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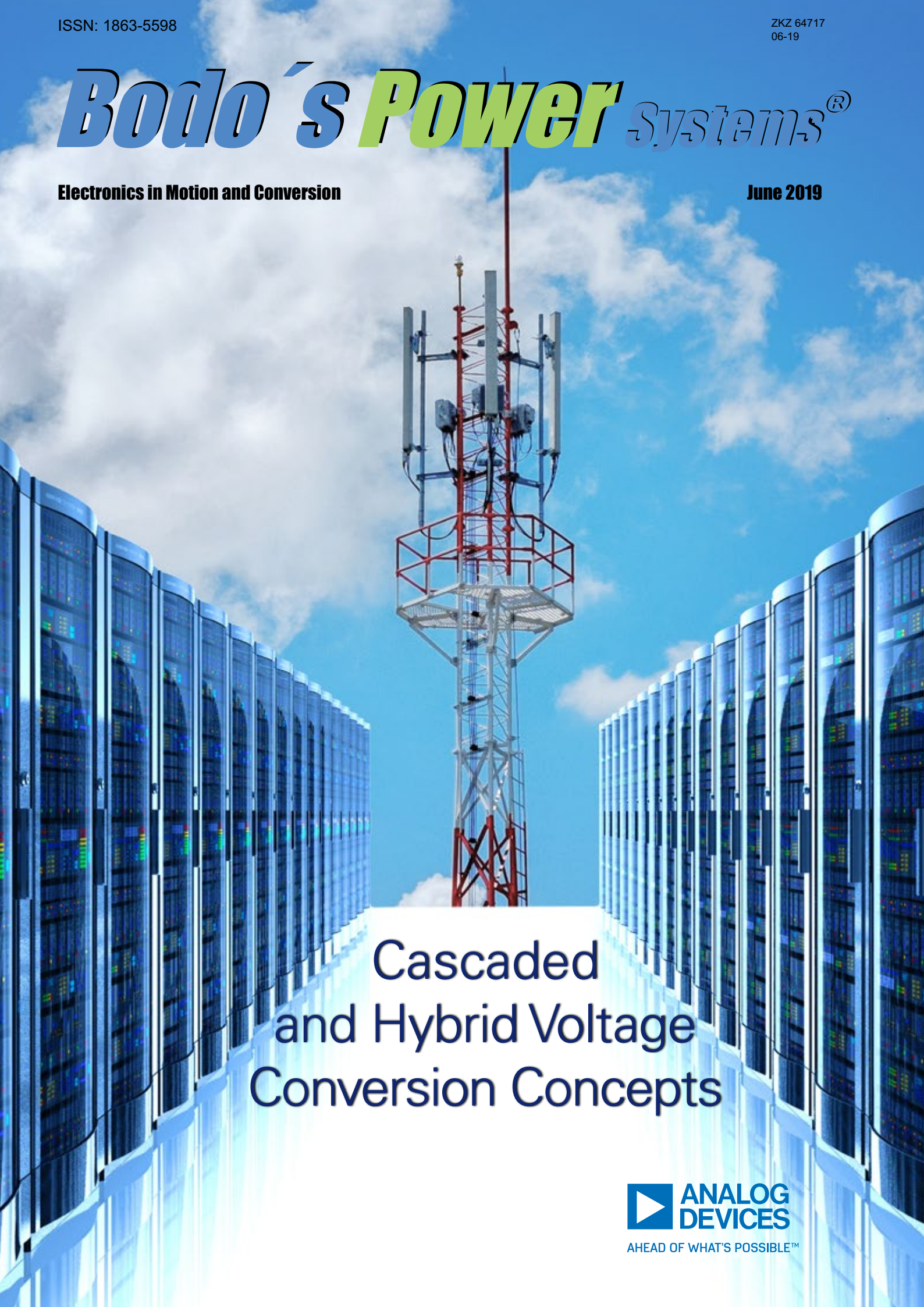
Bodo´s Power Systems®

Electronics in Motion and Conversion

June 2019



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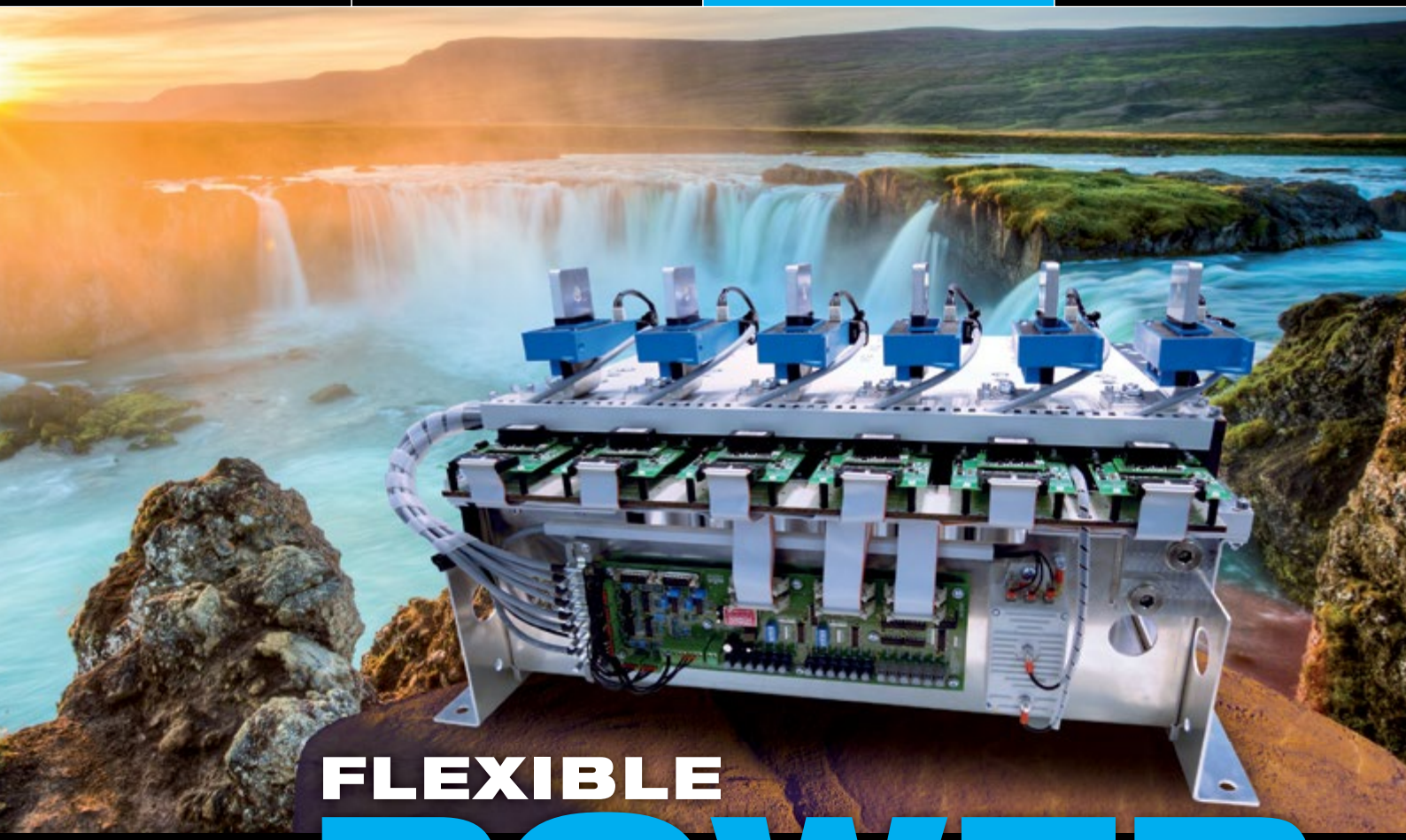

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GvA Power Electronics

CONTENT

The Gallery

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- Up to 0.995 coupling coefficient
- Up to 2.0 kV isolation
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- Large portfolio

High Coupling	High Voltage	Various Turns Ratios	Low Profile	High Current	High Saturation Current
					
WE-MCRI	WE-CPIB HV	WE-EHPI	WE-TDC	WE-CFWI	WE-DCT

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Enjoy the Beach

It is time to plan your vacation. Going to the beach is a very simple thing for me. Just outside the doors of our house or office is a very short walk to the beach. Hopefully the weather will be as friendly as last year here in Laboe. So I might do some work sitting in our beach-chair, doing my thing in a very relaxed mode. Hopefully Holger will be answering the phone.

A hot topic at PCIM was the Wide Band Gap Semiconductor podium discussion on Wednesday 8th – now a tradition for many years. The session was so popular that we did not have enough seats for the audience and many visitors were left to stand. Experts from industry gave comprehensive information on their development progress. For sure, wide band gap devices have reached a mature position and significant investment is ongoing for production quantity. For instance, Cree has announced an investment of US$1 billion over the next five years to increase both SiC and GaN production. These new generations of semiconductors will drastically improve efficiency and the investment is warranted. So, stay in touch with the magazine for upcoming articles and future activities on wide band gap devices. We will continue to serve you with the important fresh information, through articles written by the experts.

And again at the end of the year, these experts will gather together in Munich for a wide band gap power conference in the Hilton Hotel at the airport on December 3rd. We will commence with a user round table on December 2nd and are in the final planning phase of the event - more details will be published in the upcoming issues. Look out for it – it's a hot topic.

By the way I had asparagus in Nuremberg and enjoyed the meal. Time will soon be over for fresh regional asparagus, but one can look forward to next year's PCIM for more great asparagus.

Bodo's magazine is delivered by postal service to all places in the world. It is the only magazine that spreads technical information on power electronics globally. We have EETech as a partner serving North America efficiently. If you are using any kind of tablet or smart phone, you will find all of our content on the website www.eepower.com.
If you speak the language, or just want to have a look, don't miss our Chinese version: www.bodospowerchina.com

My Green Power Tip for the Month:
Minimize print out of documents at the office. You can file all that electronically. You can help in keeping the trees preserved in nature and cleaning the air. That was the promise of the digital age – remember ?

Best Regards

Events

GPECOM 2019
Cappadocia, Turkey, June 12-15
www.gpecom.org

BEVA 2019
USA San Jose, CA, USA, June 18-20
www.beva-usa.com

Fortronic Power 2019
Modena, Italy, June 19-20
www.fortronic.it

Sensor+Test 2019
Nuremberg, Germany, June 25-27
www.sensor-test.de

PCIM Asia 2019
Shanghai, China, June 26-28
www.pcimasia-expo.com

Workshop on Supercapacitors 2019
Bologna, Italy, June 27-28
www.supercap.org

IPFA 2019
Hangzhou, China, July 2-5
www.ipfa-ieee.org

SEMICON West 2019
San Francisco, CA, USA, July 09-11
www.semiconwest.org

Thermal Management 2019
Denver, CO, USA, August 07-8
www.thermalconference.com

CIRED 2019
Hall 9, Stand D19A

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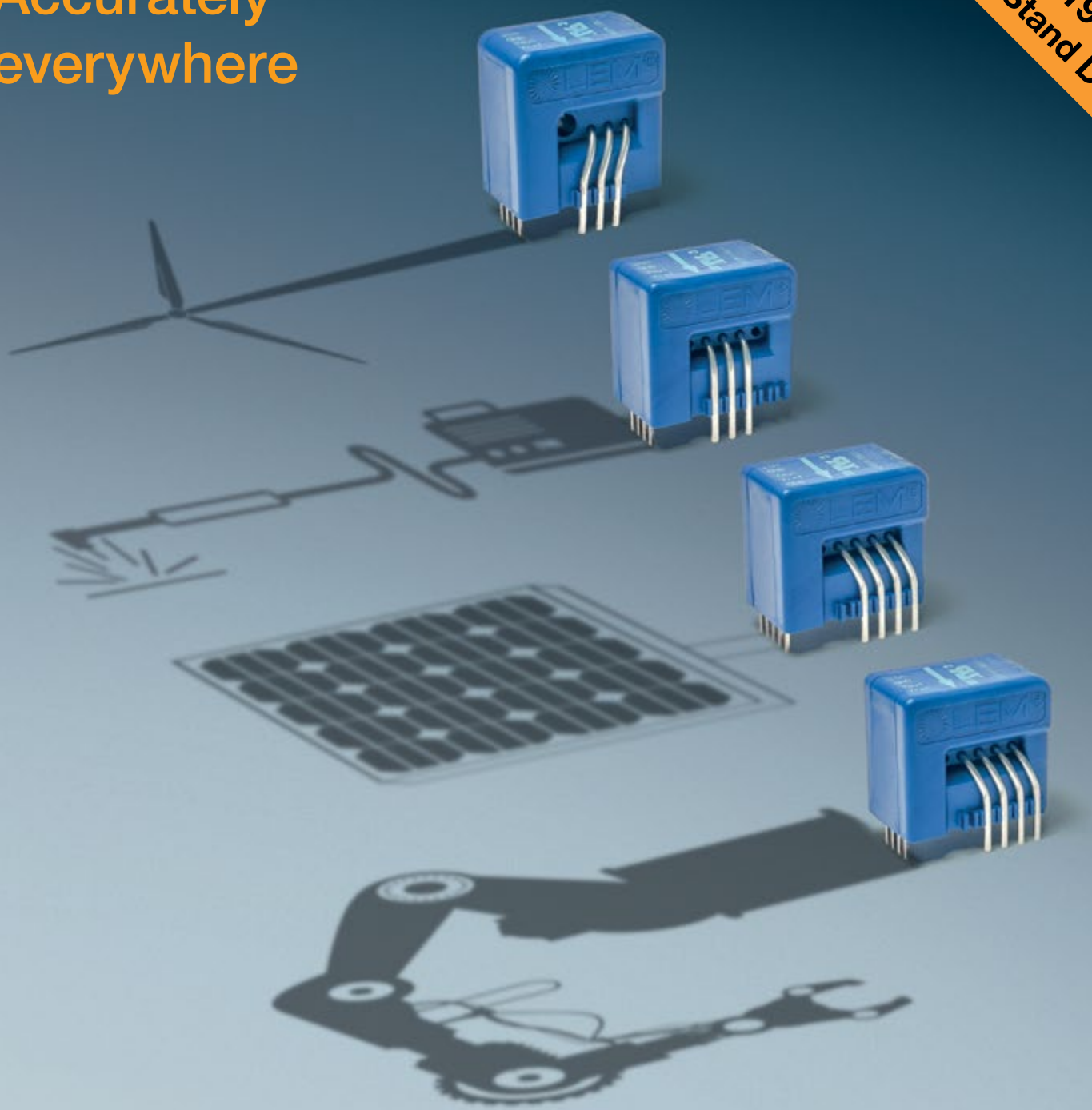

LXS, LXSR, LES, LESR, LKSR, LPSR series

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

- 1.5 to 50 A nominal current
- PCB mounting
- Low offset drift (4 – 14 ppm/°C)
- Overcurrent detection output (LPSR models)
- -40 to +105°C operation
- 100 % compatible with previous LEM generation
- Multi-range configuration

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LEM®

$1 Billion Investment to Expand Silicon Carbide Capacity

As part of its long-term growth strategy, Cree, Inc. announces it will invest up to $1 billion in the expansion of its silicon carbide capacity with the development of a state-of-the-art, automated 200mm silicon carbide fabrication facility and a materials mega factory at its U.S. campus headquarters in Durham, N.C. It marks the company's largest investment to date in fueling its Wolfspeed silicon carbide and GaN on silicon carbide business. Upon completion in 2024, the facilities will substantially increase the company's silicon carbide materials capability and wafer fabrication capacity, allowing wide bandgap semiconductor solutions that enable the dramatic technology shifts underway within the automotive, communications infrastructure and industrial markets. "We continue to see great interest from the automotive and communications infrastructure sectors to leverage the benefits of silicon carbide to drive innovation. However, the demand for silicon carbide has long surpassed the available supply. Today, we are announcing our largest-ever investment in production to dramatically increase this supply and help customers deliver transformative products and services to the marketplace," said Gregg Lowe, CEO of Cree. "This investment in equipment, infrastructure and our workforce is capable of increasing our silicon carbide wafer fabrication capacity up to 30-fold and our materials production by up to 30-fold compared to Q1 of fiscal year 2017, which is when we began the first phase of capacity expansion. We believe this will allow us to meet the expected growth in Wolfspeed silicon carbide material and device demand over the next five years and beyond."

www.cree.com

Success in Japan

Strong growth in a strategically important market: According to the latest research from Strategy Analytics, Infineon Technologies increased its automotive business in Japan by almost 25 percent in 2018. It thus grew faster than any other of the top ten automotive semiconductor suppliers in the country. Japan accounts for approximately 10 percent of global car production. A key pillar to Infineon's success is its quality leadership strategy. The biggest Japanese car manufacturer Toyota once again honored Infineon for five years of zero defect deliveries to its Hirose plant. "Quality requirements are particularly high among Japanese car manufacturers," said Peter Schiefer, President of the Automotive Division at Infineon. "Receiving an award for half a decade of immaculate shipments makes us very proud. Our strong commitment to zero defects is one of the reasons why we have continuously outgrown the automotive semiconductor market in Japan since 2010." The data from Strategy Analytics shows that Infineon has far more than doubled its respective market share since the beginning of the decade.

www.infineon.com

Expansion of the Management Board

ROHM Semiconductor Europe is strengthening its management board to pursue its growth. The company appoints Mr. Toshimitsu Suzuki as President of ROHM Semiconductor Europe, effective immediately. Mr. Christian André will continue as Chairman of ROHM Semiconductor Europe.
The company would like to thank Christian André, who has been working for ROHM for 29 years and acting President for 14 years, for his dedication and great success in driving the company transformation. Mr. André will focus on the next phase of growth and strategic vision of the company to generate a long-term value to our customers and shareholders. In the new position, Toshimitsu Suzuki will take over the full responsibility of the European business. Mr. Suzuki has worked for ROHM in Europe for over four years as Senior Sales Director. He has profound experience and deep understanding of the business. Mr. Suzuki will set new impulses for further strategic developments and the successful implementation of the company's products in the European market. "I'm very proud and honored to lead an organization for which I have been working passionately and look forward to contributing to even greater success," said Toshimitsu Suzuki as new President ROHM Semiconductor Europe. "ROHM has an exceptionally talented team of people. I look forward to taking the helm on the road to an exciting future." Mr. Suzuki continued, "I would like to thank Christian André for his tireless efforts at ROHM."

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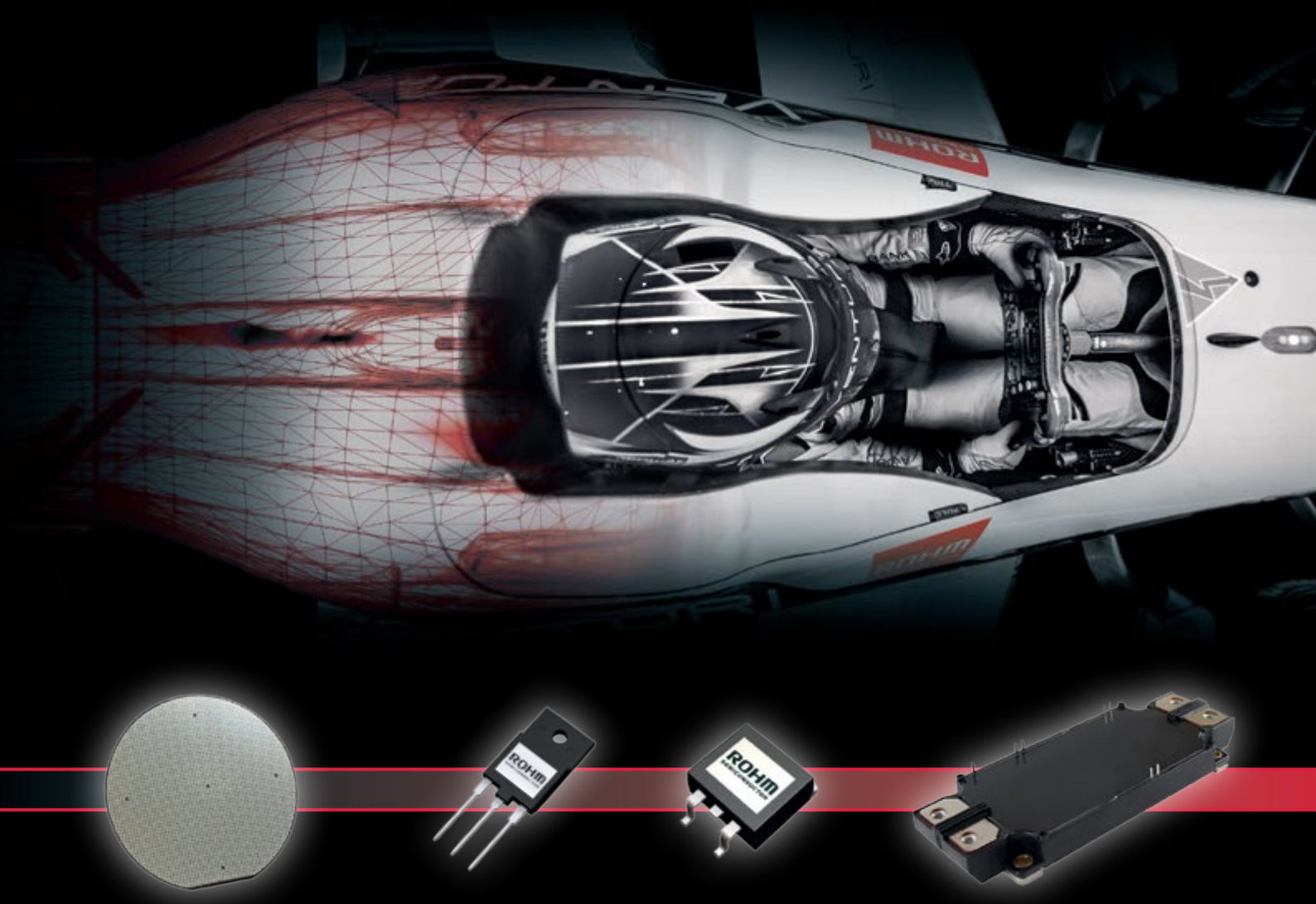

FROM THE RACETRACK TO THE ROAD

VENTURI Formula E team has adopted ROHM's full SiC power modules for its fully electric racing cars. ROHM's innovative products power the implementation of e-mobility by delivering the next generation of power semiconductor devices. Our unique vertically integrated in-house manufacturing guarantees high quality and a consistent supply to the market.

SiC technology enables **SMALLER** inverter designs in terms of volume and weight.

SiC can achieve higher power density for **STRONGER** performance.

SiC helps vehicles to cross the finish line **FASTER** and supports fast-charging solutions.

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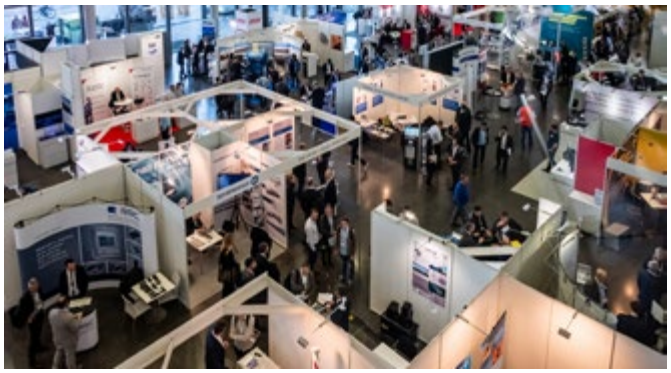
Battery Experts Forum a Great Success

The Battery Experts Forum - Europe's largest conference on battery technology - celebrated from 10.-12. April 2019 its premiere on the fairground of the city Frankfurt am Main. The organizer draws summary - the forum was sold out and thus an absolute success! Due to the expansion in the financial metropolis, the high demand from the previous year was covered. Overall, the event has doubled in



Frankfurt. The enormous interest from the public, industry and politics in the battery industry was clearly noticeable. With participant growth of around 100 percent, in 2019 twice as many participants arrived at the industry event as in 2018. The exhibition was also strongly represented with approximately 60 percent growth in exhibiting companies and a threefold space. Renowned international companies from the battery industry were among them - including the leading cell manufacturers such as LG Chem, Murata, Samsung, Panasonic and BYD, which is an absolute unique selling point of this event. From cell and battery manufacturers to OEMs and users, new design, production and manufacturing solutions including battery systems, materials and components, as well as testing and recycling processes were presented. Outside, a number of e-vehicles, including modern e-bikes from ZEG and Rotwild, as well as the new e-scooter from Metz, were tested. Even large-sized e-vehicles such as the electric bus from Solaris or the latest prototype of the ACM City Taxi were an eye-catcher.

www.bu-lab.eu

Vice President of Intellectual Property and Licensing

pSemi Corporation announced that Rajappan "BG" Balagopal has been named Vice President of Intellectual Property (IP) and Licensing. Mr. Balagopal will drive strategic development and management of pSemi's patent portfolio. Mr. Balagopal brings over 20 years of broad experience in IP management, including strategy, valuation, supply chain management, general legal counseling, business development and transactions. He has supervised interdisciplinary teams of attorneys, technologists and business professionals to solve complex IP problems, generate IP revenues and reduce IP costs and risks for large and small companies. Mr. Balagopal has also held numerous high-level positions, including Vice President of Technology IP Management at The Walt Disney Company and Director of Patent and Technology Transactions at Intel Corporation. Prior to joining pSemi, Mr. Balagopal ran an IP law and business consulting practice, serving diverse clients in industrial equipment, consumer products, semiconductors, communications, media and software.

"I am excited to join pSemi, the RF SOI pioneer that continues to push the frontiers of innovation in semiconductor processing, radio and power electronics," says Mr. Balagopal. "It is great to get back to my roots in semiconductors at a time when 5G is on the horizon and IP business models are also undergoing fundamental change."

www.psemi.com

Upcoming ECPE Events

ECPE Tutorial 'EMC in Power Electronics'
3 - 4 June 2019, Padova, Italy
Chairmen: Prof. Eckart Hoene (Fraunhofer IZM)

ECPE Workshop 'Humidity and Condensation in PE Systems - Degradation Mechanisms and Lifetime Modelling'
5 - 6 June 2019, Bremen, Germany
Chairmen:
Prof. N. Kaminski (University of Bremen), M. Piton (Alstom)

ECPE Tutorial 'Model Predictive Control for Power Electronics, Drives and Power Grid Applications'
2 - 3 July 2019, Vienna, Austria
Course Instructors: Prof. R. Kennel (TU Munich), Prof. T. Geyer (ABB Corporate Research), Prof. S. Liu (TU Kaiserslautern)

ECPE Workshop 'Availability of Power Electronics by Fault-Tolerant Designs for Automotive and Aircraft'
3 - 4 July 2019, Leinfelden-Echterdingen (near Stuttgart Airport), Germany
Chairmen: Prof. E. Wolfgang (ECPE), Prof. V. Pickert (Newcastle University), Dr. W. Wondrak (Daimler)

ECPE Tutorial 'Thermal Engineering of Power Electronic Systems - Part I: Thermal Design and Verification'
9 - 10 July 2019, Nuremberg, Germany
Chairman: Prof. U. Scheuermann (Semikron)

www.epce.org

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Your beating heart

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Rated Top Company by Kununu

Due to the overwhelmingly positive kununu ratings, RECOM Austria received the kununu Top Company award. Kununu is an employer rating platform that allows employees to rate their employer anonymously. Companies benefit immensely from this valuable feedback, which contributes to a better external perception for potential new colleagues. With a rating of 4.3 out of 5 stars, RECOM is among the best 4% companies in Austria. RECOM sees this award as a result of its fantastic working environment and its steady improvement of HR measures. One year ago, RECOMs first HR department was founded in Austria and many structures were created to ensure optimal working conditions. The company success can be traced back to the employees, who are not only technically qualified and highly motivated, they are also open-minded, humorous and everyone is actively involved in the company life. RECOM has brilliant professionals, many women in technical careers and leadership positions, as well as employees from various countries around the world who all share the same RECOM vision.

www.recom-power.com

Featuring Latest Power Electronics Research and Innovation

PCIM Asia is a leading international exhibition and conference for power electronics, intelligent motion, renewable energy and energy management. Jointly organised by Shanghai Pudong International Exhibition Corp, Guangzhou Guangya Messe Frankfurt Co Ltd and Mesago Messe Frankfurt GmbH, the fair will be held from 26 – 28 June at the Shanghai World Expo Exhibition and Convention Center. It is expected that the three-day show will attract over 8,000 visitors and host nearly 100 exhibitors, showcasing the latest products and technologies of power semiconductors and modules, power electronics components, power converters, test and measurement, and more. One of the highlights of the exhibition is the PCIM Asia Conference, which will take place across the three-day fair period. As in the past, the conference will showcase the latest developments in silicon carbide (SiC) and gallium nitride (GaN) devices and their respective applications in renewable energy, transmission, and especially electric vehicles. This year, a total of 49 conference papers will be presented, including 27 oral presentations and 22 posters. One of the major focuses of the 2019 edition will be the applications in the field of electrified transportation, which are also covered in two keynote speeches.

www.pcimasia-expo.com

Finalists Provided Solutions for a Modern, Clean Energy World

With innovative business models and pioneering projects, the finalists of The smarter E AWARD 2019 are driving the sustainable energy industry forward. Projects completed in the areas of solar, storage, energy management and clean transportation take center stage in the Outstanding Projects category. The Smart Renewable Energy category shines the spotlight on the grid infrastructure of the future, digitalization technologies, the coupling of the electricity, heating and mobility sectors, and business models for electricity trading and marketing. The prizes were awarded on May 15, 2019 at The smarter E Forum as part of The smarter E Europe, Europe's largest platform for the energy industry. Once again in 2019, the finalists in the Outstanding Projects category showed that solar technology is on the rise worldwide and is taking on the role of a key technology. Hybrid concepts, as well as photovoltaics combined with storage technologies, guarantee the availability and stability of renewable energies. This inspires new business ideas and creates opportunities which make a real difference to people's lives. The trend towards installations operated without feed-in tariffs is also extremely visible.

www.thesmartere-award.com

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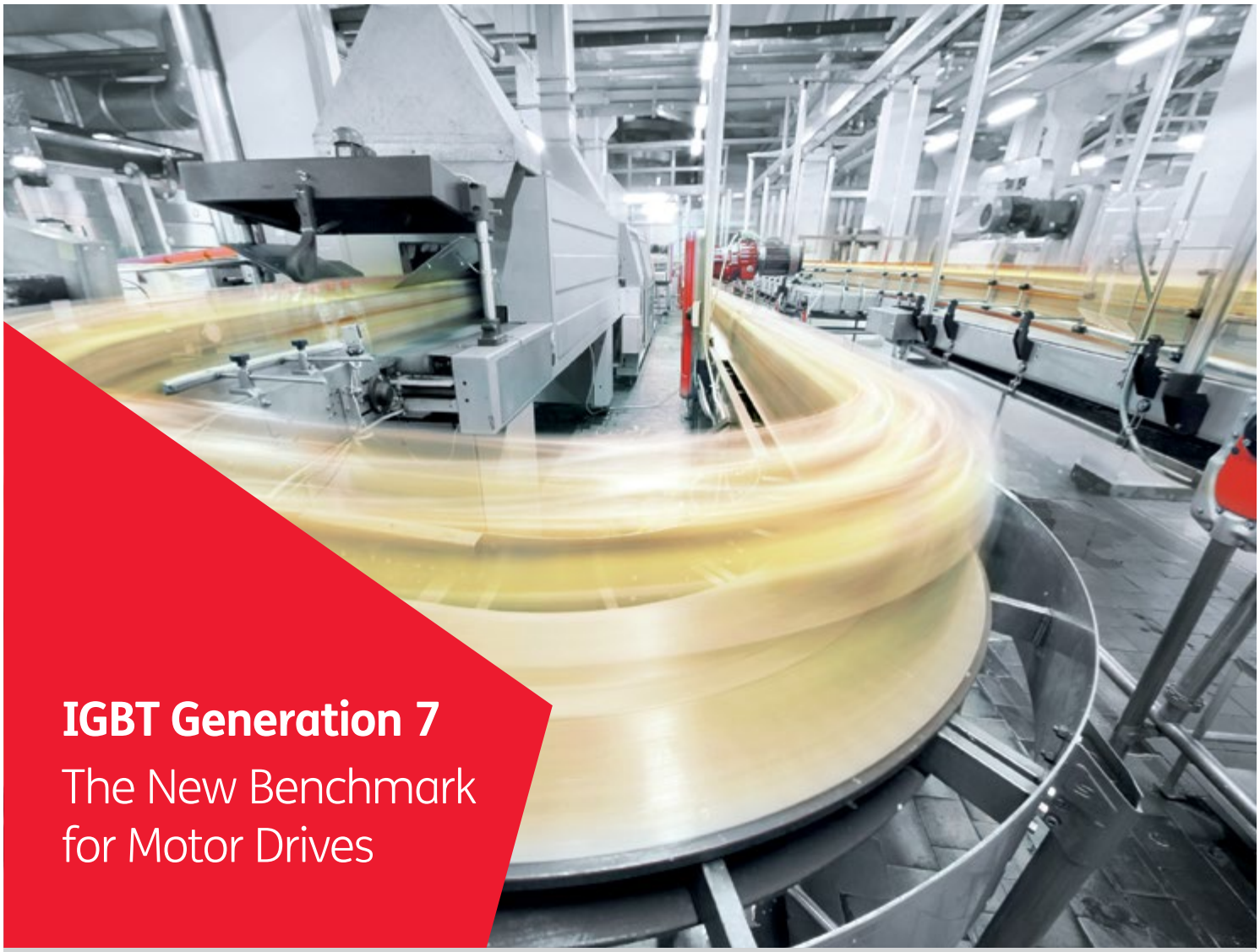


IGBT Generation 7

The New Benchmark for Motor Drives

The generation 7 IGBTs are specifically designed to match the requirements of motor drive applications. They provide lower system cost thanks to reduced power losses and increased output power and power density.

For low/medium power motor drives available in MiniSKiiP and SEMITOP E1/E2 as CIB and sixpack. For medium/high power motor drives available in SEMiX 3 Press-Fit and SEMiX 6 Press-Fit in CIB and sixpack topologies.

Features

- Optimized IGBTs for motor drive applications
- Reduced saturation voltage and chip size
- Higher nominal currents
- Up to 45% more module output power
- Lower overall system costs

GENERATION IGBT 7

MiniSKiiP

SEMiX 3 Press-Fit

www.semikron.com

Semiconductor Device Business Transferred

ROHM announced the acquisition of a part of the diode and transistor business from Panasonic Semiconductor Solutions Company, a Group Company of Panasonic Corp.. The transfer is scheduled for October 2019 with ROHM handling sales of these products to Panasonic's current customers thereafter. Since the 1960s, ROHM has been developing, producing and selling semiconductor devices as a core business of the ROHM Group and has today the largest shares of the global markets for small signal transistors and diodes. Looking ahead, given the strong prospects of continuous growth in the automotive electronics, industrial equipment and other application markets, ROHM will be expanding its business in bipolar transistors, circuit protective Zener diodes, TVS diodes and other products. As a part of that, ROHM will proactively invest in a wide range of business resources in order to strengthen product lineups, further enhance product quality and ensure stable supplies. By acquiring the said business from Panasonic, ROHM aims to further expand its market share. To ensure a smooth transition and stable supplies to customers, ROHM will outsource production to Panasonic and maintain the exact same supply structure as before until the transfer is complete. Going forward, both companies will be jointly preparing for the transfer of business, including obtaining all necessary approvals and permits. The transfer schedule details will be hammered out in the process.

www.rohm.com/eu

Power Technology Roadmap Provides Critical Insights

The Power Sources Manufacturers Association (PSMA) announces the 2019 edition of the Power Technology Roadmap. The report, which forecasts the power technology and power delivery trends through 2023, includes a printed report along with a feature-rich USB memory drive containing a record number of seventeen recorded webinars with up-to-date explanations of the information contained in the final report. The webinars add much to the presentation materials because the listener can hear and understand the context and the subtext of the original presentation in the speaker's voice. The recordings also capture the interesting and informative question and answer periods.

In this edition a new section on University Research in Power Electronics has been added. University research provides a window into what products and technologies are in store for Power Electronics. Leading power electronics research universities were asked about their research areas and priorities and their responses were analyzed to extract most common research areas, least common/missing research areas and unique research areas.

The overall structure of this year's PTR largely follows the format of and keeps the improvements made in the 2017 report. It offers a consolidated view of the latest trends in the power management, power control, and power delivery technologies by integrating the most recent inputs from webinars, surveys, analyses and discussions.

www.psma.com

Dan Leibholz Named Chief Technology Officer

Analog Devices announced that Daniel Leibholz, Vice President of ADI's Communications Business Unit, has been named Chief Technology Officer (CTO), effective immediately. As CTO, Dan will develop and lead ADI's technology strategy for applications across the company's end markets. "Over the years we have built ADI's brand as a premier analog technology and solutions provider for B2B applications," said President and Chief Executive Officer Vincent Roche. "In our rapidly evolving industry, staying on the cutting edge is essential as we seek to solve the very hardest problems faced by our customers. Dan's combination of technology vision, experience developing ADI's digital and analog offerings, and strong business background will help us to continue to deliver innovations of maximum impact for our customers and their markets now and into the future."

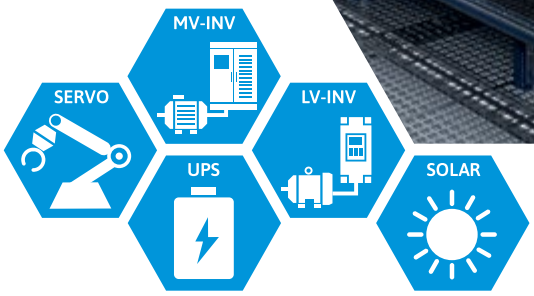
In his previous role as Vice President of ADI's Communications Business Unit, Dan has overseen a period of tremendous growth as the company has delivered best in class offerings for the 5G wireless and wired markets. Prior to assuming the Communications role, Dan led a number of teams across ADI, including Digital Signal Processing and Consumer/Portable technologies. Dan joined ADI in 2008 from Advanced Micro Devices, where he had served as an AMD Fellow.

www.analog.com

Launch of Global Website

Mersen is pleased to announce the launch of a Electrical Power website. "The global website is an innovative and powerful tool that provides quick and easy access to our electrical power data," said Charlie Raynes, VP Global Marcom. "And the website highlights our commitment to having the customer at the center of every decision we make." The site includes enhanced global product data, custom products and solutions, fast access to technical experts and enhanced market schematics that showcase our entire product line.

https://ep.mersen.com



The 7th Generation Modules

Dual XT & Premium Dual XT

series 7G

Dual XT – Main features

- 7G IGBT & FWD
- New internal layout
- Higher reliability
- Improved silicone gel
- Solder or mini press-fit pins
- More power, lower losses

Premium Dual XT – Additional features

- Advanced bond wire design
- High thermal conductive ceramic substrate
- Package material with CTI > 600
- V_{WW} = 4 kV
- High power density

International Automotive Quality Recognition

Indium Corporation has earned IATF 16949:2016 management system certificates for five of its solder manufacturing facilities in Clinton and Utica, NY, USA; Singapore; Milton Keynes, UK; and China. The company's headquarters in Clinton, NY, USA has also achieved IATF 16949 certification. Indium Corporation has demonstrated effective implementation of a management system that satisfies the tough global auto supply chain standard recognized by automotive industry leaders worldwide. Designed to improve customer satisfaction by meeting customer requirements and needs with high-quality products, IATF 16949 provides a critical guiding framework for the industry and encourages an internal culture focused on ongoing improvement. According to Ross Berntson, President and Chief Operating Officer, "These certifications reaffirm to all of our customers worldwide that Indium Corporation's soldering materials are produced with the utmost quality to ensure the reliability of our customers' finished goods." The IATF 16949:2016 is an international Automotive Quality Management System Standard aimed at continuous improvement, emphasizing defect prevention, and reducing variation and waste in the automotive industry supply chain.

www.indium.com

Highly Relevant Conference Contributions

After two intensive days, the Smart Systems Integration 2019 in Barcelona, Spain, from 10 - 11 April 2019, looks back on an abundance of relevant lectures and international exhibitors on innovative smart systems and their applications. The 242 participants of the Smart Systems Integration were able to further their knowledge in a total of five keynote lectures, 52 specialist lectures, two special sessions from the European Technology Platform on Smart Systems Integration (EPoSS) and 25 poster presentations. A special highlight was the panel discussion on the topic "Future aspects of smart integrated systems" on Thursday, 11 April 2019. The conference once again dealt with the application areas of smart systems as well as smart systems themselves, starting with the design via new components for sensor technology, data processing, control, networking and smart powering up to the heterogeneous integration of the different components, embedded software and manufacturing of the systems. Renowned speakers provided exclusive insights into the multifaceted spectrum of topics: Professor Wilfried Mokwa from the RWTH Aachen University, for example, dealt with the topic "Artificial Vision - Retinal Implants to Restore Vision in Blind People" in his keynote lecture and described highly topical application possibilities of smart systems in medicine. In addition, various European projects presented their success stories for the first time in two special sessions.

https://ssi.mesago.com

Establishing Subsidiary in Norway

Yokogawa Electric Corporation has announced its subsidiary in Norway to engage in the sale of control products and provision of related services. The subsidiary, Yokogawa Norge, was established on 14th February 2019. Renewable energy, pharmaceuticals, and foods are targeted under Yokogawa's Transformation 2020 mid-term business plan, and each of these industries enjoys good prospects for growth in Norway. The country has played a leading role in Europe's transition to a low-carbon economy and is diversifying its economy to lessen its dependence on natural resources.

In the Norwegian market to date, Yokogawa has relied on its distributors and a representative office to provide and promote control systems, field devices, and related services to the oil & gas industry's upstream and downstream sectors, including refining and LNG. In July 2017, Yokogawa acquired TechInvent2 AS, a Norwegian company with advanced chemical injection technology that helps to prevent blockages and corrosion in oil wells and pipelines and renamed it Yokogawa TechInvent. Through the establishment of Yokogawa Norge and the creation of synergy with Yokogawa operations in Aberdeen, Scotland, Yokogawa will be able to solidify its sales and service organisation in Norway and accelerate growth not only in existing markets but also in the renewable energy, pharmaceutical, and food industries. Yokogawa Sales and service operations in Fornebu, Norway will begin from April 2019.

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UF3C Series
FAST 650V & 1200V SiC FETs

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Simply More Efficient

Get faster switching speeds, lower switching losses, and better power conversion efficiency.

The new UnitedSiC UF3C series of FAST 650V and 1200V SiC FETs deliver:

- Easy drop-in replacement for IGBTs, Si and other SiC MOSFETs
- Lowest RDS(on) in TO-220 (27mohm)
- Excellent reverse recovery
- New TO-247-4L and D2PAK-7L Kelvin packages

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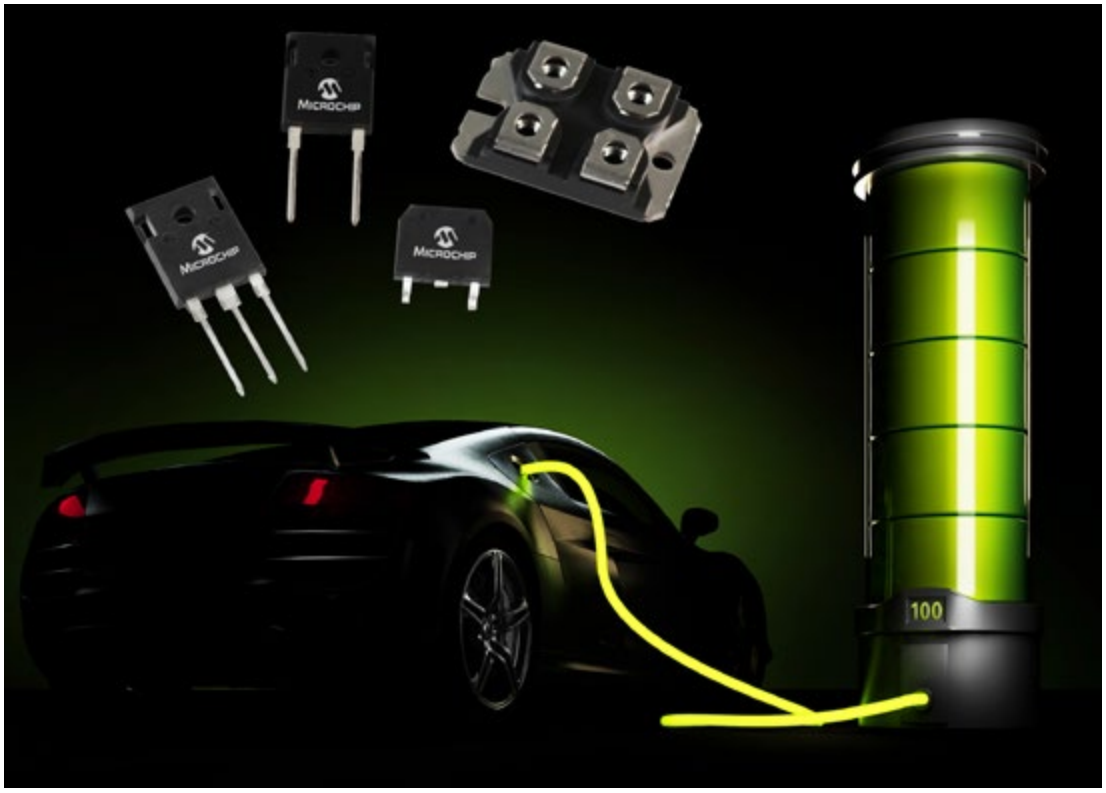
Silicon Carbide (SiC) Products for High-Voltage, Reliable Power Electronics



Microchip announces, via its Microsemi subsidiary, the production release of a family of SiC power devices that offer proven ruggedness and the performance benefits of wide-bandgap technology. Complemented by Microchip's broad range of microcontrollers (MCUs) and analogue solutions, the SiC devices join a growing family of reliable SiC products. These products meet the need to improve system efficiency, robustness and power density in Electric Vehicles (EVs) and other high-power applications in the industrial, aerospace and defence markets.

Microchip's 700V SiC MOSFETs and 700V and 1200V SiC Schottky Barrier Diodes (SBDs) join its existing portfolio of SiC power modules. The over 35 discrete products that have been added to Microchip's portfolio are available in volume, supported by comprehensive development services, tools and reference designs, and offer outstanding ruggedness proven through rigorous testing. The broad family of SiC die, discretes and power modules are offered across a range of voltage, current ratings and package types.

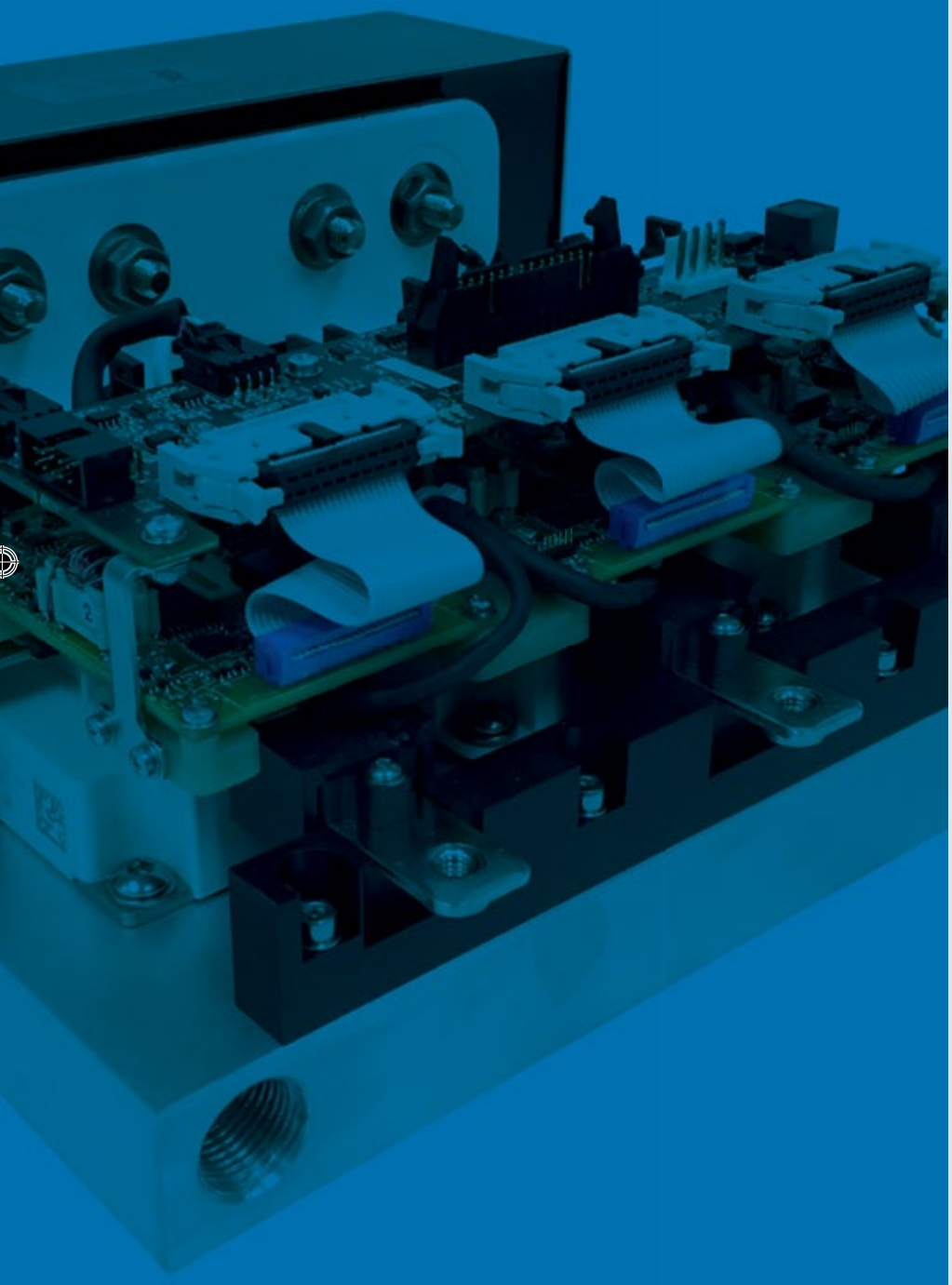
Microchip's SiC MOSFETs and SBDs offer more efficient switching at higher frequencies and pass ruggedness tests at levels considered critical for guaranteeing long-term reliability. The company's SiC SBDs perform approximately 20 percent better than other SiC diodes in these Unclamped Inductive Switching (UIS) ruggedness tests that measure how well devices withstand degradation or premature failure under avalanche conditions, which occur when a voltage spike exceeds the device's breakdown voltage. Microchip's SiC MOSFETs also outperform alternatives in these ruggedness tests, demonstrating excellent gate oxide shielding and channel integrity with little lifetime degradation in parameters even after 100,000 cycles of Repetitive UIS (RUIS) testing.

Microchip is one of the few suppliers to provide a range of both silicon and SiC discrete and module solutions. The company's products are ideally suited for the growing number of EV systems including external charging stations, onboard chargers, DC-DC converters and powertrain/traction control solutions. The new SiC devices are backed by Microchip's customer-driven obsolescence practice, which ensures devices will continue to be produced for as long as customers need them.

The expanded SiC portfolio is supported by a range of SiC SPICE models, SiC driver board reference designs and a Power Factor Correction (PFC) Vienna reference design. All the company's SiC products are available in production volumes along with their associated support offerings. A variety of die and package options are available for the SiC MOSFETs and SiC diodes.

www.microsemi.com/sic

INNOVATING SOLUTIONS FOR BATTERY AND POWER ELECTRONICS MANAGEMENT



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Powering the World with Technology that Achieves More and Consumes Less

At PCIM 2019, Infineon was launching power products and solutions that, according to Dr. Peter Wawer, Division President Industrial Power Control at Infineon during a press conference, will make a difference and deliver customers a cutting edge in competition.

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

Product highlights for an energy-efficient world

With the safe completion of the production ramp of its Silicon Carbide (SiC) MOSFET base technology, Infineon enters high volume production of a comprehensive discrete product portfolio of 1200V CoolSiC MOSFET devices (Fig. 1). The discrete SiC portfolio comprises seven different on-resistance ratings available in both TO247-3 and TO247-4 housings. The expansion includes a surface mount device (SMD) portfolio and a 650V CoolSiC MOSFET product family, which will be launched soon.

The CoolGaN 600 V e-mode HEMT devices together with the GaN EiceDRIVER ICs open up new levels of efficiency for high performance applications. Several demonstrators at the tradeshow explored Infineon's GaN solution in next-generation server, data center, telecom, motor drives, charging and adapter applications. The 48V architecture for hyperscale data centers is evolving. Enabling highest efficiency and power density for this innovative design, allowing for an easy transition path from 12V to 48V, Infineon's new proprietary zero-voltage-switching switched capacitor converter (ZSC) is a technology to rely on. The ZSC board was also showcased, shedding a light on future infrastructure for big data.

Figure 1: 1200V CoolSiC MOSFET

Moreover, at PCIM 2019, Infineon introduced the Easy 3B package making the Easy family the broadest power module portfolio at 12mm height without base plate. Easy 3B is the platform to extend current inverter design to achieve higher power without changing much on the mechanical side. The new package inherits many of the advantages of the family portfolio such as the flexible pin-grid system for customizing. Extending its large portfolio of high voltage devices, the newly introduced package XHP 3 represents a flexible IGBT module platform for high-power applications in the voltage range from 3,3kV up to 6,5kV. The module allows for scalable designs with best-in-class reliability and highest power density. Due to its symmetrical design with low stray inductance it offers significantly improved switching behaviour: a solution for demanding applications such as traction and commercial, construction and agricultural vehicles as well as medium-voltage drives.

Infineon presented the first member of a new family of magnetic current sensors, too. The coreless Hall sensor XENSIV TLI4971 provides an accurate and stable current measurement in industrial applications. It offers a high level of flexibility as customers can individually program product parameters such as the current range, the overcurrent threshold and the output mode.

For its automotive customers, Infineon launched four new derivatives of the HybridPACK Drive power module (Fig. 2) for main inverters in hybrid and electric vehicles. They are optimized for different inverter performance levels between 100kW and 200kW. Since all members of the product family have an identical footprint, they allow for inverter performance to be scaled quickly and without a major system redesign.

Other PCIM 2019 Infineon highlights included:

- CIPOS Tiny, a new member of Infineon's intelligent power module family
- 1200 V TRENCHSTOP IGBT7 and emitter-controlled EC7 diode in the wellknown Easy package
- iMOTION IMM100 series combining motor controller IC and a 3-phase inverter stage in a single, highly compact 12 x 12mm PQFN package
- TRENCHSTOP Feature IGBT Protected Series combining a 20A/1350V RC-H5 IGBT with a protecting gate driver IC.

Accelerated roll-out of discrete CoolSiC MOSFET portfolio

Infineon enters high volume production of a comprehensive portfolio of 1200 V CoolSiC MOSFET devices. They are rated from 30mΩ to 350mΩ and implemented into TO247-3 and TO247-4 housings. The expansion includes a surface mount device (SMD) portfolio and a 650V CoolSiC MOSFET product family, both to be launched soon. With these products, Infineon addresses the fast growing demand for energy-efficient SiC solutions in power conversion schemes such as battery charging infrastructure, energy storage solutions, photovoltaic inverters, uninterruptable power supplies (UPS), motor drives as well as server and telecom switched-mode-power supplies (SMPS).

"At Infineon, the launch of a new base technology is subject to strict quality criteria," commented Dr. Peter Wawer. "Production flows for high volume manufacturing must be proven, for front- and backend even when assembling discrete housings. This

includes the collection of statistical data, production monitoring, and application-relevant testing beyond standardized procedures. After the production ramp of the silicon carbide (SiC) MOSFET base technology has been safely completed, we are now bringing the most comprehensive discrete SiC portfolio for industrial applications to the market".

As for all previously launched CoolSiC MOSFET lead products in TO247 and Easy power module package, the new discrete devices build on a leading trench SiC MOSFET semiconductor process. This process was developed to allow for both lowest losses in the application and highest reliability in operation. Furthermore, according to related application profiles, gate-source operating voltages are adopted for discrete package solutions. A benchmark low dynamic loss enables highest efficiency with a simple unipolar gate drive scheme.

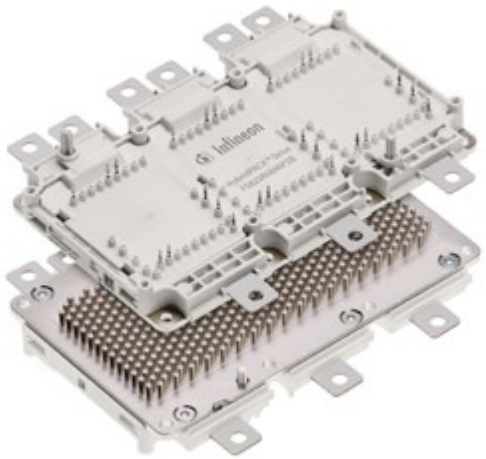

Figure 2: HybridPACK-Drive

CoolSiC trench technology features an exclusively high threshold voltage rating (Vth) larger than 4V combined with a low Miller capacitance. For this reason, CoolSiC MOSFETs exhibit best-in-class immunity against unwanted parasitic turn-on effects compared to other SiC MOSFETs on the market. Together with a turn-on gate-source voltage of +18V with 5V margin to maximum rated voltage of +23V, the new Infineon SiC discrete MOSFETs deliver an advantage over silicon (Si) IGBTs, superjunction MOSFETs as well as over other SiC MOSFETs at highest level. Including a robust body diode rated for hard commutation, the CoolSiC MOSFET portfolio gives engineers a pathway for highest energy efficiency and making "more out of less". MOSFET functionality in SiC material offers a new degree of system design flexibility in power factor correction (PFC) circuits, bi-directional topologies and any hard and soft switching DC-DC converters or DC-AC inverters.

Infineon completes its discrete offering with a range of selected driver IC products fulfilling the needs posed by the ultrafast SiC MOSFET switching feature. Together, CoolSiC MOSFETs and EiceDRIVER gate driver ICs leverage the advantage of the technology: improved efficiency, space and weight savings, part count reduction, enhanced system reliability. This opens up the possibility to lower system cost, reduces operational expenses and total cost of ownership, enabling new solutions in an energy-smart world.

www.infineon.com

Optimized Inverter Design by IPMs and SiC-SBDs

During a press conference at PCIM Europe 2019 in Nuremberg, Masamitsu Okamura, the new Executive Officer, Group President, Semiconductor & Device Group Mitsubishi Electric Corporation (since April 2019, before he was Group President of Electronic Systems) introduced the Power Semiconductor business of the company.

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

Following his presentation, Dr. Gourab Majumdar, Senior Fellow, Semiconductor & Device Group Mitsubishi Electric Corporation highlighted new power device technology;

- he introduced silicon chip technologies: 7th generation, reverse conducting IGBT and beyond;
- he gave a summary of product development trends by application;
- he demonstrated the progression of package and assembly technologies and latest products
- and he took a look at aspects and prospects of SiC devices including high voltage full SiC 3.3kV and 6.5kV dual modules.

Semiconductors are indispensable components for today's increasingly high performance products, making them equally important to "resources" for a better future. Mitsubishi Electric, a global leader in the field of semiconductors, has secured its top position with continuous innovative research and development and the investment in the state-of the-art production techniques. The worldwide customers of Mitsubishi benefit from the comprehensive technical services as well as from a broad sales and distribution network.

Mitsubishi Electric's German subsidiary is located in Ratingen in North Rhine-Westphalia. Today, Ratingen branch is responsible for the technical service, sales and marketing activities in Europe as well as in Russia and South Africa. The success in the semiconductor industry is a result of the company´s expertise in four product areas: High Frequency-, Opto- and Power Semiconductors as well as TFT-LCD Modules. Regarding quality and reliability as core values, Mitsubishi Electric Europe B.V. has achieved ISO 9001 and 14001 certifications continuously.

Mitsubishi Electric is a leading manufacturer of power semiconductors. The company offers a wide range of products, which covers a broad spectrum of application fields, including power transmission and distribution, railway, renewable energy, motor control, automotive, UPS, medical technology, elevators, welding engineering, home appliances and pumps.

Power electronics is an inherent and intelligent part of the control system of any electrical network. For example, in applications like frequency converters, the use of intelligent Power Modules (IPM) reduces the complexity, size and cost of the drive control circuitry. The required electronics periphery is integrated into the modules.

The state-of-the-art of the development of power electronic devices evolves from current control GTO and bipolar Darlington Transistor to the first voltage controlled IGBT. The compact integrated design features exhibit distinct advantages, especially making it suitable even for stringent ambient conditions. Additional advantages of IGBTs over predecessor technologies are minimal switching losses, high switching frequencies and enormous cost savings by simple control.

Today Mitsubishi Electric has more than 60 years of successful experience in the field of research and development of power semiconductors. The market trend towards more compact modules with high efficiency is continuously pursued by Mitsubishi Electric. A future aim of the company emphasizes on the best utilization and development of new materials and processes to offer miniature products at an affordable price with environmentally features.

Large DIPIPM+ series eases inverter design

To guarantee simpler and more compact designs for inverter systems in air conditioners and industrial applications, Mitsubishi Electric Corporation announced the launch of three new Large DIPIPM+ transfer-mould intelligent power modules featuring an input stage rectifier that realizes simpler and more compact designs for use in air-conditioner and in industrial inverters. Mitsubishi Electric has developed the world´s first* high-density output 100A/1200V module in its transfer-mould package. Sales of the new Large DIPIPM+ series began on May 29. Also, the modules were exhibited at major trade shows, including PCIM Europe 2019 and PCIM-Asia 2019 in Shanghai, China.

Mitsubishi Electric has been contributing to the miniaturization and energy efficiency of inverter systems since commercializing its first DIPIPM+ series in 1997. The compact and innovative DIPIPM+ series consisting of an integrated inverter, three phase converter and gate-

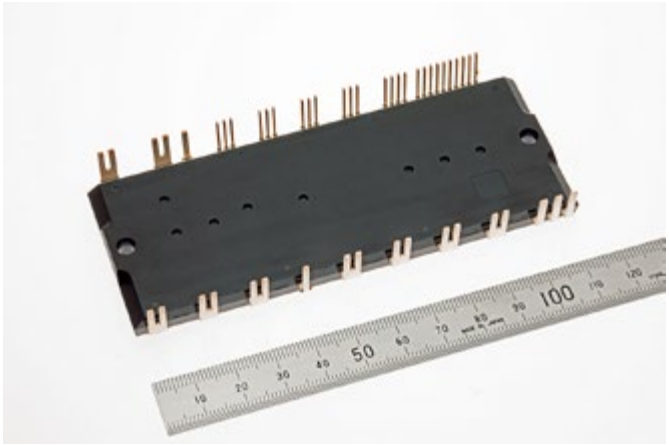

Figure 1: DIPIPM+ series eases inverter design

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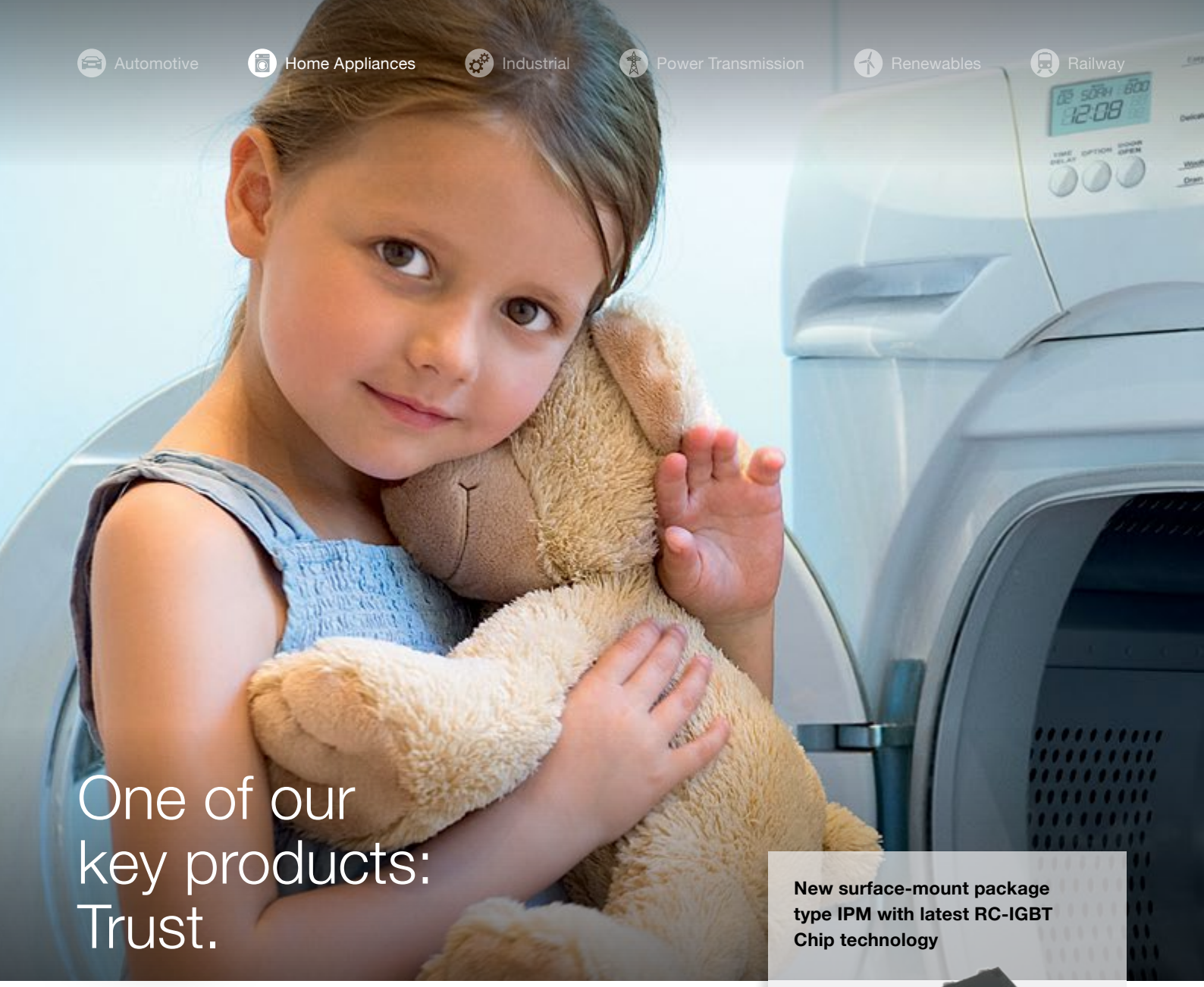
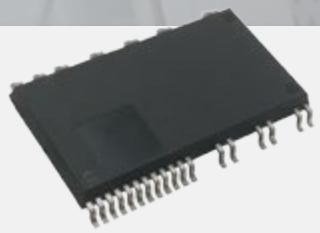


One of our key products: Trust.

Power Devices from Mitsubishi Electric.

Home appliances are becoming more and more demanding regarding functionality, reliability and efficiency. In the field of Power Semiconductors Mitsubishi Electric had created the necessary basis already 20 years ago as the pioneer of the DIPIPM™ Transfer molded package intelligent power modules, followed by the continuous development and expansion of this series. Consequently, with the new MISOP™ a surface-mount package Intelligent Power Module has been added to the line-up to realise compactness and easy assembling in small power inverters for pumps and fans. Also low power servos in industrial applications can be covered. The versatile integrated features are designed to give the benefit of reduced development time for the complete inverter system.

New surface-mount package type IPM with latest RC-IGBT Chip technology



The MISOP™ Surface-mount Package IPM

- Optimized terminal layout enabling simple and compact PCB design
- Integrated driver ICs (HVIC and LVIC)
- Integrated bootstrap diodes and capacitors
- Short circuit protection through external shunt resistor
- Power supply under-voltage protection: Fo output on N-side
- Over temperature protection
- Analog temperature voltage signal output
- Interlock function

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driver components along with protection functions was introduced in 2015. In response to increasing demands for medium power industrial applications, Mitsubishi Electric is now adding a new line-up in the DIPIPM+ family. This product category is called the Large DIPIPM+ and includes three different current ranges: 50A, 75A and 100A (1200V) in accordance with platform inverter design requirements.

The integrated protection features and driver functionalities are aimed at optimizing the engineering efforts required for the inverter design. The protection features include a short-circuit protection system (via current sense), a control power supply under-voltage (UV) protection and an analog over-temperature protection system. In addition, the Large DIPIPM+ is compliant with the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS) directive 2011/65/EU and (EU) 2015/863.
*According to Mitsubishi Electric research as of May 7, 2019

New 1200V SiC Schottky Barrier Diode reduces power loss and physical size
At the same event, Mitsubishi announced the launch of a new 1200V silicon-carbide Schottky-barrier diode (SiC-SBD) that reduces the power loss and physical size of applications such as power supply systems for infrastructure, photovoltaic power systems and more. Sample shipments start in June 2019 and sales will begin in January 2020. The diodes will be exhibited at major trade shows, including – besides PCIM Europe – MOTORTECH JAPAN 2019 during TECHNO FRONTIER 2019 at Makuhar exhibition complex in Chiba, Japan, and PCIM-Asia 2019 in Shanghai, China.

The target is to utilize the advantages of the SiC technology in order to achieve an energy-saving inverter design. With the Mitsubishi SiC diode, up to 21 per cent of the energy losses can be optimized. In addition, the possibility of achieving high switching frequencies allow to minimize the size of peripheral components. The combination of the Schottky barrier diode with the P-N junction (JBS structure) results in higher reliability.

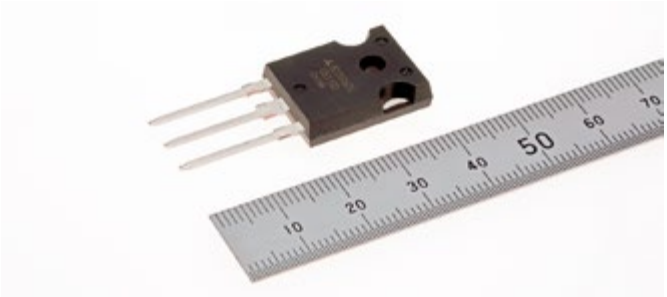

Figure 2: 1200V silicon-carbide Schottky-barrier diode (SiC-SBD)

The extended product ranges with different current classes of SiC Mitsubishi diodes make it possible to meet the requirements of different applications including automotive applications. The 600V/20A devices are already available with different packages (TO247, TO263S, TO-220FP-2). The line-up which includes the 10A and the 20A devices in the 1200V category are available from June 2019.

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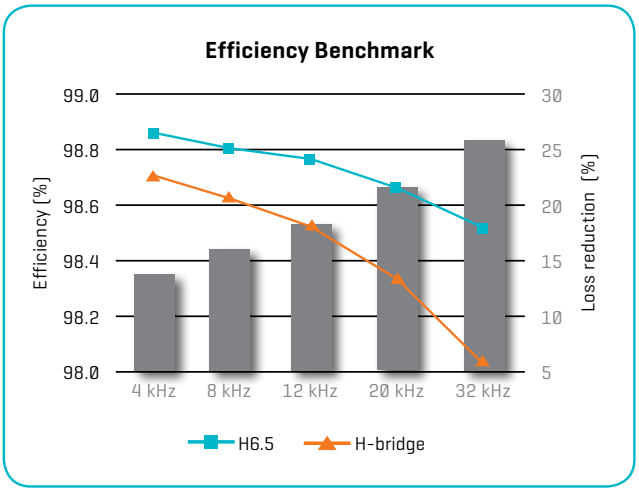
- Compact, integrated solution reduces weight and increases power density
- Secure supply chain thanks to multi-sourced components



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EMPOWERING **YOUR IDEAS**

Presentation of HiRel Microprocessor, Innovative Data Converter and SiP Solutions

During a press briefing in Grenoble, Laurent Monge, President and Site Director, Evelyne Tur and Thierry Bissuel, Business Unit Directors, and colleagues gave an interesting update of the data and signal processing as well as the integrated microelectronics offerings of Teledyne e2v.

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

Teledyne, founded in 1960, provides enabling technologies for industrial growth markets. The company with a revenue of around 2.9 billion USD and approximately 11,000 employees serves multiple markets that require advanced technology and high reliability. Business is growing through new technology development and acquisitions; e2v in Grenoble, France, founded in 1955, with an annual turnover of around 140 M Euros and 400 employees (200 engineers) was acquired in March 2017 to create Teledyne e2v, which i.a. is a leading European competence center for System in Package (SiP) solutions.

Teledyne e2v's innovations lead developments in healthcare, life sciences, space, transportation, defence and security and industrial markets. It is a world leader in re-engineering and up-screening commercial technologies and has held a strategic partnership with NXP for over 30 years to develop space, military and industrial grade versions of NXPs commercial processors. With access to original test vectors, Teledyne e2v offers guaranteed extended reliability versions of a broad line of the QorIQ Power Architecture based portfolio and is developing solutions based on NXPs Layerscape Series.

Taking HiRel microprocessors to a higher standard

In 2015, Teledyne e2v has introduced Qormino, a common computer platform concept ideally suited for the aerospace and defence markets. In 2017, the first lead customers have successfully started their design on the first generation of Qormino. In 2019, leveraging on the success of its space microprocessors, the company will introduce two new disruptive space solutions for LEO and GEO environments (LS1046-Space and QLS1046-4GB-Space). From the design up to the delivery of the first flight models, Teledyne e2v will continue to guarantee the highest level of quality and reliability for space customers and applications. Teledyne e2v recently has qualified and released the first upscreened processor from NXPs new Layerscape Series, the LS1046A, part of NXPs 64-bit Arm Layerscape portfolio that implements a quad-core Arm Cortex A72 design providing unparalleled performance in the smallest form factor possible while enabling access to the vast ecosystem of software services, applications and tools compatible with Arm technology.

The LS1046A from NXP is a 1.8GHz processor integrating packet processing acceleration with high-speed peripherals and is recognized for its high-performance architecture and market-leading compute density. Offering more than 45,000 CoreMarks of compute performance, paired with dual 10Gb Ethernet, PCIe Gen3, SATA

Laurent Monge, President and Site Director, Teledyne e2v

Gen3 it is suitable for a range of high reliability mil-aero applications. The Teledyne e2v military qualification of this device assures its functionality between -55°C and 125°C and is available in both RoHS and leaded packages. In addition, as part of Teledyne e2v's Semiconductor Lifecycle Management program, SLiM, the lifetime of this device can be supported for 15+ years, avoiding common and costly obsolescence issues.

Processors produced in Grenoble are tailored to support PowerArchitecture (legacy) for the next decades; they are ready for the next steps with ARM based processors, facilitate make/buy decisions with Qormino Common Platform solutions and reduce time to market. Highlights of the Space Microprocessors, available in ceramic and in organic package solutions:

- GHz class for compute intensive applications
- Space portfolio with flight heritage
- Radiation tolerant devices
- De-risking the introduction of ARM Cortex A72 based solutions.

The next Space Microprocessors are to enable increased on-board data processing, a higher level of data selection, higher accuracy level of data transmitted, an increased Quality of Service, increased autonomy and increased observation capabilities – all at an equivalent level of reliability.

Electronic Concepts

Film Capacitor Innovation Without Limits

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- High Voltage
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- Capacitance Range: 25µF to 325µF
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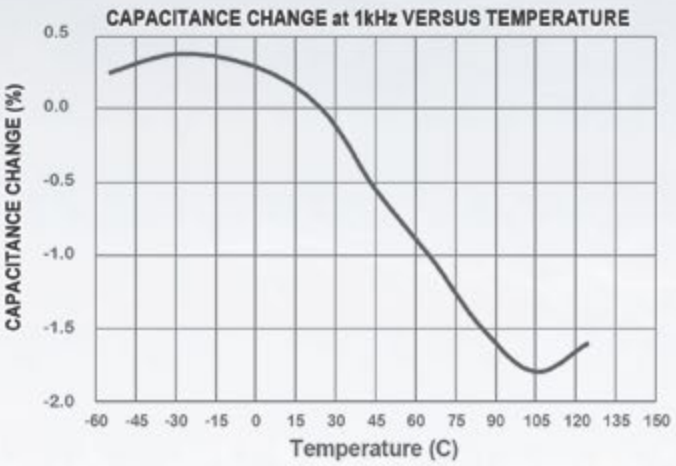

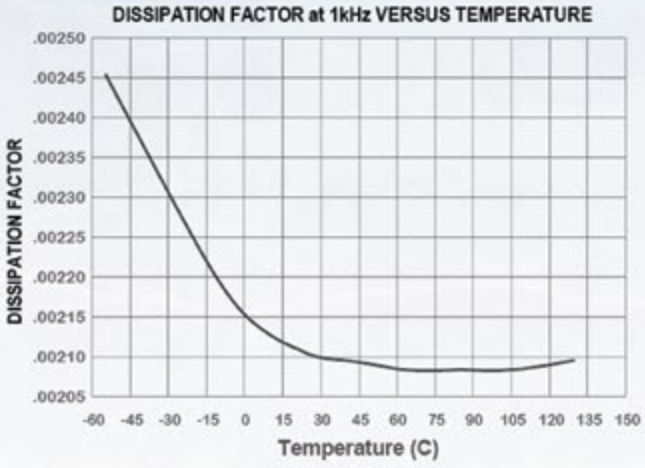

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Data Converters Innovation Update

Having started in 1995, the company is now in its 3rd decade of GHz class data converters. Starting with the world first GHz class data converter 24 years ago, and followed by further world firsts since, Teledyne e2v has grown and kept working hard to deliver further historical landmarks in data conversion technology, such as:

- First Ka-Band capable data converters, supporting ever-increasing higher signal and RF bandwidths.
- First controlled synchronization of multiple data converters in antenna arrays.
- ESIstream: An open source serial interface protocol, enabling controlled synchronization and other benefits.
- Enabling array antennas with digital interface instead of RF on coaxial cables.

The product portfolio covers all bands – the Rx ADCs from base band through L and S to C band with the EV12AQ600 quad channel 6GSPS ADC leading this section, and the Tx DACs up to the Ka band, here with the EV12DD700 dual channel 12GSPS DAC with extended dynamic range in Ka as the newest and most innovative offering. Target applications of the portfolio are

Space Systems: High throughput comms satellites, telecommunication constellations, SAR radar imaging, GNSS systems, data links and telemetry, tracking and command.
Defence Systems: HTS military SatCom, SAR radar imaging from space, airborne SAR imaging, SAR/GMTI, EW and ECM.
Industrial Systems: Precision lab instruments, radar target simulator, industrial testing, telecom T&M, fiber optic sensing and LiDAR.
Telecom Systems: Microwave backhaul, microwave base station, Gigabit passive optical network and high frequency trading.

The innovations the company is working for, and their target markets are

- Interstellar H2020 Update; project partner here is Fraunhofer Institut IIS – Erlangen, Germany;
- Simplification of the RF signal chain with the goal to help system designers move RF hardware to the digital side;
- Direct conversion up to Ka-Band without intermediate frequencies in L-, S-, C-, X-, Ku- and Ka-Band, opening ways to unprecedented frequency agility.
- Evolutions of implementations of data converters: The way GHz class ADCs and DACs are implemented is changing significantly. Innovating in multi-ADC synchronization for antenna arrays, and setting the ground for distributed data converters in antennas – #ESIstream, #SYNC, #Ka-Band.
- From old space to new space – supporting the evolutions of the space industry.

Teledyne e2v´s areas of innovation and the resulting benefits to system designers are

a. More digitization of the RF domain – ensuring significant transition of RF circuitry from unflexible analog hardware to reconfigurable digital replacement, reduction of component counts and SWaP savings.
b. More frequency bands supported with direct conversion L-, S-, C-, X-, Ku- and Ka, resulting in removal of frequency conversion stages in RF systems plus no intermediate frequencies in the supported bands.
c. Simultaneous operation in multiple band, offering more possibilities to use the restricted available RF spectrum, more performance with increased bandwidths over several bands and better radar imagery with rich multi-bands sensing – from B&W to colour.
d. Enabling more flexibility – on-the-fly software reconfiguration of entire RF system for frequency of operation, beamforming. Flexibility on physical location of antenna elements, so distance no longer matters on fiber.
e. Enabling system simplification: RF hardware is done in the smallest possible form factor: digital code. Heavy RF harnesses of coaxial cable and waveguide to be replaced by digital data on fiber.
f. Enabling future architecture – array antennas with no RF interface, but digital interface on fiber.

Latest News

On April 8th this year, Teledyne e2v, Wind River and CoreAVI announced that they will provide key technologies for BAE Systems' new mission computer. A mission computer is the central hub that processes all mission critical data on an aircraft: Receiving information from various external subsystems, it processes the data and presents it to the pilot on various displays in the cockpit. The joint solution includes Wind River VxWorks RTOS running on Teledyne e2v Qormino Common Computer Platform, and CoreAVI supplying its temperature-screened AMD Embedded Radeon E8860 GPUs as well as its safety critical ArgusCore SC1 OpenGL1.0.1 graphics drivers.

Qormino QT1040-4GB is a smart, small and powerful common computer platform from Teledyne e2v designed to respond to SWaP constraints (Size, Weight and Power). It combines a T1040 Quad PowerArchitecture e5500 core running at 1.4GHz, 4GB of DDR4 memory, on a custom Teledyne e2v substrate, with a 64-bit memory bus and 8 bits of ECC (Error Correction Code), and will run VxWorks on BAE Systems' platform.

www.teledyne-e2v.com

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Cascaded and Hybrid Concepts for Voltage Conversion

There are different solutions for applications that require conversion from a high input voltage down to a very low output voltage. One interesting example is the conversion from 48 V down to 3.3 V. Such a specification is not only common in server applications for the information technology market, but in telecommunications as well.

By Frederik Dostal, Analog Devices, Inc.

If a step-down converter (buck) is used for this single conversion step, as shown in Figure 1, the problem of small duty cycles emerges.

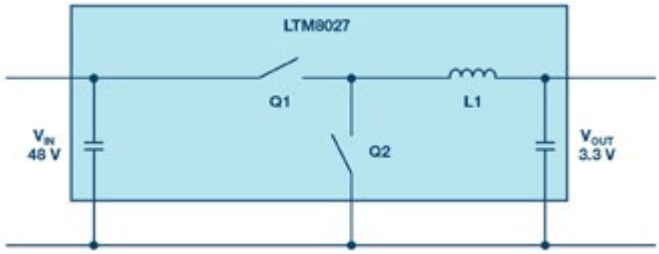

Figure 1: Conversion of a voltage from 48 V down to 3.3 V in one single conversion step.

The duty cycle is the relationship between the on-time (when the main switch is turned on) and the off-time (when the main switch is turned off). A buck converter has a duty cycle, which is defined by the following formula:

$$Duty\ Cycle = \frac{Output\ Voltage}{Input\ Voltage}$$

This means that at a switching frequency of 1 MHz (1000 ns per switching period), the Q1 switch is turned on for only 70 ns. Then, the Q1 switch is turned off for 930 ns and Q2 is turned on. For such a circuit, a switching regulator has to be chosen that allows for a minimum on-time of 70 ns or less. If such a component is selected, there is another challenge. Usually the very high power conversion efficiency of a buck regulator is reduced when operating at very short duty cycles. This is because there is only a very short time available to store energy in the inductor. The inductor needs to provide power for a long period during the off-time. This typically leads to very high peak currents in the circuit. To lower these currents, the inductance of L1 needs to be relatively large. This is due to the fact that during the on-time, a large voltage difference is applied across L1 in Figure 1.

In the example, we see about 44.7 V across the inductor during the on-time, 48 V on the switch-node side, and 3.3 V on the output side. The inductor current is calculated by the following formula:

$$i_L = \frac{1}{L}\int u_L dt$$

If there is a high voltage across the inductor, the current rises during a fixed time period and at a fixed inductance. To reduce inductor peak currents, a higher inductance value needs to be selected. However, a higher value inductor adds to increased power losses. Under these voltage conditions, an efficient LTM8027 µModule® regulator from Analog Devices achieves power efficiency of only 80% at 4 A output current.

Today, a very common and more efficient circuit solution to increase the power efficiency is the generation of an intermediate voltage. A cascaded setup with two highly efficient step-down (buck) regulators is shown in Figure 2. In the first step, the voltage of 48 V is converted to 12 V. This voltage is then converted down to 3.3 V in a second conversion step. The LTM8027 µModule regulator has a total conversion efficiency of more than 92% when going from 48 V down to 12 V. The second conversion step from 12 V down to 3.3 V, performed with a LTM4624, has a conversion efficiency of 90%. This yields a total power conversion efficiency of 83%. This is 3% higher than the direct conversion in Figure 1.

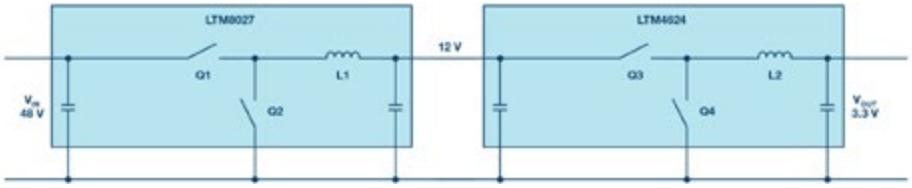

Figure 2: Voltage conversion from 48 V down to 3.3 V in two steps, including a 12 V intermediate voltage.

This can be quite surprising since all the power on the 3.3 V output needed to run through two individual switching regulator circuits. The efficiency of the circuit in Figure 1 is lower due to the short duty cycle and the resulting high inductor peak currents.

When comparing single step-down architectures with intermediate bus architectures, there are many more aspects to consider besides power efficiency.

One other solution to this basic problem is the new LTC7821, hybrid step-down controller from Analog Devices. It combines charge pump action with a step-down buck regulation. This enables the duty cycle to be 2× VIN/VOUT and, thus, very high step down ratios can be achieved at very high power conversion efficiencies.

Figure 3 shows the circuit setup of the LTC7821. It is a hybrid step-down synchronous controller. It combines a charge pump to halve the input voltage with a synchronous step-down converter utilizing the buck topology. With it, conversion efficiencies of more than 97% for converting 48 V to 12 V at a 500 kHz switching frequency are possible. With other architectures, this high efficiency would only be feasible with much lower switching frequencies. They would require larger inductors.

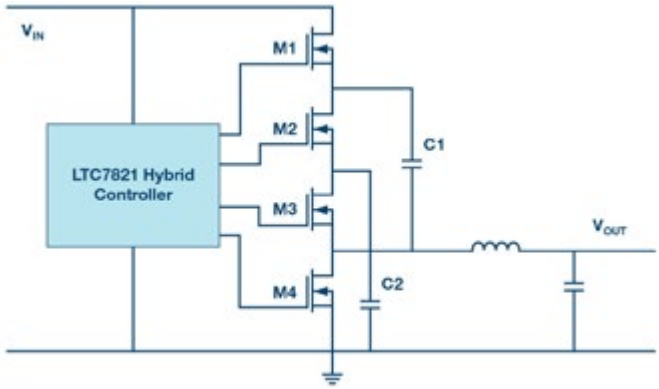

Figure 3: Circuit design for a hybrid step-down converter.

Four external switching transistors are activated. During operation, the capacitors C1 and C2 generate the charge pump function. The voltage generated in this way is converted into a precisely regulated output voltage with the synchronous buck function. To optimize the EMC characteristics, the charge pump is used with soft switching operations.

The combination of a charge pump and a buck topology offers the following advantages. Due to the optimal combination of charge pump and synchronous switching regulator, the conversion efficiency is very high. The external MOSFETs M2, M3, and M4 only have to withstand low voltages. The circuit is also compact. The coil is smaller and cheaper than in a single-stage converter approach. For this hybrid controller, the duty cycle for switches M1 and M3 is D = 2 × VOUT/VIN. For M2 and M4, the duty cycle is calculated as D = (VIN – 2 × VOUT)/VIN.

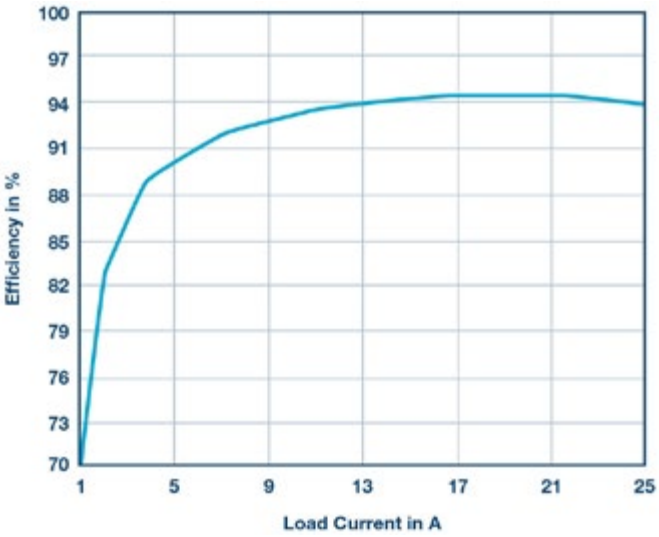

Figure 4: Typical conversion efficiency for converting 48 V to 5 V at a switching frequency of 500 kHz.

For charge pumps, many developers assume a power output limitation of approximately 100 mW. The hybrid converter switch with the LTC7821 is designed for output currents of up to 25 A. For even higher performance, multiple LTC7821 controllers can be connected in a parallel multiphase configuration with synchronized frequency to share the overall load.

Figure 4 shows the typical conversion efficiency for a 48 V input voltage and a 5 V output voltage at different load currents. At approximately 6 A, a conversion efficiency exceeding 90% is reached. Between 13 A and 24 A, the efficiency is even higher than 94%.

A hybrid step-down controller supplies very high conversion efficiency in a compact form. It offers an interesting alternative to a discrete two-stage switching regulator design with intermediate bus voltage and to a single-stage converter that is forced to operate at a very low duty cycle. Some designers will prefer a cascaded architecture, others a hybrid architecture. With these two available options, every design should be successful.

About the Author

Frederik Dostal studied microelectronics at the University of Erlangen-Nuremberg, Germany. Starting work in the power management business in 2001, he has been active in various applications positions including four years in Phoenix, Arizona, working on switch mode power supplies. He joined Analog Devices in 2009 and works as a power management technical expert for Europe. He can be reached at frederik.dostal@analog.com

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GaN Makes a Frontal Attack on Silicon Power MOSFETs

Silicon has been around long enough. It's time for a younger and a far more fit semiconductor to take over.

When I first started developing power devices 44 years ago, the "king of the hill" was the silicon power bipolar transistor. In 1978 International Rectifier (IRF) launched power MOSFETs as a faster alternative to the slower and aging bipolar devices. The early adopters of the power MOSFET were applications where the bipolar just was not fast enough. The signature example for its adoption was the switching power supply for the desktop computer; first at Apple, and then at IBM.

By Alex Lidow Ph.D., CEO and Co-founder, Efficient Power Conversion

It was not until the mid-1980's that the scale of power MOSFET production was big enough to bring the costs of the power MOSFETs in line with bipolar transistors. It was then that IRF made its frontal assault on the bipolar transistor.

The target incumbent was Motorola as they were the largest market share holder of the bipolar transistor. As a reaction to the onslaught of the MOSFET, Motorola initially deployed resources to scare potential MOSFET users. These scare tactics included rumors of reliability problems, high prices, and an unreliable supply chain. Despite these attacks, the power MOSFET continued to gain acceptance into traditional applications where the bipolar transistor used to be dominant. Recognizing the superiority of this new technology, Motorola launched their own power MOSFETs pledging to be agnostic between the two technologies -- "We make both, so buy from us" was their battle cry. The problem was, they didn't make the best power MOSFETs, and eventually, they lost the war.

Today the power MOSFET is the "king of the hill," and GaN-on-Si power devices are the challenger. The early GaN adopters needed the speed. Big examples were lidar systems for autonomous cars, drones, and robots, and 4G/LTE base stations. The volume has grown, and now GaN power devices are at a point where the prices are equivalent (see figure 1) to the slower, bigger and aging power MOSFET. Thus, it is time for GaN's frontal assault!

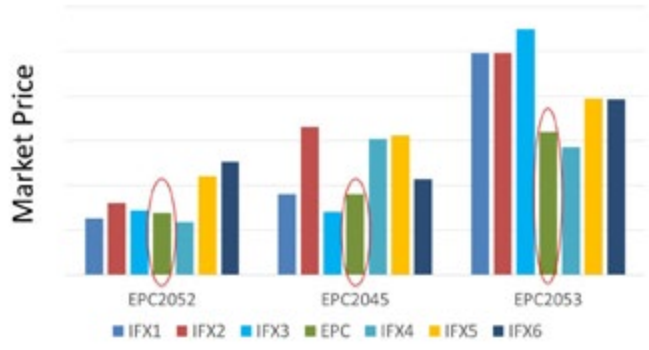

Figure 1: April 2019 distributor pricing survey result for 100 V rated eGaN FETs compared with equivalently rated power MOSFETs. Inside the red ovals are eGaN FET prices.

The Roman philosopher Seneca wrote, "Luck Is what happens when preparation meets opportunity," In the case of GaN transistors, there has been a decade of "preparation" with over 100 billion hours of field experience with fewer failures than the mature power MOSFET. In addition, during this period GaN transistors have followed a Moore's Law pattern of higher performance and lower cost year-after-year. Now comes the "opportunity." In 2009, Facebook recognized that their exponential growth was causing similar growth in the cost of servers and energy requirements. As a reaction, Facebook started working on a new generation of data center design with great success. In 2011 Intel and Rackspace joined the effort and together launched the Open Compute Project.

Among the many technological advances and improved standards and practices came the realization that changing the input voltage to the server rack from 12 V to 48 V would save a significant amount of energy while lowering the cost of printed circuit boards and connectors. Since the initiation of these standards, many high-performance servers have converted from 48 V to the point-of-load (POL) on the mother board with the processors (CPUs or GPUs).

Instead of heavy, large, and costly isolated "brick" 48 V – 12 V DC-DC power supplies that lived in the server rack, there was a new demand for 48 V – 12 V (or even much lower output voltage) DC-DC converters that could squeeze onto the mother board in close proximity to the processors. These DC-DC supplies did not need to be tightly regulated or provide isolation like their predecessors. However, they needed to be low cost, small and highly efficient.

The emerging onboard 48 V DC-DC converter opened up many new design opportunities for the lower-cost, higher-performance, and smaller GaN FETs in applications that were traditionally dominated by power MOSFETs. Two power conversion topologies, both using 100 V GaN FETs have emerged as preferred by both server and power sup-

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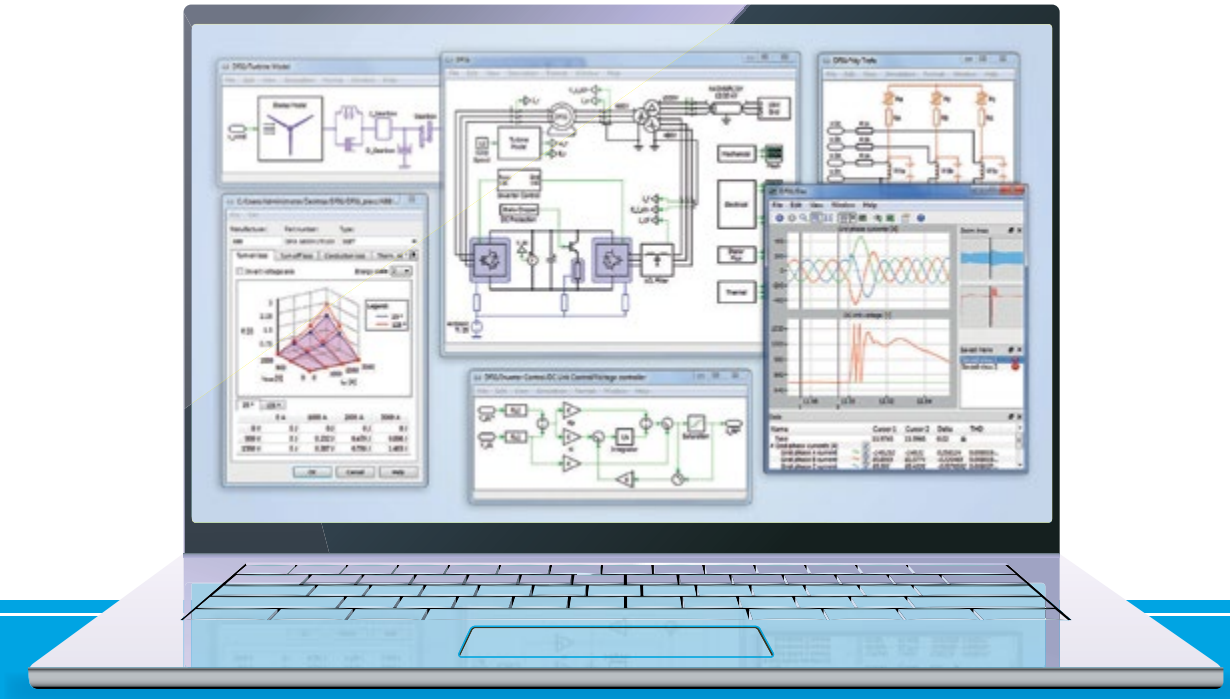

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ply manufacturers; (1) simple 48 V – 12 (or 5) V buck converters such as shown in figure 2 with the efficiency shown in figure 3, and (2) the 48 V – 6 (or 4) V LLC converter shown in figure 4 with the efficiency shown in figure 5.

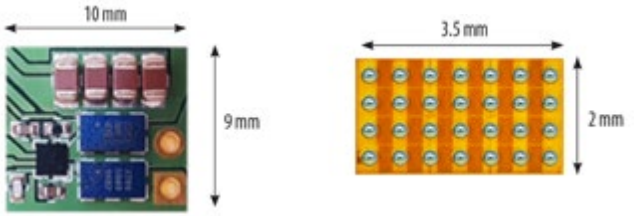

Figure 2: On the left is a 48 V – 12 V buck converter power stage showing the two GaN FETs with blue backs. On the right is the front side of the EPC2053 chip-scale FET.

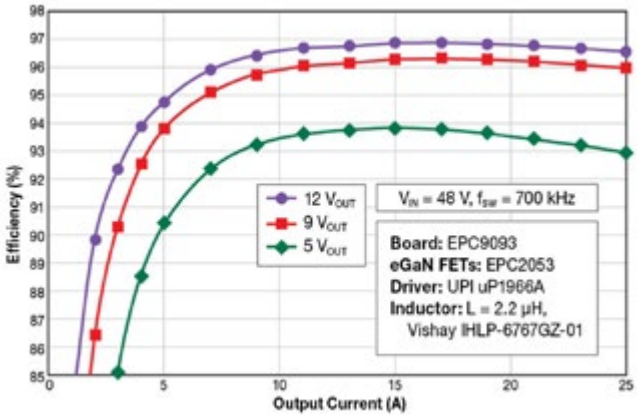

Figure 3: Efficiency vs output current for 48 VIN to 5, 9 and 12 VOUT when operating at 700 kHz and using EPC2053 eGaN FETs. At 12 V output, the efficiency is 97%.

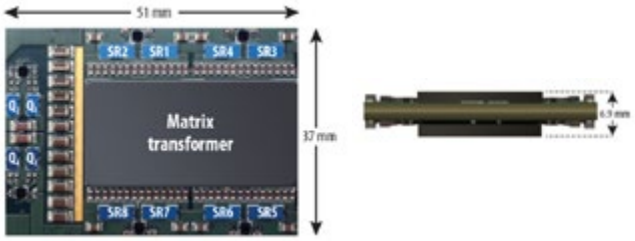

Figure 4: Photo, with dimensions, of the 1 MHz, 900 W, 48 V to 6V LLC converter using EPC2045 FETs (Q1-Q4) and EPC2023 FETs (SR1-SR16).

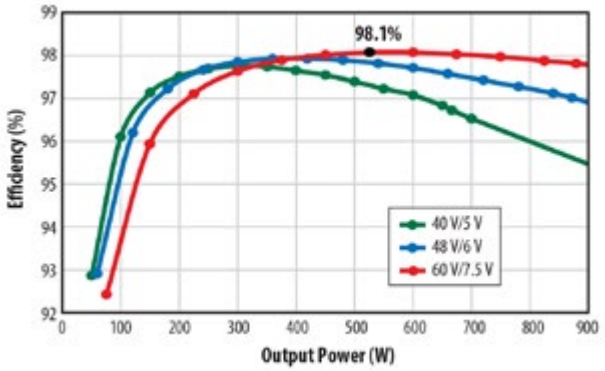

Figure 5: Greater than 98% peak efficiency is achieved as shown in this graph of efficiency as a function of output power at 40 V, 48 V, and 60 V input voltage

And then the automotive industry started to follow a similar path, opening up another large opportunity for GaN. Given the growing demand for electronically-driven functions such as electric steering, electric air conditioning, electric suspension and a multitude of USB-C charging ports on modern cars and trucks, the traditional 14 V power distribution buses have been growing in size and weight at an alarming pace. A mild hybrid car today requires between 2 and 8 kW of electricity to be available. At 14 V, 8 kW requires wires to conduct 570 A. At 48 V that number is reduced to 170 A, which saves on the need for heavy and hard-to-manage wiring harnesses.

Recognizing the value in moving to a 48 V system, the Tier-1 automotive electronics manufacturers are all producing or planning to produce 48 V – 14 V bi-directional DC-DC power supplies to accommodate this new electrical architecture while maintaining compatibility with legacy 14 V systems. The simplest, lowest cost and most efficient solution today is the GaN FET-based buck/boost converter such as shown in figure 6.

Figure 6: A 97% efficient 6 kW 48 V – 14 V bi-directional automotive-grade DC-DC buck/boost converter that uses 16 EPC2208 100 V eGaN FETs.

Today's GaN FETs are improving rapidly in size and performance. The benchmark devices are still 300 times away from their theoretical performance limits. Incumbent MOSFET producers, with full knowledge that their products are near their performance limits, are already broadcasting vague warnings – scare tactics – of reliability issues and unreliable supply chains or cite obsolete GaN pricing and performance comparisons. Already the trope that "we can do MOSFETs or GaN, we are agnostic" has reappeared from entrenched silicon players.

As Mark Twain allegedly said a century ago, "History doesn't repeat itself, but it often rhymes."

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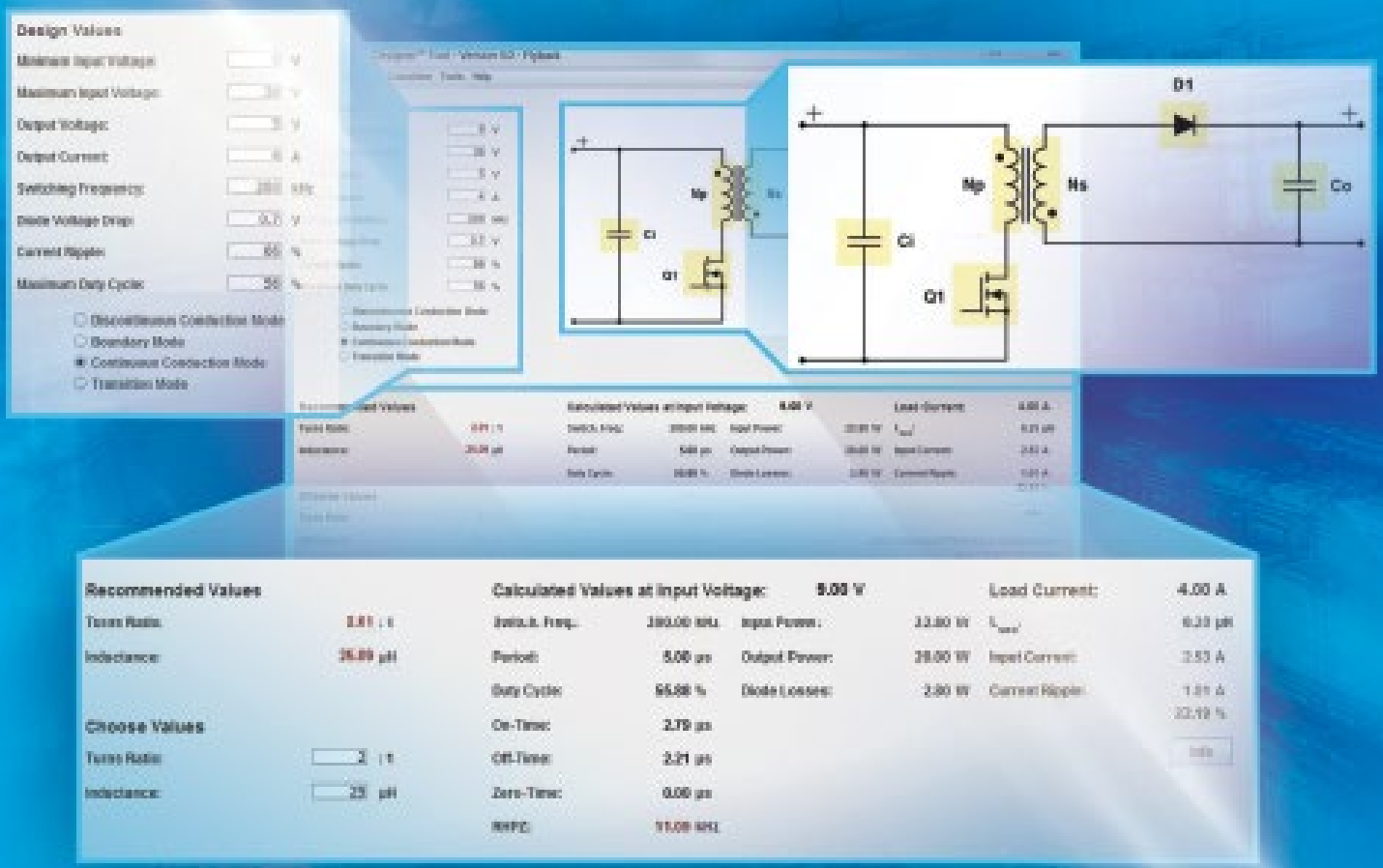

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Simple Slew-Rate Control Technique Cuts Turn-on Energy

The reduction of switching losses in power electronic systems such as drives is limited by EMI or parameters like the slope of switched voltages. This behavior is usually fixed by selecting the effective gate resistance of power transistors. It cannot be adapted spontaneously during operation. This article shows a simple way to overcome this dilemma by operating conventional gate-driver ICs in parallel. It also presents an evaluation of characterisation data regarding improvements of the turn-on energy.

By Wolfgang Frank, Infineon

Introduction

The dimensioning of the gate resistor that interfaces MOS-gated power transistors has generally two optimization targets: Firstly, the gate resistor should get the power transistor to switch faster by dimensioning the gate resistor with low values. This leads automatically to lower switching losses, hence to lower overall losses. Secondly, the gate resistor can also reduce the switching speed, e.g. dv_{CE}/dt or di_C/dt. This will trigger fewer oscillations of parasitic stray inductances or coupling capacitances in the gate circuit. A trade-off is therefore needed to find the relative optimum in a given layout. However, it would suffice to manage only specific points of operation, for example temporary overload or underload conditions. Such conditions can point to a slower switching speed than what is normal operation of an application.

A typical example of an underload condition is, for example, the low load operation of an electric drive. The current commutation from a diode, which conducts only little forward current to an IGBT, can result in heavy oscillations if the turn-on of the opposite IGBT is too fast. These oscillations are strongly reduced, or vanish if the forward current is in the range of 25% of the nominal current [1] or higher.

Proposed gate-drive concepts

A normal gate-drive circuit is depicted in Figure 1. A single gate driver sources and sinks the gate current, which is defined by the gate resistors. The current i_{OUT+} charges the gate of the power transistor, and the current i_{OUT-} discharges the gate.

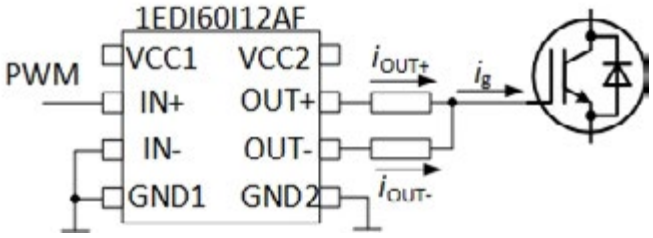

Figure 1: Conventional gate drive using a single IC

Other than more elaborated gate-drive circuits [1], or IPMs [2], the proposed gate-drive system consists of two conventional gate-driver ICs as shown in Figure 1.

Figure 2 shows the proposed gate- drive concept with improved sourcing capability. Two gate drivers of type 1EDI60I12AF are operated in parallel. The input configuration with the terminals IN+ and IN- allows the terminals IN+ to be used for the conventional PWM input signal. The terminal IN- of gate driver IC2 is used to select and deselect the additional output of IC2 by means of an inverted enable-signal /EN. This signal can be simply generated from the application control, or derived from sense signals, which are relevant for switching performance, such as temperature or collector current. Enabling IC2 injects another contribution i_{OUT+2} to the gate current i_g for turn-on.

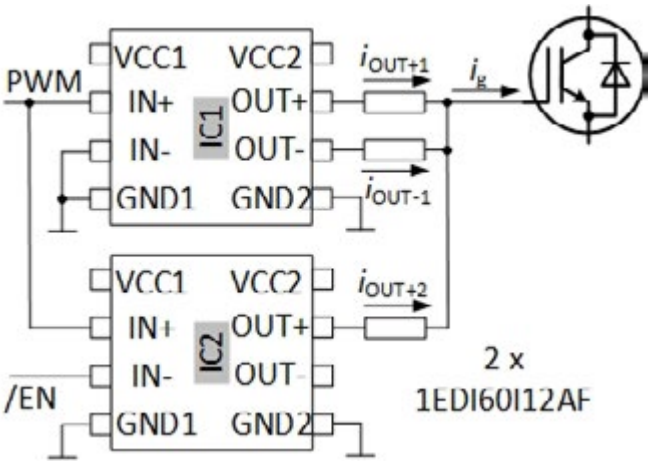

Figure 2: Proposed gate drive using two driver ICs for a simple slew-rate control with improved sourcing (top) and sinking (bottom)

Figure 2 depicts that only driver IC1 can be used for turn-off. The sinking capability of IC2 cannot be used at the same time, as there could be a condition, where IC1 is sourcing and IC2 is sinking. This would result in excessive power dissipation either in the ICs or in the related gate resistors.

The timing of the gate current $i_g(t)$ is shown in Figure 3. The gate current for turn-on and turn-off is provided only by IC1 during low load as shown at the top of Figure 3. The turn-on performance can be adjusted with respect to the individual application needs or design guidelines, such as the maximum dv_{CE}/dt in drive systems [3]. The change between high-load and low-load operation is done by applying an inverted enable signal to terminal IN- of IC2 according to Figure 2. It activates the sourcing output of IC2 resulting in a faster turn-on. The

value of the additional turn-on gate resistor at terminal OUT+ of IC2 is selected so that the turn-on performance of the power transistor again meets the application needs.

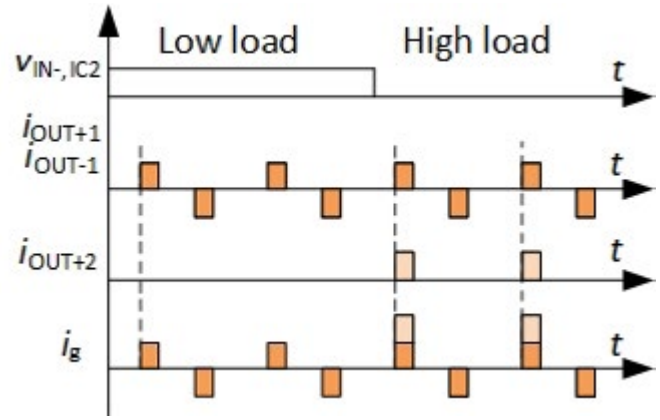

Figure 3: Timing of gate currents for IC1 and IC2 for the proposed gate-drive concept with enforced sourcing

Measurement results' evaluation

Figure 4 depicts the related results of double-pulse tests for the turn-on energy E_{on} and dv_{CE}/dt for various gate resistors and collector currents IC for the gate-drive concept with enforced sourcing.

The gate resistors range from 10 Ω up to 47 Ω (solid lines for conventional solution) and the collector currents from 10% up to 100% of the nominal current. The software calculates the 90%/10% value for the dv_{CE}/dt. The tested power transistor is a 40 A / 1200 V IGBT from Infineon (IKW40N120T2).

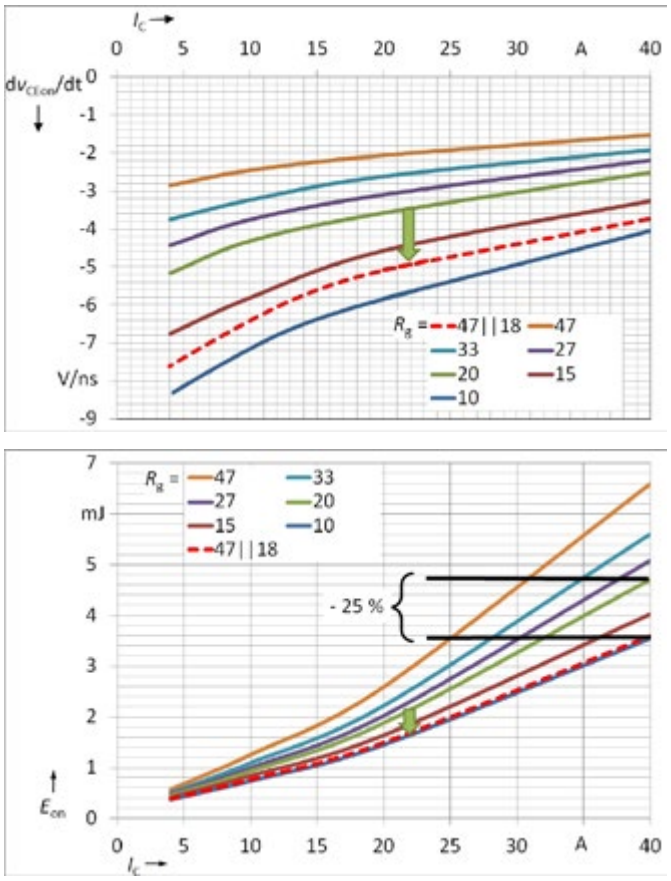

Figure 4: Effect of the proposed slew-rate control technique on dv_{CEon}/dt (top) and switching energy E_{on} (bottom) during turn-on

The voltage slew rate dv_{CE}/dt is continuously increasing over the collector current range. The only exception is the curve representing R_g = 10 Ω at I_C = 10 A. Here, a measurement singluarity is observed, as the voltage drop over the setup´s stray inductance triggered the starting condition for the automated dv_{CE}/dt measurement. The same singluarity applies to the results of the proposed driver that is depicted by the red dotted line. Two gate drivers with individual gate resistors of R_{g1} = 18 Ω and R_{g2} = 47 Ω are applied. The proposed gate-drive technique can use the gate resistor R_{g1} in the lower collector current range. It is assumed that the green line representing R_g = 20 Ω in Figure 4 yields similar results as R_g = 18 Ω, and shows rather low dv_{CE}/dt. A changeover to the parallel operation of the two gate-driver ICs with R_{g1} = 18 Ω and R_{g2} = 47 Ω in parallel may occur in the area of 50% of nominal current (I_C = 20 A).

The turn-on energy is shown in the top part of Figure 4. It can be reduced at nominal current (I_C = 40 A) from 4.8 mJ down to 3.6 mJ when using the proposed gate drive. This is approximately 25% lower turn-on energy E_{on}.

Conclusion

Using two gate drivers per power transistor, combined with a spontaneous selection of the operated gate drivers, is a simple way to enhance the performance of power transistors, since the gate resistors of the two outputs can be dimensioned independently. The use of two gate-drive ICs can be tailored for enforced sourcing capability or enforced sinking capability in a simple way. Furthermore, the use of gate-driver ICs such as Infineon´s 1EDI60I12AF reduces the design effort compared to discrete solutions with the same functionality. Reductions of the turn-on energy E_{on} up to 25% with enforced sourcing can be easily achieved by applying conventional design guidelines. The proposed gate-drive concepts are therefore outperforming conventional approaches.

References:

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[3] Gambica Association: Motor Insulation Voltage Stresses Under PWM Inverter Operation, Technical report No.1, third edition, UK, 2006.

Three-Level NPC Topology with Tandem Diodes:

The Cost-Efficient Solution for 1500 $V_{DC,}$ Multi-String Solar Inverters

Innovative solutions aimed to improve efficiency without upping costs are sure to interest users, particularly in a very competitive business environment. This article presents the benefits of efficiency-enhancing tandem diodes in an NPC topology for solar inverters.

By Guillem Gargallo Pallardó, Product Marketing Manager, Vincotech GmbH

Introduction

The adoption of new technologies such as SiC and the implementation of 1500 V_{DC} systems has enabled higher power densities in the PV inverter market. A light, compact wall-mounted device can now cover power ranges it once took an entire cabinet full of components to muster. This is why multi-string inverters are a rising force in the utility-scale market.

On the downside, the price per-kW of these new devices is still higher than that of central inverters. One of the reasons is the strong demand of power electronics. That has brought the supply of some key components to its limits, keeping the price level of new technologies such as SiC at a higher level than initially expected. This leaves the door open for creative solutions that make the most of well-established and cost-efficient Si technologies.

NPC topology with a tandem diode for 1500 V_{DC} systems

Neutral point clamped (NPC) topology is one of the preferred choices for 1500 V_{DC} systems. The possibility of using fast 1200 V Si components that work in the 10-to-20 kHz frequency range offers clear advantages compared to the alternative three-level Mixed NPC (MNPC) topology. MNPC would require 1700 V components, but these are unsuitable for the targeted switching speeds.

The first option for improving the NPC topology's efficiency would be to replace key Si components with more efficient SiC chip technology. This upgrade comes at a higher cost. Increasing the switching frequency to accommodate smaller and generally cheaper passive components could offset some, but not all, of this added cost. In most cases, the more expensive semiconductors will raise the per-kW price.

A second option for boosting efficiency would be to use more complex topologies such as Advanced NPC (ANPC) or multiple levels in combination with SiC components. This requires more gate drivers and power supplies, which would complicate the design effort and increase costs.

So how does one enhance efficiency at an acceptable cost? A viable solution is to go with a tandem diode configuration – that is, to replace the relatively slow 1200 V diodes with two much faster 650 V diodes connected in series. While there will be a slight increase in the forward voltage of the diodes, the superior dynamic characteristics of 650 V diodes provide an advantage in terms of total losses even at low switching frequencies. In solar applications, for which the most relevant efficiency point is for cos(Φ) close to 1, only the buck diodes of the NPC need to be replaced with tandem diodes as pictured in figure 1.

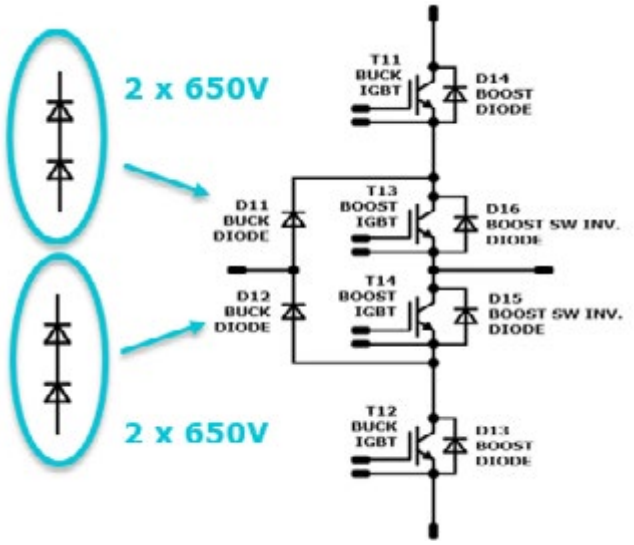


Figure 1: NPC topology with tandem diodes

Figure 2 compares the loss distribution of various NPC modules with different buck diodes at 16 kHz.

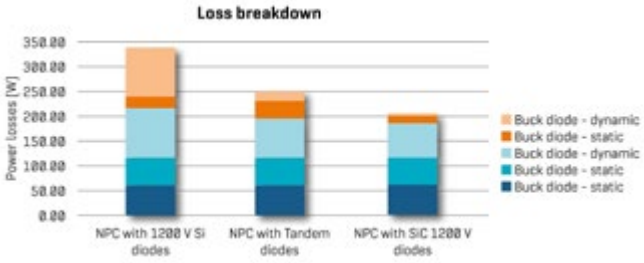


Figure 2: Loss breakdown and comparison of an NPC module with different buck diodes.
Conditions: P = 120 kW / cosΦ = 1 / VIN = 1300 V / VOUT = 400 V / IRMS = 100 A

It shows that when using 1200 V fast Si diodes, nearly 30% of total losses are directly related to their switching performance. Moreover, these diodes also influence the dynamic behavior of the outer IGBTs, as they are partly responsible for the E_{ON} losses. This reduces

efficiency and increases the junction temperature in the affected components, shortening their service life and precluding higher switching frequencies.

Replacing these diodes with 1200 V SiC diodes, a so called hybrid module, would reduce total losses by as much as 40% with an extraordinary drop of 95% in the diode's switching losses. The far lower E_{ON} also results in a 30% reduction in the buck IGBT's switching losses. However, as figure 3 shows, this improvement has a considerable impact on the module's cost, which is then twice as high as the price of a full Si module.

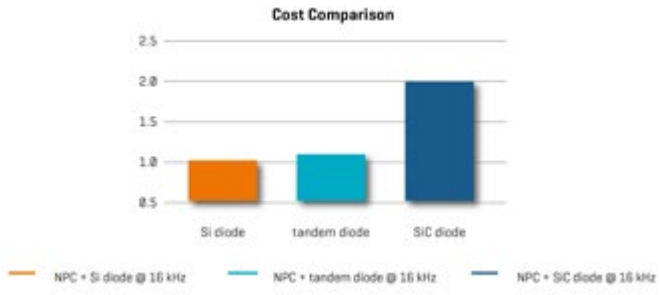


Figure 3: Normalized cost comparison of an NPC module with different buck diodes

Replacing the 1200 V Si buck diodes with tandem diodes would increase static losses by just 5%. On the other hand, the reduction in the diodes' and IGBTs' switching losses –80% and 21%, respectively – would more than compensate for this slight uptick in static losses, resulting in an overall decrease of 25% in losses. As figure 3 illustrates, the difference in cost between this proposed solution and a standard NPC module is all but negligible. And that makes tandem diodes a very attractive way of improving the NPC module.

Another advantage of the tandem diode configuration's lower losses is that the switching frequency can be increased. For example, an NPC module featuring tandem diodes switched at 20 kHz will achieve the same efficiency as an NPC module with fast 1200 V diodes at 8 kHz. This would enable engineers to use smaller passive components and build much lighter and more compact devices.

Conclusion

In a very competitive and supply-driven market, the NPC topology with tandem diodes provides a reliable, cost-efficient solution for multi-string solar inverters. With efficiency approaching that of a hybrid SiC module and the price tag of a full Si device, it not only enables inverter manufacturers to build lighter and more compact devices; it also maximizes the ROI for these vendors and their customers.

www.vincotech.com

G.Fast Transformers Now Available

Würth Elektronik is proud to announce the release of additional G.FAST transformers to the MID-DSLSCK family approved for use with Sckipio chipsets. “These transformers cover both the 106Mhz & 212Mhz G.fast profiles and have low insertion loss over the entire frequency range, allowing data rates up to 1Gb/sec on lines less than 300 meters long”, explained Swaroop Vaidyanath, Product Manager for Telecom products at Würth Elektronik. These low profile transformers are surface mount with maximum heights between 3.7mm and 5mm, and offer low interwinding capacitance and low insertion loss. Featuring 1875V isolation, and having an operating temperature of -40°C to 85°C,

these pick-and-placeable transformers are designed to meet IEC60950-1, EN60950-1, UL60950-1/CSA60950-1 and AS/NZS60950.1 supplementary insulation with 6kV surge or functional insulation.
In addition to providing isolation, the new MID-DSLSCK transformers maintain the quality of the signal over a maximum transmission distance. These transformers enable Sckipio’s SCK1002 AFE and SCK1001 DFE chipsets to deliver high speed broadband access for G.FAST modems, present in consumer residences or CPE, Central Office (CO), distribution point units, and supporting data speeds up to 1Gb/s on phone lines or coax lines.

www.we-online.com

Programmable Bi-Directional Regenerative Supply Packs

Elektro-Automatik announces the EA-PSB 10000 30KW Programmable Bi-directional Power Supply. The 4U rack-mounted PSB 10000, engineered with advanced SiC power conversion devices switching at 150 kHz, boasts the industry’s best power density—requiring as little as half the rack space for the same power output as competing programmable supplies. The PSB 10000 combines an auto-ranging programmable power source and programmable load providing a single chassis solution for simulating source and load for wide range of applications including battery chargers and batteries, electric vehicle power trains, solar inverters and other power conversion devices and systems. The energy utilized in the test is then returned to the ac source via the programmable load’s regenerative output. The result is up to 95% reduction in the energy consumed in the test.

“The high-power density, parallel operational capability and regenerative load feature of the EA-PSB 10000 provide an exceptional solution to large-scale systems testing in automotive, solar and large-scale power supply burn-in applications,” says Eric Turner, EA Elektro-Automatik USA’s Sales & Marketing Manager. “A recent case study involving a production-level power supply burn-in facility operating 24 12.5 KW racks and the potential for over one million BTUs of heat per hour, was able to achieve a 94% reduction in heat generation and saved almost $200,000 per year in energy costs, by utilizing EA’s regenerative load technology.”

www.elektroautomatik.us

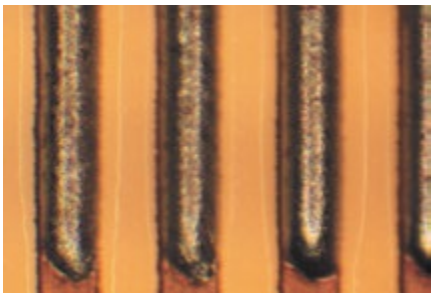
Guide to Power Supplies for Test & Measurement Applications

SL Power Electronics has developed an extensive power supply guide centered around test & measurement applications. Functionality and durability of test equipment, whether used for validating electronic circuits, testing electronic equipment, analyzing chemical substances, monitoring environmental conditions, or testing discrete components, is becoming more and more critical as technologies advance. The challenges facing test equipment designers are increasingly complex and frequently changing. Dealing with these challenges should be the main part of your effort. Integrating a power supply into the design should not.

www.slpower.com

Solder Paste Enables Further Reliable Miniaturization

For the production of miniaturized electrical systems, such as those used in the automotive industry, solder material must meet extremely high requirements. In response, Heraeus Electronics has developed its solder paste Microbond SMT650, which guarantees consistently high surface resistance. The combination of the F650 flux system with the Innolot metal alloy increases reliability and prevents electrochemical migration even under the most extreme environmental conditions.
With its material composition, Microbond SMT650 offers a consistently high surface resistance that prevents the risks of electrochemical migration. The chemical



composition of the flux is decisive here. "With the F650 flux system, we have found a very good balance between wetting under nitrogen reflow, excellent pressure properties, and surface resistance," explains Manu Noé Vaidya, Product Manager at Heraeus Electronics. In addition, it is compatible with many protective lacquers for electronics and printed circuit boards. The specially developed F650 flux system can be combined with a variety of alloys - and in the future with numerous solder materials. The patented Innolot alloy is intended for applications with high requirements, such as in the automotive sector.
Innolot contains various metals that increase the service life of the entire electronic assembly through their high thermomechanical stability. In other words, this means longer use at higher temperatures.

www.heraeus.com

Water-Soluble, Halogen-Free Flux

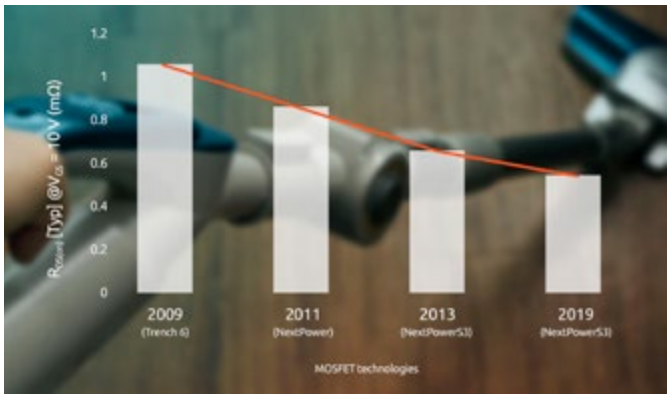
Indium Corporation has released TACFlux® 066HF, a water-soluble halogen-free (ORH0) hand soldering and rework flux. TACFlux® 066HF is compatible with typical Sn/Pb and Pb-free alloys for PCB assembly applications. It joins Indium Corporation's versatile offering of specialty fluxes designed to provide solutions for current and evolving industry challenges. Benefits include:

- Halogen-free per IEC 61249-2-21 test method EN14582
- Outstanding wetting performance in air or nitrogen atmospheres
- Shelf life of up to 6 months

www.indium.com

MOSFETs in Trench 11 Technology

Nexperia announced its lowest-ever RDS(on) NextPower S3 MOSFETs in Trench 11 technology that have been achieved without compromising other important parameters such as drain current (ID(max)), Safe Operating Area (SOA) or gate charge QG. Very low RDS(on) is required by many applications such as ORing, hot-swap operation, synchronous rectification, motor control and battery protection, to reduce I²R losses and increase efficiency. However, some competing devices with similar RDS(on) values suffer from reduced SOA - a measure of the ruggedness of the MOSFET – and reduced ID(max) ratings due to shrinking cell-pitches. With a maximum RDS(on) of 0.67 mΩ, Nexperia's PSMNR58-30YLH MOSFET improves the maximum drain current rating up to 380 amps. This parameter is especially important in motor control applications where motor-stall can result in very high current surges for short periods, which the MOSFET must withstand for safe and reliable operation. Some competitors provide only computed ID(max) whereas Nexperia demonstrates continuous current capability up to 380 amps, and 100% final production test at up to 190 amps.



Devices are offered in LFPAK56 (Power-SO8) and LFPAK33 (Power33), both offering unique copper-clip construction which absorbs thermal stresses, increasing quality & reliability. The PSMNR58-30YLH is housed in LFPAK56, Nexperia's 4-pin Power-SO8 with a footprint of 30 mm2 and a pitch of just 1.27 mm.

www.nexperia.com

Speedier Switching with Tandem Solution

A family of high-speed power modules is now available to boost efficiency and strike the best balance between costs and benefits. Launched by Vincotech, the flowPACK 1 1200 V sixpack features tandem diode technology and a high-speed IGBT. This product line extends the company's portfolio of power modules for motion control applications requiring higher switching frequencies and lower power loss. This family of high-speed 1200 V sixpacks with tandem diodes is comprised of several IGBT modules to cover currents ranging up to 75 A at room temperature. Its unique feature set ups current control capability and efficiency to slash overall system costs. All products ship in a flow 1 package with Press-fit pins. Every package shares the same pin-out and footprint, so drive manufacturers can easily re-use the same PCB design for various power applications.

www.vincotech.com

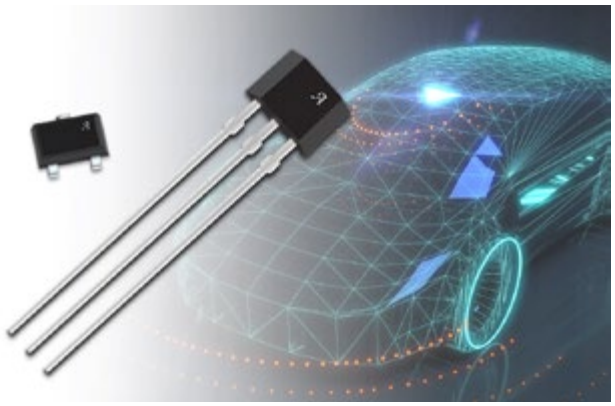
Photodiodes and Phototransistors

Würth Elektronik eiSos is expanding its optoelectronics portfolio: Following infrared LEDs, the company now also has a wide range of detectors in its program that are perfectly matched to the LEDs. Developers of various infrared applications can be sure that the spectra of emitters and detectors match. All infrared components are available from stock any time, and free samples can be requested. Infrared light (IR), invisible to the human eye, offers a huge number of possible applications - especially through the use of extremely compact components. In addition to classic light barrier installations, remote controls and smoke detectors, infrared can be used in many applications for data transmission. Infrared even goes under the skin: An individual's pulse can be monitored and blood pressure measured using fitness track watches. Another usage would be security systems, such as eye, face and gesture recognition, which can also work with IR products. Since the spectra and wavelengths of Würth Elektronik IR LEDs and photodetectors match perfectly, the modules are ideally suited for data transmission. Identical design of IR LEDs and photodetectors facilitate PCB design. The photodetectors are available in numerous designs with or without daylight filter. All products are equipped with a gold wire for excellent contacting.

www.we-onlin.com

Hall-Effect Switch and Latch ICs

Allegro MicroSystems has announced the release of the APS11450 and APS12450, adding two Hall-effect sensor ICs to its growing portfolio of solutions for systems that require functional safety. The APS11450 is a family of unipolar switch ICs, while the APS12450 devices are bipolar latches. They are pin-compatible upgrades for existing three-wire Hall switch and latch ICs developed in accordance with ISO 26262:2011 with ASIL-B capability (pending assessment). These magnetic sensors have integrated self-test features that are always active in the background while the system is running, leading to very short fault detection times. This action is automatic, and the tests are executed so quickly (25µs, typical) as to be transparent to host system—even in the case of latches used in high-speed motors and encoders. The unique voltage-mode output communicates the sensor's status (including the safe state), while remaining backward compatible with logic-level interfaces, application circuits, wiring, and firmware. "Our challenge was to achieve the safety level required by present and future ADAS systems while being backward-compatible with our installed base of billions of Hall switches and latches," explains Jim Judkins, Product Line Director for Allegro's Digital Position Sensor ICs. "The result is the fastest diagnostics available for magnetic switches and latches and a logic-compatible output that can communicate the sensor status and support wiring open/short detection."



www.allegromicro.com

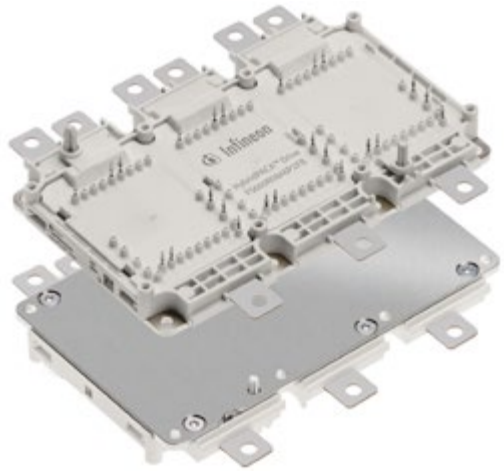
Cost Optimized, High Efficiency DC/DC Converters

TRACO POWER has announced the release of their THL 15WI family of 15 watt DC/DC converters that are designed for industrial, mobile, instrumentation, and communication markets or any application where size, cost and quality are critical factors. The THL 15WI series 15 Watt DC/DC converters deliver a combination of both reduced cost and high performance in an encapsulated 1 x 1 x 0.4" metal case with an integrated EN 55032 class A filter. The family consists of 14 models offering 9-36 or 18-75Vin range and single / dual outputs ranging from 5-24Vout with efficiencies up to 91%. All models feature: Full-Load operating temperature range of -40°C to +70°C (+90°C max temperature); 1500 VDC I/O isolation; Remote On/Off; VTrim (±10%); precisely regulated outputs; and Over Current / Short Circuit / Over Voltage protection circuits. These features combined with UL 62368-1 safety qualification and an integral Class A filter make these ideal for use in a wide variety of applications. High reliability > 1.3 million hours MTBF per (MIL-HDBK-217F at +25°C, ground benign) is further supported by TRACO POWER's extended 3 year product warranty.

www.tracopower.us

Power Modules Enable Electrification of Vehicles

In order to support the automotive industry in building up a broad and cost competitive portfolio of hybrid and electric vehicles (xEV), Infineon Technologies is launching power modules for xEV main inverters. At this year's PCIM trade fair Infineon presented four HybridPACK™



Drive modules optimized for different inverter performance levels between 100 kW and 200 kW. Furthermore, Infineon introduced the HybridPACK Double Sided Cooling (DSC) S2, a technology upgrade to the existing HybridPACK DSC. This module targets main inverters up to 80 kW in hybrid and plug-in hybrid electric vehicles with high power density requirements. All derivatives of the HybridPACK Drive have the same footprint as the already established lead device (FS820R08A6P2x) in the product family. This will allow system developers to scale inverter performance quickly and without a major system redesign. At the lower-performance end of the product family, the HybridPACK Drive Flat (FS660R08A6P2Fx) and Wave (FS770R08A6P2x) are cost-optimized for 100 kW up to 150 kW inverters respectively. Their baseplates – which connect to the cooler of the inverter – have different structures and thus lead to different capabilities of thermal dissipation. Instead of the estalished PinFin baseplate, which offers the highest cooling performance, the Flat version uses a flat baseplate without any structure at all.

www.infineon.com

DC/DC Converters Simplify Design-in

Available now at Dengrove Electronic Components, RECOM RP40Q-RUW and RP60Q-RUW DC/DC converters are railway certified and serve a wide range of rolling-stock applications and high-voltage battery-powered systems with their ultra-wide 14V-160V DC input-voltage range. The single-output 40W and 60W quarter-brick converters accept all commonly used supply voltages, from nominal 24V DC to 110V DC. They feature basic isolation and a choice of regulated 5V, 12V, 15V, 24V, or 48V DC output, with Sense and Trim pins for adjusting the voltage by up to ±10%. Offering high efficiency across the full input-voltage range, these converters make battery energy go further while minimising thermal challenges. They can operate at full load without forced air cooling or derating, from -40°C to 85°C (RP40Q-RUW) or 68°C (RP60Q-RUW). An optional heatsink is available, which extends the maximum temperature to 90°C and 77°C respectively.

Also featured for safety and reliability, the enclosures have threaded inserts for secure mounting to withstand high shock and vibration. The converters are certified to EN 50155 and the EN 45545-2 railway-equipment fire-safety standard, in addition to EN 55032 and EN 55024 EMC and electromagnetic-immunity standards. EN 60950-1, and the incoming EN 62368-1 hazard-based safety standard.

www.dengrove.com

Open Frame Non-Isolated DC-DC Converter

MORNSUN launched an ultra-thin open frame non-isolated DC-DC converter K78-JT-500R3. The dimension of K78-JT-500R3 series is 12.50 x 13.50 x 3.50mm, which is 4.75mm lower in height than that of K78-T-500R3 series. Besides, the K78-JT-500R3 series features SMD package, and provides an ultra-wide input voltage range of 4.75 - 36V. This series also eliminates the need for a heat sink and its operating temperature is from -40 to +85°C. What's more, this series delivers efficiency up to 95%, features low stand-by power consumption and short-circuit protection, which can be widely used for applications in industrial control, electricity, instrumentation industries, etc.

www.mornsun-power.com

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Overvoltage Protection Line

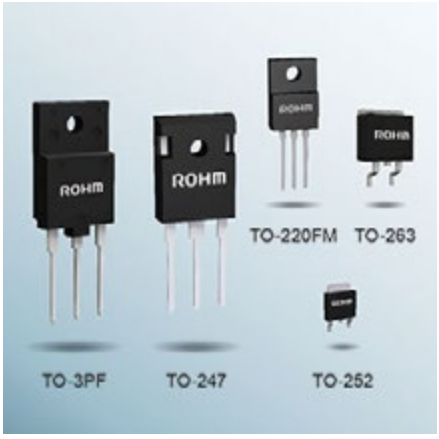
Bourns, Inc. introduced the company's GMOV™ line of overvoltage protection components. Bourns' innovative hybrid design combines its patented, space-saving Gas Discharge Tube (GDT) with FLAT® technology with a Metal Oxide Varistor (MOV) to create a compact and enhanced overvoltage protector that is a drop-in replacement for standard 14 and 20 mm MOVs. Bourns designed its MOV™ family to be an enhanced protection solution that helps overcome degradation and catastrophic failure issues that can occur in discrete MOVs that are subjected to transient surges or temporary overvoltage exceeding their maximum rated values. The GDT is used to isolate the MOV from the line voltage so it remains «on call but not on duty» thereby shielding it from transients and temporary overvoltage spikes that typically damage the MOV over time. Another significant benefit of combining the two technologies is that the GMOV™ device offers ultra-low leakage (<0.1 µA) helping to reduce damage due to watt loss heating. The result is a higher reliability protection solution with virtually zero standby energy consumption.

Overvoltage protection remains a consistent requirement to guard against unstable electrical service swells, switching and lightning voltage transients. MOVs are popular overvoltage protection devices, but they are susceptible to degradation and failure issues in certain harsh and uncontrolled environment applications.

www.bourns.com

Series of 600V Super Junction

ROHM recently announced a lineup of its PrestoMOS™ series, R60xxJNx series, of 600V super junction MOSFETs that includes 30 new models. This series increases design flexibility while maintaining the industry's fastest reverse recovery time (trr) optimized for EV charging stations and motor drive in home appliances such as refrigerators and Air Conditioners (ACs). Recent trends towards improving energy savings has driven the demand in a variety of applications for MOSFETs with reduced power consumption during steady state operation. To meet this need, ROHM launched the PrestoMOS™ series of power MOSFETs in 2012. This series features the industry's fastest reverse recovery characteristics, achieving lower power consumption. As with our conventional products, this new series leverages our proprietary lifetime control technology to achieve ultra-fast trr. This enables a reduction in power loss of about 58% at light loads when compared with IGBT implementations. Additionally, raising the reference voltage needed to turn ON the MOSFET prevents self turn-ON, which is one of the main causes of loss. Furthermore, optimizing the characteristics of the built-in diode allowed us to improve the soft recovery index specific to super junction MOSFETs, which reduces noise that can lead to malfunctions. Eliminating these barriers to circuit optimization provides customers with greater design flexibility.



www.rohm.com

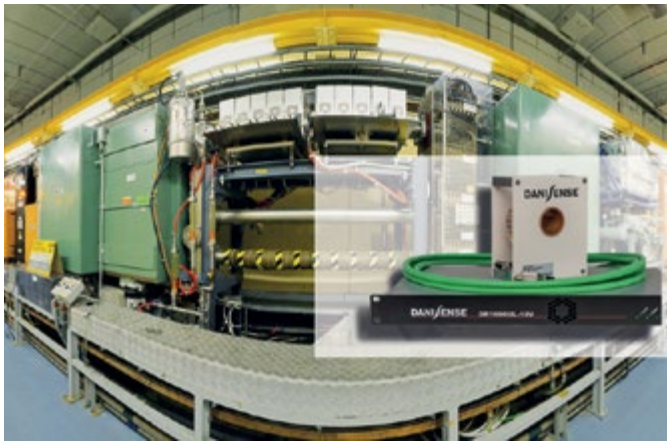
Switcher ICs with Integrated 900 V MOSFETs

Power Integrations announced the release of a suite of offline switcher ICs incorporating 900 V primary MOSFETs. The devices include ICs for high-efficiency isolated flyback power supplies and for simple non-isolated buck converters. Applications include three-phase industrial power supplies up to 480 VAC, and high-quality consumer products destined for regions with unstable mains grids, tropical regions with frequent lightning strikes or any area where high-energy ring-waves and surges are prevalent. The products include 900 V versions of the LinkSwitch™-TN2 ICs for simple, non-isolated buck converters plus three new members of the flagship InnoSwitch™3-EP IC family, which enable extremely high-efficiency isolated flybacks up to 35 W. All members of the 900 V product families feature internal control engines optimized for high efficiency across load, enabling designs to easily meet energy-related products (ErP) limits, and a variety of line and load protection mechanisms to further enhance system robustness and reliability. The 900 V LinkSwitch-TN2 ICs deliver the lowest-component-count switcher solutions for buck converters. Devices feature selectable current limit and fully integrated auto-restart for short-circuit and open-loop protection. The use of frequency jittering greatly reduces EMI, and devices easily meet high-voltage creepage and clearance requirements between DRAIN and all other pins both on the PCB and at the package.

www.power.com

Current Transducers Used at CERN

Danisense has announced that its current transducers have been used by teams at CERN as part of a significant upgrade program. The Danisense zero-flux DC current transducers (DCCT) are used in the design of QTRIM power supplies for the PS booster accelerator which are part of a chain of accelerators that inject the beam into the LHC (Large Hadron Collider) at the European Laboratory for Particle Physics. The upgrade, explains Miguel Cerqueira Bastos, team leader for the section at CERN which manages high precision current measurement for power supplies, will “increase the beam energy in the PS booster accelerator from 1.4GeV to 2GeV”. Stability and linearity in the order of 10ppm as well as noise performance of under 10ppm pk-pk for a 10kHz bandwidth were required for currents of 1000A - the quality of the beam is strongly dependent on the quality of the current measurement provided by Danisense. Other demanding specifications required by the CERN team included very high immunity to magnetic fields in the order of a few mT - which can be present in some locations - and tight noise controls on the outputs of better than 30ppm pk-pk with a 1MHz bandwidth.



www.danisense.com

Current Transducers with Closed-Loop Hall Effect Technology

LEM announces the LZSR family of transducers, a range that can be mounted on printed circuit boards (PCBs) for non-intrusive, isolated measurements of DC, AC and pulsed currents from 100A to 200A nominal. The family consists of three new models: LZSR 100-P, LZSR 150-P and LZSR 200-P.

These transducers are based on LEM’s latest leading-edge ASIC technology, which has been proven in the past launched LF xx10, LH, LxSR current transducer series. Used in a closed loop mode, the ASIC based on Hall effect technology can reach a low offset drift up to 3 ppm/K of VREF. This new family takes advantage of these benefits at currents such as 100, 150 and 200A nominal. Working over a temperature range from -40°C to +85°C, LZSR offset drift is much better than the previous generation of Closed-loop Hall effect current transducers working with traditional Hall effect chip (up to 7 times better). Operating from a single supply voltage of + 5V, the LZSR models measure peak current up to 3 times the primary nominal current reaching 450 A pk with the 150 ARMS nominal model (LZSR 150-P/SP1). They provide their internal reference voltage to a VREF pin.

www.lem.com

Low Loss 20A to 40A DIN Rail Mount Redundancy Module

TDK Corporation announces the introduction of the DRM40 series DIN rail mount redundancy modules. The two 20A 10V to 30Vdc rated inputs can be connected to provide a 20A redundant configuration, or using the load balancing option, to deliver a 40A output. For capacitive and inductive loads, the DRM40 will support an additional 50% peak load for four seconds. The use of low-loss MOSFET reverse current protection devices reduces the internal voltage drop to just 200mV. Applications include industrial process control, factory automation, battery chargers, and test and measurement equipment. If the input currents are unbalanced, the DRM40 front panel mounted LED is off. When the input voltages are adjusted and the load current is shared equally, the LED is illuminated. In addition, the DRM40 has two isolated DC Good PhotoMOS relays to indicate that each input voltage is between the limits of 10V and 30V. Two front panel mount DC Good LEDs provide visual indication. For cost sensitive applications the DRM40B has identical electrical performance without the current balance and DC Good functions. The DRM40 series is housed in a compact rugged metal enclosure, with overall dimensions of 35mm x 124mm x 125mm (W x H x D) and is suitable for mounting on TS-35/7.5 and TS-35/15 DIN rails.

www.us.tdk-lambda.com

High-Density DC/DC Converters

TT Electronics has introduced the HA74 series of surface-mount power inductors, which combine a low profile, small footprint, and 3MHz switching capability for efficient, space-saving DC/DC converters. AEC-Q200 certified and specified for operation from -55°C to +155°C, the HA74 series is ideal for automotive use cases including the latest generation of high-density converters and pi filters for ADAS (Advanced Driver Assistance System) controllers. The shielded inductors ensure low EMI and are highly resistant to corrosion. The maximum height of just 2.05mm allows designers to create ultra-slimline modules for applications where height is a critical parameter. Leveraging the compact 5.5mm x 5.5mm footprint, with current ratings up to 2.9A and DC resistance down to 74mΩ, the HA74 series enables high power density and energy efficiency. With 3MHz switching capability, allowing use in high-frequency converter designs, these compact inductors are the ideal companion to the small high-frequency filter capacitors and help minimise module size and weight. TT's advanced low-loss metal-alloy core composition ensures high efficiency and low heating at elevated frequencies.

The complete HA74 family comprises 10 parts covering standard inductance values from 4.7µH to 33µH and current ratings from 1.2A to 2.9A. Semi-custom inductors conforming to individual customer specifications are also available, to special order.

www.ttelectronics.com

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CIPOS™ Tiny

Newest generation of IPM to offer the highest power density for variable speed motor drives

The energy efficient CIPOS™ Tiny module integrates best-in-class power and control components to increase reliability, optimize PCB size, and lower system cost. This improves the power circuitry and reduces product time-to-market.

By using our latest generation of IGBTs, it is possible to realize maximum efficiency with minimum footprint. In addition, system mechanical design flexibility is also considered by offering both CIPOS™ Tiny SIP and DIP form factors. Ideal applications for the IPM include high efficiency washing machine, industrial fans, compressors, and general purpose drives ranging from 6 A to 20 A current requirements.

Features

- Smallest IPM with current rating up to 20 A
- Offered in both DIP and SIP package
- Integrated bootstrap function
- Single 3-phase driver IC for best protection
- Integrated package standoff
- Rated max T_{case} of 125 °C
- Ideal for 250 W to >1.5 kW applications.

Benefits

- Enables cost and size reduction for home appliance motor drives
- SIP option allows PCB size reduction and alternative heatsink mounting
- Package and temp sensor certified by UL
- MADK demo boards available to reduce design and evaluation cycle time

www.infineon.com/cipos-tiny