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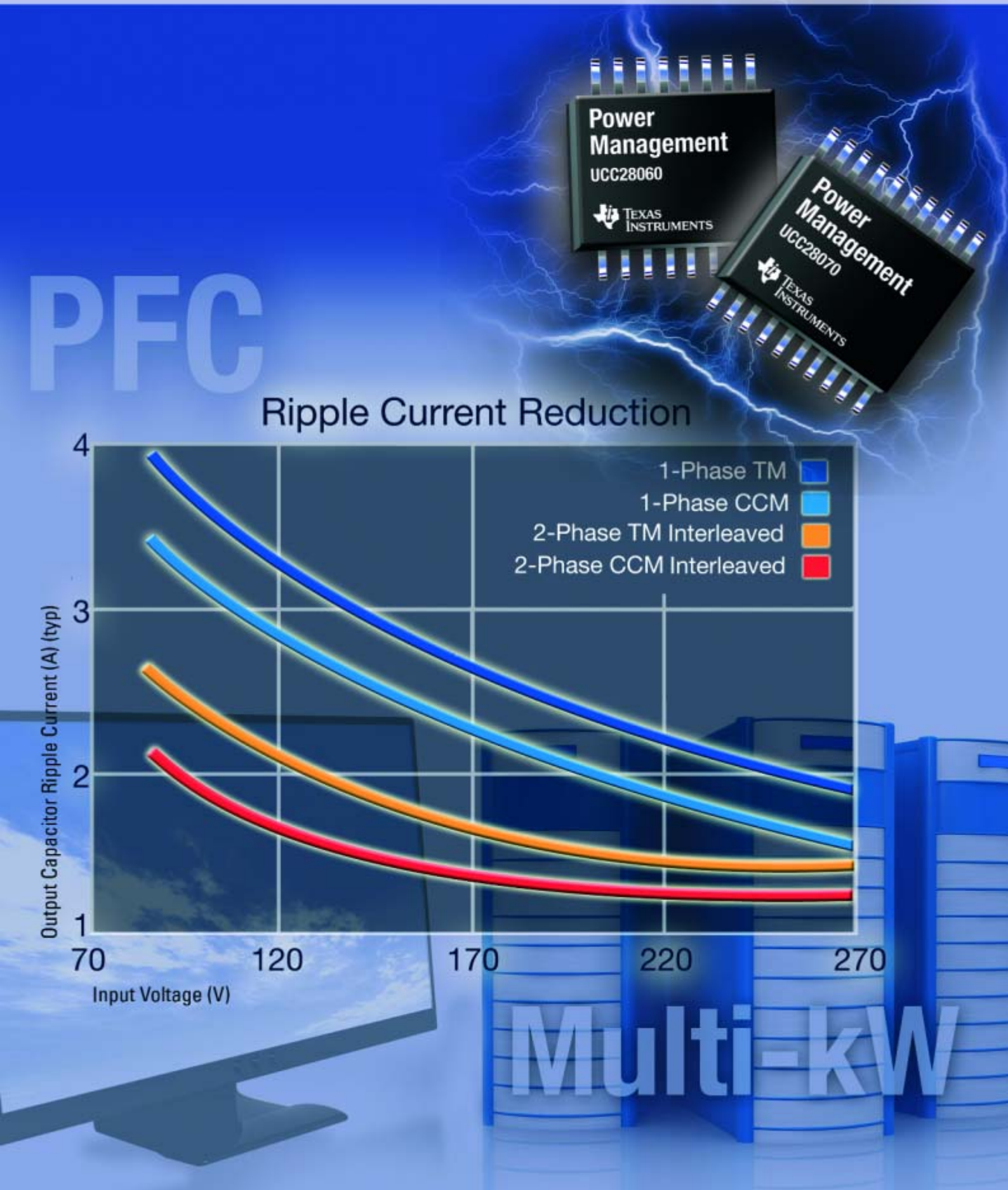
Bodo's Power

Electronics in Motion and Conversion

March 2008



FAIRCHILD
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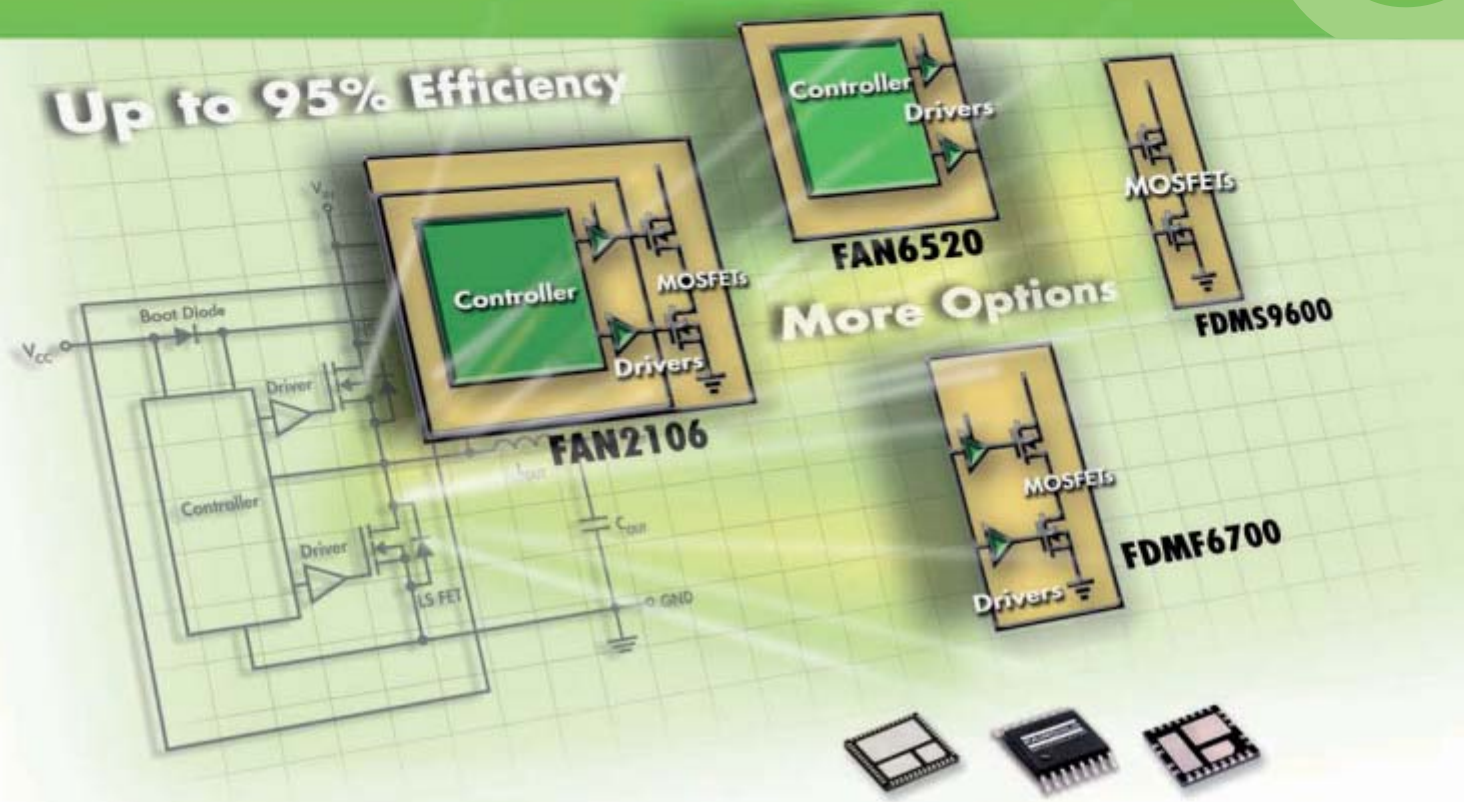
Maximize energy efficiency in every DC-DC design.



Here is a selection of our integrated DC-DC solutions:

Product	Part Numbers*	Features
Integrated Switching Regulators (Controller + Drivers + MOSFETs)	FAN2106 FAN5350	• Up to 95% efficiency • Small, ultra-thin package (MLP and CSP)
Power Controllers (Controller + Drivers)	FAN6520	• Drives N-Channel MOSFETs in a synchronous buck topology • Output voltage range as low as 0.8V to V_{IN}
Power Drivers (FET plus Driver Multi-Chip Module)	FDMF8704 FDMF6700	• >85% efficiency • Optimal synchronous buck power stage DrMOS solutions • Unique MLP 6×6 package
Integrated MOSFETs (multiple MOSFETs in one package)	FDMS9600 FDMS9620	• 50% board space savings versus discrete solution • Ease of layout in PCB design • Optimized matching and sizing of MOSFETs (>92% efficiency) • MLP 5×6 package

*These products represent a small sampling of Fairchild's DC-DC portfolio.

Choose your DC-DC functions, performance, size and energy savings

No one offers more efficient DC-DC options than Fairchild. We combine perfectly matched power analog and discrete components with advanced packaging and power expertise for the industry's leading energy-saving portfolio. You can choose the optimum combination of controller, drivers and MOSFETs in a wide range of performance and size specifications.

Whatever your system performance and time-to-market needs may be, Fairchild has your ideal DC-DC solutions.

Learn more about all of our DC-DC solutions—including PWM controllers, voltage regulators and MOSFETs—at www.fairchildsemi.com/dcdc.

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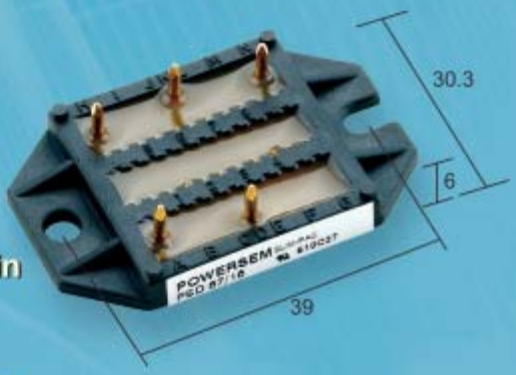
The Gallery

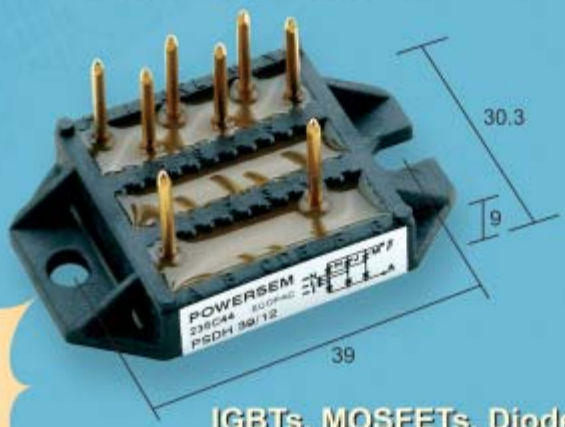
POWERSEM

Lowest Profile Package for Power Modules with Highest Performance and Widest Choice of Customized Circuit Configurations



Rectifier Bridges in SLIM-PAC™

AC Controllers, Diodes, Thyristors, IGBTs in ECO-PAC™ 1



Two different pin heights are available with all ECO-LINE™ - Modules

IGBTs, MOSFETs, Diodes, Thyristors in ECO-PAC™ 3

IGBTs, MOSFETs, Diodes, Thyristors in ECO-PAC™ 2

all dimensions in mm

- Customized choice of Circuit Configurations
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- Two different pin heights are available with all ECO-LINE™ - Modules

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INTELLIGENT MOTION
POWER QUALITY
18-20 March 2008, Shanghai

Booth #5202, Hall E5

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Events

CIPS 2008
Nuremberg/Germany
March 11-13
www.cips-conference.de

PCIM China 2008
Shanghhai March 18-20
www.mesago.de

Battery Developer Forum
Regensburg/Germany
April 9-10
www.batteryuniversity.eu

SENSOR+TEST 2008
Nuremberg May 6-8
www.sensor-test.de

PCIM Europe 2008
Nuremberg May 27-29
www.mesago.de

SMT/Hybrid 2008
Nuremberg June 3-5
www.mesago.de

Blue Efficiency Counts for Design

The 23rd annual IEEE Applied Power Electronics Conference and Exhibition is hip and trendy – so say General Chairman Steve Pekarek and the Austin Convention Bureau, the city hosting APEC 2008. Certainly, coming from Europe in wintertime to enjoy a few days of warmer weather and to learn about progress in research and development is an excellent idea. Everyone in power electronics must pay attention to this event in North America. The 200 exhibitors and the conference activities from Sunday to Thursday provide a great program for engineers. A mix of university and industry papers serves the audience practical information on developments. Both motion and conversion are given balanced coverage. Presenters have traveled from all over the world to Austin. That international contribution helps us see the world as one market place for innovation.

My strategy for the magazine is also to employ innovative approaches. Bodo's Power, in English, serves a worldwide need for engineering information to develop the future. With a new local language program being established, Bodo's Power will serve other languages as well. Submitted articles can be contributed in several languages, in addition to English. The printed magazine will have a note at the end of each article for the available languages. The local language article will be found by downloading the pdf of the full magazine from the website, www.bodospower.com. Innovations provide the flexibility and efficiency to serve the market on time and consistently – at the first of every month my magazine is delivered, twice in the month e-news letters give up to date information and a preview.

The upcoming PCIM Europe is the next big show for our attention. Efficiency will be a predominant theme and will lead the way to careful handling of our resources. "Blue Efficiency" is the next level of efficient design.

This year's podium discussion at PCIM will focus on Blue Efficiency. I hope to see you at the podium on Wednesday the 28th of May between 12:20 and 13:20. The podium location is the same as last year: Booth 12-366 at the end of the hall, next to ECPE and a few steps away from Bodo's Power booth.

Green Power is now used for a wide range of expectations in industry and has lost its unique focus on Power Electronic technical subjects. But still, it is nice to continue having a little Green Power Tip. If all my readers would take note and follow along, it would be a success for the environment.

My Green Power Tip for this month is:

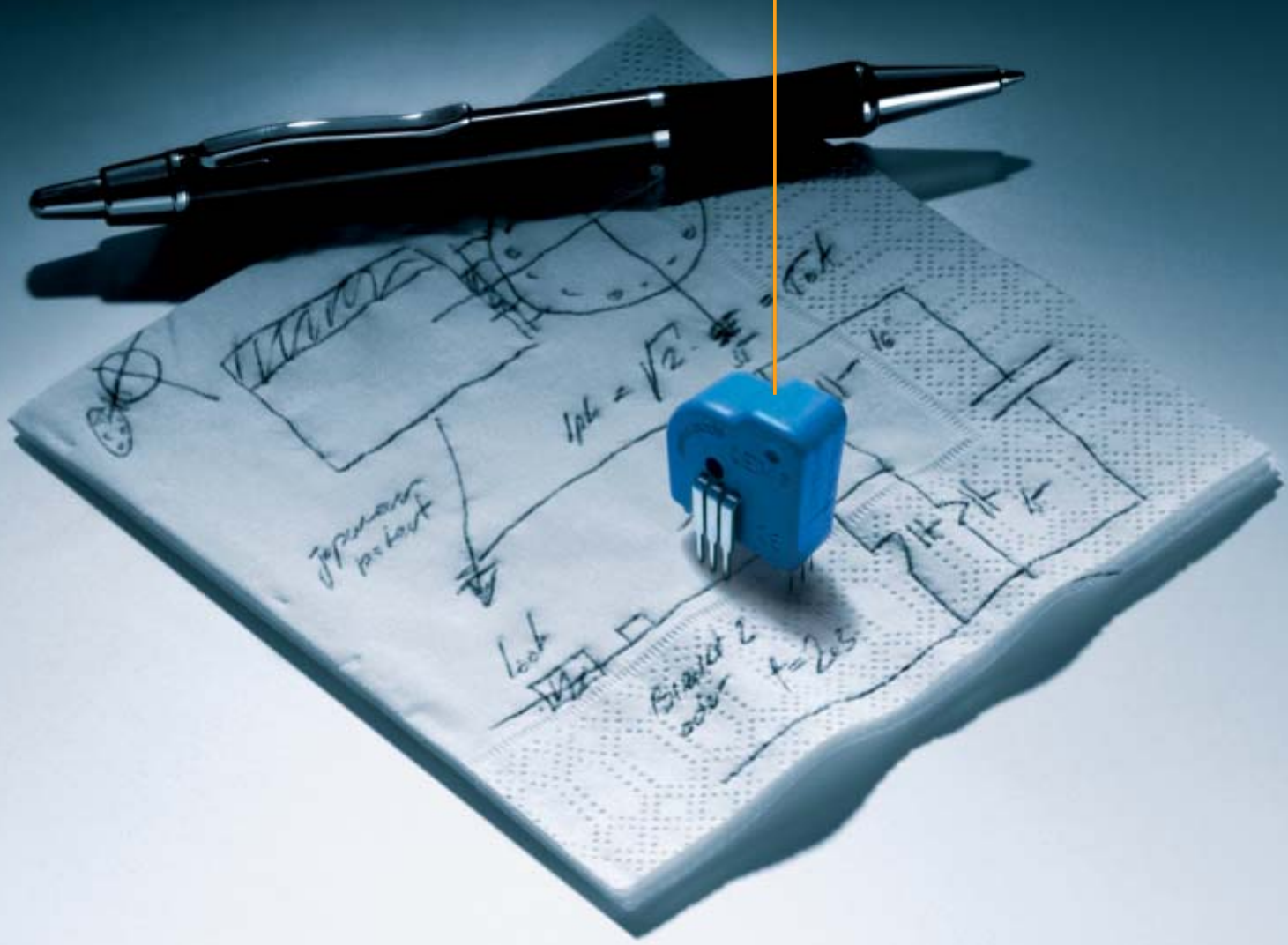
Keep the bedroom unheated in wintertime. Use a nightcap - like me for my bald head. Besides an extra portion of oxygen, you will receive better resistance against colds. I bought my nightcap at Selfridges in London years ago and use it frequently.

See you at the next show.

Best Regards

Bodo Arlt

Already part of your vision.
LEM.



Whatever you invent, imagine or develop, LEM's transducers are at the heart of your power electronics applications from the very start. LEM's products, R&D, and people provide knowledge intensive solutions to keep up with your changing industry, allowing your visions to come to life.

www.lem.com

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Oleg Khaykin President and CEO

International Rectifier announced the election, effective March 1, 2008, of Oleg Khaykin as President and Chief Executive Officer, succeeding Donald Dancer, who has served as acting Chief Executive Officer since August 30, 2007. Mr. Dancer will be actively involved in ensuring a smooth transition and will remain with the Company supporting Mr. Khaykin in his new role.

Mr. Khaykin, 43, brings to International Rectifier extensive global experience in the semiconductor industry, having served most recently as the Chief Operating Officer of Amkor Technology. At Amkor, he was responsible for all aspects of sales, marketing, R&D and manufacturing operations, including accountability for the development and implementation of corporate and business strategy, business development, strategic partnerships and IP management.

Commenting on his appointment, Mr. Khaykin said, "I look forward to hitting the ground running at International Rectifier. I was attracted to this company because of its advanced technology, rich history of technological innovation, industry leading product portfolio and strong customer base. I expect us to leverage those assets to drive growth of existing and new products and technology platforms even as we drive to improve our operational efficiencies and organizational effectiveness. At the same time, I share the Board's deep commitment to ensuring that our operations are conducted with transparency and adherence to the highest ethical standards."

Prior to joining Amkor as Executive Vice President of Strategy and Business Development in 2003, Mr. Khaykin was Vice President of Strategy and Business Development at Conexant Systems Inc. and its spin-off Mindspeed Technologies Inc, where he held positions of increasing responsibilities from 1999 to 2003. Prior to Conexant, he was with The Boston Consulting Group, a leading international strategy and general management consulting firm, where he worked with many European and US firms on a broad range of business and management issues, including revenue growth strategies, operational improvement, M&A, divestitures, and turnaround and restructuring.

Mr. Khaykin holds BSEE from Carnegie-Mellon University and MBA from the J.L. Kellogg Graduate School of Management.

www.irf.com

Developer Forum on Battery Technologies

Primary (disposable) batteries and secondary (rechargeable) batteries are the focus at the top-class developer forum hosted by batteryuniversity.eu, which Sven Bauer, founder of the BMZ Batterien-Montage-Zentrum, Karlstein, Germany has established, and the FH Aschaffenburg (University of Applied Sciences), Germany.

The goal of this first event, held from April 9 to 10, 2008 at the FH Aschaffenburg (University of Applied Sciences) in Aschaffenburg, Germany, is to present to the attendees in 28 professional sessions - held mainly in German - a broad knowledge on different topics such as current battery technologies and chemicals, battery drives for electric vehicles, battery test systems, regulations and standards, battery charging technologies, safety requirements, safety tests and protection circuits.

The complete program of events and registration form can be obtained by sending an Email to mail@batteryuniversity.eu with the subject "Developer Forum Battery Technologies".

www.batteryuniversity.eu

Voltage Regulation Market Weakened in 2007

The global voltage regulation IC market grew by 5% in 2007, to more than $7bn, according to the latest analysis from IMS Research.

The results reveal that the non-isolated regulation market weakened in 2007, following a period of prolonged high growth. However, the isolated market continued to perform well, due to demand for highly efficient controllers for AC-DC power supplies.

Despite the relatively low growth seen in the voltage regulation market last year, some pockets of high growth were apparent. "It is clear that the voltage regulation market weakened in 2007, partly due to inventory correction; however, some applications, such as notebook PCs and high-end consumer equipment bucked this trend," commented Research Director Ash Sharma. "Vendors are hoping for a much stronger 2008, but whilst the long-term drivers for power management remain favourable, short-term spending in the consumer and computing sectors looks uncertain due to the current economic climate" Sharma added.

www.imsresearch.com

Meter Management Systems Improve Energy Efficiency

Improving energy efficiency for electric metering systems by up to 30 percent and helping streamline utility business operations, Incotex Co. Ltd., Moscow is leveraging multiple technologies from Texas Instruments in its meter management solutions now being implemented throughout Russia, Kazahstan, the Ukraine and Belorussia. TI's MSP430 microcontroller (MCU) and TMS320C2000 digital signal controller (DSC) technologies help utility companies comply with environmental protection standards, minimizing power leakages while also advancing customer service with automatic outage detection and more accurate, timely readings. Based on TI's TMS320F28015 DSC, MSP430F155 and MSP430FE427 ultra-low power MCUs and data converters, Incotex's automated meter management (AMM) systems for electrical power distribution networks are optimized to deliver advanced efficiency capabilities to utility providers and end-users around the world. For more information, go to www.ti.com/microcontroller.

www.ti.com/mcu

The Best-Selling 2-Channel IGBT Driver Core

The 2SD315AI is a 2-channel driver for IGBTs up to 1700V (optionally up to 3300V). Its gate current capability of ±15A is optimized for IGBTs from 200A to 1200A.

The 2SD315AI has been established on the market as an industrial standard for the last four years. The driver has been tried and tested within hundreds of thousands of industrial and traction applications. The calculated MTBF to MIL Hdbk 217F is 10 million hours at 40°C. According to field data, the actual reliability is even higher. The operating temperature is -40°C...+85°C.

The driver is equipped with the award-winning CONCEPT SCALE driver chipset, consisting of the gate driver ASIC IGD001 and the logic-to-driver interface ASIC LDI001.

Chipset Features

- Short-circuit protection
- Supply undervoltage lockout
- Direct or half-bridge mode
- Dead-time generation
- High dv/dt immunity up to 100kV/us
- Transformer interface
- Isolated status feedback
- 5V...15V logic signals
- Schmitt-trigger inputs
- Switching frequency DC to >100kHz
- Duty cycle 0...100%
- Delay time typ. 325ns

Driver stage for a gate current up to ±15A per channel, stabilized by large ceramic capacitors

Specially designed transformers for creepage distances of 21mm between inputs and outputs or between the two channels. Insulating materials to UL V-0. Partial discharge test according IEC270.

Isolated DC/DC power supply with 3W per channel

More information: www.IGBT-Driver.com/go/2SD315AI

CT-Concept Technology Ltd. is the technology leader in the domain of intelligent driver components for MOS-gated power semiconductor devices and can look back on more than 15 years of experience.

Key product families include plug-and-play drivers and universal driver cores for medium- and high-voltage IGBTs, application-specific driver boards and integrated driver circuits (ASICs).

By providing leading-edge solutions and expert professional services. CONCEPT is an essential partner to companies that design systems for power conversion and motion. From custom-specific integrated circuit expertise to the design of megawatt-converters, CONCEPT provides solutions to the toughest challenges confronting engineers who are pushing power to the limits.

As an ideas factory, we set new standards with respect to gate driving powers up to 15W per channel, short transit times of less than 100ns, plug-and-play functionality and unmatched field-proven reliability.
In recent years we have developed a series of customized products which are unbeatable in terms of today´s technological feasibility.

Our success is based on years of experience, our outstanding know-how as well as the will and motivation of our employees to attain optimum levels of performance and quality. For genuine innovations, CONCEPT has won numerous technology competitions and awards, e.g. the "Swiss Technology Award" for exceptional achievements in the sector of research and technology, and the special prize from ABB Switzerland for the best project in power electronics. This underscores the company´s leadership in the sector of power electronics.

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www.IGBT-Driver.com

Let experts drive your power devices

Website Dedicated to Embedded Power

Emerson Network Power, a business of Emerson and the global leader in enabling Business-Critical Continuity, has launched a new website that is dedicated to embedded power conversion products. Known as www.powerconversion.com, the website brings the company's Astec and Artesyn product brands together for the first time, making it home to one of the largest portfolios of ac-dc power supplies and dc-dc converters in the world.

Designed from the outset to be one of the fastest and most user-friendly websites in the power industry, www.powerconversion.com is the result of substantial development. Backed by a product database containing comprehensive performance details of more than 3,400 standard power conversion products - each with its own downloadable datasheet - the website is set to become a definitive reference source for system integrators and OEMs seeking the most appropriate power solutions for their applications.

The website's navigation tools make extensive use of hierarchically-structured drop-down menus, enabling users to access a page displaying all relevant products with just one mouse-click - usually in less than three seconds.

www.powerconversion.com

Innovation Award of the German Economy

The 28th "Innovation Award of the German Economy" in the category of "Start-Up Companies" was awarded to Concentrix Solar GmbH, distinguishing it as the company with the most promising innovation. The prize has been promoted annually since 1980 and is awarded by the Wirtschaftsclub Rhein-Main e.V. and the German weekly news magazine WirtschaftsWoche. It is the world-wide oldest distinction of its kind and is under the patronage of the Federal Minister of Economy and Technology, Michael Glos. The award was presented at a gala event on January 19 in Frankfurt´s Old Opera House.

The prize was given to Concentrix for its innovative concentrator photovoltaic technology, which achieves almost twice the efficiency as compared to conventional PV technology and realizes cost savings of 10-20%, depending on the location, for electric power production. "We are very happy about this success", says CEO Hansjörg Lerchenmüller, "it confirms our strategy to further develop this technology for solar power production on a large scale". The main differences to conventional photovoltaic technology are the high efficiency which can be attained as well as the realization of a completely new concept whereby sunlight is optically concentrated on the solar cells using Fresnel lenses. Because the sunlight is focused in this system, the modules must track the sun, making sunny regions with a high proportion of direct sunlight such as in southern Europe the best locations for these systems.

www.concentrix-solar.de

Mitsubishi to obtain Ownership of Renesas Kumamoto Factory

Mitsubishi Electric Corporation and Renesas Technology Corp. announced that they have reached an agreement for Mitsubishi Electric to acquire buildings and its manufacturing facilities of Renesas' Kumamoto factory. Mitsubishi Electric currently concentrates its resources on power and high-frequency optical devices, which prove effective in achieving high synergies within the company.

Reflecting the increasing demand to save energy and protect the environment globally, the inverter controller equipment market, where power devices are used in industrial machinery, home appliances and others, has been steadily growing and is expected to expand. To meet the growing demand for these devices, Mitsubishi Electric has been trying to increase its wafer production capabilities, thus boosting the company's business. Specifically, Mitsubishi Electric has been working to increase the production capability for 6-inch wafers at its existing factory, the Kumamoto Factory of Power Device Works, also located in Kumamoto. Meanwhile, the company has been seeking to manufacture its products using 8-inch wafers to further increase its production capability. The Renesas Kumamoto factory is located on the same grounds as Mitsubishi Electric's Kumamoto Factory of Power Device Works. Furthermore, the Renesas factory has already been commissioned to manufacture Mitsubishi Electric's power devices using 8-inch wafers.

www.mitsubishichips.com

Albany University and IMEC to Collaborate

The world's two leading centers for next-generation nanoelectronics research and development the College of Nanoscale Science and Engineering ("CNSE") of the University at Albany in Albany, NY and IMEC in Leuven, Belgium - announced plans to jointly perform extreme ultraviolet lithography ("EUVL") experiments in order to accelerate the introduction of EUVL into manufacturing. The first set of collaborative experiments will be carried out at CNSE's Albany NanoTech Complex, with future joint studies to be conducted at CNSE and IMEC, depending on throughput and/or availability of the tools.

This groundbreaking collaboration between CNSE and IMEC will also involve scientists from IBM and ASML, which has built the world's first full-field EUVL R&D tool, the Alpha Demo Tool ("ADT"). The majority of activities will focus on the advanced imaging capabilities of the EUVL system, with additional effort devoted to the understanding of new materials and various aspects of equipment technology.

The collaboration between CNSE, IMEC, IBM and ASML is expected to further advance the learning on EUVL technology and the associated infrastructure required to support it. Ultimately, this alliance is intended to effectively demonstrate the practical feasibility of EUVL and build confidence in the technology for the 32nm half pitch device node and below.

www.imec.be

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with Soldering Pins
1200V: 225A - 450A

DualPack
with Spring Contacts
1200V: 225A - 450A

6-Pack IGBT
600V: 15A - 150A
1200V: 10A - 150A
1700V: 100A - 150A

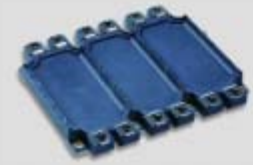
PIM IGBT
600V: 30A - 100A
1200V: 10A - 75A

1-Pack
1200V: 1200A - 3600A
1700V: 1200A - 3600A

2-Pack
1200V: 800A & 1200A
1700V: 600A & 1200A

2-Pack IGBT
600V: 50A - 600A
1200V: 50A - 450A
1700V: 150A - 400A

1-Pack IGBT
600V: 600A
1200V: 200A - 800A



High Power 6-Pack
1200V: 225A - 450A
1700V: 225A - 450A

Special version available for rough environments

Discrete IGBT
600V: 5A - 75A
1200V: 3A - 25A

IPM-IGBT
600V: 15A - 300A
1200V: 15A - 150A

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Fast and Efficient Controllers for Intel Montevina Platform

Intersil Corporation introduced new power management ICs that will be designed into notebook, server and desktop computers based on Intel's upcoming Montevina platform. Intersil's new ISL6266A chip is a two-phase core controller designed to improve the efficiency and performance of systems based on this new generation of Intel Mobile, Core 2 Duo and Quad Core CPUs.

The ISL6266A features Intersil's patented R3Technology (Robust Ripple Regulator) which commands variable switching frequency during load transient events and provides the fastest transient response of any comparable IC on the market. R3 ensures fast and highly efficient performance across the entire loadline of CPU operation.

Intersil has long been a leading provider of complete core power solutions for Intel-based systems, particularly for Intel Napa and Santa Rosa-based Core 2 Duo CPUs. With the new Montevina-compatible ICs announced today, Intersil has the industry's broadest line of power management ICs for Intel-based systems. This product diversity offers great flexibility to end users who want to select the right controller based upon the power requirements of their CPUs.

With enhanced load line accuracy, the ISL6266A ensures Intel specification compliance in mass production and, along with a 0.5% system accuracy over temperature, the overall output decoupling requirements leading to lowest total output capacitor cost.

The ISL6266A also features fault-proof capability in the form of overvoltage, undervoltage and overcurrent protections to protect the regulator, the CPU and the upstream power supply. In addition, the ISL6266A features power and thermal monitors, making it one of the most safety-optimized controllers on the market for the latest Intel platform.

All of the ISL6266A's features are incorporated into a small 48-lead, 7mm x 7mm package that is compatible with existing board layouts that use Intersil's previous generation of power management ICs. This reverse compatibility packaging will save costly redesign cycles for computer makers transitioning their product lines to the new Intel platform.

The ISL6266A is available now in a 48-lead QFN package and priced at $2.86 each in 1,000-unit quantities. More information on the ISL6266A is available at http://www.intersil.com/cda/deviceinfo/0,1477,ISL6266A,0.html

About Intersil's Power Management Portfolio
Intersil is a recognized global leader in power management solutions, offering a broad portfolio of products that simplify a variety of power designs. Intersil's family of power management ICs ranges from building blocks such as charge pumps, to highly-integrated, multiple-output and multiphase PWMs, to quad-voltage hot-swap controllers. As a leading supplier of PWM controller ICs with over 2 billion units shipped, Intersil addresses a broad range of power management needs for applications that include computing, communications, peripherals, display, networking, telecommunications, industrial, instrumentation and battery-powered products.

www.intersil.com/power

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High Performance Analog

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General Purpose Supervisors

Single	Dual	Triple
ISL88011 Fixed V_{TRIP} Adj POR	**ISL88012** Adj V_{TRIP} Adj POR	**ISL88021** Triple VMON UV monitor
ISL88014 Adj V_{TRIP} Adj POR	**ISL88705/6/716/813** WDI/WDO PFI/PFO	**ISL88022** Triple VMON UV/OV
ISL88013 Fixed V_{TRIP}	**ISL88707/8** PFI/PFO Adj POR	**Quad**
ISL88015 Adj V_{TRIP}	**ISL6132** Dual VMON UV/OV	**ISL88041** Quad VMON Adj V_{TRIP}
ISL88016/7 Pin-select 26 fixed V_{TRIP}		**ISL6131** Quad VMON Sep. outputs
		Quintuple
		ISL88031 Quint VMON

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E^2PROM	I^2C	SPI
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HIGH PERFORMANCE ANALOG

Power Source Manufacturers Meet the Efficiency Challenge Head-On

By John Wanes, Business Lead, Murata Power Solutions, Toronto

Designers and manufacturers are taking the matter of energy efficiency, both at a system and module / device level more seriously than ever before. It's true to say that efficiency in the design of products such as AC/DC power supplies and DC/DC converters have always been important. However, with growing awareness throughout industry and society of the adverse impact we are having on our planet and its resources, energy efficiency in the power electronics sector has become more relevant than ever.

The level of technical advancement in power electronics in recent years has been high; this has included good progress in enhancing energy efficiency. Looking forward, this trend looks set to continue with systems architectures as well as the modules that power them likely to benefit from the inherent technical competence in the sector. Numerous industry associations, bodies and 'think tanks' have also sprung up. These are helping to galvanize and focus the knowledge of competing companies to speed progress to sometimes very specific efficiency goals and targets.

Device level Efficiency

Technology and process developments driven by OEM requirements for smaller, more feature packed power products have helped realise the current generation of AC/DC power supplies and DC/DC converters. These products utilise the latest semiconductor technologies along with a range of innovative features and processes. Included in this are planar magnetics, multi-layer heavy copper PCBs and synchronous rectifier topologies that give high-power density modules in small packages boasting efficiency levels exceeding 90%.

There is a strong link between small form factor design and higher efficiencies. However, modules with high component densities are more prone to thermal problems and it is important that all the gains made are not lost by a necessity for power hungry cooling fans and costly heatsinks.

System level design for efficiency

Many designers and manufacturers of power supplies and related modules will advocate that system architects talk to them as early as possible in the design process. Different architectures can have a significant effect on overall efficiency and power supply manufacturers can often provide some useful input and guidance. They can also steer designers towards standard products which are more likely to be better optimized for efficiency as well as offering cost benefits over custom or modified standard products.

System architects should be wary of selecting the lowest cost solutions for their designs. Higher cost, better quality modules may prove to be a better option in the long run due to the fact that they will often be better engineered, more reliable and may help reduce system and energy costs by alleviating the need for fans and ducting.

Load / efficiency considerations

Efficiency figures for power supply modules are most often quoted at full load, however for most industrial applications it is important to also look at half-load efficiency as this is region where equipment tends to spend most of its working life.

For consumer applications standby load efficiency - almost no load - is perhaps even more important than both full and half-load efficiency as products such as TVs, Hi-Fi etc. spend the majority of time either completely powered down or on standby.

Industry collaboration for efficiency

Industry associations involved with promoting energy efficient design of power products include Green Grid, PSMA (EPSMA in Europe) and Climate Savers.

The PSMA and EPSMA have existed for some time and been very successful in helping to improve technical knowledge in the power source sector. They have also provided a conduit for educating the electronics industry, academia and government about power sources and power conversion.

Green Grid and climate savers are very directly concerned with energy efficiency; Green Grid targeting data centres and business computing ecosystems, and Climate Savers specifically addressing the energy efficiency of personal computers.

All of these bodies will help provide crucial profile and momentum to further improve the energy efficiency of both commercial and consumer electronics equipment. If technical advancement continues at its recent rate then we can be confident that the designers and manufacturers of power supply and conversion products will be able to make a valuable contribution to the overall efficiency challenge.

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Never stop thinking

Electronics Industry Digest

By Aubrey Dunford, Europartners

GENERAL

Leading members of the corporate community, among IBM, Nokia and Sony, have come together in a first-of-its kind effort to help the environment, unleashing dozens of environmentally-responsible patents to the public domain. Availability of these patents is set to encourage researchers, entrepreneurs and companies of all sizes in any industry to create, apply, and further develop their

consumer or industrial products, processes, and services in a way that will help to protect and respect the environment. The pledged portfolio, dubbed the "Eco-Patent Commons," is available on a dedicated, public Web site (http://www.wbcsd.org/web/epc).

SEMICONDUCTORS

The IC market is projected to grow in 2008, ranging from +6.2% (Gartner) to +12% (Semico Research). Other forecasts are +10% (IC Insights), +7.5% (VSLI Research and iSuppli).But semiconductor market conditions will be extremely weak in the first half of 2008, so iSuppli.

TI reported annual revenue of $13.83 billion, down 3 percent from 2006. For the year, revenue in

semiconductors was $13.31 billion, a decrease of $421 million, or 3 percent, because revenue was lower for RISC microprocessors, semiconductors used in cell phone applications and DLP products. Combined, the declines in these areas more than offset strong growth from high performance

analog products. For analog products, annual revenue was $5.29 billion.

In 2007, Intersil net revenue was $757.0 million, a 2.2% increase from $740.6 million for 2006. Net income from continuing operations was $142.7 million as compared to $151.4 million for the previous year.

In 2007, North American equipment makers experienced a modest two percent growth in their global billings, so SEMI. December booking levels are 18 percent below one year ago, and reflect the general expectation that capital expenditures will be about 10 percent lower in 2008.

OPTOELECTRONICS

In order to expand the OLED TV market, Sony, which released the world's first OLED TV last year, is looking for strategic partners to cooperate in the production and sales of OLED panels, according to Chinese media reports.

Shipments of TFT-LCD TV panels surged 18% Q/Q and 70% Y/Y to 27.9M units in Q4, so DisplaySearch. This brings the annual total to 86.0M TV panels, a 58% increase over 2006. On a display-area basis, 2007 shipments of LCD TV panels grew 91% over 2006 as the average TV panel size increased 10%. The value of these shipments rose 23% Q/Q and 78% Y/Y to $11.4 billion in

Q4'07. For the year, LCD TV panel sales totaled $33.5 billion , $11blillion more than in 2006.

PASSIVE COMPONENTS

Murata has opened a SAW filter and resonator measurement facility in Milan, Italy. The measurement

facility has a team of RF engineers to support designers at all stages of their RF projects in the 300, 400 and 800MHz ISM bands.

Worldwide connector sales achieved a +6.6% increase in 2007, to $ 42.6 billion, making five consecutive years of growth, so Bishop & Associates.

OTHER COMPONENTS

The EDA industry revenue for Q3 2007 grew 7.2 percent to $1.41 billion. The four-quarter average growth rate, which compares the most recent four quarters to the same four quarters in the prior year, was 12.3 percent, so EDA Consortium. Western Europe revenue was up 13 percent in Q3 2007 compared to Q3 2006, with revenues of $284.5 million. The four quarter moving average growth for Western Europe was 8.5 percent. North America, EDA's largest region, purchased $624.2 million of EDA products and services in Q3 2007. Although this represents a 1.9 percent decrease compared to Q3 2006, the four quarter moving average growth rate was 14.2 percent for North America.o

EMS Providers

Klaus Pildal Management has compiled the so far only known complete directory of the European EMS Industry. In 2006, European employment in this industry has risen from 177.350 by 2% to 181.570 and turnover by 1% to € 27,055 billion.

Swedish EMS provider Note has signed an agreement to acquire the operations of the UK's EMS company Proqual. Proqual operations are focused on services early in product life-cycles like prototyping and sophisticated electronics production in shorter runs. Annualised sales are some SEK 45m and the company has 40 employees.

Ethertronics, a US-based provider of standard and customized embedded antenna solutions for wideband and multi-band wireless devices, has acquired Flextronics' design center located in Kalmar, Sweden. Ethertronics acquired the facility's lab and design center as well as approximately 10 engineers. This acquisition is part of Ethertronics' expansion plan in Europe.

DISTRIBUTION

Rutronik and Hirschmann Car Communication, a German manufacturer of communication systems for use in automobiles, have reached a distribution agreement for sales throughout Europe.

This is the comprehensive power related extract from the " Electronics IndustryDigest ", the successor of The Lennox Report. For a full subscription of the report contact: eid@europartners.eu.com or by fax 44/1494 563503.

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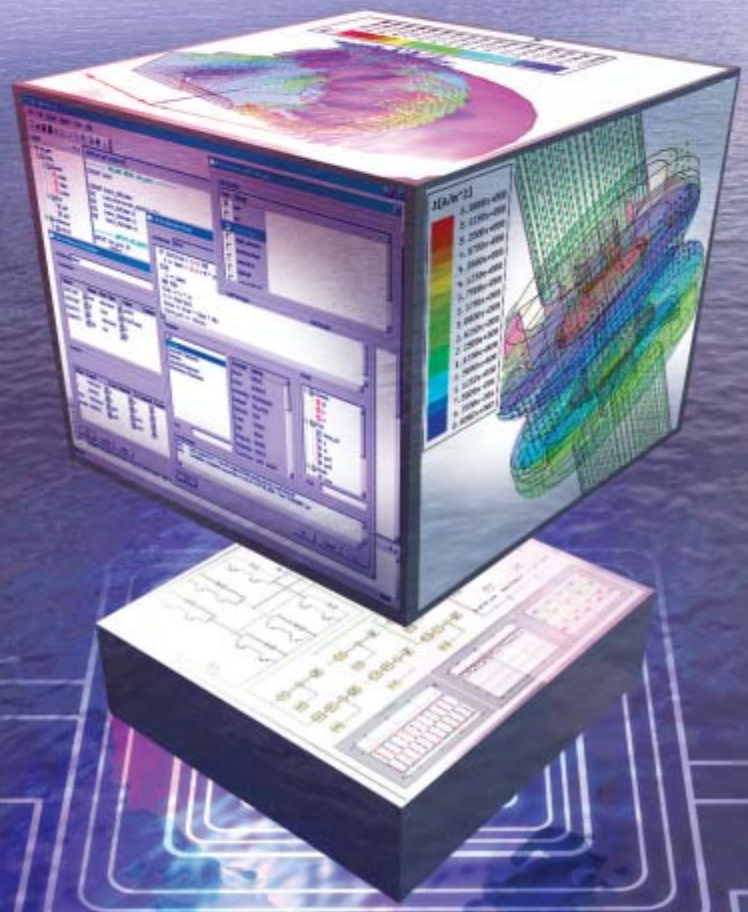

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Automobile Applications Drive HB-LED Adoption

By Jeff Shepard, President, Darnell Group, Inc.

Darnell Group projects that high-brightness LEDs will be taking an increasingly important role as an alternative to incandescent bulbs and halogen or xenon lamps in automotive applications. Currently, LEDs are primarily found in interior lighting such as backlighting dashboards and displays, indicator lights and brake lights.
LEDs offer numerous benefits for automotive applications including: increased reliability, low power consumption, mercury-free devices, new design opportunities due to the small size of LEDs, faster response time (LEDs turn-on about 250 milliseconds faster than incandescent bulbs when used in brake lights), and so on.

LEDs are expected to be available at prices comparable to halogen and xenon alternatives within 3 years. When price parity is achieved, use of LEDs in exterior lighting applications is expected to grow more rapidly. In addition to the numerous performance features detailed above, LED headlamps can be less than half the thickness of today's alternative lighting technologies, opening up space and adding styling options.
Daytime running lights, fog lamps, directional signals, and headlights will present the most growth opportunities for LEDs in automobiles in the next five years. As a result of the growing use of LEDs, the average number of LEDs in a luxury car is expected to grow from about 200 LEDs today to over 800 within two to three years.
At the same time that the number of LEDs per car is growing, the number of cars using LEDs will also increase, compounding the growth rate. Also within the next two years, exterior lighting applications will exceed 40% of the overall market and begin to challenge interior lighting as the major opportunity for LEDs in automobiles.

According to the major suppliers to this segment (Lumileds, Osram, Toyoda Gosei and Cree), the cost target of $10/kilo-lumen will be reached by 2010 for a wide range of HB-LEDs in exterior front lighting, including headlights and daytime running lights. Examples of LEDs in automotive exterior lighting applications are already growing. The LED headlamps in Audi's R8 sports car were developed by Magneti Marelli with LED modules supplied by Philips Lumileds and OSRAM Opto Semiconductors.

The Lexus LS600 luxury sedan is another example of successful deployment of LED headlights. According to reports, the LS600's LED headlights employ several thermal management solutions to counter the high temperatures coming from the engine compartment including fans, water-cooling and high-temperature glass packaging in place of conventional plastics.

Hella KGaA Hueck & Company will be providing LED headlamps for General Motors in North America on the 2008-model Cadillac Escalade Platinum. In this new, upscale sport utility vehicle, LED technology for low- and high-beam functions will be used for the first time in North America. Production of the Cadillac Escalade Platinum is expected to begin in the summer of 2008. Approval for usage of LEDs in low- and high-beam lighting in Europe is expected by 2008, as well. According to Hella, LED headlamps emit light considerably closer to daylight, improving perception when driving during twilight and darkness, as well as increasing overall driver comfort and safety. Hella's Full-LED headlamps are expected to last up to 20 times longer than traditional automotive lighting.

Hella is using newly developed multi-chip LEDs as light sources for low- and high-beam. LED technology makes new lighting functions possible, opening up new, innovative styling and differentiation potential for vehicle manufacturers.

The new Cadillac marks one of the first uses of free-form glass projection lenses. Thanks to their individual optical design, each area of the lens is responsible for a certain part of the light distribution on the road. Of the seven glass lenses used in a headlamp overall, only two are completely identical; all the others are of different shape.

A high-performance ventilator, developed especially for the particularly demanding requirements in the automotive sector, is responsible for the thermal management in the headlamp and takes over the active cooling and ventilation of the LED chips.

The low-beam light section of the headlamp is generated by five optical units arranged underneath one another and situated at the outer edge of the headlamp housing. The low-beam light is responsible for close-range illumination in front of the vehicle.
The daytime running function is achieved by dimming the same five optical units of the low-beam. The remaining two identical optical units in the headlamp are responsible for high-beam light and are situated at the inner edge of the headlamp housing. High-beam light illuminates upward and straight-ahead of the vehicle to maximize visibility.
Also utilizing LED-technology, position lights are placed vertically between the low-beam and the side marker, which is located on the very outer edge of the headlamp. In the 2008-model Cadillac Escalade Platinum, direction indicators and fog lamps are mounted in the lower area of the bumper.
Within the United States, LED lighting technology for secondary lighting functions, such as the position lights and direction indicators, is becoming more common in automotive lighting.

Taiwan makers are also targeting the automotive LED market. LED packaging house Everlight Electronics - in cooperation with Hua-chuang Automobile Information Technical Center (Haitec), an affiliate of local Taiwan automobile firm Yulon Group - claims that it has successfully resolved issues concerning heat-dissipation for LED headlamps, and Everlight estimates that the LED headlamp will soon pass heat-dissipation tests and be ready for commercialization by the third quarter of 2008.

Before working on headlamps, Everlight successfully made inroads into the automotive market by supplying direction signal lights and brake lights. The company spent five years passing the direction signal light certification tests for Mercedes Benz and BMW, as those lights need to function properly at a temperature of -20 to +100 degrees centigrade.

Complete information on this detailed global analysis is available at:

www.darnell.com/leds/

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Interview on Power Electronics for Windmill Applications

with Dejan Schreiber, Senior Application Manager; Semikron

By Bodo Arlt, Editor BP

Bodo Arlt: What influence does the growing wind energy market have on the development of power semiconductors at Semikron?

Dejan Schreiber: We achieve our biggest growth rate in the renewable energy market. 31GW of the 72.6 GW of total wind power capacity installed since 1993 worldwide feature Semikron technology. In fact, we provided the first power semiconductor solutions for windmill applications at the beginning of the 90`s when we invested into the technologies and drive topologies of an Integrated Power Module specifically developed for use in wind generators owing to its high operational reliability, service life expectancy, efficiency and scalable design.

Our long track record enables us to develop state-of-the-art products and designs. This gives us a head start over our competitors.

Bodo Arlt: What are the challenges/alternatives in this market?

Dejan Schreiber: Up to now power electronics was used at the back-end of energy production. But power electronics is also to be used in front-end, for example in windmill applications, as well as for power distribution - in front-end and back-end solutions for power transmission lines. Power quality therefore has to be improved. Smart grid requirements for power distribution are becoming ever-more stringent. Standards and approvals make the requirements even more complex. And all of these needs have to be met, despite the fact that pressure to increase development speed has been stepped up. The best way to meet this requirement is to develop products which can form a base platform and which can then be easily expanded to meet the demands of an ever-increasing power range. This is a huge challenge for the power electronics industry.

Bodo Arlt: Which solutions does Semikron offer to stay ahead in the wind market?

Dejan Schreiber: We offer SKiiP, an integrated power module that includes perfectly matched cooling, gate driver, current sensors and protective functions. We also have power assemblies and scalable solutions in the MW ranges. To stay ahead in the wind market, however, we have to develop solutions for even higher power requirements of more than 5 MW. Within 5 years this may be as high as 10 MW. As with all high-power generators, windmill generators have to be medium-voltage units.

Bodo Arlt: What semiconductor voltage do you recommend for variable-speed wind turbines?

Dejan Schreiber: 1700 V. Renewable energy applications undoubtedly need high-efficiency, proven semiconductors.

As seen in inverter operation when using different IGBT modules with the same module case but for different voltages, 1700V (low-voltage device), 3300V and 6500V devices, and simulate the available output power, it is obvious that medium-voltage IGBTs are not an economical solution (See Fig. 1). Output power limitation equals the total power losses. For the same power losses, 3.3kV 1200A medium-voltage modules can produce only half of the available power. Only a quarter of the available power is produced by 1.7kV 2400A and 6.5KV 600A modules.
Operation conditions are adjusted to the voltage levels; the switching frequency 3.6 kHz is equal in all cases. The reason for identical switching frequency in use is the filter size. At 3 to 4 kHz, the power of the sinusoidal filter is approximately 15% of the inverter power. In that way all inverters have similar filter sizes & costs. This means that for MV drives there is a need for different inverter circuit approaches.

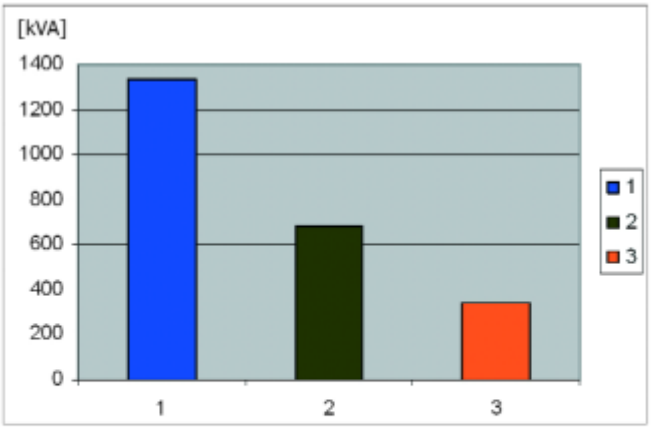

Figure : Three-phase IGBT inverter output power with same module size and cooling conditions with Fsw= 3.6kHz

Bodo Arlt: What sets Semikron apart from other module suppliers?
Dejan Schreiber: We are application-oriented. We develop and produce power semiconductors which are easy to use in the given application. For example, many years ago huge IGBT single-switch modules had two terminals only (collector & emitter), and two versions, like in a mirror, one for the BOT and one for the TOP switch. We recognized the disadvantages of this type of solution from the very beginning. For a voltage source inverter, the power module has to be a half-bridge with separate DC and AC terminals. The SKiiP layout, which is more than 15 years old, has the DC terminal on one side and the AC terminal on the other side of the module with several ter-

minals in parallel. This design is now being used by other suppliers too and has not been topped.
Furthermore, our experience in windmill applications allows us to integrate solutions where we can guarantee reliability and high efficiency. For example, modules without base plate with SKiiP® technology, which is based on thermal pressure contacts. The base plate is removed and a pressure system has been integrated to press the DCB onto the heat sink at several, uniformly spread points. This pressure contact technology ensures low thermal contact resistance, excellent durability against temperature cycling and increased power densities. Plus, if higher currents are required, several modules can easily be switched in parallel.

Bodo Arlt: How much is Semikron involved in the end customer's wind power applications?
Dejan Schreiber: From the initial specification to the design-in stage we work closely with our customers and provide them with local service and support.

Bodo Arlt: How do you see the future in IGBT gate driver technology for use in solar inverters and wind power applications?
Dejan Schreiber: In wind power applications more intelligent driver circuits where integration is the major driving force are called for.
As for solar inverters, Semikron is working closely with solar inverter manufacturers. The efficiency of a solar inverter is one of main selling arguments for the end market owing to the shorter pay-back period for higher current supply. Solar inverters operate at high switching frequencies to reduce the filter sizes. Silicon carbide diodes and MOSFETs are alternative solutions to standard silicon free-wheeling diodes and IGBT´s to reduce the switching losses. An inverter with SiC and IGBT´s has up to 30% lower switching losses. Very often customer-specific topologies are used in modules.

Dejan Schreiber
Dejan Schreiber received his Honours degree in electrical engineering from the University of Belgrade in 1970. Until 1988 he has been with the Technical Institute Nikola Tesla in Belgrade at the department of Power Electronics and Control. During the same time he was lecturer and visiting professor at universities in Belgrade and Novi Sad, Yugoslavia as well as in Harare, Zimbabwe.

In 1989 he joined SEMIKRON in Nuremberg, Germany, as Senior Application Manager. He specialises in power electronic converters for variable speed windmills and medium voltage drives designs for AC motor drives from, high speed micro turbine and variable speed gen-sets, innovative circuits for UPS applications, traction applications in trains, trolley-busses and trams, battery driven vehicles, automotive drives and fuel cell applications.

dejan.schreiber@semikron.com

Bodo Arlt: Do you expect monolithic inverters to be used in future wind power applications?
Dejan Schreiber: Definitely. Monolithic building blocks will allow for more flexibility.

Bodo Arlt: Can we expect to see more silicon carbide devices from Semikron for wind power solutions?
Dejan Schreiber: Not in the near future. Since high currents are required, the trade-off between the investment and the net metering makes it a non-viable proposition economically.

Bodo Arlt: Who of your competitors do you believe will fuel the race for leadership?
Dejan Schreiber: Again, looking at the total of 72.6 GW wind energy power capacity installed since 1993, 43% of this wind power capacity feature Semikron technology. Manufacturers of windmills need all-in-one power solutions that include matched cooling, gate driver, current sensors, as well as integrated protective functions. Here, we differ from the competition. Our customers value the ready-for-use SKiiP module, which provides excellent load and temperature cycling capability. This IGBT subsystem is suitable for power applications into the MW range, which is why it's one of the most powerful IPMs on the market.
At present, the dynamically growing wind energy market in Asia is also presenting new opportunities for us. By 2020 the Chinese government plans to cover 10% of their energy demands with renewable energies.

Bodo Arlt: Mr. Dejan Schreiber, thank you very much for your time. We look forward to a bright future for power modules in wind power and solar applications.

www.semikron.com

Local Languages at Bodo's Power
The Interview is also available in the following local languages: *Russian, Chinese, Spanish and Italian.*
The local language article will be found by downloading the pdf of the full magazine from the website, **www.bodospower.com**
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Interleaving Brings PFC to New Heights

Single-chip controllers enable a growing trend

The art of power supply design, like most worthy endeavors, is a never-ending challenge of balancing several objectives to reach the most desirable outcome. For switched mode power supply (SMPS) designs, competing objectives typically include total system cost, form-factor limitations, overall efficiency specifications, thermal concerns and time-to-market pressures. Occasionally, a new idea breaks upon the scene, dramatically changing the power landscape.

By Bob Neidorff and Thomas Lewis, Texas Instruments

Global demands for lower overall system costs and thinner profiles have lead to interleaved power factor correction (PFC), the industry's latest breakthrough. The concept of interleaved PFC was discussed as early as 1992 by Miwa, Otten, and Schlecht[1]. Single-chip interleaved PFC control became a reality in 2007, and is now radically changing the face of several end equipments over night – most noteworthy digital TV. This article addresses the need for PFC and the latest breakthrough in design thought. It should prove especially helpful to engineers facing difficult design specifications on a limited budget, and those simply interested in learning more about this new trend.

Typical PFC

A typical PFC circuit is a boost switching regulator with control circuitry. It maintains input current proportional to instantaneous line voltage, while simultaneously regulating output voltage (Figure 1).

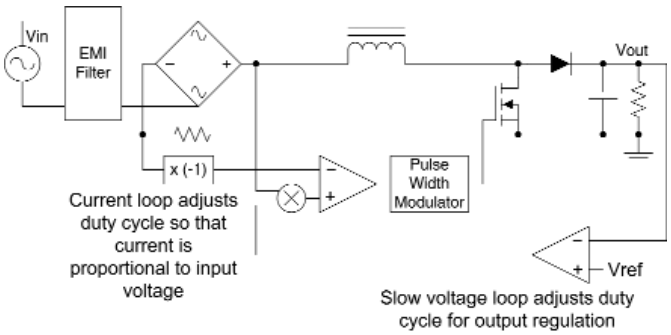

Figure 1: Typical power factor corrector architecture

The feedback loop that regulates current has a bandwidth of approximately 10kHz. It smoothly regulates average input current proportional to input voltage so that power factor is very high, and harmonics are minimized. The voltage regulating loop has a bandwidth much lower than 60Hz so that it doesn't interfere with the current loop. Often, non-linear feedback elements are added to the voltage loop to improve response to large input and output steps.

For heavy load currents, boost switching regulators maintain continuous inductor current, typically with 60 percent current ripple. Low ripple current can be advantageous because it attenuates easier with the input EMI filter. For lighter load currents, current ripple can increase to 200 percent. The input current can even go discontinuous, as long as the current loop controls average input current.

Another practical way to produce input current proportional to input voltage is to use a "transition mode" converter with regulated on-time, which remains constant throughout the line cycle. Transition mode, or "critical conduction mode," means that the converter starts a new switching cycle every time that input current decays to zero. In other words, this is the boundary between continuous and discontinuous conduction mode. By definition, transition mode has 200 percent ripple current.

With a transition mode boost switching regulator operating with fixed on-time, average input current is inherently proportional to input voltage. For any switching cycle, peak current is Ipeak=Vin*Ton/L and valley current is zero. Therefore, average input current is half of peak current: Iaverage=Vin*Ton/(2*L). As long as the inductor and on-time stay constant, average input current is directly proportional to input voltage.

Fixed on-time transition mode has many advantages such as no current feedback is required. Thus, much less power is lost in sensing current. Another advantage is that the converter is immune to errors in the current sense circuit. A third advantage is that the converter always starts a new switching cycle with zero output-current, minimizing diode switching losses. Transition mode converters can operate efficiently with inexpensive silicon diodes, as long as the diodes have moderately fast-switching speed. Comparatively, continuous current circuits often require expensive silicon-carbide diodes for high efficiency.

Figure 2 shows the schematic of a fixed on-time power factor corrector built around an inexpensive 8-pin transition mode control IC. This circuit uses a current-sense resistor to detect zero current and overcurrent faults, but otherwise does not rely on precision current sensing. With this IC, current is limited to less than 425mV across the current sense resistor. By comparison, typical power factor control circuits using current feedback have maximum current limit signals between 1V and 2V, greatly increasing power lost in the current sense resistor.

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Why Interleave?

All switching supplies conduct some portion of switching energy onto the power line through current ripple. Current ripple can be larger, as with a transition mode PFC with 200 percent ripple, or smaller as with a continuous current mode PFC with 60 percent ripple. Although this represents a 10dB improvement, it comes at the expense of a larger boost inductor. Regardless of approach, some form of EMI filter is required.

If we built two identical PFC circuits and operate each 180º out-of-phase, the combined two-stage ripple current would be significantly less than the single-stage ripple producing the same total power. Hence, a much smaller input EMI filter could be used. Operating two stages at exactly 50 percent duty cycle reduces ripple to zero! At different duty cycles, ripple reduction is lower, but still significant. Figure 3 shows reduced ripple current achieved by interleaving two power stages for different duty cycles.

Operating two identical stages 180º out-of-phase is called interleaving, which is practical today thanks to modern highly integrated circuits.

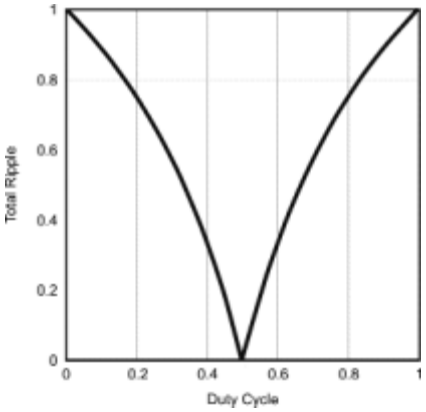

Figure 3: Ripple current versus duty cycle for two interleaved power stages

Another advantage of interleaving is reduced output ripple current. This allows for a smaller output capacitor, or less current stress on the original capacitor selection – resulting in longer life and higher reliability. A third advantage is that two smaller versus one large component can be used. This includes the boost inductor, power MOSFET, and power diode. These smaller components enable distributed board layout, which dissipates heat from various power devices and enables lower profile power systems.

Interleaving also enables higher power than would be practical with a single-phase architecture. Two existing 250-watt, single-phase

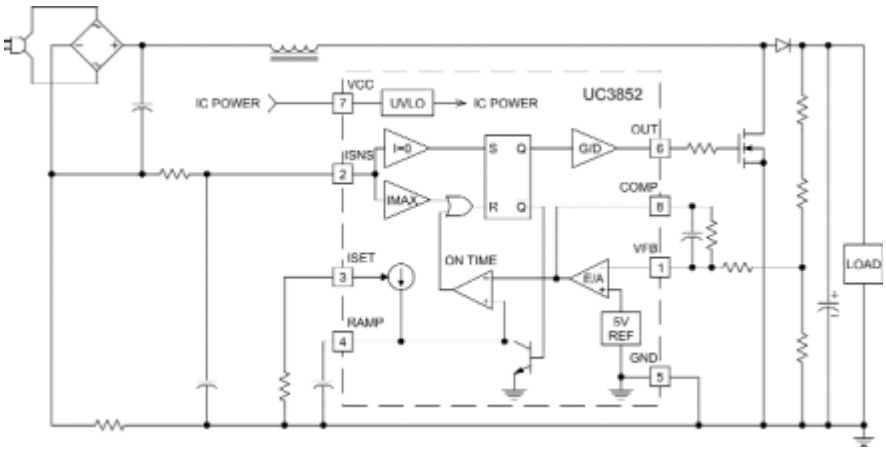

Figure 2: Typical fixed on-time transition mode power factor corrector

PFC stages can be easily interleaved, quickly developing a 500-watt power PFC from the same parts.

Typical Interleaved CCM PFC

Figure 4 shows a complete interleaved continuous current mode PFC built around the UCC28070, an interleaved PFC controller IC. This fixed-frequency controller includes all of the control circuitry required for two interleaved PFC stages, as well as frequency dithering.

feedback loop is shared by two current loops. In this way, the two current loops have the same current reference and ensure current balancing between two channels.

This PFC operates at a switching frequency set by RRT. If a very dense power supply is required, this design can operate at switching speeds of up to 300 kHz or higher, allowing very small inductors to be used. For highest efficiency, however, switching at <75kHz is recommended. Frequency dithering, which further reduces EMI noise, is also implemented and programmed by capacitor CCDR and resistor RRDM. Maximum duty-cycle is set by RDMAX. Soft-start is programmed by CSS. This design operates in continuous or discontinuous mode, depending on the load current. Therefore, high-speed silicon carbide diodes are recommended for D1 and D2.

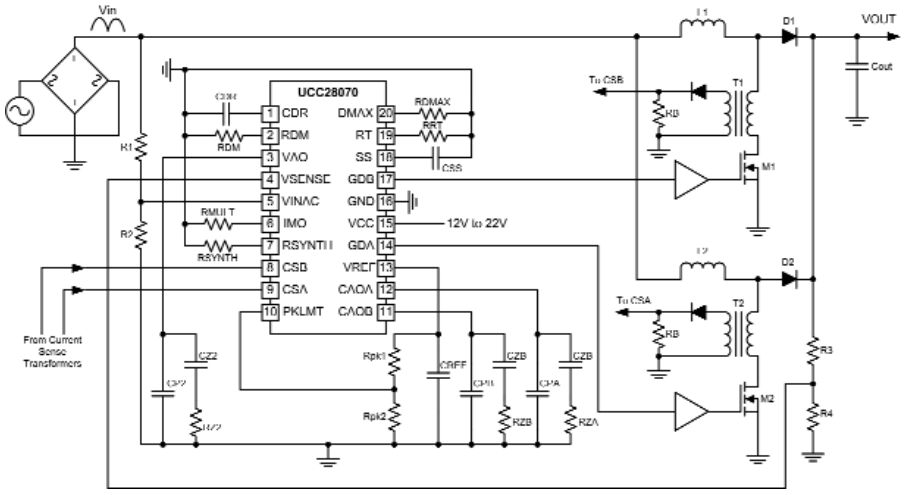

Figure 4: Typical interleaved continuous current mode PFC

This PFC design uses current-sense transformers T1 and T2 to monitor power MOSFET drain current. This produces a signal that represents current when the power MOSFET is on. Inductor current during the remaining switching cycle is reconstructed by the IC, based on input and output voltage. This current synthesis technology uses only two current transformers versus four to reconstruct the inductor current, reducing overall system cost.

The IC regulates current in each inductor with two independent, fast, average-current feedback loops. The overall slow voltage

Select the output capacitor, COUT, to permit downstream converter operation during the longest expected line dropout. Although not shown, input EMI filtering is usually required.

Typical Interleaved TM PFC

Figure 5 shows a complete interleaved transition mode PFC built around the UCC28060, the industry's first interleaved PFC controller IC. This design takes advantage of the frequency modulating inherent in transition-mode control. This spreads the EMI spectrum and reduces required EMI filtering. The UCC28060 also implements phase management, a powerful technique for improving total efficiency by switching between two-phase operation at heavy load, and one-phase operation at light load. Other advantages of the UCC28060 are that low-cost diodes and smaller inductors can be used.

Inductors L1 and L2 each have a second winding for sensing zero inductor current and starting a new switching cycle. Resistors RZA and RZB combined with capacitors CF4 and CF5 remove noise. They also provide a small time delay, allowing the MOSFET drain to resonate down to its lowest level.

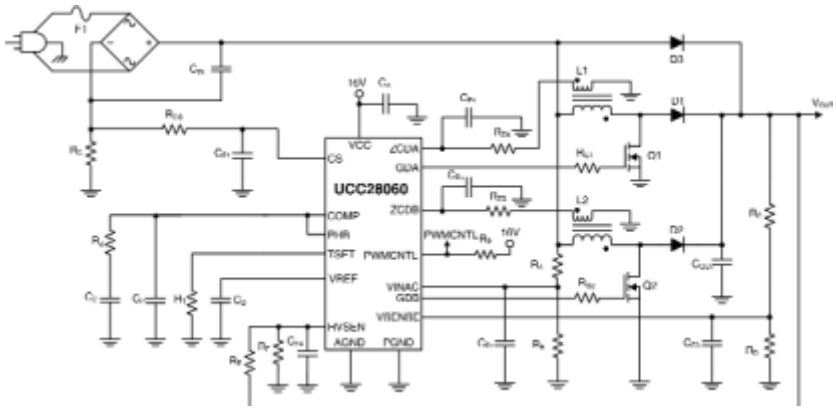

Figure 5: Typical interleaved transition mode PFC

Although not perfect, this approximation to zero-voltage switching can improve efficiency by minimizing the energy lost discharging the power MOSFET drain capacitance as the power MOSFET turns on.

This converter uses fixed on-time control to achieve high power factor, so individual power MOSFET currents are not sensed. One overall current sense resistor, RS, is used to prevent switching during turn-on inrush and to stop switching in the unlikely event of over-current.

Switching converters with a constant load have negative input impedance at low frequencies. In other words, as input voltage increases, voltage feedback reduces input current to maintain constant output voltage. This can cause the EMI filter to become unstable. To minimize this risk and help reduce input EMI, use a small high-voltage capacitor CIN on the bridge rectifier output. For a 300-watt converter, a 1µF capacitor may be sufficient. This capacitor value should be as low as possible to save cost and maintain high power factor at high line.

This converter uses two independent paths to sense output voltage. One senses output voltage using pin VSENSE and divider RC and RD. This sense circuit is used to regulate output voltage and to shut down the converter in the event of output over-voltage. The second path uses pin HVSEN and divider RE and RF. The second path implements a redundant over-voltage sensing for safety. It also senses the output voltage to switch on the load. Logic output PWMCNTL asserts low when the output voltage is high enough for operation. PWMCNTL de-asserts (goes high impedance) when the output voltage falls below the dropout threshold, or when one of the power stages has a fault.

Dealing with Light Load

Converters are engineered for many performance attributes at full load, including peak efficiency, safe operating temperature, reliable component operation, and ability to operate through a power line dropout. However, performance during light-load operation is also important. Standards like Blue Angel and Energy Plus set efficiency standards at full load and light load.

Figure 6 compares the efficiency of a typical interleaved PFC operating in both single-phase and two-phase modes. Although interleaving gives excellent efficiency and reliability at full load, light-load efficiency is higher with only one-phase switching. This is because energy consumed slewing drain capacitance becomes more dominant at light load.

A practical interleaved PFC should switch to single-phase operation at light load. The optimum crossover point is a function of line voltage and other design variables. To facilitate Blue Angel and similar standards, switching to single-phase before 20 percent load realizes maximum benefit.

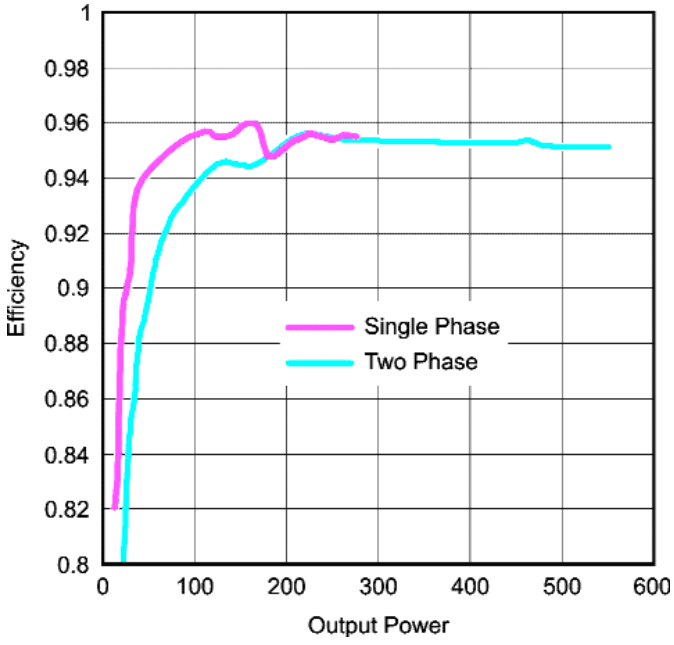

Figure 6: Efficiency comparison for one- and two-phase power converters shows a five percent higher efficiency for one-phase operation at light load

At no-load, standards demand extremely low quiescent power consumption. While today's Energy Star® standard allows no more than 0.5 Watts, future standards will require under 0.3 Watts – and even lower standards are expected. To achieve this ultra low power consumption, the most practical solution is to completely disable the boost PFC, and run the downstream PWM from the unboosted, rectified power line.

The UCC28060 interleaved transition mode PFC (Figure 5) contains circuits for phase management that switch between two-phase, one-phase and shutdown, dependent on load.

Minimizing Acoustic Noise

Capacitors, inductors, heat sinks and shielding can vibrate audibly due to signals from the switching converter. Switching converters operate above 20kHz, but certain line and load conditions can stimulate audible vibrations.

One example is transitioning from full to light load. Although the output capacitor decreases the effect of the load step on the converter, the converter must still change on-time or duty-cycle by a large amount to regulate output voltage, while the voltage regulation loop must be slow to provide good power factor.

In this example, some output overshoot is inevitable. If overshoot is too high, the output capacitor or following power converter could be damaged. Thus, PFC ICs like the UCC28060 contain error amplifiers with fast, non-linear response to very large overshoot. For some load steps, this quickly brings the output back into regulation. But for the worst steps, even these fast, non-linear loops can't respond quickly enough and the output over-voltage protection will trip, switching off the converter. The converter will restart when the output drops below the lower over-voltage threshold. It can take a few low-frequency cycles of high-output over-voltage followed by zero load decay before the loop is back in regulation.

These low-frequency cycles may be audible or otherwise undesirable. To prevent this issue, some PFC ICs like the UCC28061 shutdown and restart slowly in response to a severe overshoot. The UCC28061 is very similar to the UCC28060, but is optimized for systems with very wide load range.

Conclusion

The era of interleaved PFC has arrived and, with it, ushers in new advancements for power supply designers across the globe. Higher efficiencies, in smaller form factors, at the same or lower overall system cost are now obtainable. That's a trend worth talking about!

[1] "High efficiency power factor correction using interleaving techniques" Miwa, B.A.; Otten, D.M.; Schlecht, M.E.; APEC '92. Conference Proceedings 1992; pp 557–568; Digital Object Identifier 10.1109/APEC.1992.228361

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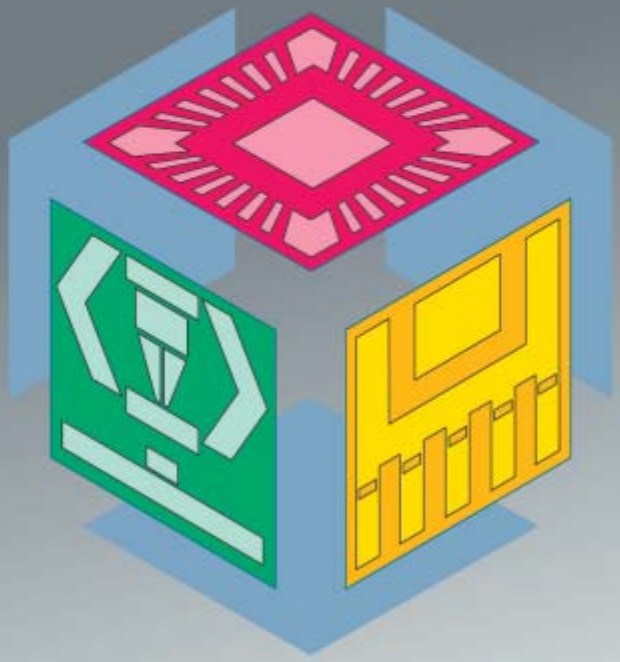

SMT HYBRID PACKAGING

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IGBTs Operating at Higher Temperatures

The potentials and the design constraints

The targeted 175°C junction temperature limit for the next generation of 1200V IGBT requires safe and reliable operation of the devices at a temperature of 200°C. In this article, we carry out an investigation into the operation of 1200V SPT-IGBTs at temperatures up to 200°C, in order to understand the potentials and possible threats, while drawing initial conclusions how such devices must be dimensioned in order to operate safely.

By Ulrich Schlapbach, Munaf Rahimo and Christoph von Arx,
ABB Switzerland Ltd., Semiconductors

Over the past years, the main development trend for power semiconductors was aimed at increasing the power density for a given targeted application. From the device viewpoint, the limitations are three fold; first is the total losses in the device, second the safe operating area boundaries, and finally the maximum allowable junction temperature during operation. On the other hand, another limitation exists for the removal of the power dissipated in the device. However, this challenge remains a focus of package and system cooling developments.

As state-of-the-art IGBTs slowly approach the limits in terms of losses reduction, the maximum junction temperature moves more and more into the limelight of the interest. The fact that the most important enabler, namely the power handling capability (SOA) of devices, has risen to a level where IGBTs can theoretically be operated at currents that greatly exceed the ratings of modern systems has further increased the pressure towards expanding the temperature range. Depending on the rated voltage, IGBTs have so far been limited to 150°C (for 1200V and 1700V) or 125°C (2500 V and higher). Since the heat flux is proportional to the temperature difference (ΔT), a higher allowable junction temperature operation of the semiconductor offers better conduction of the generated heat and hence, an increase in the power density for a given device area. An increase by 25°C enhances the rated power by 25 – 35%, depending on the cooling conditions. However, due to the exponential scaling of several IGBT parameters, such high temperatures will subject the IGBT to new levels of stress, guiding chip designers and application people onto completely new grounds whose firmness is largely unknown. Our analysis started with the thorough characterization of state-of-art 1200V IGBTs over a wide temperature range of up to 200°C. Investigated parameters included many static characteristics as well as switching performance and losses tradeoffs. From the results obtained, the apparent conclusion is that the IGBTs can still operate well at 200°C. Unfortunately, this does not yet permit the conclusion that the devices can be rated for this temperature. In order to draw such a conclusion, one must ensure that the IGBTs do not destabilize as a result of non-uniformities and parameter variations. The stronger emphasis when operating at elevated temperatures will be put on stability issues: the fact that most 1200V IGBTs are run in parallel operation, raises the danger of current miss-sharing, which may under unfavorable conditions lead to thermal runaway and failure of the devices. Whether or not this happens depends on the temperature-dependent characteristics of the IGBT. Hence, a complete assessment requires that stability criterions are formulated, and that device characteristics are tailored to support stability. The conducted investigation represents a fundamental contribution to the discussion of raising the maximum operation temperature for potentially increasing the power density of IGBTs.

Static Performance of 1200V IGBTs up to 200°C

All measurements were carried out on a 6.5mm x 6.5mm 1200V Soft-Punch-Through (SPT) IGBT rated at 25A. By implementing a reliable and effective guard ring junction termination and passivation, the

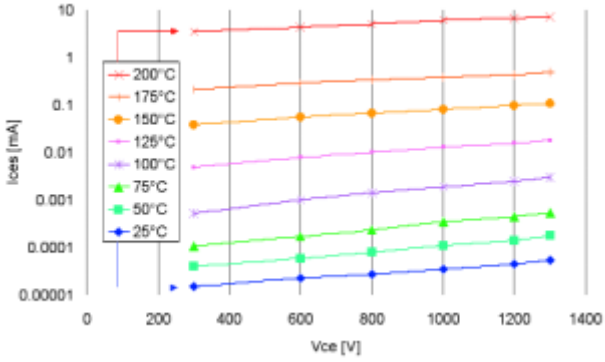

Figure 1a: 25A/1200V IGBT leakage current measurements.

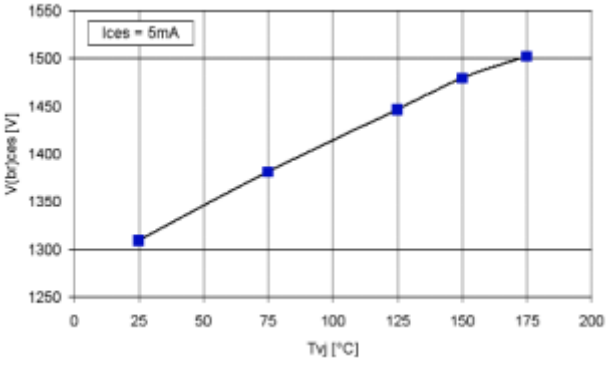

Figure 1b: 25A/1200V IGBT breakdown voltage vs. temperature.

IGBT exhibits stable blocking characteristics and suitable leakage currents for operation at higher temperatures. The reverse blocking characteristics were the first to be measured due to their critical dependence on the device operating temperature. Figure (1a) shows the IGBT leakage current values at reverse voltages up to 1300V and for temperatures ranging from 25°C up to 200°C.

Under static reverse bias conditions, the main critical parameter is given by the leakage current. It is clear, that thermal runaway sets upper limits for the operating temperature. Results show that the leakage current maintains a value below 1mA up to 175°C. Nevertheless, a clear increase to above 5mA is obtained at 200°C. From basic cooling calculations of thermal stability during blocking, for the given chip size mounted on a standard DCB substrate, base-plate and heat-sink, a stable reverse blocking condition at 900V can be maintained if the leakage current does not exceed 4mA. This is clearly not the case at 200°C since the leakage current exceeds 5mA. These results provide the first most important criteria for stable device operation. Maintaining low and uniform leakage currents becomes an even more important target when designing for very high temperature operation. The IGBT breakdown voltage for temperature range was measured at a leakage current of 5mA as shown in figure (1b). The curve exhibits a normal trend with increased breakdown voltage at higher temperatures. The breakdown voltage at 200°C does not appear in this graph since the leakage current at this temperature is above 5mA. However, the IGBTs maintained stable reverse avalanche behaviour for the whole temperature range.

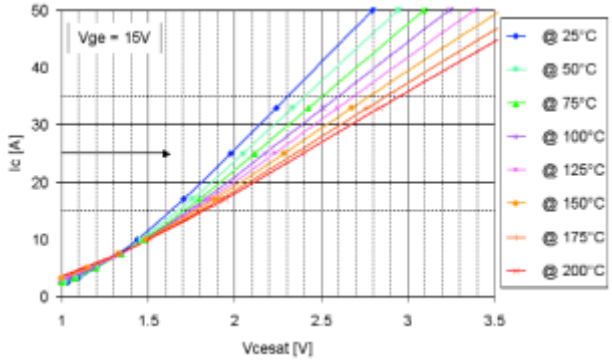

Figure 2: 25A/1200V IGBT Vcesat measurements up to 200°C.

Figure (2) shows the IGBT on-state characteristics up to 200oC. Due to the thin wafer SPT design, the 25A/1200V IGBT achieves low conduction losses with a typical on-state voltage of 2.0V at 25°C and 2.4V at 200°C at 25A. The curves clearly exhibit a positive temperature coefficient for the whole temperature range. This decisive factor for safe parallel operation especially at high operating temperatures in order to get a minimal current de-rating. As it turns out in this case, a temperature-independent current of 8A guaranties for a positive temperature coefficient under all operating temperatures up to 200°C.

Dynamic Performance of 1200V IGBTs up to 200°C

The dynamic performance of the 25A/1200V IGBT was evaluated in a standard inductive load circuit. Figure (3) shows the nominal switching characteristics of the SPT-IGBT during turn-off (a) and turn-on (b) at 200°C. The tests were carried out at a nominal current of 25A and a DC link voltage of 750V. The losses calculations reveal that the switching losses are practically doubling when increasing the temperature from 25°C up to 200°C. The turn-on losses increase from 4.5mJ at 25°C up to 9mJ at 200°C, while the

turn-off losses increase from 2mJ 25°C up to 4mJ at 200°C. From the losses obtained, the output current was calculated for a wide range of frequencies as shown in figure (4).

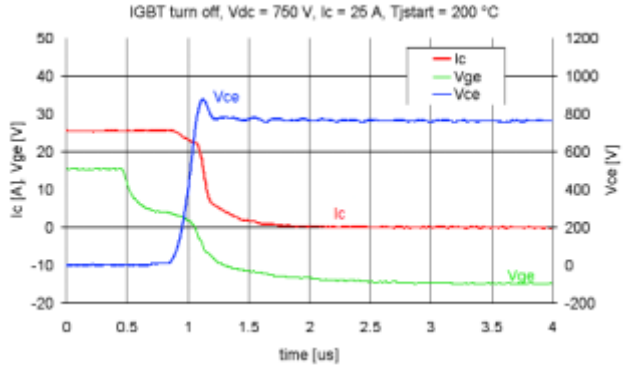

Figure 3a: 25A/1200V IGBT switching waveforms at 200oC. Turn-off waveforms.

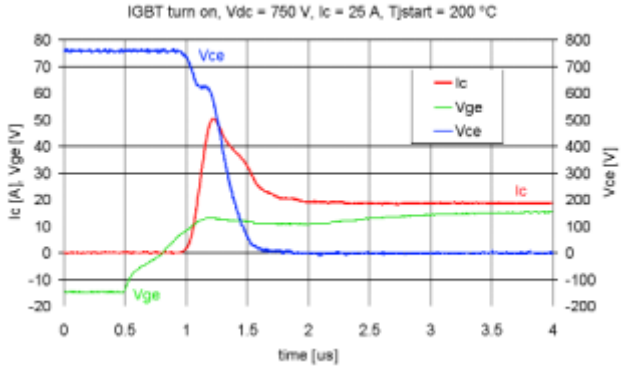

Figure 3b: 25A/1200V IGBT switching waveforms at 200oC. Turn-on waveforms.

The graphs reveal the potential to increase the total output current at higher temperatures despite the high static and dynamic losses obtained. A 50% increase in capability is clear when increasing the temperature from 125°C to 200°C.

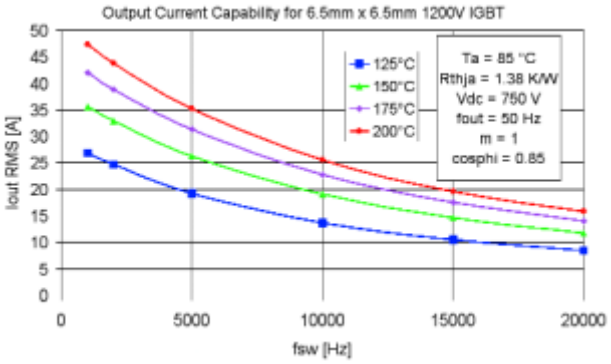

Figure 4: 1200V IGBT output rms current capability vs. frequency.

RBSOA and Avalanche Capability up to 200°C

Figure (5a) shows the RBSOA switching characteristics of the SPT-IGBT during turn-off with a collector current of 100A and a DC link voltage of 1000V at 200°C. Rugged performance is demonstrated for the IGBT while employing a large stray inductance value of 800nH. The turn-off capability is remarkably high four times nominal current, which corresponds to the de-saturation current with 15V applied to the gate. To further investigate the ruggedness of the 1200V IGBT, unclamped inductive tests were carried out to evaluate the device avalanche capability at high temperatures. The dynamic tests forces the IGBTs into self-clamp mode during turn-off and measures the device ruggedness such conditions. Figure (5b) shows the voltage and current waveforms obtained from avalanche testing at 200°C.

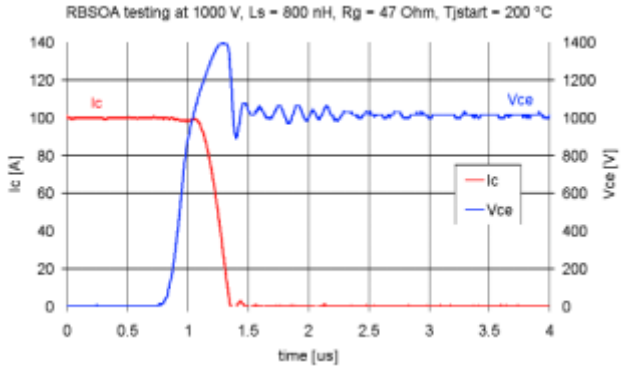

Figure 5a: 25A/1200V IGBT RBSOA at 200°C.

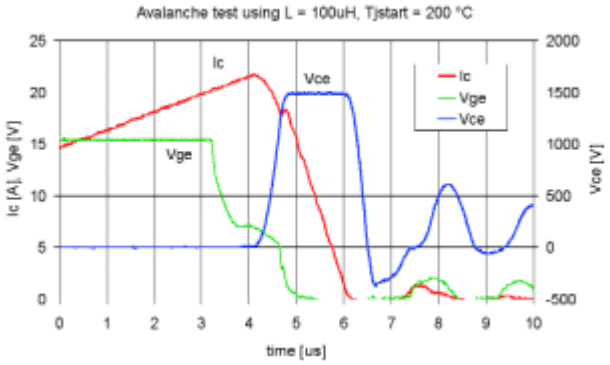

Figure 5b: 25A/1200V IGBT Avalanche Test at 200°C.

Although the device exhibits a maximum current turn-off potential under avalanche conditions in excess of 100A, this capability is strongly reduced with increased temperatures as shown in figure (6). Although the IGBT maintains at 200°C a certain nominal current level withstand capability, it is expected that the reduced capability will still impact the device SOA performance under heavy paralleling in high current modules.

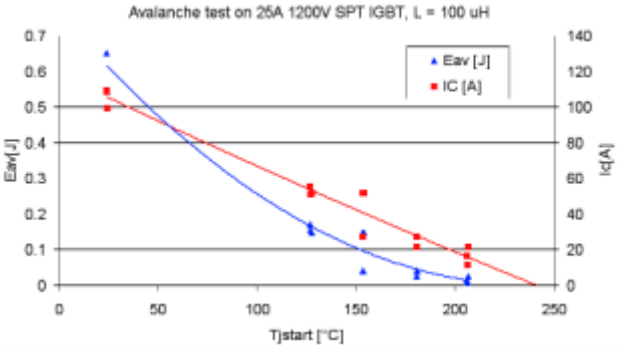

Figure 6: 25A/1200V IGBT maximum avalanche energy and current vs. temperature.

Short Circuit Capability up to 200°C

The short circuit performance is a very important issue when operating at higher temperatures. First, it is important to note that the short circuit current decreases significantly with higher temperatures. The short circuit current level at high temperatures should at all times maintain a given value above the normal operating currents, which

are typically equal to twice the rated current. This is vital for ensuring controllable turn-on behaviour and low switching losses. Normally, short circuit operation raises three major concerns: (i) short circuit turn-on failures due to field distortion, (ii) short circuit turn-off failures because of latch-up, and (iii) thermal runaway due to excess energy during short circuit. The first concern is normally associated with higher currents and lower temperatures. Thus, operation at a higher temperature will not have a negative impact. The second concern relates to the device ruggedness, which was addressed earlier. Therefore, the main focus here is with regard to concern (iii). Figure (7a) shows the results obtained from short circuit tests carried out at 25°C and 200°C for two different pulse widths respectively. The junction temperature was plotted using adiabatic thermal calculations for Tj of the chip silicon volume heated up by the short circuit pulse, and confirmed by the temperature dependence of the short circuit current.

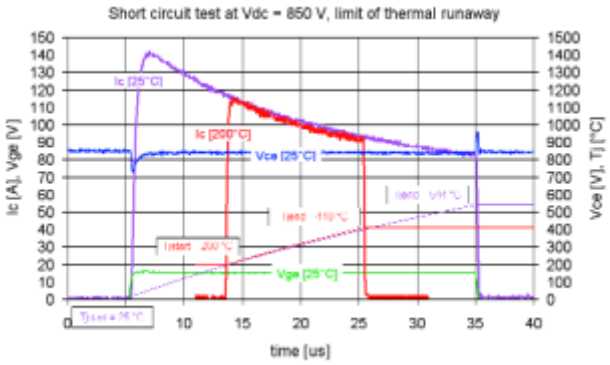

Figure 7a: 25A/1200V IGBT short circuit waveforms at 25°C and overlaid short circuit current at 200°C.

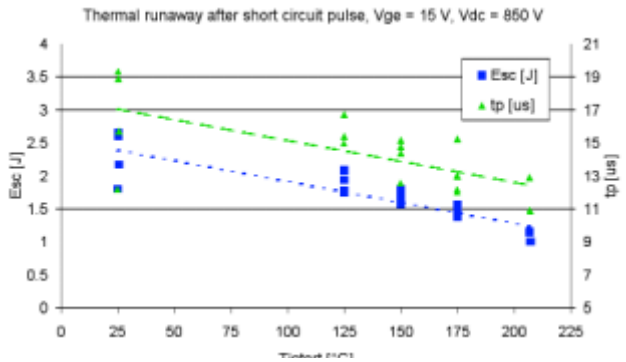

Figure 7b: Short circuit energy and pulse width versus temperature.

It was observed that thermal runaway occurs for devices starting at a higher temperature, however failing with a lower peak junction temperature at the end of the short circuit pulse. This is due to reduced transient cooling at high ambient temperatures. From destructive measurements due to excess energy at a wide temperature range, two plots were generated for the short circuit energy and corresponding pulse width versus temperature as shown in figure (7b). As can be seen clearly, the maximum allowable energy and pulse width has dropped considerably at higher temperatures. This approach could be overcome either by reducing the short circuit current with limitations regarding controllable switching behaviour as mentioned earlier, or by shortening the short circuit withstand duration as is currently widely discussed.

The results presented in this article for a 1200V SPT-IGBT bring forth important data with regard to the device behaviour for future applications that aim for a permanent higher temperature operation. The main conclusion points out to stable behaviour for the device at higher temperatures with clear limitations in terms of leakage current, avalanche capability and short circuit performance. Moreover, today's applications with requirements for an intermittent operation lifetime and safe operation limits will also benefit from a better knowledge of the margins in order to estimate the effects of transient or exceptional high temperature conditions. Focus must also be directed towards the reliability aspects of high temperature operation, which is strongly linked to the packaging technology.

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High Performance Controller with Comprehensive Fault Protection

Features Designed for High Reliability Systems

Data center facilities and telecom base station subsystems must manage the balance of two essential commodities - power and cooling capacity. For example, processors in rack mounted servers demand large amounts of power and are one of the greatest sources of heat during normal operation.

By Ricardo Capetillo, Applications Engineer, National Semiconductor

The LM3743 is a DC-DC voltage mode PWM buck controller featuring synchronous rectification at 300 kHz or 1 MHz. It can deliver current as high as 20A and step down from an input voltage between 3V and 5.5V down to a minimum output voltage of 0.8V. It is a highly integrated device in a small MSOP-10 package. Features include; pre-biased soft-start, tracking capability, and comprehensive fault protection features suitable for high reliability systems such as rack mounted servers and telecom base station subsystems.

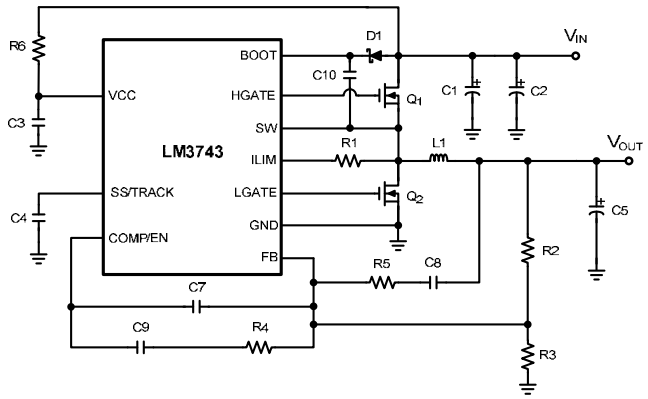

Figure1. Typical Application Circuit

Data center facilities and telecom base station subsystems must manage the balance of two essential commodities - power and cooling capacity. For example, processors in rack mounted servers demand large amounts of power and are one of the greatest sources of heat during normal operation. Substantial increases in heat during normal operation and fault conditions will reduce the reliability of many components in the server racks including semiconductor components, hard drives, and fans. The LM3743 will minimize power consumption during fault conditions thereby reducing thermal loads and increasing reliability.

LM3743 Comprehensive Fault Protection Features

The LM3743 provides the following comprehensive fault protection features: high side current limit (HSCL), output under-voltage protection (UVP), and low side current limit (LSCL). When engaged, these three features can each independently initiate a hiccup protection mode which disables both the high-side and low-side FETs and begin a cool down period of 5.5 ms, see Figure 2. At the conclusion of this cool down period, the LM3743 performs an internal 3.6 ms soft-start to check for the removal of the fault condition and to continue normal operation. Hiccup protection mode enables the system designer to avoid the need to over design components due to thermal runaway during fault conditions resulting in a lower bill of material cost.

To help quantify the power consumption during a persistent fault condition, let us examine an application with a 10A low-side current limit (ILIM). Once in overload, the low-side current limit controls the valley current and only allows an average of 10A plus the ripple current to pass through the inductor and MOSFETs. Hiccup mode initializes after 15 switching cycles allowing only a very small temperature rise. Once in hiccup mode, the average current through the high-side FET is:

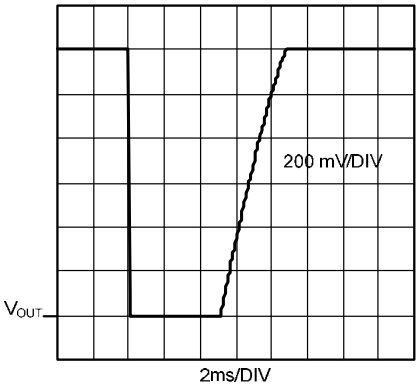

Figure 2.
Hiccup Time Out and Internal Soft-Start

$I_{HSF\text{-}AVE} = (I_{LIM} + \Delta I) \times [\, D(15 \text{ cycles} \times T_{SW}) \,] / 5.5 \text{ ms} = 71 \text{ mA}$

With an arbitrary D = 60%, ripple current of 3A, and a 300 kHz switching frequency.

The average current through the low-side FET is:

$I_{LSF\text{-}AVE} = (I_{LIM} + \Delta I) \times [\, (1\text{-}D) \times (15 \text{ cycles} \times T_{SW}) \,] / 5.5 \text{ ms} = 47 \text{ mA}$

And the average current through the inductor is:

$I_{L\text{-}AVE} = (I_{LIM} + \Delta I) \times [\, (15 \text{ cycles} \times T_{SW}) \,] / 5.5 \text{ ms} = 118 \text{ mA}$

Protecting Typical Fault Conditions in High-Reliability Systems

Server racks and telecom base station subsystems require high reliability to enable uninterrupted flow of data and communication. When unexpected failures occur, the LM3743 fault protection features can help to prevent further electrical and thermal stress. Examining some typical system fault conditions, we can elaborate on the protection modes of the LM3743 device and the operational benefit:

A capacitor such as a POS-cap located at the output of the LM3743 fails as a short circuit after an over-voltage surge exceeds the maximum capacitor voltage rating, refer to Figure 3. In such a situation duty cycle and the inductor current increase cycle by cycle, but fortunately input current is decreased because the LM3743s' UVP initializes Hiccup-Mode.

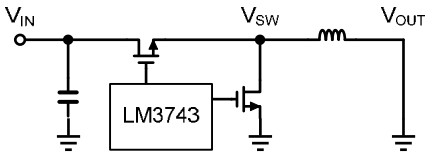

Figure 3. Output Short-Circuit to Ground

A small piece of metal falling into the product from the outside or a piece of metal that was loose in the product changes positions during shipment and lands across the switch node (VSW) and ground, see Figure 4. High side current limit immediately senses the short circuit fault condition.

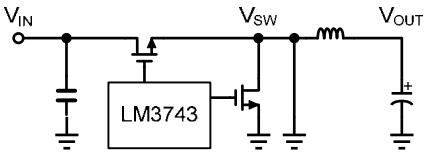

Figure 4. Switch Node Short-Circuit to Ground

Excessive load and/or incorrect selection of the MOSFET results in an open circuit failure. For example; if the low side MOSFET (Q2) fails, depicted in Figure 5, the inductor current will not flow during the time Q2 should be on, thus the inductor current will increase cycle by cycle. The high side current limit will capture the over current event, thereby protecting the high side MOSFET (Q1) from over heating and failure.

In all these situations the LM3743 provides fault protection, reduces the average input current and relieves the power components from thermal stress during persistent fault conditions. After the removal of the fault condition, the LM3743 performs an automatic self test and recovery sequence. User intervention is not required, in so reduces maintenance cost and designed in circuit complexity.

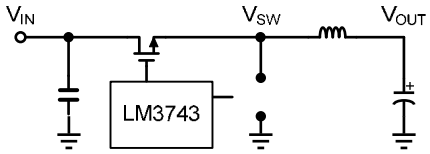

Figure 5. Low Side MOSFET Open-Circuit Failure

The LM3743 provides comprehensive fault protection and a reduction in server power consumption during fault conditions. It also combines high efficiency with high drive capabilities for loads up to 20A. With the LM3743, the balance between power and cooling capacity are much more manageable during device failure and short circuit conditions.

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Voltage Drops on Battery Lines, of 3ms – 6 sec, Can Cause Interrupts

Converters 10W - 500W DC/DC avoid system interruptions

Supply line interruptions and voltage drops on battery wiring may lead to unexpected system behaviour in electronic systems.

By Willi Spiesz, Grau Elektronik, Karlsbad, Germany

In safety related electronic systems, like brake and door control systems used in trains or busses, system interruptions must be prevented. Supply line disturbances may have several sources, for example:

- A sudden opening, or switch bounce on closing, of the supply lines switches
- Additional switch on of large capacitive loads parallel to the voltage converter input
- A short circuit at other loads sharing the supply, during the fuse clearing time

Voltage converters must provide a very stable output voltage – not changing through input and output changes. Railway battery supply voltages may vary over a wide range – possibly fluctuating ±40% from nominal values. At a battery system nominal voltage of 72V, a dc/dc converter must operate safely from 43V to 101V input voltage. Within these limits the converter must provide a stable output voltage, for example, 12V or 24V. And output voltage must be stable during changes in load current from zero to full load. In addition, there are more dynamic deviations of the board system voltage. These may be caused by load changes on the battery, e.g. switch in of high current loads or short circuit conditions, with a common source impedance due to long line wire distances of 50m … 100m. (See Fig 1 + 2).

Voltage drops at the system board voltage of up to 1msec can be compensated for with the output smoothing capacitance of standard classic DC/DC converters working with switching frequencies between 25kHz and 250kHz. This is possible when allowing an output voltage drop of 5% from nominal, which the electronic load will tolerate. (See Figure 3).

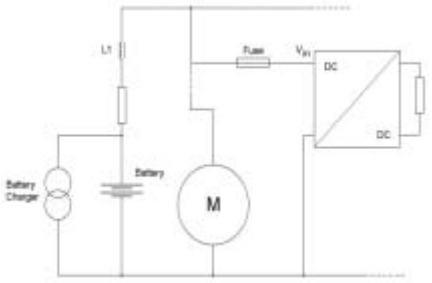

Figure 1: Battery Voltage Net

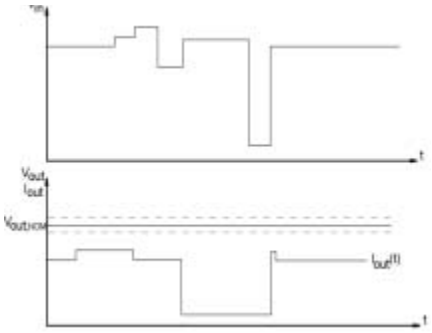

Figure 2: Battery Voltage and Load Current

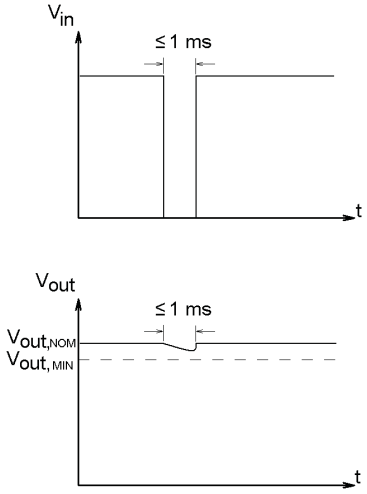

Figure 3: Input Voltage Drop

However, converters with higher switching frequencies of 400kHz to 1 MHz, (e.g. resonant converters) have only a small output capacitances of a few µF. With this small capacitance essentially no hold up time is provided. Capacitors must be connected in parallel to the load, outside of the converter if necessary.

Example:
50W converter, Vout = 12V, Iout = 4A, Cout = 8mF (8000 µF), 5% Voltage drop.

Hold up time, as provided by the stored energy in the 8mF output capacity, can be calculated from Equation (1):

$I = C\ dv/dt$ ……. Equation (1)
$\Delta t = C * \Delta V / I$ $\rightarrow t = 8mF * (12V * .05)/ 4A = 1.2msec$

(neglecting an allowance for capacitor series resistance, aging, dry out of electrolytes, and line resistance).

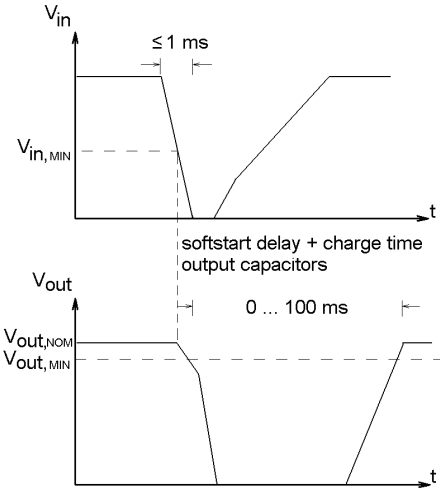

Figure 4: In- Output Voltage Drop

Supply line disturbances and voltage drops, as short as 100usec, may cause the converter to switch off. Such short interruptions have no influence on the secondary electronic side. The assumption is that the electronic load can handle a voltage reduction from nominal of 5% and the DC/DC converter has enough storage capacity and no soft start or any other delaying factors when it was switched off. The reaction time to switch off the converter is typ. 0.1ms - 0.3msec. Therefore the converter does not react to smaller line disturbances. But converters are protected for longer interrupts as input currents may become excessive.

Typical voltage drops from the common source impedance of battery lines, e.g. caused through fuse blowing or crowbar protection elements like “transil” diodes blowing a fuse, can cause voltage dips with time durations between 0.1msec and 25msec.

The input operating voltage range of voltage converters is measured with under and overvoltage monitoring stages to avoid operation outside the specified input voltage range. This means, that if the battery voltage decreases to a value below the defined limit, in our example below 43V, the DC/DC converter is switched off. Otherwise the duty cycle, relation ton / switching period, for the switching power transistor and diode would become too high and eventually damage the transistor or diode. Right after switching off of the converter, the output voltage decreases. The restart of the converters or electronics can lead to a much longer system interrupt than the duration of the battery line disturbance, caused by soft start or boot procedures.

For railway systems there are different hold up times for nominal voltage and load specified as follows:

S1: no hold up time required
S2: 10ms

The railway standard EN50155 references the S2 hold up time of 10ms only to Vnominal. This can cause some problems, as high battery voltage provides longer hold up times, low battery voltage shorter hold up times.

Line voltage drops are undefined and random in occurrence and repetition rate. To avoid disturbances during whole life cycle of a voltage converter, e.g. 20 years, the hold up time design must be done careful. For example, aging of aluminium electrolytic capacitors during this period will be strongly influenced by dry out caused by heating of the electrolyte.

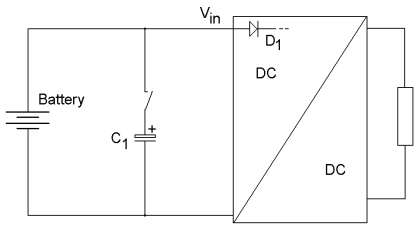

Figure 5:
Input Short Circuit, Energy Direction

When relative long hold-up times are needed, energy storage cannot easily be provided by secondary output smoothing capacitors. The hold up time is then realized on the primary side of the converter - also by aluminium electrolytic capacitors, but at a higher voltage level. Grau Elektronik converters are available for hold up times, depending on output power (5W …. 500W), between 10ms and 6 seconds.

Hold up time can be evaluated with the following equation:
$W = ½ CV^2$ (Eqn.2)

Referencing the example converter with Pout = 50W, with t = 10ms, leads to the capacitance value necessary:
$C \geq 2 * P / \eta * t / [V2^2 - V1^2]$,
$2 * 50W / 0.85 * 0.01s / [(72V)^2 - (43V)^2] = 352\mu F$

Hold up time through charging of AL capacitors on the board system nominal voltage

This equation, Eqn. (2), is only a rough estimation, because each DC/DC converter appears to have a negative input resistive behaviour in its current consumption. That is, high input voltage means low input current and low input voltage high current. The capacitor discharge time can be evaluated more exactly with the following equation:
$V(t) = Vo * e^{-t/RC}$ Equation (3)

Vo = charge voltage, V(t) = time dependent discharge voltage before the converter switches off, R = $v(t)^2/P^*$, C = capacity of the charging capacitor, P* = input power of the converter.

Rearanging Equation (3) and solving for t:
$t = - \ln (43V/72V) * ((72V/0.81A + 43V/1.36A))/2 * 660\mu F = 20.1ms$

Therefore two capacitors, rated at 330µF / 160V, are necessary. The tolerance of the manufacturer is typically ± 20% so the worst-case scenario provides Cmin = 660µF * 0.8 = 528µF. With C = Cnominal – 20% there are still 16ms available. In meeting a 10msec hold up requirement, this allows 5.1ms for aging of the capacitors, voltage drop at the decoupling diode, as well as series resistance. The stored energy is also a function of Vin.

When the hold-up capacitor is charged only to 65V (Vin,nom – 10%), the hold up time is only
t = 16.3ms (660µF), t = 13.1ms (528µF respectively.

This requires charging capacitors with higher voltage class than the battery line voltage. At higher voltages it is possible to store more energy in smaller volumes. Therefore, at Grau, we use a regulated auxiliary voltage that is independent from the line voltage of about 100V. The capacitances C for 10ms then becomes:
$C \geq 2 * P / \eta * t / [U2^2 - U1^2]$, $2 * 50W / 0.85 * 0.01s / [(100V)^2 - (43V)^2] = 144\mu F$.

One capacitor with C = 330µF at a voltage of 160V is enough to get a reliable hold-up time over the life of the converter.
$t = - \ln (43V/100V) * ((72V/0.81A + 43V/1.36A))/2 * 330\mu F = 16.7ms$

Also, with a – 20% tolerance from the nominal capacitance, the hold up time still is:
$t = - \ln (43V/100V) * ((72V/0.81A + 43V/1.36A))/2 * 264\mu F = 13.1ms$

It is necessary that the stored energy not flow back to the shorted input - otherwise there would be no advantage from the stored energy. This can be easily avoided by a series diode, for example.

For higher output power converters, 150W, 250W or 500W, energy storing with high voltage capacitors provides space and cost savings.

Both methods have their advantages and disadvantages. When charging capacitors directly from the battery line, the input current surge in a totally discharged cap must be considered - otherwise the input fuse will fail, or at least age prematurely. Charging capacitors to a higher voltage than the input line voltage means a little bit more effort in the electronics. The advantage is independence from battery variations and always the same hold up time.

Grau Elektronik converter designs have hold up circuits that are independent from input voltage fluctuations. With this concept, neither temperature nor input voltage influences hold-up time. Reliable and easily controllable hold-up times at optimized space relations are realized.

Grau Elektronik dc/dc converters, with galvanic isolation, series WBB 50W to 150W, and dc/dc converters, series DDB 250W, 500W, have efficiencies between 87% and 91% over the full input voltage range and over their rated output range of 20% to 100%.

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Something New Has Been Added

Attention all Space, Military, Aerospace, Hi-Rel Power semiconductor users.

A new Power Semiconductor Package, The Ecconowatt, has been designed and the concept patented. It is Ceramic, Hermetic, Surface Mountable, Lightweight, assembly friendly, with short cycle time and most importantly Low Cost.

By Robert Satriano, CNS Power Ceramix

A New Power Semiconductor package has been designed and the concept patented. It is Ceramic, Hermetic, Surface mountable, Lightweight, Assembly friendly and Automatable, with Short cycle time and Firstly and most importantly Low Cost.

The manufacturing process to produce The Ecconowatt is proprietary and it is the technique used and the experience acquired in ceramics that provides the assurance to allow all the above characteristics to be met.
CNS Power Ceramix, A company founded by a business man, a ceramic engineer, and an assembly manufacturing systems and packaging engineer, represent the management. This team is dedicated to producing the Ecconowatt packaging concept in a manner that takes into consideration the Package Manufactures, the Device assembly house, and above all the Users.
The package is designed in strip form (5 per strip) Similar to the Plastic Manufacturing System. This allows automatic die attachment and wire bonding operations adequate landing area has been provided to allow multiple wire bonds if necessary.

Thermal Resistance is addressed by brazing into the five position strip base a slug of Silicon Cemented Diamond which thermal conductivity is 580 W/mK.
Being all ceramic, the strip can be tested in strip form which allows a yield check and discounts the need to assemble a cap on a reject.
Ceramic caps and a low temperature Eutectic pre-form material is loaded into a slot in the base strip of five and then vacuum sealed.
After sealing the strips are put through a separation fixture which allows the separated devices to be loaded into plastic shipping sticks.
The devices can be marked or branded in the stick prior to shipment to the customer.
In reading this narrative it should have become evident that CNS management team are confident that this package concept will be used for all Power Semiconductors.
As mentioned earlier in this text getting anything new to the market place is a discouraging realization but change is inevitable and will occur when the risk and effort justifies the need.

The Ecconowatt name was adopted because it represents a product that supplies power at low cost, with absolute reliability.
The inventors of the TO-220 plastic encapsulated package named it the Versawatt due to its versatility to various levels of power devices to the users.

The Ecconowatt will be accepted as the package of choice for Power Semiconductors but not before the ultimate users become aware of its existence and demand it for their products.
CNS stands ready and waiting to assist all Hi Rel requirement product manufacture with design information. CNS needs your support to get this Ecconowatt style packaging concept to the users.

Power Semiconductor packaging has not had any innovation since the advent of thermo-set plastic encapsulation technology introduction in the 1970's.
A few Hermetic packages have surfaced that mimic the plastic package configuration. These packages are expensive, difficult to produce, not assembly friendly and users are clamoring for something new.

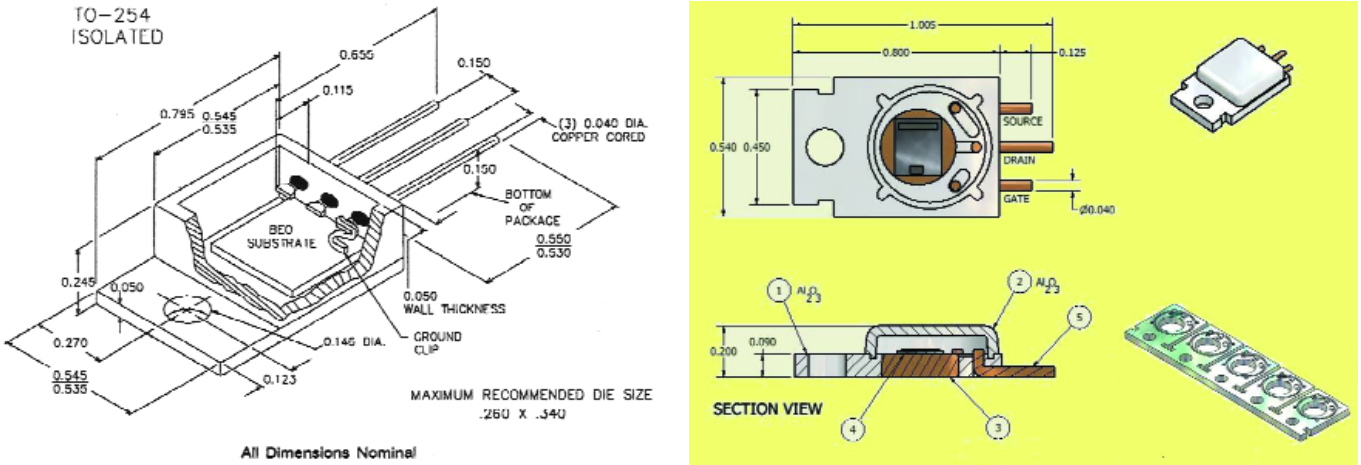

Figure 1: To 254 versus Ecconowatt

Power Semiconductor packaging underwent a change in the 1970's. From hermetic "tin cans" to silicone plastic encapsulated packages. Cost being the major driver, was instrumental in changing over some device users to the plastic package but Reliability did not meet the old "tin can" standards.

A change from silicone plastic to epoxy was a step in that direction. Epoxy, found to improve reliability was now in vogue, however this change did not fully remedy the issue and many users were reluctant to make the change to plastic encapsulated devices.
Epoxy brought forth an entirely new set of problems. Wire bonds were being ripped off bond pads on the chip due to the "Glass Transition Temperature" factor creating the coefficient of expansion to accelerate exponentially. Epoxy was a help in many respects but created other issues that had to be addressed. A correction to this issue came with the plastic manufactures filling the epoxy powder with "glass" to lower the "Glass Transition Temperature" to be suitable enough to achieve reliability acceptance.
Glass filled epoxy powder gave the Rel community what they demanded and device users were satisfied.
Although reliability improved significantly, the factory suffered, molds, post mold tools and all equipment associated with the glass filled epoxy began to quickly show wear and need of replacement. The cost now became the problem. The additional maintainance costs were eating into the margin and demanded immediate attention.

The mold makers used different steel, and applied very expensive coating to the mold cavities which improved the life of the molds and tooling.

Now Product Engineering, Reliability Engineering, the factory, and device users were at a point where they considered the Plastic Encapsulated Semiconductor to be "Good Enough", However continued Rel testing revealed that since these devices were not hermetically sealed the solder used to attach the power chip to the copper lead frame was being attacked by O^2. It was found that after power cycling, micro cracks formed in the solder under the chip and continue to propagate until finally the chip is severed from the base.
The device continues to function due to the compression forces of the epoxy exerted upon the chip to maintain contact with the base. Although this condition is troublesome no one has voiced a concern since the Rel data did not change.

Hermetic packaged Power device sales began to decline giving way to the plastic system.
Device users for Space, Hi Rel, and Military applications began to show an interest in "New" Hermetic packaging concepts that allow the leads to exit the top and side of the package similar to the plastic version as opposed to the old "tin cans" having the leads protrude from the bottom side.
After years of continued requests this type package was offered to the Military, Space, and Hi Rel users.
A typical design is the JEDEC outline TO-254. Although, this package met the lead requirement to exit the top side of the package and matched the appearance of its plastic cousin, it was not assembly friendly. Nevertheless, this design was becoming acceptable regardless of cost, difficulty in device assembly and package fabrication. Since volumes for these devices were low and cost not a factor for Hi Rel, Military and Space users this geometrical configuration thrived.

The package was plagued with considerable problems which dealt primarily with hermeticity and therefore changes had to be made which only added to the cost.
An acceptable manufacturing process was finally established that satisfied reliability and hermeticity requirements but not without paying the penalty of cost. The cost of the TO-254 when first introduced ranged in the neighborhood of $28 each. It now sells for $4-$6 at a volume level of 50,000 per month.

Package Comparison Data

	To-254	ECCONOWATT
Cost	$5.00	$1.40
Weight	5.8g	1.5g
Footprint & height	.540"x.800x.255"	.540"x.800x.200"
Chip attached to…	Tungsten copper	Silicon Cemented Diamond
Thermal Conductivity	1.47 watts	5.5 watts
Package body material	Steel	Ceramic
Lead material	52 alloy	Steel
Lead disposition	Cantilevered	To base
Lead seal	Glass or Ceramic	Ceramic
Surface mountable	Lead forming Required	YES
Package fabrication	Difficult & lengthy	Simple
Assembly automatable	NO	YES
Device Manufacturing Time	LONG	SHORT
Corrosion Property	POOR	EXCELLENT
Package Handling	One at a time	Strip of Five

*Includes Cap 50,000/month

Figure 1: To 254 versus Ecconowatt

It is evident that the users of this TO-254 concerned themselves only with the fact that the package was hermetic which connotes reliability and paid the price to acquire the product.

Being acquainted with the evolution of Power Semiconductor Packaging and how passionate the engineers were who invented and generated these geometrical configurations, it displeases me to see the "Its Good Enough" attitude prevail because to make a change in a packaging design and have it accepted is a monumental task.

Selling any new concept, passing reliability, passing customer qualification is enough to discourage change because it takes perseverance and a lot of blood, sweat and tears to get anything new and different into customer products.
This discouraging realization is paramount in having an new power semiconductor package emerge.

CNS feels very strongly that once this package gets into the hands of device manufacture and users, it will ultimately become the choice for all power semiconductors. The design lends itself to high volume production and will compete with plastic encapsulated packaging costs at the high volume levels. Please contact CNS at the email address below and share with us your needs as we are totally committed and prepared to help. Currently the Ecconowatt is being considered for the automotive ignition circuit driver which only tells you about the flexibility of its design.

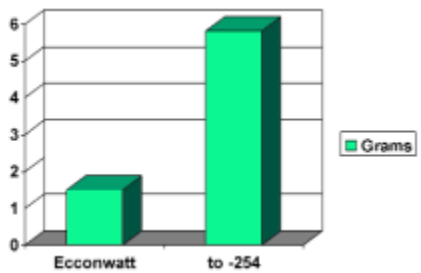

Figure 2a: Weight Comparison

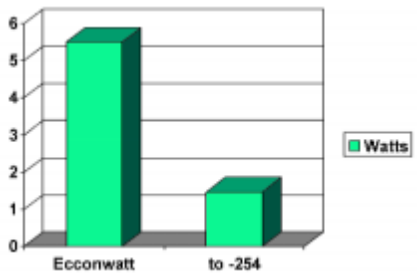

Figure 2b: Thermal Comparison

Circuit Protection Designs for a Connected World

Integrating overcurrent and overvoltage protection

The demand for more and more features and functions in consumer electronics presents new challenges to design engineers. Circuit protection device manufacturers must also continue to deliver new solutions to support emerging technologies and meet new system level protection requirements.

By Adrian Mikolajczak, Tyco Raychem Circuitprotection

The electronics industry's unrelenting demand for smaller, more reliable circuit protection devices continues to drive the miniaturization trend. As a result, circuit protection device manufacturers must provide their OEM customers with smaller and smaller devices; but the objective is clearly more than size reduction. The real challenge lies in scaling down component size without sacrificing electrical characteristics. Advanced material research and technology has been the key to developing new devices that meet existing performance levels within smaller, more reliable, and more convenient packaging.

Another important design challenge is the need for coordinated circuit protection. Because overcurrent and overvoltage protection are often viewed as two unrelated elements of the design process, protection strategies can result in costly multi-component solutions, and synergies between protective devices can be overlooked. Coordinating these devices or integrating overcurrent and overvoltage protection functions in a single device effectively reduces component count and, appropriately applied, can expand performance attributes and help improve system reliability.

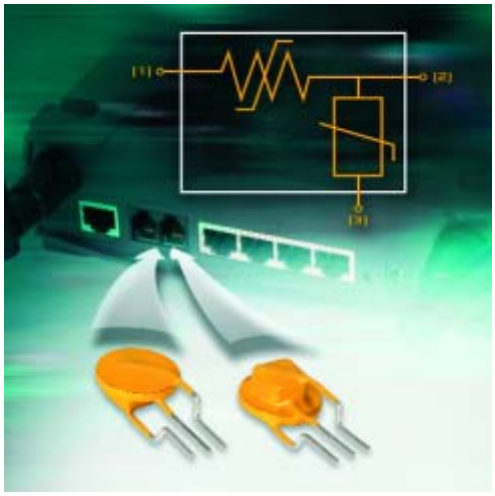

Figure 1. 2Pro™ Device helps protect telephony and VoIP equipment.

Following are three examples of how Tyco Electronics' applied innovation in circuit protection materials and technology can help design engineers conserve valuable board space and meet evolving safety and performance standards.

The new 2Pro™ device integrates overcurrent and overvoltage circuit protection technology to help prevent damage to telephony communications equipment. The device's small footprint, resettable functionality and coordinated protection capabilities make it suitable for a wide range of telephony and VoIP equipment applications such as cordless phones, VoIP gateways, data modems, set-top boxes, security systems, MDF (Main Distribution Frame) modules, analog linecards and ISDN (Integrated Services Digital Network) linecards.

The RoHS-compliant 2Pro device incorporates PolySwitch™ PPTC overcurrent technology with an MOV component into one thermally protected device that helps provide current limiting during overcurrent events and voltage clamping during overvoltage events. This single-device approach helps reduce component count and improve equipment reliability. Figures 2 and 3 illustrate how the 2Pro device is used in both an ungrounded and grounded circuit protection scheme.

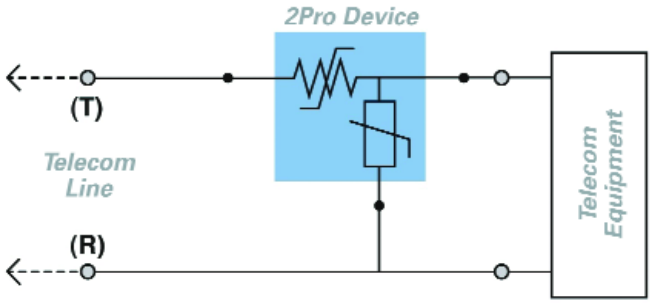

Figure 2. 2Pro in ungrounded system

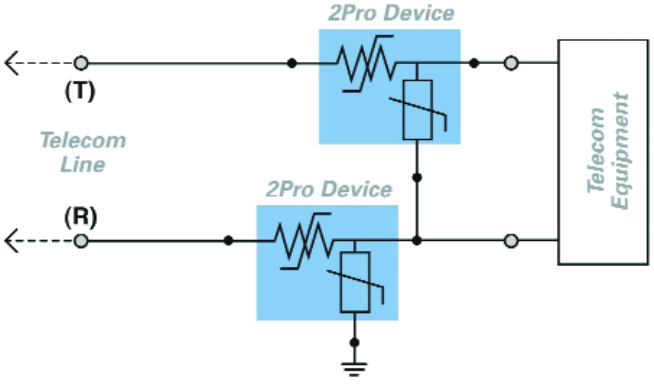

Figure 3. 2Pro in grounded system

The 2Pro device helps equipment manufacturers comply with UL 60950 and remain operational after specified lightning tests. It also helps equipment comply with surge tests per TIA-968-A, IEC 60950, and ITU-T K.20/K.21. The UL 497A listed protector also helps provide ESD protection, improve network reliability, reduce maintenance and warranty costs, and enhance user-satisfaction with Customer Premise Equipment.

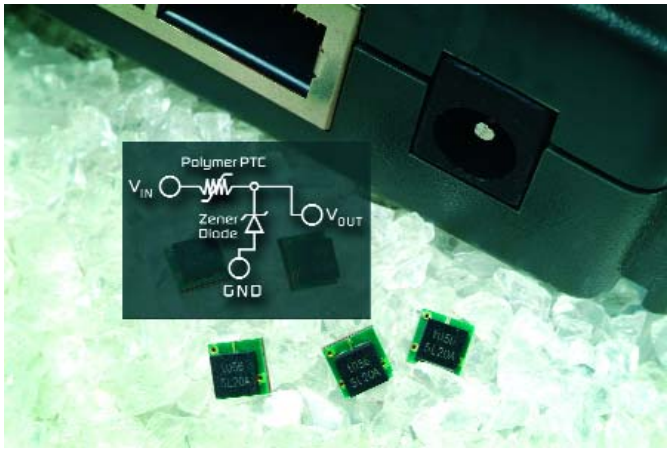

Figure 4. PolyZen™ Device helps protect against charger-induced system failure

The continuing miniaturization trend in portable and desktop electronics necessitates the use of external power supplies for normal operation and/or charging. However, the widespread market availability of external and universal power supplies forces the design engineer to incorporate additional safeguards against unexpected damage caused by use of unauthorized charging systems, a leading cause of device warranty returns. Complicating the challenge, the solution itself must be designed to accommodate ever-smaller portable electronic packages.

Tyco Electronics recently introduced the PolyZen™ device to help provide DC power port protection for portable electronics and systems using barrel jacks for power input. The PolyZen device is a polymer-enhanced, precision Zener diode micro-assembly. It consists of a low resistance, precision Zener diode that is thermally coupled to a PPTC "thermal switch."

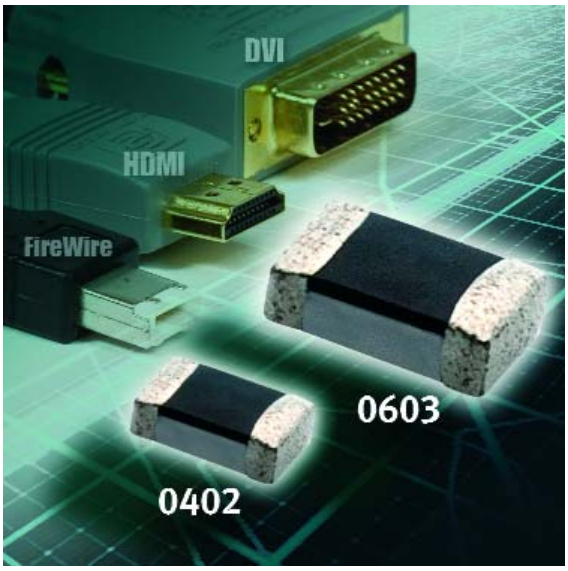

Figure 5. PESD devices help protect high-speed ports on set-top boxes and portable devices.

In operation, extended overvoltage or reverse bias conditions will cause the PPTC element to "trip" as the diode begins to heat up. A "trip event" causes the PPTC "thermal switch" to transition from a low to high-resistance state, helping protect downstream electronics by generating a series element voltage drop. Also, by limiting the current, it helps to prevent Zener diode failure caused by thermal runaway.

Simply put, the PolyZen device helps provide coordinated protection with a component that protects like a Zener diode, but is capable of withstanding very high power fault conditions without requiring any special heat sinking structures beyond normal PCB traces. The PolyZen solution helps protect sensitive electronics from damage caused by inductive voltage spikes, voltage transients, incorrect power supplies and reverse bias. These devices offer power handling on the order of 100 watts (depending on device) in a 4mm package, have the ability to withstand high current inrush and faults in a small form factor, and are particularly suitable for portable electronics and other low-power DC devices.

At the high-speed data rates of USB 2.0, IEEE1394, DVI and HDMI, the parasitic impedance of traditional protection devices can distort and deteriorate signal integrity. Low capacitance ESD protection is critical to maintaining data integrity at these high speeds.

Figure 6 shows a typical HDMI circuit protection design utilizing Raychem Circuit Protection's PESD device. These protection devices shunt ESD away from sensitive circuitry and provide exceptionally low capacitance compared to traditional MLV (multilayer varistor) or TVS (transient voltage suppression) diode technology.

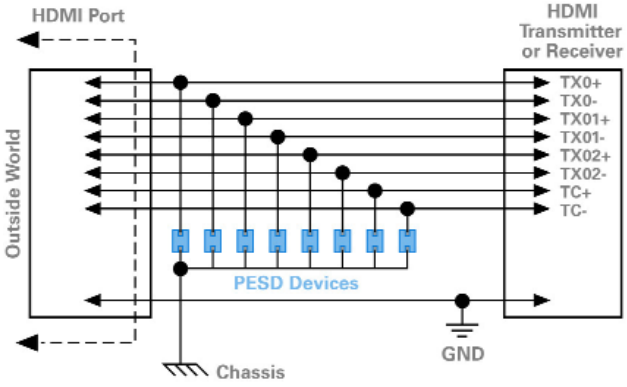

Figure 6. Typical HDMI circuit schematic with PESD devices (based on HDMI Specification Version 1.2)

They perform better than other comparable components in transmission line pulse (TLP) testing, as well as IEC61000-4-2 testing, especially after multiple hits (up to 1000). The PESD's low trigger voltage and low clamping voltage also helps protect sensitive electronic components.

Integrating polymeric materials into "traditional" products such as MOVs and Zener diodes has expanded PPTC technology to a wider range of industries and applications - from automotive navigation systems to USB ports, from security and fire alarm systems to cell phones and set top boxes.

Pioneering designs - based on Tyco Electronics' commitment to anticipating market trends and collaborative relationships with electronic OEMs - have helped the company deliver new and innovative products to support emerging technologies, reduce warranty repair costs, and meet new safety and performance requirements.

www.circuitprotection.com

Magnetic Systems in Electric Motor Scooters

Electrically powered two-wheelers have long left the prototype phase behind and are now seeking a wider public - a trend borne out by the first electric "Maxi Scooter" from US manufacturer Vectrix.

By Wolfgang Unterstein, Product Marketing for Permanent Magnets, VACUUMSCHMELZE

The scooter's powertrain incorporates a magnet system containing VACODYM® 655 AP magnets from Vacuumschmelze. VACODYM® is the VAC's tradename for neodymium-iron-boron magnets.
VACODYM® has been produced on an industrial scale since 1986. The VAC's materials have the highest energy densitiy available to date.
Additions of carefully selected suitable materials (including cobalt) to the neodymium-rich phase have improved their corrosion behaviour and systematically stopped intergranular corrosion in a warm, humid atmosphere. The corrosion behaviour of such VACODYM® alloys is similar to that of pure iron materials (steel).
The ultra-high-grade magnetic material is bonded at the factory. The magnets with VACCOAT® 10047 corrosion protection are integrated into the rotor unit, with technical specifications imparting maximum stability at up to 6500 rev/min.
It is the VAC's magnets that combine with the electronic and battery systems to make the Vectrix® Maxi-Scooter go - and what an incredible driving experience it is.

Full speed ahead for commercialization
After the scooter's market launch in 2007, the assembly plant in Poland now aims to take markets by storm initially in Italy, Spain, England and Australia. Vectrix® has drawn up a schedule of advertising and city centre campaigns and plans exclusive VECTRIX® stores in London, Madrid, Rome, Barcelona and Milan, but also in glamorous Mediterranean resorts such as Marbella and Cannes, to spark surging sales.

Sleek, appealing design
The appearance of the new Vectrix® electric Maxi-Scooter has little in common with conventional scooters; the front is more reminiscent of chunky cruiser bikes, while the back has sporty, trim lines. But the Maxi-Scooter offers a comfortable seat and the relatively large wheels (14-inch front, 13-inch back) typical of premium-class scooters.

Technical specifications
Delivering more power than a 400-series petrol scooter, the Maxi-Scooter is driven by NiMh batteries (125 volts, 3.7 kW/h) and a brushless motor/magnet assembly integrated into the rear wheel. It offers top-of-the-class acceleration, from 0 to 80 km/h in a mere 6.8 seconds at maximum torque of up to 65 Nm. In addition, like all electric scooters the Maxi-Scooter is a zero-emission vehicle and is virtually silent. At 27 hp at 3000 revs/min, the Maxi-Scooter requires a standard motorcycle licence. According to Vectrix®, it reaches top speeds of around 100 km/h.

Reducing the scooter's speed automatically initiates the world-patented Vectrix® regenerative braking system which recharges the batteries, increasing the scooter's range by around ten per cent. Thanks to the powerful engine brake, application of the Brembo brake is often superfluous. The battery range is stated by the manufacturer at 100 km, with 80% recharging level after only two hours of charging. In addition, Vectrix® claims battery life of ten years under conditions of normal use - around 8,000 km/year.

Figure 1. The electric motor is housed in this aluminium swingarm

And then there's the price. The company is endeavouring to introduce a retail price of around 12,000 EUR, plus an annual all-in payment of 250 EUR for insurance and maintenance over a four-year period - a price category that makes Vectrix® significantly more expensive than conventional 400 or 500 series scooters. However, there may be the possibility of government subsidies for this zero-emission mode of transport. In addition, running costs are low - given by Vectrix® as -25% in four years - as are maintenance costs (given as -70%). The scooter comes with a two-year manufacturer's warranty.

The Vectrix® management is hoping for surging sales in densely populated urban areas and major cities which impose congestion charges on conventional combustion-engine vehicles. Of course, the launch of this new electric-motor scooter is unlikely to shake up the European market immediately. However, it is clear that by producing this future-oriented technology, Vectrix® has won competitive edge over other manufacturers - and by supplying the magnet systems, we have made a significant contribution to the product's engine performance and reliability.

www.vacuumschmelze.com

www pcim.de

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Precision Digital Temperature Sensor Series

STMicroelectronics announced a new series of precision digital-output temperature sensors, operating over the -55 to +125 degrees C temperature range, which are ideal for low power applications in a broad range of product areas. The cost-competitive STxx75 devices are software-compatible drop-in replacements for industry-standard LM75, DS75 and TCN75A parts, and also complement ST's STLM20 analog temperature sensor, now being used in several mobile phone designs.

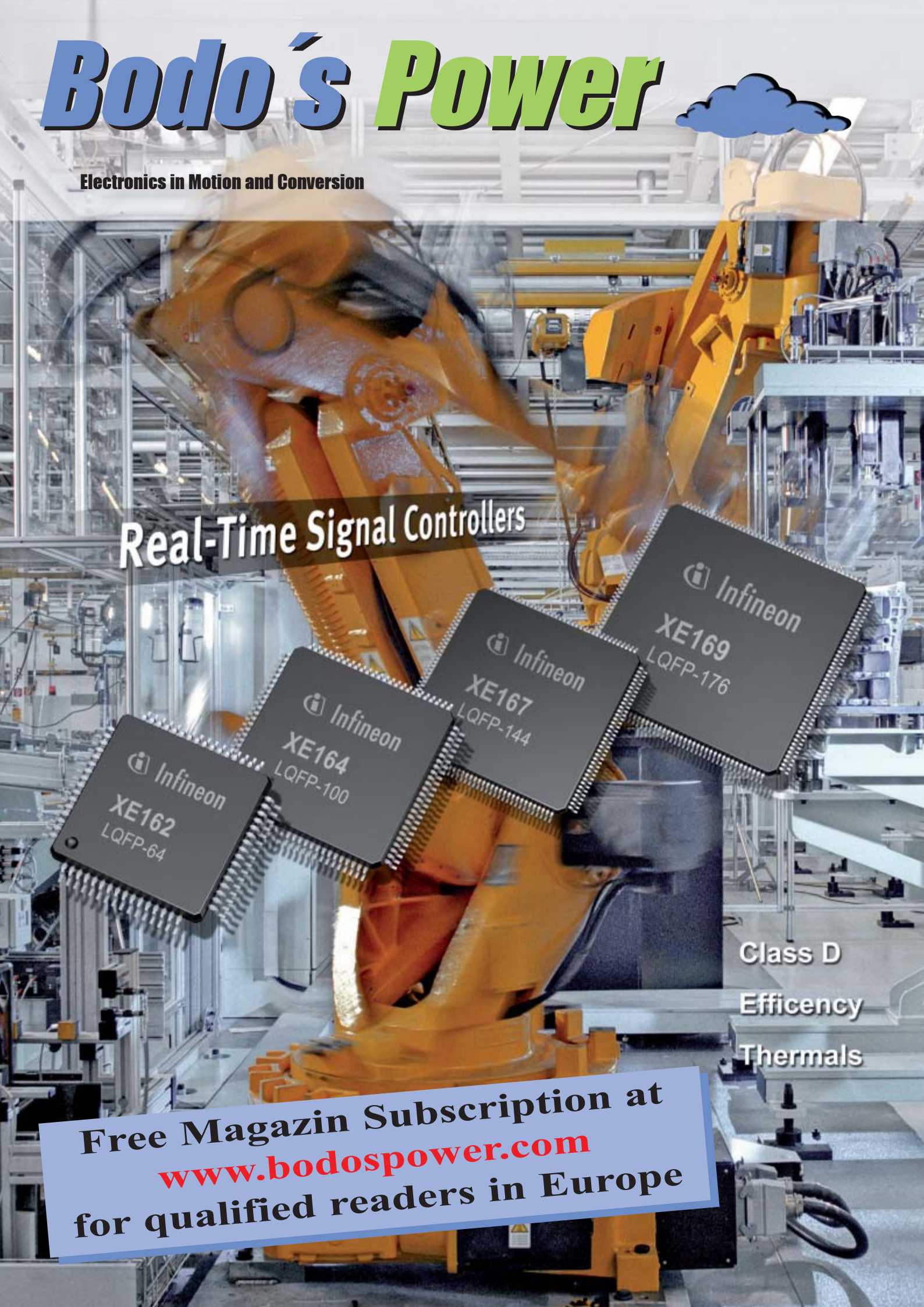
The digital sensors, in standard 8-lead TSSOP and SO-8 packages, are intended for use in any control application where a processor with an I2C bus/SMBus needs to take action based on an accurate digital reading of the local temperature, or where an alarm or interrupt is required when a preset temperature level is reached. They use a band-gap temperature sensor, with a programmable 9-bit to 12-bit sigma-delta ADC (analog to digital converter) to digitize the temperature reading to a resolution of up to 0.0625 degrees C. The STTS75 devices are factory-calibrated and require no external components.

Accuracy is plus or minus 3 degrees over the full -55 to +125 degrees C temperature range, and plus or minus 2 degrees from -25 to +100 degrees C. The sensors are designed for a supply voltage range of 2.7V to 5.5V and have a low operating current of 75uA (typical) at 3.3V. In the power-saving shutdown mode the standby current is a very low 1uA maximum. Power-up defaults enable standalone operation as a thermostat, and both temperature and hysteresis values are programmable.

www.st.com

Bodo´s Power

Electronics in Motion and Conversion



Wide Input Voltage Controllers to Save Power

Intersil announced a new family of Triple Sync Buck PWM and LDO Controller. The ISL9440, ISL9440A and ISL9441 are designed to be extremely flexible, operating in a wide input voltage range of 4.5V to 24V, and they offer an independent "digital enable" feature that allows designers to save power and board space.The digital enable feature on the controllers affords "green" power savings by offering the ability to shut down device rails that are not in use. The digital enable features on the ISL9440, ISL9440A and ISL9441 controllers can also be logic-driven for sequencing to avoid using additional chips, saving cost and board space. In addition, the digital enable feature provides better control for sequencing on power rails than standard analog soft-start.

All three members of this new family of triple sync buck controllers help control noise within the system by offering out-of-phase switching to minimize spikes.

For system and data safety, the ISL9440 and ISL9440A feature an "Early Warning" VIN detection feature that allows 5.5 microseconds for the system to perform functions like writing key registers to memory before the system loses power completely.

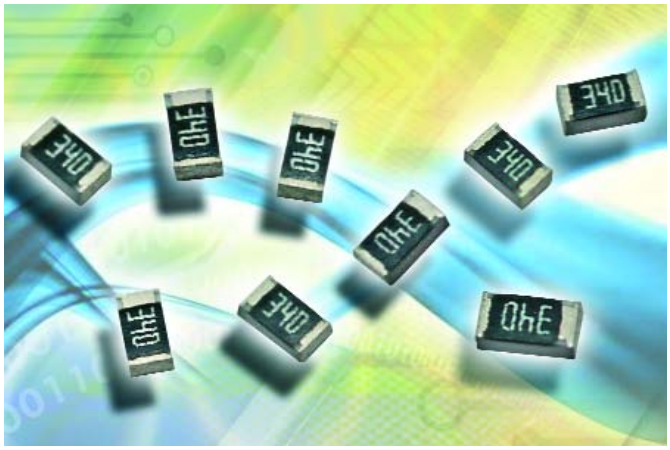
www.intersil.com

Ultra High Precision Chip Resistors

The RN73 series of ultra high stability precision chip resistors from Tyco Electronics has been extended to offer resistance tolerances down to 0.01%, making the devices up to 10 times more accurate than previously available models.

Designed for telecommunication, industrial and military applications, RN73 series resistors are available in a choice of packages, down to 0402 case size. Standard package size is 0805. Based on nichrome thin film technology, the devices are produced with three sputtered layers of resistive metal film. This enables very stable high frequency performance to be achieved. Temperature Coefficient of Resistance (TCR) values down to 10 ppm/°C, and even 5 ppm/°C for some case sizes, are available over a wide value range (5R1 - 470K) in the E96 and E24 value grids.

Accurate and uniform physical dimensions facilitate automatic placement of the RN73 devices. Pack quantities are very flexible ranging from a small volume 250 piece cut strip up to higher volume 1000, 5000 and 10000 piece tape on reels. Together with a short standard lead time of only four weeks this makes RN73 series devices the flexible fixed precision SMD chip resistor.



www.tycoelectronics.com

Wide Temperature Digital Optocouplers

Avago Technologies announced the addition of three new high-temperature, high-speed digital optocouplers which are the first in the industry for use in industrial applications. These new wide temperature optocouplers, which are housed in a 5-pin surface mount package, have been designed to operate over a wide range of temperatures from -40 to 125-degrees C making them extremely reliable and ideal for use in applications that operate in harsh industrial environments. Avago provides its industrial customers with wide temperature optocoupler products in speeds ranging from one megabaud (1 MBd) to 10 MBd. Avago is a leading supplier of analog interface components for communications, industrial and consumer applications.

These latest additions to Avago's optocoupler family include a 1 MBd single channel digital optocoupler (ACPL-M43U), a 10 MBd logic gate optocoupler (ACPL-M61U), and an intelligent power module optocoupler that includes an aluminum gallium arsenide (AlGaAs) layer optically coupled to an integrated high gain photo detector (ACPL-M46U). These new high-speed digital optocouplers are low-power and high common mode transient rate (CMR) components that provide immunity to transient noises, EMI and ground loop eliminations. Avago's ACPL-M43U, M46U and M61U optocouplers are compliant to most industrial safety standards such as IEC/EN/DIN EN 60747-5-2, UL 1577 and CSA.

www.avagotech.com/optocouplers

High-Current Radial-Leaded Inductors

In electronic equipment designed for service in lightning prone, other high voltage areas and/or high reliability environments, damage from EMI can be prevented with the new DR370-1, -2 and -3 Series Radial Leaded Inductors from Datatronic Distribution, Inc.

The new DR370-1, -2, -3 Inductors combine high performance over a wide inductance range in challenging EMI operating environments with rugged packaging, ROHS compliant lead material, long-life and economy. They provide excellent protection against the damaging effects of EMI problems.

Depending on the specific model, the DR370-1, -2 and -3 Inductors feature an inductance range from a low level of 0.31 UH to an upper range of 2.2 uH. The DCR is specified from 0.75 to 4.0 mOhms maximum over a maximum current rating from 20 to 42 Amps. They are compatible with temperatures ranging from -55 to +125°C.

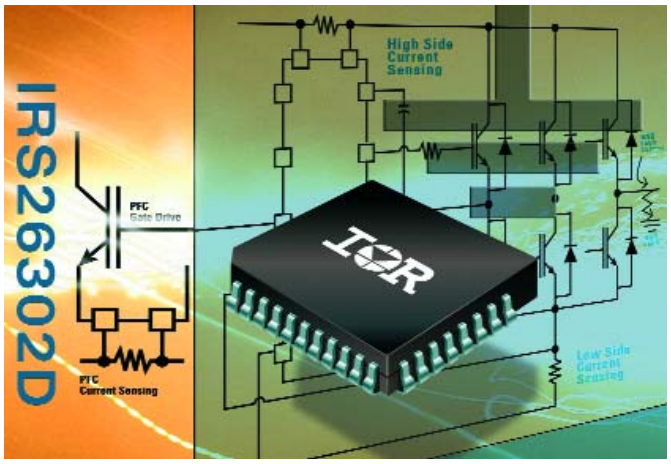
The DR370-1, -2, -3 Inductors are ideal for commercial and industrial equipment, including automotive, factory automation, heavy equipment, industrial machinery, instrumentation, power supplies, telecom and more. Requirements for inductors with high current ratings are becoming increasingly common in lower voltage circuits used in today's higher density power supply designs, as well as in many types of electronic equipment operating outdoors or within industrial plants.

With their through-hole design, the DR370-1, -2, -3 Series Inductors come in square packages sized from as small as 0.492 inches wide -x- 0.492 inches long (12.5 mm wide -x- 12.5 mm long) diameter, with a height from 0.374 inch (9.5 mm) depending on the specific model. There are compatible with high-speed assembly equipment, and they are also suitable for high-temperature soldering.

www.datatronics.com

600V IC Features PFC or Brake

International Rectifier has introduced the IRS26302D protected 600V three-phase gate driver IC with ground fault protection. The IC has a seventh gate drive channel for a power factor correction (PFC) switch or inverter brake, making it well-suited to medium power appliance motor control and many other general-purpose three-phase inverter applications.



With its integrated bootstrap functionality, PFC or brake, and ground fault protection this latest high-voltage IC is ideal for three-phase inverter applications with space limitations. As part of IR's latest HVIC generation, this compact IC also delivers many protection features including negative Vs immunity circuitry, to withstand very large negative Vs transients seen during high-current switching and short-circuit conditions.

The IRS26302D integrates power MOSFET/IGBT gate drivers with three high-side and three low-side referenced output channels to provide 200mA/350mA drive current at up to 20V MOS gate drive capability operating up to 600V. An additional low-side driver is provided for a PFC switch or inverter brake.

The IC incorporates negative Vs immunity circuitry to protect the system from catastrophic events that can be seen during high-current switching and short-circuit conditions in addition to ground fault protection, critical features for industrial systems that require high levels of robustness and reliability. Also, an advanced input filter has been integrated to reject noise and reduce distortion, improving system performance in many motor control applications.

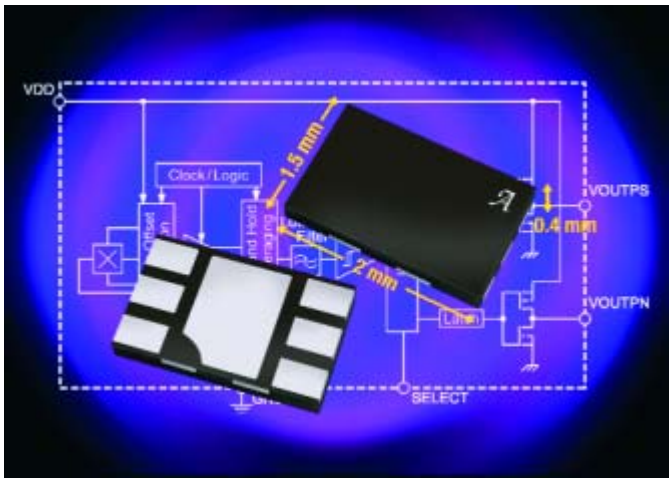
www.irf.com

Hall-Effect Switch Features Battery Applications

The new A1171 from Allegro MicroSystems Europe is an ultra-sensitive micropower Hall-effect switch with latched digital outputs and either unipolar or omnipolar actuation. It features operation at low supply currents and voltages, making it ideal for battery-operated applications in portable or handheld communications and computer equipment.

The low operating supply voltage (1.65 V to 3.5 V) and unique clocking algorithm assist in reducing the average operating power consumption: typically less than 15 µW with a 2.75 V supply.

Unlike some traditional Hall-effect switches, the A1171 allows the user to configure how the device is magnetically actuated. Under default conditions the device will activate output switching with either a north or south polarity magnetic field of sufficient strength. The polarity specific actuation can be set by the user via an external selection pin to operate in a unipolar mode, switching only on a north or south polarity field.



www.allegromicro.com

IGBT/MOSFET Gate Drive Optocouplers

NEC Electronics introduces the first product. The wide application range includes frequency converters, AC drives, brushless DC drives, industrial inverters, uninterruptable power supplies and induction heaters. It can drive IGBTs supplying up to 1200 V and 100 A.

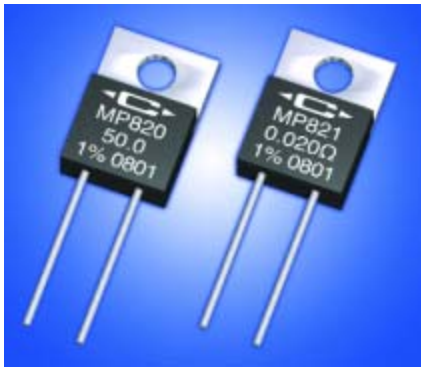
The PS9552 consists of a GaAlAs LED on the input side and a photo diode and power stage on the output side. It is a combination of galvanic isolation and an IGBT/MOSFET driver supplying high current. The design features high common mode transient immunity.

The PS9552 optocoupler is ideal for industrial inverter and motor control applications

www.eu.necel.com/opto

Metal Tab Resistors Compliant with EU RoHS Directive

AMS Technologies announces a product enhancement at Caddock Electronics: MP820 and MP821 TO-220 Style Metal Tab Resistors are now compliant with the EU RoHS Directive (2002/95/EC).
A new EU RoHS Compliant molding compound has been qualified by Caddock for use in the MP820 and MP821. All MP820 an MP821 resistors manufactured after January 01, 2008 (Date Code 0801 and later) are fully compliant to the EU RoHS Directive (2002/95/EC).
MP820 and MP821 Series are 20 Watt resistors in a TO-220 style power package with metal heat sink mounting tab. The resistor element is electrically isolated from the mounting surface. MP821 devices feature a resistance from 0.020 to 9.99 Ohm; MP820 devices from 10 Ohm to 10KOhm. The non-inductive resistors are especially designed for measurement, high speed switching, snubbers and RF applications.



www.caddock.com

www.ams.de

Power Relay DC-only Devices Up to 32A

Clare, Inc., a wholly owned subsidiary of IXYS Corporation announced that it has fully released four new DC-only 1-Form-A Solid State Power Relays with the CPC1718, CPC1727, CPC1779 and CPC1788, offering designers up to 32 Amps (at a Case Temperature of 25 degrees Celsius) of current handling.

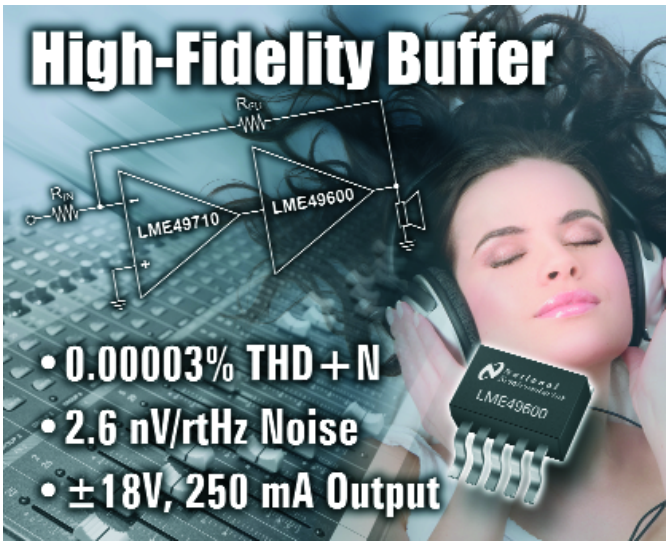
Available in the self-isolated ISOPLUS-264 package, the CPC1718, CPC1727, CPC1779 and CPC1788 have blocking voltages of 100, 250, 600, and 1000 Volts, and on-resistances of 0.075, 0.090, 0.400, and 1.250 Ohms respectively.
Development of these power relay products was founded on the blending of Clare's traditional strengths in the design and manufacture of photovoltaic integrated circuits (ICs), leadframe design and multi-chip packaging with IXYS' expertise in power MOSFETs, power packages and substrate technology.
Optically coupled MOSFET technology is used to provide 2500 Vrms of input to output isolation and, as in all Clare solid state relays, the optically coupled output is controlled by a GaAlAs infrared LED.

www.clare.com www.ixys.com

Industry's Lowest-Noise Audio Buffer

A new buffer from National Semiconductor delivers the industry's lowest noise and harmonic distortion for professional audio applications. Part of National's high-fidelity LME audio amplifier family, the LME49600 produces the necessary output current to drive multiple low-impedance headphones and the voltage swing to drive several high-impedance headphones. Additionally, the buffer is well-suited for a wide range of other applications, including line drivers, analogue-to-digital converter (ADC) input drivers, low-noise and wide-frequency voltage regulators, and it can also drive the headphone amplifier output stage in mixer consoles as well as capacitive loads in low-power audio amplifiers.

The LME49600's high-fidelity specifications ensure that it can respond to highly dynamic inputs, accurately reproducing these signals without degrading them by adding distortion. The device delivers 180 MHz bandwidth, a high slew rate of 2000 V/us and has 2.6 nV/rtHz input referred voltage noise density. In a closed-loop configuration with National's LME49710 single operational amplifier), the total harmonic distortion plus noise (THD+N) is a vanishingly low 0.00003 percent. Combining the LME49600's +/- 250 mA output current capacity with the LME49710 and an LM4040 low-noise bandgap reference produces a very high-performance, low-noise, wide-bandwidth, audiophile quality, voltage regulator.



www.national.com/audio

Extension of +5V Current Transducers

LEM has added to its LTS range of current transducers designed to operate from a single +5V power supply. The LTSP model measures positive and negative AC, DC and pulse currents on printed circuit boards and provides a current output instead of the voltage output provided by the other units in the family. This allows the LTSP to detect currents up to at least 14 times the nominal current.

The LTSP uses the same ASIC as LEM's LTS and LTSR models. This device, designed by LEM, allows the high performance offered by the Hall-effect closed-loop current transducers to be offered in an extremely small package (22.2L x 10W x 24H mm). The LTSP provides better offset drifts than units based on traditional discrete technology, as well as access to the internal reference (2.5 V) on a separate external pin, for use with microcontrollers and/or A/D converters.

The transducer's multi-range configuration has been designed for nominal currents of 8A, 12A and 25ARMS with galvanic isolation between the primary and output circuits. The current output allows users to manage the accuracy level and thermal drift by selecting the output resistance. The choice of the output resistor also allows the designer to adjust the gain to suit the application.

The LTSP transducer is CE marked, UL recognised and conforms to the EN 50178 standard for industrial applications. It is provided with a five-year warranty, as are all LEM industrial products.

www.lem.com

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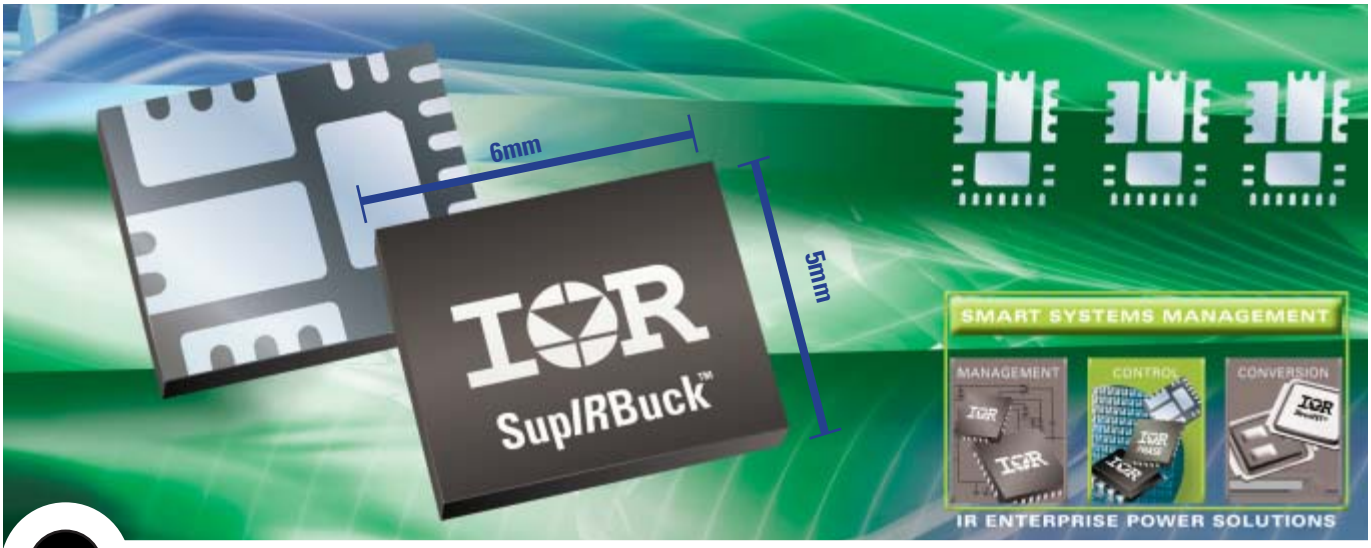

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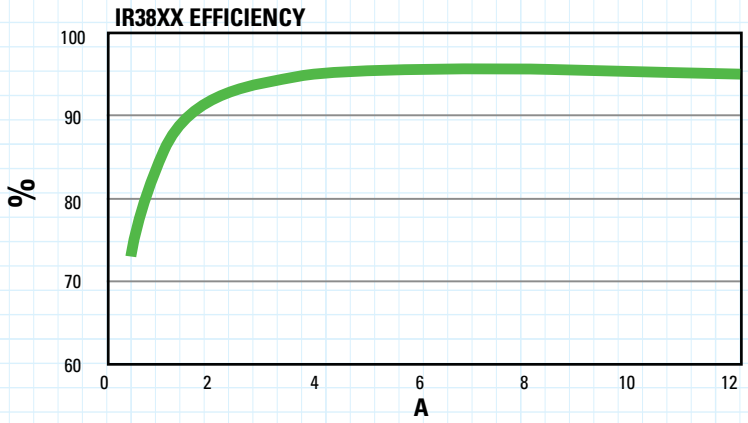

Part Number	V_{IN} Max/Min	V_{OUT} Max/Min	Max Current	F_{SW}	Package	Features
IR3812MPBF	21 / 2.5	12 / 0.6	4A	600KHz	5mm x 6mm QFN	OCP; OTP; Tracking
IR3822MPBF	21 / 2.5	12 / 0.6	4A	600KHz	5mm x 6mm QFN	OCP; OTP; PGood
IR3822AMPBF	21 / 2.5	12 / 0.6	6A	300KHz	5mm x 6mm QFN	OCP; OTP; PGood
IR3811MPBF	21 / 2.5	12 / 0.6	7A	600KHz	5mm x 6mm QFN	OCP; OTP; Tracking
IR3821MPBF	21 / 2.5	12 / 0.6	7A	600KHz	5mm x 6mm QFN	OCP; OTP; PGood
IR3821AMPBF	21 / 2.5	12 / 0.6	9A	300KHz	5mm x 6mm QFN	OCP; OTP; PGood
IR3810MPBF	21 / 2.5	12 / 0.6	12A	600KHz	5mm x 6mm QFN	OCP; OTP; Tracking
IR3820MPBF	21 / 2.5	12 / 0.6	12A	600KHz	5mm x 6mm QFN	OCP; OTP; PGood
IR3820AMPBF	21 / 2.5	12 / 0.6	14A	300KHz	5mm x 6mm QFN	OCP; OTP; PGood

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Intervista sull'elettronica di potenza per applicazioni eoliche

con Dejan Schreiber, Senior Application Manager; Semikron

Di Bodo Arlt, Editore BP

Bodo Arlt: Qual è l'influenza che il settore dell'energia eolica, in forte crescita, ha sullo sviluppo di semiconduttori di potenza in Semikron?

Dejan Schreiber: Abbiamo raggiunto il nostro più alto tasso di crescita nel settore delle energie rinnovabili. 31GW dei 72,6 GW di capacità di energia eolica totale installati in tutto il mondo a partire dal 1993 contengono tecnologia Semikron. All'inizio degli anni '90, siamo stati proprio noi a fornire le prime soluzioni di semiconduttori di potenza destinati alle applicazioni per turbine eoliche, investendo nelle tecnologie e ottenendo la topologia di un modulo integrato di potenza sviluppato specificamente per l'utilizzo su generatori eolici, grazie alla sua affidabilità operativa, aspettativa di vita di servizio, efficienza e design scalabile.

La nostra vasta e comprovata attività ci permette di sviluppare prodotti e linee di altissimo livello, fattore che ci consente senz'altro di partire avvantaggiati rispetto alla concorrenza.

Bodo Arlt: Quali sono le sfide/alternative in questo settore?

Dejan Schreiber: Fino ad ora l'elettronica di potenza è stata utilizzata nel back-end della produzione di energia. L'elettronica di potenza è comunque utilizzata anche nel front-end, ad esempio nelle applicazioni per turbine eoliche, nonché nella distribuzione dell'alimentazione, nelle soluzioni front-end e back-end per le linee di trasmissione. È quindi necessario migliorare la qualità dell'alimentazione. I requisiti delle cosiddette "reti intelligenti" di distribuzione dell'alimentazione stanno diventando sempre più severi. Gli standard ed i benestare rendono tali requisiti ancora più complicati. Tutte queste necessità devono comunque essere soddisfatte, sebbene vi sia stato un rafforzamento della pressione nei confronti dell'aumento della velocità di sviluppo. Il modo migliore per soddisfare questo requisito è sviluppare prodotti che possano costituire una piattaforma di base, oltre a poter essere facilmente ampliati, al fine di soddisfare la richiesta di una gamma di potenza in continua crescita. Si tratta di una sfida enorme per il settore dell'elettronica di potenza.

Bodo Arlt: Quali soluzioni propone Semikron per essere all'avanguardia nel settore eolico?

Dejan Schreiber: Offriamo SKiiP, un modulo di potenza integrato che include raffreddamento, driver, sensori di corrente e funzioni di protezione perfettamente abbinati. Inoltre, disponiamo di gruppi di alimentazione e soluzioni scalabili per potenze nell'ordine dei MW. Per restare all'avanguardia nel settore eolico dobbiamo tuttavia sviluppare soluzioni per requisiti di potenza persino maggiori di 5 MW. Entro 5 anni, questa cifra potrebbe raggiungere i 10 MW. Per quanto riguarda i generatori ad alta potenza, i generatori eolici devono essere unità a media tensione.

Bodo Arlt: Qual è la tensione del semiconduttore raccomandata per le turbine eoliche a velocità variabile?

Dejan Schreiber: 1700 V. Le applicazioni per le energie rinnovabili hanno indubbiamente bisogno di semiconduttori la cui alta efficienza sia stata comprovata.

Come già visto nell'esercizio degli inverter, quando si utilizzano differenti moduli ad IGBT con lo stesso case ma con tensioni differenti : 1700V (dispositivo a bassa tensione), 3300V e 6500V e si simula la potenza di uscita disponibile, è chiaro che gli IGBT a media tensione non sono soluzioni economiche (vedere Fig. 1).

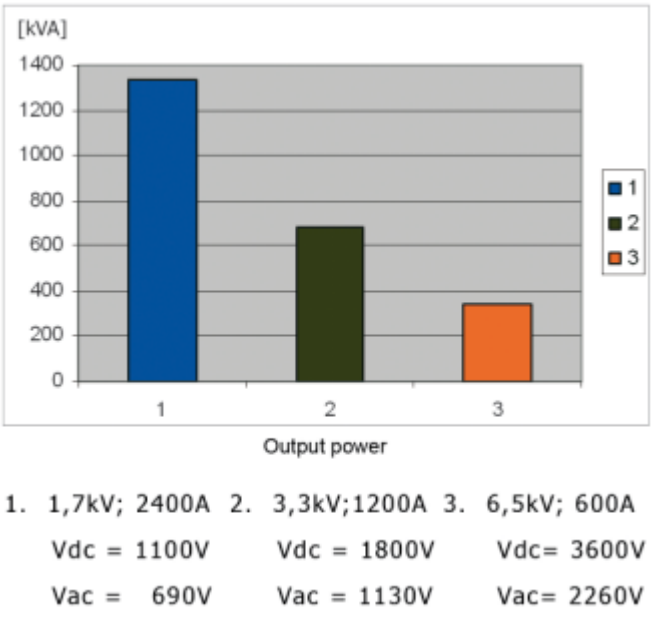

Figura: potenza di uscita di un inverter ad IGBT trifase a parità di dimensioni del modulo e condizioni di raffreddamento, con Fsw= 3,6kHz

La limitazione della potenza di uscita equivale alle perdite di potenza totali. A pari perdite di potenza, i moduli a media tensione da 3,3 kV/1200 A sono in grado di produrre esclusivamente la metà della potenza disponibile. I moduli da 1,7 kV /2400 A e da 6,5 kV/600 A producono invece solo un quarto della potenza disponibile. Le condizioni di esercizio vengono adattate ai livelli di tensione, mentre la frequenza di commutazione, pari a 3,6 kHz, resta uguale in tutti i casi. La dimensione del filtro è la ragione per la quale la frequenza di commutazione in uso rimane invariata. Da 3 a 4 kHz, la potenza del filtro sinusoidale è di circa il 15% della potenza dell'inverter. In questo modo, tutti gli inverter hanno dimensioni del filtro e costi simili.

Ciò significa che, per i motori MV, è necessario un approccio diverso in materia di circuiti inverter.

Bodo Arlt: Cosa differenzia Semikron dagli altri fornitori di moduli?

Dejan Schreiber: Siamo orientati verso le applicazioni. Sviluppiamo e produciamo semiconduttori di potenza facili da utilizzare nelle applicazioni specifiche. Ad esempio, parecchi anni fa, gli enormi moduli ad IGBT a singolo interruttore avevano solo due terminali (collettore ed emettitore) e due versioni, come in uno specchio: una per il l'interruttore BOTTOM e una per il TOP. Fin dall'inizio eravamo comunque consapevoli degli svantaggi di questo tipo di soluzione. Per un inverter a tensione impressa, il modulo di potenza deve essere un mezzo ponte con terminali CC e AC separati. Nel layout SKiiP, che ha più di 15 anni, il terminale CC si trova su un lato, mentre il terminale AC è posizionato sull'altro lato del modulo, con numerosi terminali in parallelo. Questa linea viene ora utilizzata anche da altri fornitori e non è stata eguagliata.

Inoltre, la nostra esperienza nel campo delle applicazioni per le turbine eoliche ci permette di integrare soluzioni in cui siamo in grado di garantire affidabilità e alta efficienza. Ad esempio, i moduli senza base plate con tecnologia SKiiP® , basati su contatti a pressione termica. Il base plate è stato rimosso, e un sistema di pressione è stato integrato per spingere il DCB sul dissipatore su numerosi punti distribuiti uniformemente. Questa tecnologia di contatto a pressione assicura una bassa resistenza termica di contatto, un'eccellente resistenza al thermal cycling e maggiori densità di potenza. Inoltre, qualora vengano richieste correnti maggiori, si possono collegare molti moduli in parallelo senza alcuna difficoltà.

Bodo Arlt: Fino a che punto Semikron è coinvolta nelle applicazioni per l'energia eolica destinate al cliente finale?

Dejan Schreiber: Dalle specifiche iniziali fino alla fase di progettazione, lavoriamo a stretto contatto con i nostri clienti, garantendo loro servizi locali e supporto.

Dejan Schreiber

Dejan Schreiber ha ricevuto una Laurea con lode in Ingegneria elettrica presso l'Università di Belgrado nel 1970. Fino al 1988 ha fatto parte dell'Istituto Tecnico Nikola Tesla di Belgrado, nel dipartimento per l'Elettronica di potenza e il controllo. Contemporaneamente, era professore in visita ed insegnava presso le università di Belgrado e Novi Sad, Iugoslavia, e Harare, Zimbabwe.

Nel 1989 è entrato alla SEMIKRON di Norimberga, Germania, in qualità di Senior Application Manager. È specializzato in convertitori per l'elettronica di potenza, per turbine eoliche a velocità variabile e linee di motori a media tensione per motori AC di microturbine ad alta velocità e motogeneratori a velocità variabile; circuiti innovativi per applicazioni UPS; applicazioni per la trazione in treni, filobus, tram motori automobilistici ed applicazioni per celle a combustibile.

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Bodo Arlt: Che previsioni ha per l'utilizzo della tecnologia dei circuiti di driver per IGBT nelle applicazioni per inverter solari ed energia eolica?

Dejan Schreiber: Nelle applicazioni eoliche arriveranno circuiti di driver più intelligenti caratterizzati da una elevata integrazione.

Per quanto riguarda gli inverter solari, invece, Semikron sta attualmente lavorando assieme ai produttori di inverter solari. L'efficienza di un inverter solare è uno degli argomenti principali di vendita per il mercato finale, a causa della durata più limitata del periodo di recupero per forniture a corrente più elevata. Gli inverter solari operano ad alte frequenze di commutazione, per ridurre le dimensioni dei filtri. I diodi al carburo di silicio ed i MOSFET costituiscono soluzioni alternative ai classici diodi di ricircolo al silicio e agli IGBT, per ridurre le perdite di commutazione. Un inverter con SiC e IGBT ha una riduzione fino al 30% delle perdite di commutazione. Molto spesso, nei moduli vengono utilizzate topologie specifiche del cliente.

Bodo Arlt: Ritiene che gli inverter monolitici verranno utilizzati nelle future applicazioni per l'energia eolica?

Dejan Schreiber: Certamente. I blocchi monolitici consentiranno una maggiore flessibilità.

Bodo Arlt: Dobbiamo aspettarci più dispositivi in carburo di silicio per le soluzioni per l'energia eolica da parte di Semikron?

Dejan Schreiber: Non nell'immediato futuro. Poiché sono necessarie alte correnti, il rendimento fra l'investimento e la misurazione netta li rende una proposta non fattibile dal punto di vista economico.

Bodo Arlt: Quale fra i vostri concorrenti ritiene possa impegnarsi nella corsa alla leadership?

Dejan Schreiber: Come ho già detto, considerando i 72,6 GW di capacità totale di potenza per l'energia eolica installati a partire dal 1993, il 43% della suddetta capacità sfrutta tecnologia Semikron. I produttori di turbine eoliche hanno bisogno di soluzioni integrate di potenza, che includano raffreddamento, driver, sensori di corrente e funzioni di protezione perfettamente abbinati. È qui che facciamo la differenza rispetto alla concorrenza. I nostri clienti danno un gran valore al modulo SKiiP pronto all'uso, il quale garantisce eccellenti capacità di resistenza ai cicli di carico e al temperature cycling. Questo sottosistema IGBT è adatto per le applicazioni di potenza dell'ordine dei MW; ecco perché è uno dei più potenti moduli IPM sul mercato.

Attualmente, il settore dell'energia eolica sta crescendo in modo dinamico in Asia, aprendoci così la porta a nuove opportunità. Entro il 2020, il governo cinese ha in programma di coprire il 10% del fabbisogno energetico con fonti di energia rinnovabile.

Bodo Arlt: Sig. Dejan Schreiber, grazie mille per averci dedicato parte del suo tempo. Speriamo in un futuro positivo per i moduli di alimentazione nelle applicazioni per l'energia eolica e solare.

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Electrónica de Potencia en Aplicaciones Eólicas

con Dejan Schreiber, Senior Application Manager; Semikron

Por Bodo Arlt, Editor BP

Bodo Arlt: ¿Cómo afecta el creciente mercado de la energía eólica en el desarrollo de semiconductores de potencia de Semikron?

Dejan Schreiber: Nosotros tenemos nuestro mayor crecimiento en el sector de las energías renovables. De un total de 72.6 GW de energía eólica instalados desde 1993, 31 GW incorporan tecnología de Semikron. De hecho, a principios de los años 90, propusimos el primer módulo semiconductor de potencia pensado para su uso en aerogeneradores e invertimos en tecnologías que nos permitieron desarrollar un modulo integrado de potencia (Integrated Power Module) específico para aplicaciones de generación eólica debido a su alta confiabilidad, eficiencia, esperanza de vida en servicio y diseño escalable.

Nuestra experiencia en este campo nos permite desarrollar productos de tecnología punta, por lo que partimos con ventaja frente a nuestros competidores

Bodo Arlt:
¿Cuáles son los retos que se presentan en este mercado?

Dejan Schreiber: Hasta ahora, la electrónica de potencia era utilizada en el tramo final de la producción de energía. Sin embargo, comienza a utilizarse también en el tramo inicial, por ej, en los aerogeneradores, y en la parte de distribución, equipos de potencia en las líneas de transmisión. Por tanto, la calidad de la potencia entregada ha de mejorar y los requerimientos de las redes de distribución eléctrica son cada vez más estrictos. Los diferentes estándares existentes hacen que estos requerimientos sean todavía más complejos. Todas estas necesidades tienen que cumplirse a pesar de que cada vez hay más presión para realizar los desarrollos rápidamente. La mejor manera de afrontar este problema es desarrollar productos que creen una plataforma base y a partir de los cuales, se pueda expandir el rango fácilmente para cumplir con las demandas existentes de mayor potencia. Esto es un gran reto al que se enfrenta la industria de la electrónica de potencia.

Bodo Arlt: ¿Qué soluciones ofrece Semikron para mantenerse en cabeza en el mercado eólico?

Dejan Schreiber: Nuestra propuesta es el SKiiP, un módulo integrado de potencia que incluye el driver de disparo, sensores de corriente, funciones de protección y el disipador. También ofrecemos montajes de potencia y soluciones modulares que nos permiten alcanzar los MW de potencia. Para seguir siendo líderes, tendremos que desarrollar soluciones para potencias todavía superiores, en el rango de los 5 MW. En los próximos 5 años, podrían ser incluso de hasta 10 MW y al igual que sucede con cualquier sistema generador de alta potencia, los generadores eólicos tendrán que estar diseñados en media tensión.

Bodo Arlt: ¿Qué tipo de semiconductores recomienda utilizar para aerogeneradores de velocidad variable?

Dejan Schreiber: Semiconductores de 1700 V. Sin ninguna duda, las aplicaciones en el sector de las energías renovables necesitan semiconductores fiables y altamente eficientes. Como se puede ver en el caso de funcionamiento como inversores, al utilizar diferentes módulos de IGBTs, con el mismo encapsulado pero diferentes tensiones, 1700V (de baja Vcesat), 3300V y 6500V, y simulando la potencia de salida que pueden entregar, queda claro que los módulos de IGBTs de media tensión no son una solución económicamente viable. (Véase Fig. 1).

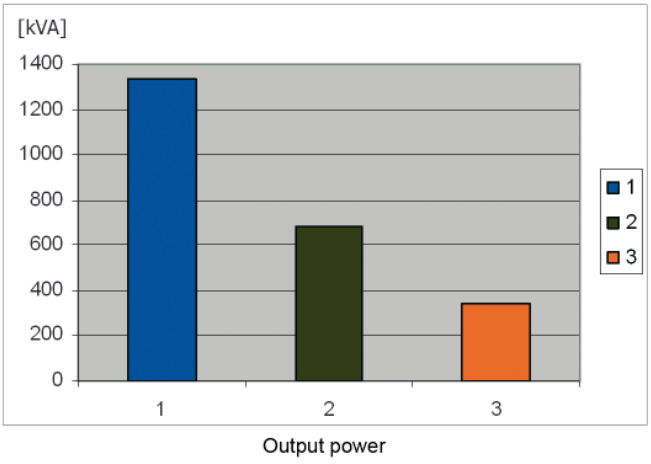

Figura 1: Potencia de salida de un inversor trifásico de IGBTs con módulos del mismo tamaño, mismas condiciones de ventilación y Fsw= 3.6kHz.

Si consideramos la potencia de salida para las mismas pérdidas generadas en forma de calor, observamos que los módulos de 3.3kV y 1200A pueden entregar sólo la mitad de la potencia entregada por los módulos de 1,7 kV y 2400 A. Los módulos de 6,5 kV y 600 A producirían sólo un cuarto de esta potencia.

Las condiciones de trabajo están ajustadas a los niveles de tensión, pero la frecuencia de conmutación es la misma, 3.6 kHz, en todos los casos. El motivo por el que se ha seleccionado la misma frecuencia de conmutación es el tamaño del filtro de salida. Entre 3 y 4 kHz, la potencia del filtro debe ser del orden del 15% de la potencia del inver-

sor. De esta manera, el filtro se mantiene similar en coste y tamaño. A la vista de estos resultados, es necesario utilizar otros enfoques para las topologías de inversores de media tensión.

Bodo Arlt: ¿Qué es lo que diferencia a Semikron de otros suministradores de módulos de potencia?

Dejan Schreiber: Nosotros nos centramos en analizar la aplicación en la que se utiliza el módulo. Desarrollamos y fabricamos semiconductores que permiten una fácil integración en la aplicación. Por ejemplo, hace muchos años, los módulos grandes de un único IGBT tenían sólo dos terminales (colector y emisor) y había dos versiones, una para interruptor superior (TOP) y otra para el interruptor inferior (BOT). Desde el principio, nosotros supimos ver las desventajas de esa configuración. Los módulos de potencia, para inversores en fuente de tensión (voltaje source inverters), deberían ser un semipuente (TOP y BOT) con terminales de DC y de AC separados. El layout del SKiiP, desarrollado hace más de 15 años, presenta los terminales de DC en un lado y los de AC en el lado contrario. Este diseño es ahora utilizado por otros fabricantes y no ha sido mejorado. Además, nuestra experiencia en aplicaciones de generación eólica nos permite ofrecer soluciones integradas donde podemos garantizar la fiabilidad y una alta eficiencia, por ejemplo, los módulos sin base de cobre con tecnología SKiiP® , que se basa en el contacto por presión. Se elimina la base de cobre y se presiona la DCB contra el disipador utilizando un sistema que reparte la presión uniformemente en varios puntos. Esta tecnología de contacto por presión asegura una baja resistencia de contacto, una larga durabilidad frente a los ciclos de temperatura y permite incrementar la densidad de corriente del módulo. Además, si se necesitan corrientes más grandes, se pueden conectar varios módulos en paralelo de una manera muy sencilla.

Bodo Arlt:
¿Cómo se involucra Semikron en la aplicación del cliente final?

Dejan Schreiber: Desde la especificación inicial y durante toda la fase de diseño, colaboramos estrechamente con los clientes y les ofrecemos un soporte y servicio locales.

Dejan Schreiber

Dejan Schreiber se graduó en Ingeniería Eléctrica en la Universidad de Belgrado en 1970. Hasta 1988 perteneció al departamento de Electrónica de Potencia del Instituto Técnico Nikola Tesla en Bel-grado. Al mismo tiempo, fue profesor en las universidades de Belgrado y Novi Sad, Yugoslavia al igual que en Harare, Zimbabwe.

En 1989, comenzó su carrera en SEMIKRON en Nuremberg, Alemania, como Senior Application Manager. Es especialista en convertidores de potencia para aerogeneradores de velocidad variable y diseño de variadores de media tensión para motores de AC, así como para microturbinas y generadores de alta velocidad, aplicaciones UPS, aplicaciones de tracción en trenes, tranvías y trolebuses, vehículos eléctricos y aplicaciones de células de combustible.

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Bodo Arlt: En un futuro, ¿cómo ve la tecnología de los drivers de disparo de IGBTS que se utilizar en inversores solares y en aplicaciones eólicas?

Dejan Schreiber: En aplicaciones de generación eólica, se necesitarán drivers más inteligentes que permitan una mayor integración.

En el caso de inversores solares, Semikron está trabajando en colaboración con fabricantes de estos inversores. La eficiencia de un inversor solar es uno de los principales argumentos de venta debido a la reducción del periodo de retorno de la inversión para mayores potencias. Los inversores solares trabajan a frecuencias de conmutación elevadas para reducir el tamaño de los filtros. Los diodos de carburo de silicio y los MOSFETs se usan como alternativa a los diodos de silicio estándar y a los IGBT´s para reducir las perdidas de conmutación. Un inversor con SiC e IGBT´s puede reducir las pérdidas de conmutación hasta en un 30%. Muy a menudo, se utilizan en los módulos topologías customizadas por el cliente.

Bodo Arlt: ¿Espera que en el futuro es usen inversores monolíticos en aplicaciones de generación eólica?

Dejan Schreiber: Por supuesto, bloques modulares monolíticos permitirán una mayor flexibilidad.

Bodo Arlt: ¿Podremos ver más productos de Semikron basados en carburo de silicio para aplicaciones eólicas?

Dejan Schreiber: No en un futuro cercano. Al ser necesarias cada vez corrientes más grandes, no compensa económicamente la inversión necesaria para fabricarlos en relación al aumento de potencia que se consigue.

Bodo Arlt: ¿Cuál de vuestros competidores cree que luchará con Semikron por el liderazgo en el sector?

Dejan Schreiber: De nuevo, hago referencia al total de potencia eólica instalada, 72.6 GW desde 1993, de los cuales el 43% incorpora tecnología Semikron. Los fabricantes de aerogeneradores necesitan soluciones de potencia completas que incluyan la refrigeración, los drivers de disparo, los sensores de corriente y que además, tengan funciones de protección incorporadas. Aquí es donde nos diferenciamos de la competencia. Nuestros clientes valoran el modulo SKiiP por su facilidad de uso y por su robustez y durabilidad frente a los ci clos de carga y temperatura. Este “subsistema” de IGBT es adecuado para aplicaciones incluso en el rango de potencia de los MW. El SKiiP es uno de los IPMs más potentes existentes en el mercado.

En la actualidad, también se nos presentan nuevas oportunidades en el creciente mercado asiático. El gobierno chino tiene como objetivo para el año 2020 cubrir un 10% de su necesidad energética mediante energías renovables.

Bodo Arlt: Sr. Dejan Schreiber, Muchas gracias por habernos dedicado su tiempo. Esperamos que haya un brillante futuro para los módulos semiconductores de potencia en aplicaciones de generación eólica y solar.

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Силовая электроника для ветроэнергетики

Интервью с Деяном Шрайбером, главным техническим специалистом компании Semikron

Bodo Arlt, редактор журнала Bodos Power

Bodo Arlt: Какое влияние растущий рынок ветроэнергетики оказывает на совершенствование технологий силовых полупроводников Semikron?

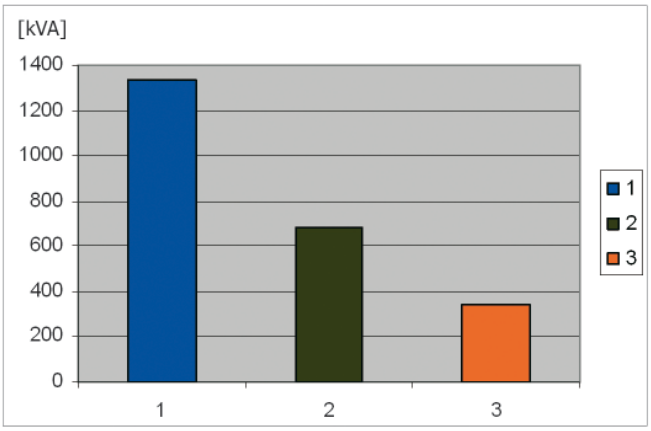
Dejan Schreiber: Мы достигли высших показателей роста на рынке возобновляемых источников энергии. 31 ГВт из 72,6 ГВт общей мощности, получаемой от ветроэнергетических установок, введенных в действие с 1993 года, вырабатывается установками, использующими технологии SEMIKRON. По сути дела мы были первой компанией, разработавшей в начале 90-х годов специализированную силовую сборку, в которой применялись технологии, схемы и конструкции интегральных силовых модулей, специально разработанные для применения в ветрогенераторах. Главным их отличием является высокая надежность, большой срок службы, высокая эффективность преобразования и масштабируемость конструкции. Огромный опыт SEMIKRON в области силовой электроники позволяет нам опираться на имеющиеся удачные решения и разработки и обеспечивает хорошие преимущества по сравнению с конкурентами.

Bodo Arlt:
Каковы основные особенности и проблемы этого рынка?

Dejan Schreiber: До настоящего времени электронные модули использовались как выходные преобразовательные элементы при производстве энергии. Однако силовая электроника может применяться и в каскадах первичной обработки мощности, что особенно полезно в области ветроэнергетики и системах распределения энергии. Это позволяет существенно улучшить качество электроэнергии, тем более что требования к «интеллектуальным» энергетическим сетям с течением времени становятся все более строгими. Еще более жесткими и трудновыполнимыми их делают современные стандарты и директивы. Однако все указанные требования должны быть удовлетворены, несмотря на тот факт, что ведущими производителями уже прилагаются максимальные усилия по ускорению развития силовых технологий. Лучшим способом решения поставленной задачи является разработка базовых масштабируемых платформ, с помощью которых достаточно легко наращивать мощность, удовлетворяя при этом современным требованиям по качеству энергии. Этот путь предоставляет грандиозные возможности для индустрии силовой электроники и энергетики.

Bodo Arlt: Какие усилия предпринимает Semikron, чтобы оставаться лидером рынка силовой электроники?

Dejan Schreiber: Прежде всего мы продолжаем совершенствовать интеллектуальные модули высокой степени интеграции SKiiP, включающие систему охлаждения, устройство управления и защиты, а также датчики. Мы способны производить специализированные силовые сборки широкого применения и масштабируемые платформы мощностью до единиц МВт. Чтобы оставаться лидерами рынка ветроэнергетики мы должны, кроме того, предлагать решения для энергетических систем высокой мощности. В настоящее время это установки мощностью более 5 МВт, а в течение ближайших пяти лет необходимо разработать преобразователи 10 МВт и более. При этом необходимо учесть, что ветрогенераторы, как и все мощные электрические генераторы, должны работать в высоковольтном диапазоне (в англоязычной литературе этот диапазон напряжения называется MV – Medium Voltage).



1. 1,7kV; 2400A Vdc = 1100V Vac = 690V
2. 3,3kV;1200A Vdc = 1800V Vac = 1130V
3. 6,5kV; 600A Vdc= 3600V Vac= 2260V

Рисунок: Выходная мощность 3-фазного инвертора, построенного на модулях одного типоразмера при одинаковых условиях охлаждения и частоте коммутации Fsw= 3.6кГц

Bodo Arlt: Силовые полупроводники какого класса напряжения вы рекомендуете для применения с ветрогенераторами с переменной скоростью вращения?

Dejan Schreiber: Только 1700 В. Несомненно, что при создании преобразователей, предназначенных для работы с возобновляемыми источниками энергии, требуются высокоэффективные и надежные силовые ключи. Если мы рассчитаем выходную мощность инвертора, построенного на IGBT модулях одного типоразмера, но различного класса напряжения: 1700 В, а также 3300 В и 6500 В, то увидим очевидные преимущества применения низковольтных полупроводников. Как видно из рисунка, мощностные возможности и эффективность работы инвертора с высоковольтными ключами существенно ниже. При одинаковом уровне потерь мощности модули с рабочим напряжением 3,3 кВ и током 1200 А способны выработать половину от возможного значения мощности. И только четверть мощности, обеспечиваемой низковольтными ключами (1700 А, 2400 А), может быть получена при использовании высоковольтных модулей с напряжением 6500 В и током 600 А. В общем случае оптимальные условия эксплуатации зависят от типа применяемых полупроводниковых модулей, а в рассматриваемом примере расчеты сделаны для одинаковой рабочей частоты 3,6 кГц. Причина этого состоит в том, что при работе на такой частоте размеры выходного синусоидального фильтра находятся в разумных пределах. При частоте коммутации в диапазоне 3…4

кГц, потери мощности на фильтре составляют примерно 15% от мощности инвертора. Однако даже при близких размерах фильтра, для построения высоковольтного инвертора на IGBT различного класса требуются совершенно разные схемные решения.

Bodo Arlt: Что в первую очередь отличает Semikron от других производителей?

Dejan Schreiber: Прежде всего, мы ориентированы на конечное применение. Наша компания разрабатывает и производит широкую номенклатуру полупроводниковых модулей, предназначенных для работы в конкретных схемах. Например, много лет назад мощные одиночные IGBT имели только 2 терминала (коллектор и эмиттер) и выпускались в двух исполнениях для применения в каскадах верхнего и нижнего плеча полумостового каскада. Мы понимали недостатки такого решения с самого начала, очевидно, что в инверторе напряжения, базовым элементом которого является полумост, силовые модули должны иметь раздельные DC и AC терминалы. Интеллектуальные силовые ключи SKiiP, конструкция которых была разработана более 15 лет назад, имеют силовые выводы для подключения звена постоянного тока и AC выхода, расположенные по разные стороны корпуса. При этом каждый полумост снабжен индивидуальными терминалами, позволяющими осуществлять их параллельное соединение с помощью простой шины. Этот конструктив в настоящее время широко используется другими производителями, и до сих пор никто не придумал ничего лучшего. Кроме того, колоссальный опыт SEMIKRON в ветроэнергетике позволил нам создать ряд интегральных силовых модулей, применение которых гарантирует как отличные показатели надежности, так и высокую эффективность. Примером является несколько семейств модулей IGBT без базовой платы, разработанных по SKiiP технологии прижимного контакта. Все тепловые связи в силовых ключах подобной конструкции осуществляются за счет многоточечного прижима, что позволяет обеспечить равномерное распределение тепла и низкое тепловое сопротивление. Безбазовые модули прижимного типа имеют гораздо более высокую стойкость к активному и пассивному термоциклированию, чем силовые ключи традиционной конструкции. Они обеспечивают предельно высокую плотность мощности и простоту параллельного соединения.

Bodo Arlt: Насколько глубоко Semikron участвует в работе над проектированием ветроэнергетических установок?

Dejan Schreiber

Деян Шрайбер получил диплом с отличием по специальности «Электротехника» в Белградском университете в 1970 г. До 1988 года он работал в техническом институте имени Николы Теслы в Белграде в отделе Силовой электроники и Управления. В это же время он читал лекции и работал в качестве приглашенного профессора в университетах городов Белград и Новый Сад (Югославия), а также университете города Хараре в Зимбабве.

В 1989 г. Деян Шрайбер начал свою деятельность в компании СЕМИКРОН в Нюрнберге в качестве старшего технического специалиста. Его специализацией являются силовые преобразователи для ветрогенераторов с переменной скоростью вращения, высоковольтные привода асинхронных двигателей, привода высокоскоростных микротурбин, мощные источники бесперебойного питания, привода для электропоездов, троллейбусов и трамваев, транспортные средства с атарейным питанием, автоэлектроника и преобразователи для топливных элементов.

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Dejan Schreiber: Вместе с заказчиком SEMIKRON участвует в работе над проектом, начиная с выдачи технического задания и до выпуска рабочей документации. Кроме того, мы обеспечиваем наших партнеров постоянной технической поддержкой.

Bodo Arlt: Как Вам видится будущее IGBT технологий применительно к солнечной энергетике и ветроэнергетике?

Dejan Schreiber: Сектор ветроэнергетики требует разработки модулей высокой степени интеграции и «интеллектуализации». Что касается солнечной энергетики, здесь Semikron работает в тесном контакте с производителями инверторов для солнечных термальных станций. Максимальная эффективность преобразования для таких устройств является главным экономическим аргументом для продвижения на рынке. Большая плотность тока и высокий к.п.д. обеспечивают минимальный срок окупаемости изделия.

Инверторы солнечных станций работают на высоких частотах, что необходимо для минимизации размеров фильтров. Диоды из карбида кремния (SiC) и MOSFET транзисторы в данном случае могут стать альтернативой кремниевым быстрым диодам и IGBT ключам, поскольку их использование позволяет снизить уровень динамических потерь. Только замена стандартных диодов на SiC в IGBT преобразователях позволяет уменьшить коммутационные потери почти на 30%. Кроме того, для такого специфического применения, как солнечные энергетические станции требуется разработка специальных конфигураций схем.

Bodo Arlt: Ожидаете ли Вы в будущем появления инверторов для ветроэнергетических установок в интегральном исполнении?

Dejan Schreiber: Определенно да, поскольку применение интегральных блоков обеспечивает высокую «гибкость» и масштабируемость изделия.

Bodo Arlt: Собирается ли Semikron шире использовать SiC технологии для ветроэнергетических применений?

Dejan Schreiber: Не в ближайшем будущем. На этом рынке требуются, прежде всего, сильноточные ключи, а инвестиции, необходимые для разработки достаточно мощных модулей на основе карбида кремния, пока экономически не оправданы.

Bodo Arlt: Кто из ваших конкурентов по вашему мнению способен бороться за лидерство?

Dejan Schreiber: Отмечу еще раз, что общая мощность ветроэнергетических установок, запущенных с 1993 года во всем мире, составляет 72.6 ГВт и в 43% из них используются технологии и компоненты Semikron. Производители ветрогенераторов нуждаются в преобразователе типа «all-in-one», содержащем силовые каскады, согласованную систему охлаждения, интегрированную схему управления, мониторинга и защиты. Мы способны предложить такое устройство и в этом наше главное отличие от конкурентов. Наличие всех указанных свойств у модулей серии SKiiP и их высокая стойкость к активному и пассивному термоциклированию обусловливает высокую потребительскую ценность компонентов данного типа для наших заказчиков. Интеллектуальные силовые ключи (IPM) SKiiP предназначены для использования в мегаваттном диапазоне мощностей, на сегодняшний день это одни из самых мощных IPM на рынке. В настоящее время большие возможности для нас представляет динамично развивающийся рынок ветроэнергетики в Азии. Правительство Китая планирует к 2020 году покрыть 10% потребности страны в электроэнергии за счет использования возобновляемых источников.

Bodo Arlt: Гн. Шрайбер, большое спасибо за то что нашли время ответить на наши вопросы. Мы с надеждой смотрим в будущее и понимаем, какие радужные перспективы открывает для нас рынок ветряной и солнечной энергетики.

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关于电力电子在风力发电中应用的访谈

访赛米控高级应用经理*Dejan Schreiber*

Bodo Arlt, Editor BP

Bodo Arlt: 不断增长的风能市场会给赛米控的功率半导体开发带来什么样的影响？

Dejan Schreiber: 我们在可再生能源市场实现了最大的增长度。自1993年以来，全球总风力发电装机容量为72.6 GW，其中31GW采用了赛米控的技术。事实上，我们在九十年代初提供了第一个用于风力发电的功率半导体解决方案。当时我们对一个专用于风力发电机的集成功率模块的技术和驱动器拓扑结构进行了研究，因为它运行可靠性高，服务预期寿命长，效率高且可扩展的设计。

我们对技术的长期跟踪，使得我们能够开发出先进的产品和设计。这给了我们一个超过竞争对手的良好开端。

Bodo Arlt: 这个市场所面临的挑战或选择是什么？

Dejan Schreiber: 直至目前为止，电力电子技术被用于电能生产的后端。但是，电力电子产品也可用于前端，例如在风力发电中，以及作为配电——在输电线路解决方案的前端和后端。由此，改进了电能质量。

配电对智能网格的要求正变得越来越严格。标准和审批使得需求更为复杂。所有这些需求都要得到满足，即使加快开发速度的压力已经增大。满足这一要求的最好方式是开发能够形成基础平台的产品，这些产品可以很容易被扩充，以应对不断增长的对功率等级的需求功率范围。这对电力电子产业是巨大的挑战。

Bodo Arlt: 赛米控提供什么样的解决方案以确保在风力发电市场保持领先地位？

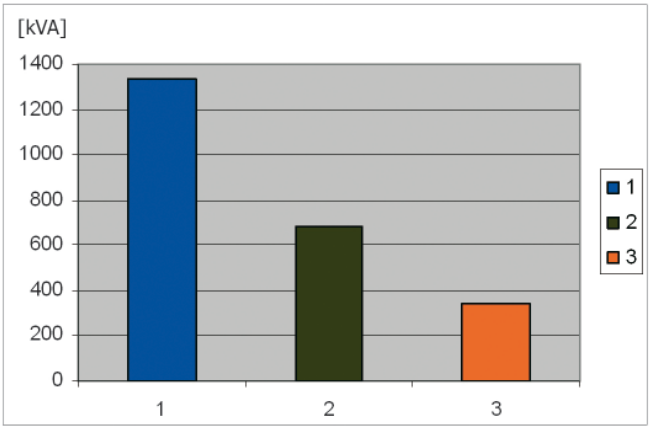
Dejan Schreiber: 我们提供 SKiiP，一款包含了完美匹配冷却系统、栅极驱动器、电流传感器和保护电路的集成功率模块。我们还有兆瓦级的功率模块装配和扩展方案。然而，为了在风力发电市场保持领先地位，我们必须为更高功率的需求开发解决方案。这些需求中功率超过5 MW，5年内将达到10 MW。 与这些大功率发电机相比，风力发电机属于中压系统。

Bodo Arlt: 对于变速风力发电机，您推荐多大的半导体电压？

Dejan Schreiber: 1700 V。可再生能源的应用无疑需要高效率和得到验证的半导体。

运行配备尺寸相同但电压不同（1700 V（低压器件）、3300V和6500V）的IGBT模块的逆变器并模拟可获得的输出功率，可以看出中压IGBT显然不是一个经济的解决方案（见图1 ）。输出功率的限制等于总功率损失。对于相同的功率损失， 3.3kV 1200A中压模块只能产生一半的可用功率。1.7kV 2400A和6.5kV 600A模块只能产生四分之一的可用功率。

根据电压水平调整运行条件。开关频率均为3.6 kHz，使用相同开关频率的原因是滤波器的尺寸。在3- 4 kHz，正弦滤波器的功率约为逆变功率的15%。这样，所有逆变器都有相似的滤波器尺寸和成本。这意味着，对于兆伏级设备，需要不同的逆变电路。



Output power

1. 1,7kV; 2400A 2. 3,3kV;1200A 3. 6,5kV; 600A

Vdc = 1100V Vdc = 1800V Vdc= 3600V

Vac = 690V Vac = 1130V Vac= 2260V

图 ：Fsw= 3.6kHz时，相同模块尺寸和冷却条件下，三相IGBT逆变器的输出功率

Bodo Arlt: 是什么使得赛米控与其他模块供应商有所不同？

Dejan Schreiber: 我们是面向应用的。我们开发和生产便于在给定应用中使用的功率半导体。

举个例子，很多年前，巨型IGBT单开关模块只有两个端子（集电极和发射极），并且有两套，就像在镜子里一样。一个用于底部开关，一个用于顶部开

关。我们从一开始就意识这种解决方案的缺点。对于电压源逆变器，功率模块必须是一个配有单独DC和AC端子的半桥。SKiiP的布局，从诞生至今已超过15年，在模块的一侧有DC端子，另一侧有AC端子，并且有几个平行端子。现在其他供应商也使用这种设计，并没有得到突破。

此外，我们在风力发电领域的经验使得我们可以整合解决方案，并保证可靠性和高效率。

例如，采用SKiiP®技术的无基板模块，该模块基于热压触点。基板被去除了，集成的压力系统在一些均匀散布的点上将DCB压在散热器上。这种压接技术确保了小热阻，出色的耐高低温循环能力并增加了功率密度。另外，如果需要大电流，可以很容易地并行开关几个模块。

Bodo Arlt: 赛米控直接参与最终用户风力发电应用的程度如何？

Dejan Schreiber: 从最初的规格到设计阶段，我们与客户紧密地配合，并为他们提供本地服务和支持。

Bodo Arlt: 您如何看待用于太阳能逆变器和风力发电应用的IGBT栅极驱动技术的未来？

Dejan Schreiber: 在风力发电应用中，需要更加智能的驱动电路，这些电路中集成度是主要驱动力。

至于太阳能逆变器， 赛米控正与太阳能逆变器制造商密切合作。对于最终市场来说，太阳能逆变器的效率是其中一个主要的卖点，由于其较短的回报期和较高的电流供应。太阳能逆变 器运行在高开关频率下，以减少滤波器的尺寸。碳化硅二极管和MOSFET是标准硅续流二极管和IGBT的替代解决方案，以减少开关损耗。配备了碳 化硅和IGBT的逆变器已经可以将开工损耗降低30 %。很多时候，模块中采用客户特定的拓扑结构。

Dejan Schreiber

Dejan Schreiber 先生1970年 获得贝尔格莱德大学电气工程专业荣誉硕士学位。此后至1988年，他一直在贝尔格莱德的尼古拉 • 特斯拉电子技术研究所的电力电子与控制部工作。与此同时，他也是南斯拉夫贝尔格莱德和诺维萨德以及津巴布韦哈拉雷几所大学的讲师和客座教授。

1989年他加入德国赛米控（纽伦堡）公司，任高级应用经理。他的专长包括研究变速风力发电机的电力电子变换器和用于交流电动机驱动的中压驱动器设计，高速微型燃气轮机和变速机组，用于UPS应用的新型电路，列车中的牵引应用，无轨和有轨电车，电池驱动汽车，汽车驱动和燃料电池的应用。

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Bodo Arlt: 您期望单片逆变器被用于未来的风力发电应用中吗？

Dejan Schreiber: 那是肯定的。单片组件将带来有更多的灵活性。

Bodo Arlt: 我们能期望在赛米控风力发电解决方案中看到更多的碳化硅器件吗？

Dejan Schreiber: 近期还不会。由于需要大电流，投资和净计量之间的权衡使得它在经济上是不可行的。

Bodo Arlt: 您认为你们的哪些竞争对手会有推动这种领导地位的竞争?

Dejan Schreiber: 再看一下，自1993年以来，已安装的总风力发电装机容量为72.6 GW，其中43 %的风力发电机采用了赛米控的技术。风力发电机制造商需要一体化的功率解决方案，包括匹配的冷却系统、栅极驱动器、电流传感器以及集成保护功 能。这里，我们有不同的竞争优势。我们的顾客从随时可用的SKiiP模块中获益，该模块提供优秀的负载与温度循环能力。

该IGBT子系统适用于兆瓦级电力应用，这也正是为什么它是市场上最强大的IPM之一。

目前，亚洲不断增长的动态风能市场也给我们带来新的机遇。到2020年，中国政府计划其能源需中的10%由可再生能源提供。

Bodo Arlt: Dejan Schreiber先生，非常感谢您抽出宝贵的时间接受我们的采访。我们期待着功率模块在风力发电和太阳能应用中有一个美好的未来。

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