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Bodo´s Power Systems®

Electronics in Motion and Conversion

August 2013

ABB IGCTs: Benchmark Performance with Developments on Many Fronts

Medium voltage
A HIGH-WIRE ACT?

o-f.de

Medium voltage components for power electronics

Does this sound familiar? You leave your comfort zone and step onto the tightrope of new territories. For MV applications in power electronics installations there's now a "double safety net". The new GvA "ready-to-use switch components", based on IGBT and Thyristor technology. These are available with or without control or current loop feed power supply – always perfectly balanced. So if you want to reach your new goals quickly and above all safely, talk to your House of Competence. It's worth it.

- **MV IGBT DC switches**
- **MV Thyristor AC switches**
- **MV IGBT / Thyristor control**
- **MV current loop feed power supply**

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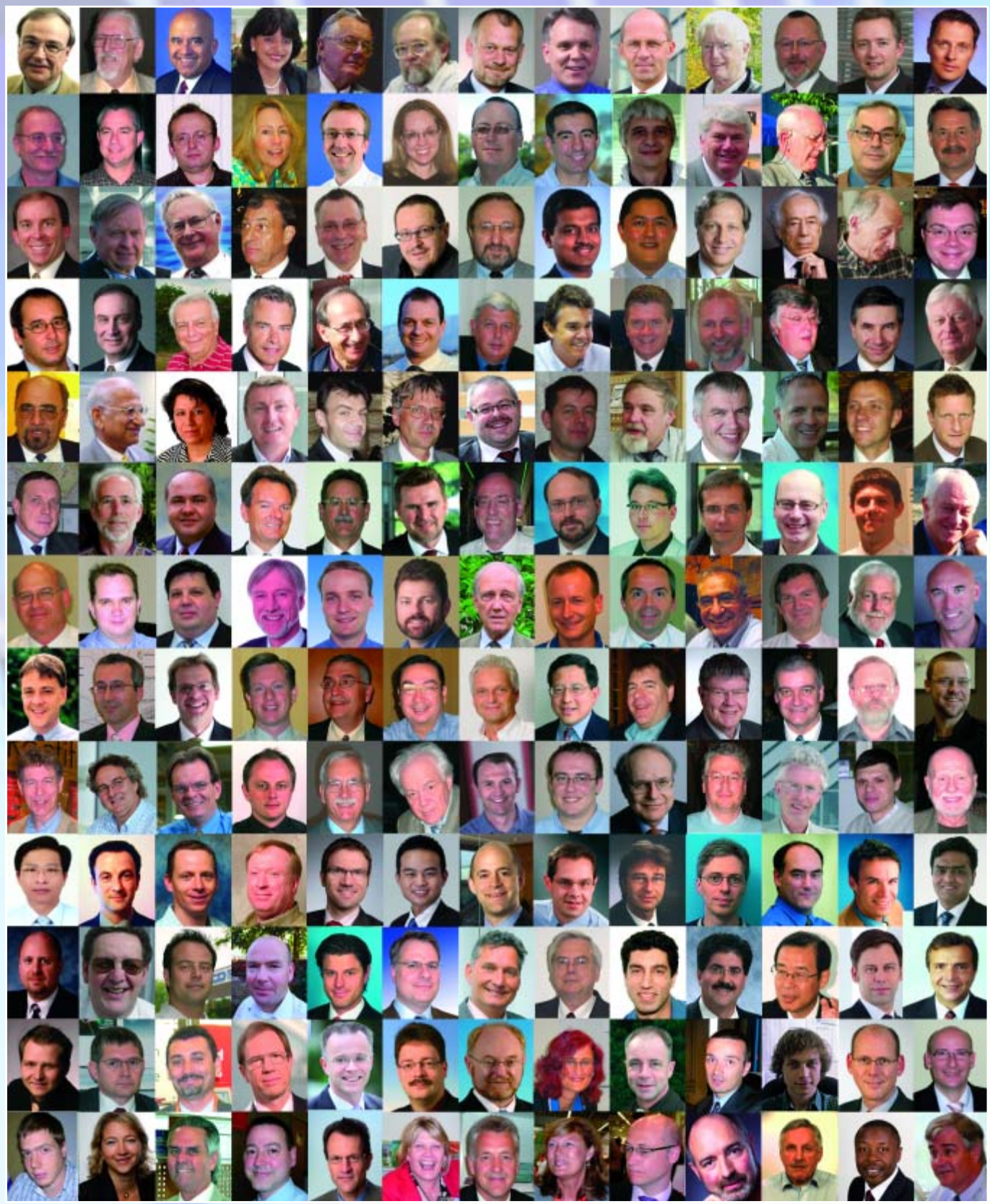
Read online and search for key subjects from all articles in Bodo's Power Systems by going to Powerguru:

powerguru.org

The Gallery



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Events

EPE 2013 ECCE Europe,
Lille, France, September 3rd-5th
www.epe2013.com/

Darnell's Energy Summit,
Dallas, TX, September 9th-13th
energysummit.darnell.com/

ECCE 2013
Denver, CO, September 16th -20th
www.ecce2013.org

Telecoms for Smart Grids,
London, UK, September 23rd-24th
www.smi-online.co.uk/2013telecomsfors-martgrids9.asp

LED professional 2013,
Bregenz, Austria, September 24th -26th
www.led-professional-symposium.com

EU PVSEC 2013
Paris, France, Sept. 30th-October 4th
www.photovoltaic-conference.com/

Battery Energy Storage

Batteries have been known for quite a while. An object with all the appearances and elements of a battery was found near Baghdad in 1936 – estimated to be about 2000 years old. It is a ceramic jar with cylindrical copper and iron electrodes, and bitumen as an insulator. You can see pictures of a recreation at the Smith College Museum of Ancient Innovation web site. About 1.1 volts can be measured when filled with an acidic solution, juice or wine. It has indeed been a long way to today's high performance batteries. The Battery University Event in Aschaffenburg at the end of June brought together manufacturers of batteries and the related industries.

Modern life depends more and more on portable electronics and tools, and both need efficient energy storage. Applications are increasing day by day and into diverse areas – our own mobility demonstrated in electric and hybrid cars, bicycles, and wheelchairs. The health of today's batteries is best maintained with controlled charging and discharging. Sensing and reporting the electric status is common. Cell sensing and bypass controls are used on industrial systems - one gets the impression from recent events that as energy density increases, the risk of faults in the battery becomes more critical. Microcontroller assisted charge and control systems are available to perform these tasks with sophistication. Important as well are standards aimed at safe operation.

Renewable energy systems, solar and wind power, where full utilization is not schedulable, create a need to store energy when generation exceeds demand. Batteries, large or small, can be a solution. Purely electric vehicles need an infrastructure to recharge the battery pack on the road or, alternatively, to swap the battery – but these approaches need further development to be suitable for volume solutions. "Wireless Charging" is an attractive solution to easily provide reliable charging by removing the connector as a source of mechanical weakness. Public wireless charging stations would avoid a need to monitor the condition of connectors. There are plenty of challenges down the road, and engineers are the ones who will develop the solutions.

With increased circulation, my magazine is now printed in both Germany and the USA, matching production to the market need. Thanks to you all, my internal and external supporters, for helping to develop such a successful communication tool. It is certainly fun and enjoyable to work with you all.

In September the race for conferences and shows will be on again: Darnell in Texas, EPE in Lille France and ECCE in Denver, Colorado. We will be serving you with the most important information communicated at these events.

Communication is the only way to progress. We delivered twelve issues last year and will continue this year, each month, on time, every time. This year, with my August issue, we have 87 technical articles amongst 536 pages. As a media partner, Bodo's Power Systems is internationally positioned. If you speak the language, or just want to take to look, don't miss our Chinese version: **www.bodospowerchina.com**

My Green Power Tip for August:
Relax and enjoy the summer, but stay in the shade. Reduced activity will lower your body's CO_2 emissions and, as such, helping the environment can be your excuse.

Best Regards

Dawn of a new intelligence for current measurement

HO

Conventional current transducers are over. The age of intelligent, interactive transducers begins with the dawn of the programmable HO. Set its operational characteristics using a simple microcontroller interface to meet your applications' needs. Its outstanding performance gives you better control and improves the efficiency of your system whilst minimising inventory with one configurable device.

The future starts now!

- Three programmable ranges: 8 A_{RMS}, 15 A_{RMS}, 25 A_{RMS}
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- Access to voltage reference
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www.lem.com

At the heart of power electronics.

LEM®

96% Efficient, 1 MHz Buck Converter Featuring eGaN® FETs

Efficient Power Conversion Corporation (EPC) introduces the EPC9107, a fully functional buck power conversion demonstration circuit. This board is a 9 V-28 V input to 3.3 V, 15 A maximum output current, 1MHz buck converter. It uses the EPC2015 eGaN FET in conjunction with the LM5113 100V half-bridge gate driver from Texas Instruments. The EPC9107 demonstrates the reduced size and performance capabilities of high switching frequency eGaN FETs when coupled with this dedicated eGaN driver.

The EPC9107 demonstration board is 3" square and contains a fully closed-loop buck converter with optimized control loop. The complete power stage including eGaN FETs, driver, inductor and input/output caps is in an ultra compact 0.5" x 0.5" layout to showcase the performance that can be achieved using the eGaN FETs with the LM5113 eGaN driver.

A Quick Start Guide, http://epc-co.com/epc/documents/guides/EPC9107_qsg.pdf, containing set up procedures, circuit diagram, performance curves and a bill of material is included with the EPC9107 demo board for reference and ease of use.

www.epc-co.com

LED professional Symposium +Expo

From September 24th to 26th, 2013, researchers and designers will discuss their newest insights and future trends in the areas of general, architectural and industrial lighting in Bregenz, Austria. 45 informative lectures, 5 detailed workshops and networking opportunities combined with a diversified exhibition make this a "must go" event for experts in the areas of LED and OLED technology.

The keynote speeches by Dietmar Zembrot, President of Lighting Europe, Menno Treffers of the Zhaga Consortium and Alfred Felder from Tridonic will be followed by two parallel lecture tracks with a total of 45 expert talks on the subjects of LEDs, OLEDs, LED Future, LED Systems, Drivers and Steering Elements, Optics, Thermal Management and Implementation. Concurrent to the lectures, there will be two workshop tracks with a total of five distinctive workshops. These workshops will offer symposium attendees detailed information about UL standardizations and certifications, 3-D module designs, printed optic technologies, LED system design tools and LED test procedures. In addition to all that, there will be two interactive tech-panels where attendees can discuss topics of the future in the area of LEDs and OLEDs. More information about all the symposium activities can be found at:

www.LpS2013.com/program

Opening of China Sales Office on Debut at PCIM Asia

Power electronics specialist Amantys has made a statement of its global business intent with the opening of its first international sales office in Shanghai, China. To mark the occasion, the company will exhibit its IGBT Gate Driver family of products at PCIM Asia 2013, taking place in Shanghai, from June 18th-20th.

Exhibiting in China for the first time, the move marks Amantys' increasing progress in the global power industry since its 2010 launch. The established presence in China follows a list of recent agreements with Fuji Electric, Hitachi Europe Limited and Dynex Semiconductor (part of Zhuzhou CSR Times Electric), as part of the Power Drive Partnership Programme announced at PCIM Europe in May.

www.amantys.com

EU PVSEC 2013: Comprehensive Conference Program

The detailed Conference Program of the 28th European Photovoltaic Solar Energy Conference and Exhibition (EU PVSEC) is available, featuring more than 1,600 Keynote, Plenary, Oral and Visual Presentations. The EU PVSEC 2013 will take place from 30 September to 04 October 2013 at Parc des Expositions Paris Nord Villepinte in Paris, France. The five-day Conference is combined with the three-day PV Industry Exhibition, held from 01 to 03 October 2013.

Globally installed cumulative PV capacity has surpassed the 100 GW mark in 2012 and will triple by 2018 according to the new Medium-Term Renewable Energy Market Report of the International Energy Agency - IEA. Reflecting that PV solar energy is now becoming a major and mature electricity source, the Conference Program of the EU PVSEC 2013 extends it focus on application and policy-oriented topics with the inclusion of the related players. New materials, PV system aspects including reliability, dispatchability and grid integration issues and the role of PV as building material are examples of key topics addressed in Paris.

Dr. Arnulf Jäger-Waldau, European Commission, DG JRC and EU PVSEC Technical Programme Chairman: 'The world PV community meets at the EU PVSEC 2013 to present and discuss the most recent innovations and developments along the entire PV value chain.

www.photovoltaic-conference.com

www.photovoltaic-exhibition.com

Capacitors for Power Electronics

IGBT Snubbers
RF Mica Capacitors
DC Link Capacitors
-High Current, High Voltage Film
-High Capacitance Aluminum Electrolytic
AC Output Harmonic Filter Capacitors

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www.cde.com/bodo

Franchise Deal for Nine Manufacturers

Chip 1 Exchange, a global distributor of electronic components, has become fully franchised with several electronic component manufacturers. Chip 1's headquarters and main distribution center is located in Germany. Chip-1 Europe, Dubai, Philippines, Asia and North America have all been commissioned in the franchise agreements in their respective markets.

The nine manufacturers that have signed Chip 1 as their franchised factory direct distributor include the following: Nemco Electronics, Tantalum Capacitors; Y.S Tech, AC/DC fans and accessories; Para Light, LEDs; Meritek Electronics, wide variety of discrete components; Emerging Display Technologies Corp, LCD panel displays; Mag Layers, varieties of discrete magnetic components; Xmultiple, connectors and other components; TGS, crystal oscillators and SAW devices; and Comchip, diode and transistor products.

www.chip-1.com

PCIM Asia Continues to Grow

PCIM Asia 2013 from 18 - 20 June closes with excellent results. With 75 exhibitors on 4,600 square meters in the Shanghai World Expo Exhibition Center, it has grown again this year. The number of visitors has increased to ca. 4,200.

Leading companies like Semikron, Mitsubishi, Infineon and Vincotech were exhibiting and presented their latest products and services. As well as longstanding exhibitors there were also many national and international companies exhibiting for the first time: European companies such as Norwe or Electrum from Russia. Leading Chinese companies such as Nanjing SilverMicro Electronics, Starpower and Zhuzhou CSR Times Electric were again exhibiting at PCIM Asia this year.

Next PCIM Asia 2014 will take place from 17 – 19 June 2014 in Shanghai.

http://www.mesago.de/de/PCC/home.htm

Europe's Manufacturing Initiative is Underway

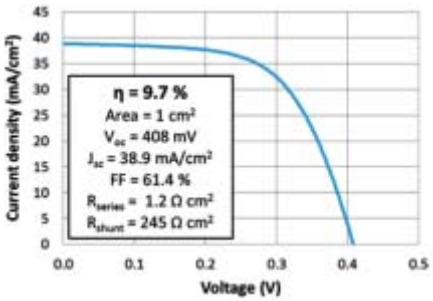
Europe's recently launched industrial strategy to reinforce micro- and nanoelectronics manufacturing is more than just a vision -- it's a major opportunity for equipment and material suppliers to participate to large-scale investment projects, increase their holding in key technologies and reach out to new customers and markets. Implementation is already underway: the first EU funding calls for projects will start at the latest in early 2014 and discussions are already underway on investment priorities. The recent launch of 5 EU projects, worth over €700 Million and bringing together over 120 partners, around 30 percent of which are small and medium enterprises, is proof that Europe can put its "money where its mouth is." So what should you be doing to join the 10/100/20 momentum?

www.semi.org/europe

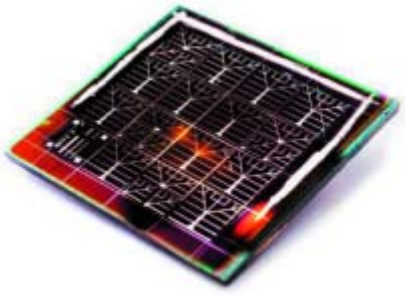
www.pvgroup.org

Achieve 9.7% Efficiency with Thin-Film CZTSe Solar Cell

At Intersolar conference in San Francisco, imomec, imec's associated lab at the Hasselt University, and Solliance, the European R&D consortium that focuses on thin-film photovoltaic solar energy (PV), has presented a CZTSe ($Cu_2ZnSnSe_4$)-based solar cell with 9.7 percent efficiency (1x1cm2, AM1.5G). This promising result is an important step bringing the solar industry closer to a sustainable alternative for the highest efficiency thin-film solar cells in production, based on CIGS (Cu(In,Ga)(S,Se)2).



CZTSe is an emerging alternative solar cell absorber in thin-film solar cells, similar to CZTS (Cu_2ZnSnS_4). Unlike CIGS, CZTS and CZTSe do not suffer from abundancy issues. At 1.5-1.6eV for CZTS, and 0.9eV for CZTSe, their bandgaps make a combined material system ideal for a multi-junction, thin-film solar cell that rivals the efficiency of CIGS cells (about 20 percent). Imomec, imec and Solliance have defined a path towards further improving the layers and cell structures of CZTSe and CZTS absorbers



aiming at developing a multi junction CZTS/CZTSe solar cell with 20 percent cell efficiency. The presented CZTSe solar cell is an important step forward to reach this goal.

www.imec.be

European Conference on Power Electronics

The EPE Conference Committee invites you to come to EPE'13-ECCE Europe, the 15th European Conference on Power Electronics and Applications (and Exhibition), to be held in Lille, France, a city located at the crossroads of Paris, Brussels and London, in an area renowned for its industrial background, its university life and the warm welcome of its inhabitants.

Special days are scheduled on the main topic of the conference and also on "Power electronics and future transport systems" "Smart Grids". Industrial keynotes, special sessions and discussion panels are organized to highlight the challenges and the future developments on these topics.

www.epe2013.com

Representative has Set Shop in Fukuoka, Japan

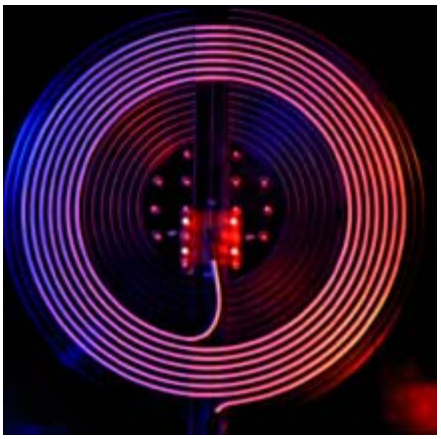
Vincotech is extending its reach in Japan and reinforcing the Asian sales team with an additional Manager FAE for Japan. This move, aimed to more effectively tap the potential of the fast growing Japanese photovoltaic market, will further enhance Vincotech's strong position as a global market leader for power modules designed for solar inverter applications.

"Expanding the Asian sales force by employing Mr. Toru Matsuoka as our new Manager FAE for Japan is another major stride in Vincotech's resolute campaign to penetrate the Japanese market. With a world-class offering, several new products on the horizon, and excellent new staff joining our team, we are well prepared to better pinpoint and capitalize on the tremendous new business opportunities in the Japanese photovoltaic market," notes Eckart Seitter, Senior Vice President Global Sales & Marketing at Vincotech.

www.vincotech.com

High Efficiency Inductive Charger for Electric Vehicles

At the Fraunhofer Institute for Solar Energy Systems ISE in Freiburg, scientists developed a highly efficient system to inductively charge electric vehicles. The wireless energy transfer to the car battery is carried out by means of an electromagnetic field between two coils: one installed in the car and a second, stationary coil integrated into the street or the parking place. A cable connecting the charging station and the electric vehicle is no longer necessary with this system. The first prototypes of the wireless charging system prove to be very efficient: An efficiency of 97.4 percent was achieved for the inductive power transmission at a coil distance of 13 cm. The transmitted power reaches up to 22 kW. All of the necessary power electronics for wireless energy transfer, the coil system and the control technology were developed and constructed at Fraunhofer ISE within the framework of the Fraunhofer project "Shared use of e-mobility: vehicles, data and infrastructure", or GeMo for short in German. Among other things, the scientists in Freiburg have developed a resonant power converter. With a resonance circuit and a stationary coil, this device creates a high frequency magnetic field which transfers the power to the mobile coil located in the electric vehicle. Another converter reshapes the high frequency current of the coil into direct current for charging the battery. The focus was to optimize all sequences in the inductive charging process chain. By employing new semiconductor devices made from silicon carbide (SiC), the efficiency of the various power converters used in the charging system could be increased greatly.



www.ise.fraunhofer.de

www.ise.fraunhofer.de

Alpha to Attend SMTA Philadelphia Expo & Tech Forum, August 15th, 2013

Alpha, the world leader in the production of electronic soldering materials, will attend SMTA Philadelphia and present a technical paper covering the compatibility of conformal coating with no-clean fluxes. Alpha is the sponsor of the Technical Conference at this event.

"Conformal coating has been an area of high interest in high reliability applications including automotive, aerospace, medical and military electronics. The Philadelphia SMTA has a high number of members specializing in these areas, so hopefully the data will be valuable to those who attend," said Mitch Holtzer, Alpha's Director of Assembly Materials R&D.

All SMTA Philadelphia attendees should also plan to visit the Alpha booth where they can learn about the latest Alpha assembly materials product technologies, and Alpha's new technologies for the LED and Power Electronics markets.

www.alpha.alent.com

www.smta.org

POWER FORTRONIC Bologna, 19th of September 2013

Having just staged its' ninth event, and following the great success achieved in 2012, Power Fortronic, promoted by Assodel (Italian Association of Electronics Suppliers), is now acknowledged as the Italian point of reference in the power electronics market.

The 2013 event will represent an important opportunity for meeting manufacturers, suppliers and customers and to contact engineers, designers and buyers, all in a single day, with maximum efficiency in terms of time and investment.

A day of meetings and conferences focused on contents and technological updates, corporate events (workshops and tutorials), business and relationships amongst companies. All this is in order to provide technology upgrades and product news and, above all, to create business partnerships.

Conferences, coordinated by Franco Musiari, Technical Director of Assodel, will focus on the important theme of efficiency, which represents nowadays a key word in electronics market:

- Very High Power: high power systems as inverter, industrial UPS, industrial control
- New Technologies: analysis and comparison of new solutions' benefits in order to consider potential applications
- Power Management: smart applications' evolution

In the afternoon, there will take place hi-tech seminars dedicated both to the depth required by a single company as well as to transfer the practical-didactic skills to participants. Furthermore a community and solutions area, will create a meeting point for people from both the supply and design communities.

www.fortronic.it

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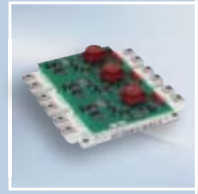
Highest Power Density tailor-made for Wind Inverter Applications



The new FS500R17OE4DP completes the state-of-the-art, compact package EconoPACK™ + D-Series in 1700 V with IGBT4.
The FS500R17OE4DP combines with the rugged package design, the high power cycle capability of IGBT4, the reinforced diode and the excellent thermal behavior of the pre-applied Infineon Thermal Interface Material (TIM) the features to fulfill the wind application lifetime requirements.

The main features of the FS500R17OE4DP:

- Highest power density in this package
- Rugged package design of EconoPACK™ + D-series
- State-of-the-art IGBT4
- Reinforced diode for generator operation
- Pre-applied Infineon TIM

The EconoPACK™ + key benefits:

- Improved lifetime
- High reliability and rugged design
- Reliable and solderless PressFIT contacts
- Long-term and stable thermal performance
- Compact inverter design
- Fit for the future and ready for next chip generations

www.infineon.com/econopack-d-series

Non-Contact Current Probes Target Advanced Power Designs

Power Electronic Measurements (PEM) has launched its latest generation of Rogowski coils for non-contact current measurement, designed specifically for monitoring today's most advanced power systems and semiconductors. The new CWT Ultra-mini probe offers higher maximum frequency and increased stability over a wider operating temperature range.

The CWT Ultra-mini current transducer is a powerful development or diagnostic instrument for examining switching waveforms, ripple currents, transients or harmonics. The extended temperature range of -40°C to +125°C and improved temperature coefficient of 50ppm/°C allow accurate measurement of semiconductors operating at increased temperatures. In addition, the wider 3dB bandwidth of 30MHz enables engineers to analyse high-order harmonics in systems operating at high switching frequencies, or accurately monitor switching waveforms with rapid rise-times.

The coil has a cross section of 1.6mm, allowing users to take measurements at locations that are difficult to access. It can be positioned between the pins of MOSFETs or IGBTs in packages such as TO-220 or TO-247.

The complete CWT Ultra-mini range comprises several variants suitable for measurements from as low as 1A to a maximum full-scale current of 6000A. The new family also has enhanced transient response, and can measure fast-changing currents up to 80kA/µs and has a typical measurement accuracy: ±2%.

PEM has special expertise in wide-band Rogowski current probes, which allow alternating current to be measured accurately by integrating voltages induced in the coil when looped around a current-carrying conductor. Since no electrical contact is required, this provides a convenient means of measuring current without effecting circuit performance. PEM's clip-around coil design allows fast and easy positioning, and provides accurate results without needing to be centralised around the conductor.

Further information can be found at:

www.pemuk.com/improved-cwt-ultra-mini.aspx

Drive happy while staying cool
Reliable power density for tomorrow's vehicles

It cannot be stressed enough: efficient cooling is the most important feature in power modules. Danfoss Silicon Power's cutting-edge ShowerPower® solution is designed to secure an even cooling across base plates. In addition, our modules can be customized to meet your automation requirements in detail, offering low weight, compact design, extended life and very low lifecycle costs. In short, when you choose Danfoss Silicon Power as your supplier you choose a thoroughly tested solution with unsurpassed power density.

Please go to powermodules.danfoss.com for more information.

powermodules.danfoss.com

Class D Amplifier Improves Power Delivery Efficiencies Two-Fold For Driving Brush-Type Motors

Provides Lowest RDS(ON) While Increasing Output Efficiencies For Next Generation Designs

Focusing on improving output efficiencies for Class D "switching" amplifiers used to drive brush-type motors, Apex Microtechnology, Inc, has introduced the SA160DP.

Designed as a complete H-bridge solution, the SA160DP features a very low RDS(ON) of 140mÙ (typical) over the full operating temperature range of -40°C to +85°C. This results in nearly 50 percent less heat dissipation in comparison to the closest competition – also an Apex PWM amplifier, the SA60.

"The SA160DP raises the performance level for single-packaged, small-foot print amplifier solutions capable of driving brushless motors in the 1-2HP range, "explains Jens Eltze, Technical Marketing Engineer. "The SA160DP sends up to 800 watts of power to the load with 97 percent output efficiency using its combination of 80 volt supply operation and 10 amps of output current. An even higher 1.2 kilo watt of power is possible with the 14 amp rated A Grade model."

The PWM switching signal for both the SA160DP and SA160DPA can be internally generated, and is programmable up to 125kHz using an external integrator capacitor. Both devices can also be controlled by external switching signals up to 250kHz. Smart low-side and high-side drive circuitry is self-contained.

For current users of the Apex SA60 who choose to upgrade their next generation design to the SA160DP/SA160DPA, both devices are drop-in, pin compatible replacements busing the same 12-pin Power-SIP "DP" style package. This Power SIP is isolated to allow direct heat sinking and offers space-efficient vertical mounting possibilities to provide a footprint measuring less than 0.3 inches square. An alternative "EE" package style features 90° bent leads for mounting situations where the PCB and heatsink are in parallel.

Pricing, Availability and Evaluation Tools

Both the SA160DP and SA160DPA are available in sample quantities for evaluation and prototyping, as well as volume production. Per unit pricing for the SA160DP is $120.80 in 1,000 quantities and $172.56 for the SA160DPA. EK-SA160DP is the new microcontroller-based evaluation kit currently in development for the SA160DP/SA160DPA and it includes a demonstration board, heatsink and all necessary hardware to provide out-of-the-box functionality for quick and immediate evaluation. Contact Complete product information is online at www.apexanalog.com. For technical support, contact Apex applications engineering at 800-546-2739, or apex.support@apexanalog.com.

Apex Microtechnology is an industry leader in high power analog components, designed to meet the performance and cost design targets of our customers' precision control applications. Apex Microtechnology is headquartered in Tucson, AZ, USA. More information about Apex Microtechnology is available at:

www.apexanalog.com

o-f.de

COMPARISONS

are always interesting!

MODIS – the modular inverter system

Thanks to its modular and flexible design, MODIS offers compelling benefits. The desired power can be easily achieved via parallel connection of the modules. You are also free to choose your preferred cooling type. And the use of standard components makes MODIS both cost-efficient and sustainable. Talk to the House of Competence, because MODIS fears no comparison. Even with your current inverter systems, right?

- **IGBT classes: 1200V or 1700V, up to 1500A**
- **Capacitance: up to 8000µF per module**
- **Parallel connection**
- **Air- or water-cooling**

engineered by

GvA Power Electronics

Welcome to the House of Competence.

GvA Leistungselektronik GmbH | Boehringer Straße 10 - 12 | D-68307 Mannheim
Phone +49 (0) 621/7 89 92-0 | www.gva-leistungselektronik.de | info@gva-leistungselektronik.de

Modular Inverter System

With MODIS, the new **M**odular **I**nverter **S**ystem, GvA Leistungselektronik GmbH focuses on sustainable solutions with standardized and cost-efficient inverters. The modular approach also provides the flexibility required for diverse applications.

The company providing development and manufacture of customer-specific power electronics based in Mannheim is marketing the new state-of-the-art inverter system as an alternative to the standard variants available. The new system allows for the flexible configuration of individual components within a modular system. Depending on the total power requirements, the individual half-bridge modules are connected in parallel thus ensuring scalability of MODIS in various rated classes. Air or water cooling can be optionally selected. The use of widely available standard components offers utmost sustainability - future replacement of individual components is easy to implement. In addition, the standardized components improve the economic efficiency of the MODIS system.

Scalability through parallel connection – one of the conceptual approaches of MODIS.

Picture 2: The individual half-bridge modules of MODIS are optionally available with air or water cooling.

Werner Bresch, Managing Director of GvA, is enthusiastic about MODIS: “We presented MODIS at the PCIM in Nuremberg for the first time and the feedback was overwhelming. Apparently, the modular concept meets expectations. Customers simply don’t want to buy a black box but request flexibility and the possibility for the future exchange of components. I am absolutely positive that MODIS will become firmly established in the marketplace.”

Please find further information on MODIS under

www.gva-leistungselektronik.de

MODIS technical data at a glance:

- IGBT module in PrimePACK™ housing
- IGBT voltage classes: 1200V or 1700V
- IGBT current classes: up to 1500A
- Capacitors: up to 8000µF per module (expandable by an external capacitor bank)
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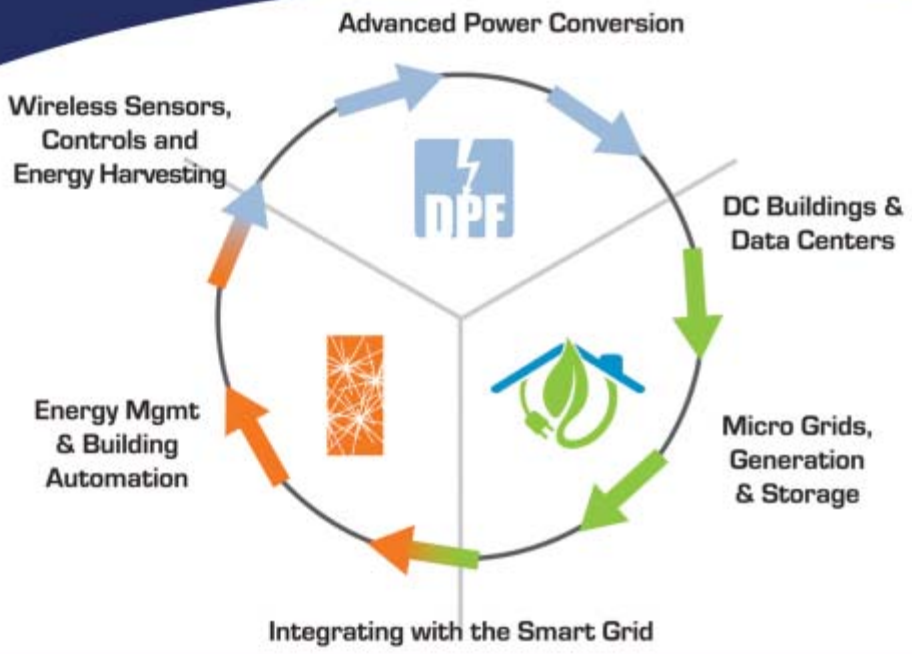

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It All Started in a Coffee Shop

By Johann Thoma, President, Mesago Messe Frankfurt

If you condense the time that has gone by since the Earth was created into a typical 24-hour day, man has only been around for about the last 5 minutes. Sixty seconds ago, we stopped roaming through forests and savannas as savage hordes and began cultivating crops and breeding livestock. And for the last few seconds, we have been driving cars. The world in which we now feel at home – holding a smartphone in one hand and a latte macchiato in the other – has existed for a mere fraction of a second since someone once said "Let there be light".

And yet, the Earth has been shaped more in the last couple of seconds than in the millions of years when dinosaurs were the dominating force – because only man is capable of changing the Earth through the power of his intellect. And even he preferred to dwell in caves for many millennia before the full power of the gray matter behind his eyes was unleashed. Until then, cerebral activity was in a deep slumber. Everything we currently know, however, could also be learned by a baby transported from the Stone Age to the present day. "Baby Flintstone" would have no problems at all growing up in Manhattan and would develop and progress every bit as well as Brad Pitt and Angelina Jolie's children.

Acquiring all of this knowledge took time, though. Agricultural activities led to the first cities and the first written language, the Greeks founded the first nation-state, and the Romans perfected public administration before the world – at least as far as Europe was concerned – was cast into the dark Middle Ages. But then, all of a sudden, at the dawn of the Renaissance period, as science started to replace religion as a means of explaining worldly events, man transformed like a phoenix rising from the ashes. From the arts and scientific studies to philosophy and social systems, great achievements were made in all disciplines, the effects of which are still present today. How can this monumental transition be explained? Why is it that after centuries of intellectual regress, the Age of Enlightenment continued to gain momentum? Printing no doubt played a significant role here. Whereas the majority of knowledge had been recorded by monastic scribes well protected by thick monastery walls, information was now readily accessible. The rising number of universities also further drove the need to know "what holds the world together at its innermost folds".

American author Steve Johnson, who delves into the correlations between technical advancement and social development, puts forth the charming theory that man entered a new era during this time because coffee houses and cafés started becoming very popular in Europe. There were several reasons for this. The boiled water used to make coffee counteracted the dizzying effects of alcohol, which had by then reached all ages and levels of society. Using plain water to quench one's thirst was far too dangerous, since the high level of bacteria it contained presented too much of a risk. Instead, people preferred to simply keep sipping what was safe to drink and wait for the synaptic gaps to close. Boiled water and the ritual of making good coffee eventually went much further by virtually replacing a depressant with a stimulant. The drunken ramblings of medieval taverns became a thing of the past as coffee houses promoted the concept of friendly socializing. Such formality was, of course, nothing entirely new, since Roman senators and medieval dignitaries of the church often spoke this way. The fact that this demeanor had penetrated so many disciplines and acted as a catalyst for instilling the Renaissance spirit was groundbreaking, however. A culture formed that gave rise to ideas and allowed them to spread and develop further through conversation.

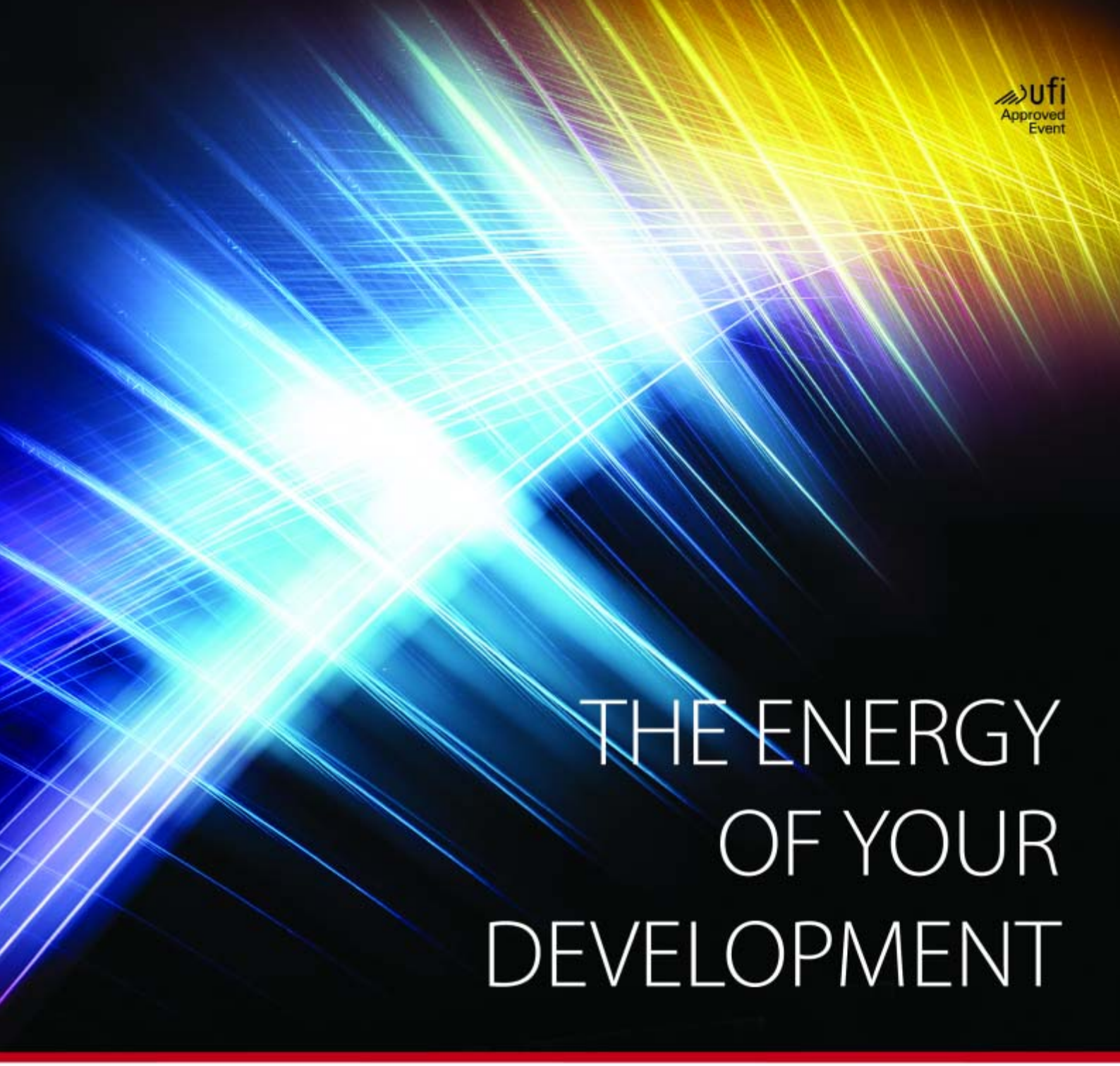
And conversation is, of course, the perfect greenhouse for new ideas. People are social beings; solitary "Eureka!" moments are few and far between. If we want to aspire to new heights, communication is the key! Talking is not a waste of time, but an inspiration. We "modern" people are in search of such dialog more than ever. As we continually expand our use of multimedia communication tools to network, we become more aware of the fact that the most rewarding and efficient form of communicating is the one-on-one discussion.

I am, therefore, very pleased and excited to invite you to SPS IPC Drives 2013 in Nuremberg. Although November is a few months away, preparations are already in full swing while the companies that will be exhibiting are busy refining their latest ideas. On the computer, on the work bench, and in expert discussion panels. Travel arrangements are being coordinated and the finishing touches added to presentations and exhibits. All of this time and effort are being expended so that visitors, of whom well over 50,000 are anticipated, will have the opportunity to interface directly with suppliers. Quantity is not the focus, however, but personal interaction.

If you use the time comparison introduced earlier and view one year of working as a single hour, visiting SPS IPC Drives takes no more than a few seconds. What a difference such minimal investment can make here, too!

I look forward to seeing you in Nuremberg!

www.mesago.de



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Electronics Industry Digest

By Aubrey Dunford, Europartners

SEMICONDUCTORS

Semiconductor makers' inventory in the first quarter declined to $ 37.6 billion, down 4.6 percent from $ 38.4 billion in the fourth quarter of 2012, so IHS. The decline in inventory paralleled the contraction in semiconductor revenues, which fell 5.1 percent sequentially, following the normal seasonal demand pattern.

EURIPIDES² has been awarded the EUREKA label in Ankara during the EUREKA High Level Group which closes the one year Turkish Chairmanship of this initiative. 18 EUREKA member countries have given their approval of this new program dedicated to smart electronic systems. EURIPIDES² will run until 2020 for an estimated total cost worth € 800 M. This outstanding support is 50 percent more than the initial label achieved in 2007. The new strategy will highlight heterogeneous electronic products integration, advanced smart sensors and power electronics but also on the promising enmeshed and implanted systems. The EURIPIDES² cluster aims to support cooperative industrial R&D from design to process and manufacturing in the crucial domain of smart electronic systems integration in aerospace, automotive, energy, health care, transport, and in all new domains like smart cities, mobility and security.

The Alliance for Wireless Power (A4WP) announced that Intel has joined the A4WP with a board of director's seat. Intel joins existing A4WP board member companies including Broadcom, Gill Industries, IDT, Qualcomm, Samsung Electronics, and Samsung Electro-Mechanics.
A4WP technology, which uses near-field magnetic resonance technology, is capable of enabling the simultaneous charging of multiple devices. The Alliance for Wireless Power is an international industry association whose purpose is to create a wireless power transfer (WPT) ecosystem that delivers spatial freedom in the user experience and industrial design of wireless battery charging of portable consumer electronics devices, including smartphones, tablets, netbooks, laptops and more.
Texas Instruments outlined its long-term strategy for manufacturing facilities in Chengdu, China. Future plans include a new assembly/test operation and the expansion of its existing wafer fabrication factory. TI's investments in these operations could total up to $ 1.69 billion over the next 15 years and potentially include facilities, manufacturing equipment and land. TI has opened its fab in Chengdu in 2010. This investment plan does not change TI's 2013 capital spending forecast. The company continues to expect its capital spending levels to remain about 4 percent of revenue until revenue exceeds $ 18 billion.

Worldwide semiconductor manufacturing equipment billings reached $ 7.31 billion in the first quarter of 2013, so SEMI. The billings figure is 8 percent higher than the fourth quarter of 2012 and 32 percent lower than the same quarter a year ago. In Europe, semiconductor manufacturing equipment billings reached $ 380 M, down 26 percent from the previous quarter and down 54 percent from Q112. Worldwide semiconductor equipment bookings were $ 7.78 billion in the first quarter of 2013.
The figure is 23 percent lower than the same quarter a year ago and 14 percent higher than the bookings figure for the fourth quarter of 2012.

Worldwide semiconductor manufacturing equipment spending is projected to total $ 35.8 billion in 2013, a 5.5 percent decline from 2012 spending, and total capital spending for equipment and new facilities will decrease 3.5 percent to $ 56.7 billion, so Gartner. The foundry segment will see an increase in spending of about 14.3 percent this year, while both integrated device manufacturers, and semiconductor assembly and test services providers will show spending declines.

PASSIVE COMPONENTS

Alps Electric has made an investment in Qualtré, a USbased company founded in 2008. ALPS and Qualtré have engaged in joint development of inertial sensors, used to detect various kinds of motion, since 2008. The $ 3 M strategic investment by the Japanese group is intended to facilitate Qualtré's development and sales of these sensors and to further enhance the range of sensor products supplied by ALPS. Qualtré uses bulk acoustic wave (BAW) MEMS sensor technology to develop its inertial sensors.

OTHER COMPONENTS

Zeiss, a German leader in the fields of optics and optoelectronics, announced the planned acquisition of Xradia, a US-based company providing 3D X-ray microscopes for industrial and academic research applications. After closing, Xradia will operate under the new name Carl Zeiss X-ray Microscopy. The Microscopy business group at Zeiss has around 2,800 employees and generates revenue of € 650 M.

Robert Bosch and the Japanese companies GS Yuasa International, an established manufacturer of automotive and non-automotive lithium-ion battery cells, and Mitsubishi have agreed to work together on the next generation of high-performance lithium-ion batteries. These batteries are fundamental for future forms of mobility, such as plug-in hybrid or all-electric vehicles. The three companies intend to set up a joint venture for joint research and development, and to support their mother companies in sales and marketing activities. Operations are planned to start in the beginning of 2014.
The headquarters will be Stuttgart/Germany. Bosch intends to hold a 50 percent stake in the joint venture, with GS Yuasa and Mitsubishi Corporation each holding 25 percent.

DISTRIBUTION

Conrad, a German electronics distributor, has increased its focus and service offering to the Italian market with the opening of a new headquarters close to Milan and the launch of a dedicated Italian website.

This is the comprehensive power related extract from the «Electronics Industry Digest», the successor of The Lennox Report. For a full subscription of the report contact: eid@europartners.eu.com
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Darnell's Energy Summit = GaN/SiC/GaAs + DC Micro Grids + Digital Power + Smart Grid + More

By Richard Ruiz, Analyst, Darnell Group

The first-annual Darnell's Energy Summit (DES '13) will be a combined event featuring the Tenth Darnell Power Forum (DPF '13, formerly called the Digital Power Forum) + the Fifth Green Building Power Forum (GBPF '13) + the Fourth Smart Grid Electronics Forum (SGEF '13). To be hosted in Richardson, Texas, September 9-13, DES '13 will bring together thought leaders from all areas of power electronics to discuss leading-edge technologies and future trends. http://energysummit.darnell.com

"With a single registration, you can attend any sessions of interest during these simultaneous leading-edge events," stated Jeff Shepard, President of Darnell Group. "Plus you'll have access to the combined Exhibit Hall and will have an opportunity to network with an outstanding group of international experts in a wide range of power electronics, DC building power, and smart grid technologies," Shepard concluded.

For example, in the area of advanced semiconductor materials, Bodo's Power Systems will chair multiple sessions including the following papers: "GaAs-based PowerStage Module Enables Disruptive Power Densities," presented by Greg Miller with Sarda Technologies. "Silicon Carbide MOSFETs Provide Simple, Rugged, Low Cost Solutions to High Voltage Auxiliary Power Supplies," presented by Paul Kierstead with Cree, Inc. "Improving eGaN® FET Performance through PCB Layout Optimization," presented by David Reusch with Efficient Power Corp. "The Impact of GaN FETs on the Future of Energy and Power Conversion" presented by, Eric Persson with International Rectifier. Plus several more papers by industry experts in GaN and SiC, and a Roundtable Discussion Panel.

DES '13 will start off with an aspirational and inspirational Keynote Address by Scott Barbour, Executive Vice President, Emerson and Business Leader, Emerson Network Power. Mr. Barbour will present his vision of: "The Evolution of Energy Management."

"We demand all information on every device we own, everywhere we go. Fast. To accommodate, industries are not only demanding more power than ever, but they are seeking new levels of efficiency in the power chain and new, more environmentally responsible sources of generation," Mr. Barbour observed. "Once disparate industries from IT to telecommunications to content delivery, are converging at record pace. Energy delivery and management, too, has become a melting pot. Both AC and DC power are viable options in facilities of all types and are bringing new energy-saving possibilities to micro grids. And the intelligence to see and control that energy use doesn't stop at the outlet. Smart Grid innovations are magnifying the energy savings made possible by the visibility and control now possible within a building's walls. This Keynote will look at today's rapidly changing energy management landscape and provide a glimpse into what may come next," Barbour concluded.

Directly following the Keynote, the Plenary Session will feature these outstanding presentations:

- "Enernet - The Big Picture," Brian Patterson, Chairman, EMerge Alliance and General Manager, Armstrong World Industries. This presentation will describe the progress toward the creation of a true energy network or "Enernet." The network is envisioned to be the electric power corollary to the Internet. Made up of interconnected layers of grids and micro-grids, it will do for power what the Internet did for data, this is, making it a true "distributed system" by giving every node in the power network the capability of being both a source and/or a load in power terms. The presentation will give insight as to the overall topology of the network as well as key changes to the existing grid and building level distribution of electric power necessary to accomplish this undertaking, including the dramatic expansion of the use of dc power therein.

- "IEEE's DC in the Home Investigation Project Accomplishments and Future Goals," Doug Houseman, EnerNex, VP of Technical Innovation, Vice Chair of the IEEE PES - Intelligent Grid Coordinating Committee, and Founding Member of the IEEE DC in the Home initiative. In June 2013 the IEEE Standards Association (IEEE-SA) approved a research project into the future of DC in the Home and what the IEEE collectively needs to do to support this effort from new standards, to guidelines, building code support, research initiatives, and encouragement to change/add new majors to major research universities. This presentation will bring people up to speed on the activities, the timelines, work to date, and how to become involved in this project.

- "DC Microgrids - Challenges and Opportunities," Kurt Yeager, Vice Chairman of the Galvin Project, Inc. The term "microgrid" reflects a new way of thinking about designing and building smart grids. The microgrid approach focuses on creating a design and plan for local energy delivery that meets the exact needs of the constituents being served, whether a city, university, neighborhood, business park, or major mixed use development. At the local level, smart microgrids most efficiently and economically integrate consumers and buildings with electricity distribution and generation. Through smart microgrids, the economic and environmental benefits to consumers of the smart grid transformation can be maximized.

- "GaN: Crushing Silicon One Application at a Time," Alix Lidow, CEO, Efficient Power Conversion Corporation. Enhancement mode gallium-nitride transistors have been commercially available for over four years and have infiltrated many applications previously monopolized by the aging silicon power MOSFET. In this presentation we will show the benefits derived from the latest generation eGaN® FETs in new emerging applications such as Class – D audio, LiDAR, wireless power transmission, and RF envelope

tracking. We will also discuss the state-of-the-art and the expected progress of the technology over the next few years. All cases support the rapidly evolving trend of conversion from power MOSFETs to gallium-nitride transistors.

- "Future Opportunities for Maximizing Efficiencies through Advanced Digital Power Control and Management," Randy Malik, IBM Distinguished Inventor, IBM. The use of digital power management can provide significant energy savings in facilities such as data centers. Using a combination of digitally-controlled power converters from the uninterruptible power supplies that provide back-up power to the board-mounted dc-dc converters that power individual subsystems in each server, and integrating digital control of the local cooling infrastructure, it is possible to reduce costs and improve the performance of data centers. Future implementations will provide increased intelligence and increased granularity of real-time digital control that will both enhance the availability of these facilities and reduce operating costs even more.

Of course, the DPF component at DES '13 will include many papers with practical, leading-edge information for digital power implementations. Some examples of the digital power papers that will be presented include: "High-Performance Isolated DC-DC Converter Implementation Using Digital Control," "Short-Cutting the Digital Converter Design Process with Advanced Control Methods," "Digital Control: An Essential Ingredient for Solid State Lighting," "I2C™ Physical Layer, the Basis for SMBus and PMBus™," "Implementing Adaptive Algorithms for Enhanced Efficiency in Fully Digital-Controlled AC-DC Power Supplies," "Advanced Components and Digital Power," "Dynamic Performances Comparison of Digital Feed-forward Controls for Input Voltage Transience," and more!

Each of the individual constituent events, DPF '13, GBPF '13, and SGEF '13, will maintain its unique identity and will continue to serve different groups of stakeholders. These co-located events will bring together thought leaders across the areas of advanced power electronics, energy management, micro grids, the smart grid, and related topics of global importance. DES '13 will leverage the successful track records of the separate events to create powerful opportunities for synergy.

DPF '13 will again be an exciting international event that focuses on "advanced power conversion technologies" needed for the successful development of next-generation power systems. There is tremendous synergy possible from discussions broadly focused on power management, energy efficiency, advanced components, energy storage, new power architectures, and more. DPF is a solutions-oriented event, with a strong emphasis on practical advances in power electronics. In addition to a strong focus on today's "best practices," DPF looks forward toward next-generation solutions and advances.

GBPF '13 will consider all aspects of building power including high-voltage and low-voltage dc distribution, hybrid ac and dc distribution architectures, and dc micro grids. A convergence of technologies is occurring that will change how buildings are powered. These technologies include the continued rapid growth of distributed generation (DG) resources; the emergence of high-efficiency lighting technologies; wireless building automation systems; demand-side management of building energy use by electric utilities; and more.

Control, Communications and Security will be three of the major themes of SGEF '13. The successful deployment of the smart grid will be dependent on numerous technology and standards developments for electronic equipment. For the smart grid to have benefits, it must be able to reliably communicate to the downstream loads and also be able to turn these loads on/off or turn them up/down as appropriate.

There is tremendous synergy possible from discussions broadly focused on power management, energy efficiency, advanced components, energy storage, smart grid innovations and more. Darnell's Energy Summit is a solutions-oriented event, with a strong emphasis on practical advances in power electronics. In addition to a strong focus on today's "best practices," DES '13 will also look forward toward next-generation solutions and advances. Registration is open:

http://energysummit.darnell.com

IGCTs: Benchmark Performance with Developments on Many Fronts

The Integrated Gate-Commutated Thyristor (IGCT) was introduced about 15 years ago and has established itself as a preferred solution for a number of high power electronics applications. These applications have in common that the rated power level is in the megawatts (MW) and they range from industrial drives and track-side supplies to power quality and high-current breakers.

By Martin Arnold, Björn Backlund, Munaf Rahimo and Tobias Wikström
ABB Switzerland Ltd, Semiconductors.

In this article we highlight the features making the IGCT so attractive for high power applications and we discuss the developments that will further strengthen the IGCT's advantages in high power applications.

Figure 1: The IGCT product family

IGCT Features
The IGCT design offers a number of outstanding features. Some of the product features, their impact on the equipment design and the resulting customer benefits are discussed in the following.

Available as asymmetric and reverse conducting (with integrated diode)
ABB offers two different types of IGCTs: the asymmetric and the reverse conducting (RC).

The asymmetric IGCT offers highest power levels. It is available as standard asymmetric IGCT and as the newer HPT-IGCT with improved turn-off capability. Applying asymmetric IGCTs allows choosing optimized free-wheel diodes as for instances ABBs new IGCT diodes as presented in Bodo's Power Systems, issue May 2012.

The RC-IGCT features a monolithically integrated free-wheel diode and therefore enables very compact stack designs. The RC-IGCT has been designed aiming for good performance in drive applications with moderate regeneration to the grid.

Voltage ratings 4,500 up to 6,500 V with current ratings of 520 up to 5,000 A of peak turn-off current
ABB's IGCTs are available with different voltage ratings. The 4,500 V and 5,500 V devices are perfectly well suited for 3-level inverters targeting the standard line voltages 3,300 V and 4,160 V (Table 1). The availability of different IGCT sizes allows drive manufacturers to offer inverter families covering a certain power range just by choosing the corresponding IGCT.

Nominal line voltage	Nominal DC-link voltage for cosmic ray rating (V)	Preferred repetitive blocking voltage rating (V)
2,300 V_{RMS}	1,900	3,300
3,300 V_{DC}	2,000	3,300
3,300 V_{RMS}	2,700	4,500
4,160 V_{RMS}	3,400	5,500
6,000 V_{RMS}	4,900	8,000
6,600 V_{RMS}	5,400	8,500
6,900 V_{RMS}	5,600	9,000
7,200 V_{RMS}	5,900	9,500

Table 1 — Preferred blocking voltage ratings for high power semiconductors used in 3-level voltage source inverters (VSIs).

Inverter output powers of up to 8 MW can be realized with 2-level inverters utilizing the large asymmetric 4.5 kV HPT-IGCT (91 millimeter wafer diameter) as shown in Figure 2. The flattening of the curves for the non-HPT devices towards lower frequencies is due to save operating area (SOA) limitations. 3-level inverters even achieve power levels that are about twice the power of 2-level inverters. Accordingly, converters rated 10 MW and beyond can be realized without the need of paralleling and/or series connection of devices.

Integrated gate unit - critical to device performance
The gate driving circuit, commonly called gate unit, is critical for the device performance and is therefore an integral part of the IGCT. There is no need to externally source a gate unit which even might compromise the device performance. The IGCT only needs a power supply and two optical fibers for the control and can be considered plug-and-play, although it may be a bit unusual to describe a MW-device in this way.

Low on-state losses

Due to its design the unirradiated IGCT has a very low on-state voltage drop and therefore very low on-state losses. This makes the IGCT very well suited for a number of static and hybrid breaker applications as well as an interesting alternative for high power multi-level converters. Traditional applications, however, require a trade-off between on-state losses and turn-off losses. The relationship between on-state and turn-off losses is determined by irradiation of the GCT wafer. ABB offers IGCTs with low on-state losses, with low turn-off losses as well as with a good trade-off between the two.

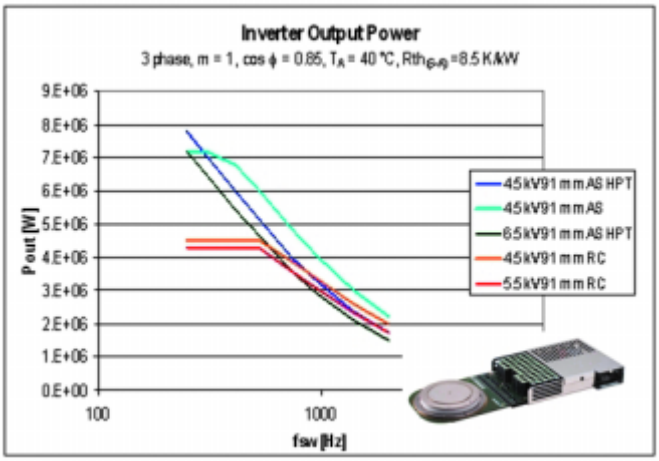

Figure 2: Achievable output powers of a 2-level inverter using ABB IGCTs

Press-pack design for efficient double sided cooling

The press-pack design of the IGCT has the advantage that the device can be mounted directly between two heat-sinks and therefore be efficiently cooled from both sides simultaneously. Further, there is no need for thick layers of thermal compounds thus allowing for very low thermal resistances in the cooling system. This directly translates into very high power densities for the assembly and reduces the space required for a converter of a given rating when compared with assemblies using isolated power components.

Press-pack design for high load cycling capability

The hermetically sealed press-pack design of the IGCT has proven its extraordinary load cycling capability and reliability in numerous applications for years in the field. Consisting of only a few layers of well-designed materials there are no issues with solder voids or bond liftoffs as apparent in other packaging technologies. Proper coatings and the used materials themselves assure that the mechanical wear of the device due to temperature excursions when operating at intermittent load are kept within reasonable limits. This makes the IGCT well suited also in applications with severe conditions as experienced in steel mills, mine hoists, marine drives and others.

Technology Outlook

To improve the IGCT performance in existing applications and to bring about further opportunities a number of developments are in progress. We will take a closer look at some of these development activities and see what the benefits of these new developments will be.

Increased junction temperature

A possible way to increase the output power of an existing converter design is to increase the temperature rating of the used power semiconductors. For continuous operation the cooling system may set a limit for the additional losses that result from the increased temperature. For intermittent operation though, the temperature increase is a valid option. This since the increase in average power, and through that the requirements on the cooling system, is limited. Important is that the semiconductor can handle a high load for a limited amount of time and by this avoids to step up in converter size.

To achieve such a high load capability, a number of improvements to the HPT-IGCT are being implemented with a targeted operating temperature increase from 125 °C to 140 °C. In the silicon the corrugated p-base doping profiles introduced in the HPT-IGCT have been optimized to allow for full SOA exploitation over the whole temperature range from 0 °C to 140 °C. Further, also internal interfaces like the metallization on the wafer have been improved to achieve a higher thermo-mechanical wear resistance. These measures allow for the higher temperature excursions of the device under intermittent operation at 140 °C. The verification of these improvements has started and the first results look very promising.

The reverse blocking IGCT

Certain AC applications and current source inverters (CSIs) require a switching device that is symmetrically blocking. Although this could be realized by using an asymmetric IGCT connected in series with a fast diode, the preferred solution is a symmetric IGCT. Since the performance requirements and some modes of operation of symmetric IGCTs considerably differ from asymmetric IGCTs, there is quite much learning needed for their realization. ABB has taken the challenge and realized the first symmetric IGCTs that are undergoing extensive testing. A new product lineup is planned with a voltage rating of 6,500 V, ideally suited for a 2,300 V line voltage as per table 2.

Nominal line voltage	Nominal AC peak voltage for cosmic ray rating (V)	Preferred repetitive blocking voltage rating (V)
2,300 V_{RMS}	3,700	6,500
3,300 V_{RMS}	5,400	9,000

Table 2: Preferred blocking voltage ratings for high power semiconductors used in current source inverters (CSIs)

The 150 mm IGCT

The quest for ever-growing power ratings makes the option of expanding into larger silicon diameters viable. The ABB HPT-technology's improved scalability combined with the advances in bipolar technology towards larger silicon wafer sizes enables the design of devices beyond the standard 91 mm wafer sizes. Phase control thyristors with a wafer size of 150 millimeters have been around for some time and based on their manufacturing capabilities first 150 mm reverse conducting 4,500 V HPT-IGCT prototypes have recently been manufactured and a prototype with gate unit is shown in figure 3.

Figure 3: 150mm 4,500 V RC-IGCT (Prototype)

First 4,500 V samples have been tested and show good turn-off capabilities (Figure 4) which gives a strong indication that the wafer, housing and gate unit have the targeted performance in respect to uniformity and absolute inductance.

With this RC-IGCT, it will be possible to realize 3-level inverters of up to about 20 MW without the need for series or parallel connection of power semiconductors. There is though still some work to be done before the device will be released. The final package design and the gate unit are still to be finished and the best IGCT versus diode area ratio to be determined. And finally, prior to sampling, extensive electrical and environmental qualifications lie ahead.

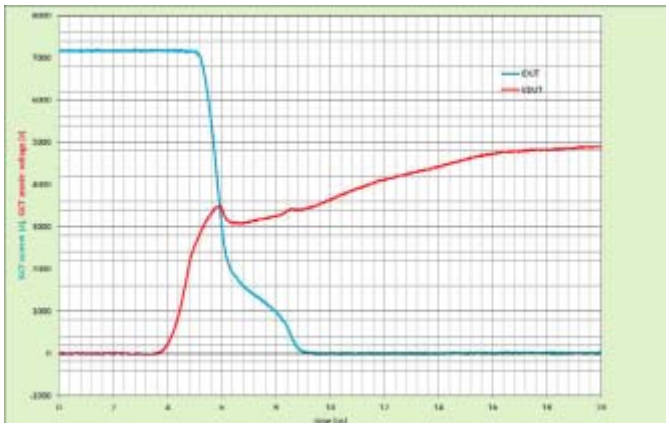

Figure 4: Turn-off wave form for the 150 mm 4.5kV RC-IGCT at IT = 7.2 kA and VDC = 2.8 kV

The 1 V initiative

Today, there is a clear trend towards multi-level topologies in many power electronics applications. Multi-level converters are operating at fairly low switching frequencies but at the same time they require high current carrying capabilities and/or high efficiency. Due to the IGCT's inherent low conduction loss thyristor properties and the hard switched functionality the IGCT is predestined for such applications. Figure 5 shows how a 4,500 V, 91 mm IGCT can be tuned to different application requirements and compares with a corresponding state-of-the-art IGBT press-pack module.

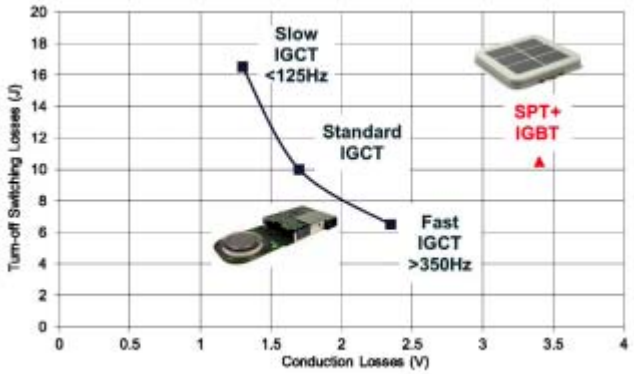

Figure 5 — Trade-off between conduction losses and turn-off losses for differently tuned 91 mm IGCTs compared with a press-pack IGBT module at IT = 2 kA, VDC = 2.8 kV, Tj = 125 °C.

Since there is a certain amount of freedom in selecting the device voltage for a multilevel system a number of simulations and experiments have been performed to see what performance can be achieved with the goal of approaching an on-state voltage drop of 1 V. The results are summarized in figure 6 and show designers how multi-level converters can be optimized with respect to minimum total inverter losses for a given topology, system voltage and current level.

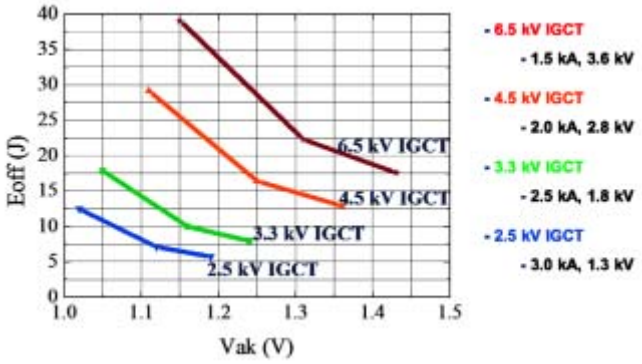

Figure 6 — Simulated technology curves for different IGCT voltage ratings approaching the 1 V on-state voltage drop goal.

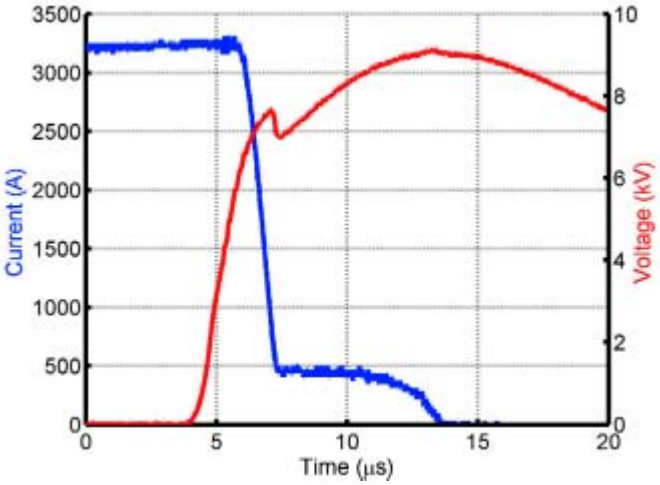

Figure 7 — Turn-off wave form of a 91 mm 10 kV asymmetric IGCT at IT = 3.3 kA and VDC = 6 kV.

Increased voltage ratings

From table 1 it can be seen that 3-level inverters for line voltages of 6 to 7.2 kV without series connected IGCTs would be possible if IGCT voltage ratings of up to 10 kV were available.

A 10 kV IGCT prototype has been produced to prove that IGCTs with higher voltage ratings are possi-ble and its turn-off wave form is shown in figure 7. Since the high blocking voltage requires quite thick silicon which translates into fairly high switching and conduction losses, these devices target applications as drives for machines with moderate speeds.

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Moving to a New Direction

The Photovoltaic market suffers in Europe but fares better in the MENA region

What will the future bring for the solar industry? Definitely severe changes. Photovoltaic will be an important pillar of our future energy supply, but on the way to this, the industry has to face lots of challenges, especially in Europe. The trade show Intersolar Europe 2013 reflected the turbulences of the industry with fewer exhibitors and a smaller exhibition area.

By Marisa Robles Consée, Corresponding Editor; Bodo's Power Systems

Fairly unusually this summer, the sun shone on the 22nd edition of the Intersolar trade show that took place in Munich from 19th to 21st of June, 2013. With about 35 °C this was one of the hottest shows ever held. However, the bright sun could not hide the fact that the industry is suffering, especially in Europe. Some 50,000 visitors from more than 150 countries flocked to Intersolar Europe 2013 at Messe München. A total of 1,330 exhibitors (2012: 1.870) from 47 different nations (2012: 48) presented technologies and services in the fields of photovoltaics, PV production technologies, energy storage systems and solar thermal technologies in 12 exhibition halls and an outdoor exhibition area, together 121,000 m² (2012: 171.600 m²) of exhibition space. This year, 53% of Intersolar Europe's exhibitors came from abroad. With 608 exhibitors present (2012: 870), Germany was the best represented country, followed by China with 242 (2012: 385), Italy with 59 (2012: 78), Austria with 40 (2012: 46) and Spain with 29 (2012: 45) companies. In terms of visitors, 44% made the journey to Munich from outside Germany, beating last year's figure.

In 2013, Intersolar Europe had a dedicated exhibition segment for energy storage systems in hall B5, which attracted a lot of visitors. A total of more than 200 exhibitors had registered for the area of energy storage systems, making Intersolar Europe the largest platform for the combination of photovoltaics and energy storage systems worldwide. The role of storage systems for on-site consumption and for the grid integration of solar power was one of the exhibition's, and the conference's core topics. This year, some 400 speakers and 2,000 attendees from all over the world participated in the Intersolar Europe Conference and Side Events.

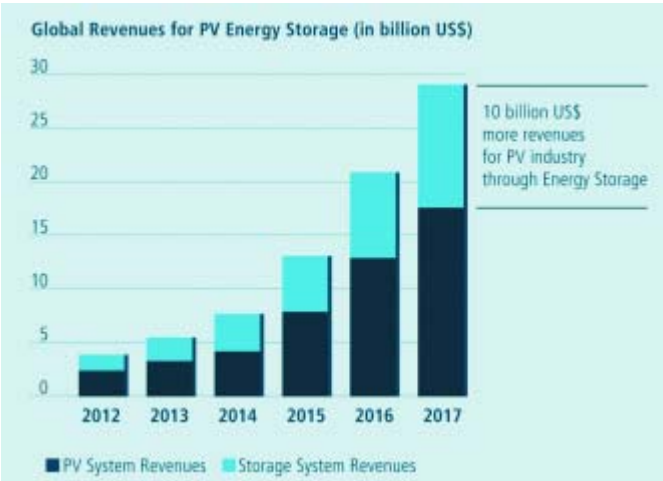

Figure 1: Revenue forecast is for PV systems installed with energy storage only. Source: IHS/Solar Promotion

Finding new markets

On the way to find new markets, the industry is moving to a new direction. Although the economic crisis and some excessive cuts in funding have currently brought about a downward trend in the European solar market, and many manufacturers of solar cells and modules in particular are facing great challenges due to tough competition, demand is up in Asia and America. Some examples: In 2013, experts are forecasting growth of around 30% relative to the previous year for newly installed photovoltaic capacity in the USA, and over 50% for China, while in Japan the photovoltaic market is expected to at least triple compared to 2012. The solar industry expects the newly installed annual solar power capacity to increase from 31 GWp in the year 2012 to around 50 GWp by 2015. This would mean more than a doubling of the installed photovoltaic capacity around the world within three years, to over 200GWp. In Germany, solar power already covers 5% of the electricity demand. The solar industry has set the target of increasing that share in Germany to at least 10% by 2020 and at least 20% by 2030.

"More and more countries are recognizing the fact that there is no alternative to a rapid expansion of solar power, and that this is significantly less expensive than holding onto fossil and nuclear energy sources. All around the world, the skyrocketing costs of climate change and the costs of importing fossil fuels are driving this realization home", explains Carsten Körnig, Managing Director of BSW-Solar, the German Solar Industry Association. The export quota of German companies grew from 50% in the year 2010 to 60% in the year 2012, and the industry association expects that it will continue to grow within the next years.

Despite struggling companies: Germany is still strong…

One in ten people in Germany already produce solar power, and more and more people are taking the "Energiewende", Germany's energy turnaround, into their own hands. Today, already 8.5 million people live in buildings that use their own solar power systems to generate electricity or heat. The active use of solar power provides greater independence from rising energy prices and additionally prevents large amounts of carbon dioxide from being released into the

environment. In the year 2013 alone, solar power systems installed in Germany will achieve savings of around 24 million metric tons of carbon dioxide emissions.

In the past two years, solar power has played the leading role among all other technologies in the German Energiewende. The past five years have seen a virtual doubling of the number of people in Germany who live in buildings supplied with heat or electricity from solar power. "People support the Energiewende, and they are increasingly taking it into their own hands. It's now up to the politicians to resolutely move the Energiewende forward and to utilize the significant readiness of citizens and entrepreneurs to invest in the transformation of the energy supply system," explains Carsten Körnig. Focussing on Germany, Carsten Körnig is convinced that a "strong domestic market is indispensable for a successful solar industry. Following federal elections, political stakeholders must therefore ensure that renewable energy sources form the core of the energy supply system, that their rapid expansion is once again given priority, and that citizens and the industry have solid investment security."

…but MENA is getting stronger (soon)

The solar industry in the Middle East and North Africa (MENA) is geared up for growth: By 2015, the regional market for photovoltaic and solar thermal power plants is expected to grow to a total output of 3.5 GW. Saudi Arabia in particular is planning to move away from generating electricity using crude oil in favour of photovoltaic and solar thermal technologies. A study conducted by GTM Research, Boston, USA, puts this development down to high solar irradiation,

rising electricity prices and requirements that arise from an increasing population size. By 2017, the expansion of solar energy is expected to exceed a combined output of 10GW in the MENA region. With a share of 70%, the majority is set to be implemented in Saudi Arabia and Turkey.

The sun also ranks among the most valuable resources in North African countries. Egypt benefitted from crude oil exports in the 1990s; however, current reductions in yields produced by oil fields and increasing energy subsidies are forcing the Egyptian government to take action. In the financial year 2012/2013, subsidies reportedly account for a quarter of the entire Egyptian state budget. As the largest energy resource in the country, the sun offers an ideal alternative to dwindling oil and gas. Every year, each square meter in Egypt receives more than 2,200kWh of solar energy. The Egyptian Solar Energy Development Association (SEDA) in Cairo sees potential application areas for solar energy in the form of solar installations for producing drinking water and intelligent lighting concepts for hotels. In Morocco, solar plants with a combined output of 2GW are set to be installed by 2020, which means that the share of renewable energy in the Moroccan power grid could reach a total of 42%. Alongside solar energy, wind energy and hydropower are also expected to form part of this share. Under the supervision of MASEN (Moroccan Agency for Solar Energy), the construction of a large, impressive project has already begun in the Moroccan province of Ouarzazate, which will be the world's largest solar thermal power plant. A capacity of 160MW will be installed in the initial expansion phase alone. Once completed, the power plant will reach an output of 500MW.

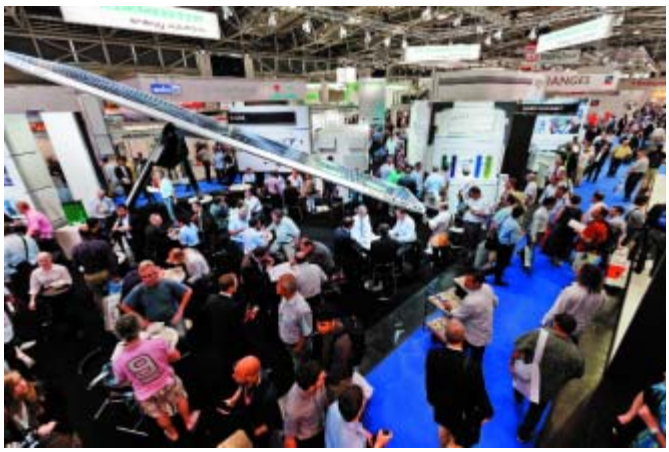

Figure 2: For the first time Intersolar 2013 had a dedicated exhibition segment in hall B5 for energy storage systems, which attracted a lot of visitors. Picture: Solar Promotion/Thorsten Jochim

Giants war

Solon, Q-Cells and now Conergy are insolvent, big companies like Bosch or Siemens are closing their solar divisions. Last year Germany installed more than 7,600MW photovoltaic output. This year this will shrink to about 5,000MW of new installations. Germany will remain as a big solar market with high potential growth, states VDMA, the German Engineering Federation. But the turnover of manufacturers of photovoltaic components, equipment and plants in Germany has decreased by almost 50% in 2012 compared to the previous year reports VDMA. This means that times of rapid increase in photovoltaic production capacities are definitely over. Already since the end of 2011, the PV equipment industry has suffered from large over capacities. This development continuously got worse in the course of 2012.

"In addition to market turbulences we have to cope with continuing trade conflicts in the solar sector. We clearly feel the uncertainty which this development means for our clients. The willingness to invest in newest machinery and production technology in order to thus maintain their own competitiveness has considerably decreased", explains Dr. Peter Fath, CEO of RCT Solutions and Chairman of the Board of VDMA Photovoltaic Equipment.

The benchmark with their international market partners, however, remains positive. With a share of 55% of the world market, German companies could consequently expand their competitive position in 2012. "German PV manufacturers and technology suppliers continue to benefit from being innovative, solution oriented and close to their customers. When it comes to competitive capacities as well as to replacement and upgrade of existing production capacities, top performers choose "Made in Germany" relying on competitive cost structures and top quality", stresses Dr. Florian Wessendorf, Managing Director of VDMA Photovoltaic Equipment.

That may be the reason why the PV-machinery industry is strongly against anti-dumping measures. The European Commission has decided to impose punitive tariffs of almost 12% on imported Chinese solar modules and their core components (i. e. wafer and solar cells). In the first instance these protective duties will be valid for two months. During that time negotiations with China are intended in order to find a solution. If that does not lead to satisfying results, then import tariffs of 47.2% will come into effect in August 2013. This has been passed although several member states, especially Germany and Great Britain, have expressed serious concerns.

The manufacturers of components, machines and equipment of PV in Germany strongly disapprove of these measures and fear an escalation of the current trade conflicts. "We want to avoid a useless trade conflict with one of the most important target markets of the machinery industry and we have been supporting a more diplomatic solution in Brussels until the very last minute", says Dr. Hannes Hesse, Executive Director of VDMA.

However, this is one of the most important decisions in the history of the solar industry. Some say it will bring salvation, others fear it will decimate the European solar market. Ironically, EU tariffs may help some segments of China's PV industry even in the short run. But without cheap Chinese modules, European developers and installers will be forced to look for new ways to cutting costs, and some may turn to Chinese inverter makers – which have struggled in the EU, and would not be covered by the tariffs – as part of the solution.

China will not stand by idly and watch while the Europeans are planning to impose anti-dumping duties on imported PV cells, wafers and modules. The "Middle Kingdom" is also investigating countermeasures against polysilicon imports from the EU, US and South Korea. China filed a complaint to the World Trade Organization charging the European Union with violating rules governing subsidies to its solar-components industry, in the latest move in a global spat over the solar industry. China is complaining that power generated in Europe using solar-energy components made in the EU receives a subsidy.

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Implementation of Low Inductive Strip Line Concept in a IGBT Module

The low inductive strip line concept offers several benefits regarding the switching behavior of IGBT modules. But for the implementation in real packages a lot of boundary conditions have to be considered. The article describes a possible implementation of low inductive strip line concept for symmetric switching in a new high power module

By Georg Borghoff, Infineon Technologies AG, Germany

The influence of a low inductive and symmetric concept on clean switching is already shown in several publications [1] [2]. The design of the internal conductors, the arrangement of the chips and the connection of the internal conductors, either to the insulation ceramics or to the external bus bar system, is highly contributing to the stray inductance and to the symmetry of the module.

The best concept for a low inductive design is the use of half bridge IGBT modules. They offer the possibility to keep the commutation path between upper and lower switch very short by implementing both switches on insulation ceramics with only internal, low inductive connections.

Strip line design

The internal conductors from the outside terminals of the DC terminals to the IGBTs and diodes are preferably designed as strip lines. The inductance of two strip line conductors carries the same current in opposite directions as shown in figure 1.

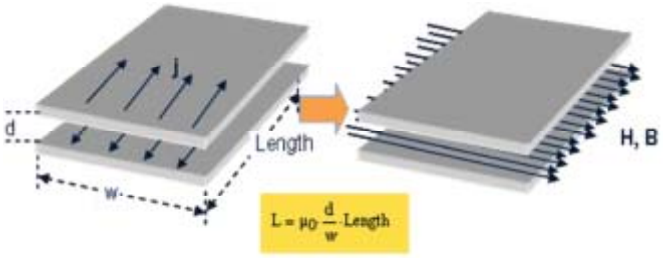

Figure 1: Strip line concept, 2 metal sheets with opposite current flow

From the formula in figure 1 it seems to be very easy to generate a low inductance design: keep the connectors short, make them very wide and reduce the distance as much as possible. But there are some constraints to be covered.

IGBT module size determines design layout

The stray inductance is mainly a function of the dimension of the used conductor sheets. So the outside dimensions of the module mainly determine the design of these parts. For ideal switching behavior it is favorable to arrange all chips in a single row. In this case the number of chips defines the width of the module. But in reality this would lead to a very long narrow construction that will not fit all requirements for a minimized system size. So the width of the internal strip line is limited by the size of the paralleled dies.

For this study a chip layout was chosen, where a nominal current of 700 Amps for upper and lower system can be implemented. The width of the module is approximately 80mm. If we take into account that we need additional space for housing and clearance for assembling, the maximum possible usable width is smaller than the module width.

Especially with higher blocking voltages, e.g. 3300V and above, the IGBT package has to fulfill the standards for clearance and creepage distances. Within the IEC 60664-1 the required distances for insulation coordination are described.

Minimum distances are depending on the voltage classification and the housing material. A way to fulfill the creepage distances and minimize the clearance between the terminals is the implementation of grooves and a housing material with a high CTI. In this example a minimum required creepage distance of 28mm leads to spacing between the terminals of 14mm.

In our study we consider feeding the DC current into the middle of the IGBT module. Driver mounting directly on the module offers the possibility for a low inductive connection to the driver. For half bridges with auxiliary collector contacts there are three different voltage levels on the driver board that require certain spacing. For maximizing the area for a driver board, it is favorable to move the DC terminals to the edge of the power module and utilize the space in the middle. Unfortunately this will increase the length of the internal conductor. A possible solution is a sloped design. The length of the conductors can be reduced compared to a solution with perpendicular bends.

Distance between the conductors

To separate the potential between DC + and DC – conductors, an insulation layer in between is needed. In order to achieve a low inductance the thickness of this material has to be kept thin. One possibility is the use of very thin heat resistant foils. With Polyimide or Teflon foils a thickness of 0.2mm and less could be possible on the basis of the insulation stability. The difficulty of using foils is the manual assembly and the need to keep it safe in place. This is possible with insertion into an injection mold and embedding the conductors with plastic. The disadvantage is a costly process and possible delamination in thermal cycling conditions.

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With conventional injection molded spacers a typical thickness of the plastic material without having the risk of pin holes or other defects is ~1mm. In the overall design the effect of the thickness of the insulation layer was calculated in simulations of different variants. The result is shown figure 2.

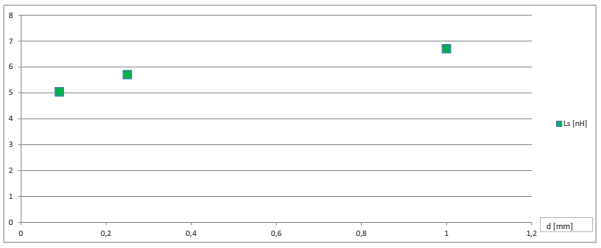

Figure 2:
Module stray inductance as a function of insulation thickness

For a 0.1mm foil the inductance could be as low as 5nH. Based on the above described boundary conditions, the use of a plastic spacer is preferred and leads to a stray inductance of approximately 7nH.

Connection to the chip

If we take a closer look to the connection of the conductors to the ceramic substrates, unfortunately there is no way to connect in a "line". With a placement of the leads in between high side and low side IGBTs there has to be a separate potential for the commutating current. In figure 3 possible points for connections are shown. Instead of using one single point, several connections as wide as possible to the outside were made. Figure 3 shows on the left side the IGBTs and diodes of the upper switch, on the right side the lower switch. The red areas show the connections to the DC + conductor, the blue areas determine the position of the DC – potential. The white arrows describe the area where the commutation current is flowing. The green areas show possible positions of the AC terminal.

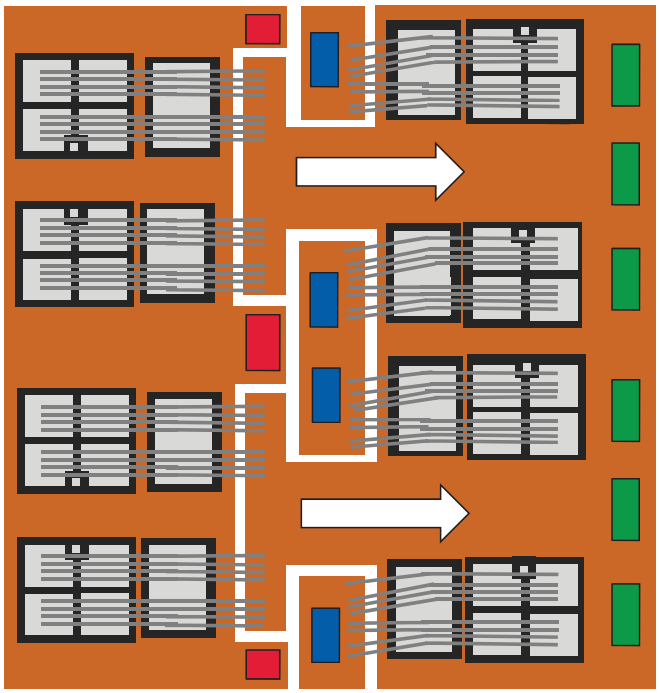

Figure 3: Half bridge layout with sketched up connection points for the DC +/DC- terminals

Connection to the external bus bar system

Another important interface of the IGBT module is the connection to the DC bus bar. The bus bar itself is an ideal strip line concept with wide conducting plates and a thin insulation sheet. This concept has to be given up at the connection points, especially when screw terminals are used. These short interruptions of the strip line have a big input on the overall outcome. For low and medium power devices the connection to the DC link can be realized with press fit pins and a PCB with reinforced copper layers. Paralleling with multiple connection points reduces inductance in this area.

In high current and high voltage applications the contacting of the IGBT module to an external bus bar system is usually realized with screws connections. The bus bar system is made of laminated metal sheets of copper or aluminum. To realize a reliable connection with little losses, screws are the most common connectors. They offer high contact forces that reduce contact resistance. Furthermore, they are easily available and can be assembled with standard equipment. As shown above with press fit pins, also with screws the use of multiple, paralleled connections reduce the negative effect of interruptions to the stray inductance.

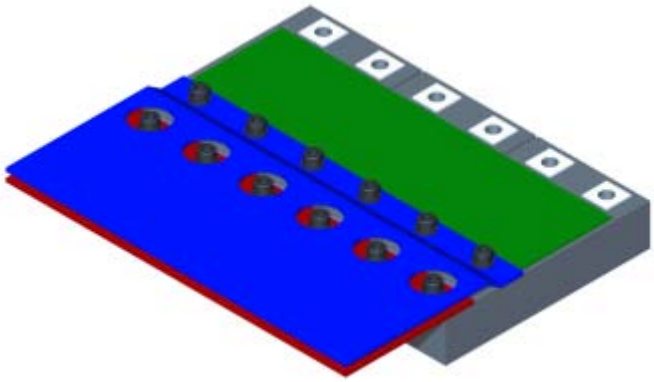

Figure 4: Triple paralleling of IGBT modules or possible 3 phase inverter design

Conclusion

Also for high power modules with high blocking voltages and high output currents a low inductive design with the strip line concept is possible. Legal regulations and standards create several constraints that do not allow the implementation of an ideal solution. But nevertheless, an IGBT study with a stray inductance of approximately 7nH at a nominal current of 700A was realized. For future applications this will enable the use of fast switching devices. With reduced switching losses higher switching frequencies could be implemented.

The concept also allows an easy way to connect several IGBT modules in parallel with the use of one common DC bus bar (Figure 4). In a 3-module parallel configuration this will lead to 2nH for a configuration with a nominal output current of 2100A per system.

References

[1] R. Bayerer, D.Domes: Power circuit design for clean switching, CIPS, 2010

[2] R. Bayerer, D.Domes: Power circuit design for clean switching, ECPE, 2011

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Designing-Out High-Power Automotive Relays

The Last Frontier for Advanced Vehicle Electrification

The electromechanical relay – at one time the power switch of choice for all automotive electrical systems – is progressively becoming replaced throughout the vehicle by lighter, smaller, more reliable and longer lasting semiconductor switches. Advanced fabrication processes such as BCDMOS, allowing power and logic circuitry to coexist on the same chip, enable manufacturers to deliver controllers comprising one or more MOSFET switches with an integrated driver as a single chip. These have already proved successful in a variety of low-power applications.

By David Jacquinod, International Rectifier

With increasing electrification of major vehicle functions such as electric power steering (EPS), integrated starter/alternator (ISA) and other high-power loads both in internal combustion engine and hybrid-electric vehicles, demand is growing for efficient and durable semiconductor power switches for loads above 10A. The electromagnetic relay retains some advantages when used with higher loads, due to its inherently low resistance when turned on. This helps avoid unwanted conduction losses that otherwise would waste energy and cause internal heating which compromises reliability.

In order to replace electromechanical relays in high-current applications, a combination of discrete low on-resistance MOSFETs and separate driver IC can provide a better, lower-power solution a fully integrated controller.

Relay Replacement for High-Current loads

Ideally, a MOSFET with on-resistance (RDS(ON)) of only a few milliohms, at logic-level gate drive, is required. An even lower overall resistance can be achieved by connecting two MOSFETs in parallel using a control IC capable of driving a pair of MOSFET gates. The AUIRLS3034 and AUIRLS3034-7P are 40V MOSFETs are designed for high efficiency when controlling heavy loads. They are packaged as D2Pak or 7-pin D2Pak-7P surface-mount power devices. The D2Pak-7P package enables lower $R_{DS(ON)}$ by providing five pins for connection to the source, complementing the large exposed tab for connecting the drain. A single pin is provided for the gate connection. The standard D2Pak has one pin for connection to the source. Both devices use IR's latest trench HEXFET® semiconductor technology. The package-limited maximum drain current is 195A for D2Pak or 240A for the AUIRLS3034-7P in D2Pak-7P.

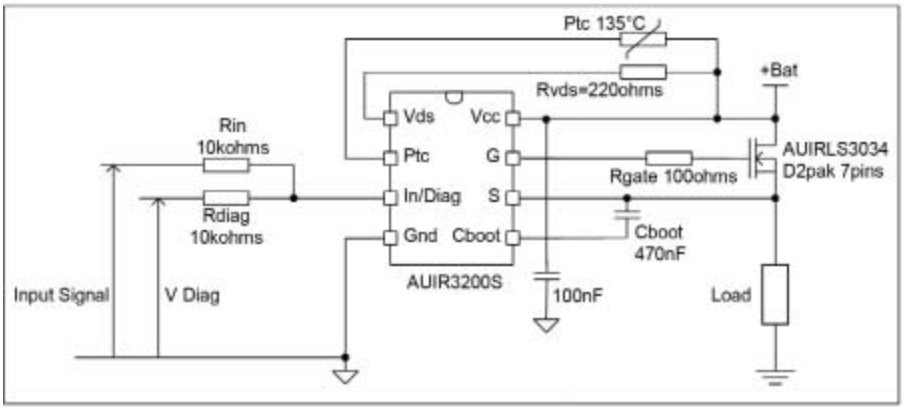

Figure 1: Driver and discrete MOSFET for high-power automotive load switching.

Effective use of either of these devices for relay replacement, or in battery switch applications, is dependent on a suitable controller/driver providing the necessary protection and diagnostic capabilities. The AUIR3200S automotive-qualified MOSFET driver IC can drive two power MOSFETs such as the AUIRLS3034-7P, thereby enabling a protected high-side switch to achieve $R_{DS(ON)}$ as low as 0.75mΩ.

Figure 1 shows the schematic of a high-side switch configured with a single MOSFET. Most of the circuitry needed for protection and diagnostics is integrated in the controller, which reduces external components to a small number of bias resistors, a gate-drive resistor, two capacitors, and a PTC (Positive Temperature Coefficient) temperature sensor, as shown.

Building a Protected High-Side Switch

Figure 2 shows the major functional blocks of the control IC, highlighting the current-source reference used for short-circuit protection.

Short-circuit Protection

Short-circuit protection is one of the most important functions in a protected high-side switch or battery switch. Usually this kind of

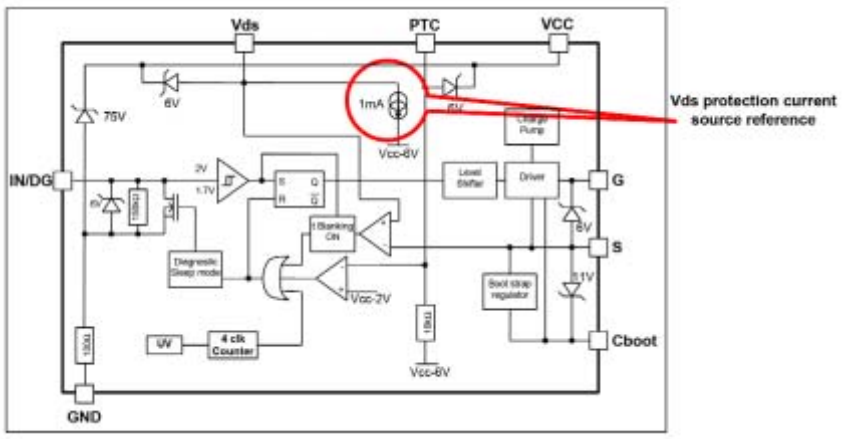

Figure 2: Major internal functions of driver for protected high-side switch applications.

protection requires sensing of the load current using a shunt resistor, which not only produces undesirable power dissipation but also requires an additional operational amplifier. Technically, a current-sensing MOSFET may be considered as an alternative, but this also would impose power losses and in any case no suitable devices are currently available in the market.

To overcome this, the AUIR3200S implements smart monitoring of the MOSFET drain-source voltage. Since smart Vds monitoring is integrated in the controller, designers have freedom to select the best MOSFET for their application. With smart Vds monitoring, the controller is able to switch off the MOSFET when Vds increases above a threshold determined by the resistor Rvds shown in figure 1. In order to maintain a consistent over-current shutdown level over the temperature range, the AUIR3200S features an internal current-source reference, highlighted in figure 2, which is designed to have a temperature coefficient similar to the $R_{DS(ON)}$ of a MOSFET. The programming resistor Rvds allows the Vds protection threshold to be adjusted according the application requirement.

The short-circuit protection based on Vds monitoring works only when the MOSFET is turned fully on such that $V_{DS} = R_{DS(ON)} \times IDS$. During MOSFET turn on the Vds protection is blanked in order to avoid an unwanted shutdown. The AUIR3200S has an integrated bootstrap regulator, which maintains a fixed voltage of 6V on the bootstrap capacitor regardless of the battery voltage, to ensure the MOSFET turn on can be completed before the blanking time expires. As a rule the bootstrap capacitor, Cboot in figure 1, should be 10 times the MOSFET gate capacitance.

Over-Temperature Protection

In a typical application using a protected switch, over-temperature protection is also required. The AUIR3200S simplifies over-temperature protection by providing a dedicated pin as shown in figure 1 for connecting an external PTC sensor. The PTC sensor displays rapidly increasing resistance within a few degrees of its nominal temperature, allowing fast and accurate temperature protection.

Figure 3:
Sample board showing position of the PTC sensor for over-temperature protection.

Figure 3 shows how the PTC is implemented in a practical circuit. It is mounted as close as possible to the tab of the MOSFET to ensure accurate sensing of the junction temperature. Due to the low $R_{DS(ON)}$ of the MOSFET, the junction temperature will increase relatively slowly during an overload condition. Hence the PTC temperature is able to follow accurately with minimal lag. The over-temperature protection can be adjusted by selecting a PTC sensor having a different temperature characteristic.

Diagnostic Reporting

In a protected switch application, the host system must be informed whether the load condition is normal, short circuit, or over-temperature. The AUIR3200S provides a diagnostic indication by shorting the input pin to ground during a fault condition. This allows the system to detect abnormal load conditions by monitoring the input pin voltage. The fault condition is latched until the AUIR3200S is deactivated allowing the device to enter sleep mode.

Repetitive Short-Circuit Ruggedness

A high-side protected switch comprising the AUIR3200S controller and AUIRL3034S MOSFET has been tested under short-circuit conditions according to AEC Q100-12, which requires the MOSFET case temperature to be fixed at 125°C by adjusting the activation frequency. The switch was able to sustain 10 million cycles without failure.

Conclusion

Electrification of automotive systems such as power steering can be enhanced by replacing bulky and less reliable electromechanical relays with alternative semiconductor switches. Low $R_{DS(ON)}$ MOSFETs can be used to overcome the last remaining barrier to relay replacement by significantly reducing power dissipation when the switch is turned on.

To use such devices successfully, designers need an automotive-qualified driver that integrates the necessary protection features and diagnostic capability. The AUIR3200S is a highly integrated driver capable of controlling two MOSFETs such as the AUIRLS30304-7P connected in parallel, to create a protected high-side switch of extremely low resistance enabling efficient and reliable control of high-power loads.

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Control Loop Modulation Applied to Programmable DC Power Supplies

Characteristics of laboratory quality, dc power supplies have changed greatly over the past two decades. Application demands have moved from the ideal voltage source with no series impedance or the ideal current source with infinite parallel impedance to user programmable output characteristics; these new applications allow for power source emulation with higher bandwidth and better response times. Box shaped voltage current profiles controlled with two knobs, fold back limiting, crowbars, and over current tripping are accepted as the most minimum requirements or they are now not needed at all.

By Ira J. Pitel and Adam Pitel, Magna-Power Electronics

Today, engineers demand dc power supplies with output characteristics that can be programmed for their ever-changing applications. Functional relationships between voltage and current, time dependent profiling, computer interfacing, higher bandwidth performance, safe remote sensing, and a host of programmable features, that were virtually impossible to implement without the programmability of today's digital devices, are needed to meet today's demands. Emphasis has changed from providing dc power with control to providing control with dc power.

The physical properties of dc power supplies have changed along with its features. Improvement in electronic switch technology and resulting increasing power processing speeds have allowed power supplies to become smaller and more responsive to load and line variations. New applications place power supplies in abusive environments: tighter packaging in equipment racks, utility trailers with poor air quality or with only water to remove semiconductor power losses, or in other locations where power supplies of the past could not effectively function.

Modulation to the Control Loop

About a decade ago, Magna-Power Electronics introduced a very basic feature in its transition from analog to embedded microprocessor-based control: modulation [1]. Modulation allows a set point adjustment of voltage or current by another input. Modulation signals can be derived from an external device, such as a thermistor, or from sampling output current or voltage. When used with software containing advanced numerical methods, feeding output voltage or current to adjust set point current or voltage allows user defined output profiles. Systems, incorporating this feature, introduce another negative feedback path with gain controlled by a user programmed attenuator.

Figure 1 illustrates a block diagram of a power supply using voltage control regulation with output current fed into the modulation input. The closed loop system is configured to regulate output voltage according to the output voltage of the D to A converter, Vx. Two inputs are fed into the A to D converter, Vref and VMOD, and the microprocessor can be programmed to produce an output voltage dependent of these two inputs. Vref is a voltage reference input and VMOD is the modulation input.

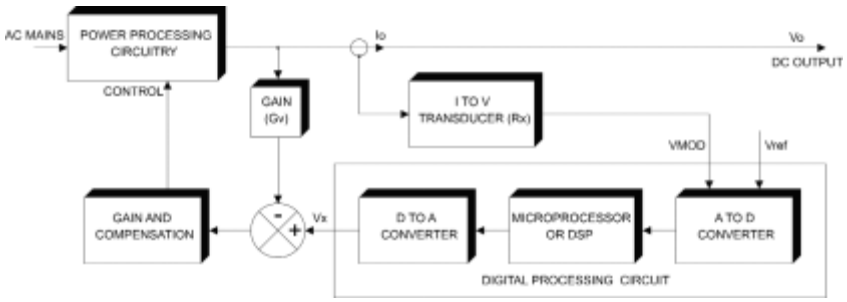

Figure 1: Block Diagram of Power Supply Incorporating Modulation

Modulation can be introduced into the control loop by adding a variable to the set point or by multiplying a variable to the set point. Additive functions are useful for introducing series and parallel impedances and multiplier functions are useful for adjusting voltage or current sources. Table 1 describes the four alternatives: Control Input 1 and 2 for voltage and current control and Function Type 0 and 1 for multiplier and additive functions, respectively.

Control Input	Function Type	
	0	1
1	$V_o = G_v\ V_{ref} \times Mod(VMOD)$	$V_o = G_v\ V_{ref} + Mod(VMOD)$
2	$I_o = G_i\ I_{ref} \times Mod(VMOD)$	$I_o = G_i\ I_{ref} + Mod(VMOD)$

Table 1: Modulation function types

Notes:
1) Vo is the adjusted output voltage as a function of the modulation operator
2) Io is the adjusted output current as a function of the modulation operator
3) Vref is the input voltage set point reference
4) Iref is the input current set point reference
5) VMOD is the input modulation set point voltage
6) Gv is the system gain as define by the full scale output voltage, Vofs, divided by the maximum input voltage set point reference, Vrefm
7) Gi is the system gain as define by the full scale output current, Iofs, divided by the maximum input current set point reference, Irefm

Mod(VMOD), modulation, can be an expression, constant, or other numerical operator. A user-friendly method chosen by Magna-Power Electronics is a table-based algorithm using piecewise linear approximation. This numerical method allows linear or nonlinear modulation to be introduced by defining constants in a table.

Table 2 and resulting curve Figure 2 illustrate a simple example of Function Type 0 modulation as applied to a 100 V, 150 A power supply. In this example and the one illustrated in Figure 1, the power supply is programmed to produce a constant power output. Current, Io, is used as the programming operator for Mod. The method requires Io to be monitored and applied to the programming or modulation input, VMOD. As illustrated, VMOD is set to linearly respond to current.

$$1: \quad V_o = G_v \; V_{ref} \times Mod(VMOD)$$

$$2: \quad V_{ofs} = G_v \times V_{refm} = G_v \times V_{ref}$$

$$3: \quad VMOD = I_o \times R_x$$

Row	VMOD (Vdc)	Mod	V_o (Vdc)	I_o (Adc)	P_o (W)
1	2.50	1.000	100.00	37.50	3750.00
2	2.94	0.850	85.00	44.12	3750.00
3	3.57	0.700	70.00	53.57	3750.00
4	4.55	0.550	55.00	68.18	3750.00
5	6.25	0.400	40.00	93.75	3750.00
6	10.00	0.250	25.00	150.00	3750.00

Table 2: Example modulation table (function type 0)

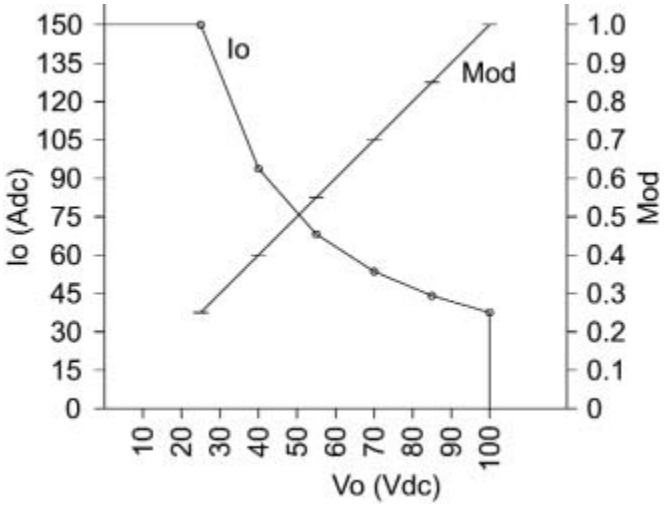

Figure 2: Curve defined in Table 2

Multiply both sides of equation 1 by Io yields

$$4: \quad V_o \times I_o = P_o = V_{ofs} \times Mod \; I_o \times R_x \; \times I_o$$

$$5: \quad Mod \; I_o \times R_x \; = {}^{P_o}\, V_{ofs} \times {}^{1}\, I_o$$

where:

V_{refm}: full scale input voltage set point reference,
R_x: transresistance of the current transducer.

Piecewise linear approximation makes a continuous curve by interpolating points on the curve between those programmed. For example, Vo is 77.5 Vdc if the operating current is 48.85 Adc. Accuracy of the approximation improves with more data points.

Challenges of Control Loop Modulation

Hardware Constraints

Modulation, as described above or by other similar means, allows emulation of power sources such as photovoltaic cells, batteries, and fuel cells. The dynamics of these applications require a frequency response beyond that needed by conventional power supplies. Furthermore, the embedded firmware must be capable of handling the speed of the application. Together, a power supply designed to perform with high speed modulation will have different characteristics than conventional power supplies.

A power supply designed to utilize modulation must have higher bandwidths and tolerate higher slew rates; such power supplies must incorporate higher bandwidth output filters. Output filters are required to filter unwanted ac components produced in the power conversion process, but with modulation or with other superimposed ac source generation, signals beyond dc must be allowed to pass through the output terminals of the power supply. Higher bandpass filters are required for such applications and they must be designed to separate wanted and unwanted power components. Higher bandwidth power supplies generally have increased output voltage ripple. Increasing the switching frequency of the power supply helps accomplish both goals, but at the cost of increased switching loss.

In conventional applications, high-capacitance, low ESR, aluminum electrolytic capacitors are the conventional components used at the output terminals; these components provide a shunt path for high-frequency harmonic currents. In higher bandwidth and high slew rate applications, these components are subjected to greater voltage deviations requiring higher power processing demands during charge and discharge periods. Furthermore, the reliability of aluminum electrolytic capacitors is greatly influenced by subjected ac currents. Lower capacitance, high-performance film capacitors must be deployed to circumvent these issues.

Higher bandwidth and high-slew rate operation also place higher demands on protection of power semiconductor components. Simple over current trip protection circuits are not suitable for this application because the power supply must tolerate these rapid output changes. To the power processing semiconductors, the load is both internal and external to the power supply. The current required to charge and discharge the output filter and external load capacitors must be taken into consideration. Slew-rate must be limited to protect power processing semiconductors.

Software Constraints

Introduction of modulation complicates the power supply's control loop. Normally, one parameter, output voltage or output current, is compared against a reference and is adjusted to maintain an operating point close to the reference. As shown in Figure 1, the system requires an error amplifier and circuitry for closed loop compensation. If the gain of the amplifier is too high or if the compensation is not properly designed, the power supply will become unstable and oscillate. Modulation adds a second parameter and an inherent lagging response. At a specific operating point, the programming parameters need to be analyzed digitally and applied to the modulation input. Using fast digital signal processors, DSP's, is required to minimize delays and make calculations of these devices transparent.

Modulation can be programmed with gains of different magnitudes. The gain for modulation can be defined as the change in Mod between two rows of a table and will have stability issues similar to the closed loop error amplifier. Forcing the power supply output to make large changes between two operating points can cause an unstable response. Slew rate limiting is an effective means for getting around these constraints, but slew rating limiting has a negative effect on the speed of response or the bandwidth of the system.

Leadless Remote Sensing

Positive Slope, Leadless Remote Sensing

Remote sensing is used to improve the degradation of regulation which will occur at the load when the voltage drop in the connecting wires is appreciable. Normally, this feature is accomplished through the connection of sense leads connected directly to the load rather than to the output terminals of the power supply. With these connections, the leads between the source and load are placed within the control loop and the resulting voltage drop will be corrected along with other parameters. The power supply must have sufficient output voltage to support the output voltage plus the lead voltage within specified tolerance.

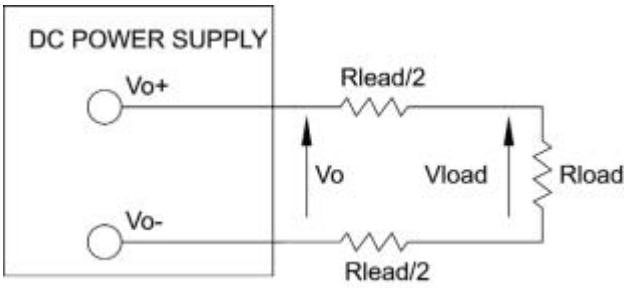

Figure 3: Leadless Remote Sensing

Sometimes sensing the load voltage is not practical or possible. Long tethers, requiring heavy cables, are hard to fabricate with sense lead cables. Sensing output current and raising the power supply's output voltage can be an effective alternative to adding remote sense leads. While this might seem trivial for relatively short lead lengths, it is not for applications of distant load points such as ocean tethers to vehicles.

Figure 3 illustrates a dc power supply with lead and load resistance. The load voltage, Vload, can be expressed as

$$V_{load} = V_o - R_{lead} \times I_o \quad (6)$$

where:

Vo: power supply output voltage,
Io: power supply output current,
Rlead: lead resistance between the power supply and load.

Applying the control scheme illustrated in Figure 1, where output current is applied to the modulation input, and substituting Vo in (6) with Control Input 1, Function Type 1 modulation (see Table 1), Vload becomes:

$$V_{load} = G_v\left[V_{ref} + Mod(VMOD)\right] - R_{lead} \times I_o \quad (7)$$

$$= G_v \times V_{ref}$$

if

$$G_v \times Mod(VMOD) = R_{lead} \times I_o$$

In this example, the power supply's output voltage adjusts in response to output current compensating for the voltage drop caused in the connecting leads to the load.

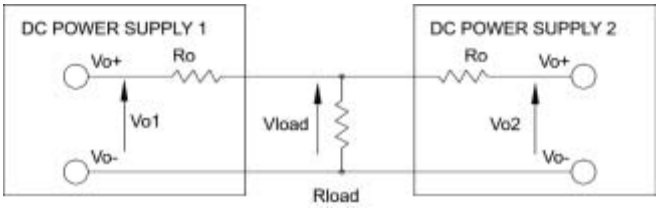

Figure 4: Paralleling method incorporating source resistance

Negative Slope, Leadless Current Sharing

There are many schemes for sharing current when multiple power supplies are connected in parallel. Most of them require some form of communications between the multiple power supplies to share output current information. Generally, this is done by designating one power supply as the master and the others as slaves. The master power supply is operated in voltage mode control and the slave power supplies are operated in current mode control. The set point current for the slave power supplies is provided by the master. The drawback of this approach is that the system is totally dependent upon operation of the master and malfunction of the master power supply means malfunction of the system.

For systems requiring N+1 redundancy, or systems requiring excess capacity of one power supply in the event of one failure, master/slave parallel operation is not well suited. For these applications, all parallel connected power supplies must be totally independent. Connecting power supplies in parallel and allowing automatic crossover between voltage mode and current mode control will work, but current sharing will not be equal. A preferred approach, as illustrated in Figure 4, is to introduce a small series resistance on each of the parallel connected power supplies to ballast the load between the other supplies. The resistance, or in this case pseudo resistance, can be introduced without additional losses by utilizing Control Input 1, Function Type 1 modulation (see Table 1). Ideally, programming both of the paralleled connected power supplies the same, the output voltage, Vload, can be made to represent:

$$8: \quad V_{load} = V_{o1} - R_o \times I_{o1}$$

$$9: \quad V_{load} = V_{o2} - R_o \times I_{o2}$$

or equating to output current

$$10: \quad I_{o1} = V_{o1} - V_{load} \quad R_o$$

$$11: \quad I_{o2} = V_{o2} - V_{load} \quad R_o$$

where:

Vo1, Vo2: power supply output voltage without source resistance,
Io1, Io2: power supply output current,
Ro: output source resistance.

For this application, the source resistance requires a negative slope.

Power Source Emulation

Battery Emulation

The impedance and cell voltage of batteries and battery packs vary according to a number of factors, such as, but not limited to, chemistry, mechanical construction, the number of charge/discharge cycles, temperature, and depth of discharge. These variables can be defined with voltage and current profiles and applied to the modulation input of a dc power supply. One modulation table cannot completely emulate a battery since the profile changes with multiple variables: primarily with depth of discharge and temperature of operation. Therefore, multiple tables are required to address the different variables and need to be integrated into the control algorithm. Detection of both voltage and current over a period of time provides the parameters needed to calculate depth of discharge. Further tables are required to adjust these profiles with temperature. At specific increments of time and temperature, modulation tables need to be replaced. Control Input 1, Function Type 0 modulation is best suited for this application.

Quickly loading tables in anticipation of the next operating point presents itself as a software challenge. Magna-Power Electronics uses cache tables embedded in storage to quickly move from one table to another.

Solar Emulation

Photovoltaic arrays produce non-linear voltage and current characteristics that are a function of temperature, irradiance, and several other technology-dependent variables. Devices interfacing to photovoltaic arrays, such as inverters and DC-DC converters, set an operating point near the array's maximum power output: a process called maximum power point tracking. A DC power supply capable of emulating these non-linear characteristics provides user defined methods for development and evaluation of photovoltaic connected devices.

Entry	Voltage (Vdc)	Current (Adc)	VMOD	Mod
1	0.00	45.00	9.992	0.050
2	293.00	44.99	9.903	0.128
3	574.30	44.94	9.697	0.366
4	689.20	44.63	9.531	0.510
5	794.50	43.11	9.273	0.671
6	840.10	41.17	9.078	0.757
7	892.40	36.39	8.640	0.877
8	907.80	34.06	8.401	0.915
9	977.10	13.03	5.010	1.000
10	1000.00	0.00	0.000	1.000

Table 3: Example Control Input 2, Function Type 0 calculated modulation data for solar array emulation using a Magna-Power Electronics TSD1000-45

Magna-Power Electronics' modulation feature can be used to define a 50-point photovoltaic profile at distinct temperature and irradiance values within the memory of the power supply. The power supply performs piece-wise-linear approximation between points to ensure high resolution operation. Data is loaded into the power supply's memory using an external program, Photovoltaic Power Profile Emulation, PPPE, that was developed specifically for the application. It defines more points near the curve's most non-linear region—the curve's knee—for the highest fidelity. PPPE software uses an EN50530 model to define a continuous voltage-current profile with temperature and irradiance dependencies. The model enables emulation of thin-film, poly-crystalline, mono-crystalline, or custom user-defined photovoltaic technologies. Timing constraints for updating voltage and current profiles are minimized by sequentially and continuously sending data to the power supply's cache table and swapping data when needed for the next update.

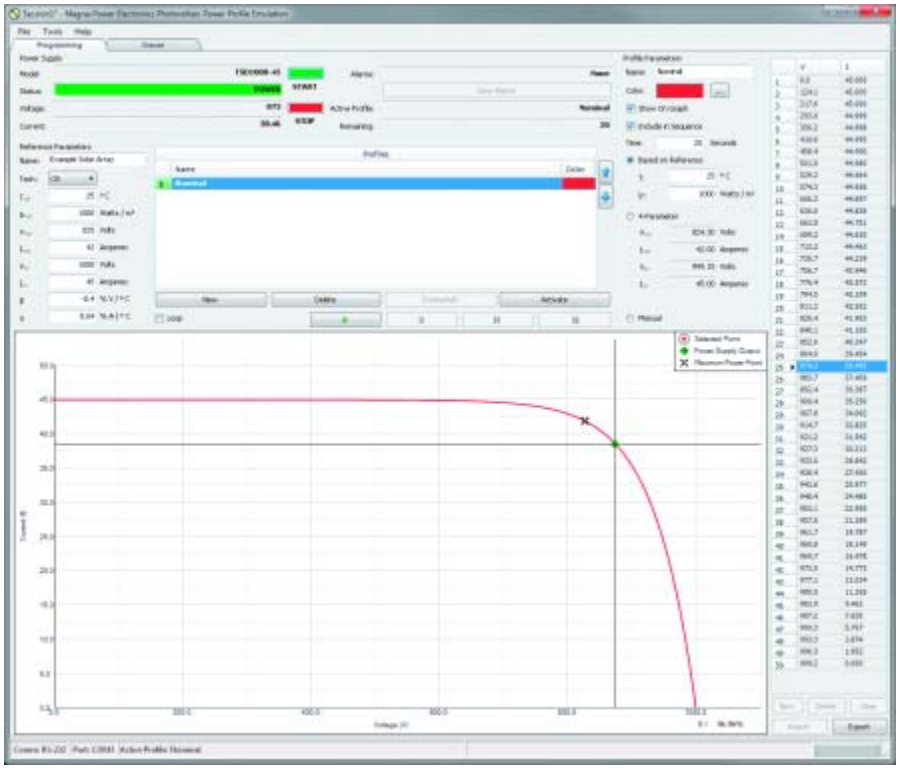

Figure 5: Magna-Power Electronics Photovoltaic Power Profile Emulation Software demonstration solar emulation using modulation

Both Control Input 1, Function Type 0 (voltage control) or Control Input 2, Function Type 0 (current control) modulation are applicable for this application. The load's control mode and method of operation determine the best method of modulation. Table 3 provides an example of an emulated photovoltaic array profile for a 1000 Vdc, 45 Adc, Magna-Power Electronics TSD1000-45 power supply. For simplicity, the example is reduced to only 10 points. The corresponding curve, implemented with PPPE software, is shown in Figure 5

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1. Operating and Service Manual TS Series IV DC Power Supplies, Magna-Power Electronics, Flemington, NJ, May. 2013.

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Optimising Power Design Through MOSFET Efficiency and Integration

Choosing advanced MOSFET technologies for enhanced efficiency through improved performance of intrinsic Diode

MOSFETs and fast recovery diodes are fundamental elements of power switching applications ranging from photovoltaic inverters to HID lamp ballasts and power supplies for telecoms and servers. Designers of these applications are under pressure to continually improve performance at the same time as reducing board real estate and ensuring reliable operation.

By Michael Piela, Toshiba Electronics Europe

Take, for example, photovoltaic cells used in solar panels. As this market grows and matures there is an increasing demand for more compact and more efficient electronics so that every possible milli-Watt of energy harvested from the sun reaches the load. Inverters are an essential part of every solar energy generation system. Photovoltaic inverters convert the DC current produced by an array of photovoltaic cells to AC at local line voltage and frequency, ready to be fed into the grid or used to power an off-grid network. Micro-inverters that connect to just one panel each are also available – ensuring that reduced output from any panel (perhaps because of shade or snow) doesn't disproportionately affect the output of the total array. Inverter designers often face the seemingly conflicting requirements of improving performance and minimising losses whilst compacting form factor and ensuring reliability. Careful selection of the appropriate MOSFET technologies can deliver significant advantages in all these areas. MOSFETs and recovery diodes are also important for telecom and server power supplies with full bridge or zero voltage switching/phase shift topologies; full bridge motor control systems; uninterruptible power supplies; and ballasts for high intensity discharge (HID) lamps.

Power switches

Power MOSFETs are typically the preferred switching technology for all of these designs because they offer a simple-to-drive option that can be switched efficiently at high voltages and at high frequencies. And in most of these applications a rating of 600V is typically used to ensure enough 'headroom' for the safe handling of high voltage transients.

MOSFETs can contribute to overall efficiency by minimising losses, broadly split into conduction losses and switching losses. A low MOSFET on-resistance (RDS(ON)) minimises conduction losses. On-resistance-area (RDS(ON)*A) is one of the figures of merit for MOSFETs; if RDS(ON)*A can be reduced, it means a smaller RDS(ON) device can be fitted into the same package size, improving efficiency.

A MOSFET's switching losses are mainly related to its parasitic capacitances, so minimising these will make switching more efficient. Even small increases in overall efficiency may mean a smaller inverter can be selected for a given application.

Another important factor to consider is the MOSFET's gate charge, QG, which indicates the energy required to switch the device. If QG is low, higher switching frequencies can be used, minimising the size of some of the external filtering components. Losses are also reduced in the gate-driver circuitry. However, low QG devices tend to have higher RDS(ON); for this reason, the figure of merit RDS(ON)*QG is often quoted.

MOSFET reliability is also a very important consideration in a system that is expected to last for much longer than the typical lifetime of a consumer product. Photovoltaic inverters or industrial motor control systems, for example, may be expected to last for 10, 15, or 20 years (or more). Furthermore, there may be requirements for the devices to maintain good performance at extreme temperatures – for example in harsh industrial environments or to address the need to maintain a stable output in all weather conditions.

Companion devices

One thing that the applications mentioned above have in common is the need for companion diodes to be used in conjunction with the MOSFET. Each power MOSFET in an inverter, for example, requires a diode to protect it from being damaged by the reverse current from an inductive load. Because the MOSFETs switch at high frequency, fast recovery diodes (FRDs) are used; their properties can also help increase efficiency. Faster FRD reverse recovery times (trr) help to minimise switching losses. In addition, choosing devices in which the FRD is integrated into the body of the MOSFET can help to reduce component count, save space, simplify design and streamline inventory.

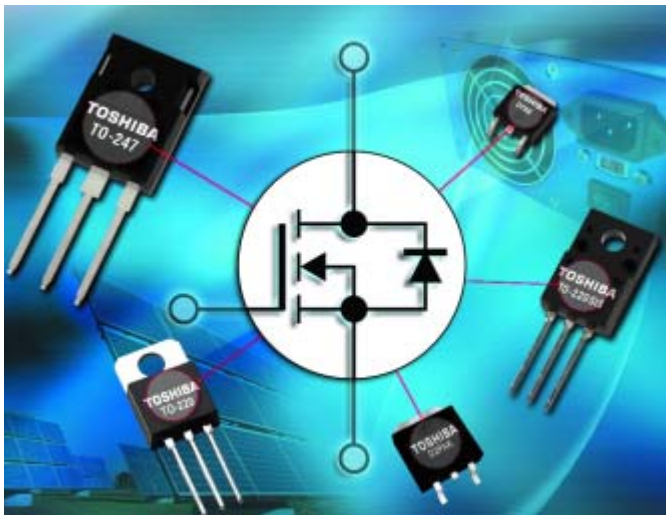

Figure 1 – MOSFET package options using FRD

A variety of MOSFETs with integrated FRDs are now available, in a range of different package options (Figure 1). As an example, Toshiba's TK16A60W5 15.8A-rated power MOSFET integrates MOSFET and FRD in a TO-220SIS package. The trr of the device is just 100ns (compared to 280ns of a standard version) and RDS(ON) is just 0.23Ω. Other examples include the high current TK31N60W5 and TK39N60W5 MOSFETs in TO-247 packaging. These are rated for maximum currents of 30.8A and 38.8A respectively. Maximum respective RDS(ON) ratings (at VGS = 10V) are 0.099Ω and 0.074Ω, with trr characteristics of 135ns and 150ns.

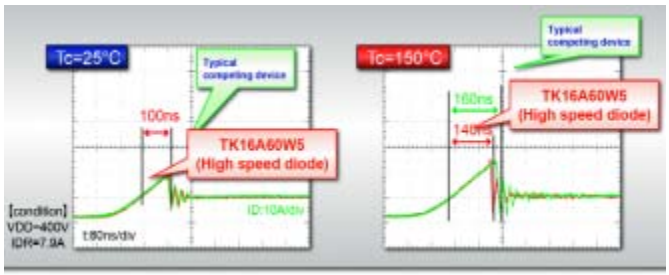

Figure 2 – Reverse recovery time versus temperature

In addition to the improvements in conduction losses and switching losses, integration has also meant that the devices can maintain a good trr at high temperatures. Figure 2 shows test results for the TK16A60W5 device compared with a typical competing device with the same trr at a channel temperature of 25°C.
At 150°C, trr for the TK16A60W5 increased by 40%, whereas trr for the competing device increased by 60%.

Fourth generation
So, how has this integration been achieved, and why does this result in improved specifications?

The underlying technology used in these devices is DTMOS IV, Toshiba's fourth generation superjunction technology. In a superjunction MOSFET, the N-region is heavily doped so that its resistivity can be taken beyond the silicon limit. This N-region is bounded by two pillars of P-type material to allow a very high breakdown voltage, as shown in Figure 3.

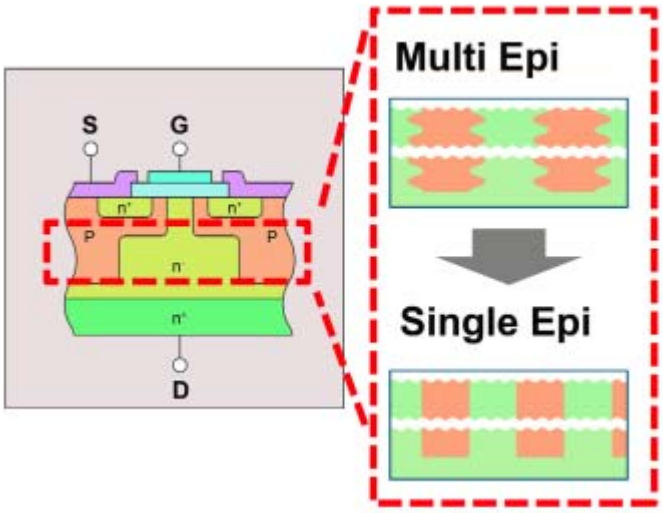

Figure 3 – DTMOS IV superjunction process

This combination of very low RDS(ON)*A and high breakdown voltage makes the technology ideally suited to power MOSFETs since space savings can be implemented without power loss penalties. DTMOS IV uses a process called deep trench filling, which allows the pitch of the columns to be narrowed and their aspect ratio to be increased. Further, deep trench filling allows the P-type material to be deposited into etched trenches in a single epitaxial process. Previously, multiple epitaxial layers were required to form pillars that were this tall and thin. Using just one epitaxial process can produce a better, more uniform pillar shape (as seen in Figure 3), shorten production lead times, save cost, and allow for easier geometry shrinking in the future. What's more, the more uniform pillar shape helps the device maintain its RDS(ON) and trr characteristics at temperatures up to 150°C.

The narrow trench pitch produced by DTMOS IV reduces RDS(ON)*A by 30% compared to DTMOS III. Devices with the same die area can therefore reduce their RDS(ON) by 30%. Alternatively, if similar RDS(ON) characteristics are acceptable, the MOSFET's die area can be reduced by 30%. A compromise between the two has seen RDS(ON) decrease while freeing up space for a fast recovery diode to be included in the same overall package size. Integrating the diode into the MOSFET package means the trr of the MOSFET-diode combination device is reduced significantly.

Narrowing the pitch of the P-type pillars also reduces QG. Low QG allows the devices to operate at high switching frequencies and reduces losses in the gate-drive circuitry. However, along with the RDS(ON) tradeoff mentioned above, if QG is too low, very high dVDS/dt can encourage ringing, along with its undesirable side effect, electromagnetic interference (EMI). Toshiba's devices are therefore carefully optimised to maintain the same performance and RDS(ON)*QG figures as the previous generation of MOSFETs.

Reducing the physical size of the MOSFET die as outlined above has a positive effect on output capacitance (COSS), which helps reduce switching losses and maintain efficiency even in partial load situations. COSS has actually been reduced by 12% in the latest family of devices. Again, this contributes to the devices' ability to be switched at high frequencies.

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Create Embedded Power Designs Online

Online development environments are becoming increasingly sophisticated. This article describes the operation and use of a new tool, Embedded Systems Power Designer, that enables web-based design of the power supply for Embedded microcontrollers and FPGAs. The application uses the processing power of cloud-based servers and an intuitive user interface based on the latest HTML 5 capabilities to implement an interactive environment for design directly in the web browser.

By Devin Crawford, senior application engineer, Transim Technology Corporation

The tool contains a vast amount of information about individual components and their application. With the aid of integrated intelligence, engineers can access this extensive knowledge and use it to design an application-specific power supply in a matter of minutes. The corresponding circuit diagram together with a parts list and summary of the design can either be stored in the "cloud" or downloaded to the local computer.

Background

In the last ten years, the Internet has become the most important resource in the day-to-day processing of technical tasks. Everyone can quickly find background information on a wide range of topics on the Internet, or get access to important standards and regulations. When working on new design tasks, an information resource such as datasheets.com is practically indispensable for many development engineers when it comes to searching for modules or integrated circuits.

Despite the huge array of information that is available, one major challenge remains: retaining an overview and using this large volume of information effectively. Arrow Electronics has used its position as one of the leading providers of electronic components to develop a unique solution to this problem. The solution allows users to access comprehensive sources of information via online design tools. These applications use modern cloud-based technologies to present information from hundreds of data sheets and technical help documents in an interactive environment. Engineers can quickly navigate through complex design challenges while ensuring sufficient flexibility for the application. The current version of the Embedded Systems Power Designer illustrates this solution.

Scalable online support

Due to their high level of flexibility and relatively low cost, programmable logic modules such as FPGAs are an attractive solution for applications in automation and control technology. However, the successful use of such modules is subject to stringent requirements regarding the power supply. The power requirement depends on the module programming, and individual supply voltages must meet exacting specifications relating to the AC component. Development engineers are therefore faced with tasks that are, to some extent, well outside their core competencies. The online design environment simplifies the overall design process by dividing tasks into separate steps. The specifications of the FPGA manufacturer, which otherwise can only be ascertained from data sheets that are several pages long, are integrated automatically at every step.

Access to this development environment is available via the Arrow Electronic Components website. First-time users receive their access data following registration. This means that information from completed development steps can be stored at any time on the server for subsequent use. Multiple users can even exchange circuit diagrams and other content with each other directly within this environment. It is therefore also a valuable tool for application engineers in providing support for their customers.

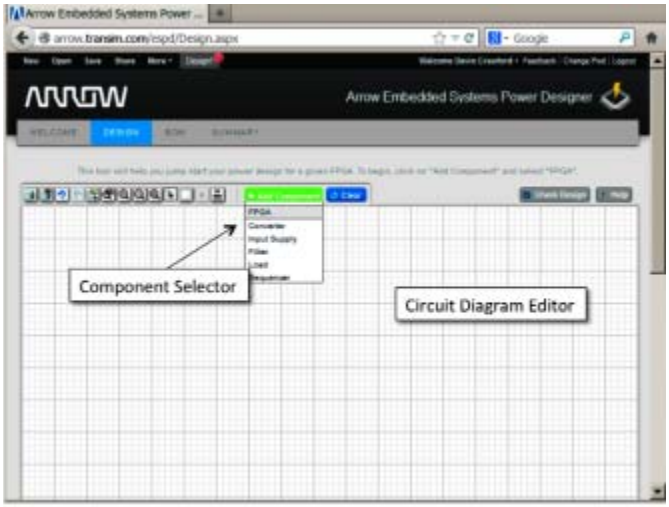

Figure 1: Circuit diagram editor for designing the circuit diagram.

When the user opens the program, the Embedded Systems Power Designer displays a blank circuit diagram editor as shown in Figure 1. The circuit diagram editor allows the user to visualize the supply plan for the FPGA with high-level abstraction. Individual converters are synthesized, simulated, and can even be modified by the user at component level in a deeper hierarchical level. The requirements of the central module (e.g. the Altera Stratix IV FPGA) are passed down through the hierarchy so that design objectives for the individual converters meet the system requirements.

The design process is started by selecting an FPGA and placing it in the circuit diagram editor as a module. Several FPGAs from Altera

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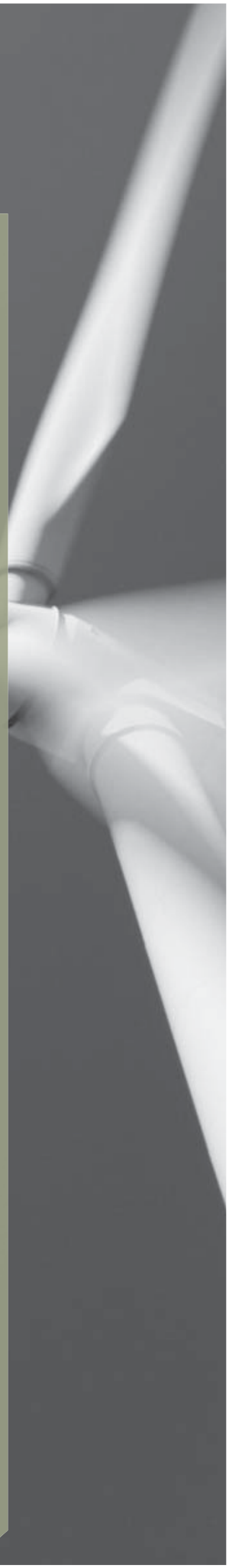

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can currently be selected. FPGAs from other manufacturers as well as microcontrollers will be available in the near future. Voltage specifications and tolerances for the individual power supply networks are automatically implemented as properties of the FPGA module. The power requirement for individual networks can either be entered manually, or, in the case of Altera FPGAs, values can be read in from the Altera "Early Power Estimator" (EPE) as shown in Figure 2.

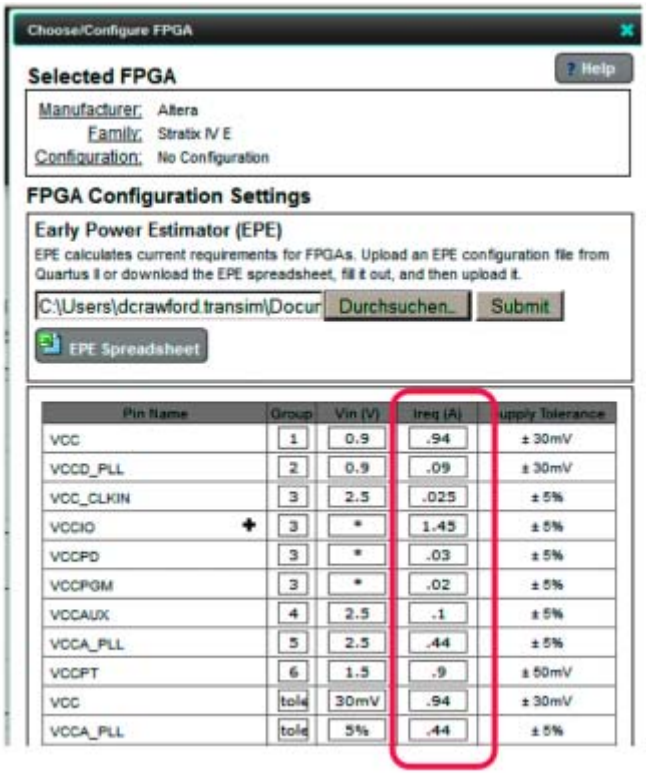

Figure 2: Current and voltage specifications for the FPGA. The power requirement can be loaded manually or from the Altera "Early Power Estimator".

The EPE provides estimated upper limits for the power requirement based on the programming of the FPGAs selected by the user. This ensures that the resulting converters are optimized for the relevant application. This link to the Altera design environment saves time and minimizes the probability of errors occurring early on in the design phase. After the FPGA has been placed in the circuit diagram and the supply specifications have been defined, a concept for the power supply is automatically created in the circuit diagram editor. An example of the power supply plan for the Stratix IV E FPGA is shown in Figure 3. In this screen, individual converters are defined as placeholders, which, thanks to forwarding the requirements for current, voltage and their tolerances, act as templates for designing the individual converters.

Design of the individual converters is started by opening the corresponding module in the power supply plan. Double-clicking on one of the modules opens a configuration screen, as shown in

Figure 4. The connections at the higher hierarchy level in the circuit diagram between converter and FPGA act as the interface for transmitting supply requirements from the FPGA to this design screen.

This information is then used to prioritize the available controller ICs in the selection list. This means that from a list containing several hundred ICs, those which best suit the specific electrical specifications for the design are displayed with highest priority. To do this, the filter algorithm accesses a wide range of data sheets and application notes and saves the engineer, who does not have detailed knowledge of the converter design, many hours if not days of work. In addition to the numerous ICs listed, there is also an item called "Design It". This is linked to an interactive design tool which creates the entire circuit around the converter ICs. The circuit is presented schematically, and in many cases there is the option to check the transient and stationary behaviour of the circuit using a simulation. In this step, it is also possible to modify component values, and the effects of any change are checked in real-time with the simulation. There is no increased computing effort associated with the simulation, as resource-intensive processes are run on the server. Figure 5 shows the circuit diagram for a converter and the results of the simulation. The results are displayed in a window together with numerous functions such as marker, zoom on/off, and display options for individual curves. The variety of functions and fast response time expected of desktop applications are available together here in the same online environment.

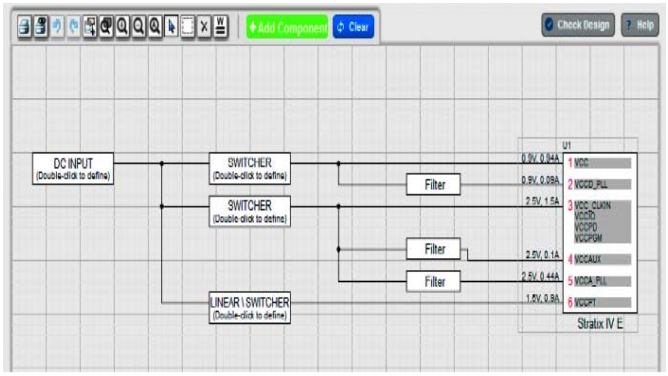

Figure 3: The topology of the FPGA circuit diagram is created automatically with placeholders for individual converters.

Figure 4: Input screen for designing a converter.

The parts list for the circuit can be displayed in the next step. The design is finished off by defining price information using a parts list specified by the user. The availability and price are displayed and the parts list can be downloaded as a table. If individual components are to be replaced or swapped out according to defined criteria, there is a useful filter function that can be used. Figure 6 shows how a capacitor can be selected according to c-value, housing, manufacturer or maximum operating voltage.

The steps described here integrate specifications and application expertise from a variety of modules in order to implement an optimized topology for the power supply of a FPGA. The algorithms sup-

port a fast online design process that can be adapted to the specifications of each individual design.

Following completion of the individual converter circuits, a check is always carried out to make sure that the specifications for the power supply have been met from the point of view of the FPGA. This check can then be carried out manually by selecting "Check Design" at the top of the circuit diagram. A summary of the complete supply, including all converters, simulation results and parts lists is then provided on the "Summary" page. The parts list can also be downloaded or adjusted at this stage, as shown in Figure 6.

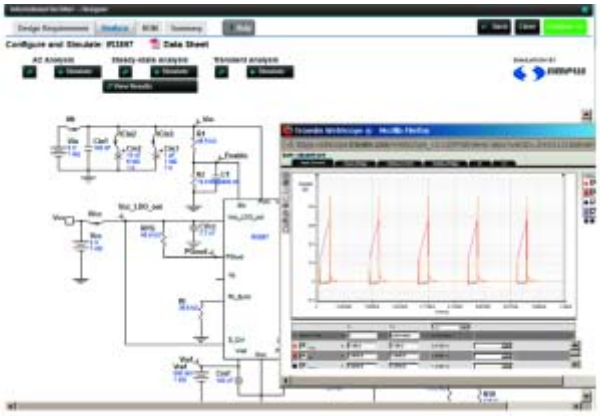

Figure 5: View of the circuit diagram and results of the simulation for a converter circuit. A circuit diagram and parts list simplify the step into production.

Figure 6: A selection filter provides help in selecting individual components from the parts list according to additional criteria.

Summary

The "Embedded Systems Power Designer" online application can be used to implement complex power supplies for embedded modules. This application combines a wealth of application expertise in an intuitive user interface that guides engineers through the complexity of the task in just a few simple steps. Based on the specifications of the FPGA, circuits are adapted for converters and their components. At the end of the process, engineers get all the design information such as the circuit diagram, parts list, topology of the supply, and simulation results as a download.

http://arrow.transim.com/designweb/

Innovative Solution to Connect Stator Main Windings in Rotating Machines via Circular Laminated Busbars.

To cope with the global challenges of competition, the growing needs of electricity and the strengthening of energy efficiency reglementations, rotating machines manufacturers need to optimize their designs and production processes in order to both improve the energy efficiency of their motors and generators and reduce their costs. A major axis to get such competitive advantages lies on the optimization of the stator main windings connection. Since no real industrial alternative has been proposed throughout time to improve this connection, most companies have been still relying on the same historical constructions as their old models of rotating machines. This is to fill this gap and make a technological breakthrough that Mersen has developed a cutting edge solution to connect the stator main windings by integrating a circular laminated busbar.

By Remy Roulier and Björn Asmussen, Mersen

Definition and Overview

Mersen circular busbar is a 100% custom electrical interconnection part for motors and generators that substitutes the stator main windings, generally made of a set of cables or coppers bars, by a single customized device. Indeed, the stator windings in rotating machines can be either wire-wound (also called random-wound) or bar-wound (also called form-wound). Thus, the stator main windings also tend to use one of these two options often leading to costly, complex assembly processes with several parts to manage and requiring a large amount of space at the stator end.

The circular busbar system provides a set of benefits targeted to reach an overall lower cost of the rotating machine through the decrease of the assembly time, the avoidance of wiring errors, the stock management of fewer parts, the ability to save space and the improvement of the electrical performances such as low inductance and low voltage drop.

Application field

Taking into account the previous benefits, this results in saying that the more complex the stator main winding system is, the more interesting gains the circular busbar will achieve. That is why this system is the most widely used in three phase induction and synchronous machines present in wind, industrial or transportation applications, with a power starting from a few kVA to several MVA. Indeed, in this case the main winding system will have to ensure at least the connection of all the stator coils for each one of the three phases in order to make the three output phases (U, V, W). Thus, the complexity is directly function of the number of coils to connect per phase. Moreover, the main winding system may have to consider an additional neutral (N) output or to double the three output phases (U1,U2 ; V1,V2 ; W1,W2). This last point depends on the electrical specifications and the requirement to have a star, a delta configuration or to keep the configuration flexible at the terminal box level. Finally, internal coil connections without associated outputs can also be considered and integrated in the circular busbar.

Whether the three phase machine is synchronous or asynchronous does not influence the conception of the circular busbar since the stator remains the same for both of these types, the difference being in the rotor construction. It may be useful to mention that the circular busbar can also fit for DC or single phase machines.

Circular Busbar Characteristics

The circular busbar custom design is based on several electrical standards such as IEC 60950-1, EN 50124-1 and UL840. It is also UL94V0 approved and RoHS compliant.

The choice of the conducting materials depends on the stator design requirements. Most of the time, copper will be chosen for its outstanding electrical and thermal conductivity. However, aluminium conductors can sometimes be preferred because they can offer larger cost savings especially when current is high and gets closer to 1000A. But on the other hand, aluminium is approximately 60% as conductive as copper according to the IACS, requiring larger conductors to carry the same amount of current as copper conductors, and thus taking more space in the stator.

The insulation materials are sized to satisfy most of the rotating machines insulation classes, such as Y, A, E, B, F and H. These classes determine the maximum admissible temperature on the rotating machine windings, and thus on the busbar. For instance, an H insulation class means that the circular busbar should be able to withstand a maximum operating temperature of 180°C. Moreover, information on the rotating machine

environment is important for the best choice of the insulation material. So, the pollution degree or the percentage of humidity will also impact the selection of insulation among a wide range such as PET (polyethylene terephthalate), aramid paper, PEN (polyethylene naphtalate), PVF (polyvinyl fluoride) or PI (polyimide). Epoxy glass or resin can also be used to close the busbar edges. Indeed, these solutions may be preferred in some circumstances, for instance when the available space inside the stator is insufficient to allow an overlap of the insulation material in order to take into account the creepage distance.

Planar Shape *Rolled Shape* *Polygonal Shape*

Figure 1: Overview the circular busbar various shapes

Different shapes can be proposed for the circular busbar to answer at best the rotating machine specifications, in particular for saving the biggest amount of space according to the available space inside the stator. Thus, the optimized busbar can adopt either a planar shape, a rolled shape or also a polygonal one.

The connection between the busbar and the stator is also a critical point in the simplification of the assembly process. Thus, depending on a sharp analysis of the stator parameters such as the section and number of coils, the available space, the stator diameter or the existing assembly process, the coils will be connected to the circular busbar using various ways. Among these solutions we can find tin soldering, silver brazing, special crimping processes or also screwing.

Conclusion:

As world competition and energy efficiency requirements continue to increase, rotating machines manufacturers need to find solutions to decrease their production costs and improve the performance of their motors and generators. Mersen circular laminated busbar is a smart way to achieve this goal, by optimizing the connection of the stator main windings using a single customized device. Such a solution provides the opportunity of a technical breakthrough compared to cables or copper bars solutions, which often require a large amount of space at the stator extremity and rely on costly, time-consuming assembly processes. Indeed, for instance in the case of a three-phase machine of multi-hundreds of kVA, many manufacturing operations are required to achieve a cable-wound stator main connection system. Depending on the manufacturing process, the output leads of the coils that compose the stator will have to be stripped, combined together, soldered or crimped, wrapped with plastic sheaths and eventually with additional tape insulation. Thus, the assembly process rapidly becomes complex and the amount of material such as insulation contributes to the space consumption at the stator end.

Thanks to its optimized shape, the circular busbar is aimed to reach significant cost savings through the simplification of the manufacturing process and the stock management, the improvement of electrical performances, the reduction of the stator space and thus the size of the rotating machine.

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Optimizing of Power Sources for Use with Fuel Cell Technology

With energy demands ever increasing, fossil fuels being depleted and concerns about climate change continuing to rise, the ways in which modern society is being powered are now under close scrutiny. International legislation is being passed to curb carbon emissions and greater emphasis is being put on the utilisation of renewable energy resources. Driven by such circumstances, the global market for hydrogen fuel cells is expected to witness a compound annual growth rate of more than 15% between now and 2017 (according to RNCOS).

By Rob Hill, Director of Sales & Marketing, Powerstax

These ambitious projections will only become a reality, however, if proliferation of fuel cell technology starts to gain more momentum in a broader cross section of everyday applications and the supporting hardware utilised has the ability to make fuel cell powered systems as cost-effective, energy efficient and easy to implement as possible.

Shipping is one of the areas where the use of fuel cells could have a major impact, as this currently represents nearly 10% of the UK's total carbon emissions. So far relatively little traction has been made here, but developments down in the West Country might help to change all that. Keen to move to cleaner energy, Bristol City Council has recently funded a £225,000 project that provides the city's inhabitants with the UK's first ever fuel cell powered ferry service. The project is part of the council's Green Capital initiative.

The 36 foot long, steel hulled ferry Hydrogenesis, which has a two man crew, traverses Bristol Harbour. It can carry up to twelve passengers and has a maximum speed of 10 knots. While diesel powered craft have a heavy impact on the environment through air and water pollution, the electro-chemical process employed this vessel produces no harmful by products. As fuel cell implementations have no moving parts, their working lifespans are much longer than diesel engines. In addition, they offer far less noisy operation.
Bristol-based Auriga Energy was given the task of designing and developing the fuel cell system that would power the Hydrogenesis. Established in 2007, the company specialises in creating of highly efficient carbon free energy solutions by employing the latest innovations in fuel cell technology. It relies on the talents a small, highly experienced team of engineers who previously plied their trade in the avionics and defence industries (working for the likes of Marconi, BAE Systems and Thales). This team takes fuel cell stacks then develops highly sophisticated, application specific systems (consisting of both hardware and software) around them that will deliver maximum operational performance.
"It was decided that ferries would be a good starting point," says Jas Singh, Managing Director of Auriga Energy. "This could show Auriga's technology in action and prove that fuel cell operation can be commercial viable as well as deriving ecological benefits." "Though the initial implementation outlay is quite high, once this is dealt with operational costs being highly competitive" he continues "If you look at the whole of life costs, then moving to fuel cells becomes more favourable, even before you take into account their green credentials." Bristol, through the work of Brunel, can boast a long and eventful history when it comes to maritime innovation. It is perhaps apt then that where the Hydrogenesis is moored lies almost in the shadow of Brunel's ocean liner the SS Great Britain.

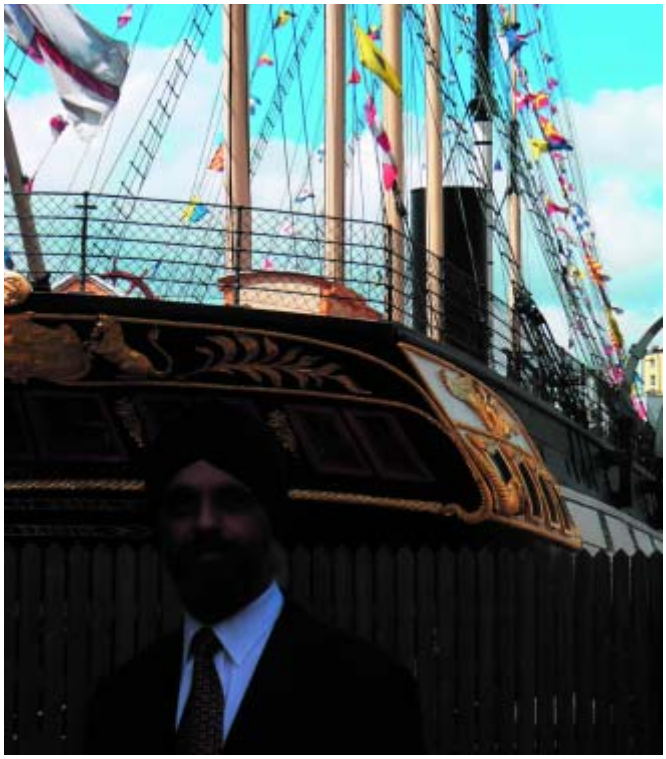

Figure 2: Jas Singh of Auriga Energy, next to Brunel's SS Great Britain

"Every element of the power system needs to be working at the highest possible levels of operational efficiency," Singh explains. "This means that the amount of hydrogen that the ferry uses each day can be kept to a minimum to lower the running costs, thereby making the project even more economical." The system, which is deployed in the ferry's stern, consists of four fuel cells delivering up to 12kW to power the ferry. The fuel cells are supplied with hydrogen from a 350Bar tank. Two DC-DC modules are needed; the first is at 24V and looks after the control system; the second is at 12V and sees to the supplemental electricity needs (such as the boats lighting system, etc.).

The DC-DC converter modules have a key role to play in the success of this application and so the specifying process needed to be given a great deal of consideration. These modules have to take care of regulating the voltage output.

It was essential that they possessed a very wide voltage range, in order to cope with the variation of the fuel cell output. In addition, high levels of efficiency and compact dimensions were both very important factors.

“I had previously used Powerstax modules in our fuel cell powered fork lift development and the performance levels they achieved were highly favourable. As a result when it came to specifying power modules for the ferry project, it products seemed like the best choice,” states Singh. “In addition the technical support that the Powerstax team were able to offer and their ability to make adjustments to the product proved will be invaluable in the future.”

Based on its industry-proven brick technology and strong power engineering expertise, Powerstax has introduced a series of high performance DC-DC converter modules that are targeted specifically at serving the rapidly growing fuel cell market. These high density modules in this series can provide engineering teams looking to implement fuel cell based power systems with a highly optimised off-the-shelf solution, rather than having to look into expensive custom designs. They accept 40V to 120V input direct from many popular fuel cells models and deliver a stabilised output of up to 500W. Power efficiency levels reach 91%. The modules in Powerstax FC series are offered in an industry standard full brick (11.68cm x 6.10cm x 1.27cm) format, with power densities of up to 5.53W/cm3.- so that system performance can be maximised while taking up minimal space.

Figure 1: The Hydrogenesis - the UK’s first fuel cell powered ferry

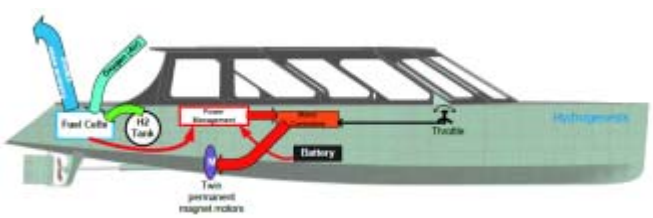

Figure 3: Schematic of the power system used in the Hydrogenesis

To increase flexibility, the FC series is available with output voltages of 12VDC, 24VDC, 28VDC and 48VDC. Over-voltage, under-voltage and short-circuit protection mechanisms have been integrated into each module. In addition, a proprietary monitoring feature safeguards against system failure conditions arising. Active load sharing means that the output from an array of multiple modules can be maximised. The FC series has an operational temperature range of -20°C to +100°C, with a MTBF value of 1.1 million hours assuring continued system reliability.

The highly reliability power systems offered by Powerstax are very well suited to performance-demanding applications. The company has off-the-shelf solutions like the FC series, as well as full custom, intelligent power solutions tailored for individual customer needs.

The implementation of an environmentally-friendly ferry via a highly integrated hydrogen fuel cell-based power solution will be the catalyst that helps to eventually make Bristol Harbour a low emission zone. Auriga is now in discussions concerning further nautical applications - on the Norfolk Broads and in Venice. The company is also talking to a major UK-based ferry operator about the possibility a larger project being undertaken in the future.

www.powerstaxplc.com

Compact High Efficiency Power Supplies for Automotive

ROHM has announced the development of compact, high efficiency power supplies designed to drive DDR memory, microcontrollers, and other components in car applications. The BD905xx series integrates a phase compensation circuit and feedback resistor, reducing the number of external parts considerably compared with conventional power supply ICs. This simplifies design load and contributes to end-product miniaturization.

In recent years the increasing popularity of electric and hybrid vehicles has led to more sophisticated electronic systems and a greater demand for microcontrollers and memory. Conventional LDO regulators are commonly used, but they feature poor efficiency and cannot meet higher current demands. As a result, DC/DC converters, which provide greater efficiency and higher current-handling capability, are becoming the preferred solution. However, they are not without their drawbacks, which include more external parts and consequently a larger mounting area, increasing circuit design complexity significantly. With the trend towards improved performance and decreasing model cycles in the automotive industry comes a need for easier-to-use, high efficiency power supply ICs that lighten the design load and minimize mounting area.

A primary factor in the number of external components used with power supply ICs is the phase compensation circuit required to maintain a stable output voltage. Normally external capacitors and resistors are used to set the desired characteristics. However, ROHM was able to successfully optimize the phase compensation circuit internally, reducing parts count by 80% and contributing to more compact automotive systems. In addition, phase compensation adjustment, which is a common problem with power supply designs, is no longer required, shortening design time significantly.

ROHM power supplies utilize synchronous rectification for high efficiency operation, in combination with Light Load Mode, ensuring superior performance with low current consumption under all load conditions.

www.rohm.com/eu

Benchmark in Reliability for Operation in Wind Turbines

Under harsh climatic conditions, secondary damages caused by moisture rank among the most common causes of failure of power electronics modules. Therefore, a classification of a module for a higher pollution degree implies a significant increase in the lifetime of that module. The IGBT module SKiiPX is designed for extreme climatic conditions and allows condensation during operation. It meets the requirements specifically for wind turbines in a power range of 1-6 MW in an outstanding way.

The internal construction of the SKiiPX is based on the SKiN-Technology. The SKiN-Technology enables a doubling of the power density within the module. Consequently, the total volume of the inverter can be decreased by up to 50%, inverter costs may be reduced by up to 15%. SKiiPX allows for the first time the integration of a 3MW wind inverter into a single cabinet. Due to the high integration level, the probability of an inverter failure - expressed by the Failure-In-Time (FIT) rate – is reduced by 30%.

The newly designed integrated liquid cooling system allows for a constant operating temperature of the coolant of up to 70° C. This hermetically sealed system requires less numbers of gaskets as compared to conventional systems ensuring higher reliability. As a result, the SKiiPX is the most reliable module in the market to be operated under extreme climatic conditions.

The SKiiPX is supplied as a fully tested subsystem (IPM) with integrated gate driver electronics, cooling and protection functions, thus reducing the design and integration effort for the complete system for the customer.

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As specialists in power conversion, RECOM Electronic brings you yet another innovation in low power AC/DC converters. All models in the RAC01 to RAC10 families (1 to 10 watt) now accept AC input voltages down to 80VAC. Thus the wide-range 80-265VAC input or ultra-wide-range 80-305VAC input converters are compatible with all mains voltages worldwide, from the Japanese 100VAC, through the European 230VAC to the American 120/208/277VAC networks.

The ultra-wide input voltage range guarantees a stable, isolated DC output even if the AC power supply varies widely or is temporarily out of range, as may be the case for example when the voltage is supplied from a generator set. Therefore the RAC series are especially suitable for countries where voltage fluctuations far outside normal tolerances are not uncommon. The converters can also be used with any mains input frequency from 0Hz (DC) up to 440Hz (aircraft electrical systems).

The AC/DC modules operate with a stable efficiency down to 10% load, so only one converter type is needed for many different applications, so reducing logistics costs and giving economies of scale. The compact mini power supplies have a built-in EN55022 Class B input filter that does not require any external components, also reducing end-user costs. The converters feature 3kVAC isolation (3.75kVAC for RAC04/277 & RAC10/277) between input and output and are CE, EN and UL certified. RECOM offers a 3-year warranty as standard on all of its products.

www.recom-electronic.com

Superior Drop Shock Performance and Thermal Cycling Reliability

Indium Corporation's new SACM™ is a high-reliability solder alloy that offers drop shock performance far superior to other SAC alloys, without compromising on thermal cycling – all at a cost below that of typical SAC solder alloys.

SACM™ meets the electronics assembly market's demand for a solder alloy that offers the combination of good drop shock performance, good thermal cycling, lead-free composition, and reduced cost. The invention of SACM™ offers superior drop shock performance versus SAC305 and SAC105, with the added benefit of thermal cycling reliability equivalent to SAC305.

This provides manufacturers with an affordable high-reliability SAC alloy. This development is especially meaningful for the manufacture of consumer electronics that normally see frequent handling, such as mobile devices.

SACM™ is doped with manganese and contains less silver than other Pb-free alloys. Manganese provides increased strength and the reduced silver content provides a more stable cost structure, especially beneficial for cost-sensitive applications.

www.indium.com/SACM

TI Boosts Battery Run-Time in Portable Devices

Texas Instruments introduced the industry's smallest and most accurate Li-Ion battery fuel gauge integrated circuit, the bq27421, which boosts battery run-time in portable medical devices, such as wearable health monitors, and industrial devices like inventory scanners and portable emergency lights and other consumer electronics.

Leveraging TI's proven Impedance Track™ advanced battery technology typically used in tablets and smartphones, the bq27421 system-side fuel gauge in a 9-ball chipscale (WCSP) package accurately reports remaining battery capacity, state-of-charge and battery voltage, allowing portable devices to extend run-time by 50 percent or higher. For samples and development kit module, visit: http://www.ti.com/bq27421-pr-eu.

"Users of portable medical and other electronics need an accurate prediction of remaining battery capacity to better manage their mobile device and decide when to recharge or replace the battery. Whether it's a blood glucose meter, wearable patient monitor bracelet or portable inventory scanner, you need accurate information to make good decisions," said Steve Lambouses, vice president of battery management. "TI's fuel gauges give consumers the battery information they can depend on, maximizing the level of convenience with their battery-powered devices and allowing them to get more run-time out of their batteries."

Gauge Studio for easier battery gauging design

Designers can use the pre-configured "plug-and-play" bq27421 fuel gauge with TI's new Gauge Studio software tool to simplify battery gauging design. The file size of the Gauge Studio design tool is about ten times smaller than TI's previous software, dramatically minimizing configuration and system firmware development. The bq27421EVM-G1A evaluation development kit is available for US$49.

www.ti.com

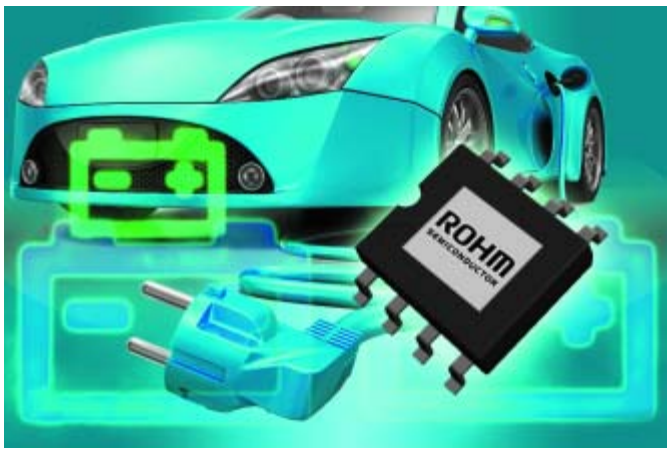
Leakage Detection IC for Automotive Applications

Suitable for backup power supplies in EVs and HEVs that contribute to greater system safety

ROHM has recently announced the development of an automotive-grade leakage detection IC designed specifically for AC inverters and chargers for AC outlets in electric and hybrid vehicles. The BD9582F-M features a wide operating temperature range and is AEC-Q100-certified, ensuring stable, reliable operation in automotive systems. In addition, industry-low current consumption (330uA) contributes to longer battery life.

In the wake of the Great East Japan Earthquake a growing number of hybrid and electric cars are being equipped with emergency or backup power systems, which include outlets that can power not only portable devices such as smartphones, but high power consumption consumer equipment as well. Safety systems similar to earth leakage circuit breakers that incorporate leakage detection ICs used in homes and buildings are currently being considered for cars in order to prevent electric shock or fires when using AC outlets. However, severe challenges regarding reliability (including temperature protection) must be overcome before full implementation is possible.

In response, ROHM developed a new leakage detection IC designed to provide safe, reliable operation of AC outlets in vehicles. The BD9582F-M expands the temperature range from the conventional -20°C to 95°C to a more robust -40°C to 105°C and protects against electromagnetic radiation, providing the necessary level of reliability for automotive applications. ROHM's leakage detection IC also complies with semiconductor standard AEC-Q100 for automotive applications and utilizes proprietary technology combined with a novel circuit design for improved cutoff (interrupt) performance and greater system safety. In addition, further circuit optimization results in the industry's lowest current consumption of 330uA, prolonging battery life while maintaining high reliability operation. Also, this IC is compatible with AC100~240V, ensuring support not only for automotive systems but consumer devices as well.

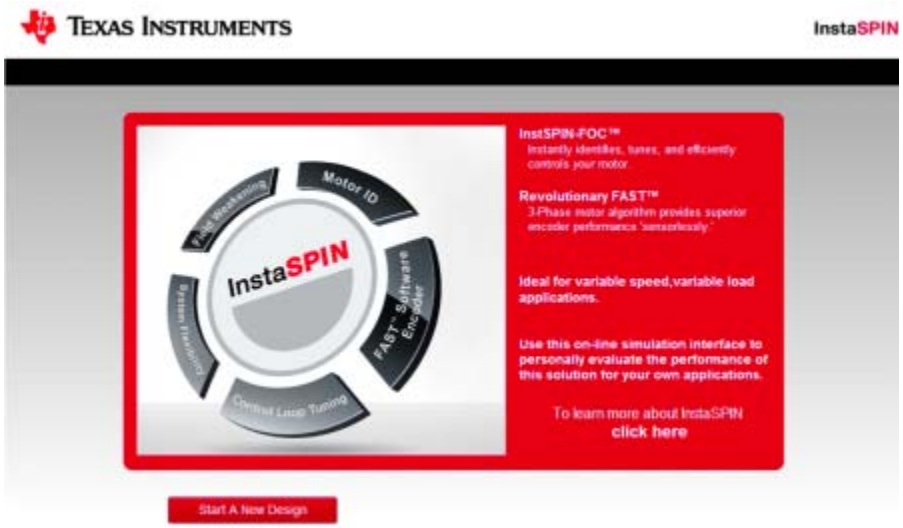


www.rohm.com/eu

Online Simulation Tool to Evaluate Breakthrough Motor Control

Texas Instruments Incorporated (TI) (NASDAQ: TXN), unveils a free, interactive online simulation tool that enables motor designers to assess TI's InstaSPIN™-field-oriented-control (FOC) technology. This online simulation allows users to fully evaluate TI

Introduced in February, TI's InstaSPIN-FOC removes the need for a mechanical motor rotor sensor, reduces system costs and improves operation using TI's new software encoder (sensorless observer) algorithm, FAST™ (flux, angle, speed and torque),



InstaSPIN-FOC's superior software-sensor-based "sensorless" control for variable speed and load applications using three-phase, synchronous or asynchronous motors. Within the online simulation, evaluators can select from a library of motors, customize speed and load profiles and obtain simulation results within minutes. The simulation viewer enables users to view each waveform with a variety of zoom and pan options, perform numerous waveform analyses (e.g., period calculations, RMS, average) and print results. The entire experience is intended to give users confidence to proceed with motor designs using TI InstaSPIN-FOC motor technology.

embedded in the read-only-memory (ROM) on TI's 32-bit C2000™ Piccolo™ microcontrollers. InstaSPIN-FOC also eases development and complexity for designers — even those with limited motor control experience — and enables premium solutions that improve motor efficiency, performance and reliability in all variable speed and variable load motor applications. This motor technology joins the previously introduced InstaSPIN-MOTION and InstaSPIN-BLDC technologies and will be followed with future InstaSPIN variations to make motor control development easier and more efficient.

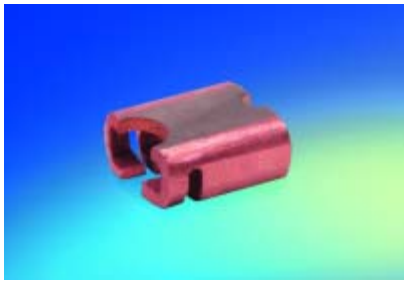
www.ti.com

Künstler: Matthew Cusick

Stoppt den Klimawandel, bevor er unsere Welt verändert.
www.greenpeace.de/helfen

GREENPEACE

The BVN Precision Resistor Uses 25 Percent Less Space



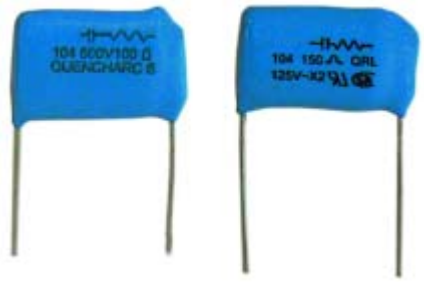
Isabellenhütte has added the new BVN four-terminal resistor to its measuring resistor range. It is exceptional due to its small size of between 3.3 and 4 millimetres plus its extremely low temperature coefficient of less than 50 ppm/K. "It is difficult to produce low-ohmic resistors with values of less than 1 mOhm that also have good temperature coefficients. The BVN has achieved it – together with a size that is 25 per cent smaller than other resistors with similar performance," confirmed Thomas Otto from the Application Management division at Isabellenhütte. The BVN can handle continuous loads of up to 100 A with a resistance value of 0.5 mOhm. Overall, it has excellent stability over long periods and is suitable for a broad temperature range between -55 and 170 °C as well as for soldering temperatures of up to 350 °C. The BVN can also be mounted on a variety of circuit boards and substrates: It can be mounted on the traditional FR4 material used in most standard applications and on DCB ceramics for high-current applications.

The BVN is suitable for numerous automobile and industrial applications: for frequency converters in drive technology and power modules in inverters, as measuring resistor in power hybrids, and for high-current applications in automobile technology. The components are ideally suited to use on ceramic substrates thanks to their excellent thermal-cycling resistance and the minimal footprint in high-current applications (control electronics, e.g. power steering). Thomas Otto explains: "Each square millimetre saved in construction equals cost savings for the manufacturer." The BVN combines small mechanical dimensions with high measuring accuracy and low temperature dependence.

www.isabellenhuette.de

Expansion of Quencharc®, Arc Suppression Series

Cornell Dubilier announced that it has expanded its Quencharc®, Q/QRL Series of arc suppressors to include 3 times as many ratings and values as it had previously offered.



Dubbed with the trade name Quencharc®, Type Q/QRL snubber networks are comprised of a capacitor and resistor in series. They are effective at reducing voltage transients and increasing the operating life of switching devices such as relays, contactors, and semiconductor switches.

New values include higher voltage networks, up to 1600 Vdc/ 660 Vac and more capacitance and resistor values to choose from at each voltage.

Cornell Dubilier stocks Type Q/QRL at their key franchised distributor sites for quick turnaround for prototype and preproduction quantities.

For inquiries, contact: Mike Rapoza; mrapoza@cde.com | Product Marketing Manager, Film Capacitors | (508) 996-8561 ext. 110.

www.cde.com

Increased Voltage Isolation in a Smaller Package

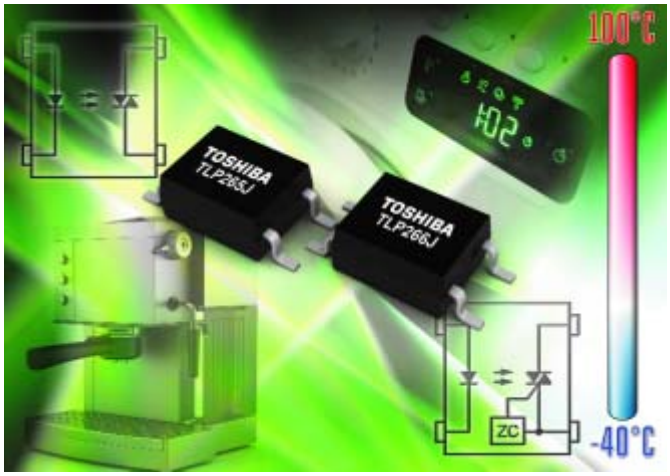
Toshiba Electronics Europe (TEE) has announced two Triac-output photocouplers* that provide reinforced voltage and electrical noise insulation in an ultra-miniature SO6 double-mould package.

The TLP265J and TLP266J have a minimum rated isolation voltage of 3750Vrms and have been designed for use in triac drivers, programmable controllers, AC output modules and solid-state relays used in home appliances and white goods.

The TLP265J consists of a non-zero crossing photo triac, while the TLP266J consists of a zero crossing photo triac. Both are coupled to a long-life gallium-arsenide infrared emitting diode (LED). In terms of electrical characteristics, they support up to 7mA of trigger LED current, which allows them to control output at a lower input current, thus contributing to lower power consumption.

The photocouplers are approved for worldwide use, as they have UL, cUL, and VDE approvals for creepage distance and clearance distance of min. 5mm. Both devices are compatible with an AC mains voltage of 240V. They support a peak-off state voltage of min. 600V and an on-state current of up to 70mA.

The TLP265J and TLP266J are both rated for an operating temperature range of -40°C to 100°C. Additionally they are easy to use,



because they support reflow mounting in accordance with JEDEC standards.

www.toshiba-components.com

Linear Hall-Effect Sensor ICs are Factory Programmed

The A1388 and A1389 linear Hall-effect sensor ICs from Allegro MicroSystems Europe are factory one-time programmable devices which eliminate the need for customers to optimise or program the devices for their finished sensor assemblies.

The sensor ICs are targeted at displacement and angular positioning sensing in the automotive, industrial and consumer market sectors.

The architecture of the A1388 and A1389 allows them to support magnetic input sensitivity ranges of 2.0 to 4.0 mV/G and 4.0 to 9.0 mV/G, respectively, but the devices initially being released are factory-programmed to specific magnetic input sensitivity levels.

The devices that are initially being released are the A1388LLHLX-2-T with 2.5 mV/G sensitivity, the A1389LLHLX-9-T with 9 mV/G sensitivity, and the A1389LLHLX-RP9-T with -9 mV/G sensitivity.

The temperature coefficients for both sensitivity and the quiescent voltage output are programmed over temperature to maximise accuracy and minimise distribution tolerances. The A1388 and A1389 provide low output noise (15 mV p-p at 9.0 mV/G sensitivity for the A1389) and reduced EMI susceptibility at various frequencies. They also support a fast refresh rate of 20 kHz for high-bandwidth applications.

The A1388 and A1389 are supplied in a small LH (SOT-23W) surface mount package.

www.allegromicro.com

ADVERTISING INDEX

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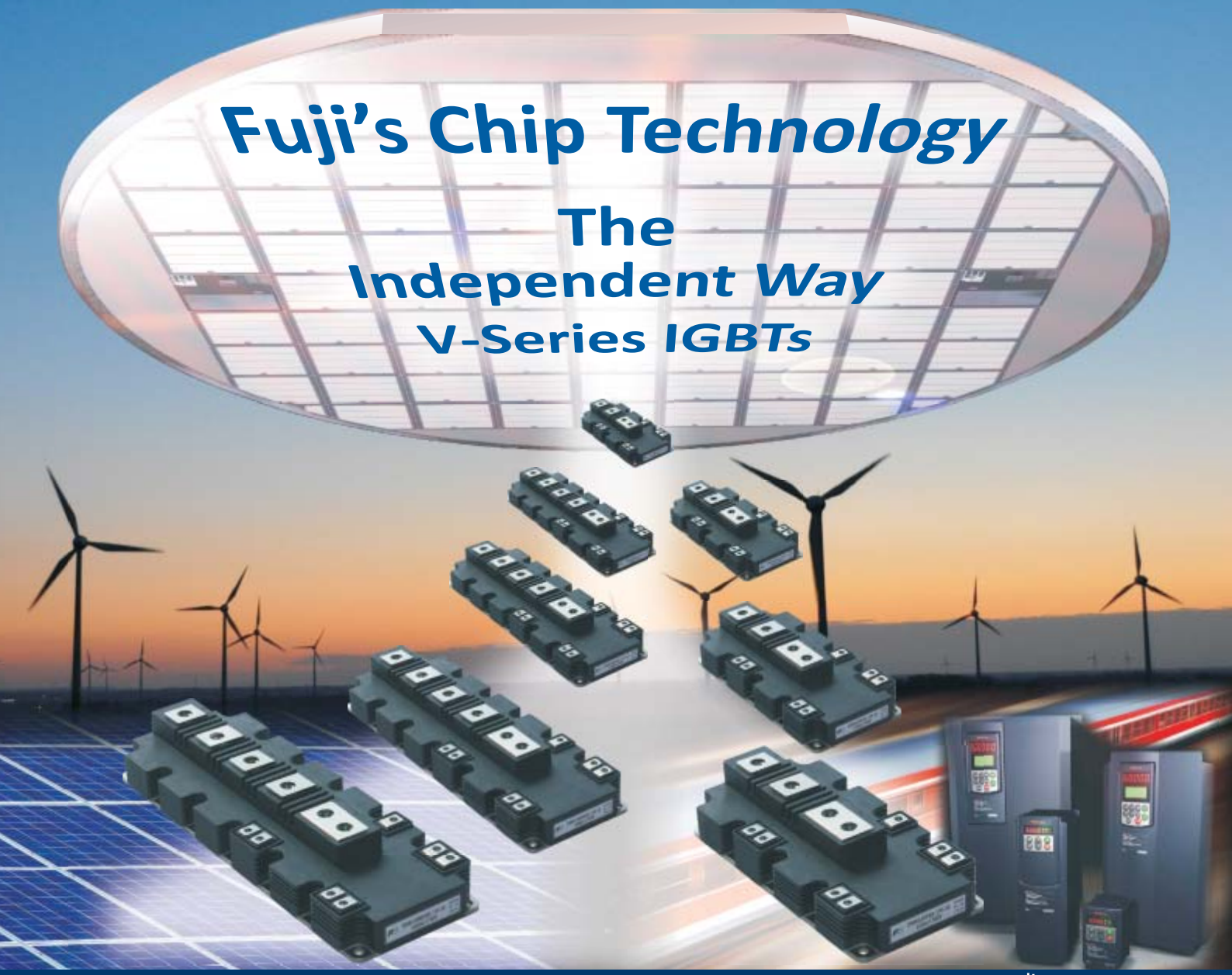
The Independent Way

V-Series IGBTs



- Trench-FS IGBT
- High thermal cycling capability
- Low spike voltage & oscillation free
- Excellent turn-on dIc/dt control by R_G

High Power Modules, 2-Pack & Chopper

	I_C	1200 V	1700 V
2-Pack	1000A		E E+ P
	1400A	E P	E P
Chopper	1000A		E
	1400A	P	E
Chopper	1000A		E
	1400A	P	E

	I_C	1200 V	1700 V
2-Pack	600A	E	
	650A		E E+
	900A	E P	
Chopper	650A		E
Chopper	650A		E

E : E-type (low switching losses) E+ : E-type with large Free Wheeling Diode P : P-type (low $V_{CE,sat}$ & soft turn-off)

Fuji Electric
Innovating Energy Technology

Fuji Electric Europe GmbH
Goethering 58 · 63067 Offenbach am Main · Germany
Fon +49(0)69-66 90 29 0 ▸semi-info@fujielectric.de
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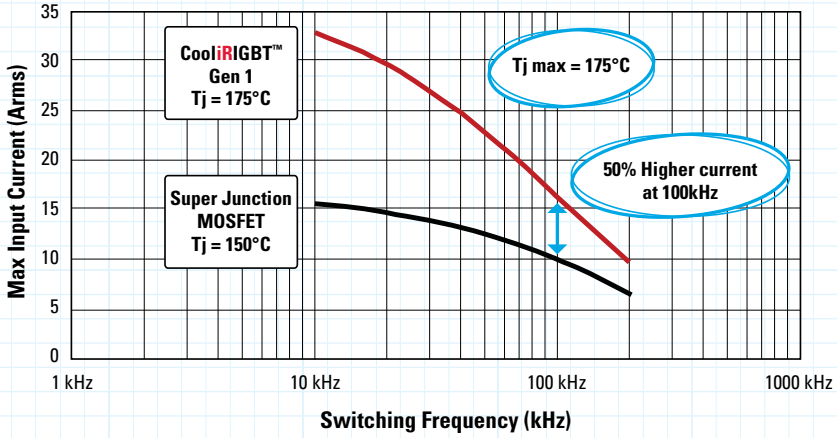
Automotive COOLiRIGBT™ Gen 1

Ultra-fast Switching, Rugged 600V High Frequency IGBTs

CooliRIGBT™ offers 50% higher current than super junction MOSFETs



	Super Junction MOSFET	COOLiRIGBT™ Gen1
Tj Max	150°C	175°C
Manufacturability	Complex	Simple
Switching Frequency	High	High
Losses At High Currents	High	Low

COOLiRIGBT™ Gen 1 are designed to be used in a wide range of fast switching applications for electric (EV) and hybrid electric vehicles (HEV) including on-board DC-DC converters, and battery chargers.

Features:

- Switching frequencies up to 200kHz
- 600V rated devices with a short circuit rating of > 5µs
- Low $V_{CE(on)}$
- Positive $V_{CE(on)}$ temperature coefficient making the parts suitable for paralleling
- Square Reverse Bias Safe Operating Area
- Automotive qualified
- Tj max of 175ºC
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