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Bodo´s Power Systems®

Electronics in Motion and Conversion

January 2017

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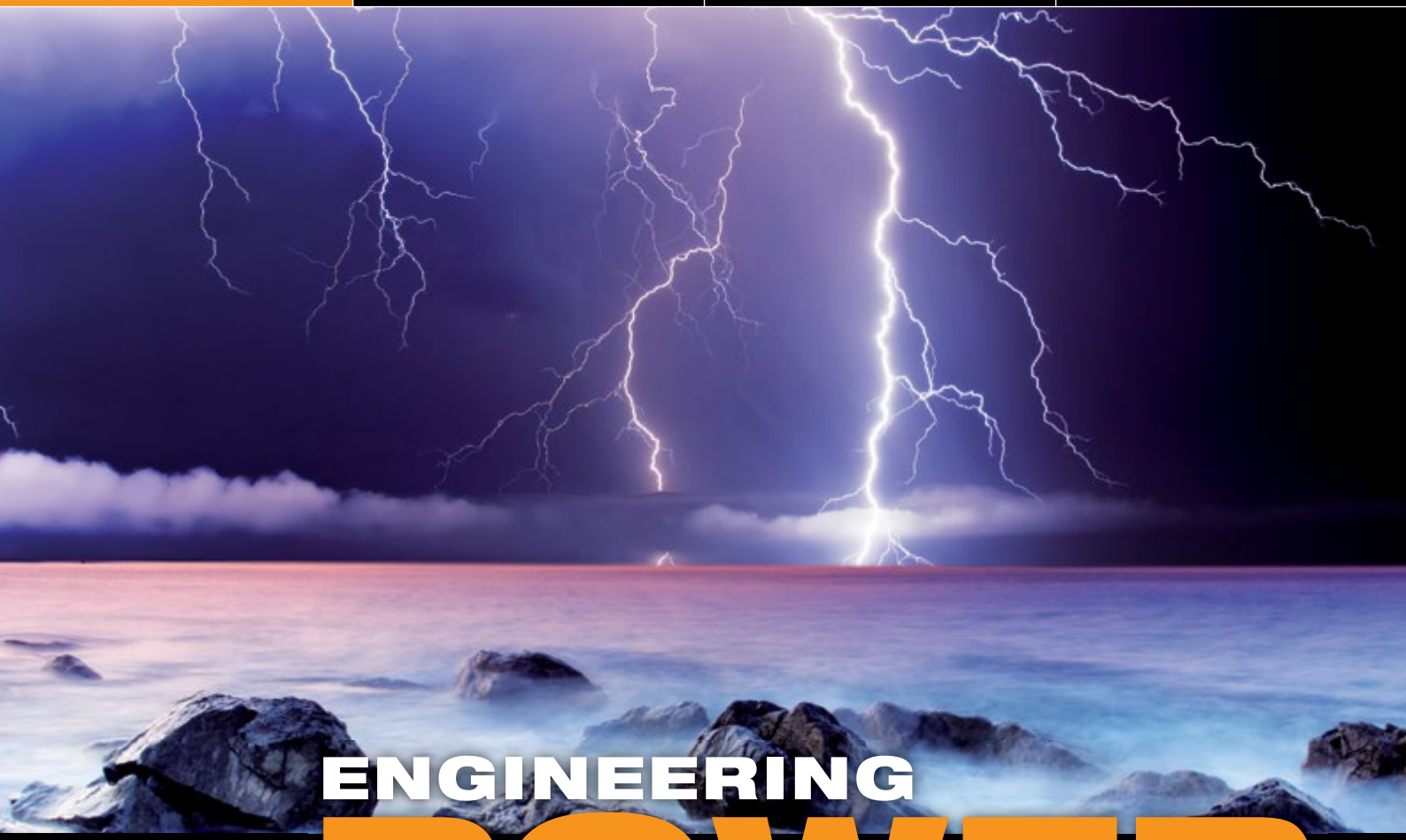

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Electronics in Motion and Conversion
March 2016

The Gallery

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embedded world Hall 3 Booth 359

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Happy New Year,

Our year ended with many conflicts in the world. Wouldn't it be great if people lived in peace with each other, and if our leaders were able to find solutions to stop wars and help people recover their lives. As engineers, we need to push for peace - it is for our children and their future. Nature provides enough challenges in our world. We humans must live with respect for others. So in 2017, we hope that we can look forward to more peace and human dignity. And that we all work together for this.

Engineers have the tools and materials to develop a more efficient world. The demand for energy should transfer to the green sources; wind, solar and water power. The right way is to save fossil resources for other purposes. Wide band semiconductors have passed a mile stone on the way to more efficiency. More and more, WBG devices are in all kinds of designs for future applications. Reduced size and losses make them to a preferred choice for new designs.

I look forward to seeing you next year in March at the APEC in Tampa. Meanwhile – keep warm! Bodo's Power Systems reaches readers across the globe. If you are using any kind of tablet or smart phone, you

will now find all of our content on the new website www.eepower.com. If you speak the language, or just want to have a look, don't miss our Chinese version: www.bodospowerchina.com

My Green Power Tip for January:
Plan the building of a house with the most efficient standards to save resources for the future.
It will benefit future generations and will save money immediately.

Best Regards

Events

Smartsystemsintegration,
Corck Ireland, March 8-9
http://www.smartsystemsintegration.com

Embedded World 2017,
Nuremberg, Germany, March 14-16
http://www.embedded-world.de

EMC 2017,
Stuttgart, Germany, March 28-30
http://www.mesago.de/en/EMV/home.htm

APEC 2017,
Tampa FL , March 26-30
http://www.apec-conf.org/

International Power Workshop on Packaging, Delft, The Netherlands, April 5-7
http://iwipp.org/

ExpoElectronica 2017,
Moscow Russia, April 25-27,
http://expoelectronica.primexpo.ru/en/

SMT Hybrid 2017,
Nuremberg, Germany, May 16-18
http://www.mesago.de/en/SMT/home.htm

PCIM Europe 2017,
Nuremberg, Germany, May 16-18
http://www.mesago.de/en/PCIM/home.htm

Sensor + Test 2017,
Nuremberg, Germany, May 30 June1
http://www.sensor-test.com/press

Intersolar 2017,
Munich, Germany, May 31 June 2
www.intersolar.de/de/intersolar-europe.html

PCIM Asia 2017,
Shanghai, China, June 27-29
http://www.mesago.de/en/PCC/home.htm

SEMICON West 2017,
San Francisco, July 11-13
http://www.semiconwest.org/

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- Low offset and gain drifts
- Over-drivable reference voltage
- Through-hole and SMT packages

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LEM®

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The first workshop tour of Isabellenhütte's sales partner CODICO took place in September in Poland and the Czech Republic. CODICO was responsible for organising the events, which were geared in particular towards hardware developers, technicians and buyers from the automotive and industrial technology sectors. The objective was twofold: to share knowledge with customers and interested parties, and to provide information on product innovations and technologies from Isabellenhütte, which the sales specialist for electronic components CODICO has had on its line card for approximately two years now.

The workshops were divided into seminar modules. The introduction of the company Isabellenhütte was followed by the most interesting part for participants: basics of current sensing. This brought all participants up to speed before the discussion delved into the key areas of measurement technology and shunt resistors. The seminar also looked at the two patented manufacturing methods ISA-PLAN® and ISA-WELD®, their complex set-up and specific areas of application. ISA-PLAN® technology is designed for the manufacture of precision resistance elements from foils of MANGANIN® and ZERANIN® alloy using etching technology. With the ISA-WELD® method, these elements are produced from massive, electron-beam-welded composite material, from copper and from the resistor alloys MANGANIN®, ZERANIN®, ISAOHM® and Aluchrom. Both methods offer very different advantages and features. The ISA-PLAN® method's planar structures permit low-inductance design forms and very low thermal internal resistances. Optimised current density distribution is characteristic of this method, which subsequently avoids the danger of hot spots.

www.isabellenhuette.de

Yokogawa Announces Acquisition of Soteica Visual Mesa

Yokogawa Electric Corporation announces has completed the acquisition of Soteica Visual Mesa (SVM), a leading energy management technology provider, further delivering on a number of key objectives of Yokogawa's Transformation 2017 mid-term business plan: specifically the expansion of Yokogawa's advanced solution business, focusing on customers and creating new value.

This announcement marks the completion of the SVM acquisition as a wholly-owned subsidiary of Yokogawa and the initiation of the integration of SVM and the cloud-based "Data as a Service" (DaaS) provider Industrial Knowledge (IK) into KBC Advanced Technologies (KBC), which was acquired by Yokogawa in April 2016. The IK business unit was established to enhance the cloud-based advanced solution business based on the technology of Industrial Evolution (IE), which was acquired by Yokogawa in December 2015. A pioneer in the use of cloud-based solutions in the process industries, IE developed a market-leading real-time DaaS solution that is deployed at many of the world's major energy and chemical companies.

Yokogawa's acquisition of SVM follows an earlier minority equity investment in SVM made in December 2012. SVM has a solid track record in the energy management solutions (EMS) field, and provides production accounting and scheduling solutions to the refining industry.

www.yokogawa.com

Strategic Collaboration to Accelerate Power Electronics Design

Semikron announced a technology collaboration with National Instruments (NI), a leading provider of deployable Field Programmable Gate Array (FPGA) based embedded control platforms. The strategic collaboration is intended to help lower the cost and risks of developing power conversion products such as renewable energy inverters, energy storage systems and specialized variable frequency drives at power levels over 50 kilowatts.

"We are very happy to announce this collaboration to help enable our shared customers to speed up their time to market substantially", says Mr. Timo Gassauer, Marketing Manager at SEMIKRON. "The complexity of power electronic systems and control is increasing dramatically and we have observed how design teams greatly benefit from building on proven and deployable platforms." Mr. Gassauer explains: "We are working with NI to help improve the productivity of power electronic system designers by providing them with reference designs, pre-validated interfaces and pre-built software templates. This way, our customers can begin developing their application software right away!"

The collaboration brings together the reliable SEMIKUBE, SEMISTACK and SKiiPSTACK families with the proven, tried and tested NI General Purpose Inverter Controller (GPIC) deployment hardware and the LabVIEW FPGA Module from NI. SEMIKRON's power electronic stacks are assembled in five stack centers located on four different continents, providing global manufacturing capability with short lead-times.

Unlike traditional DSP-based control systems, the NI GPIC powered by Xilinx Zynq-7020 with embedded FPGA contains hundreds of embedded DSP cores, that deliver up to 70 times higher performance per dollar. LabVIEW FPGA enables control design engineers to implement the most advanced control capabilities using intuitive and familiar graphical programming. The NI tool chain includes an extensive library of power electronics floating point control algorithms for many different converter topologies from 50 kW to 5 MW.

www.ni.com/power/electronics

www.semikron.com

Challenge Winners Present Real-World Engineering Concepts at electronica Trade Fair

Engineering students from across Europe took centre stage at the electronica trade fair in Munich on 10th November, as winners of the Texas Instruments (TI) Innovation Challenge European Design Contest presented their concepts on how TI technology can be applied to solve challenges faced by our world today.

Doug Phillips, Texas Instruments Worldwide University Program Director said: “The reason the TI university program exists and why we hold design contests is to give students the tools and resources needed to nurture innovation: from idea to invention and possibly even to industry. Judging the TI Innovation Challenge Design Contest filled us with excitement about the future of engineering as students think about how to solve problems from automotive to industrial, from environmental to energy.”

More than 600 students from more than 30 European countries participated in the design competition, with winners chosen from three different categories: automotive, industrial, and innovation. Winning projects were selected for their use of engineering practices and were judged on industry-ready standards, such as quality of the design,written documentation and effective use of TI technology.

First prize in the automotive category went to the University of Bologna (Italy), where students used a range of TI technologies including two MSP432™ microcontrollers (MCUs) to create a connected motorcycle helmet that alerts motorcyclists to potentially dangerous situations on the road. Students from the University of Trento (Italy) won the industrial category with their design for a long-range monitoring system powered by plant microbial fuel cell, and using TI’s HDC1080 digital humidity sensor. Finally, in the innovation category, the winning design came from future engineers at Brno University of Technology (Czech Republic). The judges were impressed with their concept for a wireless system using TI technology including the Sub-1 GHz CC1101 low-cost sub-1 GHz RF transceiver, to deliver very accurate (<1ms) low latency time measurements in sports.

http://www.ti.com/ww/eu/TIIC2016/

High Performance Power Design in Half the Time

Learn how to cut design time, reduce risk, and simplify the design of your power system using the Power Component Design Methodology.

Paul Yeaman, Director, Applications Engineering talks about:

- Traditional approaches to power systems design
- The benefits of treating power distribution as one system
- Use of the Power Component Design Methodology
- Online tools to help reduce design cycle time

http://www.vicorpower.com/powerbench/webinar-rebroadcasts/pwrsys

This Webinar is ideal for all engineers involved with power systems design, and will address the design of the complete power chain from the power source (front end) to the point of load. The Power Component Design Methodology offers significant advantages for experienced power system designers and to engineers for whom power system design is only a part of their role.

www.vicorpower.com

Expanding UK Presence, Partners with Solution in Silicon

DELTA Microelectronics, the European leader in ASIC supply chain services, announced that it has partnered with Solution in Silicon to augment UK sales and customer support.

Solution in Silicon has a rich experience offering ASIC sales and support services to companies in a wide range of industries including consumer products, medical equipment, communications, IoT and security. The new partnership will provide UK customers access to DELTA’s extensive supply chain services including wafer procurement and probing, packaging, component testing, storage and IC distribution. DELTA operates the largest microelectronics testing facilities in Europe, which ensure the highest quality control measures and a low-risk path to production.

based in Denmark and the UK, with service partners in Europe and Asia. For more information, visit www.asic.madebydelta.com

http://www.solutioninsilicon.com

Arrow Europe Signs Distribution Agreement with EOS Power

At the Electronica 2016 Arrow Europe and the german-indian power supply experts of EOS Power announced to have just signed a distribution agreement for the EMEA region. Holger Schierenbeck, Key Account/EMEA Sales Teams Coordinator PEMCO Power Supplies of

Arrow Central Europe GmbH and Ralph Bischoff, CEO of EOS Power Pvt. Ltd based at Mumbai, agree on the powersupplies of the EOS Power as good supplement to Arrow's portfolio of compact and highly efficient AC/DC converters. Especially the EOS medical and industrial open frame supplies of the (M)WLP series and the brand-new (M)ULP series first presented last week at the Electronica 2016, are marking significant technological breakthroughs due to their power densities and market leading specifications. EOS converters are already distributed by the U.S. branch of Arrow Electronics for several years.

EOS Power is a privately owned German company located in Mumbai, India, providing Power Conversion Solutions, Manufacturing and Value Added Services to its Distribution and OEM customers globally. EOS Power employs 500 direct and indirect employees worldwide with principal offices in Mumbai, India and sales and support offices on each continent.

www.arrow.com

www.eos-power.com

Compact, High Frequency DC/DC Converter for Aviation

The efficiency of power electronic systems is not solely dependent on electrical efficiency but also on weight, for example, in mobile systems. When the weight of relevant components and devices in airplanes, for instance, is reduced, fuel savings can be achieved and correspondingly greenhouse gas emissions decreased. New materials and components based on gallium nitride (GaN) can help to reduce weight and increase the efficiency. With these new materials, power electronic switches can be operated at higher switching frequency, resulting in higher power density and lower material costs. Researchers at the Fraunhofer Institute for Solar Energy Systems ISE together with partners have investigated how these materials can be used to make power electronic systems in aviation applications more efficient.

In the project "GaN-resonat – Efficient, highly compact, high frequency power electronics with GaN transistors," the partners SUMIDA Components & Modules GmbH, Liebherr Elektronik GmbH and Fraunhofer ISE form a highly qualified consortium. The partners complement each other ideally in the fields of inductive components, aviation technology and power electronics. The concrete aim of the project was to develop a resonant DC/DC converter with GaN transistors, with switching frequencies significantly above 1 MHz and a nominal power of 3 kW. The converter was designed especially for applications in aviation, where compatibility between the economic and ecological challenges plays a major role.

www.ise.fraunhofer.de

8 Benefits of Giving a Lecture at the LpS 2017

Submit an Abstract for Europe's Leading Lighting Conference

The LED professional Symposium +Expo (LpS) is the leading annual European lighting conference focusing on technologies, innovations and applications. The LpS 2017 will emphasize "Smart Technologies for Lighting Innovations" and cover the latest trends in application

areas. Experts from academia and industry are invited to submit an abstract and present their newest research, developments, innovations and expectations for future trends to a highly qualified audience. Between the 26th and 28thof September 2017, expert speakers, attendees and exhibitors from more than 50 countries will exchange their technological know-how at the Festspielhaus in Bregenz, Austria.

Requirements and Website

The submitted papers must be original material and not have been previously presented or published and should cover latest technologies, innovations or market insights. The selected papers will be presented in English in a 25-minute time slot at the LpS 2017 conference.

You can submit your abstract at: www.LpS2017.com/call-for-papers.

Schedule

- Feb 3, 2017: Call for Papers Deadline
- April 3, 2017: Notification of Acceptance
- June 2, 2017: Submission of Full Paper
- Sept 11, 2017: Submission of Final Presentation
- Sept 26-28, 2017: Lecture at the LpS 2017 Event

www.lps2017.com

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PSIM v11.0 is Now More Powerful than Ever

Powersim is pleased to announce the release of PSIM v11.0, with the addition of extensive new features, including a new SPICE engine.
The SPICE engine will allow the PSIM simulation platform, optimized for topology verification and control design, to support the vast library of industry standard SPICE models for a more in-depth simulation. In addition, the PSIM/SPICE engine has the ability to support majority of PSIM library elements, including s-domain control blocks and PSIM users will have the ability to easily import their existing SPICE libraries or circuits and simulate them in the PSIM environment.
The PSIM/SPICE platform will provide the most complete and integrated simulation environment available today in terms of speed, workflow, and overall design path for switch mode power supplies, motor drives and other applications.
Key features of PSIM v11.0 include:

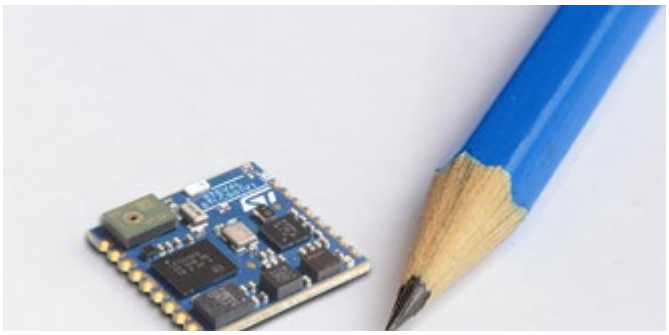
- Addition of new SPICE Engine Module.
- Ability to export netlist from PSIM schematic for LTspice simulation, for users who need to use LTspice models and run simulation in LTspice.
- Support of Texas Instruments' InstaSPIN motor control algorithm, both for simulation and automatic code generation, making the evaluation and use of InstaSPIN easier.
- New script function for plotting (including Bode plot) and controlling simulation runs, including optimization.
- Support of SimCoder automatic code generation with variable switching frequencies.
- Enhancement of C block functionalities for both simulation and hardware code generation

To learn more about the new PSIM v11.0 release and to request trial access, please visit us at

https://powersimtech.com/

Miniature Multi-Sensor Module Jumpstarts IoT and Wearable Designs

STMicroelectronics' 13.5mm x 13.5mm SensorTile is currently the smallest turnkey sensor board of its type, containing a MEMS accelerometer, gyroscope, magnetometer, pressure sensor, and a MEMS microphone. With the on-board low-power STM32L4 microcontroller, it can be used as a sensing and connectivity hub for developing products such as wearables, gaming accessories, and smart-home or Internet-of-Things (IoT) devices.
SensorTile has a complete Bluetooth® Low-Energy transceiver including a miniature single-chip balun on-board, as well as a broad set of system interfaces that support use as a sensor-fusion hub or as a platform for firmware development. It can be simply plugged to a host board, and when powered it immediately starts streaming inertial, audio, and environmental data to ST's BlueMS smartphone app that can be downloaded free of charge from popular app stores.
Software development is fast and easy thanks to a vast ecosystem of Application Program Interface (API) based on the STM32Cube Hardware Abstraction Layer and middleware components, including the STM32 Open Development Environment.
The complete kit includes a cradle board, which carries the 13.5mm x 13.5mm SensorTile core system in standalone or hub mode and can be used as a reference design.



The pack also contains a LiPo rechargeable battery and a plastic case that provides a convenient housing for the cradle, SensorTile, and battery combination.
Also part of the SensorTile kit is a cradle/expansion board with an analog audio output, a micro-USB connector, and an Arduino-like interface that can be plugged into any STM32 Nucleo board to expand developers' options for system and software development. A programming cable is also included.

www.st.com

Alpha Launches China WeChat Account

Alpha Assembly Solutions announced the launch of their official account on WeChat, a popular social media platform in China. The local platform will provide Mainland customers with easy access to relevant information on ALPHA® Products and technical knowledge, such as troubleshooting guides and best practices.
Followers of Alpha Assembly Solutions will receive the latest information on leading products, upcoming events, new product introductions, and relevant contacts in China. This platform will not only engage customers/followers in China, but will facilitate more interactions with them through this continuous mode of communication.
"With the current volume of smartphone users worldwide, using a smartphone for searching information is more convenient and likely than using a laptop at home or in the office. This new WeChat platform is designed not only to get the latest product information to our customers, but to also allow them to easily find the latest of Alpha's solutions for process, reliability and compliance anytime they need from their smartphones." said Sally Lee, Regional Marketing Communications Manager for Asia Pacific. "The app is very easy to use and is ideal for anyone who may need to frequently access ALPHA® product and technical information while on-the-go."
Alpha's WeChat account is only accessible by those in the China region and can be accessed by scanning the QR code below or searching for the account name "AlphaAssembly" from within the WeChat mobile application.
To learn more about Alpha's vast product offering and capabilities, please visit our website at www.AlphaAssembly.com

www.AlphaAssembly.cn

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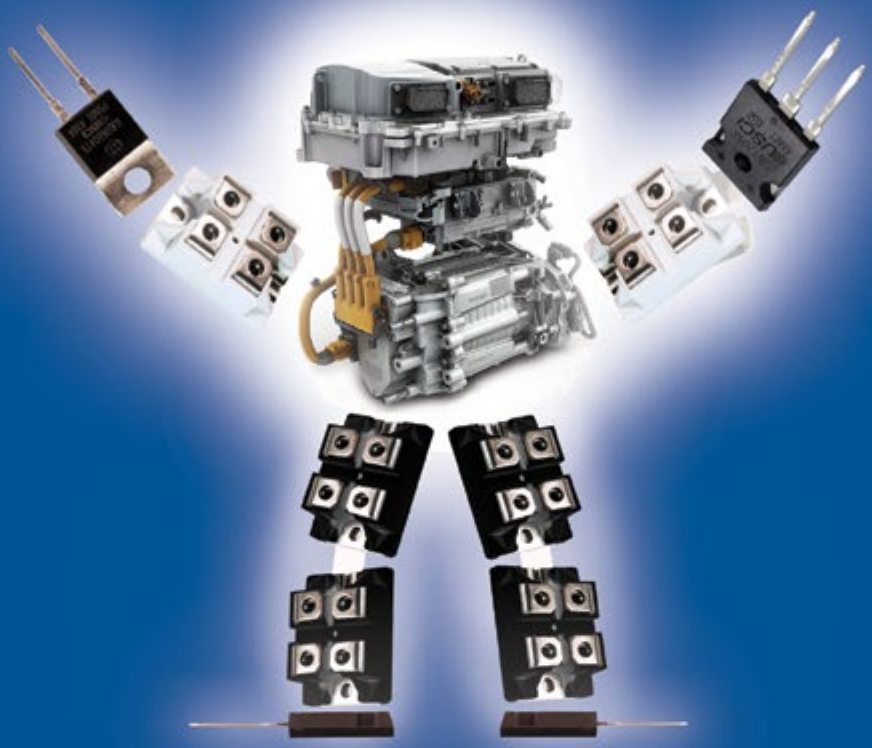
Code Name: ***UJ3D***



SiC Schottky diodes for
high-frequency & high-efficiency
power systems with minimum
cooling requirements.

650 V Schottky Diode	UJ3D065200Z	650 V/200A	Samples Available
1200 V Schottky Diode	UJ3D12100Z	1200 V/100A	Samples Available

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ECPE Tutorials and Workshops in the First Half of 2017

ECPE Tutorial 'Passives in Power Electronics: Magnetic Component Design and Simulation'
9 - 10 February 2017, Barcelona, Spain
Chairmen: Prof. G. Hurley (Net. Univ. of Ireland), Dr. A. Muesing (Gecko Sim.)

ECPE Tutorial 'Power Circuits for Clean Switching and Low Losses'
16 February 2017, Dusseldorf, Germany
Chairman: Dr. R. Bayerer (Infineon Technologies)

7th ECPE SiC and GaN User Forum
in conjunction with the ECPE Annual Event
8 - 9 March 2017, Nuremberg, Germany
Chairmen: Prof. A. Lindemann (Univ. of Magdeburg), Prof. L. Lorenz (ECPE), Dr. P. Friedrichs (Infineon)

ECPE Lab Course 'EMC Optimised Design (Parasitics in Power Electronics)'
3 - 4 April 2017, Berlin, Germany
Course Instructor: Prof. E. Hoene (Fraunhofer IZM)

ECPE Tutorial 'Power Semiconductor Devices & Technologies'
26 - 27 April 2017, Berlin, Germany (programme follows)
Chairman: Dr. A. Mauder (Infineon), Prof. D. Silber (Univ. of Bremen)

ECPE Tutorial 'Power Electronics Packaging'
21 - 22 June 2017, Wurzburg, Germany (programme follows)
Chairmen: Prof. U. Scheuermann (Semikron), Dr. J. Popvic-Gerber (TU Delft)

ECPE Tutorial 'Thermal Engineering of Power Electronic Systems - Part I (thermal design and verification)'
18 - 19 July 2017, Erlangen, Germany (programme follows)
Chairmen: Prof. U. Scheuermann (Semikron), D. Malipaard (Fraunhofer IISB)

Please forward this information also to interested colleagues inside and outside your organisation.
On the ECPE website www.ecpe.org you always find the up-to-date information on the ECPE Events.

www.ecpe.org

Awarding the Distributor of the Year

Future Electronics has been awarded EMEA Distributor of the Year by ROHM Semiconductor during electronica 2016 in Munich. The award recognises Future Electronics for its sales growth performance during ROHM Semiconductor's last Fiscal Year (April 2015 – Mar 2016) and its differentiated capabilities demonstrated to provide enhanced support to the channel throughout EMEA.

"The commitment Future Electronics made to focus on ROHM Semiconductor's flagship technology 'Silicon Carbide Solutions' as a leading supplier also makes us see Future Electronics as an integral part of the sales channel strategy in providing technical, sales, logistical and additional marketing services to the market", said Christian André, President ROHM Semiconductor Europe.
"We are excited to have achieved this success and to be recognised by ROHM Semiconductor GmbH for our dedicated customer support and Demand Creation activities. The award underlines our commitment to focussing on the latest products and technologies provided by Rohm with our customers" commented Jill Thomas, Supplier Development Director at Future Electronics.
"We strongly believe distribution plays a very important role to reach a broad range of customers and targeted market segments. Future Electronics has demonstrated its capability in identifying new customers and opportunities for ROHM Semiconductor, most importantly supporting customers with their technical and commercial requirements," added Oliver Edelmann, Director of Distribution at ROHM Semiconductor.

www.futureelectronics.com

www.de.rohmeurope.com

Appointing Division VP of Corporate Quality and Reliability

Exar Corporation named David Matteucci to the position of Division Vice President of Corporate Quality and Reliability. Mr. Matteucci will be central to managing Exar's Quality and Reliability function as well as supporting tier 1 engagements.

Mr. Matteucci has over 30 years of experience in the semiconductor industry, having held executive positions at Power Integrations, Nano Nexus Inc., Zoran Corporation, Galileo Technology, National Semiconductor, as well as previously at Exar Corporation, where he served as Vice President of Operations Engineering and Quality and Reliability.

"We are pleased to welcome Dave back to Exar to lead our corporate Quality and Reliability Group as we ramp and support tier 1 engagements. Dave's broad background within the industry makes him uniquely qualified to facilitate our growth strategies," said Dan Wark, Vice President of Worldwide Operations.

www.exar.com

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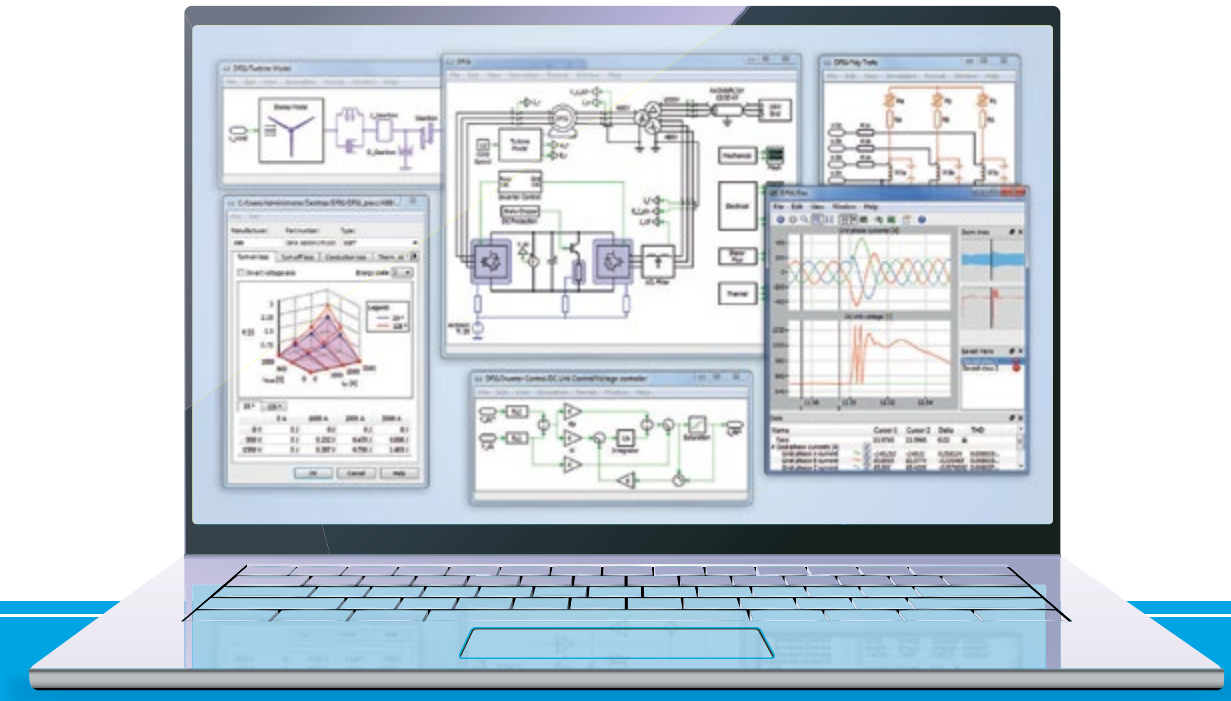

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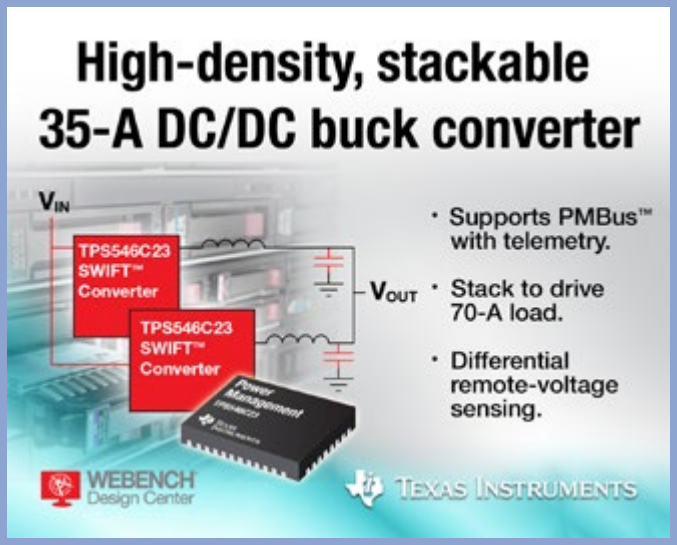
Stackable 18-V input, 35-A PMBus Converter Delivers Industry's Highest Density

Texas Instruments introduced the industry's highest-density, 18-V input, stackable 35-A synchronous DC/DC buck converter, which offers full differential remote-voltage sensing and PMBus to support telemetry. TI's TPS546C23 power converter integrates high- and low-side MOSFETs into a small-footprint package that is significantly denser than competitive devices. Designers can stack two converters in parallel to drive loads up to 70 A for processors in space-constrained and power-dense applications in various markets, including wired and wireless communications, enterprise and cloud computing, and data storage systems. For more information, samples and an evaluation module, see http://www.ti.com/tps546C23-pr-eu.



The highly integrated TPS546C23 power converter is 44-percent denser (amperes per square millimeter) than competitive devices. It features 0.5 percent reference-voltage accuracy over temperature and full differential remote-voltage sensing to meet the voltage accuracy requirements of deep sub-micron processors. Current sharing enables the stacking of two converters and high efficiency and excellent thermal performance are delivered via the device's single-pad, stacked die, quad flat no-lead (QFN) package. Read the blog post, "Stack current with PowerStack packages for higher POL."

TI also offers the TPS546C20A PMBus converter that supports pin-strapping for both the output voltage and soft-start time. Get more information on TI's entire portfolio of converters with the PMBus interface.

TPS546C23 key features and benefits

- Integrated low Rdson power MOSFETs support 35 A of continuous output current.
- On-chip PMBus interface and non-volatile memory simplify power-supply design and enable customization.
- Output current, output voltage and internal die temperature telemetry supported via PMBus facilitate active power management. Read the blog post, "PMBus – what is the value anyway?"
- Voltage-control mode with clock frequency synchronization and input feed-forward improves EMI/noise and responds rapidly to input-voltage changes. Frequency synchronization to an external clock eliminates beat noise and reduces electromagnetic interference (EMI).

TPS546C23 support and tools

Used in conjunction with TI's WEBENCH® online design tools, the TPS546C23 simplifies power conversion and speeds the power-supply design process.

About WEBENCH tools from Texas Instruments

The WEBENCH Designer and Architect component libraries include more than 40,000 components from 120 manufacturers. TI's distribution partners update price and availability hourly for design optimization and production planning. Offered in eight languages, users can compare complete system designs and make supply-chain decisions in minutes. Start a cost-free design with the TPS546C23 in TI's WEBENCH design environment.

Availability and pricing

Available now from TI and its authorized distributors, the TPS546C23 is offered in a 40-pin, 5-mm by 7-mm by 1-mm PowerStack™ QFN package and is priced at US$4.62 in 1,000-unit quantities. Order the TPS546C23 evaluation module.

- Find out more about TI's power portfolio
- See all of the power designs in TI's reference design library.
- Review the guide to TI's extensive portfolio of PMBus product solutions, design tools and technical resources.
- Read the white paper, "How to Select Digital Power ICs."
- Search for solutions, get help and share knowledge in the TI E2E™ Community Power Management forum.

# # #

About Texas Instruments

Texas Instruments Incorporated (TI) is a global semiconductor design and manufacturing company that develops analog ICs and embedded processors. By employing the world's brightest minds, TI creates innovations that shape the future of technology. TI is helping more than 100,000 customers transform the future, today. Learn more at www.ti.com.

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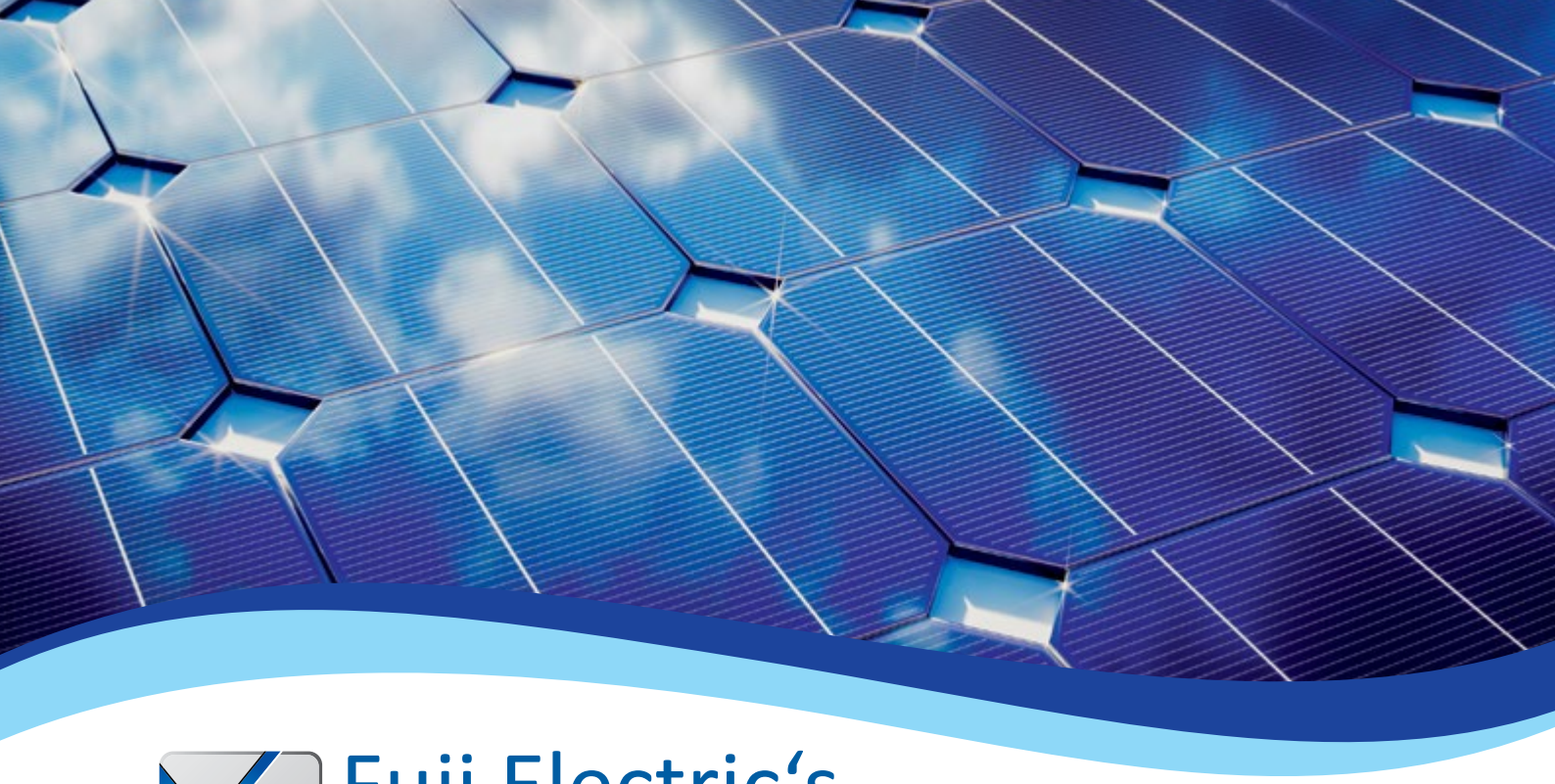
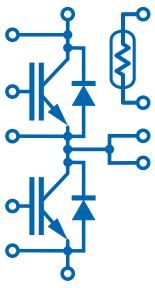


Fuji Electric's X-Series - 7G IGBT

Dual XT, improved package with enhanced performance



1200V	1700V
225A	225A
300A	300A
450A	450A
600A*	**600A***
800A*	

Main features

- Reduced power losses
- Expanded current rating
- Increased output power
- $T_{j(op),max}$ = 175°C
- $T_{storage}$ = -40 ~ 175°C
- Available with solder pins and pressfit contacts

*) *With additional enhanced features & improved thermal performance:*
+ Cu-wires and thicker terminals for lager output current
+ AlN substrate with high thermal conductivity
+ CTI > 600
+ V_{isol} = 4.0kVAC

Fuji Electric
Innovating Energy Technology

Fuji Electric Europe GmbH
Goethering 58
63067 Offenbach/Main-Germany

Fon +49(0)69-66 90 29 0
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www.fujielectric-europe.com

APEC Comes to the Sunshine State – See You in Tampa, March 26-30, 2017

By Greg Evans, Special Correspondent Bodo's Power Systems

The Applied Power Electronics Conference, which will convene March 26-30, 2017 at the Tampa, Florida Convention Center, continues the longstanding tradition of addressing issues of immediate and long-term interest to the practicing power electronics engineer. This annual event is jointly sponsored by the IEEE Industry Applications Society (IAS), IEEE Power Electronics Society (PELS), and Power Sources Manufacturers Association (PSMA). The event seems to set records every year for the number of papers, the size of the exhibit and the number of attendees. And APEC continues to be an exceptional bargain with full registration for as little as $825. Check the APEC website for details (www.apec-conf.org).

"APEC allows power electronics professionals from all sectors to gather annually and participate in a rewarding exchange of technical knowledge and gaining valuable industry connections," said APEC 2017 General Chairman, Jonathan Kimball. "I look forward to APEC every year as a time to meet colleagues, see what new directions are emerging in our field, and find new solutions to the problems or sometimes find new problems to solve."

APEC 2017 has put together the best-ever program and one you that you really don't want to miss.

- A Plenary Session on Monday, March 27 that will feature world-class presentations to keynote our week-long conference. You'll not want to miss these talks from technology visionaries from Google, Texas Instruments, GE Global Research, Jet Propulsion Labs and ELMG Digital Power. In addition, the Power Sources Manufacturers Association (PSMA) Power Technology Roadmap Committee will present highlights of the latest edition of the roadmap.
- Eighteen Professional Development Seminars on Sunday, March 26 and Monday, March 27 taught by world-class experts that are designed to bring you up to speed on critical power electronics design technologies and techniques.
- A Technical Program from Tuesday, March 28 through Thursday, March 30 comprising 593 top-quality, peer-reviewed papers to choose from.
- An Industry Session program running concurrently with the Technical Program with 20 topical areas and 124 timely presentations.
- Three controversial topics will be covered in the annual "Rap Sessions" on Tuesday evening. These sessions present pro vs. con arguments about important issues. This year topics are power electronics architectures, GHz switching in high power applications and Power Supply on Chip (PSoC)/Power Supply in Package (PSiP) vs. discrete designs. Plan to get there early to be sure to get a seat.
- A crowded exhibit hall packed with the latest power electronics products.
- The annual MicroMouse contest pitting teams from around the world to solve the maze the fastest with their intelligent motorized mice.
- A terrific social event that brings us all together on Wednesday evening.

When asked about this year's venue, Dr. Kimball had this to say, "Tampa is a stunning location which I'm sure you will enjoy as you experience all the city has to offer. I hope you take advantage of this by visiting Busch Gardens, the New York Yankees spring training facility, or one of the nearby world class beaches. Your families will have endless options to explore, including the Florida Aquarium, Lowry Park Zoo, SS American Victory, Henry B. Plant Museum, and Glazer Children's Museum. In addition, there are extensive dining destinations and entertainment venues for you to visit with old friends and new colleagues at the conclusion of the day's programming."

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STSPIN32F0: 32-bit MCU-based BLDC motor driver

A three-phase, half-bridge gate driver and a 32-bit MCU integrated in a 7x7 mm QFN package

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- Compact design with a 7x7 mm QFN package

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Power Module with Exceptional Thermal and Efficiency Performance

By Roland R. Ackermann, correspondent editor Bodo's Power Systems

Exar Corporation´s Senior Vice President Sales and Marketing, James Lougheed, recently in Munich presented the latest and positive business figures after the completion of the IML divestiture. Meanwhile the continuous investments in power management products are expected to almost double the revenue in Q117 and Q217 and increase the operating income to more than USD 15 million.
With around 200 employees the company designs, develops and markets high performance integrated circuits and system solutions primarily for the industrial market (70%), infrastructure (enterprise networking and servers, switches and routers, carrier class hardware, 20%), the automotive aftermarket and the audio/video market (around 5% each). The broad analogue mixed-signal product portfolio includes power management, sensing and signal conditioning, interface, LED lighting, data compression & security and video processing solutions. The power management portfolio contains numerous focus products and new products, especially modules in the power conversion branch plus universal PMIC controllers and regulators in the programmable power sector.

Exceptional new power module

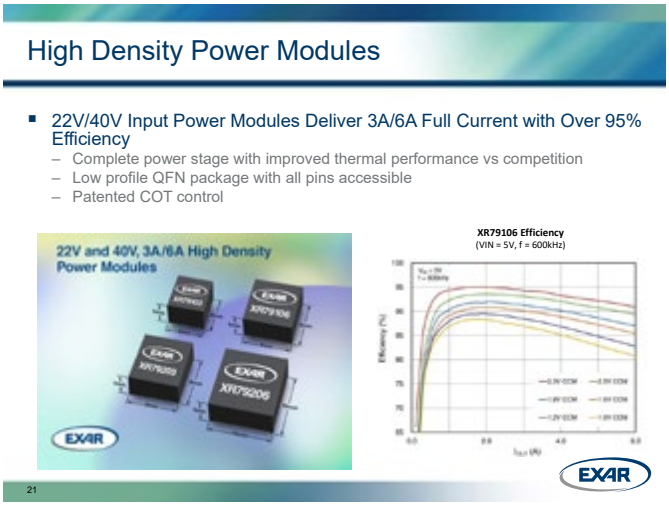
Tuomas Hollman, Division VP of Power Management Products, presented the new XR79313 dual 13A power module offering exceptional thermal and efficiency performance, that entered the market mid December 2016. Controller, drivers, bootstrap diode/capacitor, MOSFETs, inductors, CIN, are all integrated in one package. The junction to case thermal performance is twice as good as that of the competing devices, and the efficiency performance is comparatively exceptional, too.

Industrial market

In the industrial market, comprising process control, automation, industrial IoT, point of sale, medical diagnostics and imaging, LED lighting plus force touch, Exar is the number 1 supplier of UARTs globally as well as of multi-protocol serial transceivers, leading supplier of serial transceivers and of single phase digital power controllers (universal PMICs, including modules); its ASB and Ethernet bridging solutions have the richest feature set in the market, and the company is performance leader of QFN based power modules and pioneer in force sensing technology – an area of significant potential.

Automotive market

Exar supports the automotive market through its power, interface and high performance analogue solutions designed to power, connect and enable applications such as infotainment systems, GPS navigation systems, event data recorders, Advanced Driver Assistance Systems (ADAS), as well as automotive diagnostic equipment.
In the automotive market the company offers low-power, rail-to-rail 2.5V to 12V amplifiers, 40V PoL regulators – the fastest growing sector, where AEC-Q100 qualification will be achieved early in 2017, mainly 3A/5A/8A synchronous buck regulators, with the CR76208 being the highest current version. Moreover the range covers universal PMICs, 40V power modules, a broad line of LDOs including 2A and 3A uLDOs with 140mV dropout at 1.1V requiring no external bias or charge pumps, plus a large portfolio of RS-232, RS-485, dual- and multi-protocol serial transceivers.



Advantages of the offering

Exar's programmable power modules and universal PMICs offer advanced dynamic control and telemetry along with remote reconfigurability. The PowerArchitect design and configuration software speeds development and significantly reduces overall time to market compared to legacy analogue power solutions. An I2C interface and multiple GPIO pins ensure easy system integration. Configurable warning and fault levels, fault behaviour and power up and down sequencing ensure that any load can be properly powered and protected. The power system design can be completed with confidence long before the final revision of the SOC or ASIC is available.
This family of power modules addresses high-current single channel solutions for various end applications. Synchronous step-down power modules are complete system-in-package power management solutions with fully integrated power converters including MOSFETs, inductors and internal input and output capacitors. A patented emulated current mode constant on-time (COT) control provides exceptional full range 0.1% line regulation and 1% output accuracy over the full temperature range. This COT control loop enables operation with ceramic output capacitors, eliminating loop compensation components.
Available in a QFN package, the modules provide superior thermal performance and manufacturability, all in the smallest footprint. The QFN package makes visual inspection of solder joints possible and eases electrical debugging. At 85°C with no airflow, no thermal deratings are required for output voltages of 1.8V and below.

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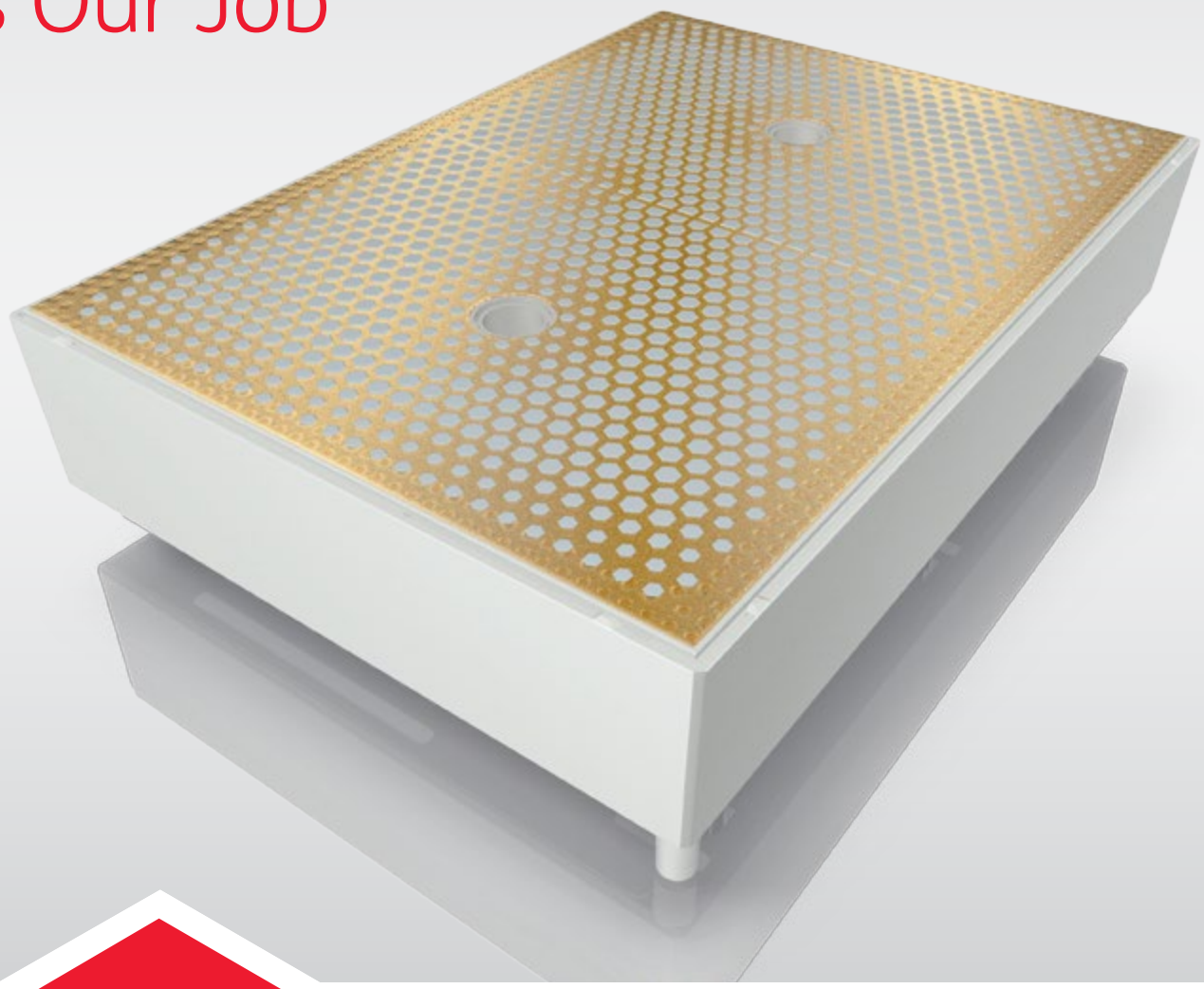

Outstanding thermal performances

- Reduction of thermal resistance chip to heat sink by up to 50% when compared to standard TIM
- Up to 25% more module output power or significant lifetime increases, up to several decades
- Fewer manufacturing processes and lower material costs
- Eliminates the need of expensive ceramic substrates like aluminium nitride
- Excellent mounting robustness for modules without a baseplate

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Driving Digital Transformation for Customers

Human Centric Innovation

With around 14,000 participants, the Fujitsu Forum – held in Munich on 16 and 17 November – is the largest event of its kind in Europe. It is to deliver an ideal platform for top management and IT-experts to exchange ideas and knowledge.

By Roland R. Ackermann, correspondent editor Bodo's Power Systems

This year´s theme of the Fujitsu Forum Europe was "Human Centric Innovation – Driving Digital Transformation". Over the course of two days the visitors discovered advanced technologies and innovative solutions for creating a digitally empowered future, they experienced how the application of a new breed of Fujitsu and partner digital technologies deliver true business value and benefitted by gaining access to IT-expertise across all industry sectors, from retail and finance to healthcare.

Through a program of more than 600 expert talks, 50 breakout sessions and a wide range of product demonstrations, the participants discovered how digital business transformation accelerates innovation.

In cooperation with its customers the company showed, how digitalization enables the rapid design, development and launch of products/services, and leverages insight to drive business growth. The objective is to enable its customers to exploit a wide spectrum of unique opportunities that come hand in hand with digital disruption. Duncan Tait, Fujitsu´s CEO, SEVP and Head of Americas and EMEIA, confirmed: "Digital disruption is the new norm, and digital technology is transforming the way we work, create, invent, sell, collaborate and think. We are harnessing this and enabling customers to digitalize with confidence."

Fujitsu is focusing on connected services, by which they mean the connection between hardware and services; transforming their business structure to enable them to compete at a global level. The EMEIA region has implemented an operating model that helps better serve global customers. And the very same has just been completed in the Americas. The goal is to drive stronger customer engagement, in the new world of co-creation, through the delivery of connected services. Fujitsu has four strategic priorities:

- The Internet of Things
- Artificial Intelligence
- Cloud and
- Security.

An increased focus on security is one of the key principles of Fujitsu MetaArc, introduced last year. It is a portfolio of solutions, services and cutting edge technologies. MetaArc Cloud Solutions give customers a choice, through access to a broad portfolio of off-premise, on-premise and third-party cloud platforms, based on Fujitsu Cloud Service K5, the most open, compatible and agile cloud platform in the market today. This summer, K5 was made available outside Japan – via data centers in the UK, and in the coming months the company plans to add availability zones in Finland, Germany and Spain. K5 is seen as a key element of the Fujitsu cloud enablement and digital transformation strategy for customer, not least because it is also powering the new Cloud IoT Platform which is now available in the EMEIA region, running on K5.

Disruption defines businesses

For some, the concept of digital disruption is cause for concern: one more thing to worry about. The reality is that digital disruption is not a negative force, merely an unstoppable one. For those with the ambition, energy and imagination to capitalize on it, digital disruption is a path to a golden age of innovation and prosperity. In Munich the Fujitsu Forum provided powerful demonstrations of how the co-creation approach is enabling customers to leverage disruptive market forces to gain a true competitive advantage.

The strategical orientation of Fujitsu was confirmed by a couple of new announcements: What does it take for an organization to thrive in the era of digital disruption? To find out, the views of 1,180 C-Suite decision makers from around the world were explored. The results:

- Digital disruption is here to stay and is fundamentally redefining the way that organizations operate. Revenue streams, processes, customer relationships: all have been transformed by digital disruption.
- Technology is at the heart of the battle. The boardroom is driving the digital agenda, and that agenda is a technological one. Not only is new technology seen as the best way to thrive in a digitally disrupted world, aging infrastructure is held up as the biggest hindrance to an organization. Evolution is key. Customers are demanding digital, and business leaders are only too aware of the consequences for failing to meet that demand. As the pace of change continues to grow, so too does competition, and many organizations say that the only way to thrive in this hyper-speed environment is to evolve. But even the scale of evolution is changing, as entire industries and the organizations within them are transformed in the digital era.
- Organizations need strategic support to succeed. Despite the challenges posed by digital disruption, business leaders are highly confident that their organization can survive. Few, however, believe that they can do it alone. Digital disruption is fuelling a desire to work with expert technology partners, not just to provide guidance, but to collaboratively create digital strategies. Successful partnerships are seen as key to an organization's long-term future.

www.fujitsu.com/global/

THINK INTEGRATED

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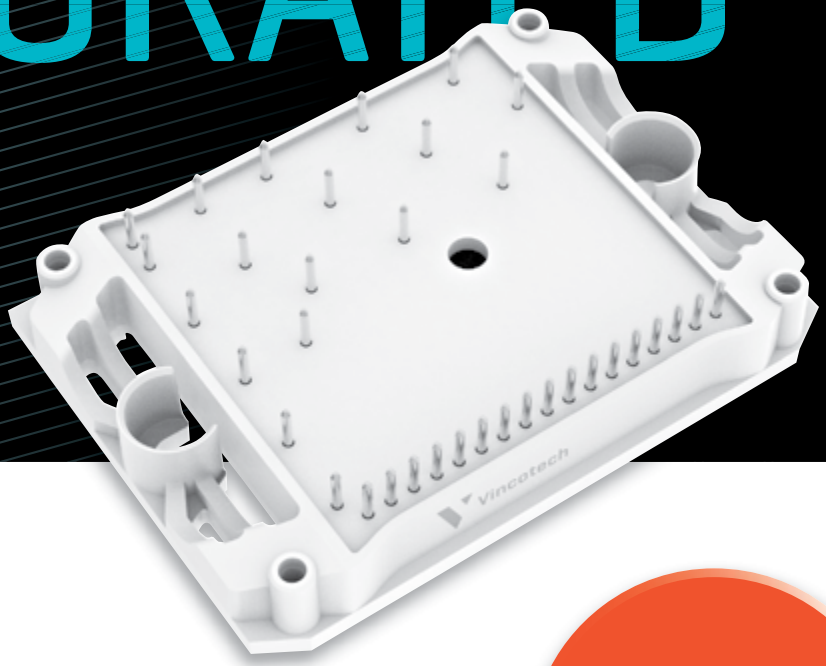

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14 A @ 80°C or 30 A @ 25°C

Big things have come in smaller packages for the latest in motion control applications. And that means higher integration and more complex subsystems.

Our new 1200 V IPM achieves the deepest level of integration of any power module available on the market today to dramatically reduce systems' cost and assembly time.

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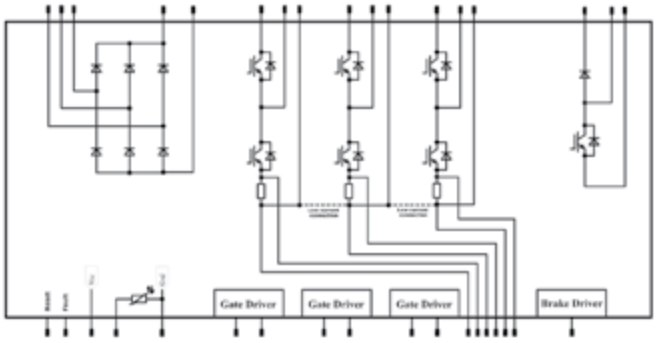
Main benefits

- CIB topology (converter + inverter + brake)
- Brake chopper with integrated gate drive
- 3 inverter gate drives, including bootstrap circuit for high-side power supply
- Current-limiting feature in each leg of the inverter
- Emitter shunts for vastly improved motor control
- Integrated temperature sensor



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EMPOWERING **YOUR IDEAS**

150-1500VDC Input Voltage DC/DC Converter PV Series Designed for 1500V PV Power System

With global non-renewable resources are increasingly scarce, the renewable energy is called upon to increase in all major electricity markets. As a cost-competitive, reliable and sustainable electricity source, Solar PV power has emerged as the dominant alternative energy source.

By Morgan Shao, FAE, Mornsun

International Energy Agency (IEA) forecasts the share of renewable energy in global power generation is expected to be over 30% before 2030, with solar PV power generation accounting for 10% of it. By 2040 it will be over 50% (solar PV: 20%) will and grow to over 80% (solar PV: 60%) at the end of this century. Meanwhile, according to a study by Solar Power Europe (SPE), Global solar power capacity is growing sharply and could reach 540 gigawatts (GW) by 2020, according to a study by Solar Power Europe (SPE). As a cost-competitive, reliable and sustainable electricity source, Solar PV is blossoming around the world. Europe is the biggest solar market with a sum of 157GW (reference: 89GW), in which UK was the fastest growing market. China is the fastest growing market globally, which is expected to add 86 GW (reference: 28GW) by 2020. India´s market is predicted to rank in third place with 54GW (reference: 3GW), followed by Japan and the United States, with 59GW (reference: Japan 23GW, the United States 19GW), respectively.

This article will show advantages and challenges of 1500V PV power system from three aspects and introduce a solution from MORNSUN with 1500V input PVxx-29Bxx series power supply.

a. Advantages of 1500V PV Power System

What's 1500V system? It simply defines that the withstand voltages of cables, converters, inverters and other components used in PV systems. PV system voltages are increasing from 1000V to 1500V. The main advantages of 1500V systems is less costs saving and higher efficiency over 1000V system.

Boosting voltage to reduce line losses is an effective measure for design cost reduction. Higher input voltages reduce wire losses of AC-side and DC-side as well as winding losses in low-voltage side of transformer and improve by 1.5-2% of the power plant system's efficiency. Calculated by P= UI, given that the power is constant, the current will drop to 1/1.5 when the voltage increases 1.5 times. Similarly, assuming the length and diameter of the cables are confirmed and the resistance R is constant, the cable loss will be 1/2.25 when the current lowers 1.5 times, as Ohm's Law $P=I^2R$. To sum up, equipment losses are reduced and power generation is increased when DC-side voltage increases from 1000V to 1500V.

A complete PV power generation system design should have PV array, combiner, DC cabinet, inverter and step-up transformer as shown in diagram 1. Compared with traditional 1000V DC voltage system, 1500V system has less connections between sting arrays and inverter. The PV arrays are constructed in series and then connect

Figure 1: PV Power Generation System

with the combiners in parallel, DC cabinet, inverter and power grid in sequence.

Another measure for design cost reduction comes from less components. 1500V system expands single-string components from 22 in a 1000V system to 32 in a 155V system, thereby reducing the quantities of strings and inverter, combiners and DC-side cables. Besides, less volumes of equipment such as inverter or transformer due to higher power density is also beneficial to reducing the costs of transportation and maintenance. Take 10MW PV power plant as an example, 1500V system could reduce 568 strings and 38 PV combiners, with cost reduction of $77,390. With less equipment, costs of post-operation and maintenance will be reduced accordingly.

	1000V system	1500V system
Number of strings (blocks/strings)	22	32
Power per string (W/string)	5500	8000
Number of connected string	1818	1250
Power per array (W/array)	110000	160000
Number of Arrays	91	63

Table 1: Design Comparison between 1000V System and 1500VSystem

b. Challenges of 1500V System

Although increasing the voltage from 1000V to 1500V benefits the system significantly, it faces challenges from three aspects, PV module and related components technology, raw material and certification. Therefore, a friendly collaboration across the industry and new standards meeting the requirements of 1500V system are needed.

KNOWLEDGE IS POWER

Massive power density in the smallest packages

Microchip Technology now offers an integrated switching power module designed specifically for height-constrained telecom, industrial and solid-state drive (SSD) applications. These products come in an impressive thermally-enhanced package that incorporates inductors and passive components into a single, molded power converter. The slim packages simplifies board design, saves space and eliminates concern over passive components that may introduce unexpected electromagnetic interference (EMI).

Highlights

- Variety of module package offerings (small to large, fit to application)
- High power density with integrated magnetic and passive components
- Performance (efficiency, thermal, transient response)
- Reliable (power and thermal stress tested)
- Low EMI (CISPR 22 Class B ratings on modules)

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a) PV module and related components technology.
Seen from the PV module itself, the main challenges are electrical safety and potential performance degradation. Seen from the system design, it causes a stricter product selection, better-matched components and higher risk of Potential Induced Degradation (PID).

b) Raw material.
The insulation and the electric clearance count most when the voltage rises to 1500V, for higher voltage may cause disruptive discharge. So, it will have higher requirements for the reliability of raw materials in terms of the layout of backboard, electrical connectors and electrical insulation. This technology overcomes and needs cooperation of other circuit breakers, fuses, lightning protection devices and switching power supply owing to higher requirements of withstand voltage and the reliability when compared to a 1000V system.

c) Certification.
1500V system requires a full range of certification standards for production components. Since 2013, multiple component groups have been certified with TUV for 1500V but very few ones for special devices such as high-voltage power supply and others meet the standard.

c.1500V PV Power System Solution
As PV combiner and PV inverter are key components of PV system, the power solution have been challenged with 1500VDC voltage. Most manufacturers directly use power products on the market because there're lots of difficulties when converting the 1000V DC high-voltage into 24V low-voltage, and certain ones choose to self-design power solution to save costs. It cannot denied that there are certain advantages for self-design, however, solutions provided by professional power manufacturers are far superior to it in terms of reliability and performance (e.g.: high temperature, life, altitude, etc.).

Besides, using power module greatly simplify the system design and avoid the risks of system failure caused by supply. Moreover, certification is the greatest challenge for power products. 1500VDC high voltage should meet the relevant standards for higher safety distance and creepage distance (see Table 2), which self-design solution is difficult to meet. High altitude also exacerbate the technical difficulty for PV module design.

Operating Voltage (V)	Pollution Degree						
	1	2			3		
		Material Group			Material Group		
		I	II	IIIa/IIIb	I	II	IIIa/IIIb
≤50	0.2	0.6	0.9	1.2	1.5	1.7	1.9a
>50 and ≤125	0.3	0.8	1.1	1.5	1.9	2.1	2.4
>125 and ≤250	0.6	1.3	1.8	2.5	3.2	3.6	4.0
>250 and ≤400	1.0	2.0	2.8	4.0	5.0	5.6	6.3
>400 and ≤500	1.3	2.5	3.6	5.0	6.3	7.1	8.0
>500 and ≤800	1.8	3.2	4.5	6.2	8.0	9.0	10.0
>800 and ≤1000	2.4	4.0	5.6	8.0	10.0	11.0	12.5
>1000 and ≤1250	3.2	5.0	7.1	10.0	12.5	14.0	16.0
>1250 and ≤1600	4.2	6.3	9.0	12.5	16.0	18.0	20.0
>1600 and ≤2000	5.6	8.0	11.0	16.0	20.0	22.0	25.0
>2000 and ≤2500	7.5	10.0	14.0	20.0	25.0	28.0	32.0
>2500 and ≤3200	10.0	12.5	18.0	25.0	32.0	36.0	40.0
>3200 and ≤4000	12.5	16.0	22.0	32.0	40.0	45.0	50.0
>4000 and ≤5000	16.0	20.0	28.0	40.0	50.0	56.0	63.0
>5000 and ≤6300	20.0	25.0	36.0	50.0	63.0	71.0	80.0
>6300 and ≤8000	25.0	32.0	45.0	63.0	80.0	90.0	100.0
>8000 and ≤10000	32.0	40.0	56.0	80.0	100.0	110.0	125.0
>10000 and ≤12500	40.0	50.0	71.0	100.0	125.0	140.0	160.0
a IIIb is allowable if operating voltage is less than 50V.							

Table 2: Minimum creepage distances

In a word, high-voltage PV module from professional manufacturers could solve the above mentioned problems and provide a more reliable and longer life-cycle power solution, which usually has CE certification meeting different requirements for PV module in different countries.

d.PV15/PV40-29Bxx for 1500V System / DC/DC Converter PV Series for 1500V System
To address the need of 1500V system, MORNSUN released 15W/40W 1500VDC input PV15/PV40-29Bxx. They have four main features as follows:

1) 200-1500VDC ultra-wide input voltage
A trend of PV industry is that 1500VDC system will be in place of today´s standard 1000VDC system, which enables 50% longer strings and lowers the costs with fewer combiner boxes, less wiring and trenching, and less labor.

2) CE/CSA approval
The PV series with 1500VDC input voltage pass EN62109 standards, which greatly improve the reliability of the converter itself and the system.

3) Built-in input under-voltage protection ensuring system stability
A PV system converts the sun's radiation into usable electricity and also powers itself. As sunlight intensity varies, so too can the voltage to the control system vary. This voltage variation may lead to frequent system restarts.PV15/PV40-29Bxx series are designed with input under-voltage protection which protect system stability from frequent restart.

4) Suitable for high-altitude applications (up to 5000 meters)
Most of the PV systems are installed in harsh environments or at high altitude fields. PV15/PV40-29Bxx are designed to meet the application requirement to ensure the systems' reliability and safety, taking the customer environment and altitude into account and passing reliability tests. They are suitable for high altitude applications up to 5000m, safe and reliable.

Features:
a. Ultra-wide input voltage: 200-1500VDC
b. Operating temperature: -40°C to +70°C
c. Isolation: 4000VAC
d. High efficiency, low ripple & noise
e. UL 1741/CSA-C22.2 No.107.1, EN62109 approval
f. Suitable for high-altitude applications (up to 5000 meters)
g. Protections: UVP, RVP, SCP, OCP, OVP

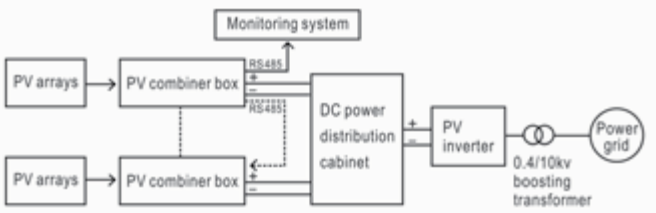

Figure 2: PV Inverter

Application 1: Monitoring Unit of PV Combiner Box
In order to enhance the reliability and practicality, PV combiner box is equipped with DC Anti-thunder protection module, DC fuse, circuit breaker and some functional circuits, such as Control and Processing, Working State Monitoring and Communication circuits, etc.

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Figure 3: Shows a typical monitoring unit solar combiner box. With the feature of 200-1500VDC input, 4000VAC isolation of PVxx-29B24, it becomes much simpler to get the power source from the solar panel array and convert it to 24VDC for the monitoring unit. DC-DC converter F0505S-1WR2 is used to drive the hall sensor with isolation between high and low voltage. DC-DC converter B0503XT-2WR2 provides the 3.3V isolated DC for MCU. The transceiver TD501D485H integrates the isolated serial communication signal and isolated power, which can impede electromagnetic interference and avoid ground loop interference. This solution is functionally meets the requirements and also provides safety isolation, which is simple and reliable.

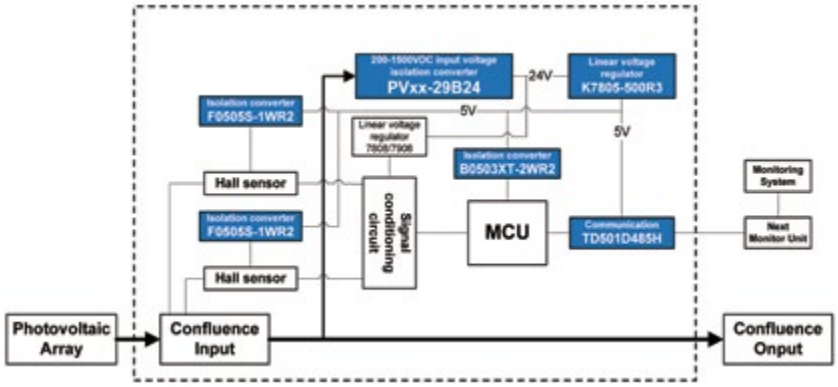

Figure 3: Application 1: Monitoring Unit of PV Combiner Box

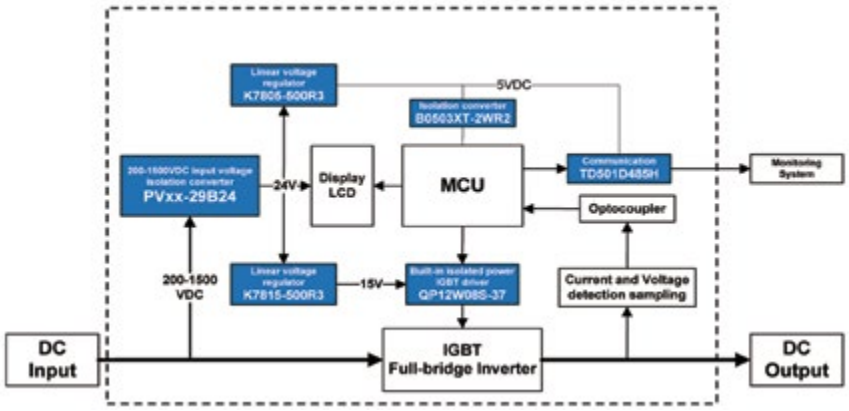

Figure 4: Application 2: Monitoring Unit of PV Inverter

Figure 4: Application 2: Monitoring Unit of PV Inverter

In the front end, the combiner box is used to combine the current, and after the DC cabinet monitoring, the DC voltage will be converted into AC through the inverter. The converting process of the inverter is also needs to be monitored, controlled and communicated to ensure the inverted voltage can meet the requirement. This monitoring unit can accept the wide input range of 200-1500VDC from the bus.

As Figure 4 shows, PVxx-29B24 gets the power source from high-voltage bus and step down to 24VDC, and the low-drop regulator K7805-500R3 and K7815-500R3 can provide the right voltage with high efficiency for the circuit behind it. B0503XT-2WR2 provides the 3.3V isolated DC for MCU. The transceiver TD501D485H integrates the isolated serial communication signal and isolated power, which can impede electromagnetic interference and avoid ground loop interference. QP12W08S-37 is isolation DC-DC integrated IGBT driver, which can simplify the design and improve reliability.

Conclusion:

The gradual large-scale popularity of PV energy is the rational development trend of global energy. MORNSUN actively participates in the development of green energy technology and develops 1500V high-voltage PV power module PVxx-29Bxx series to address the needs of control monitoring units in 1500VDC PV power system. PV power itself does simplify the circuit solutions, reduce the cost of building and maintenance and comprehensively enhance the stability, security and reliability of the system.

For more details about PVxx-29Bxx series please visit:

www.mornsunamerica.com

References

1. Grid integration oflarge-capacityRenewable Energy sources and use of large-capacity Electrical Energy Storage
2. Global Market Outlook for Solar Power 2015-2019
3. PV industry to pick only a matter of time in the first three quarters of the amount of an additional installed capacity of 161%
4. Renewable Energy Markets and Prospects by Technology
5. Renewable Energy Medium-Term Market Report 2015
6. Study on 1500V Photovoltaic Components and its Systems

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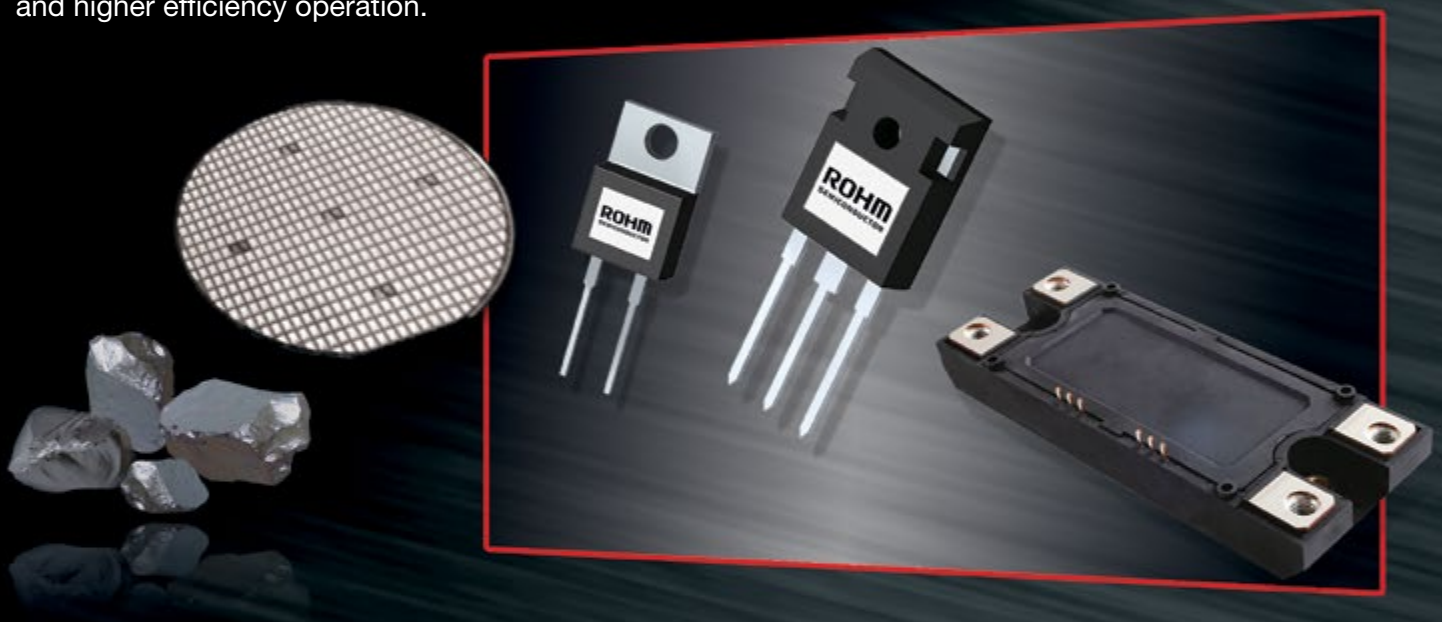

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Design of a Power Module for Automotive and CAV Traction Drives.

This article will explain the continuum of often conflicting technical and application requirements faced when designing a new IGBT based power module targeted for use in automotive and Commercial, Construction and Agricultural Vehicle (CAV) traction drives.

By Andre Christmann and David Levett Infineon Technologies North America

When the Infineon design team started working on a new IGBT based power module, the HybridPACK™ Drive, HPDrive, for the automotive and CAV traction market it was important to focus on the needs of the end user and have a clear understanding of the application requirements. Amongst these are such diverse elements as: low cost, high efficiency, power density, torque at locked rotor, lifetime due to temperature cycling and again cost. This paper describes how all aspects of the new module design were combined with the stated goal of providing an end product that would be a best fit for all of these, often disparate, requirements and what improvements were made compared with the well-established, existing HybridPACK™ 2, HP2, module. The focus here will be on three of these technical requirements: power loss reduction, module packaging and higher stall current ratings, with cost casting its long shadow over all design decisions. The resulting module package is shown in Figure 1.

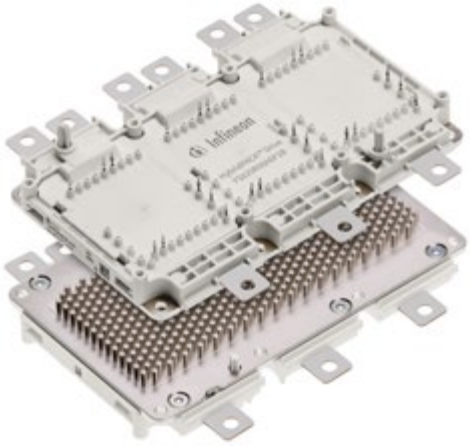

Figure 1: HybridPACK™ Drive, HPDrive module package

Reduction of Losses

In a typical power converter the IGBT module is the source of the majority of the power losses. If the losses can be reduced, not only will this help with the increased capability of the energy source, for example a battery pack or generator driven by an internal combustion engine ICE, but it will reduce the requirements for the entire cooling system i.e. pumps, heat exchangers etc. All this can save cost and weight in a vehicle. There are three main sources of losses in the module: silicon conduction losses, silicon switching losses and copper or I^2R losses.

Conduction Losses

For the module a new chip was developed named Electric Drive Train 2, EDT2. The new EDT2 750V IGBT chip features a similar vertical structure to the previous IGBT3 650V generation, but with an improvement using a “Micro Pattern Trench” structure based on the TRENCHSTOP™ 5 chip design, with a sub-µm mesa width see Figure 2. This construction enables the device to have a very low forward voltage drop (Vcesat), see Figure 3, while still keeping an ≈ 5µS short circuit capability.

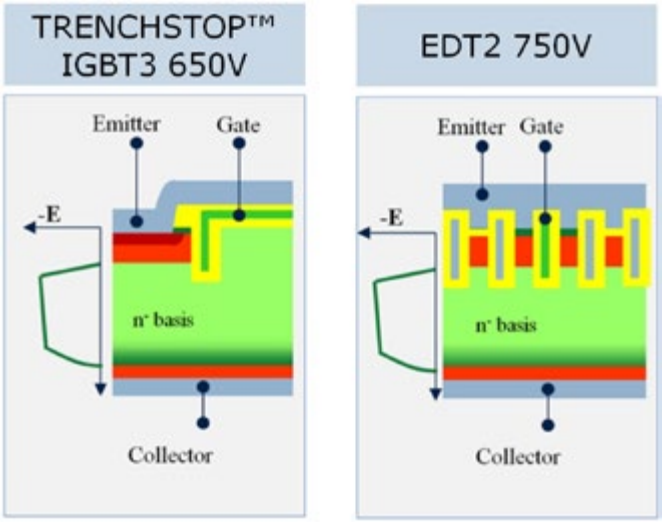

Figure 2: Vertical structure of the IGBT3 650V and EDT2 cell geometry

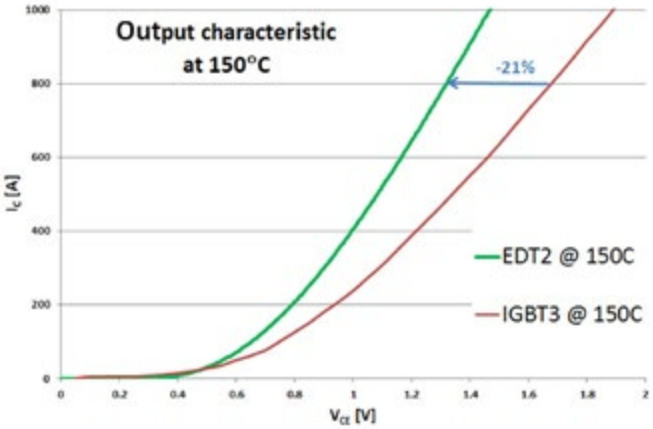

Figure 3: Output characteristics of an IGBT3 and EDT2 chips of the same size

Switching Losses

The p-emitter strength was chosen as a compromise between surge voltage capability and switching speed. Besides the maximum peak overvoltage withstand level the p-emitter also influences the Eoff vs.

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Vcesat trade-off point. The 100V increase in blocking voltage from 650V to 750V minimizes overvoltage as a limiting factor, resulting in less of a need to slow down the switching speed, e.g. by the use of an increased external gate resistor, to stay within the IGBT RBSOA curve. Figure 4 shows how, at a bus voltage of 400V, the turn off losses were reduced by up to 29% compared to an IGBT3 operating with an increased gate resistor value.

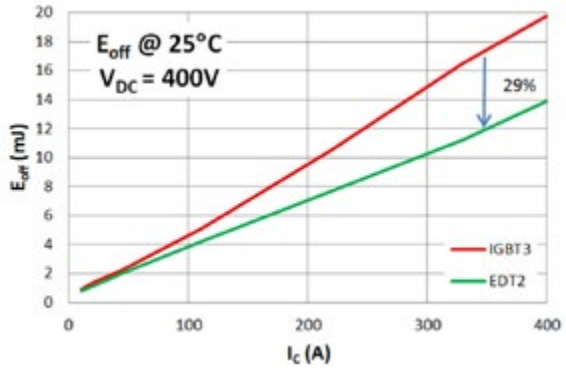

Figure 4: Comparison of turn-off losses for IGBT3 and EDT2 measured in the same package at VDC = 400V.

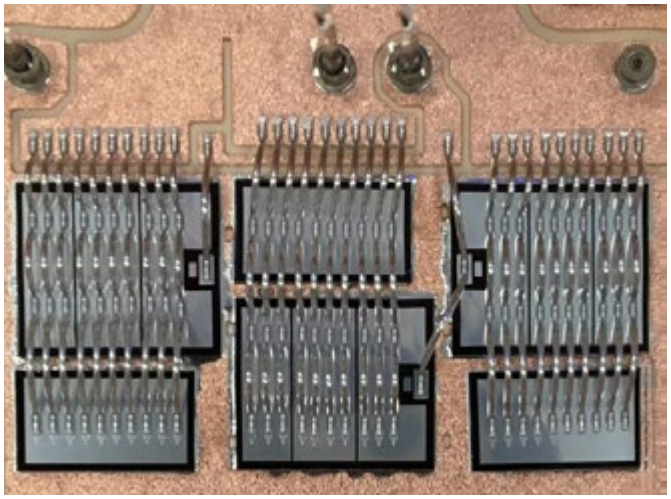

Figure 5: Optimized chip layout for HPDrive

I2R Loss

Often overlooked, I2R or copper losses internal to the module can be significant, especially at high rms currents. Three main components of this loss are: the main bus terminals, the top surface of the Direct Copper Bonded DCB ceramic and the bond wires connecting to the top side of the chips. By designing the IGBT chip with a gate pad located at the side of the chip, see Figure 5, rather than the center, allows a larger copper area for the main emitter current path. Also by adjusting the shape of the chip to be more rectangular, compared to the chips used in the HP2, allows for an increased number, 10 compared to 8, and shorter, bond wires, see Figure 5, for the top side die attach. In total the series resistance was reduced by 20%.

Package Design

The base HPDrive package has carried over the pin fin and internal material stack from the well proven HP2 family. However the HPDrive comes with a 36% smaller baseplate with weight reduced by 40%, all leading to a lower cost. It also introduces a flexible control pin placement system, giving the module designer the ability optimize the placement of the control pins see Figure 1. This reduces the copper trace area required for control connections on the DBC. Also as the control pins are not molded into the package, future upgrades such on-chip temperature or current sensing can be much more easily integrated into the package. For the connection of the signal pins it was decided to use PressFit technology. This is a fast and reliable production process compared to selective soldering and the gas tight connection is very robust against corrosive environments and vibration. For the power tabs the DC terminals are height staggered to simplify the connections to a laminated DC bus and there is an option for elongated output terminals to fit a current sensor as shown in Fig 6. With the current sensor terminals at the same height as the module control terminals the current sensor can be attached to the gate driver PCB directly eliminating the use of additional cables and connectors. A smaller package and optimization of the module internal layout has enabled a 40% reduction in inductance from 14nH (HP2) to 8nH. This reduces the voltage overshoot for the IGBT's allowing faster switching speeds and/or operation at a higher DC bus voltage.

Locked Rotor/Stall Current Rating

Stall or locked rotor mode, sometimes also referred to as "hill-hold", is often the point of highest temperature stress on the device silicon as the current can flow in a single device at the peak of the sine wave current waveform. As a result this corner operating point can set the limit for the power module current capability. The new EDT2 chips have the capability to operate for short time periods, less than 10 sec, at 175°C to meet this stall condition requirement. Table 1 compares operation for the HPDrive and the HP2 at stall and shows that 300mm2 of EDT2 chips can match the stall current rating of 400mm2 IGBT3 chips.

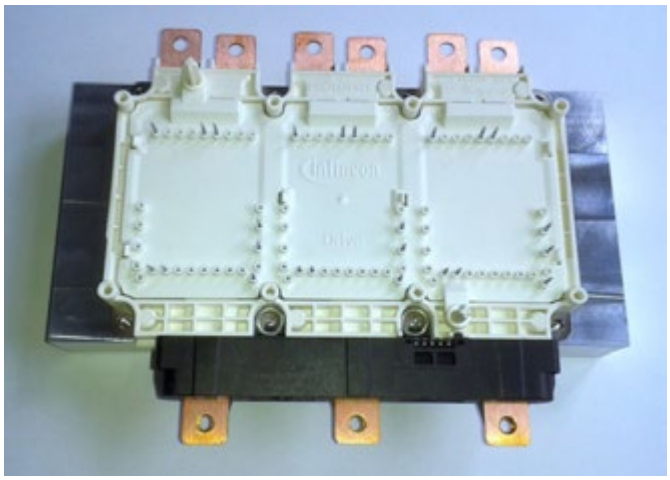

Figure 6: HPDrive with extended tabs to fit LEM current sensor example HAH3DR 800-S07 shown

	Est. IGBT Conduction Losses in W	Est. IGBT Switching Losses in W	Total IGBT Losses in W	Thermal Resistance J- Coolant °C/W	Max Junction Temperature in °C	Margin in °C
HybridPACK™ Drive	502	166	668	0.12	160	15
HybridPACK™ 2	551	132	683	0.097	146	4

Table 1: Comparison between HPDrive and HP2 modules at: 2kHz, 400Vdc bus, 500Arms, 707A peak, 80C coolant and 50% duty cycle

However maximum junction temperature is not the only limiting factor but the module lifetime due to temperature cycling effects is also a key design criterion. To mitigate the effect of high ΔT events the chip solder system has been improved to provide a 40% increase in the power cycling seconds capability, for example 60.000 cycles at a ΔT of 100K of the chip.

Product Family

The development of a new lower loss, higher temperature rated, IGBT and Diode EDT2 chip set, offered two different module design paths, the first to make a smaller lighter module with a similar output current capability as the existing HP2 module. At the same time the new package could incorporate some technical advantages such as lower inductance and press fit control signal pins. This was the chosen design path for the HPDrive. The second design path is to incorporate the EDT2 chips into the existing HP2 package, which allows an increase in current rating from 800A to 1100A. So for customers already using, or considering the HP2 package, there is the option of either increasing the current and voltage rating or keeping the same performance in a smaller lower cost package. In addition the new HPDrive module and will come in two flavors: with a pin-fin baseplate rated at 820A and with a flat baseplate rated at 660A. These new ratings will expand the HybridPACK™ family and complement the extensive Infineon range of automotive and CAV rated power modules, such as EconoDUAL™ 3 or PrimePACK™, designed for vehicle traction drives.

Conclusion

The authors hope with this paper to illustrate the importance of a holistic design approach, where all the different component parts of a power module must work together to best meet the application requirements. For example reduced chip on state voltage, chip gate pad layout and plastic frame control pin placement all contribute to lower losses. Increased chip voltage rating and lower module inductance allow for operation at higher bus voltages. Higher chip temperature rating, improved chip bonding technology/materials with lower losses all contribute to higher stall/locked rotor current capability and with it increased motor starting torque rating. Overall a physically smaller module with reduced active chip area, lower losses and the ability to use the latest high volume assembly techniques all contribute to a lower system cost.

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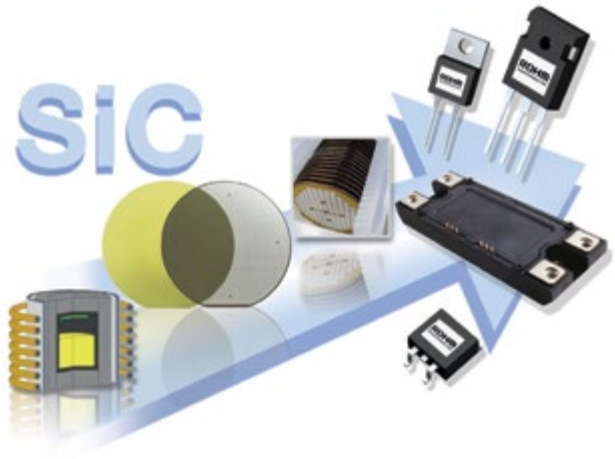

The History of Silicon Carbide

Silicon carbide (SiC) is a rather young base material in the semiconductor industry compared to silicon or gallium arsenide, but its origins date back to the end of the 19th century. In 1891, Edward Acheson developed a method for producing crystalline SiC as an abrasive material, a method still in use today. The first mineralogical studies of the "second-hardest mineral occurring in nature" carried out by the French chemist H. Moissan also date back to this time. SiC is sometimes still called Moissanite today.

By Dr. Robert Eckstein, CEO SiCrystal AG and Aly Mashaly, Manager Power Systems Department; Rohm Semiconductor GmbH

When the semiconductor age began in the middle of the 20th century with the introduction of the bipolar transistor, the enormous potential of silicon carbide for specific applications was already understood. According to the discoveries of E. Johnson, the product of breakdown field strength and saturation drift velocity may be used as an indication of a material's suitability as a base material for transistors in RF and power applications. In this comparison, SiC turns out to be much better than both silicon and gallium arsenide.

In practical applications however, the innovative semiconductor material was unable to prove its superiority immediately. No process existed at that time able to produce sufficiently large silicon carbide substrates with the low defect rates required to manufacture meaningful test structures. Following on from the Acheson process and the so-called Lely process as an intermediate step, it was the modified Lely process that provided the basis for the modern production of SiC substrates at the end of the 1970's. When better and larger silicon carbide substrates became available thanks to the evolution of this basic process, SiC provided a completely convincing performance.

Prerequisites for Producing Silicon Carbide Crystals

Before the production (which is called 'growth' by experts) of a silicon carbide crystal can begin, the essential components must be in place. These include the crystal growth equipment itself, the growth process, various media, the source material and the seed crystal.

The source material, silicon carbide, acts as raw material in the growth process and continuously feeds the growing crystal. The source material normally is in powder form, and it is produced in a preceding process. This process is a strictly controlled high-temperature process combining the base materials which are highly pure silicon and carbon. Precise control ensures that base material is used which is characterized by a specific, internally specified purity, stoichiometry, grain size, grain distribution and other internally defined specified parameters.

The seed crystal is a mono-crystalline, round silicon carbide slice that initiates (and largely controls) the growth of a large mono-crystal, hence the term 'seed'. Like the seed of a plant, the seed crystal imparts significant 'genetic information' to the growing crystal. The structural perfection of the seed crystal determines much of the crystal's optimum absence of defects. The multi-stage selection process used in our company continuously ensures that seed crystals will only be made of the best in-house crystals featuring optimum material quality.

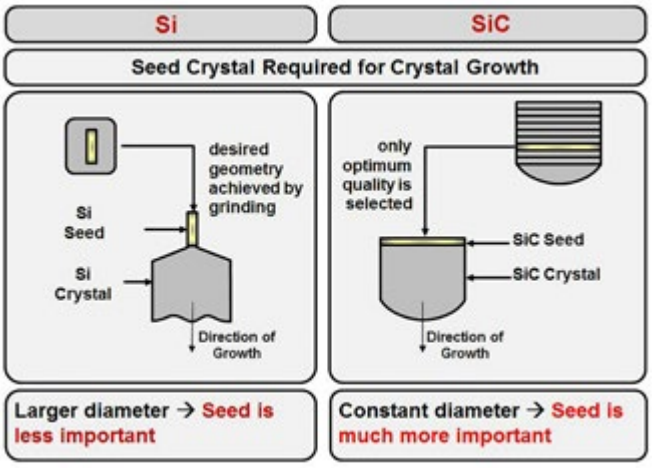

Figure 1: Significance of the Seed Crystal for Growing Si and SiC Crystals

This constant internal selection acts like a distillery process continuously improving the quality of the seed and the final product.

The Significance of the Seed Crystal as Confinement to the Growth of Silicon Crystals

The crystal growth equipment, the growth process, the media, the source material and the seed crystal play a significant role in the processes used for producing other semiconductors as well (including silicon). However, silicon carbide is different!

As explained in more detail in the section below, SiC crystals are grown by a special vapor-phase process. For this reason, the diameter of the seed crystal should have at least the target diameter of the crystal to be grown. It is not possible to grow a large crystal of sufficient quality on a seed rod with a relatively small diameter, as would be the case with silicon (see Figure 1). Any defects in the seed would be 'inherited' by the growing crystal due to the 'genetics' described above, mandating the use of a flawless, large-diameter seed crystal for silicon carbide.

Therefore, the seed crystals are among the factors supporting the secure operation of the enterprise. Not commercially available anywhere, this material acts as a kind of copy protection. Securely protected by internal processes, it is always available in sufficient quantity at SiCrystal.

The Growth of the Silicon Carbide Crystal

When all the required conditions are met as described above, the growth process itself can begin. The sublimation growth method is usually used for SiC. The setup then consists of a graphite crucible, which is surrounded by carbon-based insulation material. This helps to save energy and is inserted into the induction-heated growth equipment (see Figure 2). The crystal growth process then proceeds in the following manner:

The induction coil of the growth equipment induces circular currents in the graphite growth crucible, heating it up to well over 2273 K. At these elevated temperatures, the source material in the lower zone of the crucible evaporates, the silicon carbide powder sublimes, turning into various gaseous species that consist of silicon and/or carbon which fills up the free space of the crucible.

The seed crystal attached to the top of the crucible does not evaporate because temperatures are lower there, although they still are above 2273 K.

Adhering to the laws of thermodynamics, the gaseous species formed by the source material at temperatures far above 2273 K have the tendency to deposit from the vapor phase when they are transported close to the colder seed crystal. Crystallizing on the surface of the seed, they form additional crystal volume and let the crystal grow. However, the crystal does not grow in an uncontrolled manner because the 'genetics' of the seed predicts the growth with a crystallographic relationship to the seed.

During crystal growth, a doping material (normally gaseous nitrogen) is intentionally added in the vapor phase. Incorporated into the crystal in a low, well-defined quantity, the dopant electrically acts as a donor ensuring the intended conductivity of the crystal.

The growth process therefore relies on the constant transfer of material from the source to the growing crystal. The growth process, which requires the continuous transport of species and dopant through the vapor phase, lasts a couple of days. When the powder has almost completely evaporated and a crystal of several centimeters in length has grown, the process is terminated in a controlled manner.

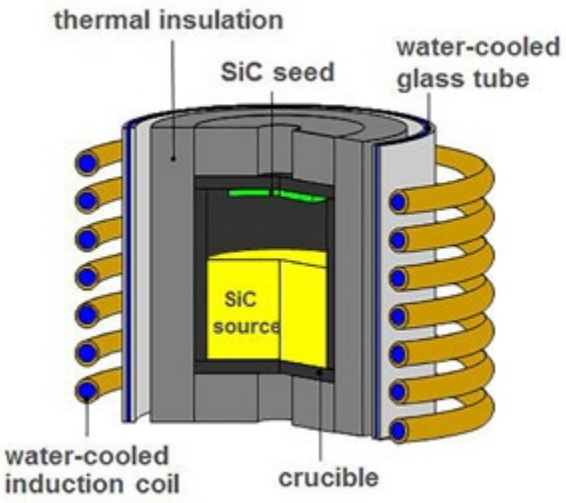

Figure 2: SiC Crystal Growth Process

Several other aspects must be considered which enable the process in the way described above. As already mentioned, the crucible and its insulation are made of carbon. Carbon lends itself to this purpose because of its high temperature stability, its availability in semiconductor purity and the fact that it does not represent an elementary contamination for SiC. However, all carbon parts would immediately burn at 2273 K under normal atmospheric conditions. Therefore, it is necessary to run the process in an inert atmosphere (Argon is often used). To contain all gases including the Argon, the crucible and its insulation are surrounded by two coaxial glass tubes whose intermediate space is cooled with water.

Manufacturing Silicon Carbide Substrates: The Wafer-Production Process Chain

At the end of the crystal growth process, a cylindrical single crystal of several centimeters in length, whose diameter is larger than the target diameter, can be taken from the crucible. The subsequent process steps are almost identical to other established semiconductors, including silicon. The main steps include:

- Crystal orientation using x-ray analysis
- Cylindrical grinding of the crystal to the desired diameter
- Grinding of flats (markings on the crystal surface)
- Sawing wafers from the crystal
- Application of individual laser markings for wafer identification
- Rounding off the edges of the wafers
- Surface treatment with methods including
- Grinding
- Lapping
- Polishing by mechanical abrasion
- Polishing by chemical/mechanical abrasion
- Cleaning the wafers using dry or wet chemical methods

As a matter of course, these process steps are accompanied by checking many internally or externally specified parameters using special optical, mechanical, chemical and electrical methods. The large amount of data that is acquired and archived ensures full traceability of the final product back even to the raw material batch used in the initial process stage.

The process described above is long established as the standard in manufacturing semiconductor substrates. The process stages, processing facilities and inspection methods are basically known from silicon processing. Nonetheless, processes and/or machines sometimes had to be modified to accommodate the specific properties of silicon carbide.

Silicon carbide is a very hard material. On Mohs' hardness scale, where diamonds represent the upper limit with a hardness of 10 and all minerals are considered very hard with hardness values greater than 6, SiC is among the top scorers with a hardness of 9. Only a few materials are available for abrasive machining of silicon carbide. Tools and sometimes even process equipment has to be adapted to reliably provide semiconductor customers the required product precision.

Growth Process and Wafer Production – Challenges and Solutions

Not surprisingly, ensuring highest quality based on ever tightening specifications is among the key challenges in the production of silicon carbide crystals and substrates. In this context, quality means the quality of the wafer surface:

- Absence of scratches
- Extremely low, nanometer-scale surface roughness
- Surface purity in a physical sense (particles, films) and in an electrical sense (electrically active impurities)

In addition, it also means geometrical quality:

- Tight diameter and thickness tolerances
- Minimum bow and warp of substrates
- Exactly specified edge shape

Also, to a high degree, it means internal or better intrinsic quality:

- Homogeneity of the doping and thus the conductivity
- Stresses in the material that are as low as possible
- Low density of dislocations or related defects

Today's State of the Art of SiC Quality

Although quality naturally is a 'fast moving target', it is justified to say that SiC fully meets the customer's requirements for an established semiconductor material today. However, much work was required in the past to reach and maintain this level.

Comparisons of 'old' and current substrates using stress birefringence method reveal the enormous improvements of material quality in the last 15 years or so. Stress birefringence is an optical method representing deviations from the ideal state as white areas, while undisturbed regions are displayed as black areas in those pictures shown below.

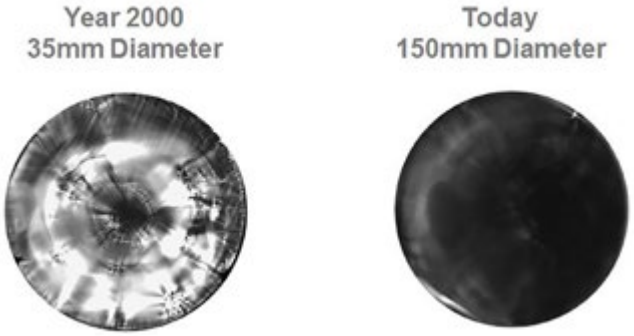

Figure 3: Diameter increase and quality improvement

Strong contrasts are visible on the entire surface of the wafer from the year 2000, which is shown on the left (see Figure 3), indicating defect-related stress. Responsible defects include dislocations and related structural defects, proving that the growth process was not sufficiently optimized in the year 2000.

The current state of the art shown (Figure 3.) on the right is quite different. Although the sensitivity of the optical method has improved a lot in the meantime, there are almost no contrasts between dark and bright areas. This clearly indicates that the growth process was optimized significantly, that the defect density within the crystal has been reduced by several orders of magnitude and that current wafers are production-worthy without any limitation.

But how can these improvements of material quality be achieved? In this case, these quality improvements were obviously achieved by an optimization of the crystal-growth process. But how can one optimize a high-temperature process operating at temperatures far above 2273 Kelvin Placing sensors in the crucible area is hardly conceivable at these elevated temperatures. Furthermore, any additional 'observation hole' in the insulation for optical temperature measurements from the outside would unacceptably influence the temperature distribution within the crucible. Any macroscopic opening in the growth crucible would also inevitably lead to the escape of process gases, which would corrupt the growth process.

The problem can be solved by numerically simulating the growth of the crystal (see Figure 4). Using special software and considering all relevant material and process parameters, crystal growth experts now can 'look into the crucible'.

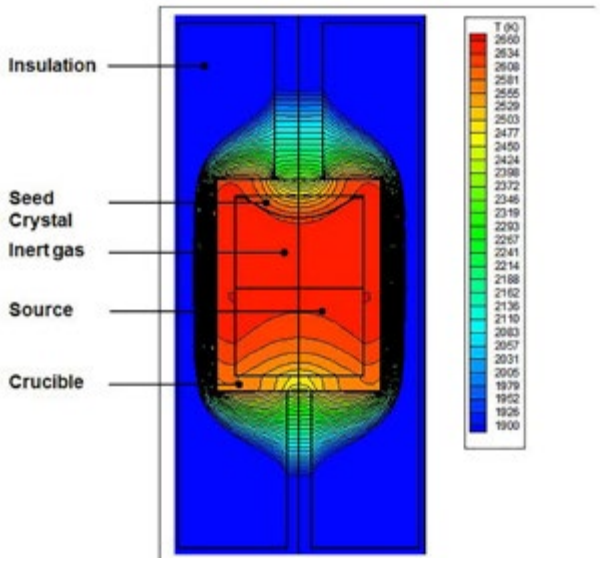

Figure 4: Temperature distribution in the crystal growth crucible

Experienced crystal growers adequately recognize from the temperature distribution (the so-called thermal field) shown above how a crystal would grow under modified growth conditions. A multitude of 'numerical experiments' will limit the number of necessary 'real experiments'. The combinations of simulation with experimental confirmation have enabled crystal growers with many years of experience to achieve the radical improvement of material quality described above.

Outlook

The above mentioned comparison between a current product and the wafer from the year 2000 also reveals the diameter increase from

35mm to 150mm, which was achieved during the intervening years. As can be seen, today's wafers feature a significant quality improvement on a wafer surface which has increased by a factor of 18. This trend towards increased wafer size accompanied by continuously improving quality will continue as the most important goal in the future. Predominantly as larger wafer surfaces can be processed more economically, thereby lowering production costs.

While the transition from 100mm to 150mm has just begun for today's customers, there is much interest in the possible introduction of the 200mm substrate as the next stage of evolution. Although it will take some time for this next step to become commercially viable, SiCrystal expects to be able to deliver the first samples within two or three years. Consequently, preliminary work on this has already started.

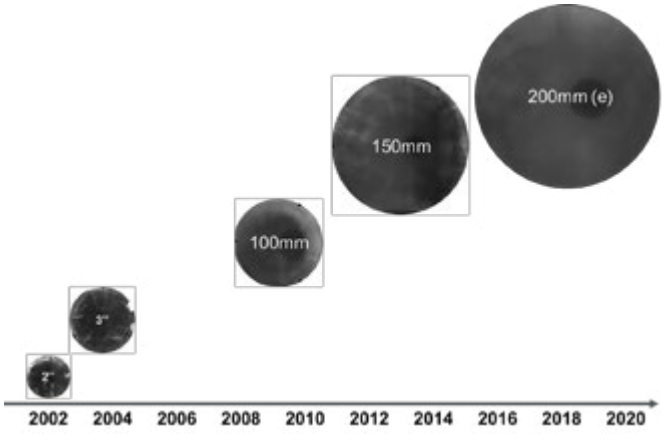

Figure 5: Evolution of SiC wafer diameters

Summary

Although the potential of silicon carbide for power and RF electronics applications has been recognized quite early, a suitable manufacturing process for this material was only developed by the end of the 1970's. In the industrial process used until today, the original SiC material sublimes before being transported through the vapor phase and crystallizing on a SiC seed crystal. This creates a single crystal which is subsequently processed into substrates using modified process stages long established in the semiconductor industry. Continuously increasing requirements regarding the quality and diameter of the substrates were and are considered by process adaptations based on computer simulation. Thanks to their high quality level, today's substrates with diameters of up to 150mm can be used for component production without limitation. Optimally positioned for the present and the future, the ROHM subsidiary SiCrystal is prepared for the journey towards larger diameters and further improved quality.

About SiCrystal AG

SiCrystal AG is among the world's leading manufacturers of silicon carbide semiconductor substrates. Founded in 1996 and headquartered in Nuremberg (Germany), the wholly owned subsidiary of ROHM CO. LTD delivers its products to customers all over the world.

The company owns all processing stages from the production of the original material to packaging the epi-ready substrate in an in-house clean-room environment. In addition to the results of its comprehensive, proprietary analysis methods, SiCrystal AG has direct access to the results of component tests within the ROHM Group. This is an invaluable benefit for advancing the material optimization based on component or even module performance.

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Dr. Robert Eckstein, CEO SiCystal AG

Aly Mashaly, Manager Power Systems Department Rohm Semiconductor GmbH

Applying Silver Low-Temperature Sintering Technology

Improving the reliability of power components with large area semiconductor element

The main idea, which is discussed in this article, is the aspects of increasing the reliability of power semiconductors with 80 mm and more diameter semiconductor chip applying the technologies of low-temperature sintering of silicon wafers and molybdenum discs using the silver nanoparticles. In addition, the dependence between the joint weld porosity and cycling capability of an experimental sample is examined, as well as the optimal pressure and temperature range of sintering process is defined.

By Dmitry Titushkin, Alexander Stavtsev, Konstantin Stavtsev and Alexey Surma, Proton-Electrotex

The technology of low-temperature sintering is widely used nowadays in the semiconductor power electronics [1, 4]. The one of the advantageous trends is the usage of this technology for connecting the silicon crystal and molybdenum discs of high and ultra-high power thyristors and diodes which are based on the 80-150 mm silicon crystal.

Sintering usage experience of high-powered single-chip thyristors and diodes is representing such advantages of this technology as improved cycling capacity [3, 4], reduced thermal resistance [2, 3, 4] as well as increased surge current values [1]. Moreover, the described technology possesses the significant benefit of the emitted layer surface injection index values [6]. Nowadays the trend for nanoparticles based silver-bearing materials is increasing. The appliance of such materials allows decreasing the pressure and temperature during the sintering process due to the increased free energy of nanoparticles. In its turn the too high level of free energy may lead to the internal mechanical stresses during the sintering process, which might be reduced by the increasing the joint weld porosity though that generates a range of other issues, which is investigated below.

Thus, for producing the power semiconductors it is significant to determine the balance of minimal pressure and temperature values during the sintering process and the porosity of the result joint.

The process mechanism of sintering

The sintering technology is based on the diffusion principles of welding and plastic deformation of silver. At that the driving force of sintering is the free energy store on the surface of silver particles.
The main sintering process model is the Mackenzie Shuttleworth model [5]:

$$\frac{d\rho}{dt} = \frac{3\gamma}{2r_0\eta(T)}(1-\rho_0),$$

γ – free surface energy;
r_0 – initial radius of a spherical hole;
ρ_0 – initial porosity;
$\eta(T)$ – weld viscosity – temperature relation.

Moreover, silver nanoparticles free energy values are increasing with the silver particles scale decrease.

Scale of silver-bearing particle	2.0 nm	100 nm	30 nm
Free surface energy	2.0 MPa	40 MPa	143 MPa

Table 1: The relation between free surface energy and scale of silver-bearing particles

The increment of free energy allows to decrease sintering temperature. At its turn temperature decrease has a positive effect on residual stress values in the silicon structure. However, sintering might proceed very intensively through high level of free energy, which may lead to internal mechanical stress and weld cracking. It is possible to prevent these negative effects by the means of increasing the porosity of the joint, as it leads to the increase of elasticity (decrease of Young's tensile modulus). Otherwise, the increasing porosity exacerbates the thermal conductivity of the weld, which might have a negative influence on thermal impedance of the semiconductor component.

Moreover, there is one more negative effect, which is typical for thyristors and diodes based on the large area crystals and which are mounted in tablet housings. While the process of thermocycling of such components the tangential mechanical strengths are transferred to the semiconductor element from the upper and lower copper disks by the friction. Herein the molybdenum thermal compensator, which is a constituent part of a semiconductor element, compensates the impact of such strengths. However, the decrease of Young's tensile modulus results in the destruction of the silicon wafer as the molybdenum thermal compensator ceases to carry out its functions.

Producing the semiconductor components with 80 mm silicon crystals it is sufficient to provide such porosity values that internal tensions would not occur during the sintering, both with critical exacerbation of thermal impedance and weld durability.

Experimental samples

For the aims of a research of the relation between thermocycling capacity and porosity of the joint and determination of the optimal temperature and pressure range of values during the sintering process the experimental samples of thyristor TFI393-2500-28 with the 100 mm semiconductor designed for repetitive reverse voltage of 2800 V and mean current of 2500 A were produced. Silver films based on silver nanoparticles were used as sintering material. The samples were produced using the following process conditions: temperature range 195 – 2350C; pressure range 5 - 20 MPa.

The opportunities for increasing the power bipolar components reliability

In the figure 1 the dependence between the result joint porosity and low-temperature sintering process conditions.

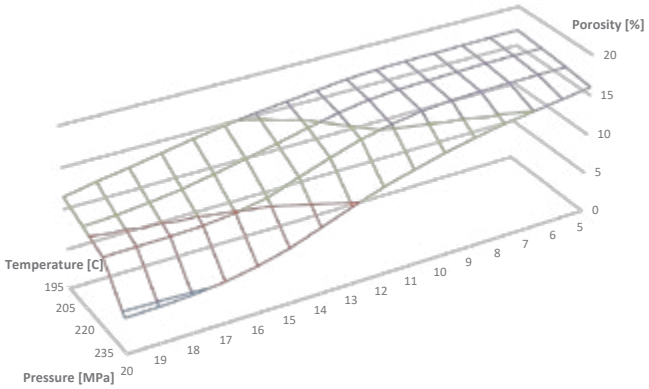

Figure 1: The dependence between the porosity of the result joint and low-temperature sintering process conditions

Using the experimental samples thermocycling capacity tests were carried out using the following process conditions — thermal gradient from 25 to 150 0C (value = 125 0C); quantity of cycles = 100; and the following results were obtained (Figure 2):

- Thermocycling capacity of the samples produced under the temperature less than 220 °C did not exceed 10-15 cycles, i.e. the porosity of the result joint was obviously surplus.
- Thermocycling capacity of the samples produced under the temperature of 220-235 °C and pressure not more than 10 MPa did not exceed 10-15 cycles as well.
- The increase of pressure up to more than 12 MPa leads to the thermocycling capacity boost.
- For the samples produced under the conditions of 20 MPa pressure and 235°C temperature the destruction and characteristics degradation was not determined.

The test results should be combined with the porosity alterations of the weld produced under various sintering process conditions (Figure 3). It could be derived from the picture 3 that acceptable thermocycling capacity would be achieved providing the condition of weld porosity not more than 7 %.

The results of the research allow to calculate and forecast the pressure and temperature value range, with which nano material sintering gives an opportunity to achieve a high thermocycling capacity silicon-molybdenum joint for thyristors and diodes with large area crystals, (Figure 4).

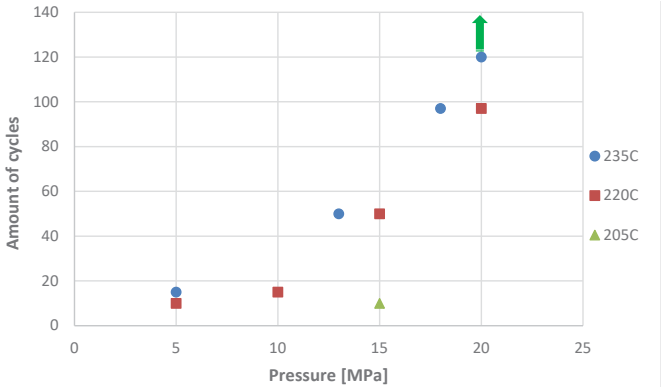

Figure 2: The dependence between thermocycling capacity of samples and low-temperature sintering process conditions

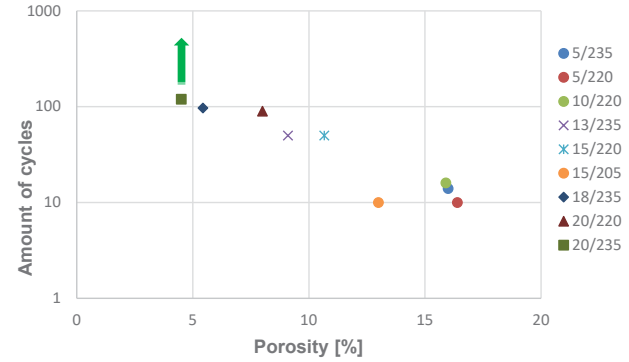

Figure 3: The dependence between thermocycling capacity of samples and porosity of the joint

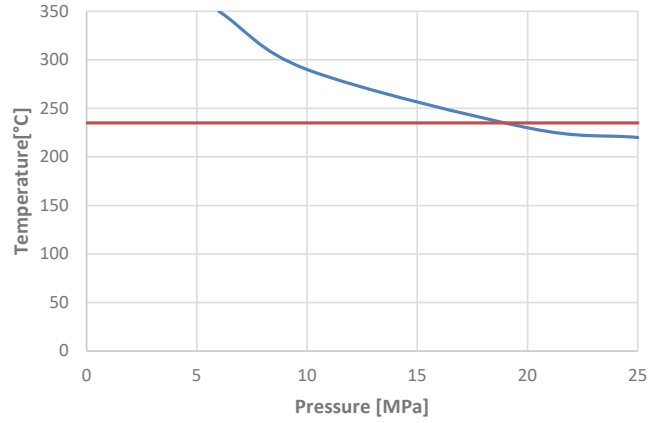

Figure 4: The area of thermocycling capacity of samples (between the lines)

Conclusion

In this article the influence of sintering process conditions using silver nanoparticles on the weld porosity and thermocycling capacity, obtained by joining silicon crystals of large area with molybdenum wafers is researched. The relation between the thermocycling capacity of the experimental samples and weld porosity is demonstrated. Moreover, it is proved that a prerequisite requirement for maintaining the thermocycling capacity of thyristors and diodes with silicon crystals of large area in tablet housings is a value of weld porosity not more than 7%. The temperature and pressure value range for sintering process of silver-bearing materials based on nanoparticles is defined. This value range allows to calculate and forecast high level of thermocycling capacity of the weld referring to the components mentioned above.

List of literature

1. H. Schwarzbauer. Novel Large Area Joining Technique for Improved Power Device Performance. - IEEE Transactions on Industrial Applications, 27 (1), 1991, p. 93- 95.
2. A. Chernikov, A. Stavtsev, A. Surma. Features of wafer - Mo joining by sintering of silver paste for large area silicon devices. – Proc. EPE'2013, Lille, 2013
3. U. Scheuermann, P.Wiedl. Low Temperature Joining Technology-A High Reliability Alternative to Solder Contacts. - Workshop on Metal Ceramic Composites for Functional Application, Vienna, 1997, p 181-192.
4. C. Göbl, P. Beckedahl, H. Braml. Low temperature sinter technology Die attachment for automotive power electronic applications. – Proc. Automotive Power Electronics, Paris ,2006.
5. M.O.Prado, C. Fredericci, E.D. Zanotto. Glass sintering with concurrent crystallisation. Part 2.Nonisothermal sintering of jagged polydispersed particles. – Physics and Chemistry of Glasses, 43 (5), 2002.
6. Dmitriy Titushkin, Alexey Suma. «New ways to produce fast power thyristors» - Bodo's Power Systems 08, 2015, p. 28- 29.

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MiniSKiiP – The Power Density Master for Motor Drives

Reducing system cost by maximizing the output power density is one of the major demands on power modules today, especially in cost-sensitive market segments like Motor Drive applications. One key to more power, is optimising the thermal resistance layer between the chip and heatsink.

By Stefan Hopfe – Product Manager Thermal Interface Materials and Stefan Häuser – Senior Manager Product Marketing International, SEMIKRON Elektronik

Based on the MiniSKiiP series, SEMIKRON has several options to achieve the highest possible power density to increase the output current capability by more than 30%, while using the same physical chipset and power module size.

The proven MiniSKiiP series has become a standard for compact motor drives of low to medium power. The baseplate-less modules are available in a range of 4 to 400A with blocking voltages up to 1700V in 6-packs, CIB topologies, with the rectifier, brake chopper and inverter as well as half bridges with separate rectifier modules. MiniSKiiP provides a cost advantage through its scalability over the full power range, and its unique one/two screw mounting concept: In just one mounting process, a complete sub-system can be assembled with the power module, heatsink, power PCB with DC bus capacitors, line and motor connection terminals, and current sensors. Another advantage of MiniSKiiP is the high quality level: every single module leaving the factory is 100% electrically tested during production.

With this ingenuity, more than 30 million MiniSKiiP modules have been sold, most powering motor drives all over the world while helping to build more compact and cost effective solutions. But how can costs be further optimized? The answer is by improving the power density through reducing the thermal impedance of the power system.

The biggest portion of the thermal resistance from chip to heatsink ($R_{th(j-s)}$) is taken up by the Thermal Interface Material (TIM or thermal grease) with an approx. 50% share. Thus it makes sense to focus on improving that layer first.

The main task of the TIM, is the thermal interconnection of two surfaces by smoothing out the module's bottom and the heatsink's roughness with a minimum layer thickness. Figure 1.a shows how the different composition layers contribute with single resistance values to the overall thermal resistance of the TIM layer, R_{th},T_{IM}.

Various ranges of TIMs on the market promise a state of the art thermal performance, and the majority of users pay attention to the datasheet value for the thermal conductivity only. But in fact, this value is only relevant for the thermal resistance of the bulk layer $R_{th,bulk}$.

As an example, pads and foils often provide a high thermal conductivity in the vertical direction and the materials are usually stiff compared to pastes, meaning they are not able to sufficiently fill the roughness and bending in micrometer range, as seen in Figure 1.b. So even though the thermal conductivity of TIM materials can be high, and

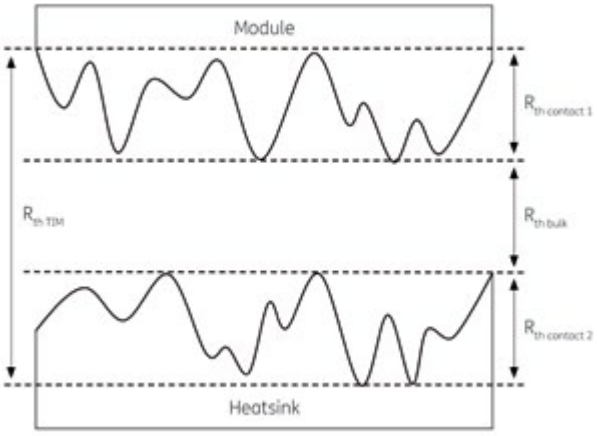

Figure 1.a) R_{th},T_{IM} composition layers

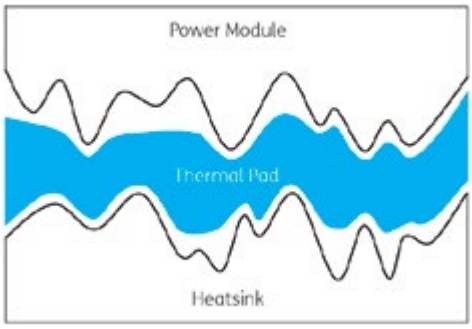

Figure 1.b) Example of a thermal pad in a module-heatsink contact layer

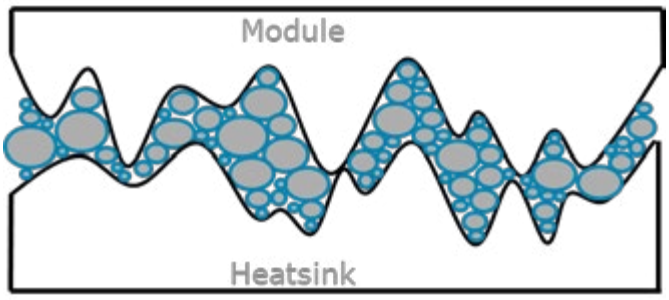

Figure 1.c) Example of TIM particles in module- heatsink contact layer (high filling degree)

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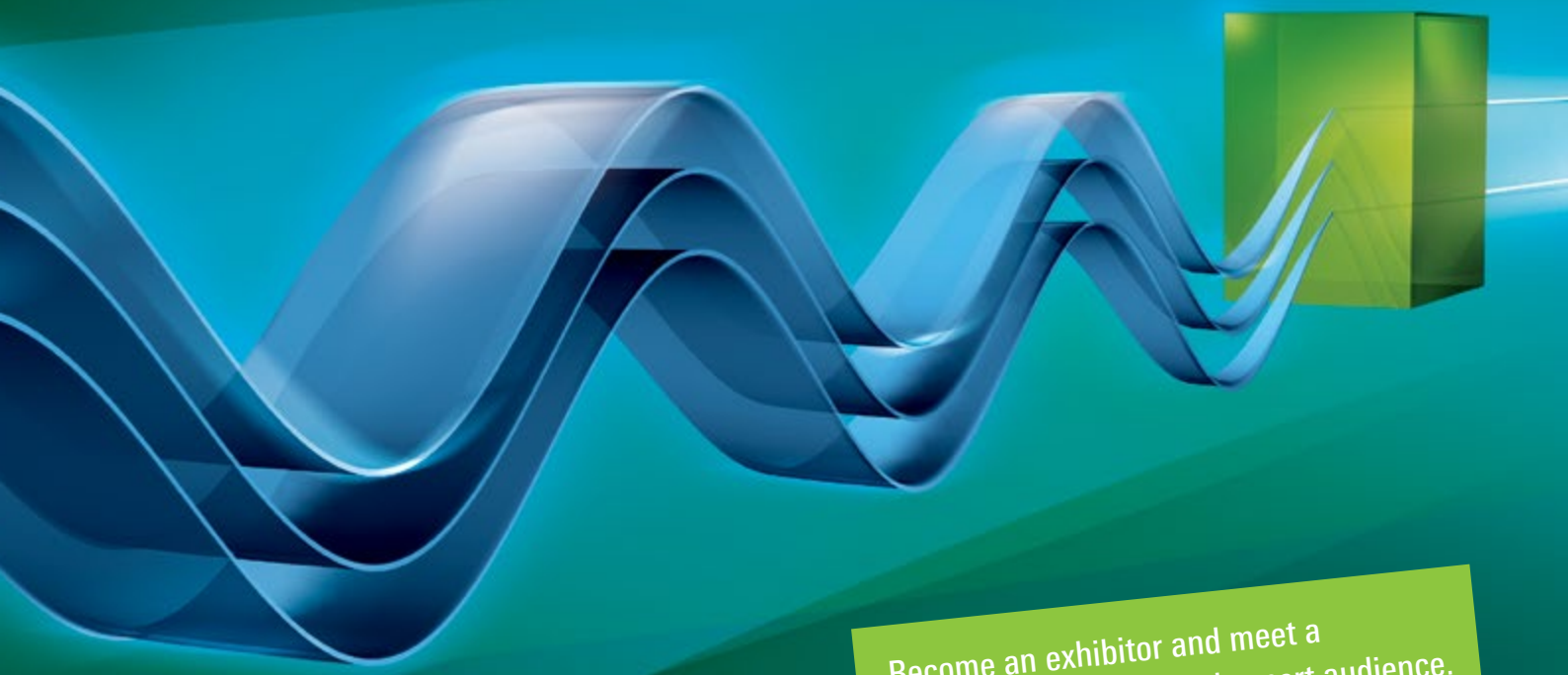

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thus the thermal bulk resistance $R_{th,bulk}$ low, the total thermal resistance for the TIM layer will not be optimal due to increased contact resistances $R_{th,contact}$.

Why does one paste perform better than another and surely better than a thermal pad? The answer is in the composition of the TIM with its two main components, the filling material (particles) as the thermally conductive material, and the matrix as a carrier material, responsible for the wettability. For the $R_{th,bulk}$ the filling degree is the most important factor, while the thermal conductivity of the single particle has less impact. The filling degree describes the volume of conductive material inside a compound, as shown in Figure 2. However, the $R_{th,contact}$ of the contact layers close to the metal surfaces is mainly defined by the particle size and the size distribution of these particles.

Therefore, for an optimum overall thermal resistance R_{th}, T_{IM} the filling degree, particle size, particle size distribution and, with less importance, thermal conductivity of the particles have to be optimized. SEMIKRON has done this with its High Performance Thermal Paste (HPTP). Figure 1.c. shows how differently sized particles help to fill in the rough surfaces.

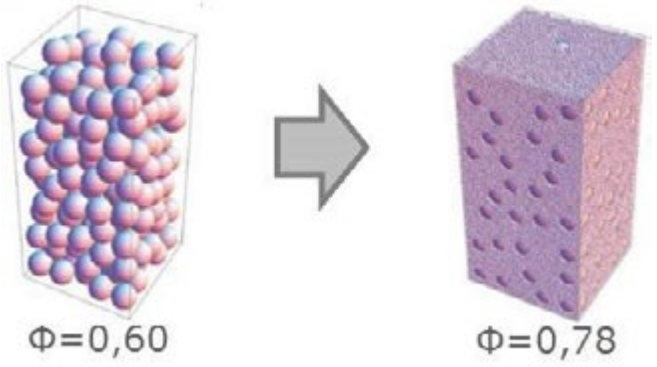

Figure 2: Example of different filling degrees Φ

The correlation of filling degree and overall performance is also visible for the HPTP: The data sheet value for the thermal conductivity is average, while the thermal performance when applied to the power module is superior, as discovered through a comprehensive benchmark test SEMIKRON performed.

Beside these factors, the power module and its mounting conditions also have a significant influence on the HPTP performance. An optimization of the thickness and distribution of the thermal paste, therefore has to be achieved for every power module type.

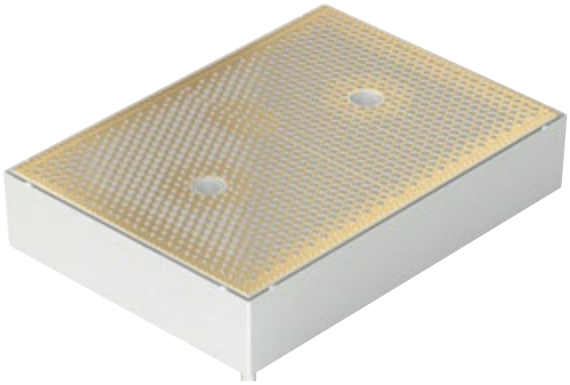

Figure 3: MiniSKiiP housing size 3 with optimized HPTP printing pattern

SEMIKRON has been printing TIM on power modules for more than 20 years, with more than 10 million pre-printed power modules in the field. SEMIKRON HPTP is available on several power modules, Figure 3 shows the bottom side of a MiniSKiiP with an optimized printing pattern. Every pre-printed module undergoes a comprehensive qualification program ensuring the long-time stability and performance of the TIM in the application as well as the shelf life before mounting. Along with industrial applications, more challenging requirements are also fulfilled, i.e. Automotive standards.

The second biggest portion of the overall $R_{th(j-s)}$ is the ceramic material, and here an optimization also makes sense. Alternatives to Aluminum Oxide (Al_2O_3) Direct Bonded Copper (DBC) substrates used today are widely available. Considering thermal and mechanical parameters Silicon Nitride (Si_3N_4) AMB (Active Metal Brazen) ceramics represents an ideal candidate having 4 times higher thermal conductivity and significantly higher figures for the main mechanical characteristics when compared to Al_2O_3: e.g the bending strength value is 650MPa compared to Al_2O_3's 450MPa and the fracture toughness is at least 7 MPa/(m^{-1}) compared to 4.2MPa/(m^{-1}). The brazing process also guarantees higher durability of the copper/ceramic joint, thus improved durability against thermal cycling.

With new materials used for optimization new qualification and testing specifications are also required. The AMB production process of Si_3N_4 substrates requires a brazing metallization layer, which usually includes silver too.

Silver can migrate under the influence of humidity and an electric field generated by a high DC voltage. Both conditions that commonly occur in power modules. This silver migration would result in a visible change of the substrate surface: A dendritic appearance of the migrating silver in the isolation trenches, see Figure 4. The standard test "High Voltage High Humidity, High Temperature Reverse Bias" (HV-H3TRB) will stimulate this effect.

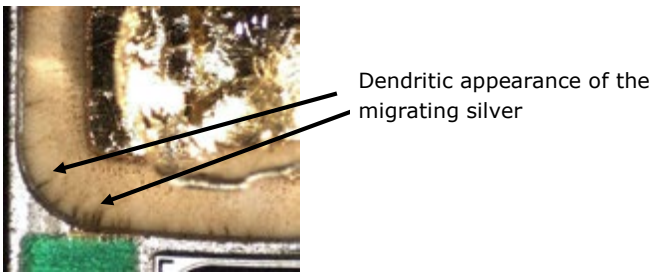

Figure 4: Example for Dendrites in the substrate's isolation trenches

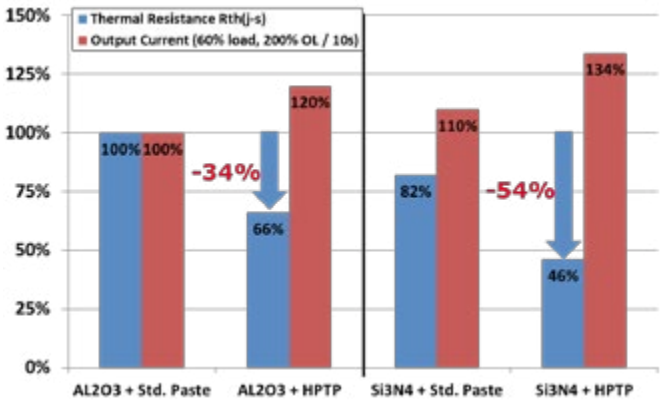

Figure 5: Application Benefits of HPTP and Si3N4 substrate in Motor Drive application (200% Overload / 10s)

To confirm that this effect has no negative impact on the product within the lifetime of the application, a newly introduced 'accelerated lifetime' test has been performed. This test reproduces real working conditions and is used to ensure reliability. The power modules are operated under climatic change, alternating between -15°C and 85°C and a relative humidity of 10% and 85% with 10 cycles and 12 hours per cycle. The modules are supplied with 540V DC bus voltage and switch with 1kHz of carrier frequency, without failure.

Figure 5 shows the benefits regarding $R_{th(j-s)}$ and output current capability. Based on a MiniSKiiP housing size 3 with six-pack topology, a typical motor drive application has been simulated. Just replacing the standard TIM with HPTP on the existing module using Al_2O_3 substrate, the $R_{th(j-s)}$ is reduced by 34%. Considering a standard motor drive application operating 4kHz with an overload of 200% for 10s, the result is a remarkable 20% higher output current at the same junction operation temperatures.

If the Al_2O_3 substrate is additionally replaced with Si_3N_4 using the High Performance Thermal Paste, the $R_{th(j-s)}$ is reduced by as much as 54% boosting the output power and therefore power density of the module by 34%.

We can see that the combination of state of the art Thermal Interface Material and Substrate Technology within the power modules boosts the output performance of a motor drive's application drastically. And all of this without compromising the lifetime of the module.

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Motor Drive Applications

Electric motors are all around us in appliances such as washing machines and refrigerators, and in transportation modes such as cars and in planes. We would not have many of the common modern conveniences we enjoy every day without electrical motors

By Patrick Baginski, Vincotech GmbH, Unterhaching/Germany

Introduction

The first motors were invented in the early 19th century by historical figures and company founders such as Werner von Siemens, Thomas Alva Edison, Nikola Tesla and George Westinghouse. Without electric motors everyday life would be very difficult to imagine.

But maybe even more important are the motors in industry which facilitated the assembly line conveyor belts used to manufacture consumer products and the motors designed into the automated welders used in the car industry. Motors also play important roles in other important sectors such as medical, aerospace, and renewable energy. There are two major applications where electrical motors are used. The first application is where motors are connected to the grid and are operated at a fixed rotor speed. The second is the wide application where motors need to be operated at different speeds and different torques. This application requires a power conversion unit to be placed between the grid and the motor and is usually known as a variable frequency drive (VFD). Let's have a closer look at the differences between the fixed frequency grid operated motors and the VFD operated motors and identify the advantages of each application.

Grid versus variable frequency drive

The end application determines if a motor needs to be operated by a VFD or just by the grid with a fixed frequency. Examples of fixed frequency grid driven applications are pumps or fans that move a medium without the need to adjust the medium's speed and some conveyor belts used in the mining industry.

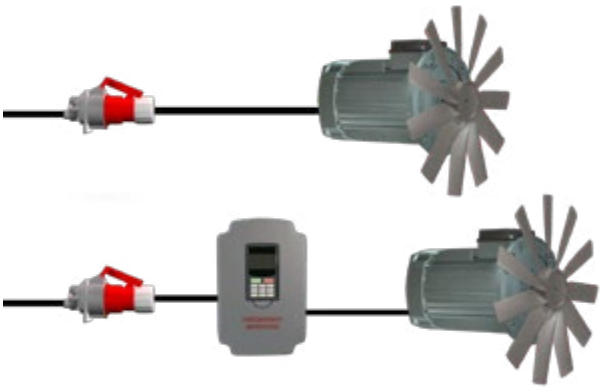

Figure 1: Grid versus variable frequency drives

In some applications, the medium needs to flow with different speeds or the pressure of the medium needs to be adjusted. Valves, dampers or gear boxes can adjust some of these parameters but with a lot of drawbacks because the fixed frequency grid driven motor always delivers full power in this case and a significant portion of power is converted into heat. Therefore in many applications, a large percentage of the electric energy is wasted because these uncontrolled motors are not operated at their optimum speed and torque which is determined by the load or work required to be delivered.

To overcome these power losses, variable frequency drives are used. With these power conversion devices, the speed and the torque of the motor can be adjusted within a wide range to meet the needs of different applications. The most important two parameters from a technical perspective are the voltage frequency determining the motor speed and the supported current which results in the motor's delivered torque. Commercially, energy and cost savings have been the major reasons for the increasing popularity of VFDs which typically are characterized by short payback periods.

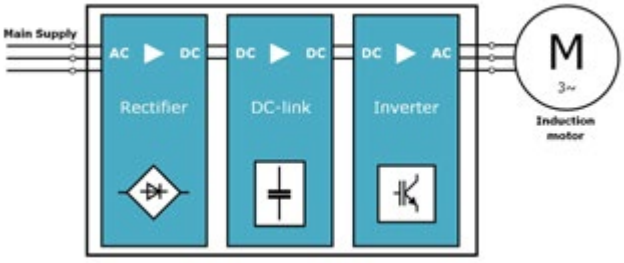

Figure 2: Main conversion steps of a variable frequency drive

Usually the energy conversion process from a fixed AC voltage to a variable AC voltage is as follows: First, voltage rectification from an AC grid voltage to a DC voltage, followed by smoothening of this DC voltage with capacitors and finally conversion of this filtered DC voltage back to AC with a frequency and voltage and determined by the desired motor speed and torque.

The most important conversion step in a VFD is the DC to AC inversion stage. A common solution to invert the DC voltage back to an AC voltage is the use of a Pulse Width Modulation (PWM) technique which normally requires a sinusoidal modulating wave and a triangular carrier wave. The triangular carrier wave is known as the switching frequency and varies between some hundred Hertz for high power drives to approximately 20 000 Hertz for lower power drives. The sine wave is a reference generated by the inverter's control circuitry and will be the frequency at which the motor will operate. By comparing triangular carrier and the reference sinusoidal waves, a pulse width modulated rectangle voltage will be the output of the VFD which changes its polarity at each crossing of the sinusoidal wave and the triangular wave. The modulated rectangular voltage drives the motor and results in a sine wave motor current with a high frequency ripple current similar to the triangular carrier's frequency.

Line operation versus VFD operation
Several advantages are experienced when a VFD is used to operate a motor.

The starting current of a grid connected AC motor can vary between 3 and 8 times its nominal current. This is because a huge amount of current is needed to magnetize the motor to overcome its inertia. This high current has to be provided by the grid and can cause issues such as voltage drops and transients and in some cases even a shutdown. These high currents also create mechanical stresses on the motor's rotor bars and windings. A VFD starts the motor at zero voltage and zero frequency and typically requires between 50 % to 75 % of the motor's current under full load.

As the motor's power is defined by its voltage times its current, the power demand during start-up is much lower by using a VFD compared to a motor which is directly connected to the grid. This is especially true at start-up if the load power demand is the same on grid or with a VFD. If a company is at its power limit with its existing electrical installation system, new installed machines without VFDs can generate unsupportable high start-up currents and force these operators to upgrade their electrical systems to carry these peak currents. Also, some companies are charged extra for the peak power provided by the electrical utility. A VFD is a good solution to resolve these start-up surge current issues.

Motor start-up causes a high input current which causes a voltage drop on the line. Some sensitive equipment can trip offline due to these low voltage drops. For example, computers, sensors and contactors are known to be voltage sensitive and can drop out during low line conditions. The use of a VFD eliminates this issue as the motor starts with zero voltage/low input current and ramps up. Also, a speed and torque change appears on the motor's shaft when the voltage drops and the motor is operated directly from the grid. This might be quite unwanted in some manufacturing processes. Controlled drives can be designed to be less sensitive to grid voltage changes enhancing the "ride-through" capability of the motor.

An immediate motor start through the grid creates a huge mechanical stress to the motor and to the distribution system connected to the motor resulting in mechanical shocks. A VFD can accelerate the motor with a defined ramp reducing shocks to a negligible level. In some applications it is not possible or acceptable to accelerate the machine to its maximum power and speed without a smooth controlled ramp.

The most important advantage of a VFD is its ability to adjust the motor speed to the needs of the whole application. The second most important advantage is its ability to adjust the motor's torque. This is quite a nice feature which protects the motor and the system driven by the motor from damage as the torque can be limited or precisely adjusted. Also, power savings can be considerable by being able to control the motor's torque. For example, a VFD driven motor connected to a fan will only consume 1/8th of its rated power when operating at half speed due to the cube root speed-to-power relationship of this system.

The controlled stopping or braking of a motor can be as important as its controlled acceleration. The greatest advantages of VFDs are realized in the braking of elevators and conveyer belts. This braking or reverse operation of motors is of great interest in many other applications. Reverse operation is possible by changing the rotary field in the motor by the VFD without having to change the order of the phase cables to the motor. VFD's also eliminate the need for vales, dampers and gear boxes. This leads to more compact systems, lower maintenance and lower operating costs.

Main components used for power conversion
The important components inside a VFD are the power rectifier diodes used to rectify the AC input voltage, the brake chopper which is used to dissipate the regenerated energy from the motor during braking and protects the DC link capacitor from damage, and the power semiconductor switches used to convert the rectified input voltage back to a controlled variable voltage and variable frequency output. The requirements of the rectifier diodes are not that great since these devices operate at the input line frequency (50 Hz or 60 Hz) and are available from many suppliers. Requirements for the components used for the DC to AC conversion stage need to be considered carefully as these power semiconductor switches are used at high voltage and high currents and switched at high frequencies. Usually IGBTs are used as the semiconductor switches due to their optimization for these applications and designer familiarity for these industrial applications.

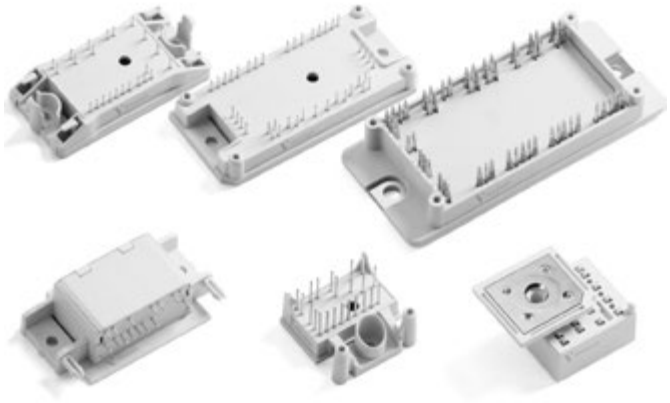

Figure 3: Overview of standard housings for drive applications

Today, many companies develop semiconductors and power modules that can be used in VFD designs.

Vincotech has been in this market for over 25 years with low and medium power VFD module experience and continues to develop new standard, optimized and customer specific VFD modules in the 600 V and 1200 V low and medium power markets.

Starting from CIB (converter, inverter, brake) modules to half-bridge modules and rectifier modules to inverter modules, Vincotech can meet many designer's cost targets, high efficiency and performance requirements.

Conclusion
Modern life is unthinkable without the benefits provided by variable frequency drives. With VFDs, induction motors can have their speed and torque adjusted, inrush currents are much lower and reverse operation is easily implemented. The most important advantages VFDs provide are lower system operating costs, the absence of additional mechanic components and savings in electrical energy. All in all induction motors and variable frequency drives contributed to our daily convenience and provide us with a more efficient and cleaner environment.

www.vincotech.com

Using a Modular Power Stage to Rapidly Prove the Design of a 14 kW, 800 V LLC

The LLC topology has been gaining favour recently as a possible topology for electric vehicle (EV) chargers, witness several papers at this year's IET PEMD event. Evaluating some of the performance trade-offs in the design of the magnetic components in the resonant stage at an early stage is useful.

By Anthony Middleton MIET, Senior Designer, Converter Technology Ltd., Pangbourne, UK

The Converter Technology Hardware Stack™ modular platform provides an ideal way to investigate the operation of an LLC in the 10 kW – 15 kW region. Providing a 1.2 kV, 25 mΩ Silicon Carbide (SiC) 3-phase full-bridge module and integrating a protection stage (OVP, OCP etc.) plus a powerful, Delfino™, 32-bit micro-controller. The controller can configure the system to use one, two or three legs of the module and provides a platform upon which complex (or simple!) control strategies may be implemented and investigated.

The design focus can now be solely on the system performance rather than the details of the PCB design, controller selection etc. greatly reducing the time and effort needed to validate a system concept and prove the magnetic design for example. Figure 1 shows the Hardware Stack™ power stage on the left with the output rectifier stage bottom right and the resonant inductor, capacitor and transformer top right.

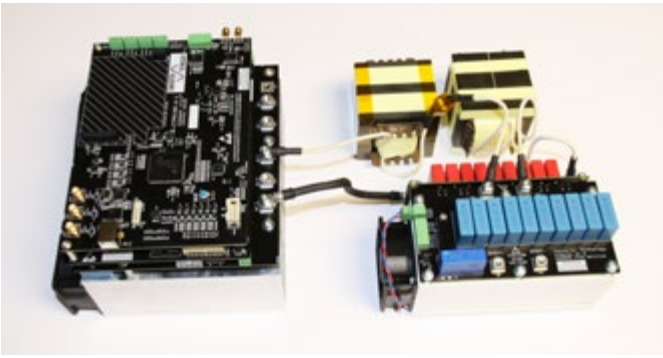

Figure1: Hardware Stack™ based LLC

The LLC as a DC Transformer

For simplicity the system was run as a DC transformer, that is open loop and operated at a fixed frequency. One of the key features of the LLC is that operation at the series resonant frequency, f_S, decouples the output load regulation from the resonant behaviour thus giving minimal voltage variation without the complexity of a control loop.

With a 1:1 turns-ratio on the transformer as implemented here, this could be used as an isolating stage after an AFE or, by changing the turns-ratio of the transformer, to provide a semi-regulated output at a more suitable voltage for the load.

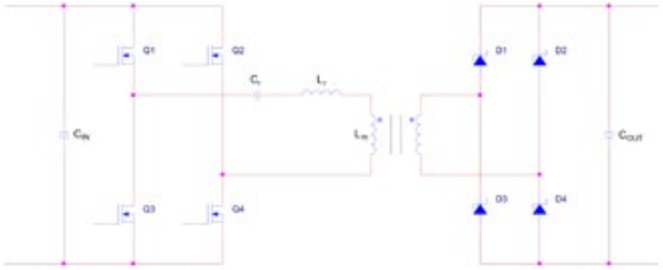

Figure 2: LLC Power Stage

With reference to figure 2, the series resonant frequency is a function of the resonant inductance, L_r, and the resonant capacitance, C_r, and is independent of the magnetising inductance, L_m. Moving the switching frequency, f_{SW}, away from f_S shows the gain increasing for lower frequencies and reducing for higher ones, the relatively shallow slope above fS highlights the control range issue.

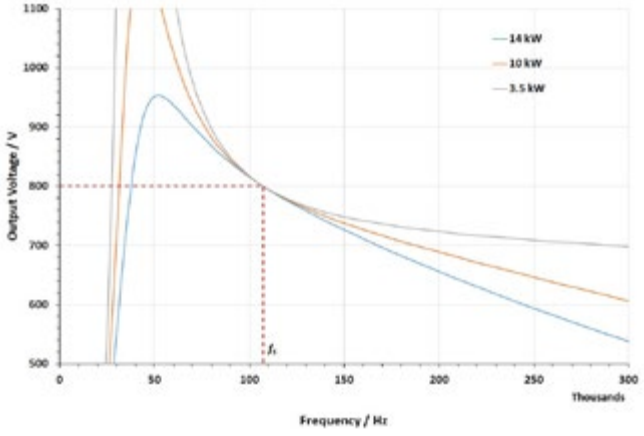

Figure 3: LLC Gain curves

The shape of the resonant curve shown in figure 3 is controlled not just by L_r, C_r and L_m but also by the turns ratio and the load impedance. With many permutations possible a means to rapidly check the preliminary design is advantageous.

A basic specification of 800 V input to 800 V output at 14 kW formed the basis of the design. The operating frequency was initially targeted

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at 100 kHz with the intention of further investigating operation at higher frequencies. A limitation of the DC supply meant that testing could only be conducted up to 600 VIN and thus 600 VOUT; this has minimal effect on the operation of the LLC.

Targeting f_S = 100 kHz, and based on a load impedance, R_L, of 30 Ω, and Q of ≈2; C_S, L_M and L_S were calculated as 100 nF, 160 µH and 22 µH. This gave f_S at 107 kHz, an L_M/L_S ratio of 7.3.

Both the transformer and inductor were constructed using Litz wire on dual E70/30/32 bobbins with 3F3 ferrite and gapped to achieve the desired inductance. It is worth noting that these are not necessarily the optimum designs, the idea was to highlight the speed with which a prototype could be constructed.

For the resonant capacitor we need a specific capacitance and a minimum ripple current capability. Furthermore, the resonant frequency of the capacitor needs to be above f_{SW}. The resonant capacitor was thus constructed using a 2x9 array of metallised polypropylene capacitors to achieve a capacitance of 100 nF, a ripple current capability ≈27 ARMS at 200 kHz and a resonant frequency in the region of 2 MHz.

Performance

Looking at the switching waveform shown in figure 4 it can be seen that the system is operating almost exactly at f_S, it is actually slightly above, at 108 kHz, and a very small step can be observed in the current waveform. The voltage transitions show full ZVS operation, the rounded corners highlighting the non-linearity of the node capacitance. Varying the frequency either side of f_S showed a small change in efficiency as well as the expected change in output voltage.

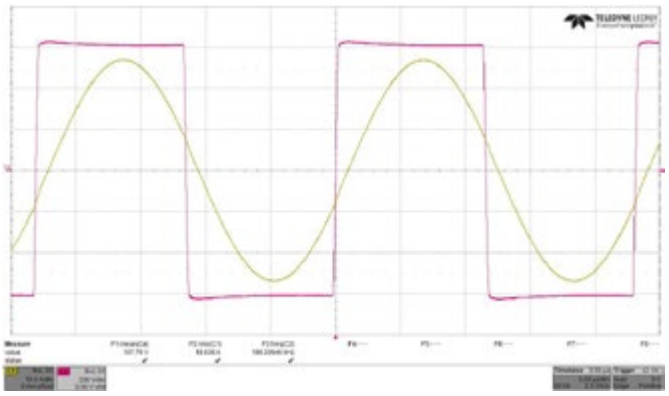


Figure 4: LLC Switching waveform

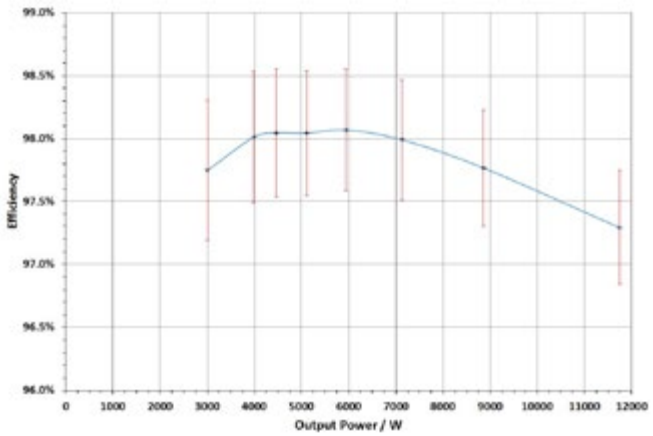


Figure 5: Efficiency vs Output Power

Varying the output load showed minimal variation in VOUT, less than 6 V difference between 5 A and 20 A load, and the current at the switching transition is independent of load ensuring ZVS.

The efficiency varies with load as shown in figure 5; the drop in efficiency at higher power is unexpected but likely related to the magnetics and rectifiers. This has not been investigated so far, but it would be expected that the efficiency should remain in the 98% region up to full power, indeed further investigation may yet yield higher efficiency all round.

On the Subject of Efficiency

The difficulties in measuring the efficiency are evident in the error bars shown in the efficiency curve and even more pronounced when the power dissipation is considered, figure 6. The uncertainty in the power measurement has been calculated at around ±0.23% giving an efficiency uncertainty of ±0.45%.

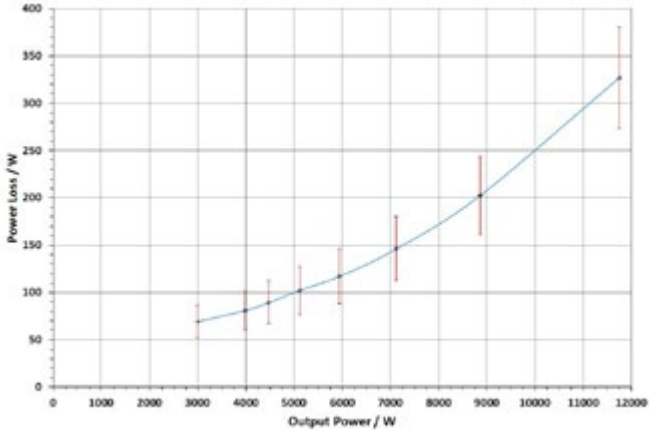


Figure 6: Power Loss vs. Output Power

Taking the difference between two large values with small errors leads to a relatively large error in the result; this translates into an uncertainty in the dissipated power of around ±16% to ±24%. In other words, the possible power loss could span a near 2:1 range! At 11.8 kW the power dissipation could be between 273 W and 381 W, not insignificant. This is based on the measurement errors being completely uncorrelated. Clearly for precision measurements, techniques such as calorimetry are necessary.

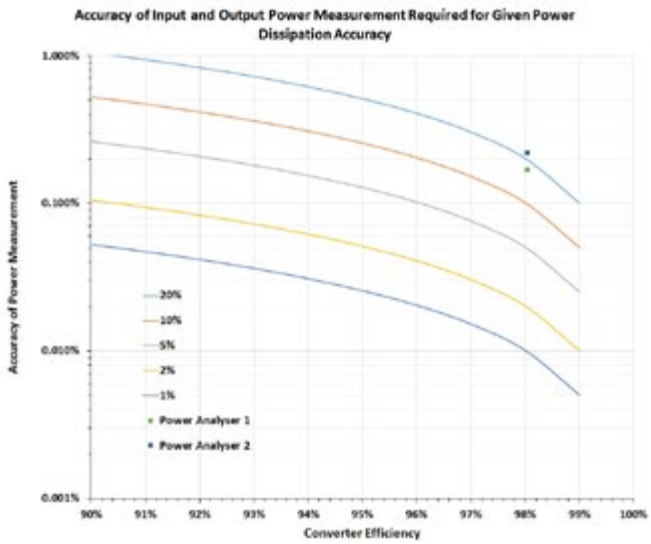


Figure 7: Power dissipation accuracy

In order to achieve even 10% accuracy on the dissipated power in a 98% efficient system requires that the input and output power are measured to better than 0.2% accuracy. Fig.7 shows how the measurement accuracy affects the accuracy of the calculation of dissipated.

Based on thermal measurements and modelling (using PLECS) the actual efficiency and power loss is much closer to the measured value than the uncertainty in the measurements indicates and 98% is not unreasonable. Furthermore, since the testing was conducted at 600 V the efficiency at 800 V, which is the real target, would be even higher due to reduced I^2R losses.

Conclusion

The LLC provides a very clean switching environment, the soft switching providing a very efficient converter that should also minimise the EMC burden. Whilst there is some work required to determine the best fit for the resonant components it has demonstrated itself to be a relatively straightforward topology to work with, of course transient conditions yet to be investigated will likely introduce complications!

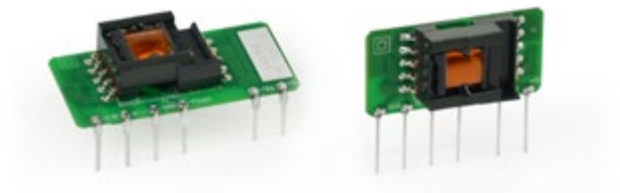
Implementing a multi-kW system using the modular building block approach characterised by the Hardware Stack™ was both quick and straightforward. A working converter was running within 1 – 2 weeks dictated mainly by the time to obtain cores etc. Within this timeframe a 98%+ efficiency is very encouraging, and the platform provides a solid base upon which to refine the magnetic/resonant design and determine the specification for the power devices, heatsink etc. (Note the heatsink for Hardware Stack™ is deliberately excessive and additionally provides a mechanical base).

Further work on the LLC is intended to look at the impact of increased switching frequency amongst other things. Equally Hardware Stack™ will be used to investigate further power stages such as an AFE, inverter etc.

www.convertertechnology.co.uk

Ultra-Compact Open Frame AC-DC Power Supplies

CUI Inc announced a family of ultracompact ac-dc power supplies in an open frame SIP package. The 3 W and 5 W configurations of the PBO series measure as small as 35 x 11 x 18 mm (1.38 x 0.43 x 0.71 in), allowing them to occupy less board real-estate than other power solutions. The 3 W models are also available in low-profile, right-angle versions measuring as small 35 x 18 x 11 mm (1.38 x 0.43 x 0.71 in), making them ideal for applications where vertical board space is at a premium.



Available with typical efficiencies up to 80%, the high density PBO series offers a wide input voltage range of 85 to 264 Vac or 70 to 400 Vdc for high voltage dc-dc systems. Single output voltages of 3.3, 5, 9, 12, 15 and 24 Vdc are available depending upon the series. For use in challenging environments, the 3 W models offer a wide operating temperature range of -40 to +85°C while the 5 W models provide a range from -25 to +85°C. Additionally, all models are designed to provide 3,000 Vac input to output isolation.

The PBO series also meets UL60950-1/EN 60950-1 standards, complies with EN55022 Class B limits for conducted and radiated emissions and includes over current and short circuit protections. The ultracompact models are ideally suited for a variety of applications including industrial systems, automation equipment, security, telecommunications and smart home devices.

http://www.cui.com/contact

Industry's Lowest-Power Vehicle-Access solution

Microchip announces the industry's lowest-power Passive Entry/Passive Start (PEPS) solution: The ATA5700 and ATA5702 are primarily intended for use in battery powered applications such as smart keys (i.e. PEPS) and complementary car access via mobile devices, smartphones and wearables where the power consumption is one of the key requirements.

Key benefits of the new devices include ultra-low power consumption, outstanding key localization accuracy and unique built-in counter relay ("man-in-the-middle") attack protection measures. Car theft based on relay attacks of vehicles equipped with a PEPS system is becoming one of the top security concerns of automakers. The two new devices have a unique built-in Low Frequency (LF) vector calculation unit that allows customers to implement effective relay attack countermeasures at no additional cost.

The new devices also feature excellent low frequency sensitivity, enabling convenience features such as customized welcome-lighting upon approaching the vehicle or automatic "walk-away locking" of the vehicle – in a range up to 10 meters. The power consumption for this "always on feature" is industry leading, tripling the battery lifetime in the highest sensitivity mode. The devices offer the highest key localization accuracy in the market which is critical to accurately distinguish whether a key fob is located inside or outside the vehicle and to comply with accuracy requirements of insurance companies.

www.atmel.com/devices/ATA5700.aspx

KMS-A Series of Single Output, Medically Certified

TDK Corporation announces the introduction of the KMS-A series of single output, medically certified 15 - 60W encapsulated power supplies. With a Class II input, the products require no earth ground connection, making them ideal for use in a range of medical, dental and home healthcare. They are also suitable for broadcast, test & measurement and industrial equipment applications.

Comprising of three power levels, 15W, 30W and 60W, the KMS-A is available in 5V, 9V, 12V, 15V and 24V output voltages. Off-load power draw is <0.1W for the KMS15A and KMS30A and <0.3W for the KMS60A with product efficiencies as high as 89%. All models can operate from a wide range input voltage of 90-264Vac.

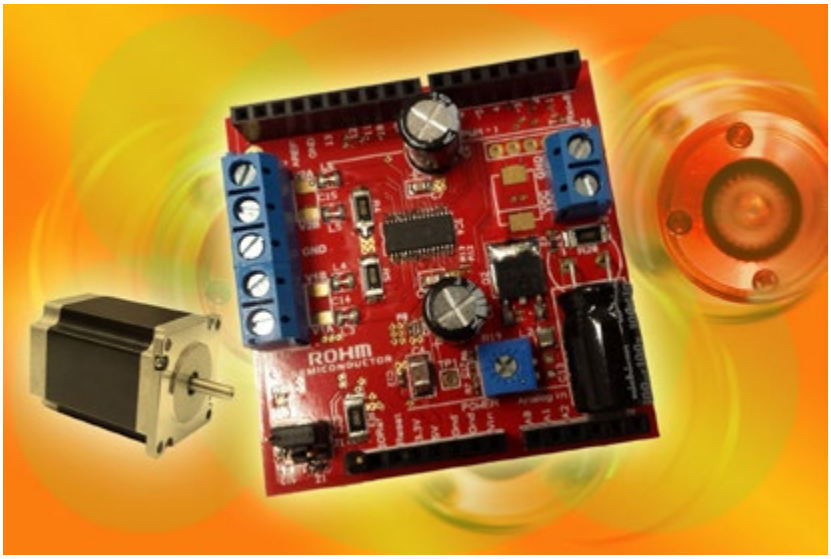
The KMS-A power supplies are suitable for board-mounting and are enclosed in UL 94V-0 rated resin cases. The 15W measures 52.5 x 27.5 x 23.5mm, the 30W 64.0 x 45.0 x 23.5mm, and the 60W 89.0 x 63.5 x 27.0mm. The products can operate convection cooled in ambient temperatures of -40°C to +85°C, with appropriate derating above 50°C, and have a maximum operating altitude of 5,000m.

www.de.tdk-lambda.com/kms-a

Arduino Shield for Easier and Faster Stepper Motor Driver Designs

At SPS in Nuremberg ROHM Semiconductor presented its Arduino-based evaluation kit (EVK) to support the evaluation of its motor driver devices as well as to enable, facilitate and accelerate customers' developments. Designed as a 'shield' to plug directly into the Arduino main board, this EVK integrates a ROHM's HTSSOP-B28 packaged stepper motor drive IC and complements ROHM's support ecosystem, allowing engineers to rapidly prototype their stepper motor systems.

Arduino is a widely used open-source platform. The new EVK comes in 15 different variants for ROHM's stepper motor driver ICs– from standard, micro step, low voltage to high voltage. This comprehensive solution covers supply voltages from 8V to 42V, enables up to 2.5A per phase, as well as micro-stepping and single- or multi-phase control of one or two stepper motors. It is ideally suited to drive bipolar stepper motors available in a wide range of supply voltages and current capabilities. It drives with CLK-IN or PARA-IN variants and provides high efficiency, easier power control and comprehensive protection functionalities in a robust and compact design, enabling accurate fine-tuning of the motor performances. Moreover, the EVK is designed to be stackable so that a second shield can be added on top to drive two motors.



The 'easy to adapt' kit is supplied with a software library, an extensive user guide and example programs to facilitate a rapid learning curve. Once the design is proven, engineers can move rapidly from prototype to production phases fully supported by the Bill-of-Materials (BOM) and Gerber-based PCB layouts that are provided as well.

www.rohm.com/eu

First Device in Family to Implement “Flexible Power Islands”

Silego Technology announces the SLG46125, further expanding the GreenPAKTM (GPAK) family of Programmable Mixed-signal ICs. This newest GPAK can serve as an ultra-small power management IC which contains a rich set of features, including voltage monitoring, power sequencing, reset and power switches that are configurable in settings and interconnect. This device is the first in a series of parts designed to create “Flexible Power Islands” (FPI).

There are many challenges when designing power systems for hand-held and wearable devices. In each succeeding generation, power systems are becoming more complex, and yet the overall board area devoted to power components keeps getting smaller. To overcome these challenges, Silego has developed the concept of “Flexible Power Islands”. Using FPIs, designers can divide their complex power system into some number of local power regions (or islands), each of which includes the power control, power sequencing and power regulation needed to support loads in the immediate vicinity. We believe this technique results in higher performance and a more efficient solution that can be flexibly tailored to the requirements of each individual system.

With the SLG46125, Silego has captured many of these necessary

power system functions (power monitoring, sequencing, reset and power switching) in a tiny 1.6 x 2.0 mm 16-pin MSTQFN fully encapsulated plastic package. Using Silego’s easy-to-use GUI based GPAK Designer™ and GPAK development hardware, designers can quickly and easily implement their unique configuration of the device, thereby customizing the functions to match their unique power requirements.

http://www.silego.com

iMOTION™ Modular Application Design Kit with Two Power Boards

Infineon Technologies AG adds two power boards to the family of iMOTION™ Modular Application Design Kits (MADK). The two half bridge boards complement the compact and flexible evaluation system providing a scalable design platform for 3-phase motor drives in the range from 20 W to 300 W. The MADK aims at applications in the field of industrial and home appliance, e.g. pumps, fans, air conditioners and major home appliances. The new power boards additionally address battery powered applications. Using the kit, a functional motor system will be running in less than one hour, enabling fast time to market.

The power boards are based on the µIPM™ from Infineon and come in power ratings of 100 V/20 A and 40 V/6 A. They feature an overcurrent/under-voltage lockout protection with fault output and an onboard power supply of 15 V and 3.3 V, respectively. Since no heat sinks are required, developers can optimize the copper area of the PCB for thermal performance. In combination with an XMC1302 or IRMCK099 control card, designers only need a few steps to run the motor: plug the cards into the PC, motor and grid equivallent voltage supply and download, install and set the parameters of the software.

The Field Oriented Control (FOC) software supports sensor-less motor control based on the XMC1302 microcontroller. The XMC1302 control card includes a debugger based on Segger J-Link technology. The IRMCK099 based control card with debug MCE-tool 2.0 features the patented and field proven motor control engine (MCE) from former International Rectifier.

www.infineon.com/MADK

High efficiency 1 kW baseplate-cooled full-brick DC-DC converter

Murata is announcing the third modular DC-DC converter development effort from Murata Power Solutions designed for industrial 12 & 24 VDC systems. The ICF series follows the same design principles to provide an industrial grade, rugged, high-power, baseplate-cooled DC-DC converter. Capable of delivering up to 1,000 Watts from an input source of 9 to 36 VDC with a typical efficiency rating of 96.4%, the ICF series offers two output voltage options (24 VDC or 28 VDC) and is packaged in an enclosed industry-standard full-brick package. Measuring 119.0 x 64.0 x 13.2 mm (4.7 x 2.5 x 0.52 inches), the converter is enclosed in a specially designed

package/baseplate that meets the environmental stress limits for shock and vibration specified in MIL-STD-810G, while offering full power with a baseplate operating temperature range of -40 °C to 105 °C without derating.

The ICF series achieves its high performance by incorporating proprietary circuit architectures, advanced packaging, and thermal design advances. Accommodating an input voltage range of 9 to 36 VDC, two single output models are available, providing a nominal 24 or 28 VDC regulated output. The outputs are fully isolated from the input supply, allowing flexibility for various grounding requirements or for creating positive or negative outputs.

www.murata.com

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PSMA Power Sources Manufacturers Association

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Introducing a New Lead-Free, No-Clean Solder Pastes

Alpha Assembly Solutions, the world leader in the production of electronic soldering and bonding materials, is introducing its new lead-free, no clean solder paste technologies.

ALPHA® OM-353 is an ultra-fine feature print and air reflow-capable solder paste that is ideal for assemblies sensitive to component warpage or processes that require cleaning. It has been tested to give excellent printing performance down to 180µm pad size.

ALPHA® OM-535 is a low temperature paste with excellent drop shock resistance and electrical reliability for low temperature reflow applications. It produces excellent solder joint and flux residue cosmetics, even when using long/high thermal soaking.

"These pastes were developed to meet new printing challenges and performance demands", said Traian Cucu, Global Product Manager for Solder Paste at Alpha Assembly Solutions, a part of the MacDermid Performance Solutions Group of Businesses. "Each has unique assets to quell reliability concerns. OM-353 has excellent transfer efficiency with small area ratios and ensures high pick-and-place yields and good self-alignment. The enhanced properties of low temperature SBX02 alloy combined with the advanced chemistry performance of OM-535 enables the formation of a better solder joint by improving the mechanical performance and cosmetics using low temperature process settings."

www.AlphaAssembly.com

Automotive-Grade Surface-Mount Fuses

AEM Components announces the availability of its new line of AEC-Q200 qualified surface-mount fuses designed specifically for reliable operation in high-stress automotive applications. The new wire-in-air AirMatrix (QA Series) and solid body SolidMatrix (QF Series) fuses are manufactured in AEM's TS16949-certified facility. The two product series together offer automotive design engineers with products that assure reliable performance in applications ranging from engine controls and battery-management systems to infotainment and communications systems.

The QA Series features the industry's highest current ratings – up to 20A/250V. Its proprietary, hermetically-sealed wire-in-air structure assures consistent electrical performance The QF solid-body fuses utilize AEM's proprietary, anti-sulfur end-cap construction and provide superior mechanical and thermal stability over a wide temperature range (-55°C to +150°C).

The QA Series is offered in two fast-acting versions: a 2410 package with a 0.5-20A/65-250V rating and a 1206 package rated at 1.5-15A/32-65V. Auto-grade QF parts are offered in fast-acting and time-lag versions, and in 1206 and 0603 versions with current ratings up to 8A.

www.aemcomponents.com

Extended Range of CeraLink™ Capacitors

TDK Corporation presents an extended range of CeraLink™ capacitors based on PLZT ceramic (lead lanthanum zirconate titanate). The low profile (LP) types for SMD soldering are now available with a voltage of 500 V and a capacitance of 1 µF, or with 700 V and 0.5 µF. The capacitors are characterized by their extreme volume efficiency and compactness. The dimensions of the variants with L-style terminal, for example, are 10.84 mm x 7.85 mm x 4 mm. Thanks to the compactness and the permissible maximum temperature of 150 °C, these capacitors can, for example, be embedded as snubber capacitors directly into IGBT modules.

The new types with J-style terminal have an even more compact design, with dimensions of just 7.14 mm x 7.85 mm x 4 mm. One great advantage of the CeraLink LP types is their extremely low ESL of just 2.5 nH.

The CeraLink solder-pin (SP) type is available for higher capacitance values of 20 µF and 10 µF for the rated voltages of 500 V and 700 V, respectively. This type has a very low ESL of just 3.5 nH.

www.epcos.com/ceralink

Octal High-Side Switch and Driver Safely Demagnetizes Any Inductive Load for Industry 4.0

Designers of industrial controllers can safely drive and demagnetize any inductive load for Industry 4.0 applications with the MAX14913 octal high-side switch and driver from Maxim Integrated Products, Inc. (NASDAQ: MXIM). With a unique, innovative, safe-demagnetizing clamp on each output, it easily and reliably interfaces low-voltage digital signals to 24V output-control lines.

For most industrial applications, engineers need a high-side switch to control inductive loads. The challenge is how to discharge the energy in the inductor when the switch opens and current flow stops. If the inductance and the resulting stored energy are high, a driver IC could be permanently damaged due to the generated heat.

Using its safe-demagnetization feature, the MAX14913 can discharge and demagnetize any inductive load safely via its integrated clamps. For a more robust solution, it provides open-wire and short-circuit diagnostics, the most-common external failure mode. Its best-in-class propagation delay enables higher system speed and throughput. Compared to its predecessor, the MAX14913 achieves 15x space savings by eliminating 16 diodes from its previous solution.

In addition, it has eight 640mA high-side switches that can also be configured as push-pull drivers for high-speed switching. Applications include programmable logic controllers (PLCs), motion control units, drives, and other industrial and process automation applications.

www.maximintegrated.com

Seven DCMs in a ChiP Package

The DCM in a ChiP package is an isolated, regulated DC-DC converter, operating from an unregulated, wide range input to generate an isolated DC output. With its high frequency zero voltage switching (ZVS) topology, the DCM converter consistently delivers high efficiency across the input line range. Modular DCM converters and downstream DC-DC products support efficient power distribution, providing superior power system performance and connectivity from a variety of unregulated power sources to the point-of-load.

Aimed at a variety of applications, including UAV, ground vehicle, radar, transportation and industrial controls, Vicor has added four new 30V input nominal modules (9-50V range) in a 3623 Chip package (1.52 x 0.90 x 0.29 in). These converters have output voltages of 5, 24, 28, and 48 V, and power levels up to 160 W, achieving a power density up to 404 W/in3.

www.vicorpower.com/new-products/dcm

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Let’s write the future
with low-priced, high-performance small thyristors.

With ABB Semiconductors’ optimized small phase control thyristors (PCTs), we now offer very competitive products for voltage classes ranging from 1800 to 6500 V and current ratings from 380 to 1660 A in D and F housings (34- and 47-millimeter pole-piece diameters). ABB’s complete range of thyristors includes PCTs, bidirectionally controlled thyristors (BCTs), and fast thyristors with ratings of 1600 to 8500 V and 350 to 6100 A. **abb.com/semiconductors**

New 62mm IGBT modules

Highest power density and increased inverter output power with same frame size

Main features

- 1200 V: 600 A
- 1700 V: 400 A / 500 A
- Also available in ‘Common Emitter’ configuration for 3-level topologies
- Available with thermal interface material (TIM)
- Add value with the new 34 mm and 50 mm bipolar modules in solder bond technology

www.infineon.com/62mm