible, as energy demand continues to rise. Forty years ago people were pleased with systems that functioned. But now we face increasing energy demand and need an electric power supply that has the highest possible levels of efficiency. Communications, once a negligible load, has blossomed into immense server farms – forty years ago, who predicted such demand?

After APEC, the next big event for Power Electronics will be PCIM Europe. It is quite a while ago that PCIM was started in the USA by Myron Miller. It is too sad to hear that Myron Miller, the Publisher and Founder of the PCIM magazine and conferences, passed away on December 9th, at the age of 89. While he retired from work in 2000, he never stopped thinking about the future and working on projects in energy-related fields. I remember our nice chats and conversations at conferences, the last time at APEC in Disney Land in Anaheim a few years ago. My deepest symphysis is with Myron`s wife and his family. Myron's spirit of cooperation and action lives on at the board meetings of PCIM.

I also look forward to see fair treatment of journalists in the world. It is not acceptable that journalists be held in jail, without any accusation for a full year. Too bad if their reports are critical of what they see. We have to work for the freedom for Deniz Yücel. Journalism keeps freedom alive for us all – there are innumerable examples from our past to teach us.

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

My Green Power Tip for February:
If it is cold outside and freezing, feed the birds. You will enjoy hearing them sing in Springtime.

Best Regards

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Intersil to Start Operations as Renesas Electronics America in January 2018

Renesas Electronics Corporation announced the integration of Intersil Corporation as a legal entity and a new branding policy following the acquisition of Intersil on February 24, 2017. Effective January 1, 2018, Intersil Corporation is expected to operate in the market under the name of Renesas Electronics America Inc. The completion of Renesas' U.S. entity integration marks a major milestone in the integration process, which remains well on track. As well, the integration process in Japan and Korea is expected to be completed on or about January 1, 2018. The remaining Intersil entities are expected to be integrated in the near future. "With the integration of the Intersil business, we have taken another significant step towards maximizing the full potential of the combined business, providing scale, stability and a comprehensive product mix," said Bunsei Kure, Representative Director, President and CEO of Renesas Electronics Corporation. "With the enhanced global strength, Renesas is in the best position to further strengthen its leadership in the global semiconductor market."

"The promise of the Renesas and Intersil integration has already begun to materialize as we've started operating as one company," said Necip Sayiner, Executive Vice President of Renesas, President of Renesas Electronics America and President, CEO and Director of Intersil.

www.renesas.com/en-hq/about/company/integration.html

Panasonic Awarded Best Supplier of the Year for Passive Components

Panasonic Industry Europe is proud to announce that it has recently been awarded Best Supplier of the Year for passive components (together with TDK, Eaton, Kemet and Vishay) by the SPDEI (French Union of Distributors). Now in its 22nd year, the award from the SPDEI is judged on five different criteria: partnership with the French distributors; innovation, price, quality and sustainability of the products; profitability for the distributor; allocated resources for the support of the distributor; protection of the design. In total 120 suppliers were nominated in 2017 in 10 product categories and 25 suppliers collected an award.

"We are very proud to have won this award for the third time now", comments Muriel Dierickx, Business Development Manager & POS, Distribution Division for Panasonic in France. "I want to thank all my colleagues for all the hard work and effort they put in every day because without this big team effort we wouldn't have been so successful", she continues.

http://industry.panasonic.eu

Amper 2018 in a Sign of Industry 4.0 and IoT!

Amper is an international trade fair focused on Electrotechnics, Electronics, Automation, Communication, Lighting and Security Technologies and is the biggest of its kind in the Czech Republic and Slovakia. It belongs among the most important events in its field in Central Europe.

The 26th edition of the Amper trade fair will take place from the 20th to 23rd March 2018 in the Brno Exhibition Centre, in the Czech Republic. Visitors to the fair represent a global mix of experts, industry professionals, and the professional public. The organizers of the fair are continuing to build upon a very successful past. Last year saw 600 exhibitors from 22 countries participate in the event and attracted over 43 000 visitors. Currently, Amper 2018 is forecasted to exceed these numbers with an ever-increasing interest from international exhibitors and visitors alike. The fair also pays great attention to ensuring a comprehensive programme of activities. The focus topics at Amper 2018 will include IoT and Industry 4.0. Professional conferences, lectures and workshops on both purely technical topics and standards, as well as topics oriented towards international trade cooperation and export. The general public will certainly appreciate lectures on energy sustainability and self-sufficiency. Traditional projects are again part of the agenda, including Amper Smart City, Amper Start Up and Amper Motion which is the largest showcase of electromobility in the Czech Republic.

www.amper.cz/en.html

North American PCB Industry Growth Continues to Strengthen

Association Connecting Electronics Industries® announced the November 2017 findings from its North American Printed Circuit Board (PCB) Statistical Program. Positive year-over-year shipment and order growth continued in November. The book-to-bill ratio remained high in November at 1.09.

Total North American PCB shipments in November 2017 were up 4.0 percent compared to the same month last year. This year to date, shipments are 2.3 percent below the same period last year. Compared to the preceding month, November shipments increased 0.4 percent. PCB bookings in November increased 15.8 percent year-on-year, raising year-to-date order growth to 5.7 percent above the same period last year. Bookings in November were down 3.8 percent compared to the previous month. "The North American PCB industry's recovery continued in November and is becoming more robust, with positive year-on-year sales growth for the third consecutive month and strengthening growth rates," said Sharon Starr, IPC's director of market research. "The outlook is also positive, based on strong order growth in recent months, and on PCB book-to-bill ratios above parity (1.0) for 10 consecutive months. Although the book-to-bill ratio has been retreating from a 12-year high in August, due to growth in sales, it remains strong, indicating a likelihood of continued sales growth in the coming months," she added.

www.ipc.org/market-research-reports

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STRONGER
FASTER

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The Formula E Venturi team has adapted the latest range of ROHM inverters derived from full SiC module technology in its electric-powered racing cars. ROHM has enabled the broad implementation of e-mobility by delivering the next generation of power semiconductor-based SiC modules. It produces these in-house using a vertically integrated manufacturing system, thus guaranteeing high quality and consistent supply to the market.

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Rutronik Launches Chinese Company Website

The launch of the website follows on from the opening of the Rutronik WeChat account on the social media platform WeChat in November. The company intends to use the website to make it easier and more convenient for its customers in China to access the product portfolio.

Accordingly, the website not only features a translation of the content in simplified Chinese, but also local and regional content, a specially designed layout and links to social media. The layout itself particularly highlights the Rutronik teams in China and other Asian countries in order to make it easier for customers to get in touch. The specially produced content includes local company news, information on seminars, webinars and trade fairs in the region, vacancies and new products.

'Our aim is to communicate with our Chinese customers as effectively as possible,' says Markus Krieg, Managing Director Marketing at Rutronik. 'Website visitors can expect additional social media links and channels, contact forms and WeChat QR codes. We are thus making sure that the process of communicating directly with our team in China is as user-friendly as possible.'

www.rutronik.com

www.rutronik.com.cn

STMicroelectronics Acquires Atollic

STM announced its acquisition of software-development tools specialist Atollic. Atollic is the supplier of TrueSTUDIO®, a professionally-recognized and highly regarded Integrated Development Environment (IDE) for the embedded development community focusing on Arm® Cortex®-M microcontrollers, like ST's market-leading STM32 family of 32-bit microcontrollers (MCUs).

A top supplier of 32-bit MCUs with a powerful hardware and software ecosystem that accelerate and facilitate application development, STMicroelectronics sees the addition of TrueSTUDIO as further strengthening that offering. Created by an established world-class team of dedicated software tools experts, TrueSTUDIO is recognized as a leading open-source Eclipse-based IDE platform and already supports the STM32 family of Cortex-M based MCUs from ST. The acquisition will allow ST to guide the future evolution of the rich and advanced features of TrueSTUDIO with the STM32 ecosystem to a fully integrated software solution.

"The outstanding quality and depth of the STM32 MCU portfolio and its easy-to-use development ecosystem has positioned ST as a leader in embedded systems," said Michel Buffa, Microcontroller Division General Manager, STMicroelectronics. "That position, and working closely with Atollic for many years as a top Gold Partner, has shown us the professional features and value TrueSTUDIO has delivered to demanding developers and will soon give STM32 developers a major

competitive advantage with the availability of the STM32 TrueSTUDIO IDE for free."

"As a leading software development tools vendor on the global market, I am delighted to see our tool and highly skilled professional team joining STMicroelectronics, a world leader in the 32-bit microcontroller market," said Lars-Erik Stenkil, Atollic CEO.

www.st.com

New Jedec Committee for Wide Band Gap Power Semiconductors Invites Industry Participation

JEDEC Solid State Technology Association announces the successful launch of its newest committee: JC-70 Wide Bandgap Power Electronic Conversion Semiconductors. JC-70 held its first meeting in late October with twenty-three member companies, led by committee and subcommittee chairs from Infineon Technologies, Texas Instruments, Transphorm, and Wolfspeed, a Cree Company. Committee members include industry leaders in power GaN and SiC semiconductors as well as prospective users of WBG power semiconductors and T&M equipment manufacturers. Global multinational corporations and technology startups from the US, Europe, and Asia are working together to bring to the industry a set of standards for reliability, testing, and parametrics of WBG power semiconductors.

JC-70 has two subcommittees, which are focusing on Silicon Carbide (SiC) and Gallium Nitride (GaN) as the most mature wide bandgap (WBG) power semiconductor materials. Both SiC and GaN offer immense potential for enabling higher performance, more compact, and energy efficient power systems. Industry interest in JC-70 has been high with several new members joining the committee after the first meeting, underscoring the importance of creating universal standards to help advance the adoption of WBG power technologies.

www.jedec.org

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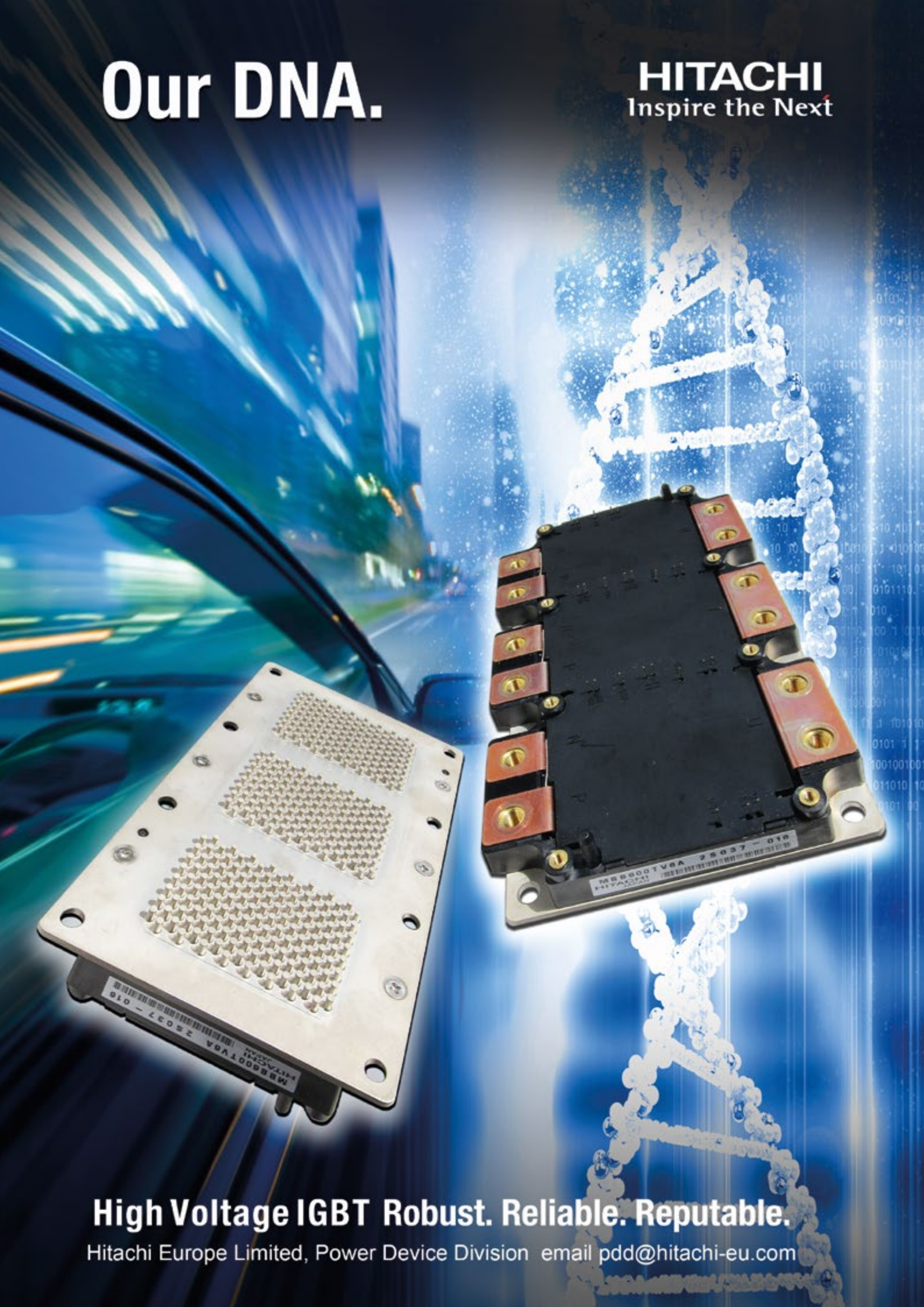

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Hitachi Europe Limited, Power Device Division email pdd@hitachi-eu.com

Riedon Announces Major Expansion with Acquisition of Deltec Shunts

Riedon announced the acquisition of Deltec Shunts, LLC. The company, based in Norwalk, California, is one of the premier US manufacturers of current shunts and fuse-block holders. The agreement signed by the two companies involves the acquisition by Riedon of all Deltec's assets and product lines. The deal is a significant move for Riedon, as it enables the company to consolidate its position in its core markets, including instrumentation, aerospace, and defense, and significantly expand into key fast-growing market sectors in renewable energy applications and power supply design.

Since its inception in 1986, Deltec has been a manufacturer of DC ammeter shunts, available in 10 different sizes, as well as fuse blocks. The company has successfully serviced solar and wind inverter markets, along with specialized shunt designs for many renewable-energy applications, in addition to the recreational vehicle (RV) and boat power-supply market segments.

"The acquisition of Deltec will provide Riedon with global scale, expanding our capabilities to service existing customers and increase our customer base in the renewable energy and power supply industries," said Frieda Hovsepian, VP Sales & Marketing at Riedon Inc. "Through this acquisition, Riedon becomes a major manufacturer of current shunt products, enabling us to offer better pricing, lead times and custom-designed services."

www.shunts.com

www.riedon.com

eVaderis Completes Tape-Out of MCU Demonstrator for Next-Generation IoT Applications

eVaderis, a semiconductor IP start-up that provides design solutions to improve the functionality, power efficiency and performance of its customers' semiconductor chips, has successfully demonstrated a fully functioning design platform through an ultra-low-power microcontroller (MCU) in Beyond Semiconductor's BA2X product line. The software, system and memory IP developed by eVaderis make Beyond Semiconductor's new MCU ideally suited for battery-powered applications in IoT and wearable electronics. By incorporating the latest perpendicular, spin-transfer-torque magnetoresistive random-access memory (STT-MRAM) technology from international R&D institute Imec, Beyond Semiconductor's new MCU can achieve non-volatile operation with high-speed read/write and low voltage. In addition, the device is designed for manufacturability using GLOBALFOUNDRIES' 40-nm low-power CMOS production process. "The tape-out of this innovative MRAM-based, memory-centric MCU demonstrates our proficiency in disruptive, non-volatile embedded IP design and flow for low-power, digital devices," said Virgile Javerliac, deputy CEO and head of technology and marketing at eVaderis. "We now plan to license the underlying IP to semiconductor manufacturers making sub-40-nm chips."

"Power consumption is still the key challenge for any battery-powered device," said Matjaz Breskvar, Beyond Semiconductor's CEO. "We have been working with eVaderis since the company's inception to jointly realize a vision of battery-powered, always-on devices with unprecedented energy efficiencies."

www.evaderis.com

www.beyondsemi.com

Infineon Enables Flexible Wireless Charging for Automotive and Consumer Applications

Efficient and Easy-to-use wireless charging for smartphones, wearables, medical and industrial devices possible with the AURIX™ and XMC™ microcontroller families. Infineon Technologies AG offers flexible chip sets for high performance including software IP for smart and safe wireless charging applications. Working with a systems solution partner, Infineon provides reference designs for both inductive and resonant wireless charging solutions for on-the-go charging, whether in the car, at home or in public places.

Automotive in-cabin wireless charging

The controller works seamlessly with power devices from Infineon to provide a complete charging solution:

- Voltage Regulator and Power MOSFET technology enable high efficiency power conversion, while network ICs serve for reliable communication according to highest automotive standards
- Supports the current 15 W charging standards, including fast charge smartphones, and can support future changes through a software update
- An enhanced power stage architecture improves Electro Magnetic Interference (EMI) performance 10-15 dB over existing solutions on the market
- A newly developed supplemental Foreign Object Detection system provides enhanced detection accuracy to meet critical customer safety requirements

"AURIX microcontrollers help the next-generation in-cabin wireless charging systems meet strict automotive safety, security, environmental and regulatory requirements", said Ralf Koedel, Marketing Director Microcontroller at Infineon. "Still, they enable industry-leading charging performance and efficiency".

www.infineon.com

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PSMA/PELS Sponsors Pre-APEC Capacitors in Power Electronics Workshop

The Power Sources Manufacturers Association (PSMA) and the IEEE Power Electronics Society (IEEE PELS) are jointly sponsoring an all-day workshop titled "(Almost) Everything You Wanted to Know About Capacitors But Were Afraid to Ask," on Saturday, March 3, 2018, the day before the start of and in the same venue as APEC 2018 at the Henry B. Gonzalez Convention Center in San Antonio, Texas. Following a similar format to the very successful pre-APEC Magnetics Workshops, this first-ever Capacitor Workshop will consist of morning and afternoon technical lecture presentation sessions and a lunchtime interactive technology demonstration session. The technical lecture presentation sessions will each be followed by a panel Q&A period. The technology demonstrations will also be available during the breakfast prior to the opening session and during the networking session at the end of the day's events. The workshop will address the fundamentals of capacitor technology, as applied to a wide range of power conversion applications, including dc-dc converters, variable frequency drives and inverters. Some of questions and issues that will be addressed include: What happens when you replace the electrolyte in an aluminum capacitor? How does the film type change the self-healing of a film capacitor? Is it possible to avoid ceramics cracking on a PCB?

The morning sessions will cover the range of capacitor technologies used on both low- and high- voltage applications. The afternoon session will address failure modes and design strategies to avoid failures.

www.psma.com/technical-forums/capacitor/workshop

Germany: Renewables' Share Tops the 36 Percent Mark in 2017

Renewable energy sources are expected to account for more than 36 percent of the gross amount of electricity consumed in Germany in 2017. The Centre for Solar Energy and Hydrogen Research Baden-Württemberg (ZSW) and the German Federal Association of Energy and Water Management (BDEW) arrived at this figure in an initial assessment. According to these projections, the sun, wind and other renewable sources will have served to generate nearly 217 billion kilowatt hours (kWh) of electricity by the end of the year. In 2016, renewable sources delivered 188 billion kWh to cover 31.6 percent of gross electricity consumption.

Offshore wind power saw the greatest percentage increase: Electricity from this source is expected to increase by a good 49 percent to 18.3 billion kWh (2016: 12.3 billion kWh). Onshore wind power production dipped slightly in 2016, but is expected to bounce back in 2017, rising by 21 billion kWh to reach 87 billion kWh, a 31 percent year-on-year increase (2016: 66.3 billion kWh). Onshore wind energy remains by far the strongest source, accounting for more than 40 percent of the electricity generated by renewables. Biomass came in second with close to 24 percent (with nearly 3 percent of waste being biogenic). Photovoltaics took third place with over 18 percent.

www.zsw-bw.de/en

EMV 2018: List of Exhibitors and Registration now Online

Over 100 companies will be presenting their products and services at the EMV, international exhibition and conference on electromagnetic compatibility in Dusseldorf from 20 to 22 February 2018. The exhibition is an ideal platform for scientists, product developers, service providers and users to exchange ideas and develop their network and to this end, participating companies can now be viewed in the exhibitor list. In addition, the EMV will once again host a further education program at the conference.

More than 90 exhibitors have already registered for EMV 2018. These once again include important key players such as Rohde & Schwarz, Ametek, Gauss Instruments, EMCO Electronics and Phoenix Testlab. Some companies will be attending for the first time in 2018, for example EMCCon's DR. RAŠEK GmbH & Co. KG, iNARTE Exemplar Global, Kitagawa GmbH, Empower RF Systems and Citel Electronics GmbH. The total exhibition space has been increased compared to the area in Dusseldorf in 2016. The exhibition and conference will be both be held in Hall 3 due to building measures by the venue in Dusseldorf. This means that the conference rooms are to be integrated in the exhibition hall; exhibitors, conference participants and visitors can therefore look forward to a lively exchange under one roof.

www.e-emc.com

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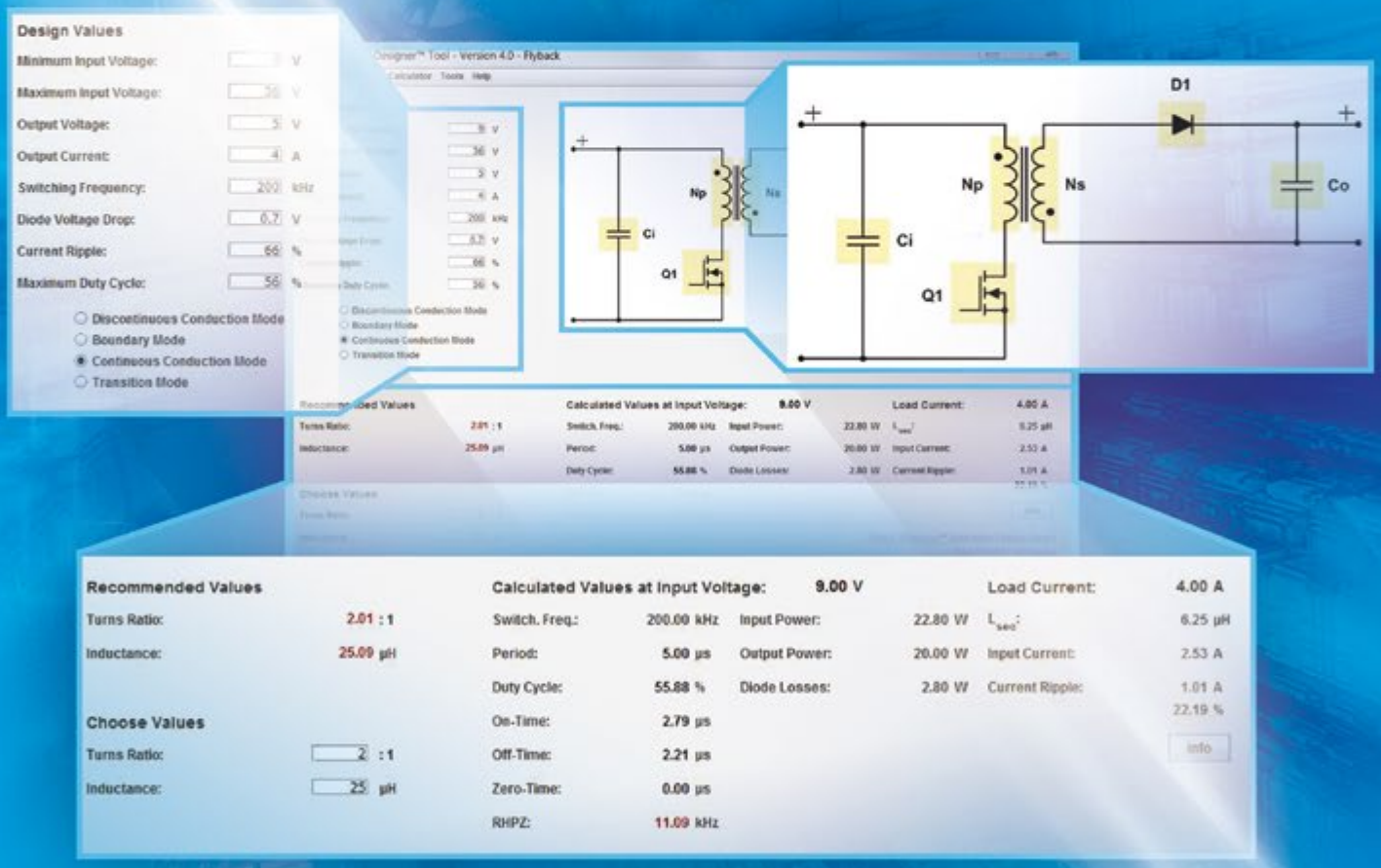

www.ti.com/powerstage-designer

1 MHz Bandwidth Current Sensor ICs with 3600 VRMS Isolation

Allegro MicroSystems Europe has added a new generation of high bandwidth current sensor ICs to their existing family of devices. The Allegro ACS732 and ACS733 current sensor ICs provide a compact, fast, and accurate solution for measuring high-frequency currents in DC/DC converters and other switching power applications. These devices are the first 1 MHz offerings from Allegro to offer 3600 VRMS galvanic isolation ratings. The current sensor ICs are Hall-effect-based and include user-configurable overcurrent fault detection. These features make them ideally suited for high-frequency transformer and current transformer replacement in applications running at high voltages. The ACS732 and ACS733 are suitable for all markets, including automotive, industrial, commercial, and communications systems. They may be used in motor control, load detection and management, switch-mode power supplies, and overcurrent fault protection applications. The devices are fully calibrated at the Allegro factory to provide a high accuracy solution over the entire operating temperature range. The fully integrated wide body SOIC-16 package has a typical resistance of 1 mΩ, providing low power loss and reduced bill of materials that allows for easy implementation. Applied current flowing through the copper conduction path generates a magnetic field that is sensed by the IC and converted to a proportional voltage. Current is sensed differentially in order to reject external common-mode fields. The current-carrying pins (pins 1 through 8) are electrically isolated from the sensor leads (pins 9 through 16). This allows the devices to be used in high-side current sensing applications without the use of high-side differential amplifiers, isolators, or other costly isolation techniques. The ACS732 and ACS733 are provided in a small, low profile, surface-mount SOIC-16 wide-body package. This package is lead (Pb) free, with 100% matt-tin leadframe plating (suffix –T).

www.allegromicro.com

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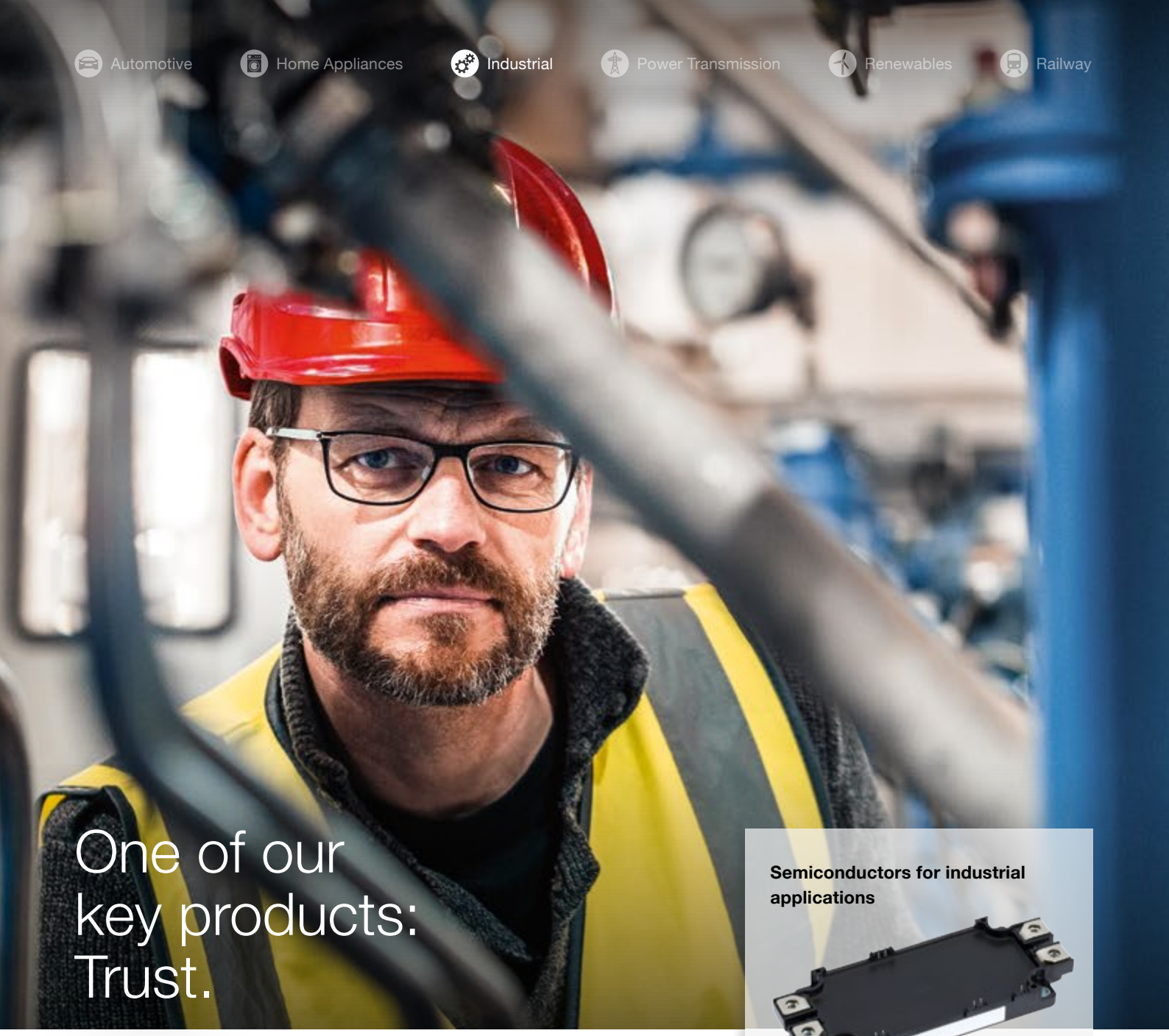

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Bus Bars: The Art of Optimized Power and Signal Interconnectivity

Today's inverter manufacturers, power electronics system integrators and engineers throughout various industrial markets look for solutions to reduce assembly footprint and to optimize connectivity in their designs. Bus bars solutions from Mersen offer an attractive alternative interconnectivity method for power and signal circuits.

By Dr. Philippe Roussel, VP Global Strategic Marketing- Mersen

INTRODUCTION

Mersen is a global expert in electrical power and advanced materials. Mersen designs innovative solutions to address its clients' specific needs to enable them to optimize their manufacturing process across numerous industrial sectors.

THE CHALLENGE

With the growth of power conversion systems, comes the need for designers to find ways to optimize various aspects of their systems such as reduced foot print and enhanced performance. Traditionally industrial power conversion systems such as inverters, converters, rectifiers and drives to name a few, utilize standard wiring and cables to interconnect the power and signal circuitry. Though wires and cables can serve the connectivity needs, considering a custom designed bus bar platform can bring in several added benefits towards a well optimized solution.

BUS BARS AND THEIR BENEFITS

Laminated bus bar is an engineered component consisting of layers of fabricated copper separated by thin dielectric materials, laminated into a unified structure. Bus bars reduce system costs, improve reliability, increase capacitance, and eliminate wiring errors. They also lower inductance and lower impedance. Plus, the physical structure of bus bars offers unique features in mechanical design. Multilayer bus bars offer a structural integrity that wiring methods just can't match.

STRAIGHT TO THE OPTIMUM DESIGN

With over 100 cumulative years of experience designing, manufacturing and testing bus bars, Mersen engineers have built a strong knowledge base of helping customers towards the optimized system.

Mersen engineers can work with inverter manufacturers at very early stages of design to efficiently integrate the passive components such as cooling, bus bars and fuses within the inverter. Using a variety of Multiphysics simulation toolsets, Mersen engineers can evaluate the thermal and electrical performance of the heat sinks and bus bars within the overall inverter design. This approach is called the "Integrated Architecture" approach and allows for the most optimum design footprint of the overall inverter assembly by sourcing the cooling and bus bar solutions along with semiconductor protection fuses all from one source.

OPTIMIZATION STARTS WITH CUSTOMER NEEDS IN MIND

As each bus bar design can be unique, a "prototype" is usually produced before final production run. To ensure the prototypes are as close as possible to the optimum design, multi-physics simulations are used in the conception phase, so that any design flaws can be spotted and eliminated before going through the prototype manufacturing process.

Figure 1: Mersen Integrated Architecture approach

Mersen's multi-physics simulation tools include mechanical, electrical and thermal simulations. During the simulation stage, two main design aspects are considered. The first aspect touches upon the need for space optimization in the final assembly, and second aspect addresses the constraints associated with the use of different heterogeneous materials.

In the bus bar design the major characteristics are layer dimensions, layer assembly, interconnection configuration and insulation material and thickness. Thermal performance is Key in laminated bus bars. Mersen application engineers can conduct temperature rise simulation on the bus bar prototypes. Engineers simulate the Joule effect heating the conductors when the current is flowing and also heat concentration at the interfaces with power modules and capacitors. The simulation process allows a significant reduction of product development time.

When it comes to electrical simulation, engineers and technicians simulate the routing of contacts to meet all clearance and creepage requirements. The current distribution is then simulated to check compliance with admissible current density in order to limit self-heating of the bus bar.

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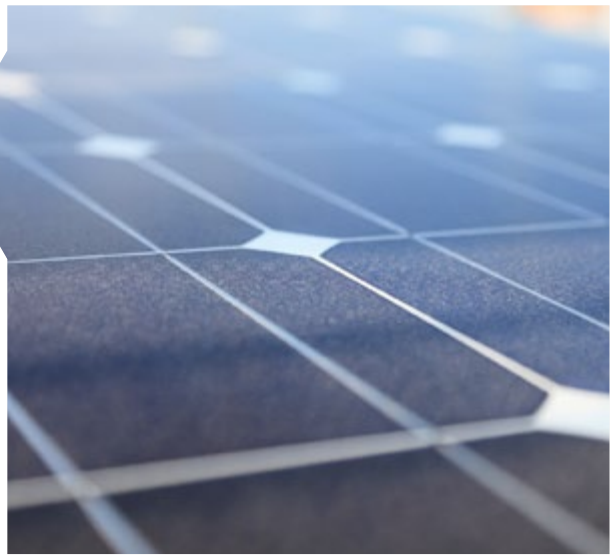

Rigorous testing is completed on each part prior to shipment to ensure long term reliability. In addition to dielectric withstanding, or insulation breakdown testing (aka “HiPot”), Mersen performs Partial Discharge (PD) testing using the state of the art PD test station. Mersen’s engineering and quality team uses DFM (Design For Manufacturability) techniques such as FMEA (Failure Mode Analysis) to evaluate each order to assure smooth transition without failures throughout the process.

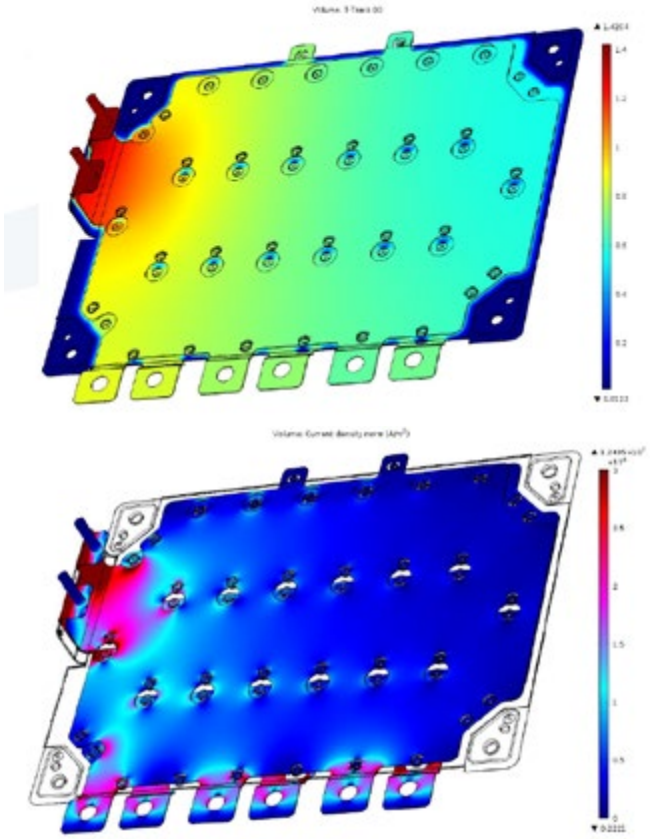

Figure 2: Bus bar thermal and electrical simulations

INNOVATIONS TO BETTER SERVE THE FUTURE
Mersen has developed several recent innovative technologies to bring additional features to bus bar products to better serve certain requirements of specific applications and industries.

Low Inductance / High T° Bus Bar:
Today’s high frequency Wide Band Gap Semiconductor manufactures are pushing the envelopes of power densities and high frequency switching capabilities within their power modules. As a result of this, temperature and inductance criteria within the power modules such as SiC or GaN modules now require superior connectivity methods within the modules themselves.

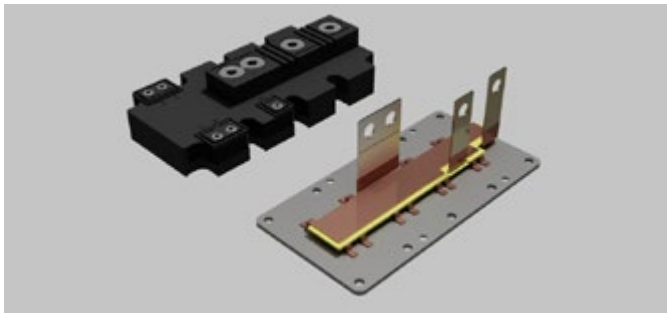

Figure 3: Internal high T° / Low L bus bar for Power Modules

Mersen has developed the manufacturing process to manage high temperatures and low inductance dielectric and associated adhesives to comply with new constraints imposed by wide band gap semiconductors and latest IGBT generations. As a result, our bus bars can now handle up to 220°C operation T° with inductance as low as 35nH and a lifetime operation of 25 years!

Monitoring Bus Bar for Battery Applications:
To cope with the growing demand of constant voltage and temperature monitoring in power electronics applications such as lithium-ion and ultra-capacitors packs, Mersen has engineered an innovative concept that combines in a single customized device a laminated bus bar, a flexible circuit, thermal sensors and other custom electronic components. It allows, with only one part, to make both the power connections and the signal collection from each cell independently, so the status of each cell is delivered to the Battery Management System via a custom connector.

Figure 4: Smart monitoring bus bar for battery cells connection

Low Partial Discharge Design to Handle High Voltage 5KV+ Breakdown:
Partial discharge (PD) is a localized dielectric breakdown of a small portion of a solid or fluid electrical insulation system under high voltage stress. Mersen is working on increasing our capabilities to be able to design and manufacture bus bars featuring low partial discharge for voltage applications up to 5kV.

Increasing the working voltage application and passing a positive partial discharge test can greatly contribute to a long life cycle of bus bar under high voltage applications. This testing is critical to inverter and drive systems manufacturers.

Figure 5: Low Partial Discharge Optimized Bus bars

Bus bars with flexible floating connectors:
Temperature cycles and mechanical environmental constraints (shock & vibration) can damage devices (capacitors, modules…) at fixture points. To avoid this, Mersen offers various floating connector designs that allow ±1mm mechanical deviation with minimal impact on electrical resistance and inductance

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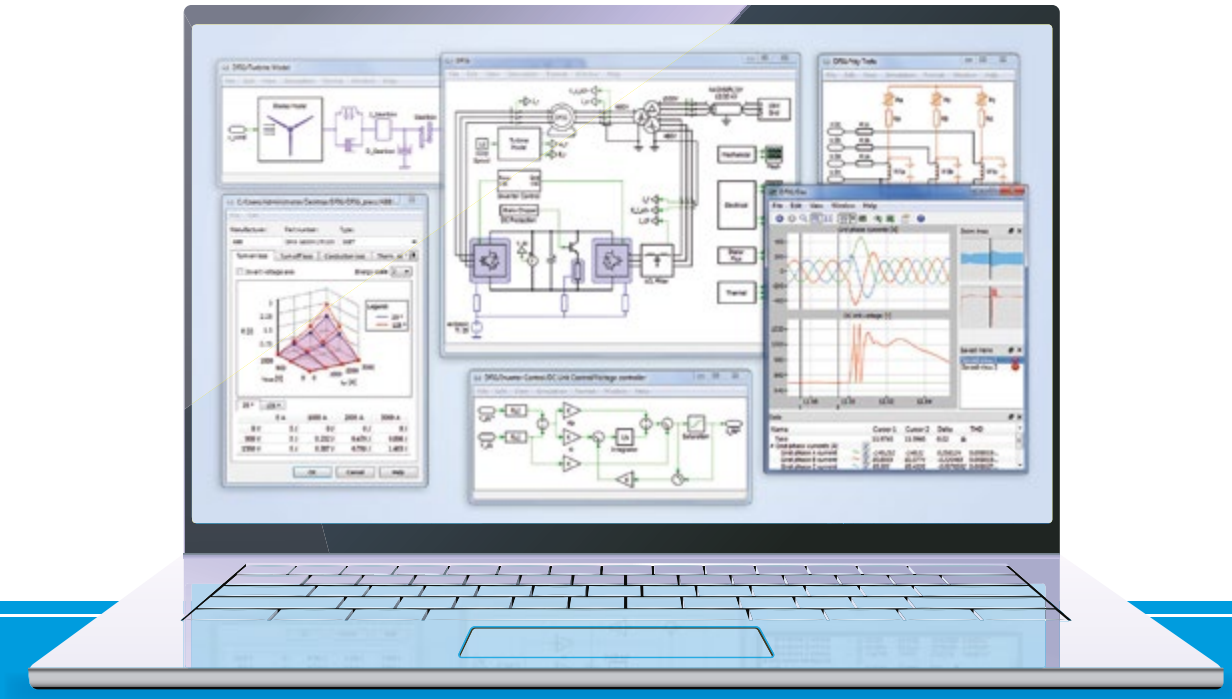

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SERVING CUSTOMERS GLOBALLY

Mersen has a global industrial footprint for laminated bus bars in the three dedicated ISO 9001 certified facilities cover the major economic regions in the world.

- Rochester – New York in USA is the center-of-excellence facility for the North American market. This site is AS9100C registered and ITAR Certified.
- Angers – France is the center-of-excellence facility for European market. Angers is IRIS Certified to better serve the rail industry.
- Shanghai – China is the manufacturing facility to serve the Chinese market.
- A fourth manufacturing bus bar facility is currently being commissioned in India & will be producing in the first months of 2018.

Figure 6: Bus bars with flexible floating connectors

State-of-the-art metal fabrication

In-house capabilities include: CNC stations, punch presses, CNC press brakes, CNC Bending press. Our metal assembly processes include ultrasonic welding, induction brazing, torch brazing and soldering.

Plating

Many available plating finishes are available: tin, tin-lead, nickel, copper, silver and gold.

Key parameters of plating processes are monitored throughout the process, and end of line testing includes thickness measurements.

Properly selected insulation

Insulation is of course at the core of laminated bus bars, and impacts directly the electrical integrity of the product. Various types of insulation materials are used: Polyimide, PVF, PET, rigid insulation, epoxy glass, GPO and Phenolic.

Assembly and lamination

Dedicated production tooling is manufactured for the lamination of each of our bus bars. Additional hardware and interconnection devices and electrical components can be mounted either before or after lamination.

SUB AND FULL POWER STACK ASSEMBLY SERVICES

Drawing on our expertise in bus bar, cooling and fuses, and based upon our multi-physics simulation tools, Mersen is positioned at the center of the inverter design cycle. We are now helping our customers to benefit from the best of these passive devices through a design optimization and assembly service that encompasses:

- Conception optimization and design cycle-time reduction, with testing and design validation in our labs.
- Preferential access to main components (Cooling, bus bar, capacitors, fuses and gate drivers)
- Overall price optimization / Scale effect
- A total customization approach: no pre-defined technical bricks.

Figure 7: Power Stack Assembly Service

From simple [bus bar + capacitor] sub-assembly to full inverter assembly, Mersen is the preferred partner for inverter / stack design-houses with limited or no production capability.

In conclusion, bus bars have evolved into an integral component and embedded platform for many power conversion systems, providing not only an optimized interconnection but also helping power electronics manufacturers to push the performance thresholds of their products.

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Evaluating Fringing Effects in Multi-Gapped Toroids

Efficiency of energy conversion and power density are the key criteria in the design of power converters. Packaging constraints, the demand for reduced size and the best performance frequently force power supply engineers to re-evaluate their approach to building magnetic components. Gapped ferrite toroids can find application in compact/low profile designs and potentially be a convenient solution compared with ferrite E-cores or toroidal powder cores.

By Rafal Kasikowski, Design Engineer; Darren Spriddell, Engineering Manager; Graham Howes, Senior Design Engineer – Stadium Stontronics

Large gaps however produce magnetic 'fringing' causing eddy current losses in adjacent conductors, significantly impacting converter efficiency [1]. This extra power loss can be observed in a form of 'hot spots'. This article analyses and presents 3D FEM simulation of the effect showing how multiple smaller gaps can decrease fringing losses and reduce the fringing flux factor. Practical measurements of comparative temperature rises in a real converter are included using thermal imaging.

Magnetics are becoming critical

Thermal management in power converters is a hot topic. Puns aside, with huge advances in the efficiency of power semiconductors, magnetic components are becoming a limiting factor for system efficiency. Simply, magnetic core construction and material technology hasn't changed much over the last decades so the cause of every loss mechanism is being ever closely examined.

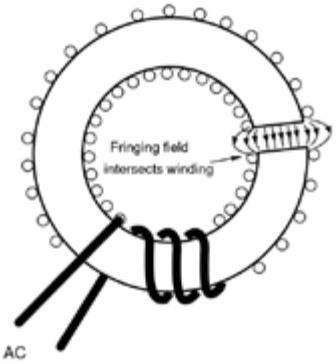

Figure 1: Fringing field around a toroid air gap.

One particularly insidious loss effect is from magnetic field looping outside of the intended circuit and coupling into adjacent conductors, either windings of the magnetic component itself or other metalwork. This coupling induces unwanted circulating 'eddy' currents, which lead to ohmic losses and increased AC resistance of windings. To reduce the effect, much effort is put into containing the magnetic field within magnetic cores.

A problem arises though when the design dictates that the core must have an air gap in the magnetic circuit. Now magnetic field lines have to cross the gap and inevitably some loop outside and intersect with windings.

Why gaps?

Let's look briefly at why a magnetic circuit gap might be needed. Headline requirements for magnetic components are inductance and current rating. A limiting factor is magnetic saturation B which for a given core of cross-sectional area Ae is proportional to inductance L and current i, and inversely proportional to turns N.

$$B = \frac{Li}{A_e N}$$

If low loss ferrite material is used, it will have a relatively high inductance factor or AL value meaning high inductance for few turns. This combination often gives an impractically high value for B for any significant value of current i. A solution is to effectively lower the AL value with an air gap in the magnetic circuit. Now B is lower because L is lower. To get our desired inductance we have to increase N, increasing B again so are we back where we started? No, because L is proportional to N^2 so we only have to increase N by a smaller multiple to get our desired L. The net effect of the gap is to achieve our headline specifications within the core saturation limits. The core size and associated Ae value is chosen to give a practical number of turns to fit with minimum ohmic losses at the operating current. A beneficial side effect is also that the new AL value is much more stable than before, defined mostly by the gap length.

Gapped core choices

Core geometry might depend on the application but usually comes down to 'E' shaped pairs or toroids in some format. Gaps in E cores are easy to achieve with a ground-back centre limb or a spacer between the two halves, effectively providing three gaps in the magnetic circuit. Often toroids are preferred though because of their simplicity and bobbin-free construction. However, forming a gap now is not trivial. Iron powder cores with an organic filler forming a distributed gap are an option but tend to be lossy at high frequencies and relatively unstable. Ferrite toroids with a laser-cut air gap are now available and give high performance but the eddy current effects of the fringing field around the gap can be an issue. It's also known that the effect of fringing fields is to reduce the effective gap length, increasing the expected inductance by a factor F, risking early saturation. Larger gaps produce disproportionally higher fringing field so a logical experiment is to see if multiple smaller gaps give significant benefits.

Evaluating losses from single and multiple gaps

At Stadium Stontronics, a power converter switching at 63.4kHz was set up with an output inductor passing 4A, wound to give 100µH with a gap lg of 4mm. Theory says though that the inductance should be about 36µH given by:

$$L = \frac{N^2 \mu_0 A_e}{l_g}$$ *Equation 1.*

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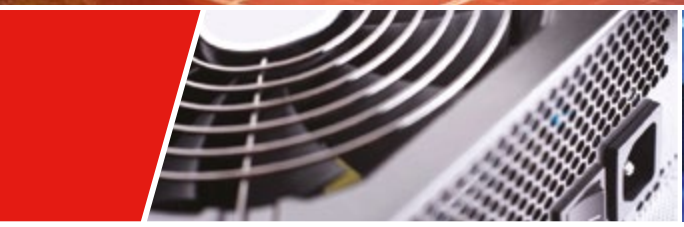

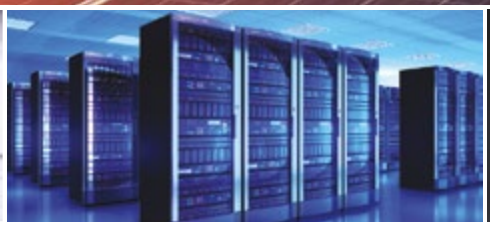

Microchip's digital power design suite includes the Digital Compensation Design Tool (DCDT), MPLAB® Code Configurator (MCC), Microchip compensator libraries and design examples.

These four components of the digital power design suite provide the tools and required guidance for developing complete digital power designs. Once the initial simulation model of your design is ready, the DCDT can be used to analyze the design and the feedback transfer function, and to generate compensator coefficients. Device initialization code can be generated with the help of MCC; and the final firmware can be created with some help from the code examples and the code generated from MCC and the DCDT.

Key Features

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Where μ_0 is the permeability of free space. The discrepancy factor F, of 2.8, is evidence of the fringing field effectively reducing the gap length and for a single gap approximates to [2]:

$$F = 1 + \frac{l_g}{\sqrt{A_e}} \ln\left(\frac{2G}{l_g}\right) \qquad \textit{Equation 2.}$$

Where G is the length of the core window (winding width). Using the data from the core chosen, (Ferroxcube 3C90 TX36/23/10), F calculates to 2.776, very close to the measured value. F is a multiplier for the effective flux density so you can see that this would be nearly three times higher than expected in this example.

To see the practical effect, the inductor was examined using thermal imaging, producing the image Figure 2 (left) showing a hot spot over the gap where the temperature is over 20°C higher than elsewhere on the inductor.

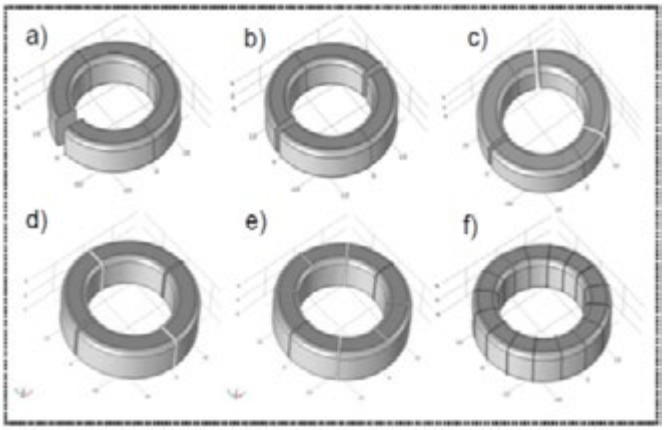
To evaluate the effect of a distributed gap, an inductor was assembled with two gaps on opposite sides, each 2mm to make 4mm total as before. With the same number of turns as before the measured inductance decreased to about 68.5µH, signalling that the fringing flux factor F is 68.5% of its value with one gap. To maintain electrical conditions, the gaps were decreased until the inductance was back to 100µH resulting in 1.1mm each side.

Another thermal image, Figure 2 (right), showed a dramatic difference: the temperature differential between the areas under the gaps and elsewhere was now only around 4°C. Measurements of the test converter showed an efficiency improvement of about 0.2% representing about 148mW saved. Though not evaluated, another benefit is expected to be reduction in EMI from the fringing field.

3D model confirms results

The effects of a fringing field from a gapped toroid can be simulated with finite element analysis (FEA) software such as that from COMSOL. This was done using the Magnetic Field Interface in the AC/DC module of the program with material properties for the gapped core and winding specified (Figure 3).

With a single 4mm gap, 42 winding turns and an excitation current of 1A, the model predicted an inductance of 106.18µH and a resistance of 28.5 milliohms compared with the 'real' inductor measuring 100µH and 26.4 milliohms. This was considered creditably accurate. The single gap was then converted to two at 2mm each and the simulation run again giving a value of 67.16µH, very close to the real value observed of 68.5µH.



Number of air gap	Air gap effective length, mm	Fringing flux factor F	Inductance µH
1 (a)	4.0	2.776	106.18
2 (b)	4.0	1.866	67.16
3 (c)	4.0	1.526	54.94
4 (d)	4.0	1.288	46.39
8 (e)	4.0	1.096	39.46
16 (f)	4.0	≈ 1.0	35.13

Figure 4: Fringing field simulation shows convergence to the ideal with more gaps.

Now the beauty of simulation comes into play with the ability to generate any number of spaced gaps to see if the process can be extended. More gaps were simulated up to 16, always totalling 4mm and the results tabulated as shown in Figure 4. The 'F' factor can be seen to progressively fall toward unity while the inductance converges to the theoretical value of Equation 1.

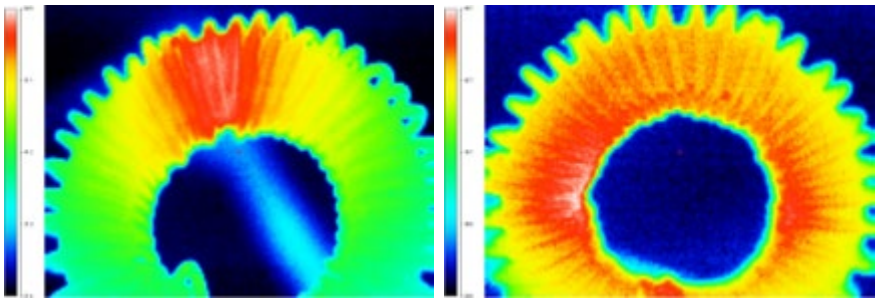


Figure 2. Left: single gap, right: two gaps.

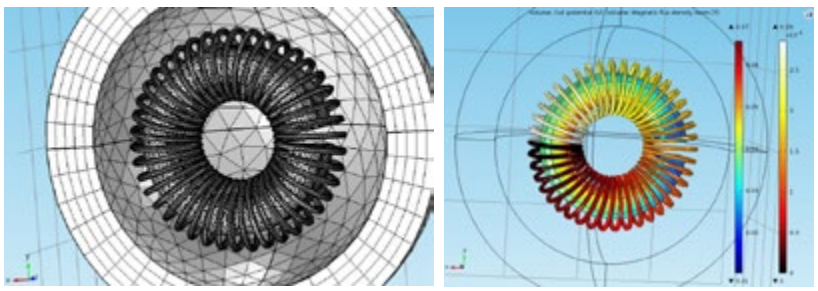


Figure 3: FEM mechanical and flux density/coil potential model of a single-gapped toroid.

A useful technique

While constructing a toroid with 16 air gaps may not be a practical proposition, it is shown that just two instead of one gives a significant decrease in overall fringing field with a consequent reduction in hot spot temperatures and potential EMI. Practical tests and simulation agree well. While exotic distributed gap toroids may be equivalent, the technique described allows use of relatively standard ferrite material saving cost while achieving the same efficiency benefits.

References

[1] Dowell, P.L., "Effects of eddy currents in transformer windings", IEE Proceeding 1966.

[2] Colonel Wm. McLyman T.: Transformer and Inductor Design Handbook, Fourth Edition, CRC Press, 2011, ISBN 9781439836880.

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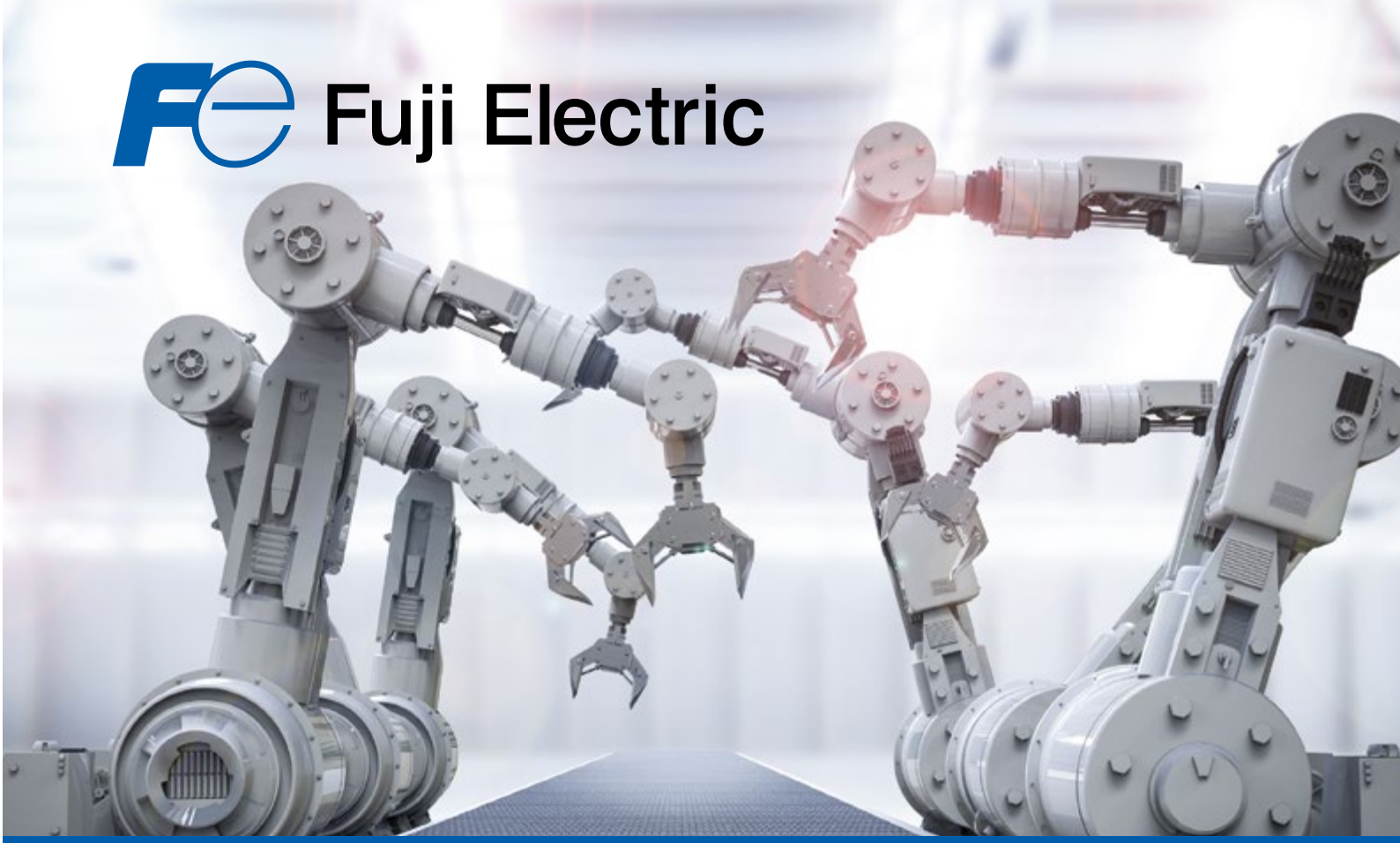

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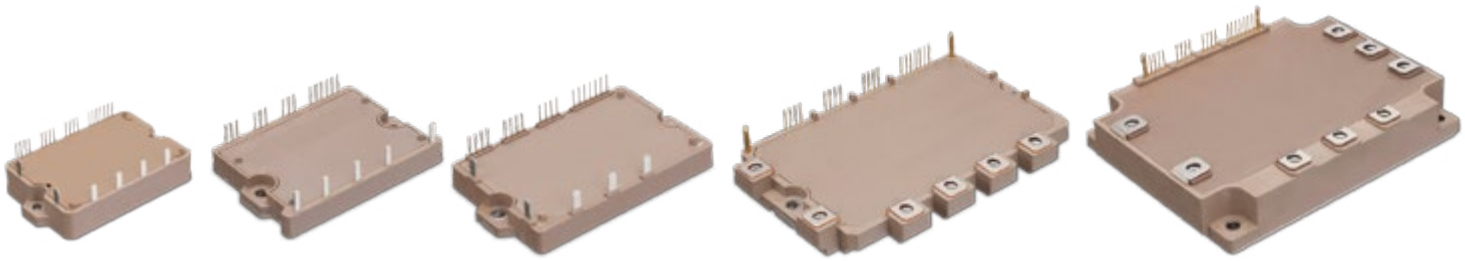

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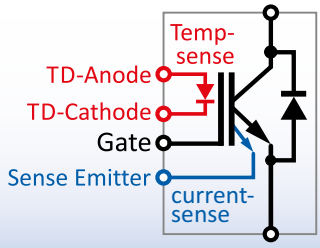

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Balancing Motor Control, Radiation-Tolerance, and Power Consumption in Space Applications

Modern satellites use motors for many purposes – moving solar panels for optimum alignment to the sun; moving reaction wheels to change the orientation of the satellite, steering antennae for telecommunication, ground contact and radar purposes; moving focal planes, mirrors, and filters in imaging satellites, to name just a few examples.

By Truman Tai, Microsemi Corporation

In space applications, the highest reliability possible is needed, as repair or rework is impractical after a satellite is launched. By controlling motors digitally, sophisticated fault detection, isolation and recovery algorithms can be implemented to prolong the useful life of motors, and therefore maximize the service life of the satellite. Furthermore, digital control allows the collection of telemetry data on motor performance and subsequent transmission to the satellite control station on earth. With digital control, power-efficient motor control algorithms can be deployed to minimize the consumption of power generated by the satellite's solar panels or stored in its batteries. Resources are extremely limited in outer space, and power conservation along with fault protection should both top the list of priorities of a spacecraft.

Fault Protection: Cosmic Radiation

Cosmic radiation in space is a well-documented problem that poses a threat to the ASICs and FPGAs where digital control is implemented, and a corruption of the control data can render the entire system inoperable. Dealing with the effects of cosmic radiation on spacecraft is an important and complex process. Single-event effects, such as latch-ups and single-event upsets, can damage spacecraft electronics severely and suddenly, while total ionizing dose (or TID) exposure accumulates over time, gradually causing electronic devices to exceed specified limits. Flight-critical and mission-critical systems need to be designed with components which have well-established and well-documented tolerance to radiation effects.

Reliability and Qualification

Although reliable processes and technologies are clear necessities for components in spaceflight applications, they are simply not enough. Reliability screening on a per-part basis is needed to screen out manufacturing defects and to eliminate early failures, sometimes called infant mortalities. Ensuring that each component of a satellite's digital control system is up to industry standards is just as imperative as the component's function itself. Implementing a system that is designed to be more efficient and more durable is great, but ultimately ineffective unless it operates reliably throughout the entire intended lifetime of the mission. This is the primary purpose of the quality standards adopted and implemented by the space industry, and this is why it is important to thoroughly test each part in accordance to those standards.

A component failing in space could jeopardize the mission of a satellite that cost billions of dollars, decades of effort, or could even cost a human life, which is why the qualifications for parts are the toughest and the tests require the most scrutiny. In this way, qualification to QML criteria provides assurance to satellite operators who are committing $100M-$1B (per satellite) that the parts they are using have been assessed by industry experts to be sufficiently reliable for flight-critical and life-critical space applications. If they are putting that much money and effort into their project and risking human lives in their endeavors, they can take their qualifications as a form of security for their investment.

However, in order for customers to put themselves through such strenuous qualification processes and invest so much into new forms of digital control, these systems must provide some clear advantage. So going back to the original solution: what exactly does power-efficient digital motor control look like?

Overview of Motor Control Algorithms

Sensorless field-oriented control (FOC) theory is one that is commonly applied in controlling basic permanent magnet synchronous motors (PMSMs) and brushless DC motors (BLDCs) using an FPGA, and is known for its precise, sensorless control while optimizing the use of control resources. The FOC system is composed of several algorithm blocks, each providing various control and feedback monitoring functions. Digital control systems communicate with the motors through voltage and current signals, and these algorithm blocks are instrumental in translating the necessary messages. FOC transformation blocks are there to ensure an optimum usage of resources; open-loop management blocks can calculate the position and speed of the motors; the rate limiter block programs a smooth transition as the motor changes speed; and there are a host of other blocks that perform a variety of other critical actions.

Additionally, these blocks can often service multiple functions for fault detection and reset purposes. The open-loop management blocks not only track motor position and speed, but also monitor the back-EMF from the motor, which can then be communicated to the rate limiter as motor feedback. The rate limiter can use this data to force the control output to zero instantaneously for an auto-restart if there is an irregularity in the back-EMF caused by an unknown exterior braking force, for example. From facilitating feedback from various position and speed sensors; to enabling precise control of motor speed over a wide range of speeds; and even detecting stall and overcurrent conditions, these algorithms employed in digital motor control structures provide such a versatile set of functions. Functions that will in the

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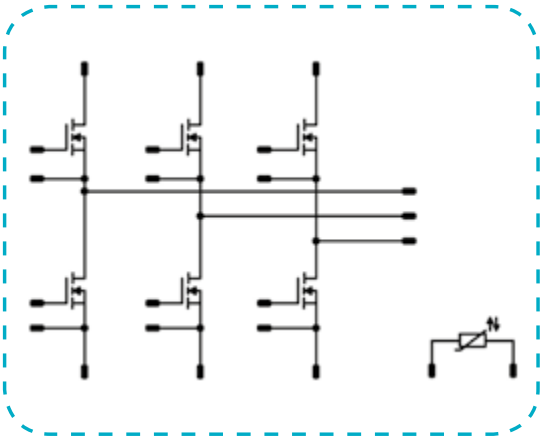

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end increase the reliability of satellites, protecting the motors and saving precious power. This is the way of the future in motor control, and some modern radiation-tolerant FPGAs can successfully tackle these challenges while having the added ability of mitigating radiation effects.

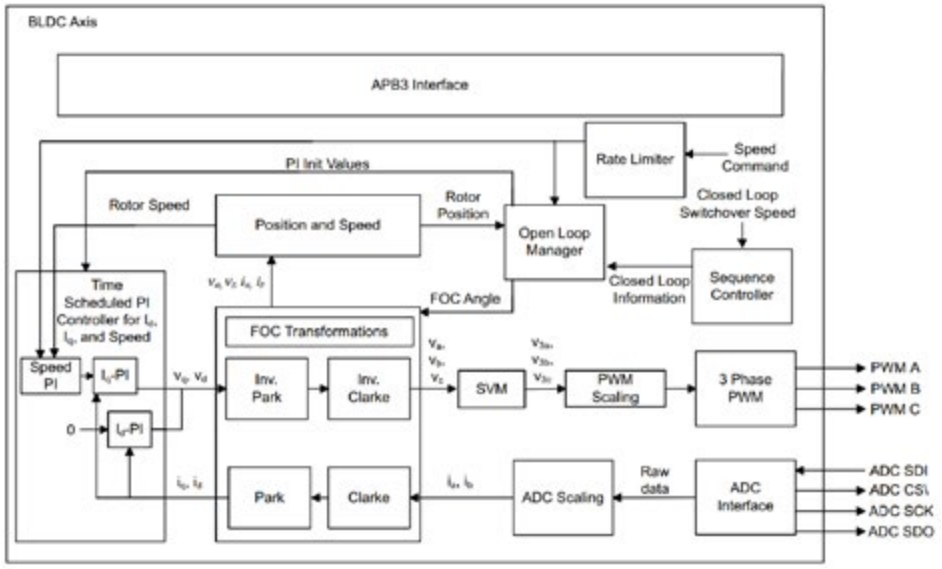

Figure 1: Block diagram of FOC sensorless implementation to control speed and torque of a BLDC motor

Today's Solutions

The latest industry FPGAs are paving the way into this future, and feature all of the IP required for sensorless FOC motor control, with the benefit of having radiation-hardened circuitry hardwired directly into their architecture. With up over 100k triple-modular redundant flip-flops; several Mb of internal storage; radiation-hardened configuration memory; and an abundance of mathblocks, user I/Os, and SERDES lanes operating at multiple Gbps, these solutions are designed to handle complex tasks in space, such as digital motor control. Development kits are also readily available on the market in support of the newest FPGAs, which allow designers to run custom tests and interface to a host PC.

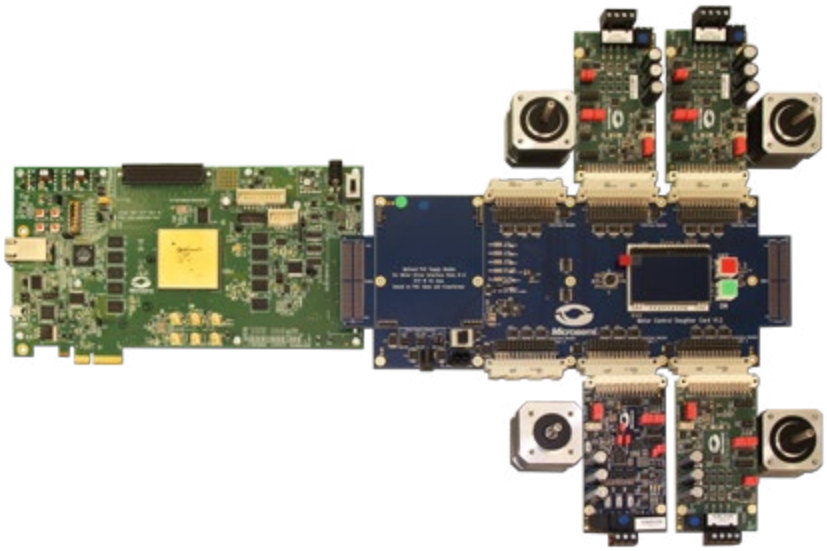

Figure 2: Sample picture of RTG4 Motor Control Kit operating 3 BLDC motors

Testing with the RTG4

A benchmark test was performed using Microsemi's Motor Control Kit, in conjunction with the RTG4 development kit, where sensorless FOC algorithms were implemented to run 4 motors simultaneously and independently. The RTG4 was found to consume only 0.6 W in the average case, and 1.8 W in a worst case scenario. Its power efficiency was similarly matched by its resource efficiency, only requiring a 13% resource usage. During the motor control simulation, only 19,000 4-input look-up tables and 19,000 D flip-flops were required, which equates to 12.9% and 12.6% of the RTG4 FPGA resources respectively.

Shifting from the design input to the motor output, the maximum motor performance saw speeds of over 5500 rpm for all 4 of the simultaneously running motors with an input clock frequency of 73 MHz. There were four independently controlled motors in the bench test setup, however the design can be easily expanded to six motors or more. Looking at the overall test results, benchmark testing has demonstrated that the RTG4 is successful in dealing with the multi-dimensional task of providing a low-power, radiation-safe, and efficient part for space applications. Furthermore, providing a platform for design engineers, like the RTG4 Motor Control Kit, to experiment and calibrate their own constraints can be invaluable to short-term and long-term space missions, especially with such exciting technology entering the market with such untapped potential.

Future Implications

Digital motor control is the clear path to the highest potential reliability in space application. Its utilization leads to new levels of conservation of power, while the added countermeasures embedded in the fabric of the algorithms provide increased protection for the motors and satellite instruments. But recall that it is not enough to protect the elements under digital control; having radiation tolerant digital electronics and FPGAs are equally needed for a completely reliable spacecraft. Radiation mitigation in digital space electronics as well as proper screening qualifications will ensure that the control center executing the algorithms is protected and can be supported by industry documents.

The operational motor control algorithms of modern FPGAs can meet the performance requirements of space systems, while meeting the radiation requirements of space applications, with minimum power consumption and maximum flexibility.

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The State of Intelligent SiC MOSFET Gate Drivers

Transportation, Renewable Energy & Energy Storage are creating dramatic challenges to safe and efficient operation of SiC MOSFETs. AgileSwitch's Augmented Switching, an advanced control technique, is conquering these challenges.

By Nitesh Satheesh, Cliff Robins, Adam Fender, AgileSwitch, LLC

The Challenges

Energy Conversion equipment is getting lighter, safer and more reliable than ever before. This has been made possible by advances in Power Devices, specifically by adoption of state of the art Silicon IGBTs and SiC MOSFETs.

However, these advances have come with costly design tradeoffs. An example of such a tradeoff is efficiency vs. turn-off overshoot voltage. To address these challenges, AgileSwitch's Intelligent Gate Drivers now feature patented Augmented SwitchingTM Technology. This technique provides a fine-pitch control mechanism for system designers that are faced with the efficiency/overshoot challenge.

Augmented Switching Revealed

IGBT performance has made tremendous progress in the last two decades. This was achieved by introducing the Non-Punch Through (NPT) technology for lower losses and Vertical Gates for lower gate charge. However, during all this time, a critical piece of technology has remained a bulwark – the Gate Driver. The operation was simple, +Vge (Gate to Emitter) through the turn-on resistor and -Vge through the turn-off resistor.

A tectonic shift has begun to take place with the adoption of Silicon Carbide. SiC MOSFETs have larger di/dt & dv/dt compared to Si IGBTs. Therefore, the conventional technology became inefficient. Augmented Switching was introduced by AgileSwitch in 2016 to tackle this problem.

Efficient switching is achieved by effectively leveraging the miller effect of MOS devices. The technique transitions quickly to the miller plateau and is then followed by a rest period on the plateau to enable controlled switching without needing to slow the SiC device down with gate resistors. A comparison of Conventional Switching and Augmented Turn-Off can be seen in the charts below

Augmented Switching includes two-level Turn-On as well as two, or more, levels of Turn-Off. Further, there can be two different Turn-Off profiles – one for normal operation, and a different profile for Short-Circuit operation.

1. Turn-On
   - 1.1 The Vgs transitions from the off state to the on state through an intermediate step.
2. Turn-Off
   - 2.1. Normal Operation
     - 2.1.1. The Vgs transitions from the on state to off state through an intermediate step
   - 2.2. Short Circuit Condition
     - 2.2.1. The Vgs transitions from the on state to off state through multiple intermediate steps

Augmented Turn-Off was first implemented in a discrete form and released in the EDEM3 – EconoDual Master 3 driver in March 2016. It was followed a year later by the launch of the 62EM1 – 62mm driver in February 2017.

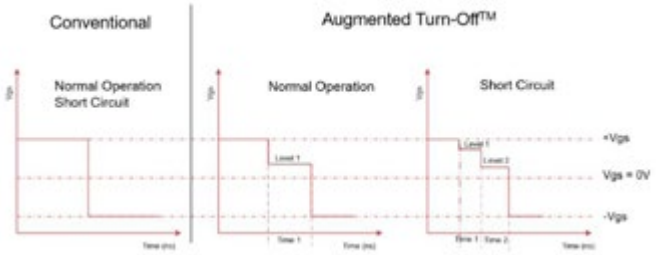

Figure 1: Augmented Turn-Off

Comparative Analysis

The benefits of Augmented Switching have been shown in head to head comparisons with Conventional Switching using commercially available Gate Drivers and SiC Power Modules.

The power module characteristics are:

- Breakdown Voltage = 1200V
- Rated Current = 250A
- Rds(on) = 8mΩ
- Recommended external Gate Resistors = 5Ω for both turn-on and turn-off

Test were performed using a Double Pulse Test method with a resistive load of 3Ω for the Normal Operation test (results presented in the top graph in Figure 2) and 0.6Ω for Short Circuit Operation test (results presented in the bottom graph of Figure 2).

The AgileSwitch Gate Driver with Augmented Switching was optimized to deliver a balance between overshoot voltage and switching losses.


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Augmented Switching resulted in a 23% reduction in switching losses for the overshoot voltage as compared to the conventional driver. A summary is tabulated in Table 1.

Table 1 - Normal Operation Results
Conditions: V=600V, I=200A

Driver	Rg	Overshoot	Losses
Augmented Switching	0	286V	1.56mJ
Augmented Switching	0.5	282V	1.86mJ
Conventional	5	282V	2.02mJ

23% LOWER Switching Losses vs Conventional

A short circuit condition is especially dangerous due to the high current in the device. When the device turns off in a short circuit condition, high voltage and high current are both present for a finite period of time, resulting in stress in the device. IGBTs were rated to endure this stress for up to 10us, whereas the SiC MOSFETs have a much narrower window. The resulting di/dt couples with the stray inductance in the system power loop to create a large overshoot voltage.

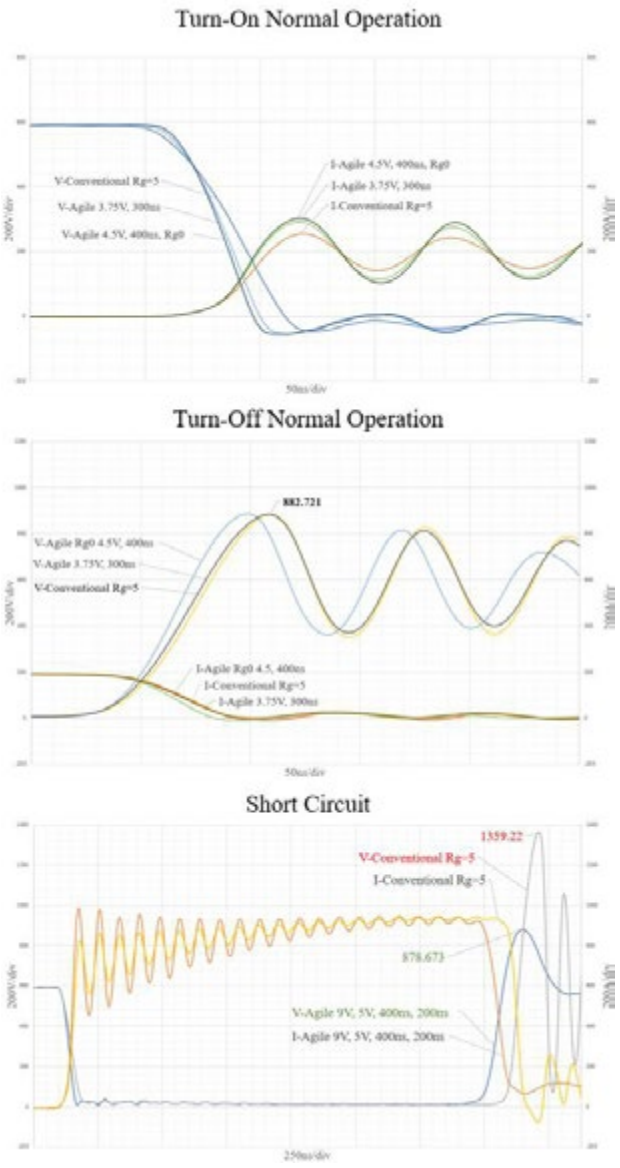

Figure 2: Comparative Analysis

Advanced techniques are implemented in Augmented Switching to improve the short circuit detection time. The use of Augmented Switching limits this overshoot voltage to 37% of the overshoot that would be observed if using a conventional driver (63% reduction). Results are tabulated in Table 2.

Table 2 - Short Circuit Results
Conditions: V=600V, I=1000A

Driver	Rg	Detection	Overshoot
AgileSwitch	0.5	1.3us	279V
Conventional	5	1.45us	759V

63% LOWER Overshoot Voltage

Roadmap
Augmented Switching is currently implemented in a discrete form with a gate array and peripheral analog circuitry. AgileSwitch is now developing a family of Gate Driver ICs that will help reduce the PCB footprint and BOM count of Gate Driver Boards.

The first of a series of Gate Driver ICs will be non-isolated, followed by the release of an isolated version. These Driver ICs will be incorporated into the existing line of AgileSwitch Plug & Play Driver Boards. Additionally, a new line of Gate Driver cores will be released.

Each of the building blocks on the AgileSwitch product roadmap address key design considerations experienced by customers. These issues are explored in detail in the next section.

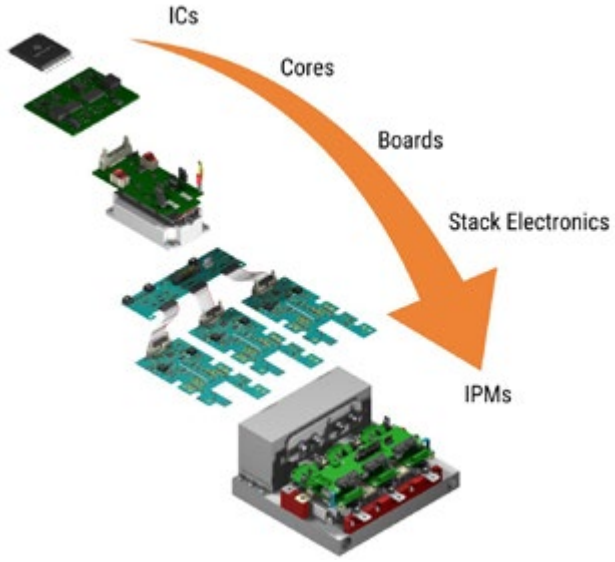

Figure 3: AgileSwitch Roadmap

Is Augmented Switching for me?
Several challenges are addressed by Augmented Switching. The challenges are unique to an application and a sampling of such applications is listed below, if you do not find your application space below, please reach out to AgileSwitch.

Electric Vehicles (EV)
Due to increasing awareness of the effects of global warming, the Transportation industry, particularly consumer vehicles are moving quickly toward electrification. The biggest challenges for consumer EVs today are addressed by Augmented Switching:

- Limited Range
  Increased efficiency lets you go the extra mile. For the same battery, the increase in switching efficiency leads to a longer range.
- Charging Time
- Improved efficiency will reduce charging time
- High Cost
  Reduction in overshoot voltage leads to an increase in design margin. Additionally, a reduction in ripple & oscillations lead to reduction in filter costs.

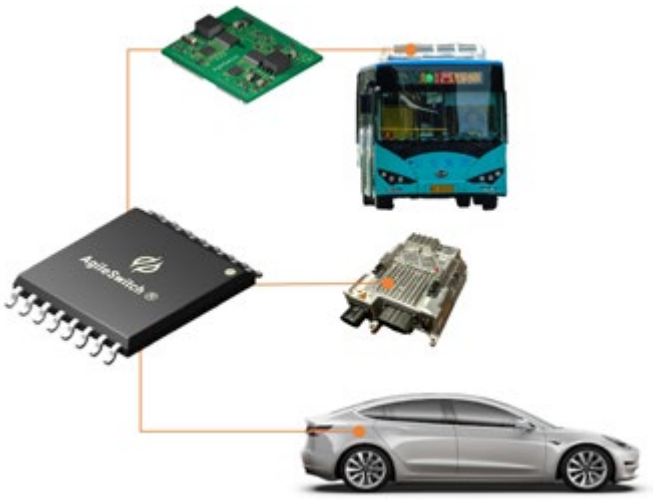

Figure 4: Example applications

Traction (Trains, Trolleys, Buses)
Traction inverters and auxiliary power units (APU) on mass transit vehicles present their own set of unique design challenges and interfering factors. Augmented Switching is able to address many of these design requirements:

- Electro-magnetic Interference (EMI)
  Reduced by managing turn-on & off parameters and tuning it to any system.
- Power Density & Weight
  For APU inverters, space is tight. This technique allows designers to use smaller and lighter filters.
- Efficiency
  For an electric or hybrid bus or trolley, inverter efficiency is key. Lower switching losses reduces heat generation.
- Down Time
  High levels of EMI may trigger false faults. Augmented Switching filters out this erroneous information and only acts if and when a real fault is present.

Energy Storage and Renewables
Storage of energy generated through renewable methods adds an additional conversion step due to the inclusion of the battery. Improving efficiency becomes critical to offset this additional step:

- Efficiency
  Increase efficiency to offset additional conversion step to and from battery.
- Down Time
  EMI can cause inaccurate faults on the control electronics. Augmented Switching reduces Vds, Vgs oscillations reducing EMI.

Summary
Augmented Switching solves the major challenges faced by users in the noted application areas. It is presented as a viable alternative to conventional switching techniques.

Higher efficiency is achieved through a reduction in switching losses.

Size reduction of Passive Filter Components is achieved by reduction in Vds, Vgs ringing and turn-off overshoot voltage suppression.

Safe operation is demonstrated through a fast and safe short circuit response.

With Augmented Switching techniques, designers are now able to realize the full set of benefits available from SiC MOSFET devices.

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www.agileswitch.com

About the authors

Nitesh Satheesh is an Applications Engineering Manager at AgileSwitch. Previously, he was at Fuji Electric where he served as a Semiconductor Field Applications Engineer. He received his Master's Degree in Solid State Electronics from Rutgers University and his bachelor's degree in Electronics and Communications Engineering from Anna University Chennai, India.

Cliff Robins is the European Director of Business Development at AgileSwitch. He is based in the UK and serves customers across the globe including Europe, Russia and the CIS countries. Has over 25+ years in power electronics sales for global suppliers and manufacturers. Prior to 2012, Cliff served as a Sales and Marketing Director for a Power Semiconductor company.

Adam Fender is a Technical Product Manager at AgileSwitch. He received his Bachelor's Degree in Mechanical Engineering from Temple University in Philadelphia, PA. Adam's responsibilities include thermal and mechanical analysis and design of power stacks, project management, and product testing.

Pulsed Field Magnetometry for Characterization of Magnetic Component

Design of power magnetic component is a key competence for power system with requirement of high efficiency. The physics behind winding loss is linear, very accurate tool is already available, but the physic of magnetization process is not yet fully understood, and the extremely non linear behavior of magnetic materials and wire wound components must be provided by measurement.

By JC Sun, Bs&T Frankfurt am Main GmbH, Andreas Müsing, Gecko Simulation AG and Christian Teske, Consolidated electrodynamics Ltd.

Introduction

Large magnetization current amplitude is necessary to see the saturation behavior of component under testing, especially for power magnetic components, with low permeable powder materials, or shaped cores with multi air gap in use, additionally the entire time interval for a complete measurement should be limited efficiently, in order to avoid impact of heat dissipation, and this information of power loss can only be provided by bipolar excitation.

The Pulse Field Magnetometry [1], utilizing the Thyristor and Diode Technology, is a very promising technology to address this demand. It is easy to made accessible for operation, and is well accepted and already established as de facto standard technology in magnetic material community, particularly rare earth material, which exhibiting 10^6 A/m as coercivity. BsT-pulse (19' with 4HE height, approximately 9 kg) is demonstrated to show that the same technology is well suitable to characterize the large power choke, and low permeable alloyed powder materials in 2017.

Principle BsT-Pulse using Thyristor Technology

Thyristor technology is known already for many of years and is often the first power product to be taught in power electronic laboratories. It delivers the highest current amplitude under high voltage among same power class compared with other power semiconductor. The bipolar excitation with full reversal current is essential to characterize the magnetic materials, regardless the initial status of device under test, like in remanence stage.

Basically the Thyristor pulse generator is a pulsed power circuit with an SCR (Silicon Controlled Rectifier) as high voltage (HV) switching element, a capacitor as energy storage and a discharge limiting inductor which limits the maximum current to a value which still can be handled by the SCR without damage, the function principle is illustrated in Figure 1.[2]

Capacitive discharge is a widely adopted technique for generating large current pulses. Charging a capacitor and accumulating stored energy are well managed in a controlled manner over a period larger than the discharge duration. The potential discharge energy is only limited by the capacitors used to store the charge and the voltage applied

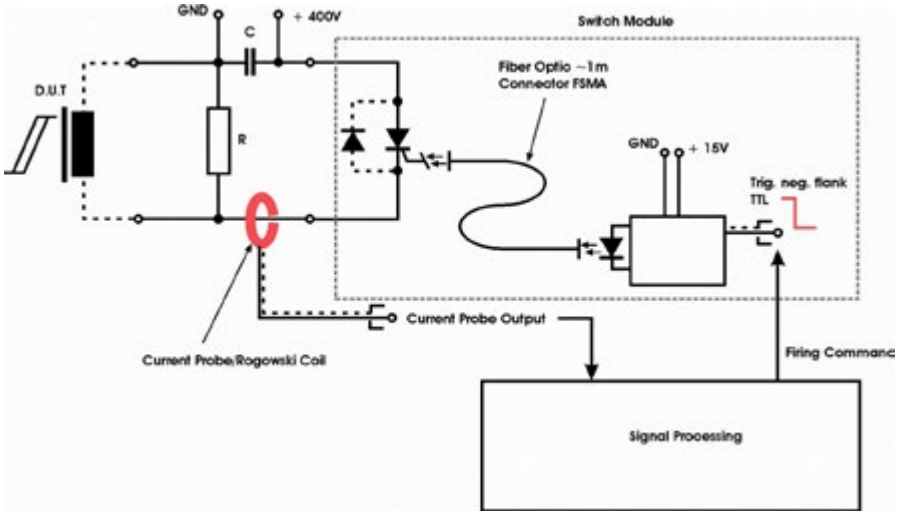

Figure1: Basic circuit layout of the pulse generator (BsT-Pulse)

The voltage pulse applied will drive the D.U.T. bipolar into saturation. Due to an integrated freewheeling diode the resulting discharge circuit is capable of full current reversal. Hence, a saturation-desaturation-saturation transition will be created which can be monitored by current and voltage probes in order to determine the saturation properties respectively. Pulse energy is dissipated during the oscillation, in form of voltage-current decay.

Option with JIG to characterize toroidal shape under pulse

A mechanical fixture as JIG enables simple construction of DUT, consists of wires and core, the parasitic effects impacted for high frequency oscillation can be kept as random, the mechanical construction of JIG is illustrated in Figure 2.

This set up enables the determination of magnetization behavior of any kind of soft magnetic material, especially for alloy powdered core with different composition, because the low permeable materials need large current amplitude to be illustrated for their soft saturation behavior, through voltage second calculation, with careful normalization with effective cross section, the flux density can be traced, the whole measurement interval is limited in range of some µs and ms.

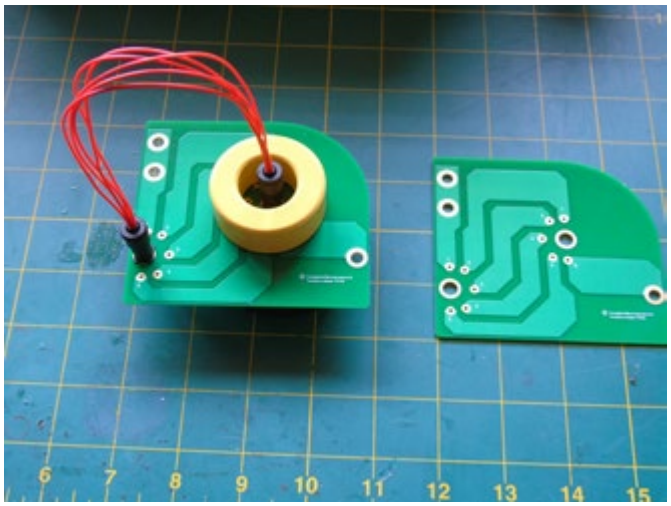

Figure 2: JIG, core can be insert / removed before / after measurement by plug the center pole

The consumption of metal alloyed powder materials is increasing double digital over the last 2 decades. Discussion takes place to integrate this kind of materials in IEC nomenclature, those metal alloyed powder materials usually exhibit permeability in range between 26 and 200, it is very difficult to characterize the magnetic properties, especially the saturation behavior after the conventional way.

The Thyristor technology, capable of providing high kA amplitude under given applied voltage, usually under 250 Vpeak with full reversal current is definitely potential candidate to meet this requirement.

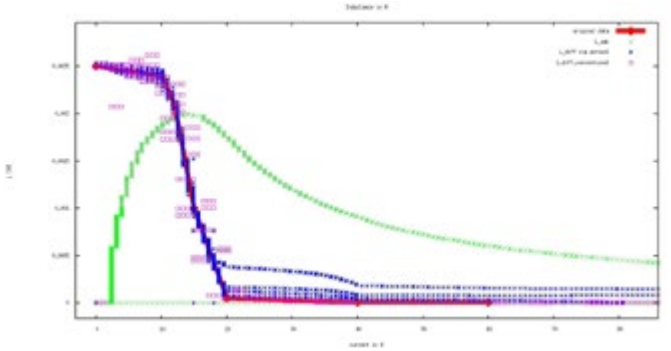

Figure 3: Simulation output differential- (green) and amplitude (blue) inductance.[3]

Data processing for impulse measurement

In general the calculation of inductance through didt method has difficulty because of limited resolution of AD convert, and the transient measuring interval.

The entire circuit consists of non linear D.U.T. for testing, limiting inductance (solenoid, a linear component) and a charging capacitor, Simulation can be performed by GeckoCircuit for analytical calculation of amplitude and differential inductance against the applied current amplitude, as shown in Figure 3.

The data processing of pulse measurement is a demanding task, since the inductance is calculated as quotient of the applied voltage and current incremental rate, which requiring high sampling rate with high resolution for a diagram of inductance value in reasonable manner. Due to its unique construction and simplified Thyristor technology the large signal measurement can be performed with moderate scope technique. The GeckoCircuit simulation result underlies this statement.

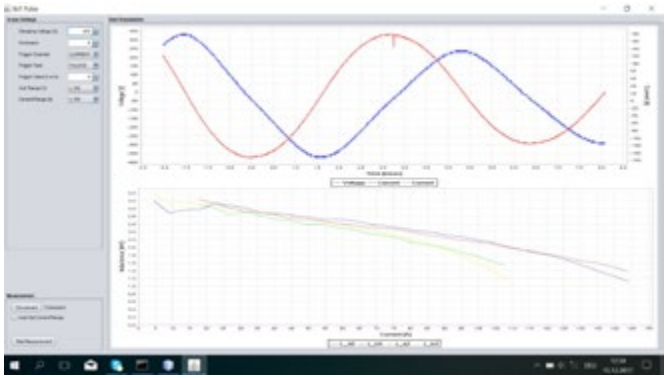

Figure 4: User Interface with integrated scope

Further Potentials

BsT-Pulse can provide the inductance (amplitude, differential), (de) magnetization curve, and further more information about the non linear properties of magnetic components, additionally it enables calculation in terms of energy/power loss of the power choke with full reversal current amplitude, driving DUT back and forth to saturation, until the accumulated pulse energy disappears. Those non linear characteristic can be illustrated with one single pulse, there are many different ways to consider and evaluate the loss of wire wound components, and it is definitely enrichment by introducing BsT-Pulse as instrument to qualify wound components and its associated materials in use.

Discussion part with measuring examples

Typical power choke with iron powder POT core in use

With a single pulse the power choke is driven back and forth into saturation, indicated by distorted current wave, the voltage peak declines with dissipated pulse energy throughout power choke, the saturation behavior is clearly illustrated just within single shot, the amplitude inductance can be expressed for different odd cycle of oscillation. The different inductance vs. current relation is visible for different cycles, and this dependence is till now not specified yet, this is only possible with BsT-Pulse.

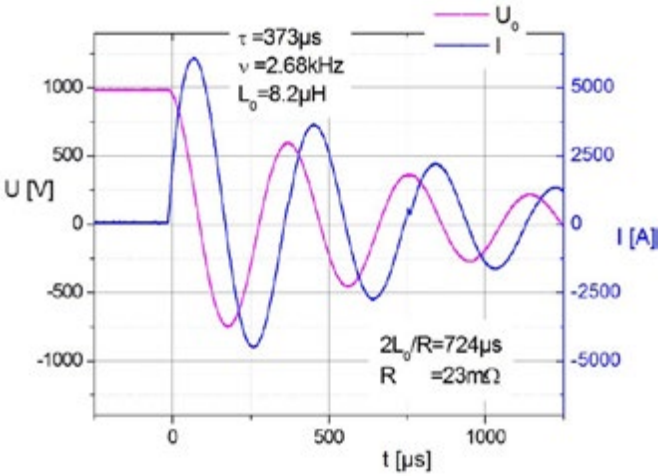

Figure 5: voltage and current decay of measurement with short circuit

Short circuit measurement

The most critical situation for BsT-pulse is the measuring condition with short circuit, with applied voltage till 1000 V, the capacitor and linear solenoid as limiting inductance builds up as LC resonance circuit, the damped oscillation process can be observed with its characteristics measurement with iron base amorphous core (~23 kg), [4]
Tape wound core made with iron based amorphous material (~23 kg) is, it is clearly visible, the process (before and after vanishing process) has large impact of material properties, which are relevant for application design, and this difference can be quantified by bipolar impulse technology, the energy dissipation and power loss can be calculated respectively.

Conclusion

BsT-Pulse, based on Thyristor-Diode technology, is introduced to characterize the magnetic components and associated metal alloy powder material in use. The economic solution provides the largest current amplitude under high voltage, is attractive for installation industry, where more and more magnetic components have to be tested for mid voltage grid application, especially in developing countries, the

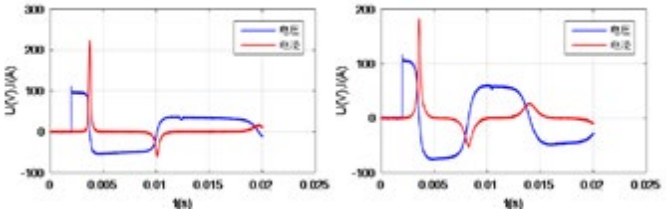

Figure 6: voltage and current decay comparison (coated), pulsed @ ~ 100 V

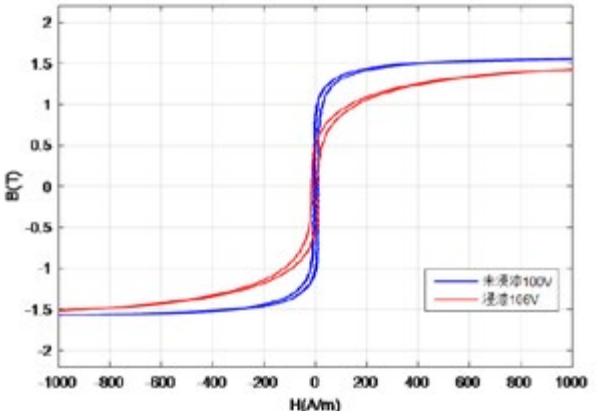

Figure 7: hysterese loop, out of the first half cycle, comparison between annealed and coated status

full reversal amplitude opens further possibility to determine the loss behavior, and this important development gains increasingly importance for DC grid deployment

Reference:

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[2] private communication with Teske
[3] private communication with Müsing
[4] private communication with Wang

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Nova Electric, a division of Technology Dynamics Inc., has introduced the most compact avionic 3- phase pure sinewave inverter at 24VDC to 115/200 VAC 400 Hz. The unit measures 17.75" L x 13" W x 8" H and weighs only 34 lbs. This inverter is rated 6KVA or 4.5KW and is intended to power avionic equipment that requires very accurate output frequency with minimal weight requirements. The unit is designed to comply with the DO-160 requirement and is currently in the qualification process. The inverter input meets MIL-STD-704 which covers the power EMC standards on board military aircraft. The inverter's output voltage is a tightly regulated pure sinewave with less than 3% THD. The unit has standard protection features including: OVP, OLP and OTP. The construction of the unit is designed to meet the MIL-STD 810 and DO-160 requirements for shock, vibration, humidity, altitude (15,000 ft.) and crash safety. This inverter can also be easily adapted to a rack mount configuration and will fit in a 5U enclosure.

www.novaelectric.com

Expanding BoostLynx* Voltage Converter Product Family

Building on its existing line of DC-DC boost converters and offering more versatility to board designers, GE's Industrial Solutions has introduced two new additions to its BoostLynx* product family—ABXS003A3X341-SRZ (a high-voltage version) and ABXS005A4X341-SRZ (its low-voltage counterpart). The additions to GE's line of non-isolated, high-efficiency DC-DC voltage converters increase the load capacity of the product family to up to 130 watts (W), equipping board designers with a range of solutions to meet the demands of today's power-hungry applications.

The new 130-W BoostLynx modules can convert a standard 12-volt bus voltage (which supports an input voltage range of 8-16 volts) to higher voltages of 16-34 volts with GE's low-voltage ABXS005 version and to between 32-54 volts with the high-voltage ABXS003 version. The new DC-DC converters join GE's previously announced 65-W versions to provide more options for board designers faced with ever-evolving power challenges. The easy-to-use BoostLynx converters—also known as point-of-load (PoL) modules—can be used to power any component with an operating voltage between 16-54 volts. For example, the PoL modules could be used in applications such as small-cell remote radio heads, radio frequency power amplifiers, LED backlighting, solenoids and actuators in machinery and automation, fans, surveillance cameras and equipment, sensors and robotics.

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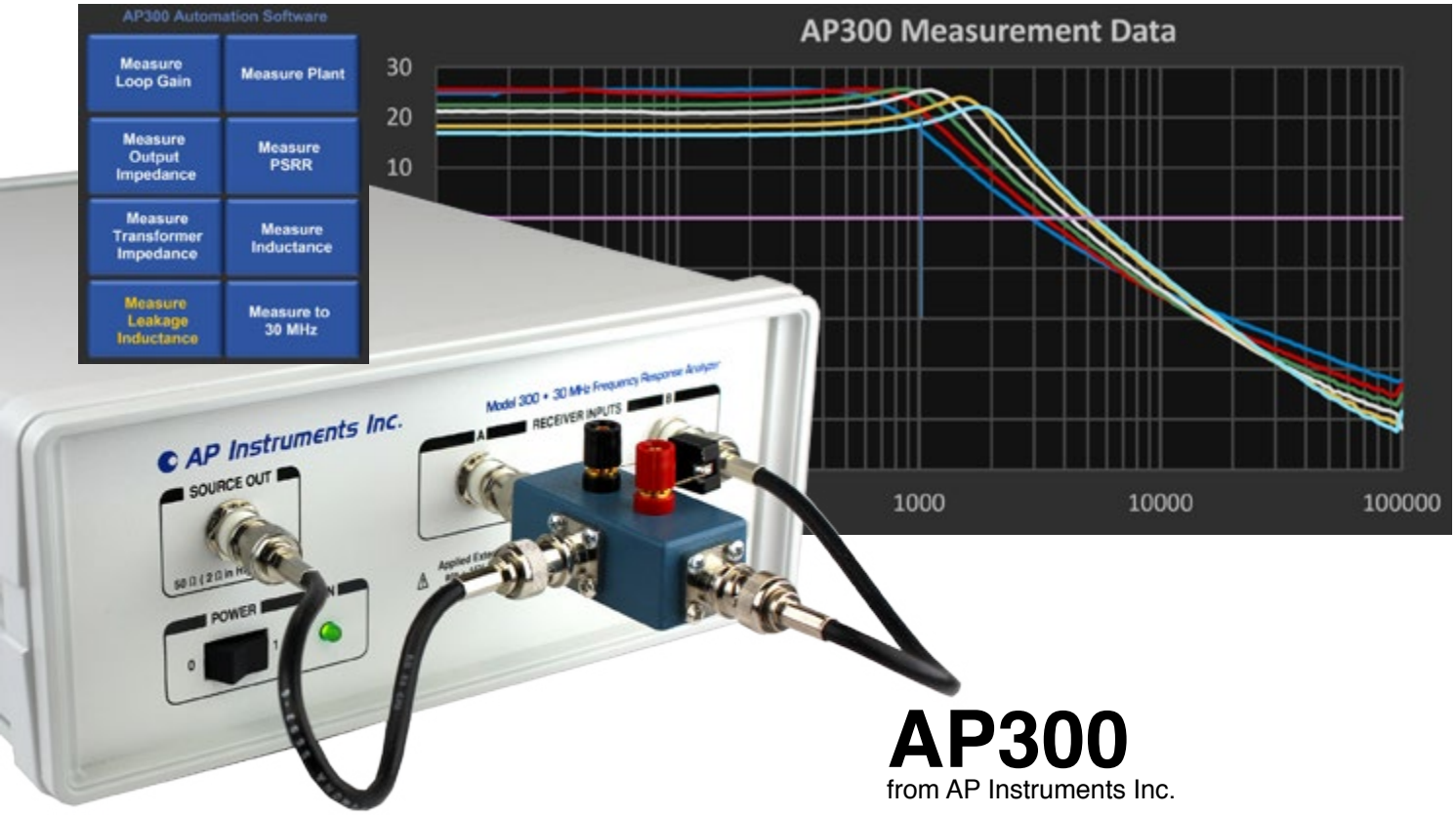

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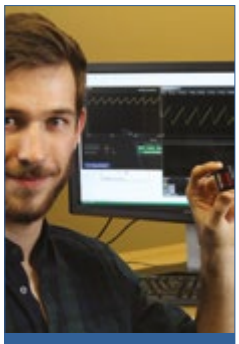
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Receiving Defense Logistics Agency Approval

Kemet announced that the Defense Logistics Agency (DLA) has accepted Kemet's qualification of C0G and BP dielectrics to MIL-PRF-32535 'M' and 'T' levels making them the first base metal electrode (BME) MLCCs qualified for defense and aerospace applications. MIL-PRF-32535 is the DLA's first capacitor specification for defense and aerospace that capitalizes on industry leading base metal electrode (BME) technology. Kemet's MIL-PRF-32535 series utilizes BME technology to deliver up to an 18-fold increase in capacitance for C0G and BP dielectrics compared to the offerings in MIL-PRF-123 and MIL-PRF-55681 using precious metal electrode (PME) ceramic capacitors.

MIL-PRF-32535 is the first DLA specification to recognize a flexible termination option. Kemet's flexible termination utilizes a pliable conductive silver epoxy in the termination system. The addition of this epoxy layer inhibits the transfer of board stress to the rigid ceramic body, therefore mitigating flex cracks that can result in low insulation resistance or short circuit failures. "This first-to-market product brings a paradigm shift in defense and aerospace applications with the use of BME technology," said Dr. Abhijit Gurav, Kemet Vice President of Ceramic Technology.

www.kemet.com

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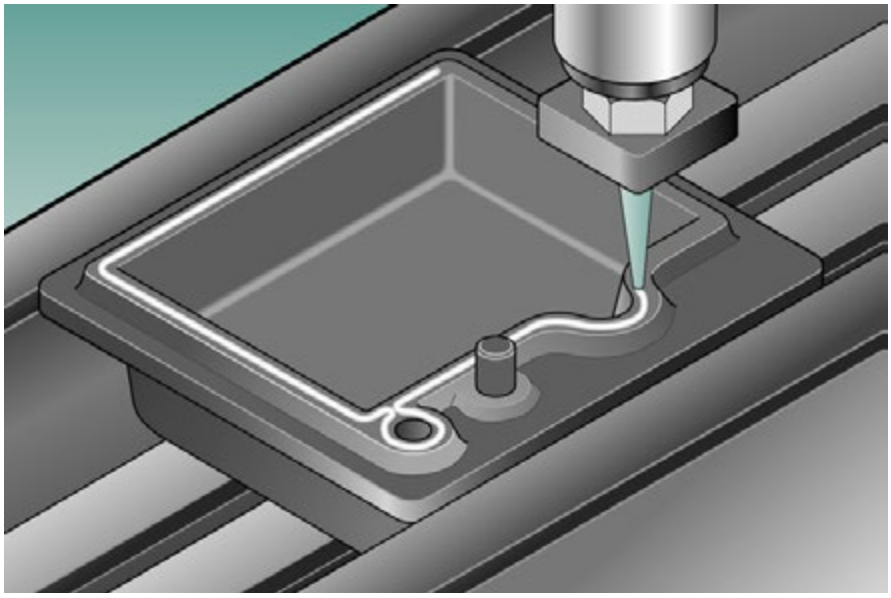
EA-6060 Adhesive Accelerates Assembly and Lowers Production Costs

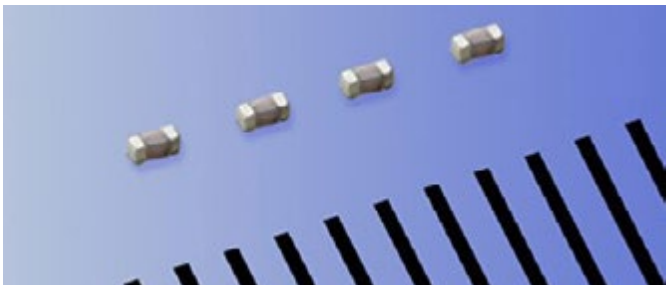
Dow Performance Silicones introduced a new high-performance material to its growing portfolio of advanced assembly solutions for the automotive industry. Offered under the new DOWSIL™ brand (formerly Dow Corning®) EA-6060 Adhesive develops strong adhesion to metal and plastic substrates in under an hour at temperatures below 100°C. This offers manufactures of automotive control units, sensors and modules significant process optimization opportunities compared to many commonly used adhesives. “Many automotive suppliers are under pressure to speed assembly and lower production costs without compromising the performance of control units and sensor modules,” said Roger Reinders, global marketing director for Dow. “New DOWSIL™ EA-6060 Adhesive helps to address all of these challenges by forming fast, reliable bonds on common metal and plastic substrates at lower temperatures than currently available products.” Available as a two-part formulation, DOWSIL™ EA-6060 Adhesive develops required adhesion within 30 minutes at 80°C (176°F), though the material also allows accelerated cure at higher temperatures. After cure, it delivers reliable adhesion for common substrates, such as the metal housings and plastic lids used in automotive module assembly.



www.dow-dupont.com

Multilayer Ceramic Capacitors for Mobile Devices

Kyocera Corporation announced that it has developed new multilayer ceramic capacitors (MLCCs) for mobile device applications in a 008004 case size, among the world's smallest*1. Measuring just 0.25 x 0.125 x 0.125mm, Kyocera's new CM01 Series MLCCs reduce space requirements by 60% in surface area and 75% in total



volume as compared to conventional products. The new MLCCs are now available worldwide. The trend toward smaller, more highly functional telecommunications equipment has increased component requirements within smartphones, wearables and related devices — creating particular demand for ultra-miniature MLCCs to facilitate greater circuit densities. In response to this demand, Kyocera's new CM01 Series' ultra-compact size will help circuit designers create more capable and functional products. The new MLCCs feature tight tolerances on key specifications, with an industry-leading*2 Q-value*3 which is 20% higher than conventional MLCCs*4 to meet the rising demand for highly efficient power amplifier modules. Kyocera will continue to develop innovative products that contribute to an expanding IoT (Internet of Things) society.

www.kyocera.com

Introducing the NANO: Ultra-Precision Die Attach

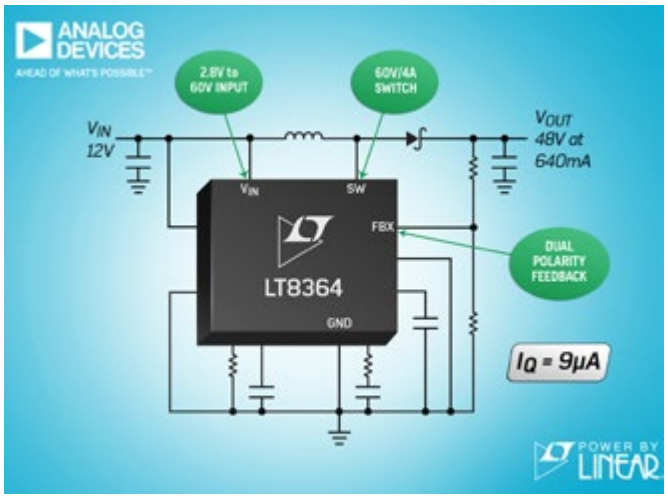
With its NANO, an ultra-precision die and flip-chip bonder for highly demanding assembly tasks, Amicra Microtechnologies GmbH is setting another record mark for die-attach accuracy.

Billed as the highest-precision placement system in its class, the new NANO supports a +/- 0.3µm placement accuracy "at full speed and at 3 Sigma," as Dr Johann Weinhaendler, Amicra's managing director of international marketing, sales and business development, underlines the operational capacity of the company's latest technological development. "The design has been completed and the Cmk tests were successful. Delivery of the first NANO will come before the year is out."

Amicra's NANO offers a host of outstanding features: quantitative parallelism calibration for large panel handling (up to 300mm x 300mm), eutectic, as well as epoxy and UV bonding, UV dispensing, and in-situ curing. The available dispensing options support all common dispenser technologies, and material traceability. Besides, NANO offers three different heated options and is equipped for laser soldering and active bond force control. Compared to the company's previous AFC version, the NANO alignment optics were significantly improved. The machine is built on a vibration-free, high-quality granite platform. Aiming at today's, and future placement demands, NANO enables the reliable handling of ultra-small and very thin die.

www.amicra.com

2MHz Boost/SEPIC/Inverter



Analog Devices, Inc. announces the Power by Linear™ LT8364, a current mode, 2MHz step-up DC/DC converter with an internal 4A, 60V switch. It operates from an input voltage range of 2.8V to 60V, and is suitable for applications with input sources ranging from a single-cell Li-Ion battery to multicell battery stacks, automotive inputs, telecom power supplies and industrial power rails.
The LT8364 can be configured as either a boost, SEPIC or an inverting converter. Its switching frequency can be programmed between 300kHz and 2MHz, enabling designers to minimize external component sizes and avoid critical frequency bands, such as AM radio. Furthermore, it offers over 90% efficiency while switching at 2MHz. Burst Mode® operation reduces quiescent current to only 9µA while keeping output ripple below 15mVp-p. The combination of a small 4mm x 3mm DFN or high voltage MSOP-16E package and tiny externals ensures a highly compact footprint while minimizing solution cost.

www.linear.com/product/LT8364

40 V Gallium Nitride Power Transistor

EPC announces the EPC2049 power transistor for use in applications including point of load converters, LiDAR, envelope tracking

power supplies, class-D audio, and low inductance motor drives. The EPC2049 has a voltage rating of 40 V and maximum RDS(on) of 5 mΩ with a 175 A pulsed output current. The chip-scale packaging of The EPC2049 handles thermal conditions far better than the plastic packaged MOSFETs since the heat is dissipated directly to the environment with chip-scale devices, whereas the heat from the MOSFET die is held within a plastic package. It measures a mere 2.5 mm x 1.5 mm (3.75 mm2). Designers no longer have to choose between size and performance – they can have both! “The EPC2049 demonstrates how EPC and gallium nitride transistor technology is increasing the performance and reducing the cost of eGaN® devices. The EPC2049 is further evidence that the performance and cost gap of eGaN technology with MOSFET technology continues to widen.” said Alex Lidow, EPC’s co-founder and CEO. The EPC2049 eGaN FET is priced for 1K units at $2.19 each and is available for immediate delivery.

www.epc-co.com

A Sixpack in a flow90 Housing

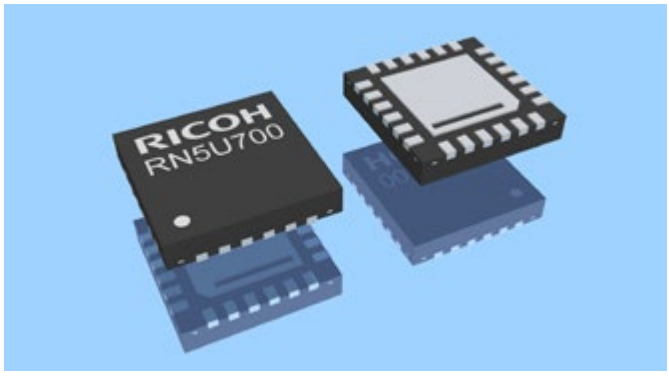
Vincotech announced the release of its new sixpack modules. The latest additions to the company's flow90 line of innovative housings, the flow90PACK 0 and flow90PACK 1 are the perfect match for bookshelf inverters and rack-mounted power applications. These modules make the most of PCB space to minimize the application's footprint. Vincotech's flow90PACK 0 and flow90PACK 1 are rated for up to 75 A and up to 1200 V. Packaged in flow90 housings, they eliminate the need for L-shaped heat sinks, cutting costs by half. The pins on these modules are arrayed at a 90-degree angle, so there is no need for a flexible PCB. What's more, a layout with this angle between the heat sink and PCB reduces the footprint by as much as 40%. Optional clip-in versions are available for even easier assembly. They slot right into the PCB on the same side as other through-hole components.
This housing comes in two sizes—flow90PACK 1 measuring 35 x 84 x 21 mm and the new 38 x 66 x 21 mm flow90PACK 0.

www.vincotech.com/flow90-modules

www.vincotech.com/products/by-topologies.html

USB Type-C Power Controller IC to support the latest Power Adapter Standard

USB Power Delivery is a technology that enables compliant devices to negotiate about what optimum power level is required for operation but also sets which device should operate as a power source or power sink. The RN5U700 makes it possible to use one universal adapter for powering applications such as power banks, smartphones, tablets, laptops, docking stations, hubs, AC adapters, monitors etc. Throughout the years, the USB port evolved from a simple external peripheral connector (combining a 5V power supply and data transmission) into a gateway that is able to connect to various devices with different requirements for the power supply, connecting data and video and has the possibility to change the active role of the connected device. For this purpose, the RN5U700 is compliant to the USB-PD Rev.3.0 and USB-C Rev.1.2 standard. The chip has many integrated analog functions, which makes it possible to build a USB-PD system with only a few external components and reduces valuable board space. For example, it has an option to operate in a standalone mode using an internal device policy manager but it is also possible to use an external microcontroller for this purpose. Another advantage of the RN5U700 is its low current consumption, in normal operation it consumes 1.6 mA and in sleep mode only 2.5 µA.



www.ricoh-europe.com

100kV HVT-DI Digital Controller

Haefely Hipotronics announces the launch of the new 100kV HVT-DI Series AC Hipot Testers.

The HVT-DI Series AC Hipot Testers are the most modern digital solution to AC field-testing of bucket trucks, aerial platforms, vacuum interrupters, breakers, switchgear, and other electrical apparatus. Each model includes a portable digital controls section and bonnet and is complete with an input line cord, interconnecting cables, and ground lead.

The HVT-DI is a valuable tool for factory and acceptance test on:

- Aerial Platform
- Bucket Truck
- Switchgear, Vacuum Bottles and Vacuum Interrupters
- Hot Sticks, Gloves and Ropes
- Hydraulic Hoses

www.hipotronics.com

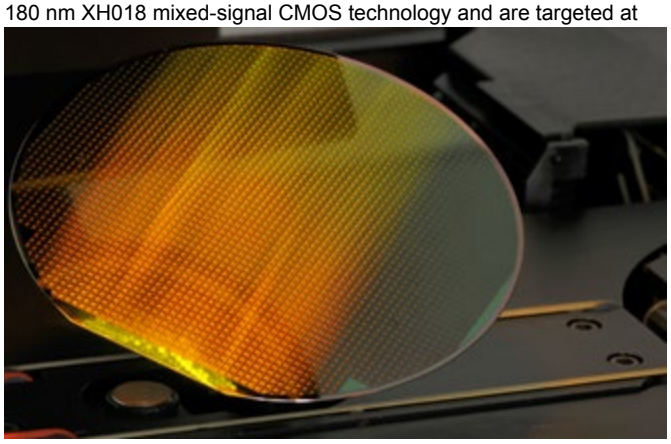
9 to 18VDC Input ¼ Brick DC/DC Converter

Calex Mfg. Co., Inc. announces the QRW series of DC/DC converters. The QRW is housed in an industry standard ¼ brick package and features an input range of 9 to 18VDC, ideal for applications powered by a 12V battery. The QRW offers two models, 3.3Vout and 5Vout, both rated at 30 Amps. Mindful of battery conservation, both converters achieve very high efficiency through the use of high-efficiency synchronous rectification technology, advanced electronic circuit, packaging and thermal design. The efficiency of the 3.3V out model is 92% and the 5V out model operates at 93% efficiency. Both models offer ON/OFF to minimize power consumption during the OFF state. The QRW Series is isolated input to output as well as the baseplate of the converter. Input to output isolation is 2250VDC. Both converter operate at a fixed frequency of 285kHz. Both converters will operate down to a no load condition. Output regulation over the input voltage range is 0.2% and from zero to full load regulation is also 0.2%. The temperature coefficient of the QRW is 0.02%/C. Output ripple and noise for the 3.3V model is 10mV peak to peak. The 5V model has output ripple and noise of 12mV peak to peak. The operating temperature range of the QRW is -40 to +100C.

www.calex.com

New Low-Power eFlash Block

X-FAB announced the availability of two new Non-Volatile Memory (NVM) IP solutions - a low power embedded Flash (eFlash) IP block and a NVRAM compiler. Both are based on the company's proprietary 180 nm XH018 mixed-signal CMOS technology and are targeted at applications requiring high reliability and field re-programmability while operating at low power and in harsh environments.



The 128-kbit eFlash, which is available as an 8 k x 16-bit IP block is based on Silicon-Oxide-Nitride-Oxide-Silicon (SONOS) Flash technology. X-FAB has built up extensive experience and manufacturing excellence in integrating SONOS memories with conventional CMOS processes, ensuring high levels of data reliability. The IP block has been designed for low power mixed-signal applications and features a deep power down stand-by mode consuming a maximum of only 50 nA.

The new X-FAB eFlash IP block is targeted at replacing standalone NVM memories and embedded One-Time-Programmable (OTP) memories in low power applications, enabling onsite program code updates. This means that it is highly suited to energy harvesting and remotely located Internet-of-Things (IoT) devices, where power constraints and harsh environments need to be dealt with, but field re-programmability must be offered at a low cost.

www.xfab.com

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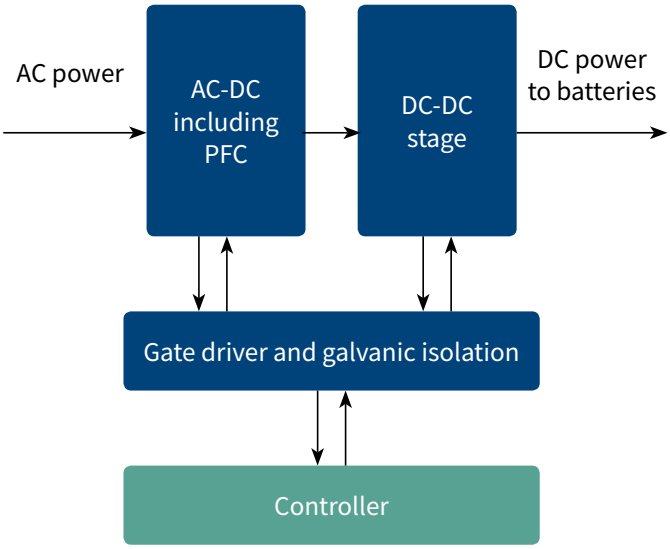
DC Charger power diagram



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