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Electronics in Motion and Conversion

August 2016

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GvA Power Electronics

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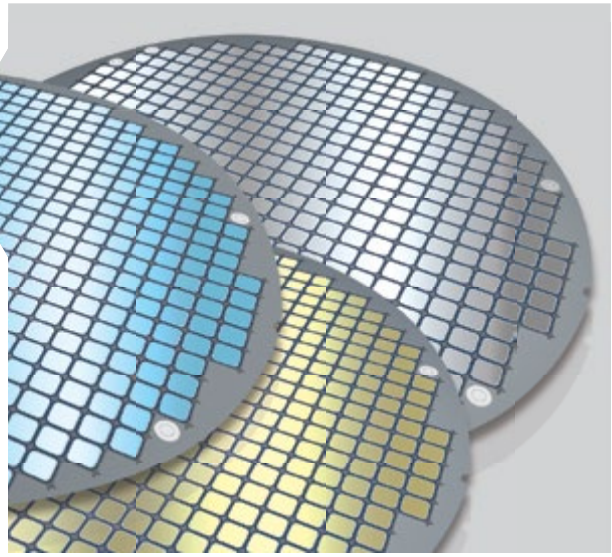

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Growing and Moving Ahead

As Bodo's Power Systems enters its next decade, our team here in Laboe has expanded to include Holger Moscheik who will

support us full-time. Holger will play an important role in helping me service our clients and readers around the world. Please join me in welcoming him to our team.

And we have other milestones to announce:

- We have begun a cooperation with EEPower to increase the distribution of the magazine content. EEPower is an interactive website that will publish the articles in my magazine, along with complete issues in PDF format.
- Bodo's Power China, published by the i2i Group, has established a strong presence in the Chinese market where we've been active since 2012.
- We are beginning cooperative efforts with ICC Media/AspenCore to support their webinar activity through my publication.

As we continue to grow we look forward to an exciting time over the next few months, and at all the coming events around the world. ECCE will take place in September in the USA and as EPE/ECCE in Germany. The biggest party for all of us in electronics is the semiannual electronica in November in Munich, and that will be followed by the sps/ipc/drives convention in Nuremberg.

For all the foreign business travelers we point out that the Oktoberfest in Munich starts on September 17th and ends October 3rd.

Strong progress in passive components is lining up with new highly efficient solutions made possible by wide band gap semiconductors. These converter designs are becoming more and more compact. GaN and SiC semiconductors have moved into the mainstream to provide higher efficiency. I am looking forward to EPE/ECCE in Karlsruhe to see the progress since PCIM.

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 web-site www.eepower.com. If you speak the language, or just want to have a look, don't miss our Chinese version: www.bodospowerschina.com

My Green Power Tip for August:
Pick your own strawberries in the fields. You can eat them while you pick! There they are as fresh as can be and if you ride your bike, it'll be not only a delicious but also an energy efficient experience!

Best Regards

Events

EPE ECCE 2016,
Karlsruhe, Germany, September 5-9
http://www.epe2016.com/

LED PROFESSIONAL,
Bregenz,Austria, Sep. 20-22
www.led-professional-symposium.com/

WindEnergy Hamburg,
September 27-30
www.windenergyhamburg.com/

ECCE 2016,
Milwaukee, WI USA, September 18-22
http://2016.ecceconferences.org/

CWIEME Chicago,
MI USA; October 4-6
www.coilwindingexpo.com/chicago

INTELEC 2016,
Austin TX, October 23-27
http://www.intelec.org/

SEMICON Europa 2016,
Grenoble, France, October 25-27
http://www.semiconeuropa.org/

electronica 2016,
Munich, Germany, November 8-11
http://electronica.com

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Current transducer range
Pushing Hall effect technology to new limits

To save energy, you first need to measure it! To maximise energy savings, you need to measure the current used accurately!
By using the most advanced materials available, LEM's new LF xx10 transducer range breaks new ground in accuracy for Closed Loop Hall effect transducer performance.
LEM ASIC technology brings Closed Loop Hall effect transducer performance to the level of Fluxgate transducers and provides better control and increased system efficiency, but at a significantly lower price.
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Infineon to Acquire Wolfspeed for US Dollar 850 Million in Cash

Infineon Technologies AG and Cree, Inc. announced that Infineon has entered into a definitive agreement to acquire the Wolfspeed Power and RF division ("Wolfspeed") of Cree. The deal also includes the related SiC wafer substrate business for power and RF power. The purchase price for this planned all-cash transaction is US Dollar 850 million (approximately Euro 740 million). This acquisition will enable Infineon to provide the broadest offering in compound semiconductors and will further strengthen Infineon as a leading supplier of power and RF power solutions in high-growth markets such as electro-mobility, renewables and next-generation cellular infrastructure relevant for IoT. Dr. Reinhard Ploss, CEO of Infineon Technologies AG, said: "Joining forces with Wolfspeed represents a unique growth opportunity. Wolfspeed's and Infineon's businesses and expertise are highly complementary, bringing together industry leading experts for compound semiconductors. This will enable us to create additional value for our customers with the broadest and deepest portfolio of innovative technologies and products in compound semiconductors available in the market. With Wolfspeed we will become number one in SiC-based power semiconductors. We also want to become number one in RF power. This will accelerate the market introduction of these innovative technologies, addressing the needs of modern society – such as energy efficiency, connectivity and mobility."

www.infineon.com

Appointment of President and CEO

Allegro MicroSystems, LLC, and its Board of Directors, has appointed Ravi Vig as President and Chief Operating Officer of Allegro and as a member of the Sanken North America, Inc. (SKNA) Board of Directors, effective immediately. Ravi previously held the position of Senior Vice President, Technology & Business Development.

Since joining the company in 1984, Mr. Vig has spearheaded significant strategic and advanced technology projects that have contributed to Allegro's overall growth and success. In 2015, Allegro reached a major milestone of 500 million dollars in revenue and the Business Development Organization, led by Mr. Vig, was a contributing factor to this key advancement in the company's history. "I am honored to lead the company into its next stage of growth and profitability. I look forward to strengthening Allegro's position as an industry leader in magnetic sensing and power IC's. Our focus will be on leveraging our core technologies and high quality manufacturing processes to create the next-generation of innovative products," said Mr. Vig.

www.allegromicro.com

Hosting Successful Customer Seminar in Liubliana, Slovenvia

Alpha Assembly Solutions last month hosted a customer seminar in partnership with Interkont Berger GmbH, it's distributor for Slovenia, in Liubliana, on the 31st May 2016. The seminar which was attended by 34 people from 12 customers focused on the topic of reliability. The event began with an introduction from Interkont's Sales Manager for Slovenia Matjaz Selijak. This was followed by Alpha's Sales & Technical Support Manager for Central Europe, Corné Hoppenbrouwers, who discussed the importance of reliability in electronic assemblies with particular emphasis on how Alpha's extensive product range provides innovative solutions for reliability issues.

Of Alpha's product range, ALPHA® Exactalloy® Preforms provide an excellent assembly solution, by both increasing the reliability and the conductivity of solder joints. Alpha's EM Sales Development Manager, Daniele Perico presented on how preforms can be used in a number of different applications and industries to increase reliability and reduce voids. ALPHA® Exactalloy® Preforms are used to precisely increase the solder volume in solder joints. The preforms increase the strength of the solder joints enabling them to withstand harsh operating conditions and improve conductivity. They also eliminate the need for wave soldering.

www.AlphaAssembly.com

Imperial College London Wins GaN Systems Geoff Haynes Future Power Challenge

At a ceremony held at the EPSRC Centre for Power Electronics Annual Conference 2016 in Nottingham, England, a post-graduate team from Imperial College London received the £2,000 prize for winning the first, annual GaN Systems Geoff Haynes Future Power Challenge. Sponsored by GaN Systems, the competition was open to all UK power electronics postgraduate students who submitted research papers or posters that contributed to accelerating the use of GaN transistors in future power conversion or control applications. Prof. Mark Johnson of The University of Nottingham and Prof. Barrie Mecrow of Newcastle University judged the competition at the annual summer school event organized by the PhD students of the 10 Universities that form the EPSRC power electronics center.

www.gansystems.com

Picture: Left to right: Mark Johnson, Paul Mitcheson, Sam Aldhaher, Dave Yates, Juan Manuel Arteaga Saenz, George Khelis, Geoff Haynes, Girvan Patterson

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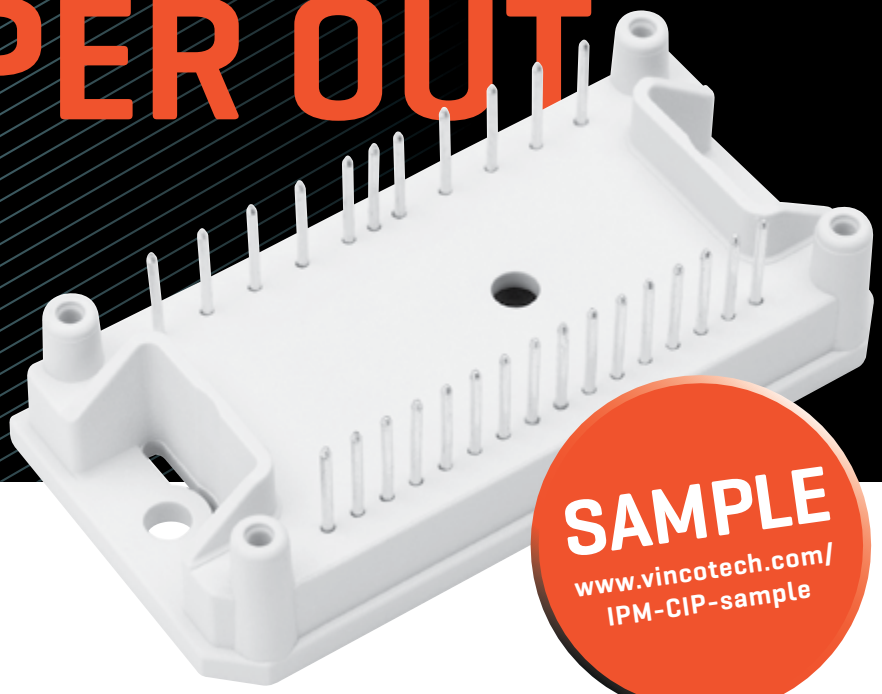
Vincotech



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10 A @ 80°C or 20 A @ 25°C

Passive components' size and price tag are a concern in sophisticated motion control systems. Our new deeply integrated 600 V IPM featuring a silicon carbide boost diode in the PFC circuit achieves the high switching frequencies you need to downsize your system's costs and footprint.

Main benefits

- Highly integrated and reliable
- Up to 150 kHz PFC switching frequency
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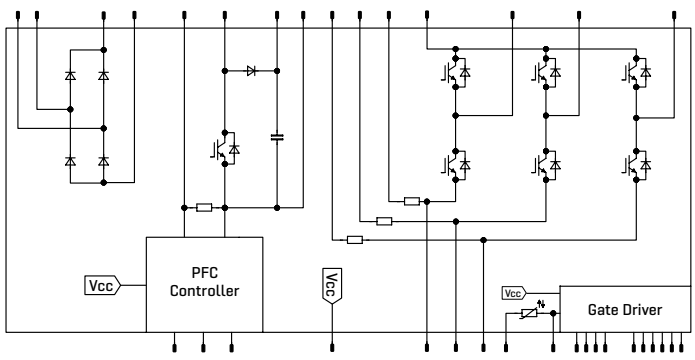
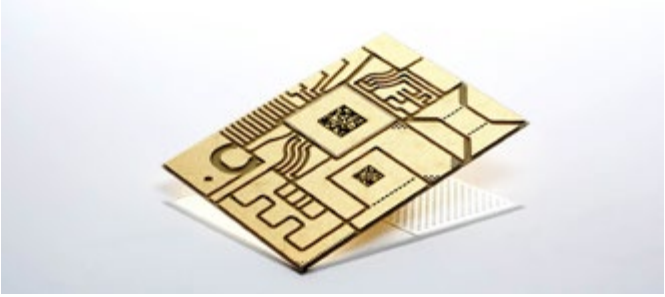


www.vincotech.com/IPM-CIP

EMPOWERING **YOUR IDEAS**

Adding Tracking/Security Numbers, Lot Numbers, and Production Dates

Rogers Corporation's Power Electronics Solutions group is introducing data matrix products codes on many of its metalized substrate materials, including curamik® ceramic substrates along with power modules, housings and baseplates. Data matrix codes are essentially two-dimensional matrix codes consisting of black and white square cells arranged in square or rectangular patterns as a unique form of identification.



Identifying Substrates: Rogers can add data matrix codes (DMCs) to a wide range of metalized substrates, including direct-bonded-copper and active-metal-brazed substrates. Codes, which can be text or numeric in form and encoded by code-reading camera systems, are written on metalized surfaces by means of a thin oxide layer formed by an optical laser system; no additional material is required on the substrate. In addition to bare copper surfaces, data matrix codes can be written on nickel (Ni), nickel/gold (Ni/Au), and silver (Ag) plated surfaces.

Standard data matrix code sizes are 2.3 × 2.3 mm and 3.0 × 3.0 mm, with other sizes available upon request. The single dot resolution is 0.164 × 0.164 mm. Positioning tolerance on a copper pad is ±0.3 mm. Using a data matrix code with 14 × 14 dots, for example, provides as many as 16 digits in a numeric code and 10 digits in an alphanumeric code.

PES Design Support Hub Resource for Engineers: Rogers PES brings its 40+ years of experience together in a handy online resource that is available 24/7. The PES Design Support Hub features complete technical information on ROLINX busbars and curamik ceramic substrates, a library of technical papers on product design and problem solving, helpful videos on products and power distribution topics, and PES University training programs. Registration for access is quick and free. The Design Support Hub helps design engineers increase power, manage heat, and ensure the quality and reliability of their devices for optimal new product design.

www.rogerscorp.com/designhub

Nottingham Electric Superbike to 3rd Place Win in Isle of Man TT Zero Race

The 8th June 2016 saw the University of Nottingham's (UoN) electric superbike become the fastest university-developed electric bike to go around the 37 mile Isle of Man road circuit winning 3rd place in the 2016 TT Zero race. Murata not only sponsored the bike but also provided IGBT gate drive DC-DC conversion technology which helped the team achieve the right balance of power output and energy preservation.

The Isle of Man TT Zero race is a particularly gruelling challenge for electric bikes because the length of the race requires performance to be balanced with energy usage, high speed being sacrificed for range to ensure a finish. Despite this the Murata/UoN bike, ridden by Daley Mathison, achieved an average speed of a fraction under 100mph, finishing ahead of the race favourite John McGuinness on the works Mugen/Honda.

www.murata.com

Picture: 2016 Isle of Man TT Zero winners (from left): Daley Mathison, UoN/Murata (3rd), Bruce Anstey, Mugen/Honda (1st), William Dunlop, Victory (2nd).

Ionic Contamination and SIR Testing at Upcoming SMTA Ohio Expo & Tech Forum

Alpha Assembly Solutions is participating in the upcoming SMTA Ohio Expo & Tech Forum on August 4th in Cleveland, Ohio as both an exhibitor and technical presenter.

A presentation on The Discrepancy Between Ionic Contamination and SIR Testing in Predicting Electrical Reliability will be given by Mitch Holtzer, Global Director of Customer Technical Support for Alpha Assembly Solutions. Among the topics covered, Holtzer will compare the results from testing two solder pastes using the IPC-J-STD-004B IPC TM-650 2.6.3.7 surface insulation resistance test, and IPC TM-650 2.3.25 in an attempt to investigate the correlation of ROSE methods as predictors of electronic assembly electrical reliability.

"Many users of no-clean solder pastes treat ROSE (Resistance of Solvent Extract) testing as suitable to ascertain whether or not flux residues will be detrimental to the long-term reliability of printed circuit assemblies", said Mitch Holtzer. "However, when compared to SIR (Surface Insulation Resistance) testing, the results of ROSE tests can be shown to provide different results than SIR on the same materials."

In addition, Alpha's exhibit will showcase their innovative materials and solutions for the electronics assembly industry with particular focus on ALPHA® Solder Paste & Preforms for Optimized Process Solutions and ALPHA® Wave Solder Alloy & Chemistries and Cored Solder Wire for Optimal Performance.

http://alphaassembly.com/en/Products/Alpha-Troubleshooting-Guides

http://www.smta.org/expos/#ohio

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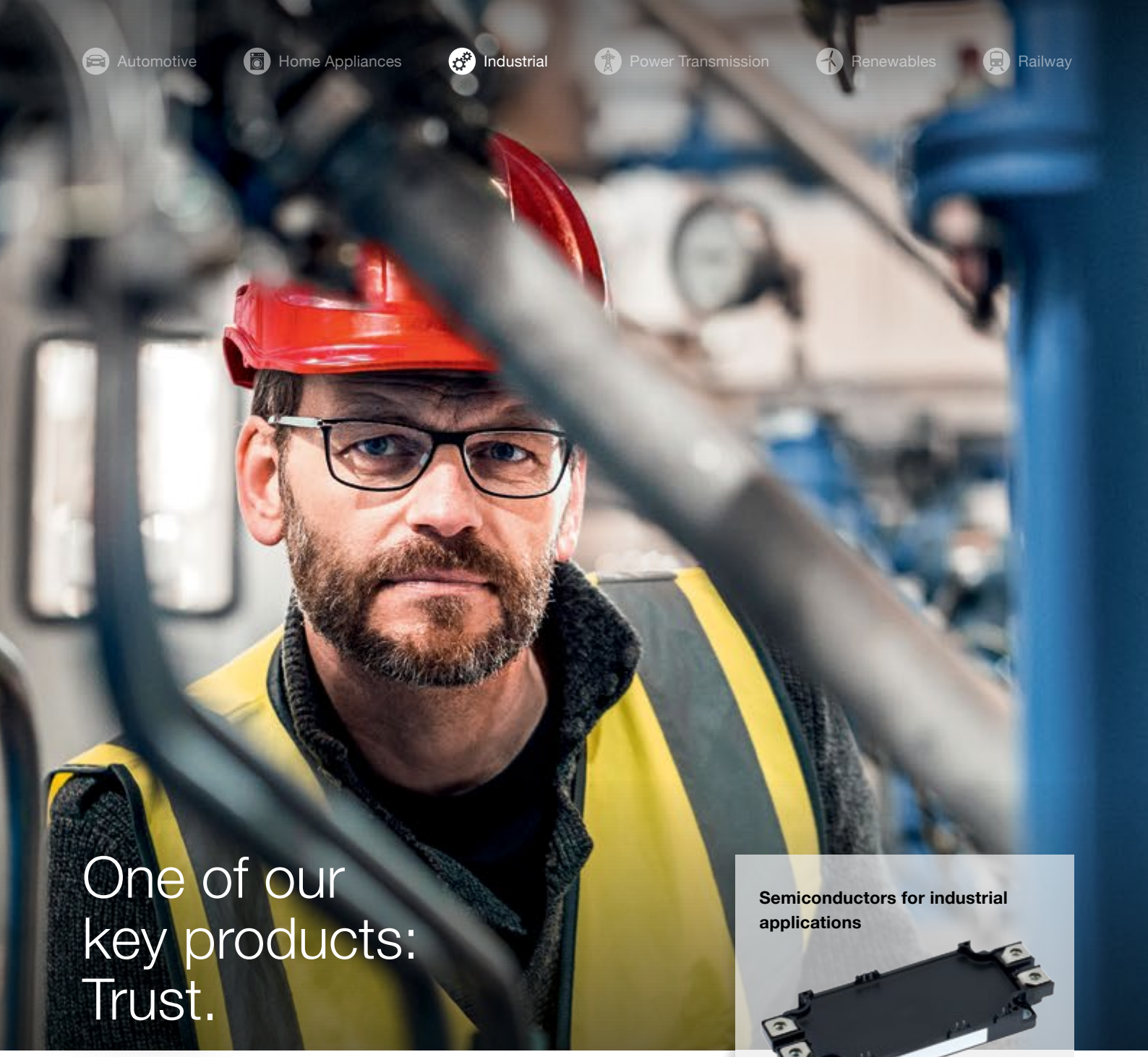

One of our key products: Trust.

Power Devices from Mitsubishi Electric.

Precise and efficient control of dynamic processes puts heavy demands on the components used. With 30 years history of IGBT production and continuously inventing pioneering technologies, Mitsubishi Electric provides superior experience and expertise to meet such requirements. Latest chip technology as well as mounting and assembly technologies offer user benefits like extended module lifetimes, high power density for compact design, easy system assembly and support of scalable platform concepts.

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7th Generation IGBT Modules NX-Package

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Changes for the Better

Global R&D Innovation Footprint with Opening of imec Florida

Imec, the world leading nanoelectronics research center, announced the opening of imec Florida, a new entity focusing on photonics and high-speed electronics IC design based in Osceola, Florida. Imec Florida kicked off with the signing of a collaboration agreement with the University of Central Florida (UCF), Osceola County and the International Consortium for Advanced Manufacturing Research (ICAMR), that is setting up fab facilities for the development and production of highly innovative III-V-on-silicon solutions for a broad range of applications including sensors, high-speed electronics and photonics. Imec Florida will be established as a design center facilitating the collaboration between imec's headquarters, based in Leuven, Belgium, and U.S.-based semiconductor and system companies, universities, and research institutes. Imec Florida's initial focus will be the R&D of high speed electronics and photonics solutions, starting with an offering of IC design research for a broad set of semiconductor-based solutions such as THz and LIDAR sensors, imagers, and a broad range of sensors. It will also provide IC design needs that will be driving the ICAMR manufacturing research. Through imec Florida, imec's design, prototyping and low-volume production service - also named imec IC-link - will provide the US market low-cost access to advanced foundry services, helping entrepreneurs to (industry and academia) design innovative products and get them to market.

www.imec.be

Smallest Motor Drivers of Battery-Powered Devices for the Internet of Things

With the expansion of portable technology in everyday life, new tiny, low-power electric-motor drivers from STMicroelectronics are enabling sophisticated battery-powered equipment to become smaller and more mobile with extended runtime.

Controlling the motors at the heart of devices like portable medical pumps and drivers, personal wellness devices, portable point-of-sale devices, miniature robots, surveillance equipment, precision tools, and portable printers requires considerable engineering know-how.

One of the biggest challenges is to combine logic and power components in a single chip on tight space and power budgets.

ST has now gathered all of these ingredients together in its new line-up of tiny single-chip motor drivers that meet the needs of the most demanding portable and wearable applications. The combination of low power consumption, small form factor, and outstanding performance of ST's new motor drivers is set to contribute to the widespread adoption of battery-powered IoT devices.

Measuring just 3mm x 3mm, ST's new devices are the world's smallest single-chip motor drivers integrating all the functionalities to enable product designers to deliver compact, lightweight, and user-friendly innovations into their target markets.

Frugal with battery energy, the drivers operate from a supply voltage as low as 1.8V and support power-saving design with ultra-low, best-in-class standby current of less than 80nA for a zero-power state when the motor is inactive. On the other hand, they can supply up to 1.3Arms to drive the motor and can therefore be used in a wide range of applications that include robotic positioning systems, printer motors, camera-autofocus mechanisms, toothbrush motors or syringe pumps.

www.st.com/stspin

Intersolar South America, São Paulo, August 23–25, 2016

Brazil's trending photovoltaic industry expected to give job market fresh impetus. Although there was a slight downturn in global employment in renewables compared to previous years, the number of jobs worldwide continues to rise in the long term – a stark contrast to the depressed labor markets of the energy sector as a whole. Solar energy is the largest global employer in renewables with an estimated 2.8 million jobs worldwide.

inter solar
connecting solar business | SOUTH AMERICA

At present, the Brazilian renewables sector mainly employs people in bioenergy and large hydropower activities, although jobs in the wind sector are also growing thanks to increased levels of deployment and local manufacturing. So solar PV is expected to be the field with the fastest expansion as local deployment increases and planned photovoltaic power plant capacity grows to 3.3 GW by 2018. On top of the 60,000 to 90,000 jobs this could create, local module production holds plenty of potential as the focus shifts away from installation. To draw a parallel, there were 100,000 solar jobs in Germany when the market hit 7 GW in 2012, so depending on developments in Brazil, solar energy holds major potential for Brazilian employment in the long term. Several firms have indicated interest in setting up solar PV manufacturing, so what is currently almost a miniature job market of just 4,000 people in Brazil could become a key part of the economy within decades, if not years.

This year's Intersolar in Sao Paulo also offers young engineers a variety of half-day workshops and training sessions to encourage newcomers to the renewable job market. The instruction program gives young and talented people insights into the market and the opportunities offered by industry leaders and associations. There will also be advanced training sessions and workshops to help installers hone their skills and learn new methods and understand regulations.

http://www.intersolar.net.br

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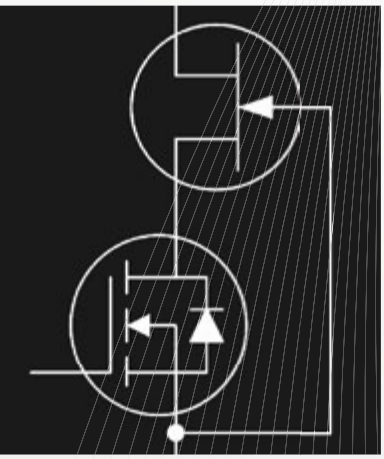
our sole focus, your superior solution.

USCi
United Silicon Carbide, inc.



Our name says it all. At United Silicon Carbide, Inc, we are solely devoted to bringing you the best and most efficient Silicon Carbide (SiC) power devices available in the marketplace. These devices deliver the performance of silicon carbide with the ease of use of low voltage silicon.

United Silicon Carbide's cascode products co-package xJ series high-performance SiC JFETs with a cascode optimized MOSFET to produce the only standard gate drive SiC device in the market today. These normally off devices exhibit ultra-low on resistance and gate charge, but also the best reverse recovery characteristics of any device of a similar current rating. These devices are excellent for switching inductive loads in bridge configurations with boot strap or floating high side drive.

By leveraging the SiC JFETs proven superior performance with low voltage silicon, these innovative devices enable industry leading efficiency in applications such as EV Charging, PV inverters, Power Factor Correction and Motor Drives. Cascode products are available through our World Wide Sales Partners, or can be purchased directly from the USCi website.

USCi has a new office in Europe (Contact: crocneanu@unitedsic.com, +49 (0) 151-210-634-11

Introduction of a Multi-mode Wireless Power Demonstration System

Compatible with all Current Mobile Device Wireless Power Charging Standards

The superior characteristics of eGaN® FETs and ICs enable a lower cost single transmit amplifier solution that can wirelessly charge devices regardless of the standard used in the receiving device.

Efficient Power Conversion Corporation (EPC) announces the availability of a complete demonstration multi-mode wireless power charging kit, the EPC9121. The purpose of this demonstration kit is to simplify the evaluation process of using eGaN FETs and ICs for highly efficient multi-mode wireless power charging systems that can cut across any standard used in the receiving units.

Two Standards, One Solution

Wireless power has arrived, but along with its emergence are two industry standards to which end products are being built – the Wireless Power Consortium (Qi) standard and the AirFuel™ Alliance standard. These two standards are based upon two different technologies for accomplishing wireless power charging. The low frequency (100 kHz through 315 kHz) inductive coupling technology approach is used by both the Qi and AirFuel standards, whereas the high frequency (6.78 MHz) magnetic resonant technology is used an an alternative by the AirFuel standard.

Thus the need for a multi-mode solution, one with a single transmitter that can power a receiver built using either standard. The EPC9121 is the first implementation of a single amplifier multi-mode solution. GaN enables high efficiency for both low and high frequency modes. In addition, this solution saves space and lowers cost.

The 10 W EPC9121 demonstration system has four components:

- A multi-mode capable EPC9511 source (transmitter or power amplifier) board specifically designed to be compatible with all the wireless standards. It can operate at either high or low frequency.
- A multi-mode source coil (transmit coil) compatible with both the AirFuel Class 2 standard and Qi (A6)/PMA standards.
- An AirFuel compatible Category 3 AirFuel device coil (receive coil) with rectifier and DC output
- A Wireless Power Consortium (Qi) and Power Matters Alliance (now AirFuel) compatible device coil (receive coil) with rectifier and DC output.

Thus, the EPC9121 demonstration kit contains all the components needed to demonstrate and evaluate multi-standard wireless power charging.

Price and Availability

EPC9121 wireless power charging demonstration system is priced at $907.20 and is available from Digi-Key.

About EPC

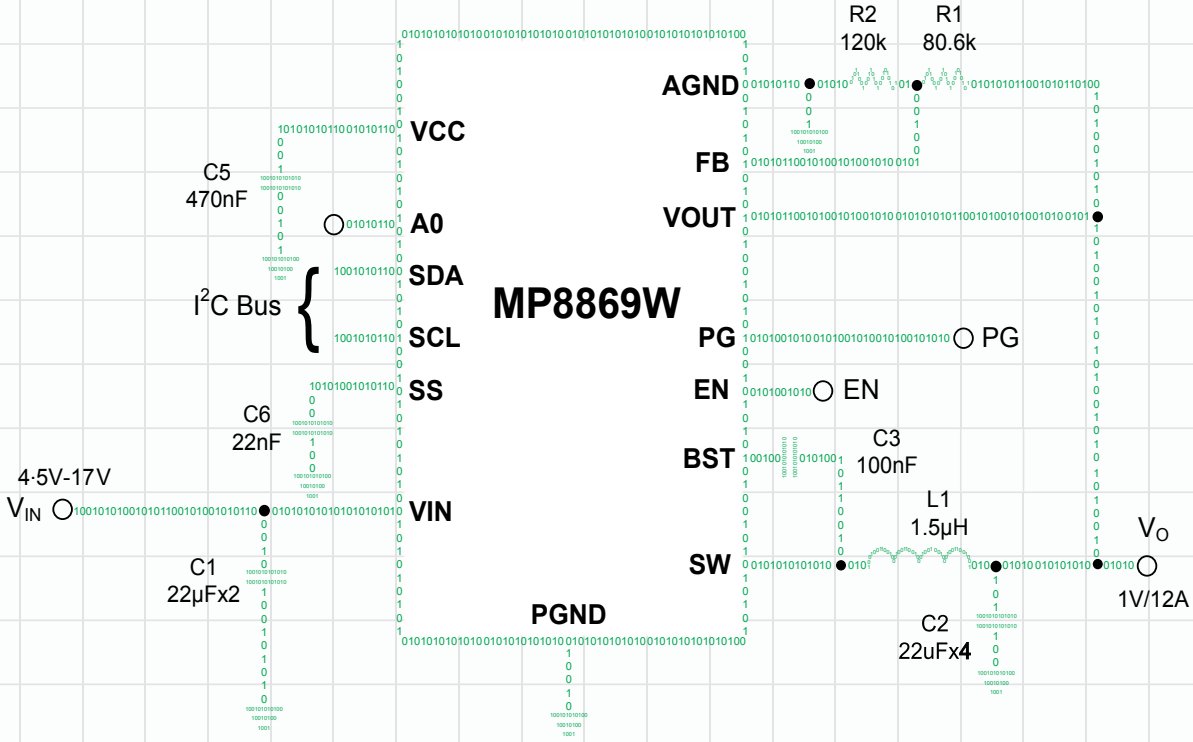
EPC is the leader in enhancement mode gallium nitride based power management devices. EPC was the first to introduce enhancement-mode gallium-nitride-on-silicon (eGaN) FETs as power MOSFET replacements in applications such as DC-DC converters, wireless power transfer, envelope tracking, RF transmission, power inverters, remote sensing technology (LiDAR), and class-D audio amplifiers with device performance many times greater than the best silicon power MOSFETs.

www.epc-co.com

Simple, Easy Solutions

Design Like You Mean It

Wide Input 3-18V, 12A, Synchronous Step-Down Converter with Integrated Telemetry via I²C Interface



Key Highlights

- 5% Accuracy Output Voltage and Output Current Monitoring
- Programmable Current Limit
- Programmable Frequency
- Selectable PWM/PFM Mode
- 1% Internal Reference Accuracy
- I²C Programmable Output Range from 0.6V

Applications

- Enterprise SSD's
- Networking
- Gaming Systems

www.monolithicpower.com

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Collaborative Approach to Overhaul Motor Inverters

By Neil Markham, Group Marketing Manager, Hitachi Europe Limited

With the exhibition and conference season in full swing, Silicon Carbide topics continue to dominate discussions but withreal business now being done. We have reached a transition phase cementing market sentiment and commitment.

PCIM 2016 offered all those who visited the chance to see an exciting array of core SiC based solutions from SMPS, to Automotive, Transportation and wider Industrial applications. The conference papers highlight the massive investments that continue to be made globally, even if some come with prize money, such as the Google Little Box Challenge. ETH Zurich, Switzerland, for me touched upon a key message that will no doubt be music to the Semiconductor manufacturers alike: “The Ideal Switch Is Not Enough”[1].

Herein lays the next challenge for the Power Electronics industry. Huge investments from the semiconductor manufacturers have realised working WBG nuclei, even in high voltage classes, introduced new ultra-low inductance packaging technologies to exploit the base technology, such as nHPD2, introduced novel new cooling methods to attain high temperature operation and innovative bonding processes for improved reliability[2]. It is definitely not enough to rely upon the switch alone.

Inductance is a formidable foe for the successful deployment of WBG devices for motor inverters. By reducing only semiconductor package inductance, the system level value remains too high. Over-voltage and EMI may nullify the performance benefits. More action is required to reach nirvana.

High power density switches must have higher junction temperature capability. It is no longer a nice to have feature. Seeking to break through the 200°C barrier, WBG can exploit its high thermal conductivity; substantially lower switching losses and benefit from inherently lower leakage-current. However, materials such as the isolation gel within larger power modules, or the interface with system component parts becomes a critical bottleneck high temperature.

The single largest challenge facing converter designers to maximise the full WBG potential is sub-system parts. Many have yet to catch-up with the rapid development pace set by the semiconductor industry.

For those engaged in busbar development for example, the challenges to overcome include the skin effect in high frequency domains, or the durability of insulation films at high temperature. Capacitor development hurdles include optimum mechanical outlines, connections, voltage versus temperature, and so on.

Bulk wafer suppliers continue to optimise crystal growth methods and the semiconductor process engineers maintain efforts to improve SiC on-state performance.

The International Energy Agency (IEA) estimated almost half of global electricity production is consumed by electric motor-driven systems, drawing more than 7,000TWh a year (2011) and 13,000TWh by 2030. This is the "responsibility" pull-factor for implementing WBG sooner rather than later.

The automotive sector forges ahead embracing PMSM technology, medium & high frequency DC-DC, to realize smaller, lightweight, high efficiency systems to achieve their CO2 obligations. Meanwhile, the majority of market sectors mull over the technology shift based on cost-performance benefit.

As a procurement professional reading this, you might consider your influence. Without relying on specific legislation as a catalyst to embrace WBG, cost-performance benefits have to be neutral worst case. It is feasible, even if your suppliers’ switching device appears to be higher at first glance today. Using a crude example, the opportunity to operate a WBG switch at much higher frequencies should lead to a transformer weight reduction inversely proportional to the frequency. The smaller transformer means a lower cost and lower weight, which itself leads to lower cost, and so on. A price cascade effect begins when a traditional paper component price comparison is exchanged for a detailed system level re-calculation.We all have much more to do to achieve our social responsibility to make a brighter, more sustainable future for the next generation.

In this Olympic year I would pass the “relay baton” to fellow industry colleagues in the key fields of capacitors, busbars, magnetics and materials development, to boost product characteristics further, notably even lower inductance and higher operational temperatures, such as Rogers’ “Rolinx®” and Mersen’s “highT°”, system architects to embrace PMSM just as Singapore’s SMRT Trains have done, and for purchasers to think “system level savings”.

With deeper collaborations between all product groups in the Power Electronics sector, let us accelerate and unlock the full benefits of WBG devices and their adoption beyond the “Google Little Box Challenge” to include the “Bigger Industrial Boxes” too.

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Solar and Smart Energy: Experts Met in Munich

The Intersolar Europe exhibition and conference, celebrating its 25th anniversary, united the solar industry and its partners – manufacturers, suppliers, distributors and service providers – from June 22 to 24 in Munich. In parallel the ees, Europe´s largest exhibition for batteries and energy storage systems connected with the world´s leading solar event. The focus of the exhibitions and the comprehensive accompanying programs was on the newest trends, services and products for the energy supply of the future.

By Roland Ackermann, Bodo's Power Systems

The share of global electricity generated by solar photovoltaics (PV) could increase from 2 per cent today to as much as 13 per cent by 2030, according to a new report from the International Renewable Energy Agency (IRENA). Released at InterSolar Europe "Letting in the Light: How Solar Photovoltaics Will Revolutionize the Electricity System" finds the solar industry is poised for massive expansion, driven primarily by cost reductions. It estimates that solar PV capacity could reach between 1,760 and 2,500 gigawatts (GW) by 2030, up from 227 GW today.

Packed halls and high spirits among exhibitors and visitors: Intersolar and ees Europe drew to a close after great success. 2016 saw strong growth, in particular for ees Europe. Intersolar and ees Europe 2016 presented systems and communication technologies, and new services and business models – including small and large electrical storage systems, intelligent transformers and virtual power plants.

The exhibition space grew by 40% and the number of exhibitors by 35%. 213 battery und energy storage manufacturers showcased their products at ees Europe alone, and an impressive 369 of the total 1,077 exhibitors across Intersolar Europe and ees Europe presented pioneering energy storage solutions. Around 60% of the companies at both exhibitions came from outside Germany, although with 351 exhibitors, Germany was the country with the largest number of exhibitors. Together, the two exhibitions recorded an 8.4% increase in the net exhibition area. In comparison with the previous year, 7% more exhibitors came to Munich in 2016. Approximately 43,000 visitors travelled from 160 countries, making Intersolar and ees Europe once again the most international events in the industry.

Numerous Innovations Exhibited

The industry launched numerous solutions and innovations, e.g. Siemens presented SIESTORAGE, a modular electrical energy storage system and a stable and reliable power supply. It facilitates integration of renewable energy sources and can help to reduce the use of fossil fuel generation moving towards a more modern eco-friendly grid. Moreover the Spectrum Power ANM is an effective lever for operating distribution grids more efficiently and with greater control. And the company supports energy needs with customized hybridization solutions.

Daimler continues to expand its network of expertise in the field of lithium-ion battery applications. The newly established Mercedes-Benz Energy GmbH focusses on stationary batteries. The usable storage capacity of the lithium ion batteries can be increased from 4.6 to 18 kWh in six steps.

H-TEC Systems, a subsidiary of GP JOULE introduced innovative solutions to store electric power as hydrogen using PEM electrolysis so as to compensate for the grid fluctuations that occur in the generation of wind and solar power. In a stack the splitting of water into hydrogen and oxygen is carried out in up to 100 cells; the hydrogen leaves the stacks at a pressure of 30 bar and is thus especially easy to store.

Deutsche Energieversorgung GmbH (DEV) increased the system efficiency of its award-winning SENEC.Home lithium storage system to up to 90.5%. It is available with storage capacities of 5, 7.5 and 10 kWh, with a 15 kWh version coming up soon. An Intersolar first were SENEC.Business 12,5 - 20 Li (including 2 inverters) and SENEC. Business 22,5 - 30 Li (3 inverters) – both can be expanded and combined up to a total capacity of 210 kWh.

The smart solar portfolio of ABB, the world´s broadest portfolio of solar products available from one manufacturer, presented best-in-class solutions for residential, commercial, and utility customers, especially inverters and advanced low-voltage components.

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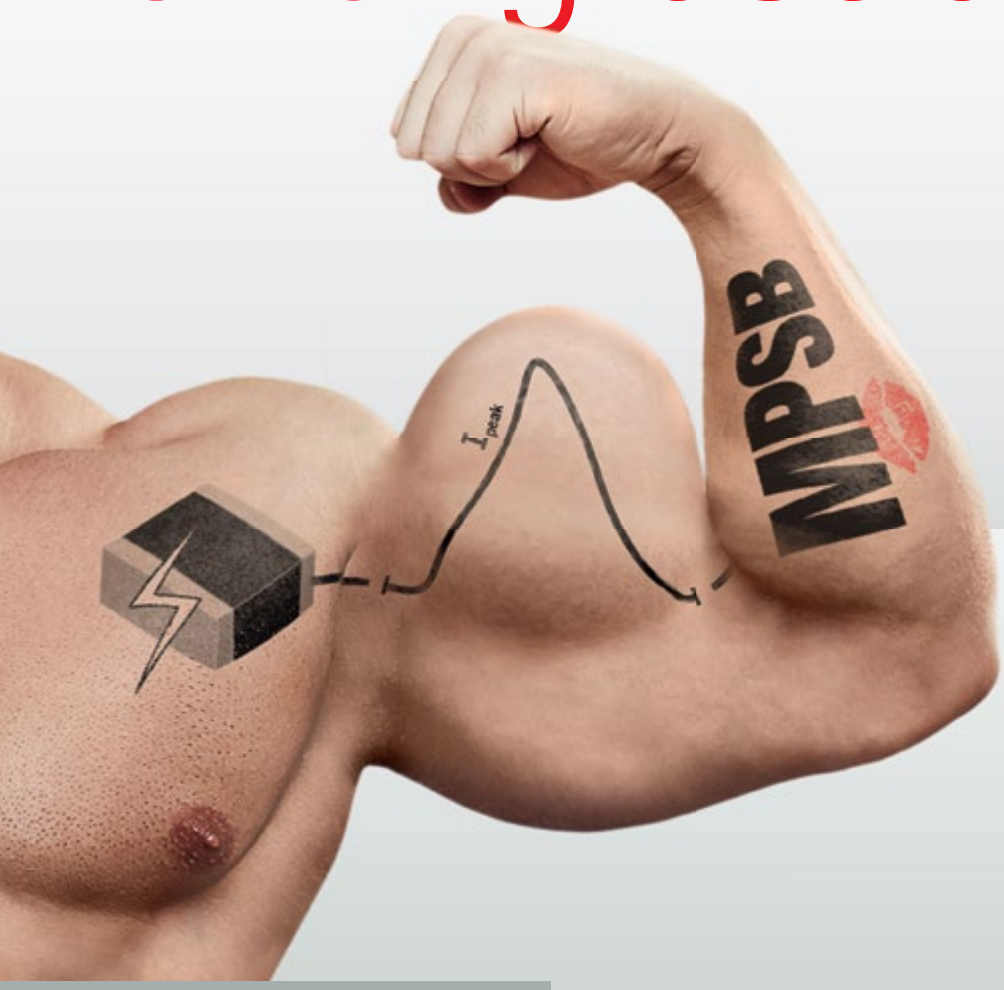

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SolarWorld introduced the Bisun System – a bifacial solar cell technology combined with optimized racking and 300W high-performance module for free-field and flat roof systems. Light reflected onto the rear side of the module enables higher yields of up to 25 per cent.

A leader in solar monitoring, Solare Datensysteme GmbH (SDS) showcased its latest production innovations and enhancements, like thee Solar-Log EDO Smart Heater Ethernet, Solar-Log API and Solar-Log Insight App for Windows 10.

More than just an exhibition

From the very beginning, Intersolar's founders have been guided by a vision of a solar future. To this end, they have cooperated closely with solar energy groups and associations since the exhibition's early days – initially fighting for sufficient remuneration to cover the costs of generating solar energy, then working on the 100,000 Rooftops program and the German renewable energy act (EEG). This type of collaboration in part laid the groundwork for Intersolar's success story. Intersolar is more than just an exhibition, it supports solar industry far beyond the scope of purely organizational or administrative activities.

The overarching aim is to develop renewable energies, particularly solar energy. To this end, the themes covered by the exhibitions and conferences always address the particular focus, aims, and challenges of regional markets – for example, reducing emissions or supplying remote regions with affordable, clean energy. The aim of each event is to promote and support the local solar energy industry, so the events bring together the best minds and technologies from all over the world.

Intersolar sees itself as a reliable partner to exhibitors and visitors, leveraging this role to further develop its international presence and comprehensive selection of premium services along the complete solar industry value chain. It provides a forum for the industry where experts can meet up – a place for showcasing best-practice solutions and promoting the international exchange of expertise. Together with the parallel event ees Europe, Intersolar Europe sent the market a positive signal to mark its 25-year anniversary. The solar and storage market is growing around the world, and this momentum could be clearly felt in Munich. Exhibitors and visitors were extremely pleased with the event.

100% Renewables

Intersolar's organizers are convinced that the global energy transition will be a success. They are certain that 100 percent renewables is achievable, with photovoltaics and wind energy serving as central pillars for a future-ready energy grid and effective climate protection. The aim of Intersolar is to safeguard solar energy supplies on a global scale. The steps that need to be taken to achieve this goal and the challenges this brings are very different depending on where you are in the world. In the meantime, Intersolar brings together people, markets, and technologies on four continents in a truly unique way – effectively, comprehensively, sustainably.

Over the past 25 years, the worldwide photovoltaic industry has undergone significant changes in this time: Solar energy is well on its way to becoming the most inexpensive form of energy generation – in many parts of the world, electricity production costs for solar energy from photovoltaics (PV) are already as low as 5 to 7 euro cents per kilowatt hour. For this reason, PV as well as wind power will play a central role in the energy supply of the future. Storage systems are the backbone of this new energy world, as they guarantee supply safety, and are therefore an important catalyst for the global energy transition. In contrast, fossil fuel and nuclear power generators are steadily being forced into decline.

Smart Energy Connection

Sensibly integrating clean energy into the grids and shaping the transition to the new energy world is essential for the future, which is why smart renewable energy was the key topic at this year's Intersolar and ees Europe. The exhibitions linked the topics of energy generation, storage, grid integration and energy management. Equally important at the exhibition: Smart technologies that analyze and optimize power generation and consumption as well as interconnect various pieces of technical equipment to help create smart concepts for utilizing, managing and storing renewable energy. The technological home – and future – of this new energy world is Germany and Europe. More renewable energy is integrated into the grids here than anywhere else in the world, and nowhere else is there more expertise and experience in this area.

The new focus on smart renewable energy and the accompanying forum proved particularly popular with visitors. At the forum, Intersolar was supplemented by an Innovation & Application Forum, where the exhibitors showcased their innovations in 15 minute presentations and where the AWARD finalists presented their projects. It was particularly popular with visitors. Moreover the Smart Renewable Energy Forum intended to show the future of modern energy supply. Exhibitors and experts showcased potential solutions for combining renewable energies and storage in a smart power grid. On the other hand, besides the ees Forum, there were special exhibits "E-Mobility & Renewable Energy" and "Wind Meets Solar and Storage".

Prices of Solar Power Storage Units Fell by One Third

Following German BSW (Bundesverband Solarwirtschaft), the number of installed home storage devices will double every two years at least until 2020. Drivers of this positive development are sharply falling prices and an increasing desire for independence. Acquisition costs for turnkey home solar power storage units (already 40,000 installed in Germany) fell by more than 30 per cent due to technical progress and economies of scale in the past 24 months.

Continuing global growth

Prospects for the global solar industry are sunny. According to GTM Research, a Boston-based market research institute, 59 gigawatts

of photovoltaic capacity were installed in 2015, one third more than in the previous year. In 2016 the total installed capacity worldwide is expected to increase from 64 to 321 gigawatts, where especially strong growth is expected in the USA (due to the incentive program Investment Tax Credit) and in China.

Start of the Future of Energy Supply

The major challenges facing the sustainable energy industry are the digitalization and networking of technologies. The modern energy supply is both smart and renewable. Photovoltaics (PV) is booming worldwide: According to SolarPower Europe, over 50 gigawatts (GW) of new PV capacity were added worldwide in 2015, including 8 GW installed in Europe. The total global capacity has reached approximately 228 GW, around 100 GW of which are in Europe.

Millions of decentralized renewable energy plants, storage systems and consumers who draw power not just from the grid, but also use environmentally friendly methods to generate power — this is the energy world of the future. To achieve, we need modern, intelligent infrastructure and storage options to make it possible to connect the many different renewable energy installations and also to offset the temporal fluctuations in supply from renewable energy sources.

Consumption and generation are automatically analyzed and optimized, creating smart energy. Large-scale storage systems and intelligent networks are already being combined with decentralized photovoltaic installations and battery storage systems for domestic power supply to provide the public grid with balancing power.

http://www.intersolar.de/de/home.html

Introduction to the AVSBus™

In all forms of today's electronics, the goal is maximum performance while using the least amount of energy. For a smart phone, this is all about customer satisfaction by providing a responsive device with a battery that lasts all day. For servers, routers, and storage in data centers customers need high availability and quick response and the operator needs to minimize both capital and operating expense. For today's computing equipment, the energy bill is a large part of the operating cost and everyone is interested in minimizing energy consumption without sacrificing performance.

By Bob White, President and Chief Engineer, Embedded Power Labs LLC

For years power consumption could be minimized by reducing the CMOS feature size and operating at a lower voltage. However, as feature size was reduced the savings in reduced power due to switching the capacitance of the transistors became matched by the off-state leakage current. Now to minimize power consumption a processor or other larger digital device (such as a large ASIC or FPGA) has to quickly shift between a low power idle or sleep mode and a high performance mode. In low power mode, the device minimizes its operating voltage to to reduce leakage losses and minimizes the clock frequency to minimize switching losses. When performance is needed, the supply voltage is ramped as fast as possible to the higher voltage needed to support the higher clock speed and then the clock frequency is increased. This approach to optimizing power consumption is called dynamic voltage and frequency scaling (DVFS) and is illustrated in Figure 1.

Years ago Intel implemented this in their high performance processors. The processor communicated with its power supplies via a proprietary high speed serial bus ("Serial VID"). Other manufacturers were left to devise their own means of implementing DVFS.

In 2012 Juan Arango and Travis Summerlin of Texas Instruments (TI) were developing a protocol for DVFS they called AVSBus (Adaptive Voltage Bus). In January 2013 TI offered this AVSBus protocol to the System Management Interface Forum (SMIF), who owns and manages the SMBus and PMBus™ standards, for inclusion as an extension of the PMBus. The SMIF accepted and after further development in the PMBus Specification Working Group, the AVSBus was released in March 2014 as part of Revision 1.3 of the PMBus standards. The AVSBus is now made available to any PMBus adopter a non-proprietary high speed bus for controlling power converters and implementing DVFS in any digital IC.

The Need For Speed

For DVFS to be effective, the power converter must change its output voltage very quickly as seen by the digital IC load. For a digital device operating with a clock frequency measured in GHz, a power converter that takes hundreds, or even tens, of milliseconds to respond will be seen as glacially slow. When transitioning to a low power mode, the digital device must lower its clock frequency immediately as it does not know exactly when the supply voltage will be lowered. If the transition time for the supply voltage is long (meaning even hundreds of microseconds) then power is being wasted. When the digital device needs to return to high power, high performance mode, it must wait until the supply voltage is at the required higher level before increasing the clock frequency. This delay reduces the performance. When power management schemes are switching between power saving and performance modes on a millisecond time scale, power conversion delays must be minimized to get the maximum combination of power savings and performance.

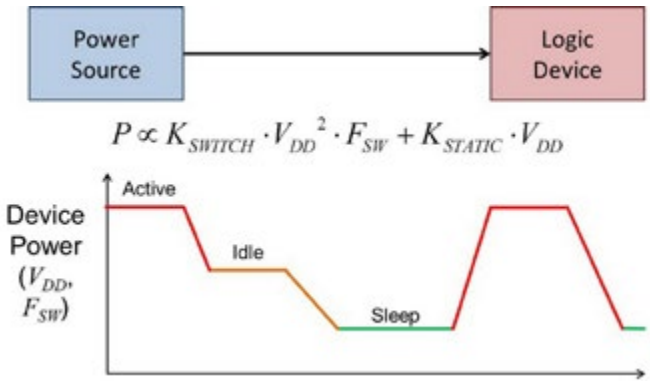

Figure 1: Saving Energy With DVFS

There are three elements to the delay from when a digital device issues the command to change voltage until the voltage has reached the new desired value:

- The communication delay from the digital device to the power converter,
- The time it takes the power converter to process the command and change the control signal (e.g. duty cycle) to the power stage, and
- The time it takes the power stage to respond

As for the time it takes the power stage to respond, that is being addressed by efforts to drive the switching ever higher. This reduces the size of the output filter inductor and allows the output current slew faster for a given input and output voltage.

The other two factors, communications delay and command processing time are addressed by the AVSBus.

While it would have been good to use the existing PMBus protocols for communicating DVFS commands from a digital device to its power converters, it is just too slow. At the typical PMBus speed of 100 kHz, it would take about 360 µs just to send the command. The PMBus protocol, which was designed to be applicable for a wide range of devices, was also not optimized for processing commands in nanoseconds. Even if the bus speed were pushed to the 1 MHZ, maximum

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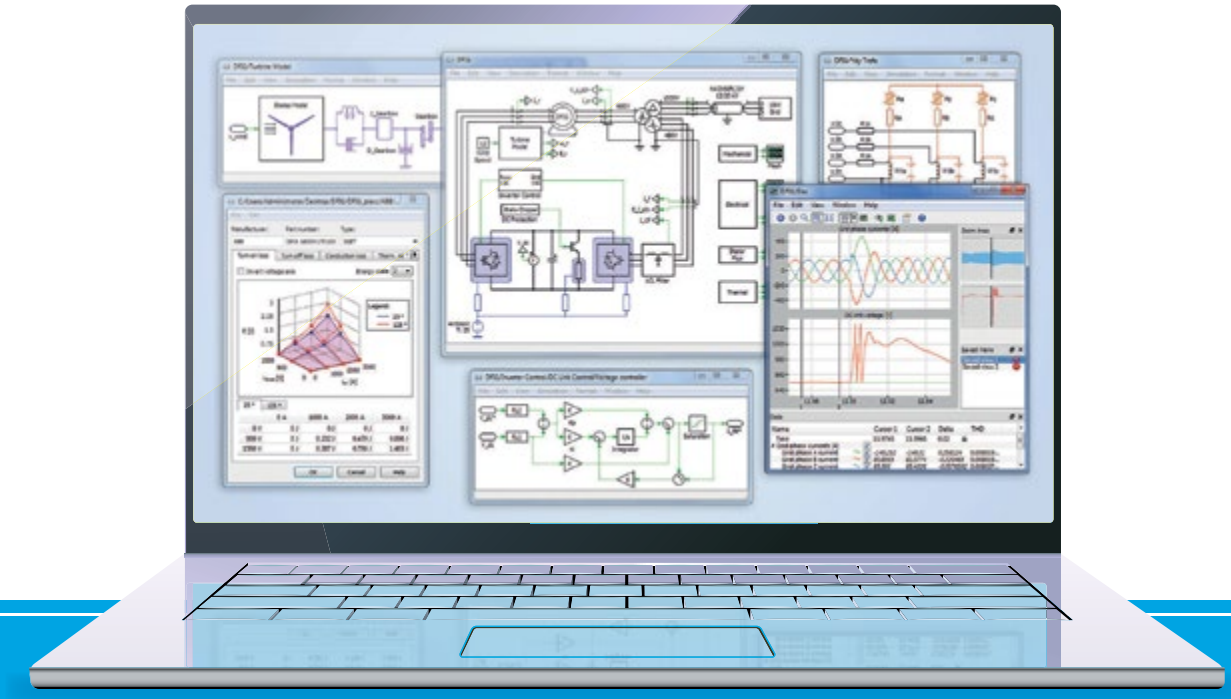

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allowed in the PMBus 1.3 standard, the 36 µs to transmit the voltage command is very slow by the digital device standards.

AVSBus addresses the communications delay in two ways: a maximum bus speed of 50 MHz and a fixed, 32-bit frame. Operating at the maximum bus speed, the command to change voltage can now be sent from a digital device to its power converter in 640 ns. The cost of the interface is kept low by using a standard SPI-like physical layer (PHY). For now this does limit the AVSBus to point-to-point communication between a digital device and its power converter but as discussed below, this is not a significant limitation.

The AVSBus addresses the processing delay by using a simple, efficient command set that is optimized for this application. This means that minimal logic is needed to decode the received command and generate the control signal that the power stage requires. With a good design and moderate clock speeds in the power controller IC, the command processing can be completed in tens of nanoseconds.

AVSBus Signals And Systems

As mentioned above, the PHY of the AVSBus is based on the standard SPI I/O ports that are readily available in the industry. The minimal implementation of the AVSBus requires two signals, AVS_Clock that is generated by the AVSBus master and AVS_MData that is used to send data from the AVSBus master (digital device) to the AVSBus slave device (power converter). If the application requires that the AVSBus master be able to receive status information from the AVSBus slave, then an optional third signal, AVS_SData, is added. The connections are illustrated in Figure 2.

Figure 2: AVSBus Connections

For digital devices that need to control more than one rail, there are two options. The first is simply to have as many AVSBus ports as rails that need to be controlled. We think the preferred option is going to be a single AVSBus communicating with a power management IC (PMIC) that has multiple power controllers, as shown in Figure 3. The AVSBus specification provides for addressing up to fifteen separate power rails over one AVSBus.

In multiple rail systems, the AVSBus specification provides flexibility on scheduling execution of commands. An AVSBus command can be sent to a rail controlled by the PMIC with the instruction to execute immediately. Or, the AVSBus master could send a command to rail 1 with the instruction to hold execution, followed by a command to rail 2 with a command to hold execution, followed by a command to rail 3 with the instruction to execute all pending commands. This provides a way for an AVSBus master to cause multiple rails to change simultaneously, which is often required to observe power sequencing requirements.

It is also possible to have a system with both PMBus and AVSBus, as shown in Figure 4. In this case, at power up the rail voltages will be set by the default PMBus output voltage settings. Once operating, the PMBus master can transfer control to the AVSBus master. The PMBus master, if need be, can also take back control from the AVSBus master. How these control transitions are managed to avoid glitching the rail voltages is described in the AVSBus and PMBus specifications.

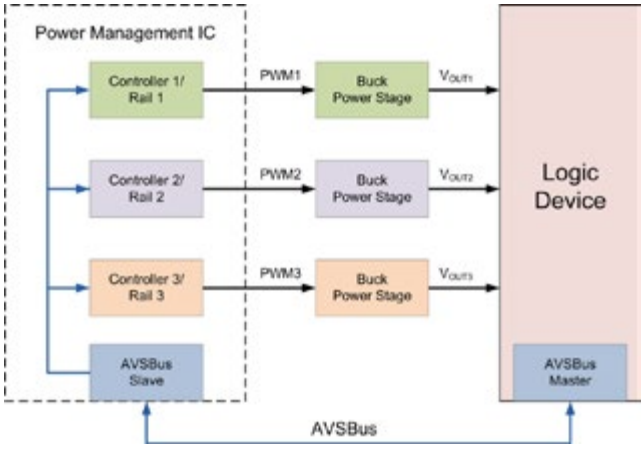

Figure 3: AVSBus System With Multiple Power Rails

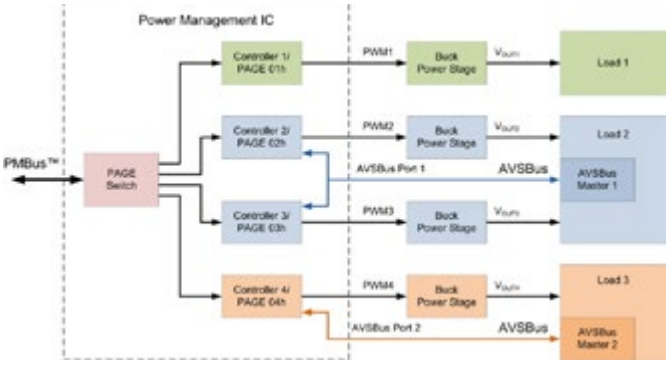

Figure 4: System With Both PMBus And AVSBus

AVSBus Data Frames and Transmission

AVSBus data is always transmitted in 32 bit fames. When the AVSBus is idle, all data lines are high. A data transmission starts when the master data signal, AVS_MData, transitions from high to low. It stays low for one bit and then goes high for one bit to complete the start of the transmission. The device sending data, such as a master transmitting a frame to a slave, launches the data on the rising edge of the clock. The receiving device captures the data on the falling edge of the clock. The last three bits of every frame is a cyclic redundancy check (CRC) that provides good assurance that the fame has been received uncorrupted.

When the master is sending a frame to the slave, there are two possible formats. A Write Frame is used to send a command to a slave device. In systems where the master can read data from an AVSBus slave a Read Frame is used to tell the slave device that the master is requesting data, such as a rail voltage. The formats of these two frame types are given in Tables 1 and 2.

If the system is using the full three wire AVSBus with the AVS_SData line, then every time a master sends a frame to the slave the slave must respond with a frame that includes a two bit ACK field and a five bit status field. If the master had sent a Write Frame and no data was requested from the slave, then most of the bits in the frame sent by the slave are set to 1. If the master had requested data, then the slave returns that data. The format of a slave-to-master frame that includes returned data is shown in Table 3.

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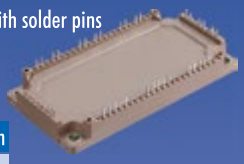
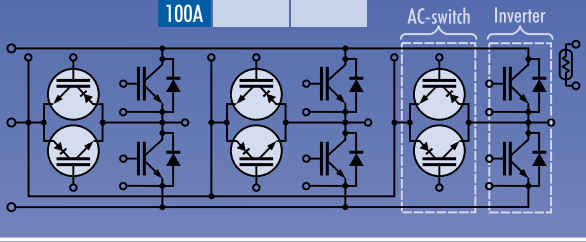
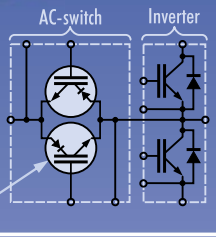


	Inverter	AC-switch
50A 75A 100A	1200V	600V



T-Type, 1 phase

	Inverter	AC-switch
450A 650A 900A	1200V	900V
450A 600A	1700V	1200V

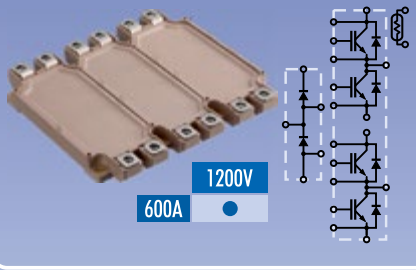


RB-IGBT = Reverse Blocking IGBT

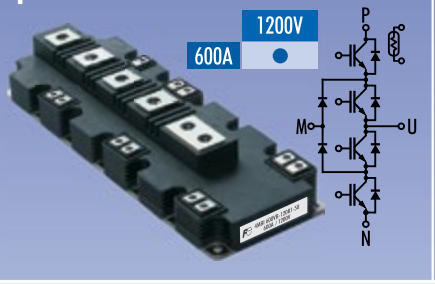
	Inverter	AC-switch
220A	1700V	1200V
300A	1200V	600V
	1200V	900V
340A	1200V	600V
400A	600V	600V
	1200V	600V

With Standard IGBT

I-Type, 1 phase

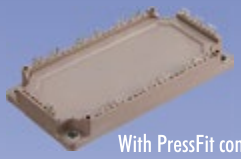


	1200V
600A	●



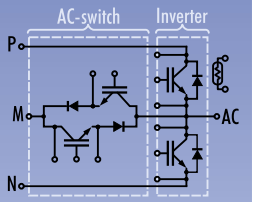
	1200V
600A	●

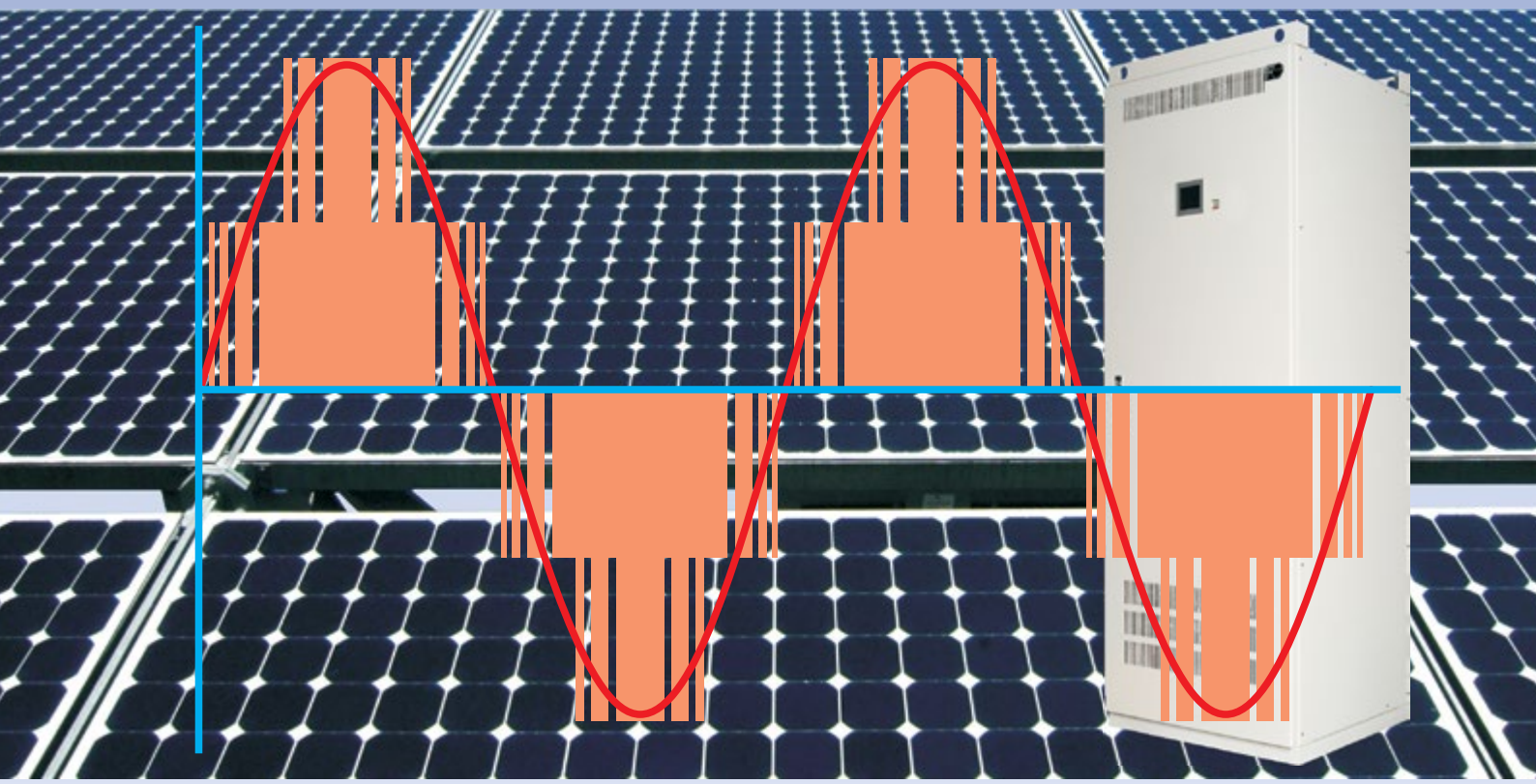
T-Type, 1 phase



With PressFit contacts

	Inverter	AC-switch
300A 400A	1200V	600V





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The two bit Acknowledge field from the slave to the master provides a significant advantage over the one bit ACK/NACK of I²C/SMBus/PMBus systems. With just one ACK/NACK bit, if a slave does not acknowledge ("NACKs") the master cannot know why. It might have been because the received data was corrupt, the received command or data was not valid, the device might have had an error processing the received data, or the slave might have been too busy to process the incoming transmission. The two bit Acknowledge of the AVSBus provides some additional information at to whether a frame was properly received and processed or not, and if not, why not. The two AVSBus Acknowledge bits indicate:

10: Bad CRC, No action taken;
11: Good CRC, Invalid selector, No action taken;
01: Good CRC but no action taken because resource was unavailable; or
00: Good CRC, All OK and action taken.

Bits	Field	Description
31-30	Start Code	Always 01b
29-28	Cmd	Command code that indicates the action the master requires, such as Write And Hold
27	CmdGroup	Tells the slave whether the coming command is an AVSBus standard or a manufacturer specific command
26-23	CmdDataType	Tells the slave what data is coming, such as a value for the target rail voltage
22-19	Select	Generally selects the voltage rail to which the command is directed. The value 1111b means "all rails".
18-03	CmdData	The data for the command, such as a new rail voltage
02-00	CRC	CRC check bits

Table 1: AVSBus Write Frame Bit Fields

Bits	Field	Description
31-30	Start Code	Always 01b
29-28	Cmd	Always 11b for a Read Frame
27	CmdGroup	Tells the slave whether the requested data is in AVSBus standard format or a manufacturer specified format
26-23	CmdDataType	Tells the slave the source of the data, such as a value for the target rail voltage
22-19	Select	Tells the slave from which rail the data is requested.
18-03	Reserved	Since no data is being transmitted, these bits are reserved and are be all 1's (FFFFh)
02-00	CRC	CRC check bits

Table 2: AVSBus Read Frame Bit Fields

Bits	Field	Description
31-30	SlaveAck	A two bit code providing basic information on whether a command was executed or not, and if not, why
29	0	This bit is always 0b
28-24	StatusResp	Five bits that provide information about the slave such as "The last commanded output voltage change has been completed or not" or the slave has status information that requires the master to send a Read Status command.
23-08	CmdData	The data for the command, such as the rail voltage
07-03	Reserved	Reserved bits, the returned value is always 11111b
02-00	CRC	CRC check bits

Table 3: AVSBus Status Response Frame Bit Fields When Data Is Being Returned To The Master

AVSBus Commands

The goal of AVSBus is to be very fast. This means that the command set, unlike the PMBus which is intended to cover a wide range of power converters, is narrowly focused. There are only nine standard commands available plus provisions for custom manufacturer-specific commands. The main command is used to set or read the rail voltage. To further simplify the implementation, the resolution of the command is fixed at 1 mV/bit. This gives a range of possible output voltages from 0 V for a command value of 0000h to 65.535 V for a command value of FFFFh.

Other commands include setting or reading the output voltage transition rate (1 mV/µs per bit), reading the output current (1 mA/bit), and reading the temperature (0.1 °C/bit). There is also an output voltage reset command that sets the output voltage to the default value. Another command instructs the power converter to operate in either a "maximum power" or "maximum efficiency" mode.

There are also commands to read the slave status and the version of AVSBus the slave device supports.

Where To Get The AVSBus Specification and Support

The AVSBus specification is available as Part III of the PMBus specification at the PMBus website, www.pmbus.org. The PMBus specifications are available at no cost although one must register with the website to access the download.

For questions about the AVSBus specification, as well as the PMBus and SMBus specifications, send your inquiry to techquestions@smiforum.org.

Summary

Large, fast digital devices such as processors, ASICs, and FPGAs use dynamic voltage and frequency scaling to minimize energy consumption. The AVSBus is now offered by the System Management Interface Forum as a non-proprietary protocol for these devices to manage the converters supplying them with power. The AVSBus has been designed specifically for this task offering high speed transmission, a task focused protocol and command language, and low cost. PMICs supporting AVSBus are already in the market and it is expected that many more will be announced in the coming months.

About PMBus

The Power Management Bus (PMBus) is an open-standard digital power management protocol: simple, standard, flexible, extensible, and easy to program. The PMBus command language enables communication between components of a power system: CPUs, power supplies, power converters, and more. For more information, please go to the PMBus.org website and download an Introduction to PMBus.

About SMIF

The System Management Interface Forum is an industry Special Interest Group (SIG) composed of more than 35 member companies and adopters who work together to develop, implement and promote standardized communications protocols. The PMBus and AVSBus name and logo are trademarks of SMIF, Inc. Commercial use of the PMBus and AVSBus name and logo is restricted to PMBus adopters. Refer to the PMBus.org website for additional details.

About The Author

Bob White has more than thirty years of experience in power electronics. He is well known for his work in digital power, power system architecture, and the application of wide bandgap devices. His work at Artesyn Technologies became the starting point for the development of the PMBus standard. He led the PMBus Specification Working Group for many years and remains the editor of the PMBus and SMBus specifications. He has his own consulting company, Embedded Power Labs. He holds a BSEE from MIT, a MSEE from WPI, and is a Fellow of the IEEE.

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Power Solution for 1500VDC Photovoltaic Power Generation System

This series of DC/DC converters accepts a wide input range from 200-1500VDC providing standard output voltages of 24V, 12V and 5V to power monitoring and control circuits in the system. The PVxx-29Bxx simplifies the wiring design reducing cost of system manufacturing and maintenance when compared with AC power or battery power. This converter also features multiple protection functions that improve system safety when a breakdown occurs.

By Min Qin, FAE, MORNSUN

Paris 2015 Global Climate conference achieved a carbon emission reduction agreement that is legally binding and practical to all parties, which further propel the development and popularity of the new green energy technology, e.g. photovoltaic industry, wind power. In 2015, China has passed Economic and Social Development 13th Five-Year Plan, which includes the continuous development plan for the PV power market and it aims to build more PV power facility to offer 150 GW. With the support of domestic and abroad policy, the request of the market, as well as the development of Energy Internet, PV power will grow in scale will offer more intelligent control, which is beneficial to reduce the cost of photovoltaic, promote technological innovation and update the industry.

The common goal of the global PV power industry is to create a type of clean energy with lower costs and higher-efficiency. Currently, the PV power system is built on the design of 1000Vdc input. However, the line loss can be reduced if the system can accept higher voltage input, which can have an extra efficiency increment of 1.5%~2.0%. The market research report by GTM estimated that the 1500Vdc PV power system would account for 9% of the global demand in 2016, which is equal to 4.6GW. Therefore, the 1500Vdc PV power system will inevitably be a growing trend in the power industry.

Basic structure and request of the PV power generation system

PV power generation system contains solar panel, combiner box, DC power distribution cabinet, inverter and boosting transformer (Diagram 1: PV Power generation System). In this system, in order to reduce the wiring between solar panel arrays and the inverters, the arrays are built by group, and connected in parallel to get electric combination into the solar combiner, and then the DC will be provided through DC cabinet to solar inverter and then into the power grid.

The output voltage of solar panel arrays varies significantly for sun light from different regions, seasons and time. And the solar combiner needs to detect every group of the solar panel array's voltage, current, power and anti-thunder condition, and realize the functions of failure warning, locating and communication. The solar inverter needs to detect the voltage, current and drive the control board while converting the DC to AC.

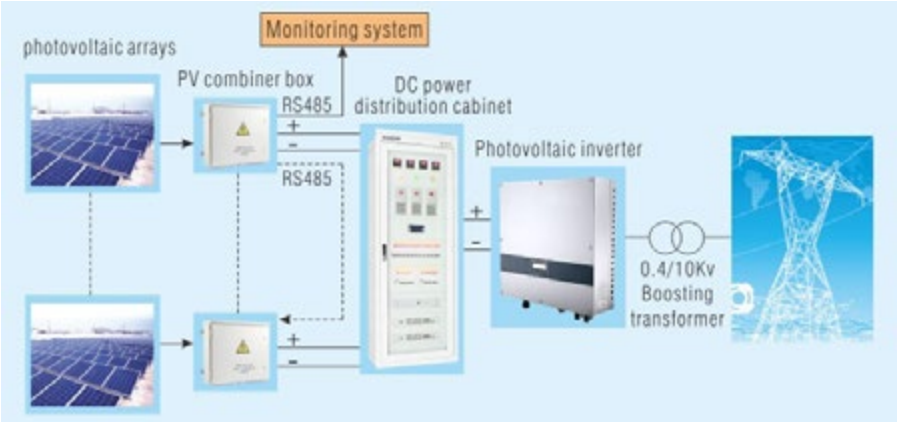

Figure 1: PV power generation system

Because the solar panel arrays output is normally higher than 1kv, conventional power module cannot accept the voltage from the high-voltage line as input, if adopting the solution of external power for driving multiple detection units for solar combiners and inverters, unstable operating voltage, wiring and single shorted circuit problems may occur and cause power failure of the whole detection system.

Therefore, these factors of a power supply should be considered for PV power system equipment:

- Input voltage and output voltage : e.g. 200-1500VDC input and standard output of 12V/15V/24V
- Isolation between primary side and secondary side: 4000VAC
- Multiple Protections: input under-voltage protection, reverse input protection output overcurrent protection, short-circuit protection and output over-voltage protection, etc.
- High Reliability in harsh environment
- Output voltage:12V/15V/24V available

To meet the PV power generation application requirement, MORNSUN released a series of DC-DC converters with 200-1500VDC input and 4000VAC isolation. Additionally, MORNSUN has a pack of DC-DC solutions which can ensure the safety isolation in different units of the circuit.

Power Solution for 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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Diagram 2 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 4: Converter

Power Solution for Monitoring Unit of Photovoltaic 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 Diagram 3 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.

Brief Introduction for PVxx-29Bxx DC-DC Converter

PVxx-29Bxx is a high reliability DC-DC converter with 200-1500VDC input, 4000VAC isolation and built-in multi-protection functions ,which can be widely used in PV generation and high-voltage inverter application as a stable and reliable power supply,

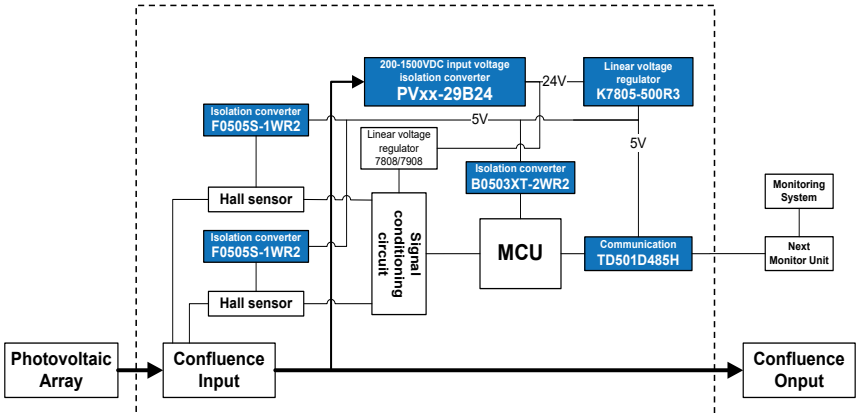

Figure 2: Power Solution for Monitoring Unit of PV Combiner Box

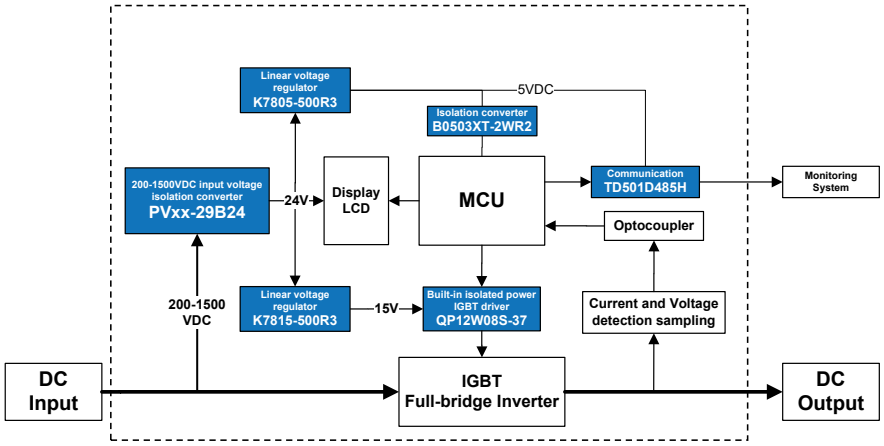

Figure 3: Power Solution for Monitoring Unit of Photovoltaic Inverter

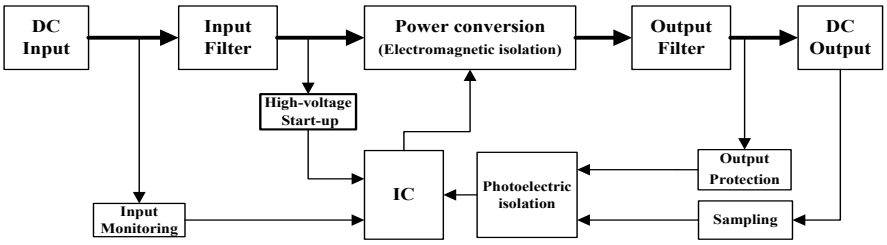

Figure 5: the Principle diagram of PVxx-29Bxx series

Features:

- Ultra wide input voltage range: 200 ~ 1500VDC
- Industrial grade operating temperature: -40□~+70□
- 4000VAC I/O isolation voltage
- High efficiency, Low ripple & noise
- Input under-voltage protection, reverse input protection,
  Output short circuit, over-current, over-voltage protection
- Meet EN62109 approval, UL508(Pending)
- PCB mounting, DIN-Rail mounting available

The block diagram of PVxx-29Bxx is shown on diagram 5. It uses fly-back topology, using a mature and reliable PWM control IC, and adopting the design of high voltage dual transistors in series and isolated power. The high-voltage start-up circuit employs MORNSUN's patented high-voltage start up technology, and has multiple protection circuits, such as input under-voltage, output over current, and short-circuit protection to achieve high reliability.

Conclusion

In summary, PV energy is a promising market and MORNSUN is to developing the right product for the right application of this industry for cleaner power. Targeting the specific requirement of 1500VDC solar PV system monitoring, MORNSUN offers the PVxx-29Bxx which can accept 1500Vdc input along with offering a full suite of power solutions, to simplify customers' design, save cost, and ensure the system reliability.

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The World's First Peak Current Load SMD Ferrite

The Multilayer Power Suppression Bead

A Chip Bead Ferrite has inductance that is established using a screen printing process. This is optimised for as high as possible losses for use as filter. Therefore, it consists of a nickel-zinc-ferrite mixture and a very fine superimposed inner silver layer with thickness of a few micrometres. This structure makes the classic SMD ferrite more vulnerable for current spikes above the maximum rated current load and in special cases results in degenerative or also immediate destruction of the component.

By Markus Holzbrecher, Würth Elektronik eiSos

A typical application is shown in Figure 1. The multilayer ferrite is used as longitudinal filter at the input of the circuit. Due to the low on-resistance of the capacitor, a very high pulse current flows for a short time at switch- on. This pulse current temporarily loads the SMD ferrite with a multiple of the current that is many times above the maximum specified rated current.

In this example, the optimized multilayer ferrite, that is designated by Würth Elektronik eiSos as Multilayer Power Suppression Bead (MPSB), has impedance of 600 ohms for a maximum permissible rated current load of 2.1 A. The one-time current peak in this constellation has a peak value of approx. 19 A and has an overall pulse length of 0.8 ms until it has been reduced to the rated current of the circuit.

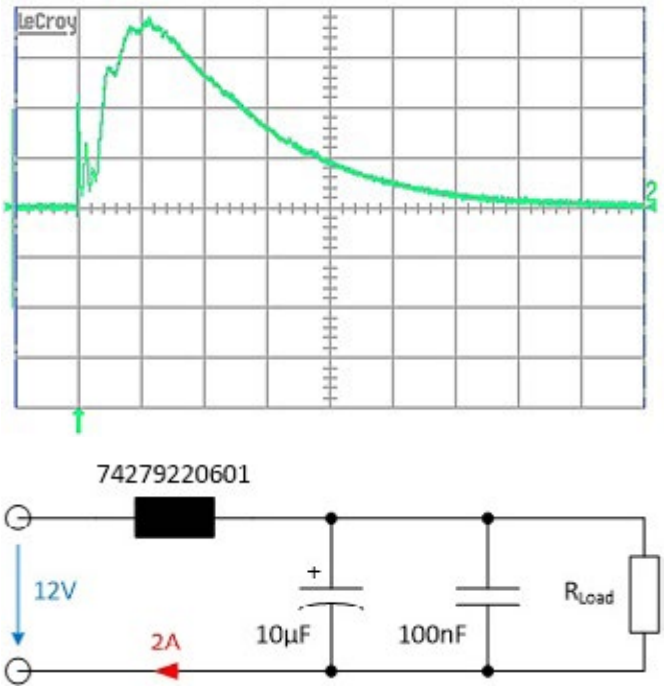

Figure 1: Application with peak current at switch-on (5 A / DIV | 100 µs / DIV)

It generally applies for the SMD ferrites that the maximum rated current also defines the maximum current amplitude for temporary load. However, using the new WE-MPSB series with pulse load, multilayer ferrites are now available that consider the peak current in the data sheet.

Background of the application

Current peaks occur frequently, for example at switch-on of diverse switch mode power supplies and for electric motors. Known applications with recurring pulses are, for example, windscreen wiper motors in vehicles. But also ballasts of luminaires can produce a high current peak at switch-on of the light. In particular, the input capacitor in a switch mode power supply can produce a high peak current that the upstream EMC filter must withstand. Pulses in this context are understood as temporary current peaks with a time limitation less than 8 ms until complete reduction to the DC current of the circuit. The appropriate approach in the search for a common standard for the measurement of pulse load capacity for SMD ferrites has been found in the definition of the melting integral for fuses. A pulse of 8 ms duration, according to the standard, is applied to the fuse to "give the current time" to heat the fuse for the determination of the I^2t value of the fuses. If the fuse withstands this, the current is increased until the increase results in destruction of the fuse. In doing so, a pause of 10 s between the pulses is required to give the component the necessary time for regeneration (cooling down). Würth Elektronik eiSos has developed an adapted test routine based on this fuse standard for the multilayer ferrites. Based on the 8 ms pulse, current with increasing pulses is applied to the multilayer ferrite until destruction. The components are loaded with iteratively increasing pulse currents starting from 1 A. The pulse rectangle shown in Figure 2 was selected as pulse shape for all tests as this loads the component with the highest possible energy for the pulse duration ɳ although it will only very rarely be applicable in practice at switch on.

Figure 2: Possible pulse shapes at switch-on

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Pulse Strength

In comparison with the fuse, it is not possible for the multilayer SMD ferrite to specify any generally applicable formula with which conclusions can be drawn about the various current peaks for different pulse lengths using the calculation of the melt integral. The empirically determined data sheet values can be traced back to long term test series with different parameters.

The following shows an example for clarification of the non-applicability of the melt integral for the multilayer ferrites using the example of the article 742 792 206 01 (Z = 600 Ω, IR = 2.1 A, RDC,typ = 43 mΩ).

The WE-MPSB has maximum peak current load capability of 18 A with a pulse length of 8 ms. This produces an I²t value of 2.592 A²ms (18 A @ 8 ms (5 sec pause, 24 °C) I²t = 2.592 A²s).

The following result is obtained if the current for a pulse length of 2 ms based on the I²t value for 8 ms is calculated:

$$I[A]_{@n[ms]} = \left(\sqrt{\frac{I^2[A] * 8[ms]}{n[ms]}}\right)$$

$$I[A]_{@2[ms]} = \left(\sqrt{\frac{2{,}592}{2[ms]}}\right)$$

$$I[A]_{@2[ms]} = 36\ A$$

However, the data sheet value shown in Figure 3 is specified as max. 24 A.

The calculated I²t value deviates significantly from the measured values. Consequently, due to this different behaviour of the SMD ferrite from the fuse, it is not possible to apply the known calculation of the melt integral I²t to a multilayer ferrite.

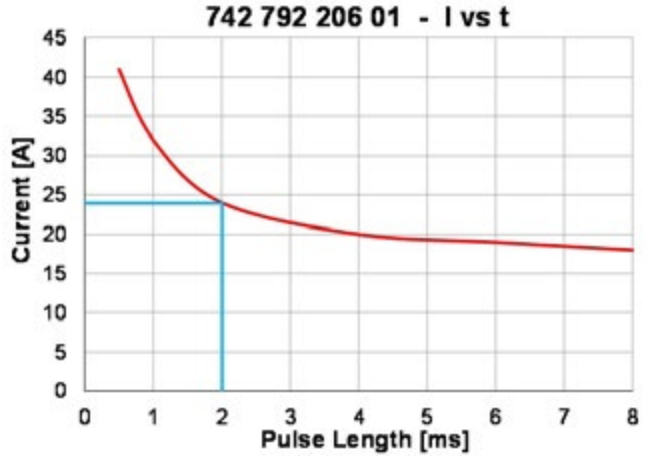

Figure 3: Specified peak current load capability

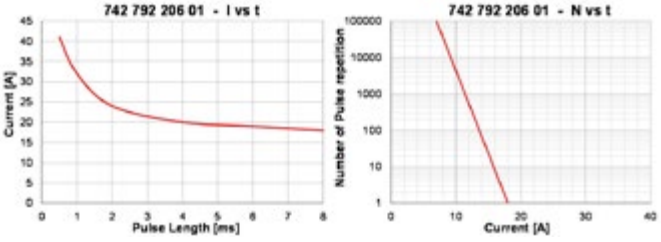

Figure 4: Display of the current as dependence on pulse length and the number of pulses

Optimisations for the WE - MPSB

Due to its silver layers with a thickness of only 8 - 20 µm, the multilayer ferrite is not constructively designed for high pulse currents. Würth Elektronik eiSos has developed a new, optimized design with a perfect mixture of high currents, up to 75% smaller RDC and as high as possible impedance over the complete frequency spectrum. Depending on the impedance and current level, the optimum design is used individually for each article.

Definition of the pulse strength

The pulse strength is considered in more detail using the example of the article 742 792 206 01.
The current / pulse curve shown in Figure 5a shows the maximum permitted peak current for the respective tested pulse lengths. The tested range covers the time range of 0.5 ms to 8 ms pulse length. This curve is measured individually for each article and is only permissible for any consideration with one-time pulse.
The consideration of the permitted maximum pulse current visible in Figure 4b for a repeating pulse is possible using the second curve in the data sheet. This curve is a limit value consideration of the maximum peak current for repeating pulses. A maximum pulse length of 8 ms was selected for determination of the curve.

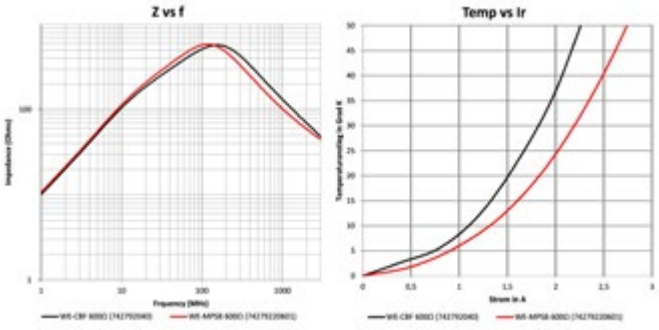

Figure 5: Comparison of the impedance and rated current load capability of the WE-CBF and WE-MPSB 600 Ω types

Tnt triangle influencing factors

The influencing factors are:

- The pulse lengths t that are tested as standard from 0.5 ms to 8 ms. The longer the pulse, the smaller is the maximum pulse load capability.
- The number of pulses that are tested from 10 to 100,000 pulses (see Figure 5b). The maximum permissible pulse load capability drops as the pulse frequency increases.
- The temperature should be noted as third reducing influencing factor; as the temperature increases, RDC increases which results in further reduction of the maximum pulse load.

Each of these interlinked systems is burdened with the dependency on the underlying pause between the individual pulses. In order to carry out an analysis of the linked system with a smaller pause time, it is necessary to measure the temperature [T], pulse repetitions [n] and pulse length [t] influencing factors again.

Comparison of the WE - MPSB with the WE - CBF series

The objective of the WE-MPSB Series is to achieve a comparable impedance as for the WE-CBF Series with additionally optimised resistance and load capability with pulse currents.

Using the example of the 600 Ω models in size 0805 shown in Figure 5, the WE-MPSB Series with almost the same impedance has a higher rated current due to the smaller resistance.

The WE-MPSB Series has significantly higher pulse load capability than a comparable WE-CBF Series model. Figure 6 shows the maximum pulse level of the 600 Ω model on the graph on the left and the maximum pulse level of the comparable WE-MPSB 600 Ω model on the graph on the right.

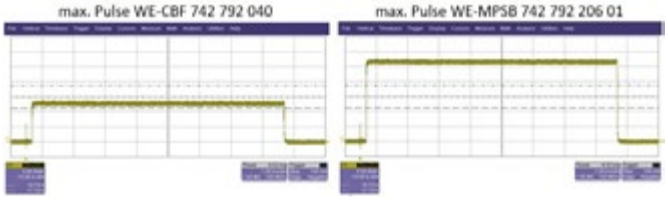

Figure 6: Comparison of the different pulse load capability of the WE-CBF and WE-MPSB series

Summary

The WE-MPSB Series has been developed based on the requirements of circuits that load the multilayer ferrites with temporary peak currents exceeding the rated current. The maximum pulse load capabilities of the multilayer ferrites have been determined by measurement using an in-house test routine that is different from that of the fuses. In comparison with existing multilayer structures, the layer structure has been optimised to generate higher current load capability using lower resistances. The WE-MPSB Series is thus ideally suitable for use in circuits with pulse currents.

http://www.we-online.com

Power Stage Designer 3.0

When designing a power supply, the first step is finding the right topology. This is usually followed by calculating average and peak values for voltages and currents of the circuit's components. Only then can the design engineer know the ratings for the components he or she has to pick for the power supply solution.

By Markus Zehendner, Systems Applications Engineer, EMEA Power Design Services, Texas Instruments

This whole design process can be quite tedious, if you have to do calculations manually or wait for simulations to finish. Afterwards, it might even take another round of calculating and simulating with a different topology to find the optimal solution for meeting your target power supply specification.

TI's Power Stage Designer is Java based and is a mighty tool to help engineers designing the power stage of their switch mode power supply (SMPS) very quickly. The tool includes 16 of the most common hard switched power supply topologies and the Phase Shifted Full Bridge. Power Stage Designer provides the user with all important design parameters. Waveforms for all components of the power stage will be visible to the designer after clicking on their symbol. No SPICE simulation is needed for this. After changing input parameters the new results will immediately be available. Besides the diode forward voltage drop, no other parasitic effects are considered for the equations. Thus, results are more or less ideal. With a slider in the graphs panel, the user can step through the entire input voltage range and look at the change in waveforms and calculated data.

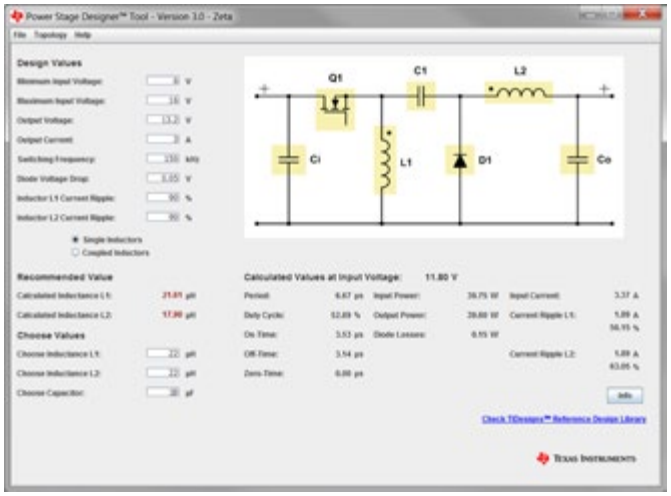

Figure 1: In the main window of each topology general data for the design is displayed

Another great benefit of this tool is that it allows both students and experienced engineers to familiarize themselves with rather unknown power supply topologies. Because the waveforms of all components' voltages and currents can be examined, it is a lot easier to understand how the power transfer works with less well-known topologies. The tool also enables the user to compare different topologies and pick the most fitting for his or her power supply solution. With the exception of synchronous Buck, Weinberg and Phase-Shifted Full Bridge, which are only available in Continuous Conduction Mode (CCM,) all other topologies support operation in Discontinuous Conduction Mode (DCM). In the main window general information is provided. For each component a set of important values is displayed in the graphs window under the respective waveform: Minimum and maximum voltage, minimum and maximum current as well as average, rms and ac currents. Those parameters have to be known before choosing the actual components for a SMPS design.

With the slider for the input voltage in the graphs panel, users have the possibility to reproduce the transition between DCM and CCM, if the inductor value is chosen in the appropriate range. This feature also allows users to observe the difference in behaviour of the circuit like increasing peak and rms current, when using a smaller but cheaper inductor, which is common practice for low-power Flyback designs.

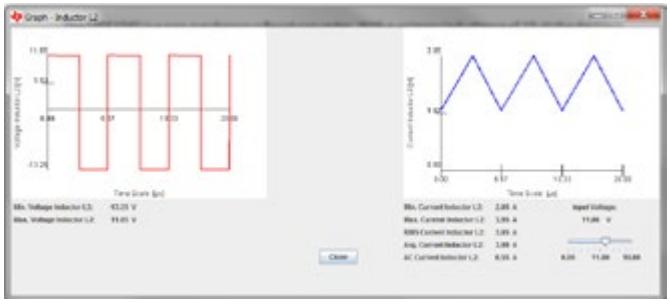

Figure 2: The graph panel shows voltage and current waveforms for a single component as well as important design parameters.

The 17 topologies supported by Power Stage Designer 3.0 are:

- Non-synchronous Buck
- Boost
- Inverting Buck Boost
- SEPIC
- Flyback
- Active Clamp Forward
- Single Switch Forward
- Two Switch Forward
- Push-Pull
- Half Bridge
- Full Bridge
- Weinberg
- Synchronous Buck -> NEW
- Cuk -> NEW
- Zeta -> NEW
- Phase Shifted Full Bridge -> NEW
- Two Switch Flyback -> NEW

What is new besides the topologies?

In Power Stage Designer 3.0 voltage and current waveforms for Input and Output Capacitors have been added for each topology to help designers estimate the ac current stress in those components. This is important for choosing the correct type and also a sufficient number of capacitors for the design to ensure appropriate current stress.

Besides this, minor improvements have been made to the user interface. The chosen input voltage is now displayed both in the

main window and the graphs window, as it is important to show the exact value at all times. Additionally, a slider for choosing a specific input voltage has been added to the graphs window. The whole input voltage range can be successively displayed, while looking at the waveforms and the component's key parameters. The slider can also be moved by the keyboard's arrow keys, while the graphs window is active. For convenient control, keyboard shortcuts are available for selecting minimum, average and maximum input voltage (this was used in Power Stage Designer 2.1) both when the main window or the graphs window is active. Keyboard shortcut CTRL+1 sets the slider to the minimum, CTRL+2 to the average and CTRL+3 to the maximum input voltage. The current ripple of inductors, and for certain topologies the magnetisation current, are now provided both as absolute and as relative values in the topology's main window.

SEPIC, Cuk and ZETA topologies contain two inductors in the circuit. Because of that, the option to choose between single or coupled inductors has been implemented. Coupled inductors will have half the inductance compared to single inductors for the same ripple requirements. Additionally those topologies do not need an additional RC-network for attenuating the effect of the resonant frequency, when coupled inductors are used.

For experienced designers the right half plane zero (RHPZ) frequency has been added to the main window of Boost, Inverting Buck-Boost, SEPIC, Cuk, Flyback and Two Switch Flyback converters in Power Stage Designer 3.0. The equations used have been simplified, thus the result is a rough estimation but it is quite helpful for the control loop design, which will follow after the design of the power stage.

After finishing the design process with Power Stage Designer there are a couple of options to proceed: The user can print the design and choose how much information to print. Another way to store design parameters with Power Stage Designer 3.0 is to save user inputs in a text file. The data stored in the save file can be recalled with the tool when needed again. Besides this, it is also possible to transfer the input data to TI's website and search for pre-built and tested TIDesigns. TIDesigns provide the designer with schematic, BOM, layout files and test report, which can effectively minimise the time spent for the design process. The last option is to start a Webench® design from Power Stage Designer with the chosen inputs for Buck, Boost, Inverting Buck-Boost, Flyback and Sepic converters. Webench® will propose possible solutions with different power controllers, converters and modules. The user can proceed with comparing the different solutions regarding size, cost and efficiency to optimise the design.

Power Stage Designer 3.0 can be downloaded from:

www.ti.com/powerstagedesigner

About the author:
Markus Zehendner is a Systems Applications Engineer in TI's EMEA Power Supply Design Services Group since 2014. He holds a Bachelor in Electrical Engineering and a Master in Electrical and Microsystems Engineering from the Technical University of Applied Sciences in Regensburg. His design activity includes reference designs of isolated and non-isolated DC/DC converters for all application segments.

Evaluating Silver Sintering as a Reliable Die-Attach Material for Automotive Power Module Applications

The pressure on reliability requirements for high-power components in smaller packages is increasing as the development of electric and hybrid vehicles is evolving, as has the pressure on manufacturers with the environmental requirements to remove lead from electronics such as the European Union's Restriction of Hazardous Substances Directive (ROHS).

By Gustavo Greca and Dr. François Le Henaff, Alpha Assembly Solutions; Olivier Mathieu, Rogers Germany; Jean Claude Harel, Renesas America and Dr. John Parry, Mentor Graphics

Some lead-free technologies have been widely investigated [1–3]. Several technologies have been developed over the past decade to produce high-temperature power modules (175 °C and beyond junction temperatures), some without lead, while providing high reliability, such as gold-tin (AuSn) alloys, self-gripping assemblies similar to the gecko's use of Van der Waals forces, electrically conductive adhesives, transient liquid-phase bonding, tin-antimony alloys, high-lead solder, tin-silver-copper (SAC) systems, and silver sintering.

However, commercializing these technologies has been a complex process. Silver sintering has attracted interest as a promising technology because it fulfills the reliability requirements of electronics devices. Alpha silver-sintering paste and film technologies enable a fast (<2 min), low-pressure (5–10 MPa) die-attach process in a wide range of applications including power modules, power discretes, thyristors, high-power LEDs, and power RF devices. Recently, researchers from Alpha Assembly Solutions, Rogers Germany, Renesas, and Mentor Graphics [4] worked together to evaluate the effects of using double-sided silver sintering as the die- and clip-attach technology on the thermo-mechanical performances of power modules (IGBTs).

Double-sided silver sintering enables further miniaturization and significantly reduces parasitic-inductance–related losses. It also improves the thermal management of power modules because heat dissipation is possible from both sides of the die. The researchers conducted an internal simulation study which demonstrated that IGBT junction temperature decreased approximately 33% when silver sintering is used as the die-attach material instead of conventional solders (Figure 1).

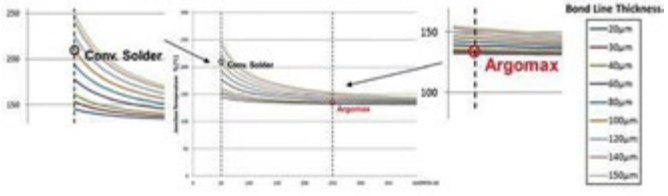

Figure 1: Junction temperature in °C (y-axis) for a 2 kW power applied to 90-µm silicon chip, using a sintered-silver material and solder at different bond line thicknesses. Thermal conductivity in [W/(m.K)] (x-axis).

They evaluated the effects of Si3N4 AMB substrates with three different metallization: raw copper, spot silver, and full electroless silver, when exposed to thermal shock and power cycling. They used thermal impedance measurements throughout power and thermal cycling tests to characterize the thermomechanical behavior of the sintered modules. Metallographic and scanning acoustic microscopy (CSAM) analysis were used to correlate failures to a defect inside the assembly.

The Experiment

A 650V/200A 8.80 x 8.80 x 0.090 mm IGBT from Renesas was assembled on a Si3N4 AMB substrate from Rogers with the raw copper, spot silver, and full electroless silver. A four-step process was used to manufacture seven sintered modules for each substrate metallization: Die lamination + placement (Figure 2), die sintering, clip lamination, and clip sintering.

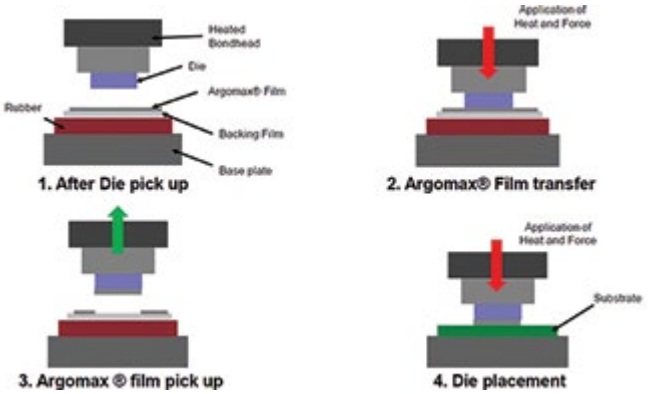

Figure 2: Die-transfer film process and die placement using die-bonder equipment.

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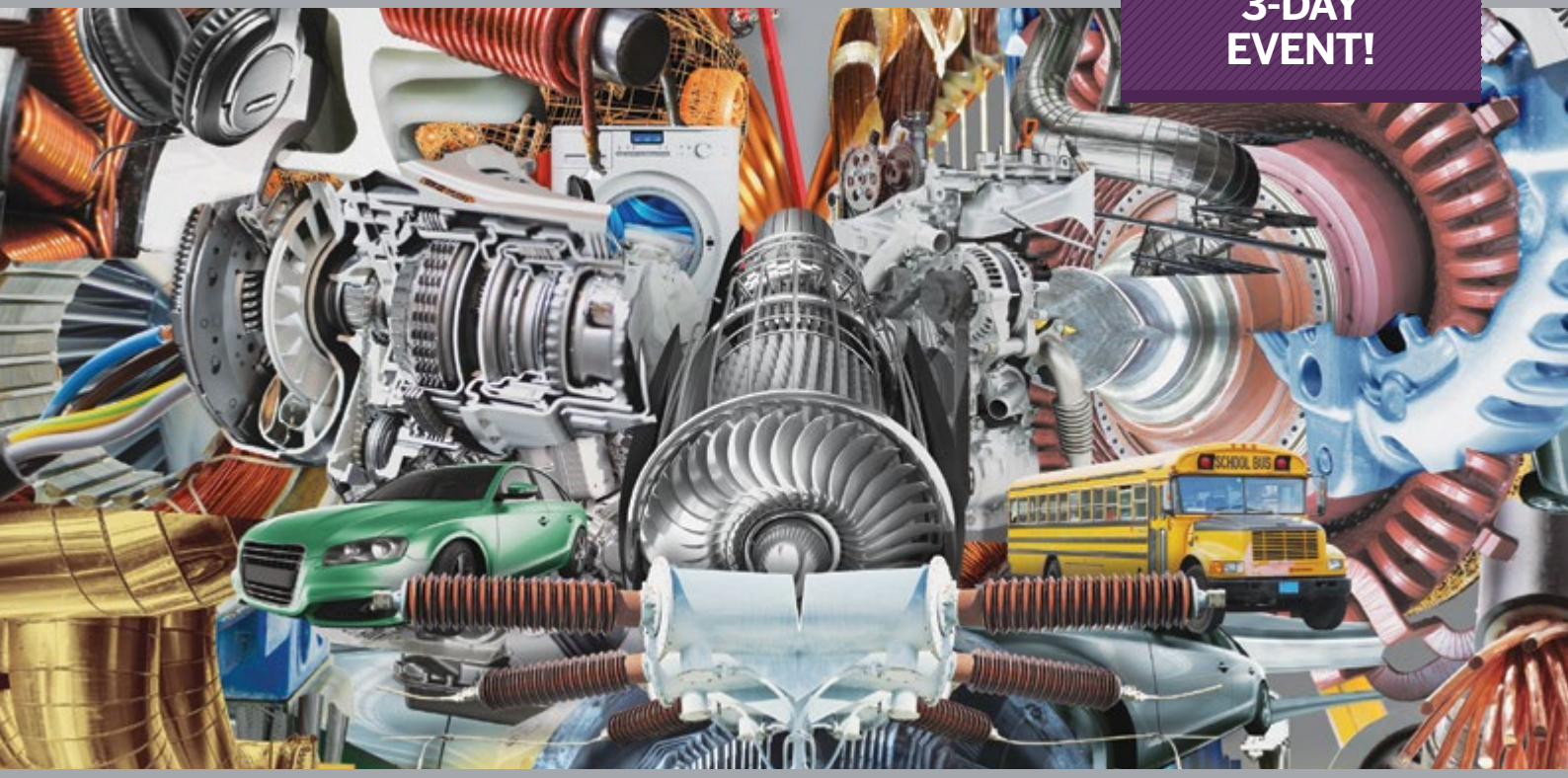

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The silver film technology from Alpha Assembly Solutions (Argomax® 8020) was used for the die-attach process on electroless silver and spot silver finish substrates; whereas, another film from Alpha that is specifically developed for copper finishes (Argomax® 8050) was used for attachment on the raw copper substrates. Copper clips also were attached to the die and substrates using the film. The clip replaced the wire bond that is usually used as the connection to the Mentor Graphics MicReD 1500A Power Tester electrical interface for power cycling and thermal impedance measurements (Figure 3).

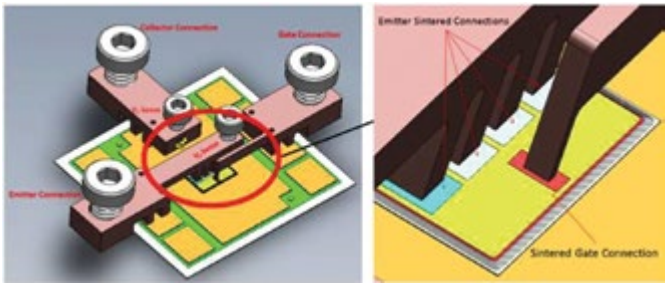


Figure 3: Test vehicle design for all configurations, using Si3N4 AMB substrate and a clip to provide power to the IGBT and substrate. Detail shows the full sintered top connection. Clip design courtesy of Renesas.

Nine modules were used for power cycling tests, nine for thermal shock tests, and the remaining one for baseline metallographic analysis. One of the modules used in power and thermal cycling tests was analyzed optically for any failure occurring in the assembly. CSAM analysis was completed on all sintered modules to detect delamination throughout the tests.

The Power Tester measured the variation in VCE (voltage between collector and emitter of the IGBT) during each relaxation period (cooling period), and calculated the variation in the thermal resistance to help indicate if the die- or clip-attach interfaces of the assembly were failing. The devices were continually subjected to 200 A for 5 s and then to 10 s relaxation (causing a delta TJ = 100 °C). The double-sided sintered modules were placed on the cooling sink with a thermal grease (G751 from ShinEtsu Group), filled with silver particles to improve the thermal path. A torque wrench and consistent application of thermal grease was used to ensure that the same pressure was placed on all modules to the cooler sink.

The cooling liquid was kept at 30 °C at all-times throughout the tests. When carrying 200 A, the maximum junction temperature was 130 °C with little variation in function of the finish observed temperature. Junction temperature reached 125.5 °C for the raw copper substrates. Three soldered pieces with wire bonding used as the electrical connection for the top face were also cycled under the same conditions to create a comparison baseline.

Material	Si_3N_4	Copper	Silicon	Sintered Silver
CTE (10^{-6}.°C)	3.3	16.9	2.8	19.5

Table 1: CTE mismatches between power module materials.

Thermal impedance measurements were taken throughout the experiment because thermo-mechanical failures in power modules are typically caused by cracks between the attachment interfaces. Coefficient of thermal expansion (CTE) mismatches between the different layers of a power module contributes to the expansion and shrinkage phenomena created during thermal variations (Table 1); especially between the substrates materials and the dies (silicon), as well as the die-attach layer.

Thermal dissipation performance in a power module becomes compromised when the ratio of cracking becomes too high in the module layers. Therefore, thermal impedance measurements, taken throughout power cycling, are used to find the failure in power modules.

The researchers conducted continuous measurements throughout the power cycling tests with the same equipment. An increase of 15% of the thermal resistance or maximum delta T °C or on the VCE (voltage between collector and emitter) of the module was defined as the failure criteria. Optical analysis using CSAM and metallographic analysis were conducted after initial processing the parts (time, t = 0) and at the end of the power cycling tests to correlate any failure to the sintered modules.

Results

Nine sintered modules were submitted to liquid-to-liquid thermal cycling (three for each substrate metallization). The tests were conducted for 1,000 cycles between -55 °C and +165 °C with a 3-min dwell time. Liquid-to-liquid equipment was used to ensure fast transition between the extreme temperatures. The thermal impedance variations for all tested sintered modules were below the failure criteria, which was a 15% increase from the initial measurements (Table 2). This result illustrated the encouraging properties of sintered modules (Figure 4).

Module Type	Thermal Impedance (°C/W) at t = 0 cycle	Thermal Impedance (°C/W) at t = 1,000 cycles	Variation (%)
Ag AMB	0.350	0.355	+1.40
Spot Ag AMB	0.338	0.343	+1.46
Bare Cu AMB	0.326	0.322	-1.22

Table 2: Average thermal impedance variation throughout thermal cycling for the three types of substrates metallization; three modules were tested for each substrates configuration.

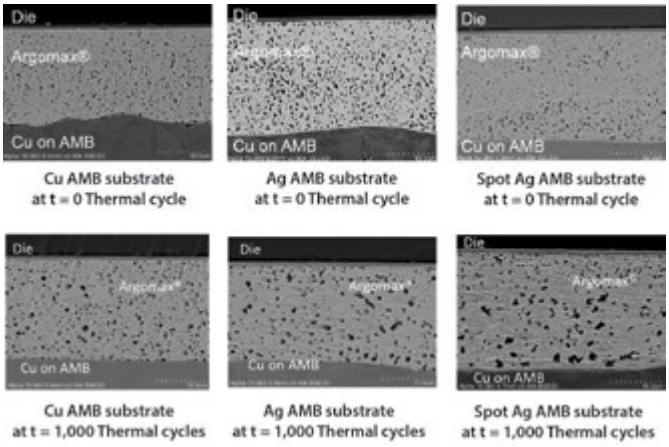


Figure 4: SEM analysis of the sintered modules at t = 0 and t = 1,000 thermal cycles (from -55 to 165 °C).

Metallographic analysis was conducted on two sintered modules for each substrate metallization: one at t = 0 cycle and one at t = 1,000 cycles. The cross-sections were taken on one edge and in the middle of each module. The sintered-silver layer exhibited an average density of 90% for all three substrate metallization types. The sintered modules presented well-formed bonds between the die and sintered-silver layer as well as between the substrates and sintered-silver layer.

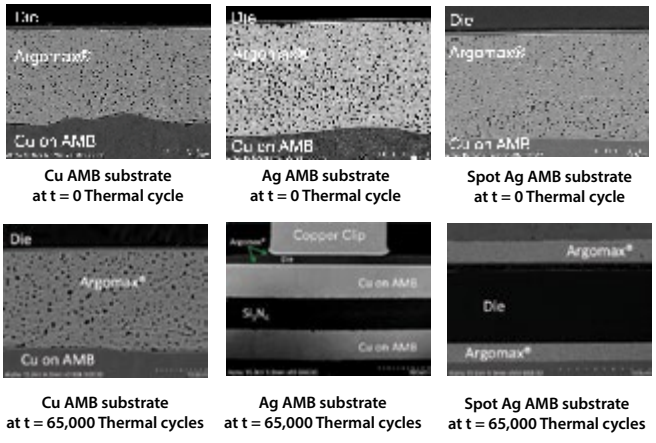
As depicted in the microscope pictures, no defect was found on all of the sintered modules. The absence of defect was expected because of the intermediate test results for thermal shock. The sintered layers and interfaces with the die and substrates did not exhibit any structural modifications throughout the thermal cycling test.

Nine sintered modules, three for each substrate metallization, were also subjected to power cycling using the Power Tester. It was agreed that the tests were to end when the failure criteria of 15% increase of the thermal impedance, maximum change in $_{T}$ °C or VCE, was reached for each module. After 65,000 cycles (200 A, 5 s on and 10 s off, ΔT= 100 °C), none of the nine sintered modules presented an increase of 15% of the thermal impedance (Table 3). In a further study, some pieces were pushed till 220,000 cycles without failure.

Module Type	Thermal Impedance (°C/W) at t = 0 cycle	Thermal Impedance (°C/W) at t = 65,000 cycles	Variation (%)
Ag AMB	0.345	0.320	- 7.25
Spot Ag AMB	0.338	0.330	- 2.37
Bare Cu AMB	0.326	0.295	- 9.51

Table 3: Average thermal impedance variation throughout power cycling for the three types of substrates metallization.

Nevertheless, the power cycling tests were stopped to proceed with the CSAM and metallographic analysis. Analysis of the aged sintered modules did not reveal any defect (delamination or cracks) inside the assemblies (Figure 5). The low thermal impedance of the silver layer creates a better thermal path inside the assembly and reduces the overall thermomechanical stress. The improved thermal performance of the sintered module permits a reduction of the maximum junction temperature to 130 °C subjected to 200 A current.



Cu AMB substrate at t = 0 Thermal cycle | Ag AMB substrate at t = 0 Thermal cycle | Spot Ag AMB substrate at t = 0 Thermal cycle

Cu AMB substrate at t = 65,000 Thermal cycles | Ag AMB substrate at t = 65,000 Thermal cycles | Spot Ag AMB substrate at t = 65,000 Thermal cycles

Figure 5: SEM analysis of the copper-finish–sintered modules at t = 65,000 power cycles

For solder, the junction temperature reached 172.6 °C because of the high thermal impedance of the solder layer (SnAgCu). Soldered power modules failed at 45,600 cycles because of cracking on the die attach that caused the wire bond to lift off.

In Summary

The results of this experiment showed that double-sided silver-sintering technology demonstrates superior thermo-mechanical performance compared to conventional solder. The power module that was double-sided silver-sintered increased the performance of the assembly because of the well-suited mechical properties of the sinter-silver layer, the high thermal conductivity of the silver layer, and the subsequent heat path (top and bottom side of the die) that was created to extract the heat from the semiconductor. The sintered modules did not exhibit any defect after thermal cycling (1,000 cycles, liquid-to-liquid, 3 minutes dwell, and -55 °C/+165 °C) and power cycling (65,000 cycles, 200 A, 5 s on and 10 s off).
The CSAM and metallographic analysis confirmed the thermal impedance measurements done throughout the cycling tests. The failure criteria was not met for all tested sintered modules; whereas, soldered samples failed at 45,000 cycles. In a further study, some of the sintered modules were pushed to 220,000 cycles without defect on the sintered interfaces.

The use of this film technology for silver sintering enables lower junction temperature and increases reliability for automotive power modules applications. The lower thermal impedance and junction temperature of the sintered assembly when compared to using solder offers the possibility to operate semiconductors at a higher current level, while aiming for package shrinkage or/ and enhaced reliability.

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3. M. Horio, et al. (2011), “New Power Module Structure with Low Thermal Resistance and High Reliability for SiC Devices,” Proceedings of PCIM Europe, pp. 229–234.
4. This work is part of a consortium between Alpha Assembly Solutions (electronic interconnection materials), Rogers Germany GmbH (electronics substrate), Renesas Electronic America (semiconductors), and Mentor Graphics (electronic design automation).

http://alphaassembly.com/

http://www.curamik.com/index.aspx

https://www.renesas.com/en-us/

http://www.mentor.com

LYTSwitch-1 LED Driver ICs Reduce Complexity in Bulbs, Tubes and Ballasts up to 22 W

Power Integrations announced its LYTSwitch™-1 single-stage, non-isolated, buck topology LED driver IC family. Featuring a very compact footprint, the IC enables the design of LED bulbs and tubes with high constant-current accuracy while using a minimum number of components. A novel driver algorithm ensures high power factor (PF) and low total harmonic distortion (THD) while maintaining very high efficiency.

Housed in a compact SO-8 package, LYTSwitch-1 ICs are greater than 93% efficient with a PF of over 0.9 and THD as low as 15%. Devices can be used in a low-side buck topology for reduced EMI or in a high-side buck topology which simplifies design. Delivering up to 22 W without a heatsink, the universal input (100 - 308 VAC) ICs incorporate a 725 V MOSFET for high reliability. Designers can make use of small, off-the-shelf inductors due to a unique peak current control algorithm. The new devices meet all applicable international standards including: DOE 6 (external power supply), CEC Title 20 and 24, ENERGY STAR® SSL, EN61000-3-2 (C) plus China and India standards.

Comments Hubie Notohamiprodjo, director of product marketing at Power Integrations: “Low system complexity and high performance make LYTSwitch-1 ICs ideal for both commercial and residential lighting applications. The low component count and compact size make

these LED driver ICs easy to fit into space-challenged applications such as tube end caps, small form factor candles and GU10 bulbs, as well as low cost A19 and decorative-filament lamps.”

https://www.power.com/lytswitch-1

Fanless Power Supply Delivers 600W with Natural Convection

The CoolX600 Series is the convection-cooled modular power supply platform from Excelsys Technologies which delivers an incredible 600W without fan assisted cooling from a very compact 8.5 x 4.5 x 1U package. The only fanless modular power supply on the market, the CoolX600 offers system designers best in class efficiency and reliability in addition to the most comprehensive feature set and specifications available. An industry leading 5 year warranty ensures quality, reliability and the lowest total cost of ownership.

Key features and options include 600W output with natural convection cooling, no fan/airflow required. This results in higher system reliability, with typically 25% longer lifetime than competitors. In addition, the CoolX600 leads the market with conversion efficiencies of up to 94%. CoolX600 provides higher input surge protection of 4KV Line to PE for operation in harsh environments, reverse energy protection without the use of external blocking diodes as well as safety certified operation at altitudes of up to 5000m. An incredible 24W, medically isolated, auxiliary supply is available as a standard feature, offering effectively another output for system intelligence, control, displays etc. With optional Digital Communications available the CoolX600

provides the most flexible, highest specification modular power supply on the market.

www.excelsys.com

Half–Bridge MiniSKiiP® Modules

Vincotech, a supplier of module-based solutions for power electronics, today announced that new half-bridge MiniSKiiP®DUAL modules have been added to the standard MiniSKiiP® product line, thereby extending the power range all the way up to 90 kW for 650 V and 1200 V applications.

Equipped with solder-free spring-contact, Vincotech’s MiniSKiiP® half-bridge modules can now replace baseplate modules with screwed bus bar connections to drive down inverter package and manufacturing costs by as much as 15 %.

MiniSKiiP®DUAL modules provide 100 A to 400 A nominal chip current for scalable designs in the 40-to-90 kW range. They feature the latest chip technologies (1200 V IGBT4 and 650 V IGBT3) with anti-parallel CAL diodes in the standard MiniSKiiP® package size 2 & 3. Samples may be sourced on demand from our usual channels.

To learn more about Vincotech’s MiniSKiiP®DUAL modules, please visit:

www.vincotech.com/MiniSkiiPDUAL

To see Vincotech’s entire range of power modules, please visit:

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

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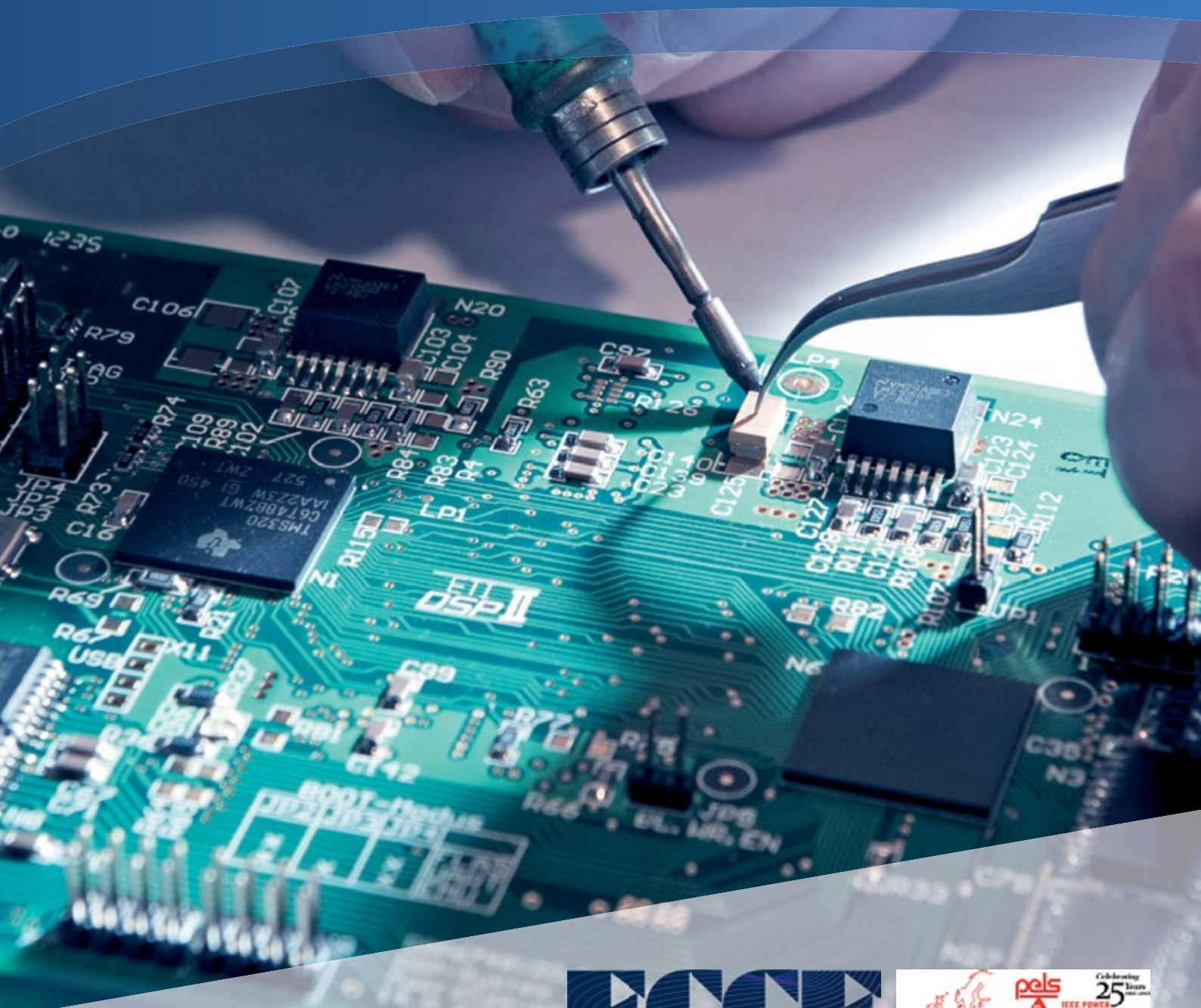

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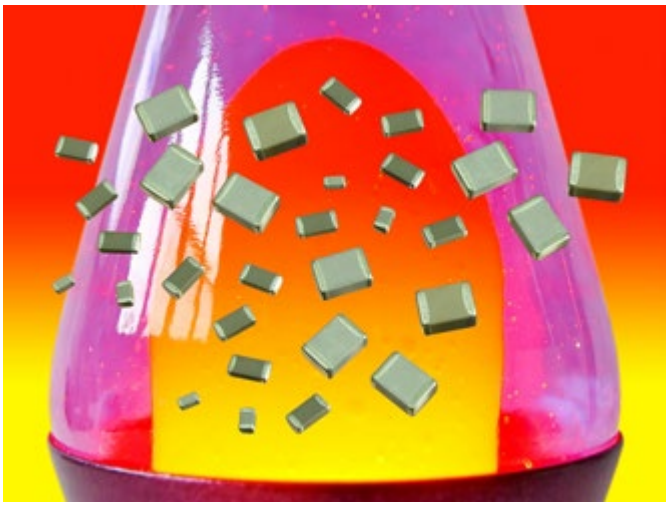


Knowles Capacitors brand, Syfer, has just released its range of High-Q MLCCs. Designated as the “H” series they are manufactured from a very stable, X8G High Q ceramic dielectric to provide Ultra-low ESR, with excellent low loss performance and low power consumption, in high environmental temperature and high frequency systems. They exhibit no ageing effects, with stability under voltage and very low drift.

The electrode system is optimized for the lowest possible ESR and provides low metal losses that result in flatter performance curves and reduced losses at higher frequencies.

An extended operating temperature range of -55ºC to +150ºC accommodates modern high density microelectronics requirements where environmental temperature could be high. They will find application in DC blocking, Impedance Matching, Coupling and Decoupling functions of PA module, LNA module and Antenna system of small cell or 5G networks - where environmental temperature is high as a result of high power generated in relatively small chambers. Automotive applications are also another area for potential use.

www.knowlescapacitors.com

Power System Designer Configures Modular Power Systems

Vicor Corporation announced the introduction of its new Power System Designer online design tool, giving system designers unprecedented flexibility to architect and optimize

end-to-end power systems leveraging Vicor’s Power Component Design Methodology and high-performance power components.

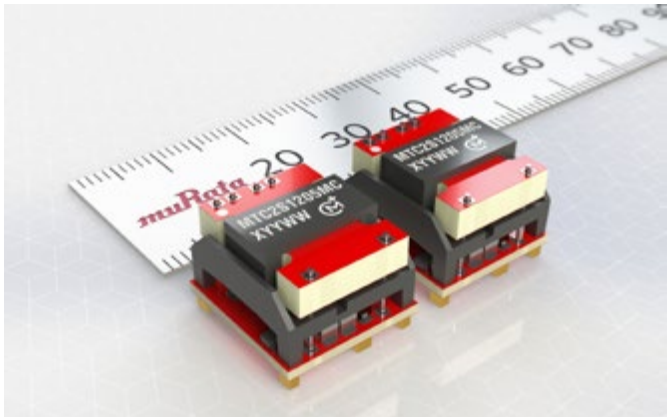
Vicor’s Power System Designer online design tool simplifies and accelerates the creation of compact, multi-output, modular power systems all the way from the input source – either AC or DC – to system loads. Engineers simply specify their AC or DC input source and operating range, and their required output voltages and respective power (or current), regulation and isolation specifications, and the tool automatically generates and identifies the best alternative solutions, each solution characterized by figures of merit including Highest Operating Efficiency, Lowest Component Count, Lowest Cost, Smallest Footprint and Recommended Best Fit. Each solution can be viewed, analyzed and optimized using Vicor’s fully editable Whiteboard tool, enabling designers to meet the exacting performance requirements of their target application.

http://www.vicorpower.com

http://www.vicorpower.com/powerbench

Miniature 2 Watt DC-DC Converter has Medical Safety Standard

Murata today announced the MTC2 series of 2 Watt single output, regulated and isolated DC/DC converters from Murata Power Solutions. Available with either a 12 or 24 VDC 2:1 input voltage range and output voltages of 3.3, 5, or 12 VDC, the surface mount MTC2 has a 3 kVAC input to output isolation.



Measuring just 0.59 x 0.56 x 0.44" (14.99 x 14.22 x 11.23mm), the converter complies with both the UL/EN 60950 reinforced insulation safety standard for use in commercial equipment and the ANSI/AAMI ES60601-1 medical safety specification with 2 x MOOP (Means of Operator Protection).

The output is regulated to ±0.5% of the nominal output voltage and an output voltage trim function permits adjustment of the output by ±10% to suit the needs of special applications. No additional regulation components are required and, with the 2:1 input range, the MTC2 is capable of accommodating applications where there may be wide deviations of the input voltage. A remote on/off pin is available to aid sequencing power start-up in a design or to enable application power saving features. A continuous short circuit protection function ensures that both the load and the device are protected from short circuit conditions.

Capable of operating at full output from -40 to +85°C, the MTC2 can operate up to +105°C with derating.

www.murata.com

Power Stack with Extremely Low Inductance DC Link

FTCAP is currently developing a 3-phase power stack in cooperation with Danfoss Silicon Power. The partners presented a demonstrator unit for the first time at PCIM. The power stack features an extremely low inductance DC link, in addition to efficient Danfoss ShowerPower® cooling. Potential applications are solar inverters, wind turbines and inductive heat generators.

The 3-phase, 2-level half-bridge power stack supports input voltages from 400 - 575 VAC. It can be used both in a back-to-back application (AC/AC) with 200A/300A and in a parallel configuration (DC/AC) with 400A/600A (6 x 300/450A - 1200V modules). It features a switching frequency of 2 - 12 kHz and a DC link capacity of 4 µF.

"In this development project we have succeeded in implementing an extremely low inductance DC link," explains Dr. Thomas Ebel, Managing Director of FTCAP. "That improves the efficiency of the solution and increases the maximum permissible switched voltage." The innovative ShowerPower® liquid cooling system from Danfoss controls the temperature of both the power module and the capacitors, to guarantee a safe operating temperature at all times.

The demonstrator is equipped with a FischerLink capacitor module, which supports capacitances of up to 4000 µF and voltages up to 900 VDC, in addition to extremely low inductance. In the patented "FischerLink" concept the capacitors are welded directly onto copper busbars and encapsulated in a shallow trough under vacuum to create a solid component. This space-saving design eliminates the need for a capacitor cover, and the volume capacity can be increased by up to ten percent. In addition, this eliminates a weak spot where diffusion-related humidity can accumulate – therefore substantially increasing the life of the FischerLink modules.

http://www.ftcap.de/produkte/elektrolytkondensatoren/axiale-kondensatoren/

www.ftcap.de

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July 1, 2016
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August 6, 2016
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Announcement

ECCE is the foremost IEEE conference in the field of electrical and electromechanical energy conversion. ECCE2016, to be held in Milwaukee, the heartland of the North America energy conversion industry, will provide researchers, engineers and professionals from industry and academia a convivial and innovative atmosphere for interaction and networking.

Some highlights of ECCE2016 include:

- Stronger than ever industrial support including Gold or Platinum sponsorship from GM, Rockwell Automation, ABB, Eaton, Danfoss, and Wolong Electric Group.
- Keynote speeches will be delivered by prominent leaders from academia and industry:
  - "Options to Create a Sustainable Energy Future" by Prof. Arun Majumdar, Stanford University and former Director of ARPA-E
  - "Future of the Smartgrid" by Prof. Massoud Amin, Minnesota University.
  - "Intelligent Motor Control in a Connected Enterprise" by Mr. Blake Moret, Senior Vice President, Control Products & Solutions, Rockwell Automation
  - "Optimized Power Management Using Data Analytics", by Mr. Michael Regelski, SVP and Chief Technology Officer Electrical Sector, Eaton
  - "Very High Power Electronics for HVDC," by Dr. Guangfu Tang, Vice President of Smartgrid Institute of China State Grid
- A high quality technical program selected from a record setting 1715 digest submissions (10.7% over the previous record).
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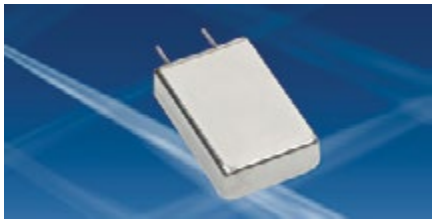
1,5kV Stack 2-level but 1500V DC with intelligent switching

Following the solar trend to increase DC voltage, SEMIKUBE extends its range with a 1300A, 2-level air cooled inverter, able to operate up to 1500V. Using state-of-the-art IntelliOff driving technology, the inverter provides safe operation under all conditions.
IBGT modules with CAL diodes ensures a high robustness of the CAL diode against cosmic rays. Designed within the same footprint and qualification level as standard SEMIKUBE family, the new 1,5kV version offers a very fast market entry into solar applications with the cost effective 2-Level topology.

www.semikron.com

Hermetically Sealed Aluminum Electrolytic Capacitors Replace Banks of Wet Tantalum

Cornell Dubilier Electronics, Inc. introduces its Slimpack, type MLSH, the first in a series of hermetically sealed aluminum electrolytic capacitors that the company plans to introduce over the next several months. With its glass-to-metal seal that prevents dry-out, this capacitor technology has extraordinarily long life to meet the most demanding applications for military and aerospace.
The hermetic Slimpack is a spin-off of the non-hermetic Flatpack series that the company has been supplying to military



and aerospace customers for more than 20 years. The company expects this technology to replace parallel and series banks of wet tantalum capacitors for new and existing designs, especially where bulk storage is paramount. According to the company, the MLSH Slimpack measuring 1.0” x 1.5” x 0.5” will weigh less and will have more capacitance than a parallel bank of 3 or more wet tantalum capacitors as at -55 °C. High capacitance at low temperature is a key requirement for power supplies used in military and aerospace applications.

http://www.cde.com/MLSH/MLSHLanding.htm

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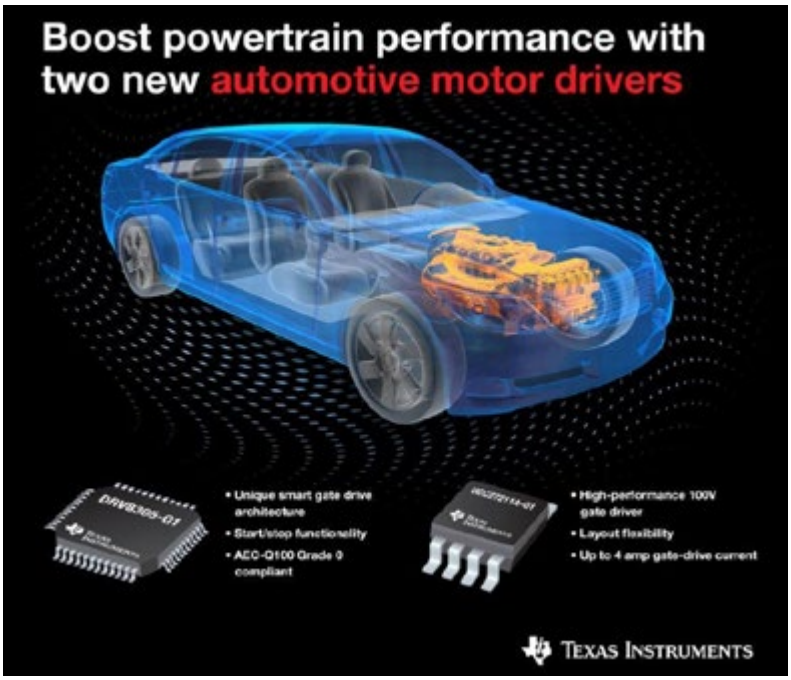
Automotive Brushless DC Motor Drivers

Texas Instruments introduced two new automotive motor drivers that support high-performance powertrain applications. The DRV8305-Q1, a highly integrated three-phase brushless DC gate driver, and the UCC27211A-Q1, a high-current half-bridge gate driver, improve system performance and provide design flexibility to meet a diverse range of automotive system requirements. For more information and to order samples, visit www.ti.com/DRV8305-Q1-pr-eu and www.ti.com/UCC27211A-Q1-pr-eu.



For powertrain applications such as transmission pumps or engine cooling fans, the DRV8305-Q1 features a smart gate-drive architecture with programmable slew-rate control that allows easy optimization of MOSFET electromagnetic compliance (EMC). With an operating ambient temperature range of -40 to 150°C, the DRV8305-Q1 meets the Automotive Electronics Council (AEC)-Q100 Grade 0 automotive temperature specification. Other features and benefits include the following:

Start-stop support: The device operates down to 4.4 V to support start-stop functionality, which enables car manufacturers to meet strict fuel efficiency and carbon-dioxide emission standards.

Reduced board space: The DRV8305-Q1's integrated 3.3V or 5V linear regulator, three current-sense amplifiers and smart gate-drive architecture reduces board size and eliminates up to 20 external components.

www.ti.com

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ABB Semiconductors' range of StakPak IGBT modules features an advanced modular press-pack housing that guarantees uniform chip pressure in multiple-device stacks. Although the most common package for IGBTs is the isolated module, press-packs are preferred in HVDC, FACTS and other applications, as they can easily be connected in series both electrically and mechanically. Furthermore, they have an inherent ability to fail in a short circuit – an essential feature where redundancy is required.

For more information please visit our website: **www.abb.com/semiconductors**

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