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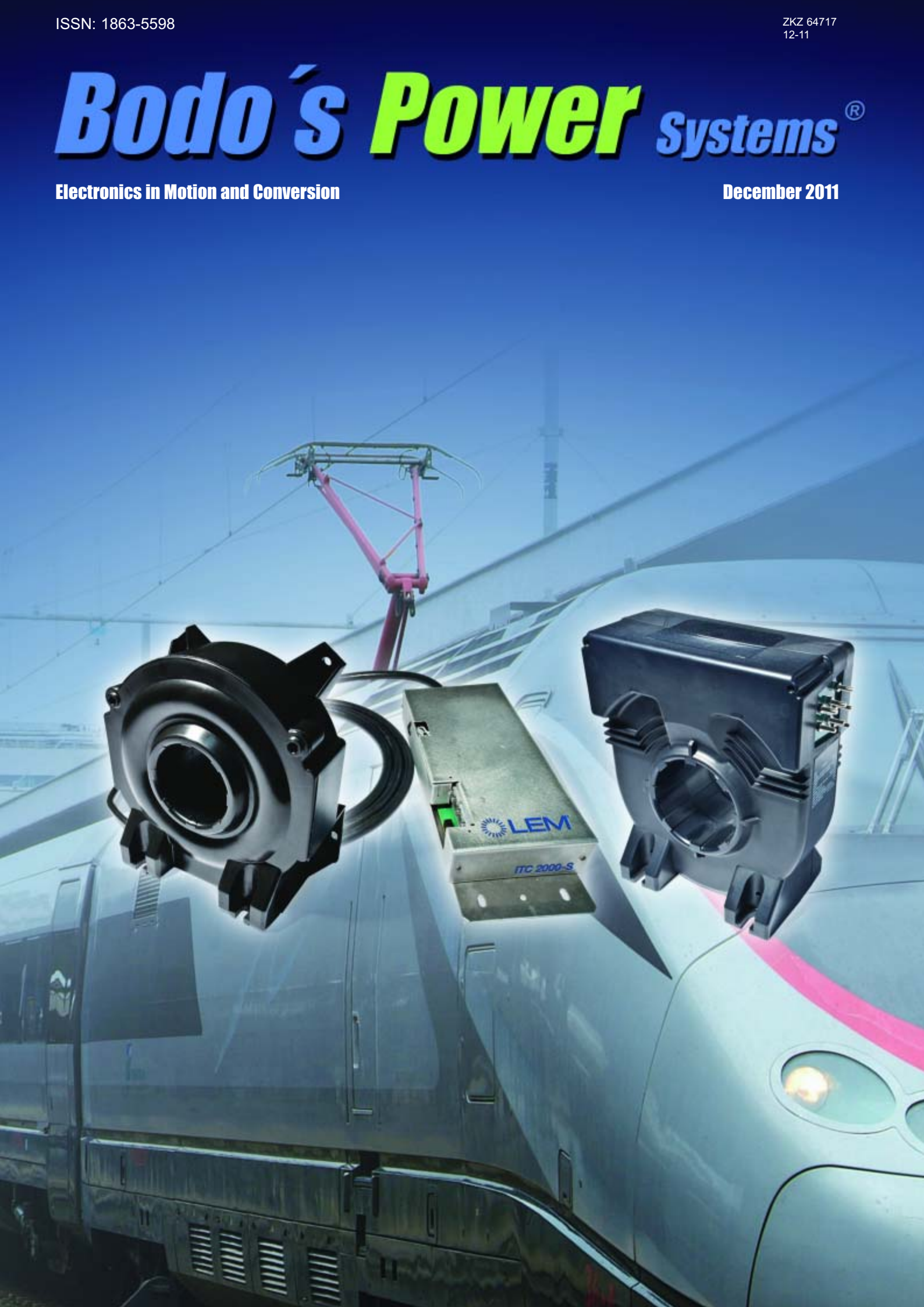
Bodo´s Power Systems®

Electronics in Motion and Conversion

December 2011



LAUNCHING YOUR PROJECTS

GvA Power Electronics

Welcome to the House of Competence.

GvA is your expert in individual problem solutions for all sectors of power electronics – state of the art know how and profound experience as an engineering service provider, manufacturer and distributor.

Consulting – Design & Development – Production – Distribution

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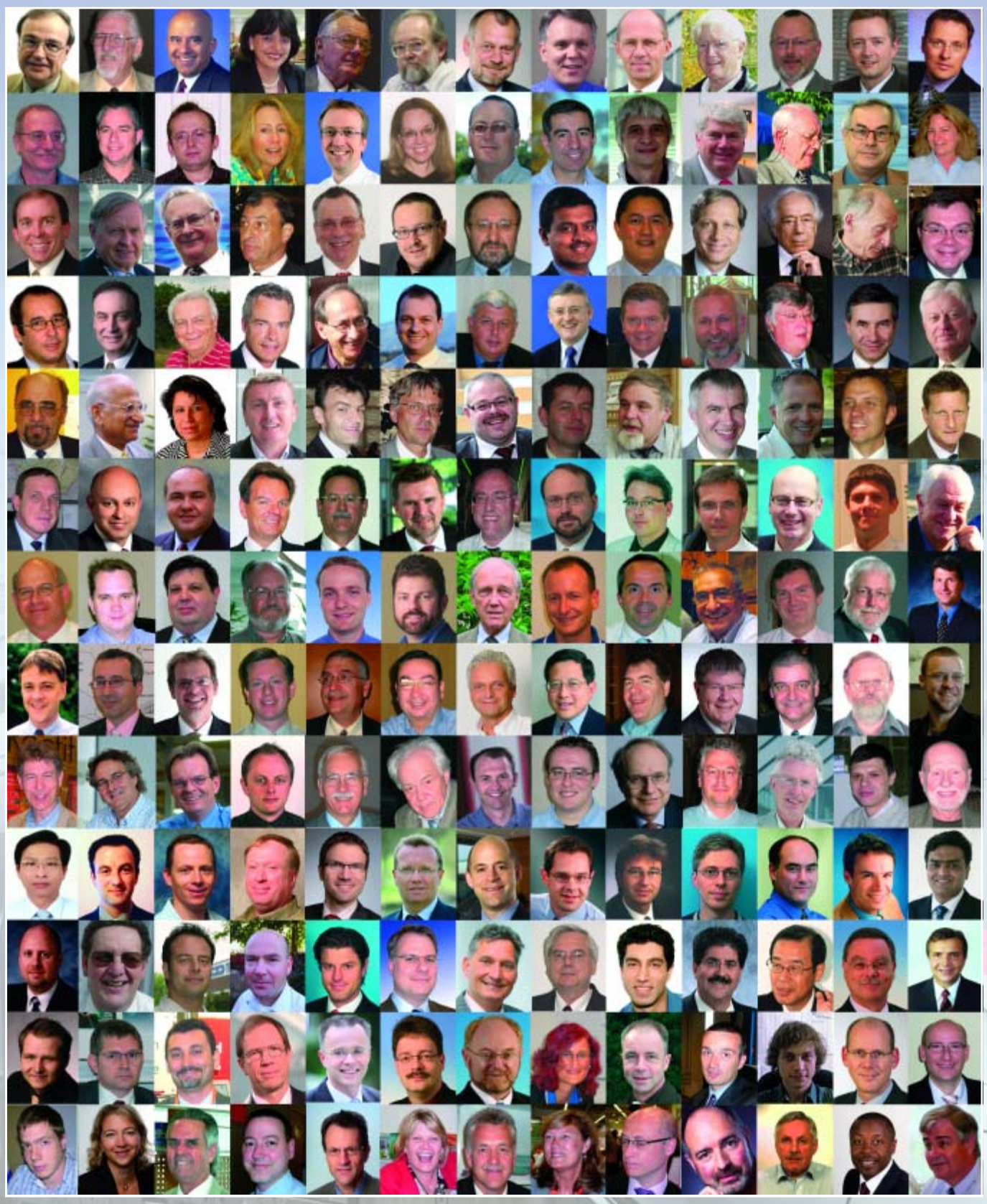
The Gallery



Achieve Superior Efficiency In Your Power Inverter Designs

With more than two decades experience, Microsemi's unique mixed semiconductor power module products feature a combination of configurations and technologies to ensure maximum performance and reliability.

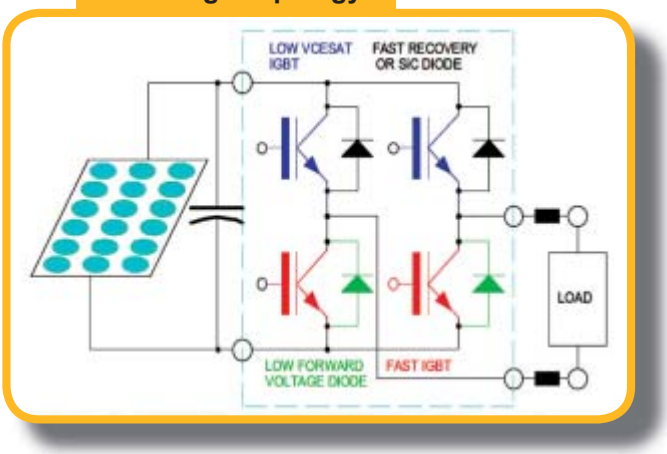
Microsemi
POWER PRODUCTS GROUP

Low-Profile Power Modules

- **MOSFET - IGBT - FRED - SiC**
- **75 - 1700 volts, 10 - 750 amps, 5 - 500 kW**
- **High-efficiency**

As Microsemi's global channel partner, Richardson RFPD provides the engineering support to identify the best solution for your application.

Full Bridge Topology



Others include: 3-Level Inverter, PFC, Phase Leg, Single Switch, 3-Phase Bridge, Rectifier Bridge, AC Switch

Download Application Brochure

View Microsemi's latest low-profile power modules brochure at: www.rell.com/microsemi

Your Global Source for RF, Wireless & Energy Technologies

RichardsonRFPD
An Arrow Company

www.richardsonrfpd.com

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Heusenstamm, Germany

Events

Power electronics,
Moscow, Nov. 29th –Dec. 1st
www.powerelectronics.ru

Green Building,
San Jose CA, Jan. 23rd-25th
http://greenbuildingpower.darnell.com

Smart Grids Summit
Stockholm, Jan. 24th -25th
www.thesmartgridsummit.com

APEC,
Orlando, Florida, Feb. 5th -9th
http://apec-conf.org

EMC,
Düsseldorf, Germany, Feb. 7th -9th
www.mesago.de/en/EMV/main.htm

Embedded world,
Nuremberg, Germany,
Feb 28th- March 1st
www.embedded-world.de

Thank You, my Dear Readers,

A very successful year for my publication is nearing its end. We've published almost 800 pages, 60% of which was technical articles and news. This ratio makes Bodo's Power Systems a preferred magazine for busy engineers in research and development. This year our readership also peaked with an overall worldwide distribution of 20,000 print issues per month. Postal distribution increased in North America to more than 3,000 readers, total international has reached 5,000, whereas five years ago we had only 300. It's the trust and support of our industry, at the leading edge, that has made this possible month after month.

I'd like to say thank you to my readers, but also to our industry which represents technologies that reflect progress and treat energy with care. Together we are a family, with a responsibility to help save the world's resources for coming generations. There are about three dozen shows and conferences around the world who recognize this and partner with my publication to our mutual success.

My website is constantly updated, delivering very current news and information. Twice monthly, my e-newsletter reaches its audience and with a 93% opening rate, an unbeatable quote in the industry, it is apparently welcomed. It feels good to have such a great Power Electronics family.

Christmas is a time for our families to come together and give thanks for peace and health. Our life on this planet is a short one and we must understand that only teamwork will get us through and preserve our future. Let's hope that governments worldwide will have the competence to guide and regulate financial disasters and prevent collapsing markets. Think about friends and relatives that have fallen on hard times and invite them to visit for Christmas. It is also the time to open the presents, let the trains come out and the kids to play and explore the world of technology.

Communication is the only way to progress. We have now delivered eleven issues this year, with 794 pages of information - on time, every time. As a media partner, Bodo's Power Systems is internationally positioned.

My Green Power Tip for December:
The leaves are falling down and gathering around our houses. Rather than panic about clearing them away, build a pile in your back yard and let the porcupine have a home for the winter. He will help keep an organic balance in your garden for next year.

Merry Christmas and a Happy New Year

Future precision.
Future performance.
Now available.

CAS-CASR-CKSR

The transducers of tomorrow. LEM creates them today. Unbeatable in size, they are also adaptable and adjustable. Not to mention extremely precise. After all, they have been created to achieve great performance not only today – but as far into the future as you can imagine.

- Several current ranges from 6 to 50 A_{RMS}
- PCB mounted
- Up to 30% smaller size (height)
- Up to 8.2 mm Clearance / Creepage distances +CTI 600 for high insulation
- Multi-Range configuration
- +5 V Single Supply
- Low offset and gain drift
- High Accuracy @ +85° C
- Access to Voltage Reference
- Analog Voltage output

www.lem.com

At the heart of power electronics.

LEM®

Arunjai Mittal Becomes Management Board Member

The Supervisory Board of Infineon Technologies AG resolved yesterday to extend the Management Board by one member. Arunjai Mittal is appointed to the Management Board effective January 1, 2012. The Management Board will, thus, consist of four persons in future.
The Industrial & Multimarket (IMM) business will be divided into two divisions, Power Management & Multimarket (PMM) and Industrial Power Control (IPC), effective January 1, 2012. The Chip Card & Security (CCS) Division and Automotive (ATV) Division will remain as they are.
Infineon has developed into a successful, stable company with sustainable growth prospects. By focusing on energy efficiency, mobility and security with its market-leading products and system solutions, Infineon addresses areas of high economic significance and social relevance.
Arunjai Mittal is the long-standing Head of the Industrial & Multimarket (IMM) Division. In his role as member of the Management Board, he will be responsible for the Regions, Sales, Marketing, Strategy Development and Mergers & Acquisitions (M&A). Therewith he will be responsible for drawing up and agreeing possible strategy options. Peter Bauer, as the CEO of Infineon Technologies AG, is and remains responsible for the overall strategy of the company and its divisions. The responsibilities of Dr. Reinhard Ploss and Dominik Asam on the Management Board remain unchanged.

www.infineon.com/presse008

Experimental Power Grid Centre to Spur R&D Collaborations

The Experimental Power Grid Centre (EPGC), one of the largest experimental power grid facilities in the world was officially opened in Singapore, on November 1st, by Mr. S. Iswaran, Minister in the Prime Minister's Office and Second Minister for Home Affairs and Trade & Industry.
Located on Jurong Island, EPGC, the Agency for Science, Technology and Research's (A*STAR's) centre for energy research is established to support Singapore's goal toward developing a smart energy economy. The facility will pave the way for cutting-edge research and research collaborations with local and international partners to develop future energy technologies in areas of electrical power networks and energy distribution and renewable energy resources, for eventual commercialisation.
At the opening, A*STAR's EPGC signed a research collaboration agreement with SP PowerGrid and three MOUs respectively with Housing Development Board (HDB), Meidensha Corporation Japan and National Instruments. These agreements span research in varied fields, including renewable energy integration, advanced high efficiency inverters and smart grid control, with the aim of developing robust, cutting-edge solutions that can be quickly adopted and implemented.
The research collaboration with SP PowerGrid will study how to improve the reliability of the grid to enable SP PowerGrid to continue delivering world-class power reliability and quality. "SP PowerGrid is pleased to work with EPGC, a leading research institute in electricity grid-related technologies, to explore and develop new smart grid technologies that are robust and yet cost-effective for our operations," said Sim Kwong Mian, Managing Director, SP PowerGrid.

www.a-star.edu.sg

Power Electronics eCommerce Portal in China

The B2B eCommerce Portal of Zhuhai SindoPower Electronics Company Ltd., a holding company of the SEMIKRON Group, went live on 01.09.2011. The unique feature of this portal is the comprehensive technological support service and information pool brought to users through a variety of media: technology chat room, E-mail and telephone service. This provides users with personal online and telephone support in all matters relating to power electronics.

Dr. Walter Demmelhuber, CEO of SindoPower

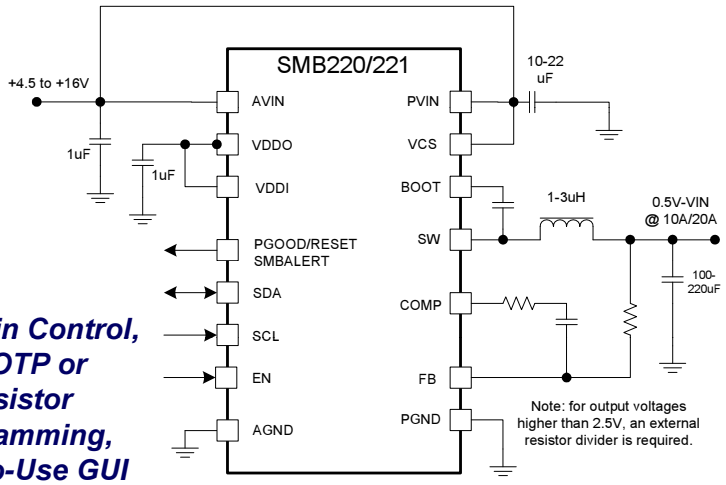
Dirk Heidenreich, CEO of Semikron

The SindoPower portal features an online shop containing a wide range of SEMIKRON products that can be delivered straight from the warehouse. Power electronic modules can be ordered directly from the online store at reasonable prices and even in small quantities. Product information such as graduated price ranges, availability, replacement time and custom duty information can be accessed directly at www.sindopower.cn. In the "Knowledge Base" users can access a comprehensive information pool covering all areas related to power electronics. Besides help with registration and ordering, the portal also focuses on providing technological support. On the technology telephone hotline and in TechChat, power electronics experts are available to answer technological questions related to the different products.
"We are undertaking to meet the typical challenges that arise in relation to purchasing demands and inquiries," states Dr. Walter Demmelhuber, CEO of SindoPower. "The slogan 'Power electronics in the web' is not intended to simply reflect the presence of power electronics on the internet, but is also hoped to set new standards in B2B order procedures, access to information and user networking. We analyse the contents of customer inquiries regularly and put the answers to frequently asked questions online."
"SindoPower is the first portal in the field of power electronics to link eCommerce with technological consultation," comments Dirk Heidenreich, CEO of SEMIKRON. "This portal gives development engineers online access to an extensive pool of technological information and the opportunity to contact experts in the TechChat or on the telephone hotline."
SindoPower also offers a number of additional services, such as electronic invoicing, online consignment tracking and connection to an EDI interface. In future, presentations and web seminars containing audio recordings on a variety of topics relating to power electronics will also be available.

www.sindopower.cn

Programmable Integrated DC-DCs Deliver Big Power and Small Size

10A and 20A Output with Built-in MOSFET's and Digital Control Advanced Power Management with No Extra Components or Cost



I²C or Pin Control, NV OTP or Resistor Programming, Easy-to-Use GUI

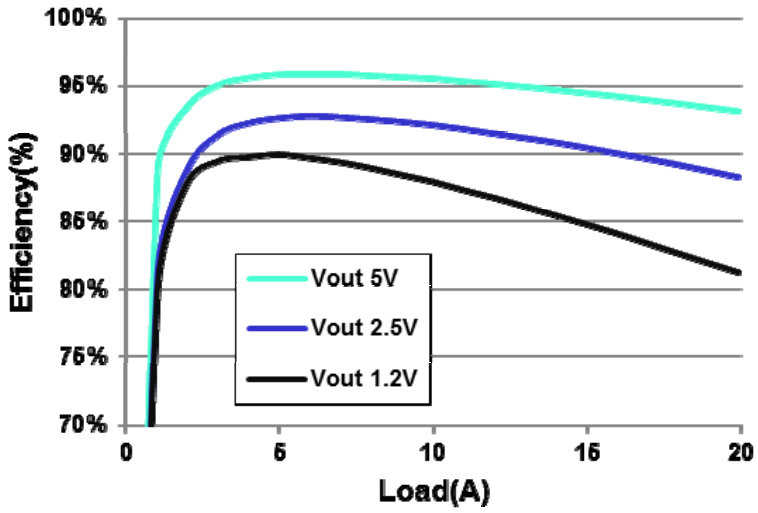
Features

- Integrated MOSFETs up to 10A/20A output
- 1% Output accuracy
- Digitally Programmable with Non-Volatile OTP Configuration or External Resistors
  - Static/dynamic output voltage/margining
  - Softstart timing/slew rate
  - RESET/PGOOD behavior
- True Current-Mode PWM Control
- Built-in Safety and Protection
  - Cycle-by-cycle current limit
  - Over-temperature protection
- Tiny 5mm x 6mm QFN Package

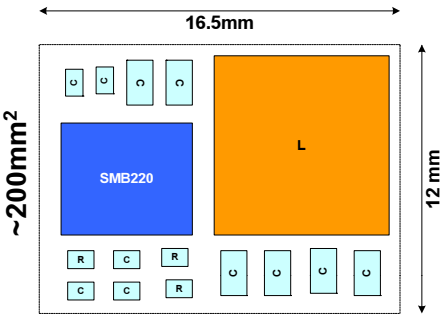
Applications

- Server, Notebook and Tablet Computing
- Enterprise Switches/Telecom Routers
- POL Power Modules
- Digital/IP Set-Top-Box/DTV/Smart TV
- Storage Equipment and Disk Drives

Efficiency with +12V Input



Fewest Components Smallest Footprint



Summit Programmable DC-DC Family

	SMB109/8/6	SMB206/7/8/A	SMB209/10/A	SMB211	SMB220/1
Input Voltage Range (V)	4.5 to 28	4.5 to 16	4.5 to 16	4.5 to 16	4.5 to 16
# of Outputs	2/3/4/8	2	1	1	1
Output Current (A)	>20	1/2/3	4/6	>20	10/20
Switching Frequency (kHz)	300-1200	500/1000	500/1000	250-1000	250-1000
Output Voltage Range (V)	0.5-VIN (Prog)	0.8-VIN (Prog)	0.8-VIN (Prog)	0.5-VIN (Prog)	0.5-VIN (Prog)
Internal/External FETs	External	Internal	Internal	External	Internal
Output Voltage, Seq., Softstart, OCP	Prog	Prog	Prog	Prog	Prog
Output UV/OV Monitor	Prog	√	√	Prog	Prog
RESET/POWER GOOD Output	√	√	√	√	√
I2C/SMBus Interface	√	√	√	√	√
Packages	7x7 QFN-56 5x5 QFN-32	3x3 QFN-20 TSSOP-24	3x3 QFN-20 TSSOP-24	3x3 QFN-20	5x6 QFN-28

For more information see:

www.summitmicro.com/SMB220

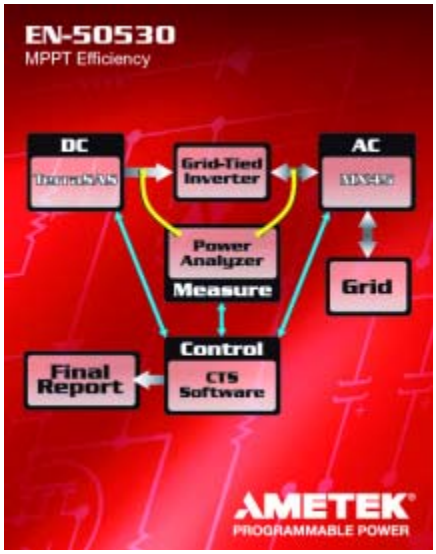
www.summitmicro.com/MobileGreen

MobileGreen™ TECHNOLOGIES

SUMMIT MICROELECTRONICS

Programmable Power for a Green Planet™

2012 Release of Fully Automated EN50530 Test System



AMETEK Programmable Power (www.programmablepower.com) announces a fully automated EN50530 test solution that utilizes three core “Surround the Inverter” elements: the AMETEK TerraSAS Solar Array Simulator, MX/RS Grid-Simulator and CTS Compliance Test System.
The automated test system is configured and controlled via AMETEK Windows®-based software that enables users to select the EN50530 Test regime, connect up the inverter to be tested, start the test, walk away and return to collect the report. Previously, testing to EN50530 standard for efficiency of grid-connected PV invertors required an engineer or technician to be present to manually progress through each curve set. Main target groups are PV inverter manufacturers and test houses.

AMETEK Programmable Power, through its Elgar brand of solutions, has supplied solar array simulators for more than 20 years for ground-based satellite test systems. Its “Surround the Inverter” programmable power products/solutions simulate the output of solar arrays, the loads applied to the output of the inverter, and the interface with the grid, providing a comprehensive and energy efficient means of testing PV Inverters. TerraSAS Solar Array Simulators are available as single or multi-channel systems from 5kW-1MW (80V-1500V). Single/Three-Phase MX/RS Series Regenerative Grid Simulators are available from 15kVA-1MVA. Shipment of the EN50530 solution is expected to begin in early Q2 of 2012.

www.ametek.com

300-Millimeter Thin Wafer Technology for Power Semiconductors

Infineon Technologies AG has produced the first chips (“first silicon”) on a 300-millimeter thin wafer for power semiconductors at the Villach site in Austria. This makes Infineon the first company in the world to succeed in taking this step forward. The chips now produced on a 300-millimeter thin wafer exhibit the same behavior as the power semiconductors made on 200-millimeter wafers – as has been demonstrated by successful application tests using Metal Oxide Semiconductor Field-Effect Transistors (MOSFETs) for

High Voltage applications.
Infineon had embarked on setting up a power semiconductor pilot line for 300-millimeter wafer and thin wafer technology in Villach, Austria, in October 2010. The team today is composed of 50 engineers and physicists from the fields of research and development, manufacturing technology and marketing.

www.infineon.com

Smart Grids 2012, Delivering Electricity Smarter

The Smart Grids Summit 2012 will bring together Europe’s leading electricity grid distribution specialists, investors and regulators to share insights into the immediate challenges and projects now started to realise the Smart Grid vision.
With the Energy 2020 strategy driving the move towards competitive, sustainable and secure energy throughout Europe, the Smart Grid Summit 2012 provides invaluable insights into the most important projects, research and developments making Europe a world leader in energy technology and innovation. Date: 24 – 25 January 2012, Stockholm, Sweden.

SMART Grids summit

www.thesmartgridsummit.com

European High-Tech Industry Powerful and Competitive at SEMICON Europa

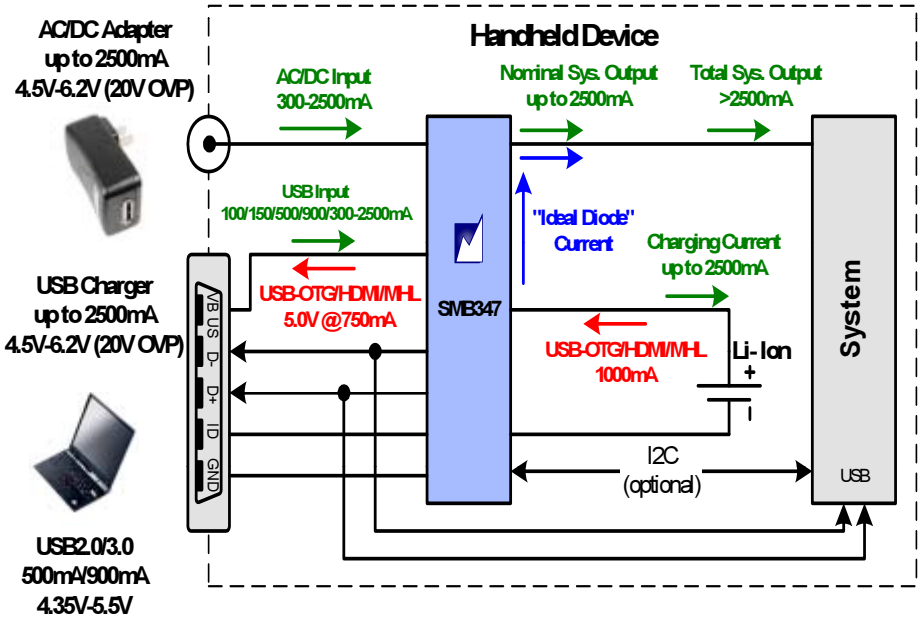
The 35th SEMICON Europa and Plastic Electronics (PE2011) drew to a close. Over 8,000 managers and experts saw the leading trade fair of the European semiconductor industry where more than 350 exhibitors from 20 nations presented themselves. The focus of the SEMICON Europa 2011 was placed on production technology and material exhibition as well as the more than 40 conferences and technical seminars - where over 2,000 participants exchanged their views about the latest technological insights. According to the industry association SEMI the companies in the semiconductor industry have a realistic and optimistic view of their future. The majority of companies are well-equipped to face future challenges. According to the latest forecasts, they can compensate well for the temporary slump in demand which was caused by the global economic weakness. Already in the second or third quarter of 2012, industrial companies, associations and analysts are expecting higher growth. "In 2012 we are counting on investments of around 4 billion US dollars to be spent on new production equipment and around 3.5 billion US dollars for material", underlines Heinz Kundert, President of the industry association SEMI Europe. "This amounts to approximately 10% of the world market."

www.semi.org/eu

Smart and Flexible 2.5A Li+ Charger, Tiny Solution for Big Batteries

High-Efficiency, Programmable Flexibility, Universal USB/AC/DC Inputs & Robust Safety Features Deliver a Complete, Cost-Effective Solution

Fastest, Safest and Most Flexible Charging Solution



SMB347 Features

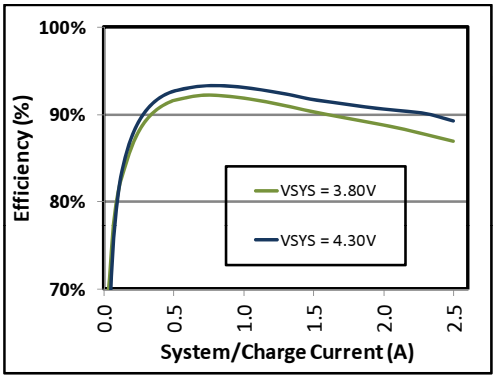
- Dual Inputs - AC/DC/USB2.0/3.0
- Dual Output CurrentPath™ for low/dead battery with 'ideal diode'
- +3.6V to +6.2V Input (+20V OVP)
- USB BC1.1/1.2 Source Detection
- Programmable Input Limit to 2.5A
- Automatic Input Limit Detection*
- Programmable Charge Current to 2.5A
- Integrated 5V USB-OTG Boost Output
- TurboCharge™* for 40% Faster Charging
- Robust Safety: JEITA/IEEE1725 Support
  - Over-Current/Over-Voltage
  - Thermal Monitor
  - Input Detection and Fault Status
- <10uA standby current
- I²C Programmable (Volatile and Non-Volatile)
- 2.5mm x 3.0mm CSP Packaging

** Patented*

Programmable Switch-Mode Battery Charger Family

	SMB347/346	SMB328A/B	SMB137B/136	SMB329B	SMB338P
Input Voltage Range (OVP)	4.0 to 6.2 (20)	4.0 to 6.3 (20)	4.0 to 6.0 (18)	4.0 to 6.2 (20)	4.0 to 6.2 (18)
# of Inputs/Outputs	2/2	1/1	2/2, 1/2	1/1	1/1
Maximum Charge Current (mA)	2500/1250	1200	1500	1150	1250
Battery Thermal Protection	HW JEITA	HW JEITA	SW JEITA	√	
USB Charging Spec	rev 1.1/1.2		rev 1.0	rev 1.0	
Package (mm)	3.0x2.5 CSP	2.2x2.0 CSP	3.0x2.5 CSP	2.2x1.9 CSP 4x4 QFN	2.2x1.9 CSP

>90% System Efficiency



For more information see:
www.summitmicro.com/SMB347

SUMMIT MICROELECTRONICS, Inc.

*"Programmable Power for a **Green** Planet™"*

New Factory in Spain

TDK-EPC, a group company of TDK Corporation, celebrated the opening of its second factory in Málaga, Spain. The new plant for the development and manufacture of power capacitors is located in the industrial park, Parque Tecnológico de Andalucía, and offers 6000 square meters of production space. A separate building with 1500 square meters of lab and office space houses the research and development activities. TDK-EPC serves important growth markets with the products made in Málaga. They include not only established application fields such as industrial drives and systems, electric trains and automotive electronics, but also promising growth markets in the field of renewable energy. “The competence and dedication of our team here in Málaga gives us good reason for high expectations as does this cutting-edge factory, with which TDK-EPC will further improve its competitiveness,” said Klaus Ziegler, Chairman of the Supervisory Board of EPCOS and Chairman of the Board of Directors of TDK-EPC, during the opening ceremonies. “Málaga plays a key role in our business: the quality of the research and development activities and the broad spectrum of products that are manufactured here are a major factor in the success of our company.”

www.epcos.com

New e-Commerce platform for High Power Bipolar Semiconductors

Infineon Technologies Bipolar GmbH & Co. KG, a joint venture between Infineon Technologies AG and Siemens AG, announced the launching of an online WEB-Portal dedicated to High Power Bipolar Semiconductors. This new e-Commerce platform has the advantage to offer our customers a fast delivery service. At first deliveries are limited to the countries of the European Community. Thyristor/ Rectifier Modules (PowerBLOCKs) as well as Discs (Hockey Pucks) from the Infineon portfolio can be selected online.

To pre-select products the Infineon Short Form Catalog “High Power Semiconductors for Industrial Applications” is available for download. The products can be either looked up through an intuitive search function or through a functional tree of product families. For each part-number it is possible to check the related data-sheet.
If the online check of stock availability is positive, customers can order the wished products within a standard lead-time of 48 hours. A 24 hours option is also available.
A technical e-mail support function is offered to help customers to easily identify the wished part-numbers, including spare parts.
Please visit our WEB-Portal site.

www.ifbip-shop.com

Territory Sales Manager for Germany, Austria and Switzerland

Chomerics Europe - a division of Parker Hannifin, has announced the appointment of a new Territory Sales Manager for Germany, Austria and Switzerland. 34 year-old Irina Ewert joins Chomerics Europe from Radio Frequency Systems – a member of the Alcatel-Lucent Group. Based in Hannover, Germany, Irina will work closely with both existing and new customers in key markets such as telecom, aerospace and military to promote and design-in Chomerics industry-leading range of shielding and thermal management products. Irina has over five years experience in technical account management and more than eight in territory sales management within the European telecoms market. She holds a Masters of Business & Economies qualification gained at The Academy of Business and Administration, Hannover.

www.parker.com/chomerics

www.parker.com

Retain Mountain Top Facility

Fairchild Semiconductor announced that it has decided to keep open the Mountain Top, Pennsylvania wafer fabrication site, reversing its March 2009 announcement to close the facility. Since the original closure announcement, Fairchild has more than doubled its sales of the high voltage and automative products which the Mountain Top facility supports. Fairchild expects to continue the rapid expansion of these businesses and determined that retaining the Mountain Top facility will be essential to supporting our customer´s current and future needs. The Mountain Top facility has been in operation since 1960, manufacturing electronic components for over 50 years. It currently employs over 220 people in leading edge 200mm semiconductor wafer manufacturing facility.

www.fairchildsemi.com

Power Integrations to Act as Sales Representative for SemiSouth SiC Diodes and JFETs

Power Integrations announced an agreement with SemiSouth Laboratories to act as a sales representative for SemiSouth’s innovative range of silicon carbide (SiC) diodes and JFETs worldwide with the exception of Europe.
SemiSouth’s SiC diodes and JFETs deliver significant efficiency and durability benefits in high-power applications such as solar inverters, motor drives, telecom rectifiers, UPSs, three-phase inverters and electric vehicles. In 2010, Power Integrations announced a strategic investment in the Mississippi-based SiC producer, which included an equity investment, a technology license and other financial commitments to support the continued expansion of SemiSouth’s SiC manufacturing operations.

www.powerint.com **www.semisouth.com**

2012 Green Building Power Forum

An Announcement and Call for Papers for the Fourth-Annual Green Building Power Forum to be held January 23-25 at the Crowne Plaza Hotel San Jose – Silicon Valley, California. GBPF '12 will encompass high-voltage and low-voltage dc power distribution as well as hybrid ac and dc distribution architectures and dc microgrids. It will be tightly focused on "Identifying Challenges, Progress and Opportunities for the use of DC Power Distribution in Facilities and the Creation of a Flexible and Dynamic Power Infrastructure."

"This is a dynamic period in the development of dc power distribution. EMerge Alliance-compliant products are on the market, the European Telecommunications Standards Institute has issued a 400-Vdc standard, the International Electrotechnical Commission has established an active project to develop global dc-powering standards, there are a growing number of dc-powered data centers around the world and dc-microgrids are being deployed across Asia. DC building power technology has reached the end of the development stage and has started the commercialization process. Darnell's Green Building Power Forum

is the only place where global thought leaders gather on an annual basis to assess progress and plan next steps," said Jeff Shepard, president, Darnell Group.

You can find the call for papers at:

http://greenbuildingpower.darnell.com

Strategic Collaboration Agreement

Rogers Corporation and Hitachi Chemical Co., Ltd. are pleased to announce that they have entered into a strategic collaboration agreement to expand global adoption and improve customer support of printed circuit board (PCB) materials for use in high speed digital (HSD) applications. The Agreement enables Rogers and Hitachi Chemical the ability to provide customers with a wider range of products, faster delivery, and enhanced technical support to meet rapidly growing material demand driven by HSD applications, which include high speed server, router, and telecommunication devices operating at speeds greater than 1Gb/s, for use in internet data and video transmission services.

The Agreement evolved from a previous agreement established in December, 2008 between the two companies to trade products and market them under their own brand names for wider product lineup and sales expansion. Under the terms of the new Agreement, Rogers is granted exclusive rights to manufacture laminates using prepregs (prepreg is the intermediate material of PCB material consisting of impregnating glass cloth with thermosetting resin) supplied by Hitachi Chemical, and to exclusively distribute these HSD PCB products to customers other than those reserved by Hitachi Chemical. The Agreement enables Rogers to offer a broader variety of high performance circuit materials, and allows Hitachi Chemical to increase sales and accelerate market adoption of its high technology products through Rogers' worldwide sales network. The companies will also work to jointly develop new HSD PCB materials for future applications.

www.rogerscorp.com

www.hitachi-chem.co.jp/english/index.html

Suntech CEO Appointed First Chief Chairman of Asian Photovoltaic Industry Association

Suntech Power Holdings Co., Ltd., the world's largest producer of solar panels, announced that its CEO and founder, Dr. Zhengrong Shi, has been appointed the first Chief Chairman of the Asian Photovoltaic Industry Association (APVIA). APVIA members, which include 670 photovoltaic (PV) enterprises, 23 industry associations and 15 research institutions, chose Dr. Shi based on his impeccable credentials and contribution to the solar industry. Dr. Shi will be the Chief Chairman of APVIA for two years.

"With the Asian PV industry projected to account for approximately one-third of global demand by 2015, Asia is uniquely positioned to lead the charge in driving the growth of the PV industry worldwide," said Dr. Zhengrong Shi, Suntech's CEO & Founder. "Asia is home to a number of leading PV companies with excellence in manufacturing, technology and R&D, and boasts amazing solar resources. Through APVIA, the PV ecosystem will collaborate to develop the best technologies, achieve economies of scale, and identify market opportunities to achieve grid parity both in Asia and the world."

www.suntech-power.com

Heinz Kundert Receives IC Industry Award for Leadership

The "IC Industry Award for Excellence: Individual" was presented today to Heinz Kundert, president of SEMI Europe, at SEMICON Europa 2011 in Dresden. Kundert has worked in the semiconductor industry for over 20 years, including executive positions at SEMI, Balzers and Unaxis.

"As president of SEMI Europe for six years, Kundert has focused on strengthening the European-based semiconductor industry by providing a collective industry voice to enhance innovation and support manufacturing," said David Ridsdale, Editor at EuroAsia. "Kundert has been a tireless advocate for supportive government policies, supply chain collaboration and other issues critical to the future of high tech manufacturing and industry growth in Europe. His work has gained him the respect and support of SEMI members, numerous organizations and industry bodies throughout Europe. In 2008 Kundert led the SEMI initiative to develop and carry key messages to the EU-- which contributed to the establishment of the European Commission Key Enabling Technologies (KET) High-Level Group."

"While I am honored to receive this award, I believe that it is a reflection of all the work that our regional advisory board, special interest groups, and many volunteer committees do to support the micro and nano-electronics industry in Europe," said Kundert.

www.semi.org

Programmable 10A and 20A Buck Regulators Deliver 96% Efficiency

Summit Microelectronics has expanded its family of programmable DC-DC products with the SMB220 and SMB221 integrated 10A and 20A buck regulators. These new products deliver unparalleled integration with built-in MOSFET's, digital programmability and non-volatile configuration.

The result is a flexible, digitally controlled power supply design that is easily customizable without tedious hardware design cycles or complex microcontroller-style GPIO-based control. The integration of advanced power control functions eliminates external components and cost, improves functionality and

Like Summit's entire programmable DC-DC family the SMB220 and SMB221 deliver advanced power management functions along with class-leading power regulation at an unbeatable bill-o-material cost. Many applications can benefit from the application of these products including Enterprise Servers and Storage Systems, Enterprise and Carrier Switches/Routers/BaseStations as well as emerging Consumer Digital Media (IP Digital Television and Set-Top Box).
The SMB220/SMB221 are 10A/20A single-output integrated DC-DC buck regulators combining Summit's digital programmability with high integration, ultra-compact size, and cost-effective bill-of-materials (BoM) necessary for dense system applications. Ultra high efficiency of up to 96% and 1% output regulation meets the most stringent digital core power requirements. With a serial digital interface and on-board non-volatile memory, the SMB220/SMB221 family can be easily configured during development and re-programmed in system by host software.

performance, and minimizes development time.
"Summit again expands its line of programmable DC-DC products with the SMB220 and SMB221 buck regulators," stated Abid Hussain, Summit vice-president of marketing and applications. "The unique combination of integrated high current MOSFETs, digital programmability and low cost bill-of-materials is clearly an 'industry first' making true digital power affordable for many new applications."

Features:
The SMB220 and SMB221 are integrated step-down DC-DC buck regulators with on-board MOSFET(s) supplying up to 10A (SMB220), or 20A (SMB220) output current. Input voltage range is +4.5V to +16V and output voltage range is +0.5V to VIN, accurate to +/-1.5% over load/line/temperature. Output voltage is digitally programmable in 10mV steps up to 2.5V and 20mV steps up to 5.0V while other custom voltages are supported with external resistors. PWM switching frequency is programmable from 250kHz to 1MHz and light load efficiency is supported by automatic pulse-skipping (PFM) operation.
Output enable, sequence delay, softstart and output voltage (UV) monitoring are all programmable as well. Output voltage monitoring is coupled to "PowerGood" or "RESET" signals with programmable output assignment and the output can be enabled via the serial I2C interface or by the ENABLE pins. Nominal output voltages maybe changed once the system is powered up, enabling the latest SoC's/ASICs to reduce platform power using advanced voltage/clock scaling modes. The output voltage programming also allows for easy voltage margining to support easy system validation and characterization of these same advanced SoC's/ASICs.
Tiny 5mm x 6mm QFN packaging and minimal external components yield an ultra-compact (typically <200mm2) solution size. Programmed configuration is held in the OTP non-volatile memory but may be changed in system by host software via the I2C port. The rated operating temperature range is -40C to +85C.

Packaging, Price and Availability
The SMB220/SMB221 are available in a tiny thermally-enhanced, RoHS-compliant , lead-free 5mm X 6mm, 28-pad QFN. Available now in production quantities, the SMB220 is priced $1.80 each while the SMB221 is priced at $2.50 respectively in quantities of 10,000 units.

Design Software and Programmer for Prototype Development
To speed user product development, Summit offers customers the SMB220/221EV companion evaluation boards and a graphical user interface (GUI) software so designers can quickly see the features and benefits and design a prototype intelligent power supply solution. This is a complete development tool that lets designers easily manipulate the characteristics of their systems. The SMB220/221EV design kits includes menu-driven Microsoft Windows (R) GUI software to automate programming tasks and also

includes all necessary hardware to interface to the USB port of a laptop or PC.
Once a user completes design and prototyping, the SMB220/221 GUI automatically generate a HEX data file that can be transmitted to Summit for review and approval. Summit then assigns a unique customer identification code to the HEX file and programs the customer's production devices prior to final electrical test operations. This ensures that the device will operate properly in the end application.

About Summit Microelectronics: "Programmable Power for a Green Planet™"
Summit Microelectronics is the leader in flexible, mixed-signal integrated power management solutions, for the consumer, communications and computing markets, combining high-performance analog power with powerful digital control in a single chip. This integration and flexibility combined with a simple GUI-based development tool and non-volatile configuration yields the lowest total BoM cost while reducing system design time and effort.

For more information visit http://www.summitmicro.com

"MobileGreen Technologies™"
Summit Microelectronics actively supports industry efforts towards creating a greener planet. The Company's MobileGreen™ technologies significantly reduce the energy consumption and waste material footprint in our customers' products. For more information visit www.summitmicro.com/MobileGreen

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High-Voltage LEDrivIR™ IC for Non-isolated LED Driver Applications

International Rectifier has introduced the IRS2980 high-voltage buck regulator control IC for LED light bulb replacement, LED tube lighting and other non-isolated LED driver applications.

Rated at 600 V, the IRS2980 is the first in a family of high-voltage LEDrivIR™ ICs, and utilizes hysteretic average current mode control for precise current regulation. The LED buck driver features low-side MOSFET drive with high-voltage internal regulator and high-side current sensing. The converter is compatible with electronic PWM dimming allowing for 0%-100% current control.

"In the rapidly growing solid state lighting sector, there is a need for low cost driver electronics to supply constant current output to high brightness, high power LEDs. The new IRS2980 LEDrivIR™ IC offers improved performance at a lower system cost than alternative solutions for non-isolated LED driver applications," said Peter Green, LED Group Manager, IR's Energy Saving Products Business Unit. Available in an SO-8 package, the IRS2980 utilizes IR's advanced high-voltage IC process which incorporates latest-generation high-voltage level-shifting and termination technology to deliver superior electrical over-stress protection and higher field reliability, in addition to other new features and enhancements.

Specifications

Part Number	Package	Voltage	VTH	Io	Max Frequency
IRS2980S PBF	SO8	600 V	0.5V	+/- 80/260mA	150kHz

Design Tools

A datasheet and application note are available on the International Rectifier website at www.irf.com. A reference design, the IRPLLED7, featuring the IRS2980DS is also available.

International Rectifier (NYSE:IRF) is a world leader in power management technology. IR's analog- and mixed-signal ICs, advanced circuit devices, integrated power systems, and components enable high-performance computing and reduce energy waste from motors, the world's single largest consumer of electricity. Leading manufacturers of computers, energy-efficient appliances, lighting, automobiles, satellites, aircraft, and defense systems rely on IR's power-management benchmarks to power their next generation products. For more information, go to:

www.irf.com

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Let's face it – thin is in. Intersil's ISL8200M, the world's thinnest 10 Amp power module at just 2.2mm, is so thin it can be mounted on the backside of most PCBs. And our ZL9117M (17 Amp) and ZL9101M (12 Amp) are the industry's thinnest digital power modules at 3.5mm.

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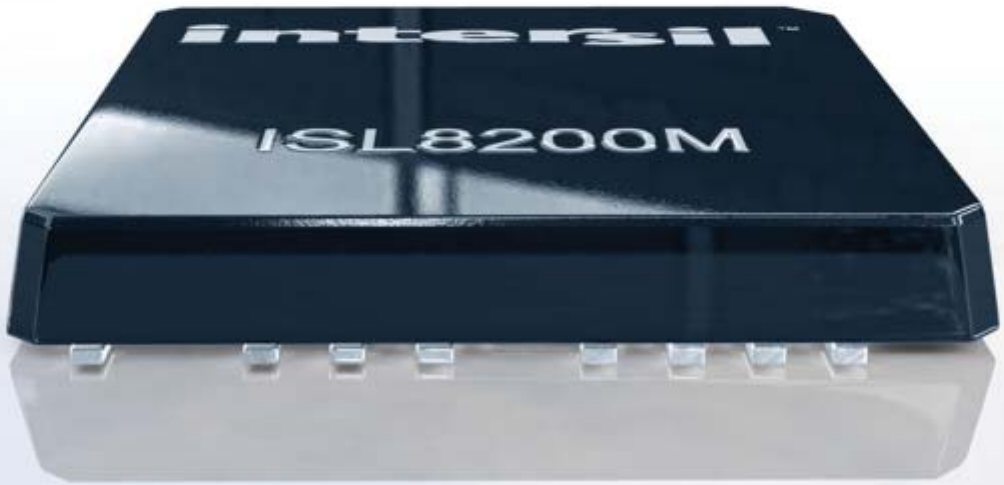

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The LED Symposium a Complete Success

By Siegfried Luger, Organizer and Event Director

The LpS in Bregenz is the leading, annual, international LED lighting technology event staged in the heart of Europe. Innovations, trends and technological breakthroughs in LED lighting are presented in an exciting atmosphere.

LEDs are the light source of the future and the future has already begun. At the LpS 2011 (LED professional Symposium 2011), over 700 participants from 34 countries met to discuss the complex subject of LEDs in lighting applications. Throughout the symposium it was obvious that the attendees and visitors as well as the 54 exhibitors were very impressed with the expert content, the expertise of their counterparts and the business impulses that radiated from the event.

The best evaluations really come from the people who attended: "A successful “first event” which will most certainly establish itself as the leading technical communication event on the subject of LED lighting."; said Beate Jungwirth, Manager Global Marcom and PR, Everlight Electronics.
Brian McNeill, Managing Director of the Scottish company, Systechnica Limited summed it up simply when he said: “The most important date on our calendar in 2012 is September 25th to 27th in Bregenz!”
“High class presentations and good networking opportunities”, attested Dr. Gerhard Kuhn, head of the worldwide team for the BU Solid State Lighting, OSRAM Opto Semiconductors. “It seems that the LpS in Bregenz will become an important meeting place for solid state lighting professionals.”

It is obvious that Anton Sonneveld, European Product Marketing Manager of Optoelectronics from Avago Technologies found the LpS 2011 a great success when he stated: “As a leading supplier of visible LEDs, this conference / event provided us with the ideal platform to interact with the key partners and customers in the industry.”
"I attend many trade fairs all over the world but the LpS 2011 turned out to be the missing piece to the puzzle when it comes to trade fair landscapes. At the LpS 2011 we showed a bit of what is achievable and are very happy with how the event ran as well as its success. The LpS 2012 will surely be another highlight and most likely top the success of the LpS 2011. e:lumix AG is also working on making this happen." concluded Thomas Zabel, CEO of e:lumix AG.
The attendees from Asia were also more than happy with the LpS 2011. Professor Ku Chin Lin from the Kun Shan University in Taiwan, had an all round positive impression: “It was a very successful meeting, well organized and a 5-star symposium. I reported my LpS 2011 experiences to my coworkers after coming home. Again, I'd like to say it is a very high quality symposium. I look forward to an even more successful one next year."

Sigrun Heiden, editor of the magazine LICHT, came to the following conclusion: “The LED professional Symposium has established itself on the interface between the semiconductor and lighting industries. Lectures and workshops offered a multifaceted spectrum of very high quality subjects. The flanking exhibition functioned as a communicative and informative forum. The good organization and atmosphere offered an efficient and at the same time, attractive environment for the dialogue requirements between the players in the SSL market.”
Dr. Eng. Stelian Matei, Manager at Semiconductor Lighting Centre at Electromagnetica SA, compared LpS with other events and came to the following conclusion: "I was not only impressed with the conference content, but with the venue and set-up as well. I had the opportunity to attend a similar event afterwards which unfortunately did not impress me as much as LpS did. I hope the LpS event will become a permanent European event."

Alex Zaretzky, Lighting Segment Manager at Renesas Electronic Europe, confirms that LpS 2011 had an "Extremely good atmosphere, fantastic location and the venue, powerful presentations and a great speaker selection. I especially enjoyed the interactive workshop and the gala dinner which allowed me to meet many valuable people and make new friends."

Sebastian Lyschick, Network Manager at LED Light for You, saw the event like this: “The LED professional Symposium has the potential to become an important event for the SSL market. It not only offered top knowledge in the lectures and workshop but it also discussed solutions for optical, thermal and electronic solutions as well as system integration issues. On top of all that, it also offered excellent networking opportunities. We are already looking forward to the next event.”
Over 40% of the exhibitors at the first event have already booked their booths for the LpS 2012. The testimonial from Stephan Wegstein, marketing director of Lighting at Recom Electronic GmbH gives an overall picture: “The visitors to our booth were very interested in our products and we were able to explain the difference between a professional and dependable LED driver and the inexpensive ones sold by our competition to many of them. RECOM Electronic will definitely be back in 2012!”

Stefan Hörth, Marketing Manager at Haeusermann GmbH summed it all up when he said: “The LED professional Symposium was an ideal platform for establishing new LED contacts with designers and decision makers as well as cultivating existing contacts. The beautiful setting and professional organization rounded off our overall positive impression perfectly from the point of view of an exhibitor and lecturer.

The next LED professional Symposium takes place on September 25th to 27th, 2012 in Bregenz.

www.lps2012.com

SiC MOSFETs for Everyone!!!

Ever wanted to be part of a technology revolution and make an impact on the world's energy dependence? Then Cree may be just the place for you. We are currently on the forefront of semiconductor power devices having just introduced the world's first commercial SiC MOSFET product that is destined to replace silicon devices in high-voltage (≥ 1200-V) power electronics. We are a leading manufacturer of silicon carbide-based diodes for power control and management. These devices provide increased efficiency,reduced size and higher frequency in a variety of applications: Power factor correction, solar inverters, industrial motor drivers, and output rectification.

Cree is a fast-growing, global company with over 4,500 employees and we are headquartered in the technology driven Research Triangle Park, in Raleigh/Durham, NC, USA. A healthy work-life balance is promoted and valued at Cree. Other benefits, besides fulfilling professional goals while contributing to the energy sustainability movement, include a sales incentive plan, car allowance, stock options, and an Employee Stock Purchase Plan.

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As a Field Applications Engineer you will be responsible for pre- and post-sales technical support for both existing and new European customers for Cree's SiC Power Schottky diodes and transistors. A successful candidate will have a strong understanding of the selling process and experience directly supporting customers with technical product specifications, product selection, system design, reliability, quality and manufacturing process. Target customers are among Europe's largest solar inverter, switch mode power supply, wind, traction, and motor drive companies. This position requires interaction with customers at all levels of system design/development, components quality engineering, procurement and general management.

RESPONSIBILITIES:

- Provide pre- and post-sales technical support for Cree direct sales and distributors through customer presentations and product demonstrations
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- Answer technical inquiries from existing and prospective customers with proper documentation and timely feedback/analysis
- Support new product launches, including training for Cree sales engineers and regional channel partners
- Design, develop, document and distribute reference and demonstration platforms for target applications
- Develop and present materials at technical seminars, tradeshows and distributor trainings
- Provide marketing department and product managers with consolidated customer requirements to define new products and product enhancements
- Provide SiC technology and product evangelism within the region

QUALIFICATIONS:

- BS degree in electrical engineering
- Minimum of 5 years experience with power systems and devices at theoretical and practical levels
- Field and lab management experience
- Good customer presentation skills
- A passion for power systems, power devices, providing world-class technical support to customers and growing Cree's SiC Power Business
- Preferred: MS or PhD in Electrical Engineering

If what you've read so far sounds exciting to you, then send your application to **CreeEurope@cree.com**,
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Electronics Industry Digest

By Aubrey Dunford, Europartners

GENERAL

As the PC market faced a slowdown, vendor consolidation has become a more apparent trend in the industry, so Gartner. Lenovo's recent merger with NEC, and its acquisition of Medion, as well as HP's announcement that it may spin off or sell its PC business, underlined this trend during the quarter. Worldwide PC shipments totalled 91.8 million units in the third quarter of 2011, a 3.2 percent increase from the third quarter of 2010.

SEMICONDUCTORS

Inventories held by semiconductor suppliers in the second quarter of 2011 swelled to levels not seen since the start of the last downturn in early 2008, raising concerns over the near-term outlook for the chip market, so IHS iSuppli. Global supplier semiconductor stockpiles at the end of the second quarter stood at an unusually elevated 83.4 Days of Inventory (DOI)—a level exceeding even the last record high of 83.1 DOI seen in the first quarter of 2008.

The Q211 capacity utilization of semiconductor manufacturing plants worldwide was 92.2 percent from 93.7 percent in Q111, so SICAS. The utilization of advanced facilities that make chips with circuits of less than 60 nm came to 96.7 percent from 98.9 percent in Q111. In Q211, the 300mm wafer production was running at 95.6 percent of capacity.

Infineon Technologies has produced the first chips on a 300-millimeter thin wafer for power semiconductors at the Villach site in Austria. This makes Infineon the first company in the world to succeed in taking this step forward. Infineon had embarked on setting up a power semiconductor pilot line for 300-millimeter wafer and thin wafer technology in Villach, Austria, in October 2010. The team today is composed of 50 engineers and physicists from the fields of research and development, manufacturing technology and marketing. As part of its investment plans, Infineon announced end of July this year to set up Dresden as the high volume production site for Power 300 technology. Until 2014, Infineon Technologies Dresden will invest around € 250 M for this purpose and will create approx. 250 jobs in Dresden. Infineon Technologies has also entered into a strategic partnership in the field of drive electronics for advanced rail vehicles with Bombardier Transportation. The agreement envisages the supply of semiconductor components by Infineon to Bombardier in the course of the coming five years.

Rohm Semiconductor announced that OKI Semiconductor, part of the Rohm group, will change its company name to Lapis Semiconductor.

EV Group (EVG), a supplier of wafer bonding and lithography equipment for the MEMS, nanotechnology and semiconductor markets, has established an agreement with research institute Fraunhofer IZM-ASSID (All Silicon System Integration Dresden) to jointly develop high volume manufacturing processes for 3D IC integration applications. The joint-development project will take place in ASSID's leading-edge facility in Dresden, the first Fraunhofer Centre with a 300-mm line dedicated to developing processes for high-volume 3D IC manufacturing and prototyping.

SEMI announced that Christian Prischmann from Ulbrich has been selected as the recipient of the SEMI Europe Standards Leadership Award 2011. Finally, the “IC Industry Award for Excellence: Individual” was presented to Heinz Kundert, president of SEMI Europe. Kundert has worked in the semiconductor industry for over 20 years, including executive positions at SEMI, Balzers and Unaxis.

Imec has signed a new agreement with ASML for a period of 5 years (2011-2015).

PASSIVE COMPONENTS

Supported by its main shareholder LBO France, Exxelia Group (Eurofarad, Firadec, Sic-Safco, Astema and Microspire) has acquired Dearborn Electronics. Located in Orlando, Florida, Dearborn Electronics designs and manufactures a wide range of paper and film capacitors and ceramic EMI filters for the aerospace, defense, and power electronics industries.

OTHER COMPONENTS

The Electronic Design Automation (EDA) industry revenue increased 17.6 percent for Q2 2011 to $ 1438.1 M, compared to $ 1222.9 M in Q2 2010, so the EDA Consortium.

Sequential EDA revenue for Q2 2011 decreased 0.6 percent compared to Q1 2011. Second quarter 2011 results represent a significant increase in all product categories compared to the second quarter 2010, with CAE, PCB & MCM, SIP, and services all showing double digit increases. Geographically, revenue in Europe, the Middle East, and Africa (EMEA) was up 8.8 percent in Q2 2011 compared to Q2 2010 on revenues of $ 246.5 M. The EMEA four-quarters moving average increased 8.4 percent.

The global SMT equipment market, which experienced a decline during 2008-2009 after a period of healthy demand growth for almost all equipment types during the last decade, revived by the end of 2010 and will reach $ 11.2 billion by 2017, so Global Industry Analysts (GIA).

DISTRIBUTION

Avnet Memec, a pan-European specialist technical component distributor, announced that its transformation into a vertically aligned and customer focussed business has allowed it to double its major account base from 400 to over 1000 and triple its monthly sales in just five years. Avnet Memec has doubled its business from € 104 M in 2006 to € 212 M in 2010 and is currently running at a rate of € 300 M. As a result Avnet Memec has increased its market share by 42 percent from 2007 – 2011.

Avnet Memec has signed six new or extended distributor agreements in six months, with Renesas, Sierra, Microsemi, Leadtek, Echelon and Smarteq.

C-MAC MicroTechnology, a supplier in high-reliability electronics, announced an agreement with Petersburg Electronic Company to distribute electronic components and modules including radiation-hardened power conditioning products and a range of high-reliability MILSTD-1553 products in Russia. PEC was founded in 1992 by importing high-reliability components from Europe and the US into Russia.

This is the comprehensive power related extract from the « Electronics Industry Digest », the successor of The Lennox Report. For a full subscription of the report contact:
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 89 x 172 mm	600A	●		
	650A			●
	900A	●	●	
 89 x 250 mm	1000A			●
	1400A		●	●

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Power System in Package Will Reach Nearly $300 Million

By Linnea Brush, Senior Research Analyst, Darnell

PSiP products are encroaching certain dc-dc converter IC markets and could replace traditional solutions over the next five years.

The total Worldwide PSiP dollar market is projected to grow from approximately $65 million in 2011 to $284 million in 2016, a compound annual growth rate (CAGR) of 34.4%. High growth rates are expected for all application segments targeted by companies making PSiP products.

The engineering innovations that have led to PSiP, PCiP and PwrSoC designs will have an impact on different levels and functions of existing dc-dc power converter ICs and modules. PSiP and PCiP (and eventually PwrSoC) products are expected to compete at the current levels occupied by LDOs, switching regulators, and controllers/FETs.

The best opportunities are in communications and computers, where unit CAGRs are expected to range between 35% and 50% between 2011 and 2016; and revenue CAGRs will be around 23% to 38% over the forecast period. Industrial applications will see good growth, as well, around 55% for unit sales and 44% for dollar sales.

The best smaller markets will have even faster unit growth, but this is due to very low starting bases. These include automotive, military/aerospace and medical applications, which will see growth between 50% and 100%. Most of these applications will not see significant revenue until 2013, however.

"Power System in Package" is a term that encompasses several new package styles that could replace certain existing dc-dc converter IC solutions in the future. For example, "Power Supply in Package" (PSiP) designs, which are highly integrated micromodules and the most commercially advanced, are still considered an emerging solution. "Power Supply on Chip" (PwrSoC) is a complete switch-mode dc-dc converter solution integrated onto a single piece of silicon (not yet commercially available); and "Power Converter in Package" (PCiP) is a design where some components are integrated, but other components are external.

PSiP devices could replace LDOs, for instance, since they can address space-constraint challenges while tripling power efficiency in ultra-low-noise environments. They could also replace noisy dc-dc switching regulators with ultra-quiet, high-efficiency dc-dc converters and miniaturize traditional discrete dc-dc converters.

It is important to identify the functions that require the specific benefits offered by PSiP/PCiP/PwrSoC products, and then identify the applications that need these functions, which are presently being met by LDOs, switching regulators, and so on. Due to pricing constraints, these products are expected to be a very small portion of the overall dc-dc converter IC market, but their share is growing.

The applications targeted by companies making PSiP products include high-performance computer applications, such as servers; telecom applications; and mobile devices, such as tablets and smartphones. Energy harvesting was also cited as a "definite market," along with "some industrial." Although not included specifically in these forecasts, PwrSoC is projected for small products and low-current applications.

As noted above, no true commercial PwrSoC products currently exist, but the functions and applications currently being targeted by PSiPs could be met by future PwrSoC designs, as well. Darnell Group believes that looking at these technologies based on the functions that the components perform opens up the commercial potential for PwrSoC, PSiP and PCiP products. For example, an isolation barrier is typical in many applications, but this function may be performed with multiple technologies. Capacitors are used for filtering and energy storage, which can also be addressed in other ways.

Looking at PwrSoC, PSiP and PCiP technologies from a functional integration perspective, as opposed to a component integration perspective, opens up the application markets where these devices can be used, since the limitations of components integration may no longer apply. Alternative solutions for these applications can be considered, and some companies are already looking at this kind of redefinition in designing products. Not all of these solutions are cost-effective yet, but they are expected to be over the coming years.

PSiP-style products are not a new trend, but they are expected to be the "advance guard" for PwrSoC products. Most companies Darnell spoke to see a growing market for PSiP-style devices, including system makers.

Companies are currently targeting their products at high-performance, high-efficiency applications, many of which require isolation/safety. This means a high penetration rate in communications equipment, which is expected to be the largest market for these devices between 2011 and 2016.

At the present time, most PSiP/PCiP solutions are being directed at the lower input voltage segments. This is expected to change over the next five years, with products being used in higher input voltage applications.

At this time, most of the server applications for POLs require 12V input, while most PSiPs are rated for 3.3/5V input voltage. One system maker says that, "They are being used today in servers where integration and efficiency is very critical." This company goes on to say that, "Once PSiP can be designed for 12V input, their use will spread to PCs and servers in a big way.

Although PSiPs are intended to primarily compete with non-isolated dc-dc converter modules, PwrSoCs are expected to compete with both modules and IC-based solutions. Printed-circuit-board-based dc-dc converter modules are dominant at current levels of 5A and more, and are less common at lower current levels. PSiPs are the more "mature" technology, are commercially available, and are becoming more cost-competitive.

Prices for PSiP products will need to come down before they will be widely implemented, particularly in price-sensitive applications like consumer devices. At this point, these products are not "high-performance" enough to make such usage practical, and they are not expected to claim any significant share of a potential total PSiP/PwrSoC market, even by 2016.

Some companies believe it is doubtful that PSiP products will increase in functionality much beyond the functionality currently seen in today's products. There will be an emphasis on digitally controlled products that inherently provide additional functionality. In other words, there needs to be a good reason for using PSiPs, since non-isolated non-isolated point-of-load converters are so inexpensive. Original equipment manufacturers (OEMs)

frequently drive trends and changes in power supply designs. The same dynamics are expected for PwrSoC. Intel sees "the start of a revolution in power delivery and power management for SoCs and high performance applications." Part of this is "combining" power delivery and power management in applications ranging from performance servers to small consumer electronic devices. Intel says, "The trend in platform power needs to shrink, become more efficient, and be more cost-effective."

With high-performance servers, multi-core microprocessor power delivery has become increasingly dense and complex. Due to the increase in the number of cores per die and the need to selectively operate the processor cores in different modes, it has become necessary to segment the power delivery to each core or functional unit block. Moreover, because of the need to reduce power significantly, the power delivery system must deliver power more efficiently and more quickly to the load, which means the power conversion must be as close to the load as possible, bypassing losses due to parasitic interconnect circuit elements. The requirements for such a device are clearly challenging, and thus integration becomes key to the solution. With system makers driving power trends and prices coming down, the PSiP (and related products) market is expected to grow significantly enough in the next few years to provide good "early adopter" opportunities for companies with the foresight to take advantage of them.

DC-DC Converter Reports

www.darnell.com/dcdc

Interview about High Power Device Technology with Dr. Thomas Neyer, Vice President and Fellow of Fairchild Semiconductor

By Bodo Arlt, Editor BPS

Bodo Arlt: RCA had been at the leading edge in December 14th 1982 having Hans W. Becke and C. Frank Wheatley receiving the Patent No 4,364,073 the basic of all IGBT patents. RCA became GE Solid State and continued to become Harris and Harris became Intersil and final the Power Group was sold to Fairchild. Now after nearly 30 years you are taking the task to get back a leading edge that has been ignored by several sets of frequent changed management in the past. What is the commitment today to continue successfully into the future.

Dr. Thomas Neyer: When Fairchild was spun out of National Semiconductor in 1997, the IP, technology and products comprised a wealth of standard and discrete ICs. Over the first few years, Fairchild refined its focus and vision for discrete MOSFETs and IGBTs. In order to establish a significant foothold in the high voltage discrete and high power markets such as industrial and automotive applications, it was then and remains today extremely important to stay in touch with market trends and to then continuously upgrade your technology capability.
Fairchild has clearly signed up to this path and has been showing clear evidence in the last years. We've started to upgrade the discrete fab in Bucheon, Korea to 200mm, we've invested in silicon carbide through the acquisition of TransSiC™ in Q1 this year – as well as the strategic decision to inaugurate our Technology Development Center (TDC) in Munich.

Bodo Arlt: The IGBT technology had been successfully developed for areas from line-voltage at the AC 110 volt level up to some kilo volt. What are the targets for you?

Dr. Thomas Neyer: Historically, Fairchild has primarily focussed in lower voltage areas and niches. This is demonstrated in our IGBT market leadership position for ignition or plasma display panel applications. Fairchild furthermore was an early mover into Fieldstop technology for 600V IGBT's which demonstrate very competitive conduction versus switching tradeoff characteristics and good ruggedness. In 1200V our FGL40N120AND Non-punch-through IGBT is known by experts as the fastest device on the market, and is enjoying considerable traction in solar inverter applications. Here we are releasing a successor technology soon.
Moving forward, Fairchild will continue to develop IGBT solutions between 400 – 1200V while, at the same time we will also extend our efforts to 1700V as well.

Bodo Arlt: What will be the position Fairchild is looking for in the wide range of IGBT discrete and module manufactures?

Dr. Thomas Neyer: Today, dependent on the region and market analysis for power semiconductors, Fairchild is ranked highly, normally in the top 2 to 6 position. This is frequently caused by the assessment that our portfolio is restricted, especially regarding higher power rating devices and packages. This is internally well understood and we have a greater emphasis on augmenting and completing our portfolio. This includes significant investments in high power module development, where we own considerable expertise and IP in Asia and we have decided to complement this with expertise from Europe within the TDC.
Overall, our goal is to be a top three supplier in all of the markets we are serving within five years.

Bodo Arlt: What are the technologies that Fairchild can offer for innovation and leadership?

Dr. Thomas Neyer: In terms of silicon technologies, Fairchild has a full range of MOSFET technologies covering 20V to 250V shielded trench platforms. These solutions demonstrate leading edge Figures of Merits (FOM). The same applies to our high voltage SuperJunction offerings, where we are currently developing the third generation of devices. And, our SupreMOS® MOSFET (Deep Trench) concept solutions have the best RSP on the market.
In IGBTs, we are covering all the state-of-the art technologies of NPT versus fieldstop, and planar versus trench concepts. The devices are matched with the best-suited rectifier technologies which are optimized for low-losses and soft switching.
One of Fairchild's strengths is our capabilities when it comes to workbench simulation, where devices are optimized based on predicted dynamic behaviour in the end-applications, significantly accelerating the design-in process.
In SiC switches, Fairchild has a very powerful BJT technology, which has a high potential compared to MOSFETs and JFETs, due to its voltage scalability and ruggedness. Furthermore, our activities in other wide band-gap projects is gearing up. We are considering SiC Diodes, GaN mid-voltage high electron mobility (HEMT) devices to name a few.
With regards to power packages, Fairchild has a wealth of automotive and industrial small and medium sized multi-chip packages covering power ranges up to 5kW. Our current R&D focus is on extending this range into the several 10's of kW, where our industrial and automotive customers can source chips and package under one roof.

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Bodo Arlt: What will make Fairchild different from other IGBT manufactures?

Dr. Thomas Neyer: The way Fairchild is set-up in terms of R&D and manufacturing for HV technologies is very compelling. The key R&D centres are in Wilkes-Barre, Pennsylvania, Seoul, Korea and now, taking off in Munich, Germany, while the majority of production is in Korea for Wafers and China and Philippines for Packages and Modules. From there we are able to combine a selection of the best brains, in the vicinity of our customers with the option of cost efficient and scalable manufacturing. Add to this our solution selling focus – where we look at the big picture and work with our customers to provide a solution to their challenge, not just a product for their design – we believe this significantly differentiates us from our competitors.

Bodo Arlt: Can you tell us about the range of your targeted technology and some of its features?

Dr. Thomas Neyer: Our IGBT roadmap comprises 600/1200 and 1700V IGBT's utilizing our unique epitaxial device approach. This enables us to independently optimize device ruggedness for motor drive and other hard switching applications from conduction and switching loss trade-offs. A lot of innovation is attributed to the collector concepts in today's IGBTs and Fairchild is utilizing Fieldstop concepts with a very manufacturable, ultra-thin wafer technology down to 2 mils, where required. I anticipate even double-side IGBT phase leg architectures (DIGBT) are in reach.
In terms of power density, our newest trench IGBT generations are already approaching 200A/cm² utilizing different stripe and square-cell trench concepts.

Bodo Arlt: Knowing from my experience the end-customer is the judge for success. Having introduced IGBTs in the early days into motion and automotive ignition in the late 80s and early 90s in Europe had shown that the customer is the important part in chain. So how much will Fairchild been involved in the end customer's applications?

Dr. Thomas Neyer: I believe that today the challenge has moved on, since IGBT's are well understood and accepted in many topologies and applications. With smart power modules (SPM®), we are able to take over a significant part of the design optimization work for customers. Still, I do agree that high voltage devices are not yet fully commoditized and there is significant value IDM's can bring to enable fully optimized end products.
However, I do see that today some of the existing high voltage wide bandgap switches require strong application knowledge and support, partially to avoid limitations in terms of device concepts or regarding changed drive requirements. In this regard, Fairchild is staffed and fully committed to enable customers and provide gate/base drivers and reference designs as needed.

Bodo Arlt: Mountaintop Pennsylvania back to the RCA time had been historically the home that combined product development and process development in the past. A great set of engineers mostly retired had worked here on the development of IGBT technology. I had learned that the close loop between the engineers in production and development together had a significant impact on development speed and correction of design steps. How much is the advantage of expertise and technology for the future depending on these historically facts.

Dr. Thomas Neyer: This is still very applicable today. In power semiconductors, successful companies synergize device architects, unit process development and process integrators well. If you look at it, a superior device concept will disappear into the drawer sooner or later if there is no congenial process development counterpart who turns the idea into a reproducible recipe. Frequently even the equipment needs to be modified or rebuilt to yield the required results.
On the other hand, this closed-loop attitude is deeply embedded into the DNA of every company and has to be enabled and developed coherently from all heads simultaneously. In all my ventures I have always discovered huge, untapped reservoirs which, once activated, came in very handy in the course of the project later on, hence I believe that this is less a question of geography than of leadership.

Biography: Dr. Thomas Neyer
Thomas Neyer joined Fairchild Semiconductor in 2011 as VP for High Voltage Semiconductor Technology to setup a High Voltage R&D Center in Munich. Prior to working at Fairchild, Thomas worked at Grace Semiconductor in Shanghai as EVP and Head of R&D and Fab Operation, where his focus was on building the first Foundry for differentiated Technologies in Asia.
In the past ten years, Thomas has also been in charge of Infineon´s wide quality programs, covering product development, R&D, and operations. Thomas was also in charge of setup for Competence Centers for Device and Product Know-How in Malaysia and China. He was put in charge for Engineering and Fab for the launch and ramp-up of the Infineon Power Fab in Kulim.
Thomas received his PhD in Physics from the Vienna University of Technology, starting his work at a design and testing engineer at Siemens HL in Austria. In 1999, he took over a senior management role in Technology at Siemens, working on BCD and HV Technologies, integrated technology development and 6"- 8" technology conversion.

Bodo Arlt: The IGBT had its strength in motion control based on switching characteristics technology wise. Does all of Fairchild have understood this fact today?

Dr. Thomas Neyer: Today, a significant portion of our business is coming from our SPM® package portfolio, predominantly used in motion control applications and using IGBTs. This is a clear result from the focus Fairchild has put on motion control modules several years ago. And, we have clear plans to extend the technologies we want to offer in this space as well as production capacity in our factories. There is no doubt that we are in this market to stay and grow.

Bodo Arlt: What do you see as a core competence for Fairchild?

Dr. Thomas Neyer: Fairchild views its core competencies in four main areas: Application Focus, Technology Leadership, Customer Intimacy and Financial Stability. We base our success on understanding what our customers need for their success. Our product and applications experts offer system level benefits that enable customers to differentiate their design solutions. We have a substantial portfolio of analog and power IP, and one of the industry's best power systems expertise to enhance the end-user experience, and meet and exceed industry energy efficiency requirements. We work closely with our customers to understand their needs to develop and deliver the right technology, for the right application at the right time. Our proactive, open and transparent supply chain management helps to ensure that we meet their inventory and manufacturing requirements - key elements to maintaining a competitive edge. And, we are financially in a strong position, which enables us to invest in future growth and

stability. Our investment in R&D drives future generations of innovative solutions at higher value.
Fairchild is a company which has redefined its business model multiple times and owns deep knowledge of several complementary fields in IC and discrete design and applications. In addition to that we have started to inject substantial amount of competitor know how by bringing in expertise in the field of high power design and manufacturing. Furthermore, since we have moved our key development teams closer to our customers, the folks that determine the next generation specifications and timelines, we have put ourselves in a position to be more successful in meeting their needs. As mentioned above, we indeed have established substantial expertise in device, process and integration know how combined with a solid manufacturing landscape which is converting to 8" wafers rapidly, differentiating us from our main competitors.

Bodo Arlt: Does your plans correlate with quarterly result racing for Fairchild?

Dr. Thomas Neyer: R&D investments are definitely measured in different time scales than quarterly results. I cannot judge how this was managed in the past decades, from my observation there were quite dynamic forces at work over the decades. Today, we have established a matured technology organization which is steered by Fairchild's CTO Dan Kinzer, who, as a key enabler for future business, enjoys emphatic support from all business lines and the executive management team. Internally, our TDC for high voltage semiconductors is seen as one of the key strategic programs company wide.

Bodo Arlt: Who are your competitors you believe will stimulate the race for leadership?

Dr. Thomas Neyer: For IGBT's the names are on the wall – its Mitsubishi and Infineon. Both have established a comprehensive portfolio by nurturing innovation in a consistent effort over decades.

Bodo Arlt: To be successfully with IGBTs you need module packaging an area that had been never received the management support in the past. Most IGBTs end up in a module package for a functional approach like the three phase stage for motion. What are the plans to overcome this limits for the future?

Dr. Thomas Neyer: A majority of our IGBTs and rectifiers today are consumed by our in-house smart power module technology, where Fairchild is way ahead of most competitors. Also, our discrete high voltage dies are frequently used at pure-play module houses and used in multiple industrial motor drive applications as well as in the renewable energy sector.
There is a need though to customize the dynamic performance of the switches to the housing in terms of thermal resistance, parasitic inductances and other key data sheet parameters. Hence, we have started an aggressive move into development of higher power modules including CIB/PIM and investing into new capacity in one of our Asian facilities. I am confident we will see results of this initiative very soon in Bodo's Power Systems!

Bodo Arlt: Thank you Dr. Neyer for your time. We look forward to a successful future for the technology innovations in IGBTs at Fairchild.

Dr. Thomas Neyer: My pleasure – I am confident we will remain in close contact going forward.

www.fairchildsemi.com

Measure DC and AC Currents with a Class Accuracy R (Railway)

Market regulations require improvements for Railway Energy Billing. European rail freight markets are liberalized (privatization of the rail networks into infrastructure and operators). Since the beginning of January 2010 passenger rail markets have been opened up to cross-border competition. This led to rising demands in terms of cost transparency (exact electricity consumption must be invoiced)

By Michel Ghilardi, R&D Project Manager, Marc Schaerrer, Development Engineer and Stéphane Rollier, Product & MarCom Manager LEM SA

Traction Units consume energy in different countries along their way:

- Railway Undertaking (RU) has contractual relationships with the respective Infrastructure Manager (IM)
- In order to be able to transparently bill the energy consumption the RU will need information regarding each border crossing
- The IM has to invoice the RU for the supply of energy

The on-board Energy Measuring System (EMS) is the system for measurement of electric energy taken from or returned (during regenerative braking) to the overhead contact line (OCL) by the traction unit, supplied from the external electric traction system.
This energy measurement allows the operators to better understand their real consumption and will enable energy management to reduce energy consumption for example.
The Energy Measurement Function (EMF) includes voltage and current measurement.
The new EN 50463 standard defines characteristics of transducers for current and voltage DC or AC measurement as well as the energy measurement function.

In order to fulfill this standard, LEM provides different solutions for current and voltage measurements:

- DV family for DC voltage measurement Class 0.5R for a single network voltage
- DI family (to be used with a shunt Class 0.2) for DC current measurement Class 1R
- ITC family for DC current measurement Class 0.5R

The Energy Measurement Function must have a total accuracy of 1,5 % for active energy for AC, 3 % for reactive energy for AC and 2% for DC at +25°C. The accuracy of current transducer, voltage transducer and Energy Meter is measured separately and combined for the overall accuracy using the following formula:

$$\varepsilon_{EMF} = \sqrt{\varepsilon_{VMF}^2 + \varepsilon_{CMF}^2 + \varepsilon_{ECF}^2}$$

With:
ε_{EMF} : Overall accuracy of EMF (system comprising current sensor, voltage sensor and energy meter)
ε_{VMF} : Class accuracy of Voltage Measurement Function (Voltage transducer)
ε_{CMF} : Class accuracy of Current Measurement Function (Current transducer)
ε_{ECF} : Class accuracy of Energy Calculation Function (Energy meter)

The EN 50463 gives the following details for the measurement of DC currents: table 1 and table 2.

For AC current transducers, the maximum permissible error at 1% of I_{PN} is 5% (class 1 R)!

Value of current	System type	Transducer temperature coefficient [%/K]	
		Ambient temperature variation (main range) -10 °C to +60 °C*	Ambient temperature variation (extended range) -40 °C to –10 °C* and +60 °C to +75 °C*
$0,1I_{pn} \le I \le 1,2I_{pn}$	DC	0,01	0,02
$0,05I_{pn} \le I \le 0,1I_{pn}$	DC	0,02	0,04
$0,01I_{pn} \le I \le 0,05I_{pn}$	DC	0,1	0,2

*Note: reference temperature is at +/-2%

Table 2: Influence quantities for current transducers

Standards:
Traction standard EN 50155
The EN 50155 standard dedicated to "Electronic Equipment used on Rolling stock" in railway applications is our standard of reference for electrical, environmental and mechanical parameters.
It guarantees the overall performances of our products in railway environments.

EN 50463 for energy measurement:
The following transducers comply with the EN 50463 standard for energy measurement:

- DV family for DC voltage measurement 0.5R for a single network voltage
- DI family (to be used with a shunt Class 0.2) for DC current measurement Class 1R
- ITC family for DC current measurement Class 0.5R

Accuracy class	± Maximum percentage current (ratio) error at percentage of rated primary current (I_{PN}) shown below, DC transducers Temperature condition: 23°C+/-2°C					
	1 %	5 %	10 %	20 %	100 %	120 %
0,2 R	2	0,4	0,2	0,2	0,2	0,2
0,5 R	5	1	0,5	0,5	0,5	0,5
0,75 R	7,5	1,5	0,75	0,75	0,75	0,75
1 R	10	2	1	1	1	1

Table 1: Percentage error limits — DC current transducers

It is possible to use these transducers for bi voltage applications (when switching from one network to another) with a slightly derated accuracy.
These transducers have a very low sensitivity to external magnetic DC or AC fields

EMC:
These transducers comply with the EN 50121-3-2 standard for emission and susceptibility (railway EMC standard) in its latest update, with EMC constraints higher than those of the typical industrial application standards.

Insulation and safety:
The EN 50124-1 ("Basic requirements – clearances and creepage distances for all electrical and electronic equipment") standard has been used as a reference to design the creepage and clearance distances for the DV, DI and ITC products.

Fire and smoke:
Materials used for the DV, DI, ITC products comply with the NFF 16101/2 standards for fire and smoke classification (tests report for materials available on request).

IRIS
Our main production centers for traction transducers are IRIS certified.
The DV, DI and ITC products are CE marked as a guarantee of product compliance to the European EMC directive 2004/108/EEC and low voltage directive. They also comply with the derived local EMC regulations (EMC: Electro-Magnetic Compatibility).

ISO 14000
LEM is proud to contribute to energy savings and is certified ISO 14001 for environmental management standards.

If each of the different components voltage transducer, current transducer and energy meter has a Class accuracy of only 1 R, the overall accuracy of the EMF is 1,732% (calculated with the square root formula)!
This is enough for a DC system (2,0% required). But the required overall accuracy shall be valid over the whole reverification time (several years, not fixed yet). Therefore it is advisable to chose lower class accuracies to have higher margin.
For multi-system trains, one voltage or current sensor for two or more voltage systems is allowed. Then the following applies:

- The voltage sensor has to fulfil the accuracy requirements for each voltage system.
- The current sensor has to fulfil the accuracy requirements for the highest rated current. For the lower rated currents reduced accuracy requirements are specified.
- For the energy meter the same applies as for the current sensor

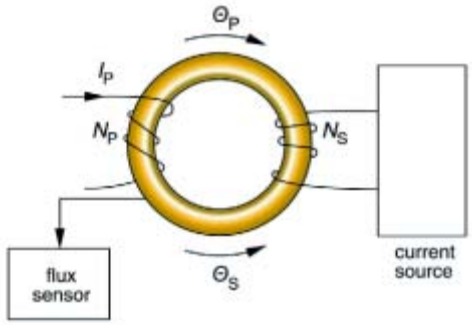
ITC current transducers series
The ITC transducer series comprises three models for measuring currents up to 4000 A_{RMS} (6000 Apk) in vehicles that are supplied with energy from networks up to 3000 V. The transmission of power and signals from a high voltage environment to a low voltage environment requires specific insulation features depending on the application. The ITC series fulfills all the necessary standards to enable these features.
These models are available for traction and industrial applications.

Figure 0: ITC series

ITC transducers have been specially designed for the railway environment and to respond to the energy measurement function evolution requiring better performances, ITC series provides Class 0.5R measurement accuracy when Class 1R is required by the prEN 50463 standard for on-board energy monitoring.

To reach this Class 0.5R accuracy, LEM used Closed loop Fluxgate technology.

ITC: Closed loop Fluxgate Technology Principle
For accurate measurement of DC currents, the methods consist in compensating the current linkage Θ_P created by the current I_P to be measured by an opposing current linkage Θ_S created by a current I_S flowing through a known number of turns N_S, to obtain (Figure 1).



$\Theta_P - \Theta_S = 0$ *or* $N_P \bullet I_P - N_S \bullet I_S = 0$
with N_P*: Number of primary turns and* N_S*: Number of secondary turns*
Figure 1: Closed loop current transducer Principle

To obtain accurate measurement, it is necessary to have a highly accurate device to measure the condition $\Theta = 0$ precisely. The aim is to obtain a current transducer with the following characteristics:

- Excellent linearity
- Outstanding long-term stability
- Low residual noise
- High frequency response
- High reliability

Operation principle
To achieve accurate compensation of the two opposing current linkages (Θ_P, Θ_S), a detector capable of accurately measuring $\Theta = 0$ must be available, which means that the detector must be very sensitive to small values of a residual magnetic flux Ψ (created by the current linkage Θ) in order to achieve the greatest possible detector output signal.

Fluxgate detectors rely on the property of many magnetic materials to exhibit a non-linear relationship between the magnetic field strength H and the flux density B.

The hysteresis cycles of the magnetic cores have a form comparable to the one represented in fig. 2 (more or less square according to the type of material used).

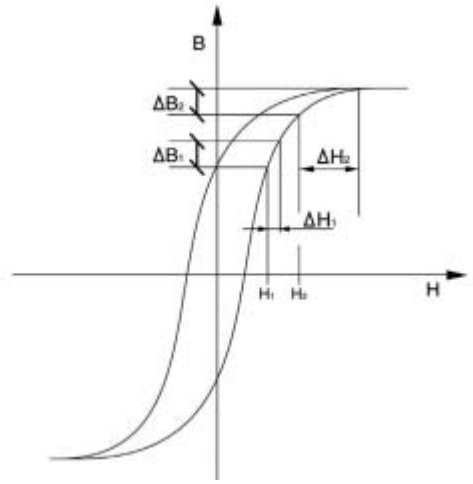


Figure 2: Hysteresis cycles of the magnetic cores

Observing $B = f(H)$ on the magnetization curve, notice that for a given field strength $H1$ a flux density variation ΔB_1 corresponds to ΔH_1. But, also observe that further along the cycle, for another given field strength H_2, for the same variation $\Delta B_2 = \Delta B_1$, the ΔH_2 variation must be much greater.
The detection of the zero flux condition ($\Psi = 0$) is based on this phenomenon.

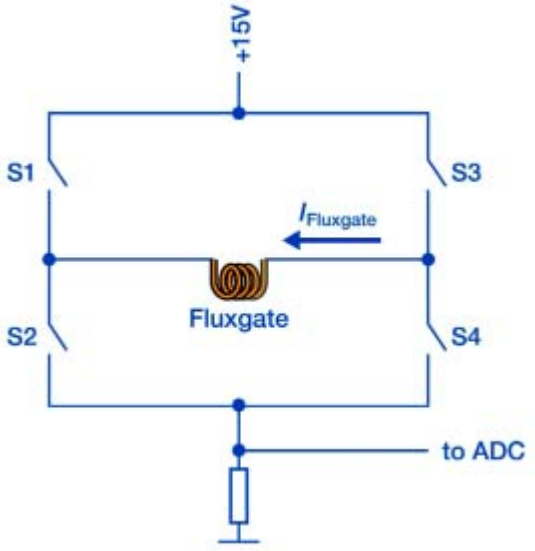
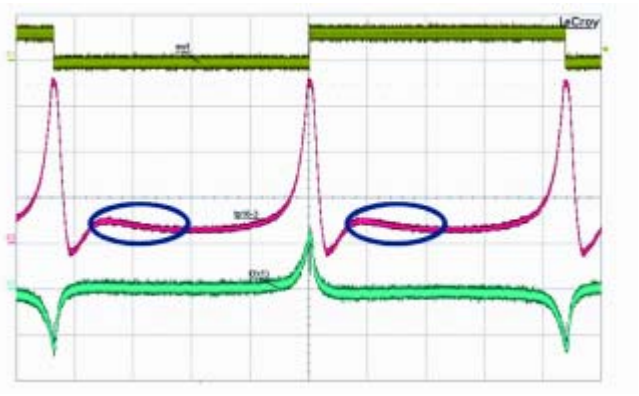


Figure 3: Full bridge to drive Fluxgate (saturable inductor)

A full bridge (Figure 3) is used to drive the Fluxgate. A current is created, flowing alternately through S1 / S4 and through S3 / S2, both currents, both through the measuring resistor. When applying a square wave voltage (yellow signal) to a saturable inductor until its magnetic core starts to saturate, a current is created. Without primary current I_P =0, this current is symmetric.
When a DC current flows through the aperture of the core, the curve of the hysteresis cycle is then shifted causing asymmetry of the current produced by the square wave voltage, (Figure 4).
This current is then measured using an accurate resistor and enables the secondary current in the compensation winding to be adjusted so that it perfectly compensates the primary current.

I_P=0



I_P=10 A, no compensation

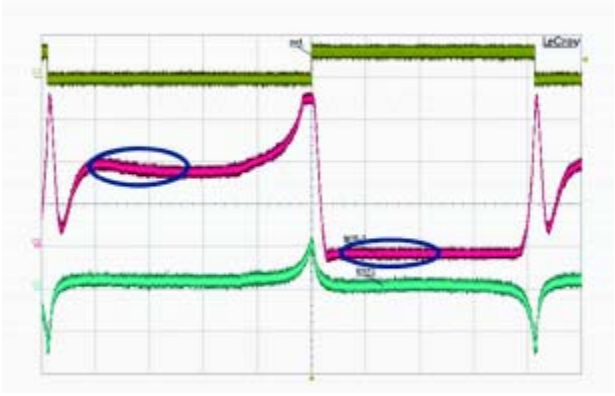


Figure 4: Square wave voltage; Current created; Asymmetry of the created current

The accuracy of the measurement will not only depend on the accuracy of the resistor measuring Fluxgate current, but also strongly on the sensitivity of the flux detector. However, in spite of the DC measurement function accuracy, there are some drawbacks to this DC measurement system (Figure 5):
As the winding “D” of the flux detector is coupled with the compensation winding “S”, the applied square wave voltage is re-injected into the compensation winding and creates a parasitic current in the measurement resistor.
However, the square wave voltage induced in the S winding by this flux may be practically cancelled out when a second D’ winding is mounted on a second detector core (identical to D) inside the compensation winding S. The residual flux (the sum of the opposed fluxes in D and D’) will create very small voltage peaks correlated with the fluxgate excitation (Figure 5).

Description of the bloc schematic (Fig.6)
Fluxgates are self-oscillating, their currents are measured by the microcontroller through an A/D converter, by reading the voltage across the bridge resistor.

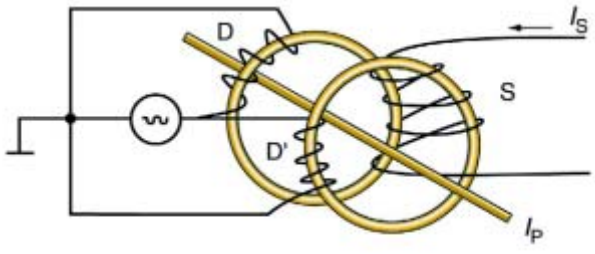


Figure 5: Solution against voltage peaks re-injection

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A microcontroller is used for different reasons:

- Synchronous rectifier of fluxgate signal
- Low pass filter
- Compensation of offset and reduction of offset drift (microcontroller replaces analogue circuits)
- Regulation of secondary current
- Protection management (supplies, overvoltage, overload)
- Output stages and Fluxgate management

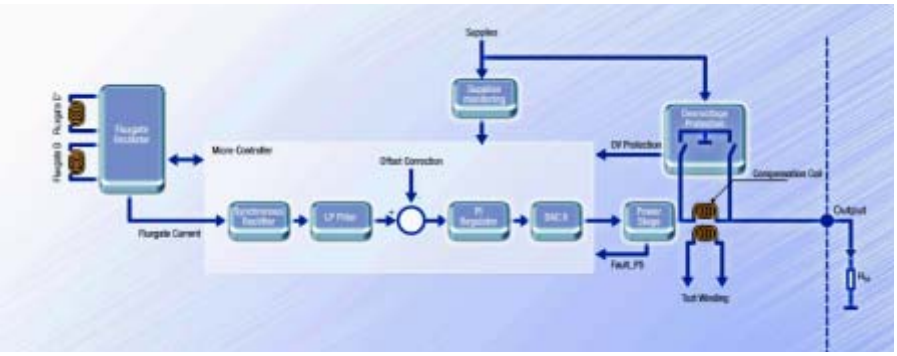

Figure 6: ITC Technology: Bloc schematic

The output of the secondary current regulator is converted into an analogue value using a D/A converter that gives the reference to the PWM generator for the output stage.

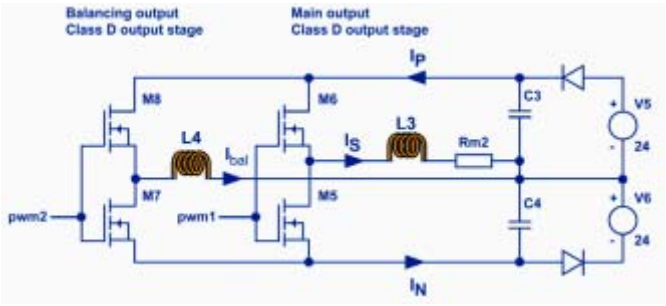

Figure 7: Class D output current generator

The Class D switch mode output stage (Figure 7) is used to reduce losses, and thus avoids using a heat sink outside the transducer.
In switched-mode amplifier, either one or other of the transistors of the output bridge are switched on by a PWM signal the duty cycle of which is varied to adjust the output voltage.
The losses are therefore only caused by the conduction and commutations losses of the semiconductors. Compared to the standard Class AB (linear), the Class D allows the losses in the semiconductors to be reduced by a factor close to 5 also improving the reliability of the electronics. An LC filter removes most of the high frequency harmonics to keep the output noise low.
A second switch mode output stage is added only for balancing supply currents between positive and negative power supply (LEM patent).
Ibal is regulated to be exactly $-I_S$.

ITC Series: Main Characteristics

ITC series reaches the Class 0.5R measurement accuracy according to PrEN 50463.
Linearity error is less than 0.05% of peak current, offset currents less than +/- 20 µA are really stable, and offset drift in temperature is less than 100 µA.

ITC models provide a current output via a Class D amplifier.
With the use of the double Class D output current generator, the supply currents are balanced and reduced versus a transducer using a Class AB amplifier.

The supply current is always positive and almost equal on both supplies: 0.3 A at nominal output current on each power supply polarity (Figure 9), electronic losses are less than 6 W when supplied under +/- 24 V.

For instance, using a Class AB amplifier would have required a supply current of 1.6 A and would have created 30 W of losses at nominal current.

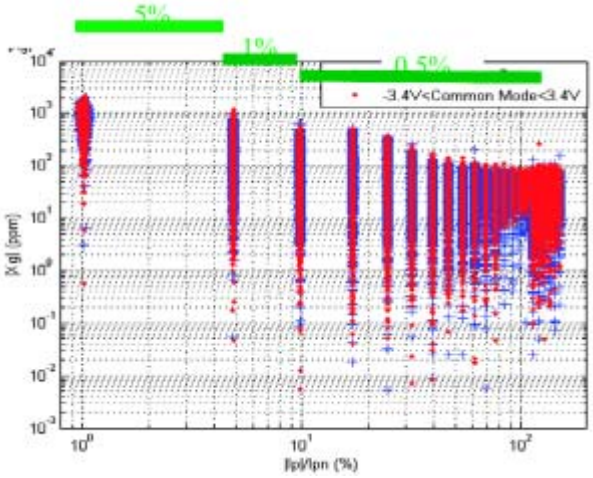

Figure 8: ITC 4000-S global accuracy over the whole temperature range and over the possible supply voltages variations; the green lines are the EN 50463 standard requirements (specifications) at 23 °C ambient temperature.

Due to the reduction of losses a large heat sink is no longer required and thus the size of the current transducer is also reduced.
With less current consumption needed, power supplies associated with the ITC transducers can be of a lower capacity and are therefore cheaper.
This technique however creates a ripple of about 25 mA.t within the bandwidth 80 kHz and 3 A.t within the bandwidth 200 kHz, this noise can easily be reduced using filter.
High primary current overloads can occur in traction applications,

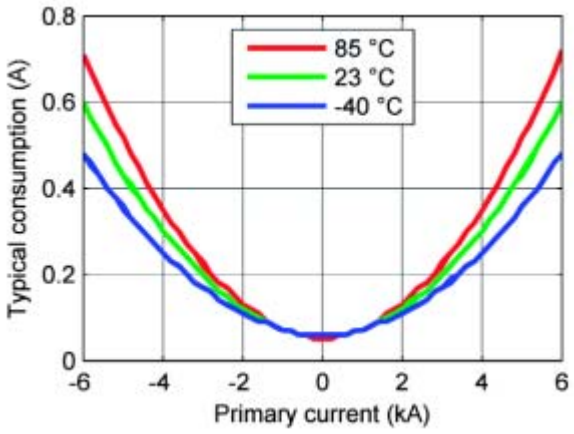

Figure 9: Consumption currents on each power supply polarity in regards with the primary current (R_M = 0.1 Ω, ± V_C = ± 24 V) (both supply currents are identical)

that's why ITC series has been designed to support high overloads until 100 kA/100 ms. 100 kA means not less than 40 A on the secondary of the ITC 4000-S, and to protect the internal components and customer burden resistance, but also printed circuit tracks, a special dedicated electronic circuit has been designed. This protection is enabled with or without a power supply, as well as whether a measuring resistor is installed or not.

If the primary current becomes higher than the measuring range, the electronics cannot maintain the flux compensation.

If this state lasts too long, the fluxgate detector becomes completely saturated and unable to measure the flux error. When this happens, the transducer stops for 300 to 500 ms and then sweeps the output current to find the point at which compensation is correct again and then normal function can resume.

In addition to the analog current output, these models offer a logic output called "/VALID" (open collector) indicating the transducer state (operational status).

The pull-up resistor is external to the transducer. It is activated (pulled to 0V) to indicate that the regulation of the output current works normally. It is deactivated (pulled to the high level) to indicate that the output current is not the exact image of the primary current. This occurs during start-up of the transducer, after a large overcurrent, if there is an internal fault or if the measuring resistance is disconnected while a primary current is present.

A test winding is part of the ITC models which can be used for a re-verification of the transducer in the application, for example in the ITC 4000, 1 A in the test winding simulates 400 A primary, representing 10% of the nominal current.

It is then easy to check accuracy of the transducer on board by using a small current.

ITC transducers are insensitive to the position of the primary conductor within their large measurement aperture, offer high insulation test voltage of up to 14 kV_{RMS}/50 Hz/1 min (ITC 4000 model), and have excellent immunity to external interferences (such as magnetic fields typical of the rail environment).

Bandwidth for the ITC 4000-S is 80 kHz (3 dB) and the transducers' apertures allow the insertion of large conductors: 102 mm diameter (for the ITC 4000-S) or 63 mm diameter (for the ITC 2000-S).

3 models form the ITC range today: ITC 1000-S, 2000-S and 4000-S, with corresponding nominal current measurement of 1000, 2000 and 4000 A_{RMS}.

They are available in either a one-piece housing (ITC 4000-S model), or a split construction (ITC 1000 and 2000-S models) with the measuring head in a case, and its control electronic mounted remotely in a metal enclosure, to facilitate locating the measuring head in confined spaces such as the train roof space.

They have been designed for the rail-traction industry sector, reaching Class accuracy 0.5R defined in the prEN 50463 standard for on-board energy monitoring operating over the temperature range –40 to +85°C.

In Addition to us in the Energy Measurement Systems, they can easily be used in any application where an accuracy of 0.5 % from 5 % to 120 % of the nominal current is required.

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A Look into the Future: Savings Potential in Inverter Design

Cost savings with high-current PCBs and spring contact modules connected in parallel

The major manufacturers of frequency inverters in the range of 40kW to 90kW expect average market prices to drop by around 3% each year. To be able to stay competitive, drive and inverter manufacturers are having to optimize their products by way of cost-efficient production and reduced material costs. By cutting down on costly bus bars, reducing module costs and using quick and easy single-screw assembly, MiniSKiiP modules can be used to reduce costs for power modules, connectors and assembly by up to 27% over inverters based on standard modules with base plate and screw connections.

By Andreas Gießmann, Application engineer, Semikron Elektronik GmbH and Alexander Langenbucher, Product manager MiniSKiiP, Semikron Elektronik GmbH

High current PCBs replace bus bars

Up to now the use of a printed circuit board (PCB) for power and control terminals instead of copper bus bars was limited to inverter outputs of 50kW due to the maximum current carrying capability of the PCBs. Thermal measurements performed on MiniSKiiP modules show that with multi-layer PCBs with copper track thicknesses of up to 210µm or copper profiles [1], maximum continuous load currents of up to 170A are possible. The maximum rated current of power semiconductor modules for PCB mounting is currently 200A, i.e. inverters of up to a maximum of 50kW can be made inexpensively without bus bars. To save on assembly and material costs for 90kW inverters with high-current PCBs, the modules for PCB mounting have to be connected in parallel. The interesting aspects here were investigated on two MiniSKiiP 6-pack modules with 150A rated current.

Module positioning is decisive

Parallel connection of two three-phase MiniSKiiP inverters offers more leeway with regard to the physical layout of the modules and the connection of two phases. While the modules may be arranged horizontally or vertically to one another, for parallel connection of the phases, the question that arises is whether adjacent phases (U_1-V_1, W_1-U_2, V_2-W2) or the same phases (U_1-U_2, V_1-V_2, W_1-W_2) are to be connected in parallel?

To answer this question, the following conflicting optimisation criteria have to be taken into account:

- Minimisation of dynamic and static current asymmetry (lower derating)
- Low-inductive design and consequently low overvoltage
- Prevention of thermal hotspots on the PCB

The improvement of one of these criteria can lead to the deterioration of another at the same time. For instance, same-phase connection (U1-U2, V1-V2, W1-W2) and horizontal module layout is beneficial in terms of dynamic and static symmetry. The problem with this, however, is that the traces would cross over, causing hot spots on the PCB at these crossover points, see Figure 1.

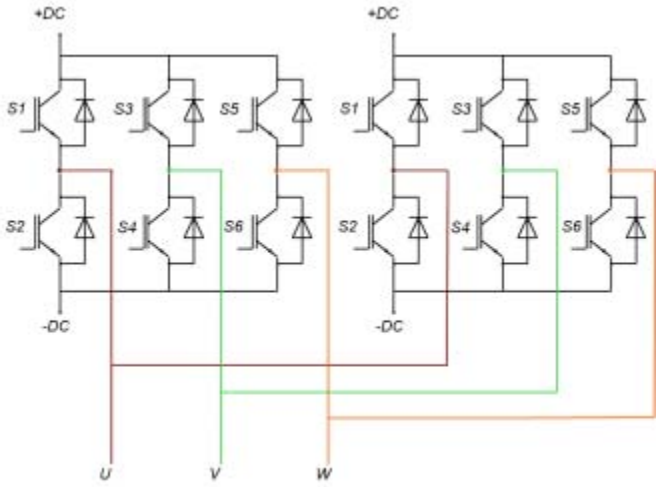

Figure 1:
Horizontal arrangement of modules with same-phase connection

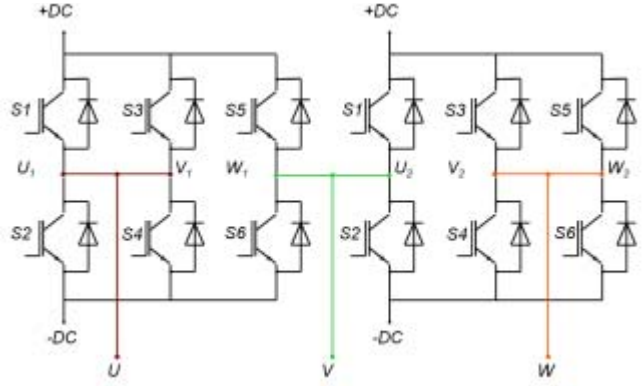

Figure 2:
Horizontal arrangement of modules with adjacent phase connection

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An advantage of adjacent phase connection (U1-V1, W1-U2, V2-W2) and horizontal layout is the short traces on the PCB. However, considerable asymmetry between the parallel phases is to be expected since the current paths are different, as are the positions for the auxiliary emitters.

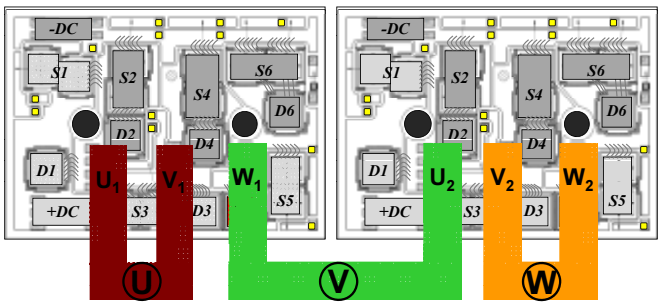

Figure 3: Horizontal arrangement of modules: No limitation of trace width by mounting holes and gate or auxiliary connections

A vertical module layout with same-phase connection is virtually impossible to achieve since the module mounting hole limit the trace width too much. Furthermore, in this case, the module driver contacts would be intersected by the power paths.

Essentially, the triple-criteria optimisation concept above can only be implemented if the internal module current paths are known. Adaptations are normally not transferable to other case sizes or module layouts, but have to be made for the specific module.

Static symmetry

Static symmetry between two parallel paths is determined by the following factors:

- Threshold voltage and slope resistance of the parallel chips
- Parasitic inductances and resistance of wire bonds and DCB
- Connection to the DC link
- Position of the AC terminals U, V, W on the PCB

The threshold voltage and the slope resistance of IGBTs and diodes are subject to manufacturing-related variations. From a statistical point of view a current derating of 10% is sufficient in order to consider the maximum amp capacity of the chips [2].

The different-length DCB paths between the DC and U, V, W terminals result in different inductance and resistance values. The positioning of the DC terminal to the left of the MiniSKiiP module results in the shortest current path for the U_1/U_2 phase and the longest for phase W_1/W_2. Parallel connection of phase W_1 of one module and phase U_2 of the other produces the greatest deviation in DCB path see Figure 3.

In this case, the position of the AC terminal V between the paths can produce greater symmetry. Theoretically, the longer and narrower the PCB path, the greater is the resistance and inductance values of the trace between these two phases. This, however, is not particularly expedient with a view to avoiding thermal hotspots. For a given trace length, width and thickness, the position of the V terminal has a far better effect on the symmetry the closer this is moved towards phase W_1.

On the face of it, this asymmetry of the V terminal counteracts the different DCB path lengths. An increase in clearance between the two modules brings about benefits with regard to thermal spreading and current symmetry. An increase in PCB size, however, means far higher costs if the dimensions of the PCB exceed the optimum number of panels per blank board. In parallel same-phase connection, particular attention is to be paid to DC link connection. For opposite phase connection, connection to the DC link can be designed such that it has an additional positive effect on the symmetry of the W_1-U_2 phases. Inside the module, phases U_1-V_1 and V_2-W_2 are connected in parallel. In this case, the DC link connection has no effect on current symmetry.

Dynamic symmetry

As regards dynamic symmetry, the aim is to reduce the different switching speeds between two switches to a minimum. The switching speed is determined by the gate resistance and the parasitic gate inductance, on the one hand, and by the position of the auxiliary emitter terminal on the other hand. The load current induces a current in the gate-emitter. Depending on the position of the auxiliary terminals, this current can have either an attenuating or accelerating effect. One gate and auxiliary emitter terminal is assigned to each switch in the MiniSKiiP module. The investigations on the 150A MiniSKiiP module showed that changing or replacing the auxiliary emitter terminals of the BOT switch brings about an improvement in dynamic symmetry.

In addition, by using SMD inductances in the nH range in the gate path, the IGBT turn-on behaviour can be influenced considerably. An inductance in the gate path of the slower switching IGBT accelerates the IGBT turn-on behaviour and can have a positive effect on dynamic current symmetry. In this case, a separate turn-on and turn-off path is needed for this IGBT.

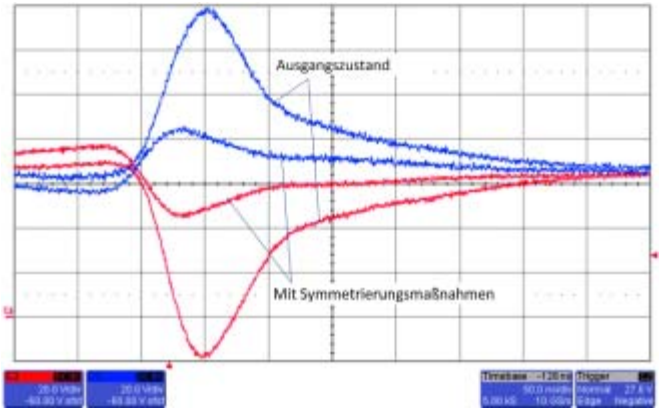

Figure 4: The dynamic symmetry can be improved by changing auxiliary emitters, increasing the gate resistance or the inductance in the gate path

Thermal investigations

For the thermal investigations, two types of PCB which differed in the number of copper layers and layer thickness were used.

Design: 4-layered PCB with 105µm copper on the outer layers, no power path on the inner layers

Design: 4-layered PCB with 210µm copper on the outer layers and 105µm copper on the two inner layers

The measurements taken on the first design showed that close to the spring contacts thermal hotspots of 150°C develop on the PCB at a phase current of 170A. In this case, the heat sink temperature at a reference point directly beside the module is 100°C.

By using thicker copper layers, the temperature on the PCB is 30K lower for a phase current of 120A in the area close to the spring contacts. In addition, the modules were paralleled thermally, meaning that at 170A the heat sink temperature at the reference point can be reduced to below 80°C.

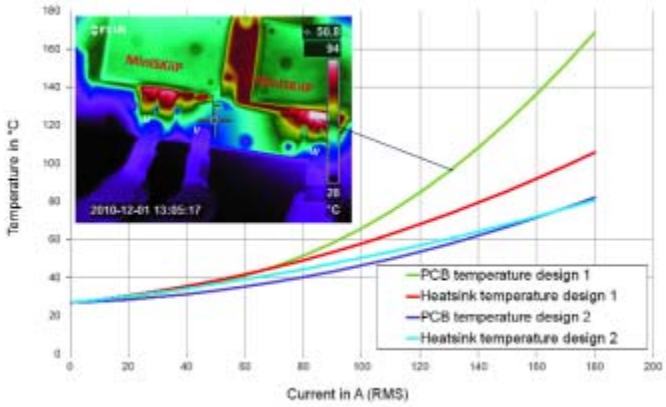

Figure 5: Comparison of heat sink and PCB temperature of 1st and 2nd design

Calculations done by one PCB manufacturer of high current PCBs show that using copper profiles in PCBs can reduce the PCB temperature at these hotspots by up to 30K.

Conclusion

Cost pressure on the inverter market will force manufacturers to switch over to less expensive PCB mounting for inverters in the 50kW to 90kW range. The necessary parallel connection of existing modules is possible but involves additional optimisation of the driver connection and power paths for every single module layout. This is complex and involves considerable time, as well as development and test capacities. To enable inexpensive inverters with PCB mounting to be developed more easily and more quickly, plans are underway to develop MiniSKiiP half bridges for fast single-screw assembly for applications with rated currents of up to 300A. This will enable material, module and assembly costs for inverter outputs of up to 90kW to be reduced substantially.

Literature:

[1] Mauer, P., Müller, D., Fine-Pitch und hohe Ströme, www.elektroniknet.de, 2010

[2] Scheuermann, U.: Paralleling of Chips – From the Classical 'Worst Case' Consideration to a Statistical Approach", PCIM Europe 2005, Conference Proceedings

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VIP Interview with Manfred Kraxenberger, Bipolar Production Line Manager of ABB Switzerland Ltd, Semiconductors

by Bodo Arlt editor BPS

Bodo Arlt: Mr. Kraxenberger, please let my readers know about ABB Semiconductors' motivation behind the expansion of their bipolar line in Switzerland and the most important features of the new line.

Manfred Kraxenberger: In order to meet the global power markets' increasing demands, ABB made a commitment to increase the overall production capacity of high power semiconductors. The most important feature of the new bipolar production line is the 150 mm wafer production line. Since 2008, ABB has been producing HVDC products using 150 mm wafers from a pilot line in the current production area. Starting in 2012, the line will be a modern, fully equipped line producing all types of bipolar products using 150mm wafers.

Another important new feature is the increased furnace capacity and the new configuration of the furnaces which allows various high temperature processes to be done in each single furnace. This flexibility in choice of furnace has been achieved by extended process control measures being implemented in daily operation in the diffusion area. In fact, the entire production layout has been changed to be able to run a controlled, lean Six Sigma operation with focus on productivity and yield. This will allow us to approximately double capacity and will improve material flow through production.

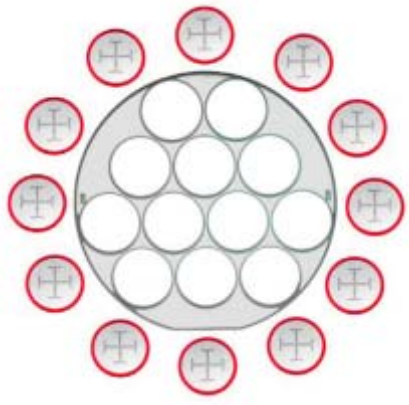

Figure 1: Photograph of a processed 150 mm wafer with 12 thyristors

Bodo Arlt: ABB Semiconductors is expanding their production facilities in Switzerland. Many other companies choose to expand in low-cost countries. Can you explain why ABB has chosen Switzerland for their expansion?

Manfred Kraxenberger: ABB Switzerland has a long tradition of providing energy management solutions. High power semiconductors are the key element in almost all of these solutions. ABB Semiconductors has profited from the Swiss “power triangle” with a close proximity between R&D and the local production sites of high power semiconductor devices and medium voltage motor drives. The requirements for high power semiconductor production are high quality productivity with highly qualified and experienced employees combined with a wide ranging product portfolio. These criteria are well-met in Switzerland.

Bodo Arlt: In comparison with your previous experience in low power semiconductors, how would you describe the challenges of working with high power semiconductors?

Manfred Kraxenberger: One of the biggest challenges is to obtain the desired dopant profiles within the narrow tolerances and the often long diffusion times at temperatures above 1200°C. The devices' performance in the full processing sequence is critically dependant on the ability to control the thermal budget in the full processing sequence.

Figure 2: Cleanroom showing new furnace and lithography areas

Another necessity is to establish state-of-the-art process and production control methods in order to increase productivity and maximize the yield. Even if the feature size is significantly larger than for instance microprocessors, a single small defective area in the silicon can cause the whole device to fail and thus compromise yield and productivity.

Bodo Arlt: As I understand, the bipolar line has been completely shut down during the expansion and refurbishment period. How were you able to serve your customers with products during this time?

Manfred Kraxenberger: Capacity extension and refurbishment was done in two steps. The first step, a building extension to gain more cleanroom space was completed in 2010 and enabled us to install additional equipment and to run a pre-production phase for one year. Stock build-up of semi-finished products based on the sales forecast from our various sales channels enabled us to continuously deliver products during the second phase: the refurbishment of the 30-year-old cleanroom. Only the wafer fab was shut down - irradiation, encapsulation and testing were still active throughout the shutdown time.

Thanks to tight project management, we were able to reduce the time for the refurbishment and restart of the front-end facility to less than 4 months. Everything has gone very well and according to plan. Like Swiss clockwork, you could say! I would like to express my gratitude to everyone involved in this complex process.

Bodo Arlt: Voltage controlled BiMOS devices are attracting a lot of development attention compared to classical current controlled bipolar devices. Can you comment on this?

Manfred Kraxenberger: ABB Corporate believes strongly in the high power semiconductor market to serve the global markets' need for energy management solutions. For this reason, ABB has invested over 150 MUSD for the expansion of both the BiMOS and bipolar lines in Lenzburg, Switzerland.
BiMOS devices show strong growth in certain market segments, but in other areas such as medium voltage and variable frequency drives for industrial motors, the properties of the bipolar on/off switch is unsurpassed in terms of the benefits to the manufacturers of drives and their customers in the industrial segment.

Bodo Arlt: ABB Semiconductors has a high reputation in the area of bipolar devices and has been one of the driving forces in the development of ever higher power levels in switching applications using bipolar devices. How do you see the future for high power bipolar devices?

Manfred Kraxenberger: There is a definite need for high power bipolar devices for switching applications. We believe that the market for multilevel medium voltage drives will benefit from high current capability semiconductors that reduce the need for paralleling devices. For the manufacturers of medium voltage drives we have the whole HPT IGCT platform with voltage ratings between 4.5 and 10 kV and current ratings between 400 and 5000 A.
ABB Semiconductors has a long history of serving the market with the latest generation of high performance thyristors for HVDC applications. HVDC installations are expected to grow from 100 GW of installed power today to more than 350 GW by 2030 and the further development of HVDC thyristors continues to benefit customers of HVDC systems. ABB Semiconductors has delivered ~200'000 thyristors for the 100 GW of installed power today, and continuous quality monitoring shows that the FIT rate is well below 10.
GTO products remain a strong product platform within ABB Semiconductors, serving mainly the traction market. With our new production line, we can optimize our service for this market segment:

Figure 3: ABB Semiconductors' IGCT HPT on/off switch and 6" HVDC thyristor

Bodo Arlt: ABB has two production sites for bipolar devices. In addition to their production facilities in Lenzburg, ABB Semiconductors also has a production site in Prague. What are the plans for the two production lines?

Manfred Kraxenberger: In 2010, Polovodice CKD in Prague joined the ABB Semiconductors family and the total number of production units now stands at four. Prior to 2010, the two companies had a very good relationship from working closely together for more than 10 years.
ABB s.r.o. Semiconductors in the Czech Republic has a strong focus on high power diode technologies and also has bipolar production technologies which are not available in Lenzburg. Synergies are being explored between our two bipolar production lines. A certain overlap in product portfolio exists, but the focus in Prague is more on medium power level applications and market segments with strong growth potential, such as the automotive welding industry.

Bodo Arlt: In your opinion, what are the main prerequisites for serving the demanding industrial market with bipolar devices for electronically controlled motor drives?

Manfred Kraxenberger: ABB Semiconductors was one of the pioneers in the development and production of bipolar devices. Over the years, much emphasis has been placed on engineering and development in order to increase the performance limits. ABB's state-of-the-art testing processes ensure high quality with long lifetime expectancy of the device in customers' applications. Our latest generation of testing equipment has been designed to increase productivity without compromising the quality level of testing of each bipolar element.

Manfred Kraxenberger
studied physical engineering and started working as process engineer at Siemens Semiconductor in Munich in 1986.

Over the last 25 years, he have held several engineering and management positions in manufacturing as well as R&D at Siemens/Infineon/Qimonda and GlobalFoundries.
Since 2011, he is in charge of ABB Semiconductors´ Bipolar Profit Center in Lenzburg, Switzerland.

Facts and Figures: Expansion of Bipolar Line at ABB Semiconductors, Lenzburg/Switzerland

- Investment:
  - 80 MUSD for new infrastructure, process automation and new equipment
- Project Figures:
  - 79 days from demolition to completion of main construction (removal of 600 tons of debris)
  - 42 days for installation, start-up and qualification testing of 140 pieces of equipment
- Technical figures:
  - Wafer production footprint: 400'000 wafers annually
  - Cleanroom size: 2500m^2
  - Cleanroom classification: 100/1000 (ISO5 and ISO6)
  - Diffusion oven capacity: 16'000 wafers
  - Ventilation system capacity: 400'000m^3/h, enabling a complete exchange of air 400 times per hour
  - 40 km of IT and safety cables, 30 km of electrical cables, 25km of automation cables
  - 4.8 MW power capacity
- Advantages:
  - increased work flow automation
  - improved process control
  - increased employee safety
  - back-up equipment for critical processes
  - substantial energy savings

Bodo Arlt: Mr. Kraxenberger, thank you for the detailed information. We are looking forward to the successful future of bipolar devices

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Sub-Harmonic Oscillations on Output Voltage Caused by Multiple POL Rails

It is very common to find server and netcom systems using multiple POL rails. Often, because of the inherent characteristics of the POL control IC and power converter FETs, the system is optimized by operating all the POL rails at a specific switching frequency that represents the optimal trade-off between efficiency and transient response.

By Saurabh Jayawant and Parviz Parto, EPBU/POL, Irvine Design Center, International Rectifier

The system designers also prefer to operate all the POL rails at nominally the same switching frequency so as to simplify filtering requirements, and reduce interference. It has been seen, however, that in some cases, with two or more converters operating in close physical proximity of each other, this approach may lead to subharmonic oscillations in the output voltage ripple, causing the effective peak to peak ripple amplitude to be more than twice the desired value. This article looks at the findings and recommendations following an investigation into the root cause and a search for a remedy of this problem.

The root cause lay in the fact that the switching frequency of the rails was only "nominally" the same, and in reality, parameter variations in the control IC as well as the timing resistor meant that the real switching frequency of the different POL rails often differed from each other by upto 5% or 10%. For a nominal switching frequency of 600 kHz, this translates to a difference in switching frequency of up to 60 kHz. Also, the architecture of these POL rails is often such that the output of one rail acts as an input voltage for another, thus coupling the two rails. Coupling may also be introduced between two seemingly unconnected rails in close physical proximity of each other, if the bias supply for the converters powering these rails is routed through a single common trace. In the latter case, the coupling means that a perturbation at f_{s2}, which is the switching frequency of one converter, is presented to the converter operating at switching frequency f_{s1}. Assuming that a high performance application circuit design sets the control bandwidth of the feedback loop at about 1/6th of the switching frequency or nominally 100 kHz, the perturbation frequency lies well outside the control loop bandwidth. However, the output of a trailing edge, naturally sampled pulse width modulator also shows sideband harmonics. The first order sideband at $|f_{s1} - f_{s2}|$ lies well within the control loop bandwidth if f_{s1} is very close to f_{s2}. forcing the converter to respond and hence, appears at the output as a subharmonic or beat frequency ripple.

In this specific example, the two rails interacting with each other provide output voltages of 1.2V and 3.3V respectively. The bypass capacitance on the bias supply (Vcc) pins of the POL controllers providing the two outputs is 100 nF. Also, as can be seen in

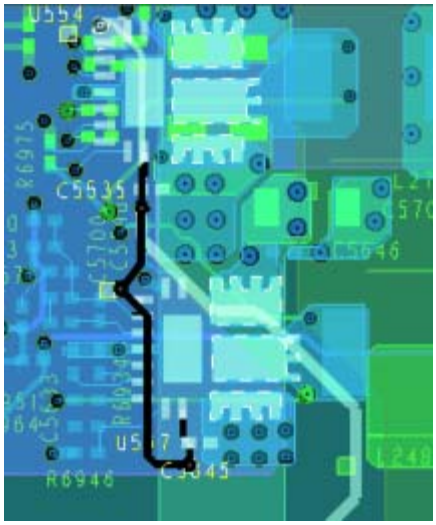

Figure 1: 1.2V and 3.3V POL rails in close proximity, with common Vcc trace (black)

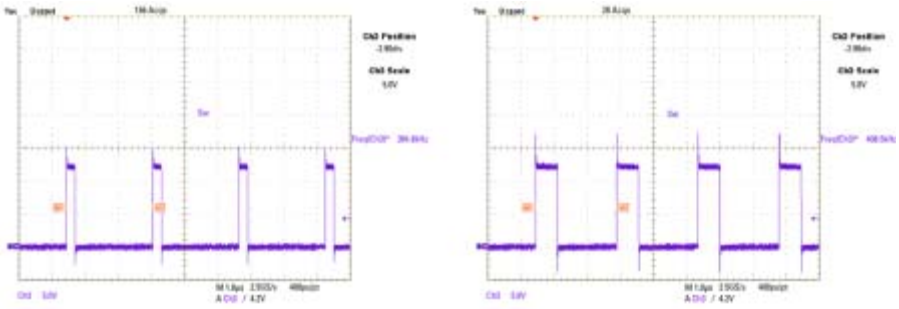

Figure 2: 1.2V rail operating at 385 kHz and 3.3V rail operating at 408 kHz

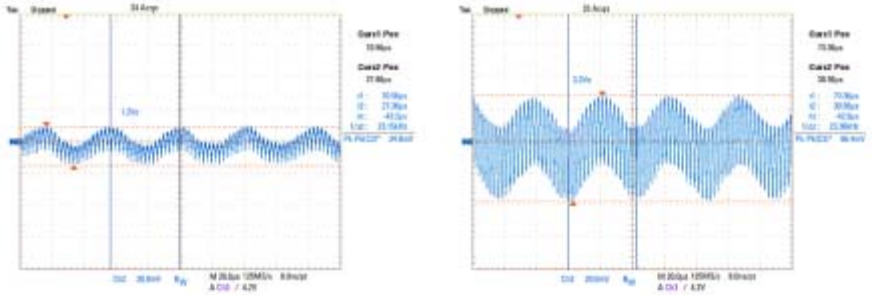

Figure 3: Output voltage ripple for the 1.2V rail and 3.3V rail exhibits 23 kHz beat

Figure 1, the two rails are in close physical proximity of each other, with the bias supply Vcc routed though a single common trace (highlighted in black). Both the rails are set up to operate nominally at 400kHz, but measurement shows them operating at 385 kHz and 408 kHz respectively, as shown in Figure 2. The output voltage ripple for each of the two voltage rails is shown in Figure 3. As can be seen from Figure 3, both output voltage ripples exhibit a beat frequency of 23 kHz which is the difference between the switching frequency of the two rails.

With the root cause established, 4 possible solutions are suggested and validated:

1] Better layout practices that establish decoupling between POL rails operating at the same nominal switching frequency. These include the use of large copper filled polygons or copper planes for the bias voltage supply, or the use of separate traces to route the bias voltage supplies to the different POL converters.

2] Attenuate the Vcc ripple by using higher bypass capacitance: In this case, the bypass capacitance was increased from 100 nF to 1 uF.

3] Force the POL converters that are coupled through the layout, to operate at the same switching frequency through the use of an external clock for synchronization.

4] If no pin is available to synchronize the converters with an external clock, and the system architecture and power budget allow, separate the switching frequencies of the 2 rails such that $|f_{s1} - f_{s2}|$ lies outside the control bandwidth of both the converters. In our study, the switching frequency of the 1.2V converter was set to 550kHz and that of the 3.3V converter was 385 kHz. The control bandwidth of both the converters is set at 70 kHz., Thus, the first order sideband at 165 kHz lies outside the control loop bandwidth.

Conclusion

In systems where multiple POL rails are deployed parameter variations in the components used and the impact of coupling in rails that are in close proximity can lead to subharmonic oscillations and a significant increase in effective peak-to-peak ripple amplitude. Techniques that designers can employ to remedy this situation include board layout that supports rail decoupling, choice of bypass capacitance value and the use of external clocks to synchronise POL converters. Separating converter switching frequencies by a suitable amount may also be an option in some cases.

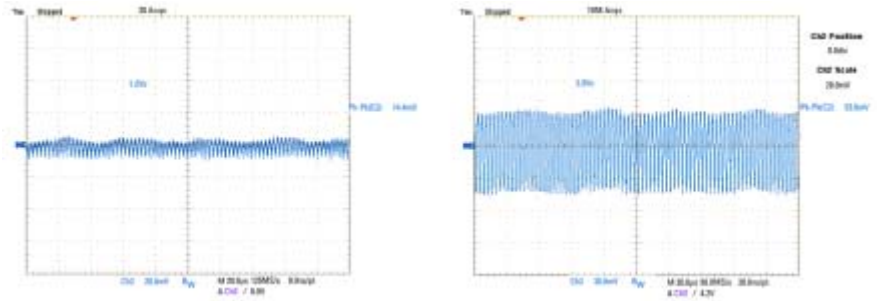

Figure 4: Eliminating subharmonic oscillations by the use of separate Vcc traces

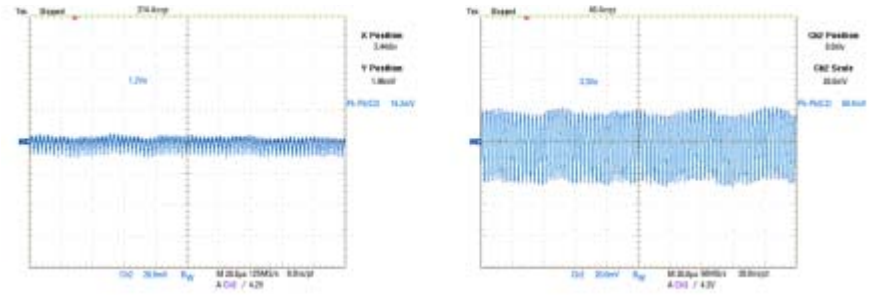

Figure 5: Eliminating subharmonic oscillations by the increasing the Vcc bypass capacitor to 1 uF

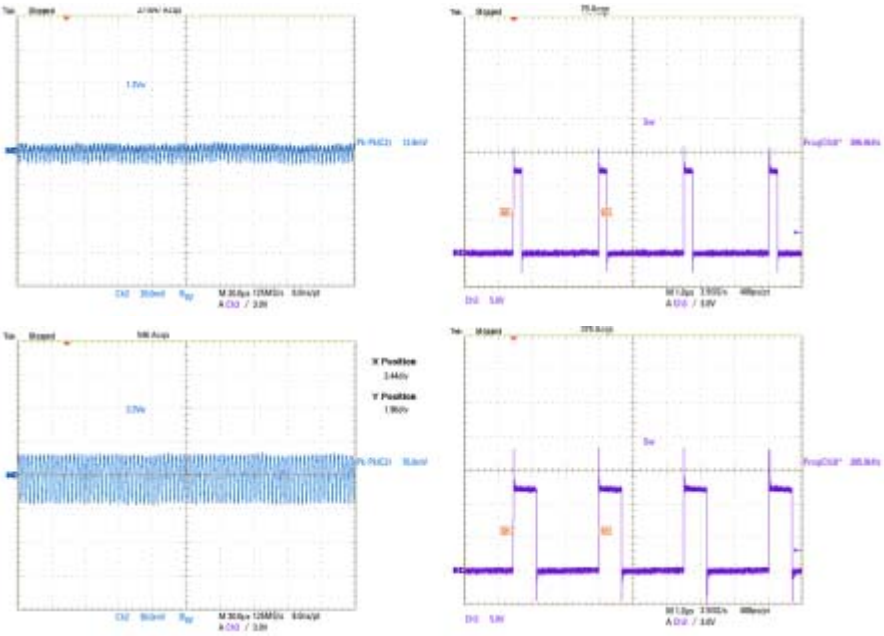

Figure 6: Eliminating subharmonic oscillations by forcing the converters to operate at the same switching frequency

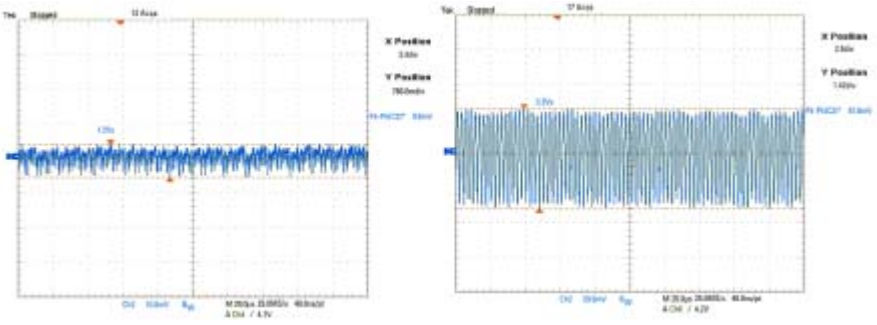

Figure 7: Eliminating subharmonic oscillations by operating the converters at switching frequencies separated from each other by more than the control bandwidth of the converters

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Features of High-Voltage Thyristors for Snubberless Stacks

Influence of design and technology features of high-voltage n+-p-n--p thyristors (impurity doping of p-base and p- emitter, carrier life time in layers) on reverse recovery characteristics (reverse recovery time and charge, reverse recovery current form, temperature dependence of the mentioned characteristics).

By Anatoly Chernikov, Vitaly Gubarev, Alexander Stavtsev, Alexey Surma, Igor Vetrov, Proton-Electrotex JSC

The requirements for thyristors' design were formulated, which could synchronous operate in series connection without RC-circuits.

The possibility of safe operating of such thyristor stacks in wide range of electric and thermal conditions was experimentally proved.

During last few years many manufacturers of high-power semiconductors started production of thyristors and diodes with voltage up to 6.5kV – 8.5kV. These devices are mostly necessary for completing units of high voltage valves of electric converters in industry and power industry meant for application with voltage of AC current 6kV and higher. Each valve is consisted of several semiconductor devices in series connection, that's why increase of voltage for each separate device is important since it allows to decrease the number of devices necessary for one valve, and as a result to simplify its design and increase its durability.

Unfortunately, increase of maximum allowed blocking voltage leads to increase of charge, characteristic of high-voltage device. This is connected with necessity to provide acceptable low voltage in on-state.

For devices with 6.5Kv-8.5kV the value of reverse recovery charge and maximum value of reverse recovery current are pretty high, even with relatively low speed of current drop.

Due to the above mentioned facts, the question of developing high voltage thyristors with specific characteristics at reverse recovery becomes very important.

These characteristics are:

- Minimized charge value and value of reverse recovery current (with low voltage in on-state);
- "Soft" character of reverse recovery; usage of thyristors with soft reverse recovery allows to simplify the requirements to RC-circuit in providing the acceptable level of peak voltage;
- Adequacy of reverse recovery charges, as well as reverse recovery current form for thyristors in series connection stack; this allows lowering the requirements to RC-circuits, and possibly in the long term to stop using them at all.

Our company undertakes all necessary steps in direction of development of high voltage thyristors with above mentioned characteristics.

Let's consider the connection of reverse recovery characteristics with parameters of semiconductor layers in more details.

Well-known that the reverse recovery charge value, first and foremost, depends on the value of accumulated charge of excess electron and holes, as well as recombination rate of accumulated charge. For high voltage thyristors, which recover at low rate of anode current drop, the second factor is more important. During the anode current drop, the bigger part of excessive carriers recombinate. So, there is optimum value of effective life time of carriers in lightly doped n-base of thyristor (the bigger part of excessive carriers is located there), which allows to reach low value of reverse recovery charge at acceptably low value of voltage in on-state.

However there are some additional ways to lower the value of reverse recovery charge. Thus, if we lower the maximum concentration of atoms of acceptor dopant in p-base of thyristor, we can lower the value of reverse recovery charge at the expense of taking part of excessive electrons accumulated in p-base right into n+ emitter, similar to the process in diode. In thyristors with highly doped p-base, as a result of transistance, there is no taking part of excessive electrons out of n-base, but injection of excessive holes into n-base, which leads to relative increase of reverse recovery charge.

Thyristors produced by «Proton-Electrotex» have rather low-alloyed p-base (as a rule maximal concentration of acceptors doesn't go beyond (1 or 2)* 1016 cm-3. It allows to reduce recovered charge without influence on loss of voltage in running order.

To provide necessary dv/dt – stability special topology of distributed cathode diversion is used.

An important characteristic is soft reverse recovery.

It is known that increasing of soft reverse recovery can be achieved during impoverishment of charge excess carrier near anode p- emitter.

There are two ways of achieving this:

- Decrease of anode p-emitter injection efficiency; it can be achieved during decrease of maximal concentration of acceptor dopant and also of charge carrier operating time in high-alloyed part of p-emitter layer.
- Local decrease of operating time in n-base layers and lightly doped p-emitter adjoining anode p-n transfer.

In thyristors of «Proton-Electrotex» production we use technologies which can realize both of these ways.

First, rather lightly doped p-emitter layers are applied. It allows reducing reverse recovery surge current. Besides as calculations and experiments show for such thyristors low temperature dependencies of time and reverse recovery charge are typical.

Secondary when it is necessary to get more flexible reverse recovery the special technology of charge carriers operating time regulation which is based on proton irradiation. This technology allows locally reduce the time of charge carriers operating time in the layers adjoining p-n transfer.

Of paramount importance is the opportunity to get thyristors with identical characteristics of reverse recovery. Herewith it is important to get not only the identical surge current and charges of reverse recovery but as well identical character of current dependence on time. It gives an opportunity in prospect to refuse from coordinating RC circuits while series assembly completing.

From written above we can make a conclusion that in order to get identical characteristics of reverse recovery it is necessary to provide high producibility for the dopant profile and as well for contribution of charge carriers life time in semiconductor devices.

Dopant species contribution identity is provided by the high level of production technology of semiconductor elements, precise control of charge carriers operating time is made with a help of special electrical or/and proton irradiation technology.

For achieving short variation of reverse recovery characteristics the following scheme is used:

Step 1: Presupposition for achieving short variation of reverse recovery characteristics is supplying of high dopant profile identity in producing silicon elements which can be achieved by well-worked technology.

On this step repetition of current reverse recovery design is provided.

Step 2: Precision control of reverse recovery characteristics (reverse recovery time, reverse recovery current, reverse recovery charge, softness) with a help of electrical and proton irradiation technology.

During this step time and reverse recovery charge values are additionally corrected in order to reduce the variation of these characteristics in series. Combination of electronic and proton irradiation allows correct softness simultaneously.

Step 3: Finish presorting while mounting, which allows examining reverse recovery of two or more consequently connected thyristors in conditions similar to operational.

Presorting is made during the examination of each thyristor in consequent connection to the etalon. Herewith the voltage applying to thyristors during the whole process of reverse recovery must be distributed between testing and etalon thyristor in equal parts.

On the same mounting it is possible to examine already mounted high voltage S-gates on the base of consequent thyristor stacks.

As a result of mentioned technologies application in production it was managed to achieve high voltage thyristors with rather low reverse recovery charge value, low temperature dependence and also with high soft reverse recovery.

In such a way for example a typical reverse recovery charge value for Txxx-xxx thyristor under the current fall speed XX A/ìs and under the temperature 125°C makes YYY-YYY ìC under typical value S-factor about one. Typical increase of reverse recovery charge under temperature changes from 25°C to 125°C makes about 30-40%.

Identity of reverse recovery characteristics for thyristors, completing series assembly, allows on the whole getting equal distribution of reverse voltage even without matching RC-circuits.

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As Bright as 30 Headlights

Using optimized sintering processes for direct LED assembly

A new combination of Alunit ceramic and innovative liquid cooling makes it possible to create extremely compact power electronics. LED arrays up to 100W/cm² and 45,000lm on an area of 40x40mm² are possible. To cool these packing densities the entire thermal path has been optimized – from the LED assembly to the ceramic heat-sink.

By Rüdiger Herrmann, Key Account Manager, Electronic Applications Division at CeramTec GmbH, Marktredwitz and Dr. Rafael Jordan, Photonics Coordinator, Fraunhofer IZM, Berlin

Thanks to their increasing light output, high-power LEDs are becoming an interesting option for new applications in medical products, industrial image processing and UV hardening, to name just a few. Hundreds of very densely packed power LED chips are needed to illuminate large-surface objects; this can lead to thermal problems. On top of that, high demands are placed on unchanging optical parameters, especially in UV applications, such as wavelength, chromaticity, forward voltage and light output. Fluctuating temperatures or very inhomogeneous temperature distribution across the power module are unacceptable. A joint project sponsored by VDI/VDE-IT Bavaria faced these challenges and developed compact LED modules with a high packing density and output. The development partners have demonstrated their expertise in every step of the process – from the design and production to the characterization and verification:

- The Electronic Applications Division at CeramTec GmbH, Marktredwitz, supplied innovative aluminum nitride (AlN) liquid-cooled heat-sinks.
- The Fraunhofer IZM institute in Oberpfaffenhofen designed the thermal and fluidic cooling.
- The Fraunhofer IZM institute in Berlin populated the ceramic heat-sinks with LEDs using new bonding techniques.
- Excelitas Technologies GmbH & Co KG (formerly PerkinElmer Elcos) in Pfaffenhofen then produced the functional LED module with an optical compound and electrical and fluidic interfaces.

The significant increase in output of the new cooling modules was made possible by several development projects. For example, the usual thermal bottleneck seen in glued components was avoided altogether through the development of new chip assembly techniques using optimized sintering processes for direct LED assembly on AlN ceramic heat-sinks. The metalized Alunit ceramic creates efficient thermal coupling between the chip and the coolant. Another area of emphasis was on the development of a special thermal management system with even temperature distribution over the entire module that also takes other general conditions into account such as scalability in every direction and simple handling. The CeramCool Box that resulted from this effort also allows quick adaption of the illumination to the respective application requirements without any complex optics.

An edge length of only 40mm for 1600W

The compact CeramCool Box is made for homogeneous and efficient cooling of packing densities up to 100W/cm². With an edge length of just 40 x 40 mm² and a height of only 16 mm, it has a total cooling capacity of 1600W. With an efficiency rating of 25%, this corresponds to 400W of optical power, or roughly 45,000 lumens with common high-power LEDs. The remaining 1200W need to be efficiently dissipated as heat, which is a challenge that already begins with the heat transfer from the component to the carrier substrate. Power densities of this magnitude call into question conventional bonding techniques for die bonding. Even highly filled Ag conductive adhesives exhibit a thermal conductivity of little more than 1 W/mK, which already results in a bottleneck for efficient cooling. Add variable adhesive layer thicknesses and even the best cooling concept cannot compensate for the absolute and relative temperatures.

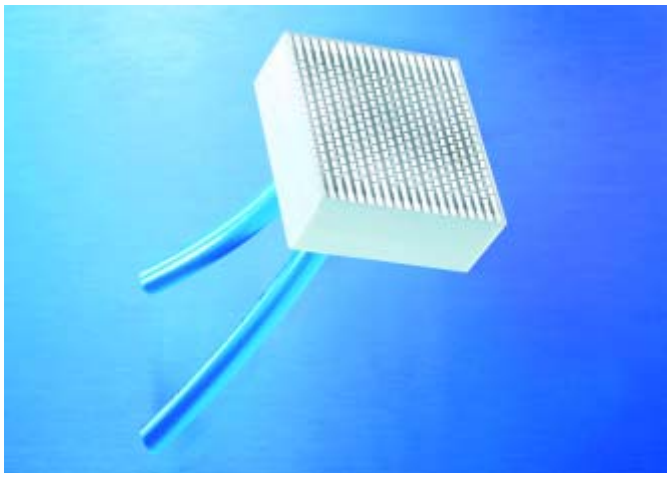

Figure 1: The compact CeramCool Box is made for homogeneous and efficient cooling of packing densities up to 100W/cm²

The Fraunhofer IZM institute in Berlin approached the problem with the bottleneck using new soldering and sintering techniques. The lower thermal resistance of this metallic bond created an excellent thermal coupling with the metalized Alunit substrate. They tested different combinations of LEDs, sintered metals and the ceramic substrate to ensure dependable adhesion. In addition to the electric conductors, this requires that the soldering points and sintering pastes are placed directly on and bonded permanently with the high-performance ceramic heat-sink without creating thermal barriers and without the risk of delamination (difference in thermal expansion coefficients). In this case the chip can be bonded directly on the heat-sink. With production costs in mind they developed techniques for

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collective bonding that deliver a high degree of placement accuracy with considerably lower costs.

Alunit ceramic: high thermal conductivity, excellent dielectric strength

Ceramic heat-sinks take on a key role in efficient cooling because achieving the required temperatures is only possible when the base material exhibits high thermal conductivity with direct metalization. Alunit ceramic not only enables efficient thermal coupling with the coolant but also ensures the spreading of heat to minimize temperature differences within the module. What's more, during the research project CeramTec succeeded in achieving series extrusion of AlN ceramics with exceptional thermal conductivity. This process was the world's first of its kind at the time and enables rod-shaped bodies and tube systems made of ceramic with high thermal conductivity, mechanical stability and dielectric strength. The CeramCool Box has multiple parts and is produced using a dry pressing process followed by solid-state sintering. The shaping of the various prototype geometries takes place in the green stage using CNC machining as this method allows for the fast manufacturing of low-cost test modules.

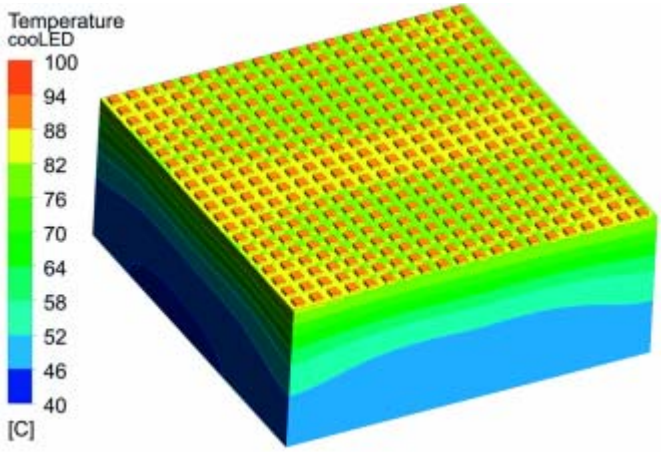

Figure 2: The temperature profile of the CeramCool Box is homogeneous. Packing densities up to 100W/cm² are efficiently cooled. An aluminum nitride ceramic material called Alunit is used

If only passive cooling using air convection is possible in spite of the extensive waste heat, then uneven heating up of the LEDs in places

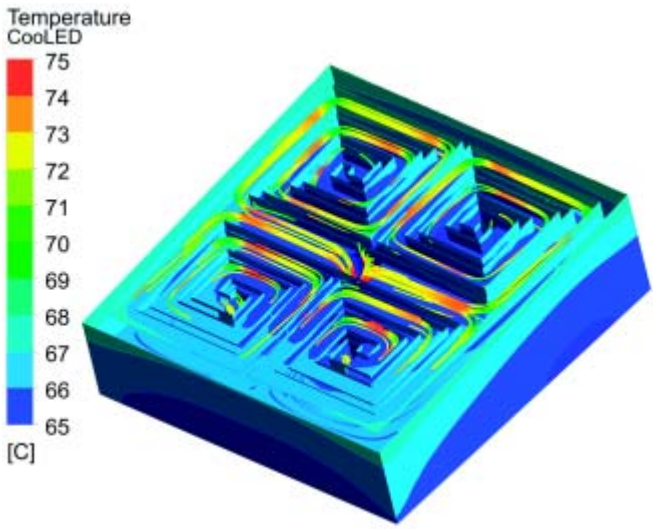

Figure 3: Symmetrically arranged spiral condensers with innovative multi-level flow paths ensure even cooling all the way to the exterior

to much higher than 100°C is unavoidable. For this reason the CeramCool Box allows for the hookup of an active water cooling system. A conventional chiller such as those used in PC technology is perfectly sufficient for heat dissipation. To ensure that the CeramCool Box is as simple to handle as possible, the designers limited the number of cooling water connections to a single inlet and outlet. Moreover, thanks to the ceramic construction, system developers can choose the coolant and even use the heat-sink in aggressive environments.

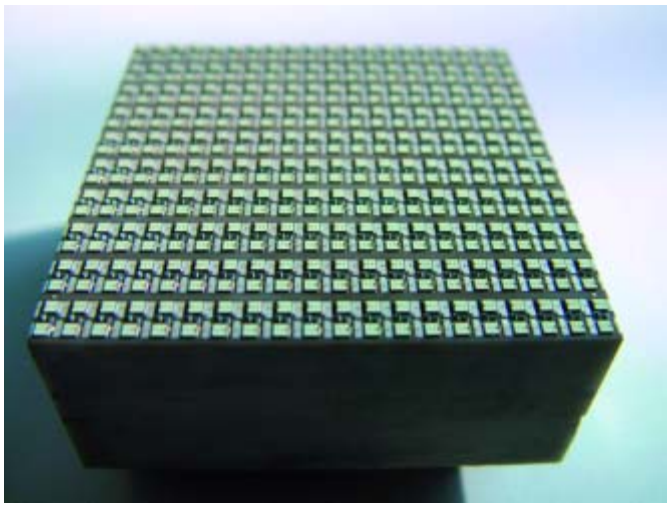

Figure 4: The scalable metalized module cools LED arrays up to 100W/cm², or 45,000lm on an area of 40x40mm². To cool these packing densities the entire ther-mal path has been optimized – from the LED assembly to the ceramic heat-sink

What makes the CeramCool Box particularly innovative is found inside the ceramic heat-sink: Four symmetrically arranged spiral condensers with innovative flow paths ensure even cooling all the way to the exterior. The interior ceramic walls are a mere one millimeter “thick”. The enables the coolant to get closer to the heat source than any other concept with a comparably long system lifetime. The CeramCool Box uses Alunit, an AlN ceramic material with a thermal conductivity at room temperature of >170W/mK. Its high heat conduction enables this ceramic to deliver superior heat spread even with very thin walls. In conjunction with the sintering technology described above, this guarantees excellent heat transfer from the heat source to the coolant.

The efficient and even temperature distribution has been proven in the thermal characterization using IR thermography and electrical junction temperature measurement. Thanks to the innovative interior design of the heat-sink, the measurements showed that the temperature only reaches 90°C with a coolant flow of 180l/h and an ambient and cooling water temperature of 30°C! For more precise measurement of the junction temperature than is possible via the wavelength shift in the UV range, a special measuring apparatus was developed that can determine the temperature via the forward voltage within an accuracy of one degree Celsius. These measurements have also confirmed the simulated results.

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Power Semiconductor Module Combines MNPC Topology with SiC Switches

SiC enable engineers to significantly increase efficiency and switching frequency

This article compares and contrasts two types of modules, one with silicon switches and the other with SiC (silicon carbide) switches. Vincotech flowMNPC 0 modules in 12mm flow 0 housings serve the purpose of comparative evaluation.

By Kuno Straub, Product Marketing, Vincotech GmbH

These modules feature MNPC (Mixed Voltage Neutral Point Clamping, Figure 1) topology. This type of circuit is designed for two types of applications, solar inverters and uninterruptible power supplies (UPS).

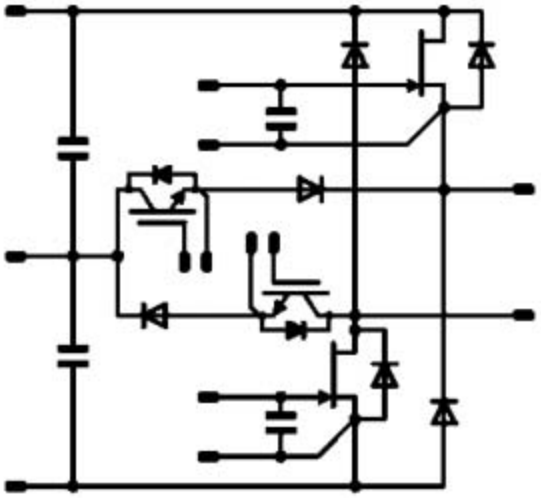

Figure 1: MNPC topology with SiC JFET

MNPC topology is a variant of three-level topology. It and the standard NPC topology are today the preferred topologies for applications requiring exceptional efficiency. In this context, the term "three-level" refers to the possibility of generating three voltage levels at the source terminals – positive, negative, and a third level usually midway between the two.

In contrast to NPC topology, MNPC topology exhibits the following properties when used for applications such as solar inverters:

The majority of losses are not attributable to switching loss at moderately high switching frequencies of around 16 kHz. While it is true that MNPC topology generally exhibits greater switching loss than NPC topology because of the 1200V switches, the difference is insignificant at 16 kHz.

MNPC topology exhibits less conduction loss than NPC topology at a high modulation index and/or high duty cycle for 1200V transistors. Solar inverters and uninterruptible power supplies generally seek to make the most of the intermediate circuit voltage, so the modulation index is usually high.

A comparison of the two topologies (Figure 2) shows that MNPC topology is about 0.5% more efficient at 16 kHz.

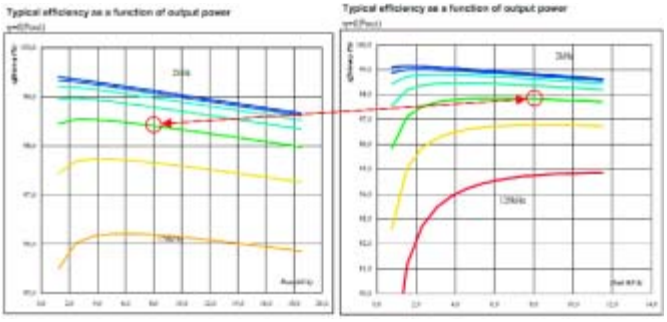

Figure 2: Comparative efficiency of MNPC (on the left) and NPC (on the right) topologies

In recent years, SiC-based Schottky diodes have been used successfully in fast switching applications such as PFC (power factor correction). The diode's excellent reverse recovery characteristics ensure that the increased switching frequency does not adversely affect efficiency. The use of smaller magnetic components also reduces overall system costs.

Today's SiC-based switches are another matter entirely. Modern solar inverters and UPS systems are mainly equipped with Si-based IGBTs (insulated gate bipolar transistor). Although their forward voltage is low, their tail current causes high switching loss. Engineers tasked to develop solar inverters and UPS want a switch that is high in reverse voltage and low in conduction and switching loss. SiC provides the underpinning for this ideal switch.

Among the many ways to implement an SiC switch, two are gaining prevalence, SiC MOSFET and JFET. The MOSFET behaves much

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like a MOSFET based on silicon. It is compatible with the usual gate drivers, and its temperature coefficient is low. However, the reliability of gate oxide remains a critical issue. The JFET may be configured both ways, normally-off and normally-on. Owing to their diode-like gate source characteristics, they are incompatible with standard gate drivers. JFETs do not incorporate gate oxides so they are more reliable from the perspective of today's technology.

To clear the final hurdle and boost system efficiency to 99%, the new family of modules was equipped with normally-off SiC JFETs sourced from SemiSouth Laboratories, Inc. The switches' forward voltage and switching loss is low. With up to four SiC JFET chips configured in parallel circuits in the module, Rds(on) is just 25mΩ at room temperature. JFETs are unipolar devices, so they exhibit good switching characteristics much like those of standard silicon-based MOSFETs. Utmost efficiency is achieved by combining MNPC topology with SiC JEFTs for the fast high-voltage switches.

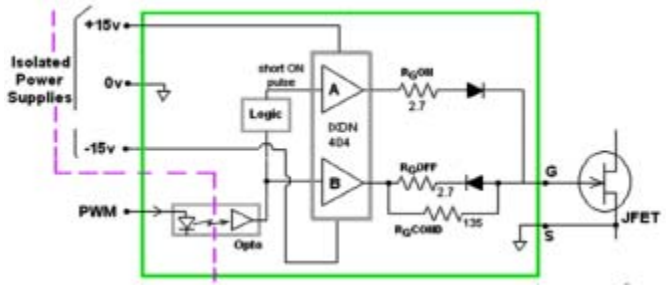

Figure 3: Example of a possible gate driver for normally-off JFETsi

Again, JFETs have diode-like gate source characteristics. Positive voltage must be applied in the diode's direction of flow to open the channel of a normally-off JFETs. To retain the JFETs' best properties, this should be done near the diode's forward voltage. The forward voltage varies considerably from component to component and fluctuates with temperature, so JFETs - unlike IGBTs or MOSFETs – should be controlled by a current source.. A standard gate driver must be adapted to limit the forward current. One way to do this is to use low gate resistance for switching and high gate resistance during the final conductive phase. The SemiSouth specification sheet provides an example of such a gate driver (Figure 3).

Vincotech's new module family features separate outputs for both commutating circuits (see Figure 1). Consequently, both circuits' du/dt are separate. This measure reduces the risk of parasitic turn-on (that is, via the Miller capacitance at high du/dt) and the resultant increase in switching loss.

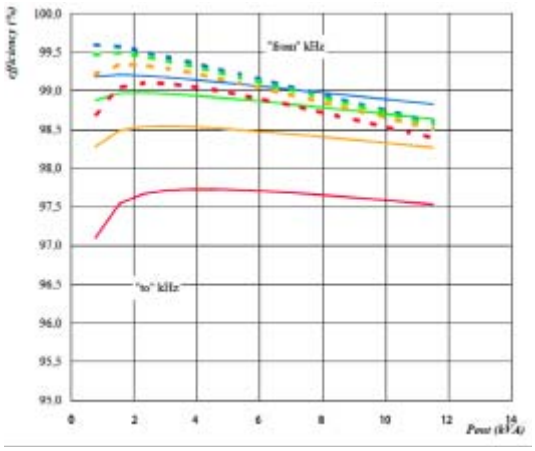

Figure 4: Comparative efficiency of MNPC modules with Si IGBTs (solid lines) and SiC JFETs (dotted lines) at switching frequencies of 8 to 64 kHz

Figure 4 shows a comparison of modules equipped with Si IGBTs and SiC JFETs.

This comparison indicates that modules with SiC JFETs achieve higher maximum efficiency, whereby the gains increase at higher switching frequencies. This means the user is able to increase both efficiency and switching frequency. Raising the switching frequency allows smaller passive filter components such as inductors and capacitors to be used, which reduces overall system costs.

The new family's pin-out facilitates an optimum low-inductive PCB layout. The intermediate circuit's positive, negative and neutral terminals are at the center of the module, enabling engineers to implement a low-inductive intermediate circuit layout that is continuous and uninterrupted. What's more, snubber capacitors may be sited very close to the module.

This family of Vincotech module also features versions with a booster configuration – that is, two parallel boosters housed in one module. Variants with 1200V IGBTs and SiC JFETs are available. Given dual boosters to work with, engineers can implement two independent MPPT (maximum power point tracker) channels in one solar inverter to boost efficiency and pulse frequency. The version equipped with SiC JFETs features four chips configured in parallel circuits to achieve Rds(on) as low as 25mΩ at room temperature.

Figure 5 depict an example 30-kW solar inverter.

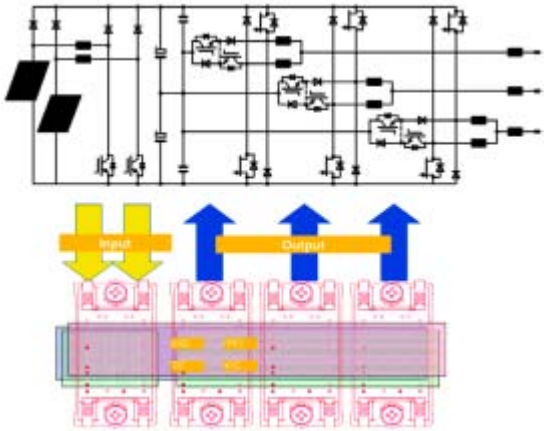

Figure 5: Example of a 30-kW, 3-phase solar inverter

SiC switches constitute a new class of 1200V switches. They enable engineers to significantly increase efficiency and switching frequency for demanding applications such as solar inverters. With such switches on board, these power semiconductor modules readily adapt to suit the given application and may be deployed to optimum effect. The modules were designed to satisfy such applications' demanding requirements for symmetric control, heat dissipation and a low-inductive layout.

Vincotech modules M340 family with Rohm SiC MOSFET M340-F and SemiSouth SiC JFET:
http://www.vincotech.com/products/by-topologies.html?rpm_id=26

www.vincotech.com

[1] SemiSouth datasheet SJEP120R100, http://www.semisouth.com

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Cosmic Radiation Kills

and may be the primary cause of failures in your high voltage MOSFET based designs

High voltage power MOSFETs are commonly used in high end power electronics where high switching frequencies are demanded by the application, enabled by the devices' low switching losses. Hard evidence shows that these MOSFETs, though used well within their safe operating areas and in a terrestrial application, are easily destroyed by cosmic rays.

By Elena Lomonova, professor, and Jan Schellekens, doctoral candidate, Electromechanics and Power Electronics Group, Technical University, Eindhoven, the Netherlands and Jeroen van Duivenbode, ASML B.V., Veldhoven, the Netherlands and Alessio Griffoni and Dimitri Linten, IMEC, Leuven, Belgium

Cosmic rays - no joke

When confronted with destroyed MOSFETs in output stages the first thoughts naturally go towards use outside of the safe operating area as defined by the components' data sheet. In the quest for high power density and low cost designs may stretch the parts to their limits. But what if you do everything right and end stages still explode every now and then for no obvious reason? You dig into the problem and find out that cosmic rays are by far the dominant cause of your problems. Skeptical? Do read on.

Elimination

Knowing that the end stages also failed under light load conditions we could rule out high junction temperature. By use of a neat soft switching topology we were sure that peak device voltages stayed below 70% of the rated voltage. Inadvertent cross conduction seemed the only possibility. Figure 1 shows that such cross conduction, in a typical half bridge configuration with two MOSFETs connected in series to a "hard" low impedance voltage bus, will indeed lead to a rapid build up of current causing a certain death of one or both MOSFETs.

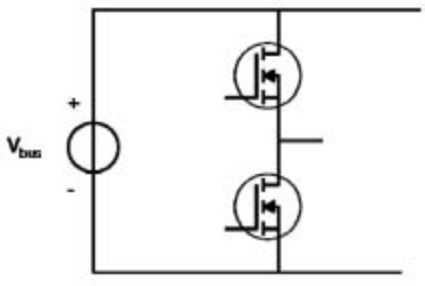

Figure 1: Typical half bridge cell

Post mortem SEM images of failed MOSFET chips indeed suggest thermal overloading due to over current.

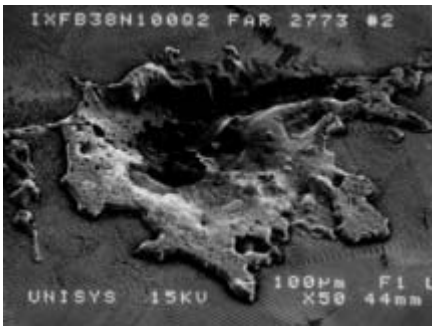

Figure 2: SEM image of failed MOSFET chip

We verified that the high and low side drivers would never turn both switches on simultaneously in every normal/start-up/error condition we could imagine. A dynamic effect, where a MOSFET is turned on through gate current injected by a high dv/dt over the Miller capacitance, was also ruled out: our soft switching topology ensures a low dv/dt, as verified by measurements of bridge- and gate voltages. Application of correct creepage and clearance distances is on a 1000 V rated device in a TO-247 or TO-264 style package certainly not obvious. However, we updated the pad shapes on our PCBs and made sure that we satisfied all relevant IEC and IPC requirements. Insulation sheet material, used to isolate the MOSFETs from the heat sink, was also optimized to rule out punch through. Still puzzled, we started to zoom in on the MOSFETs themselves and focused on cosmic radiation as root cause. While the effects of radiation are always taken into account in space applications and military operations in the stratosphere, it is commonly neglected for terrestrial applications. Nevertheless, literature indicates the failure mechanism exists for many high voltage power devices such as IGBTs, diodes and MOSFETs.

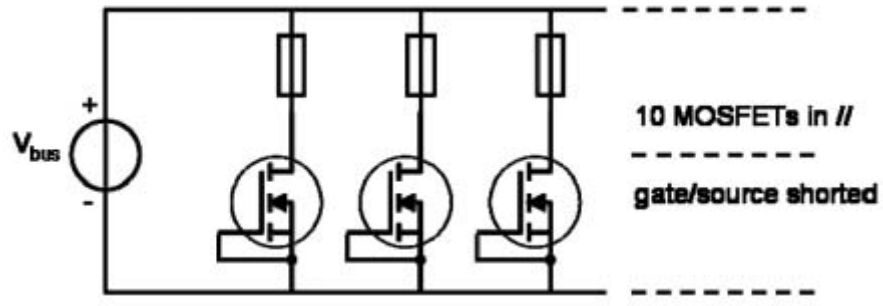

Figure 3: static reverse bias (SRB) test

Testing for cosmic rays

As a first approach, we connected 10 MOSFETs to their rated voltage (1000 VDC) and made sure they remained "off" by shorting the gate/source junctions, in a "static reverse bias" configuration, so called for the reverse bias of the intrinsic body diode. Fuses were used to electrically remove failed MOSFETs from the test set up.

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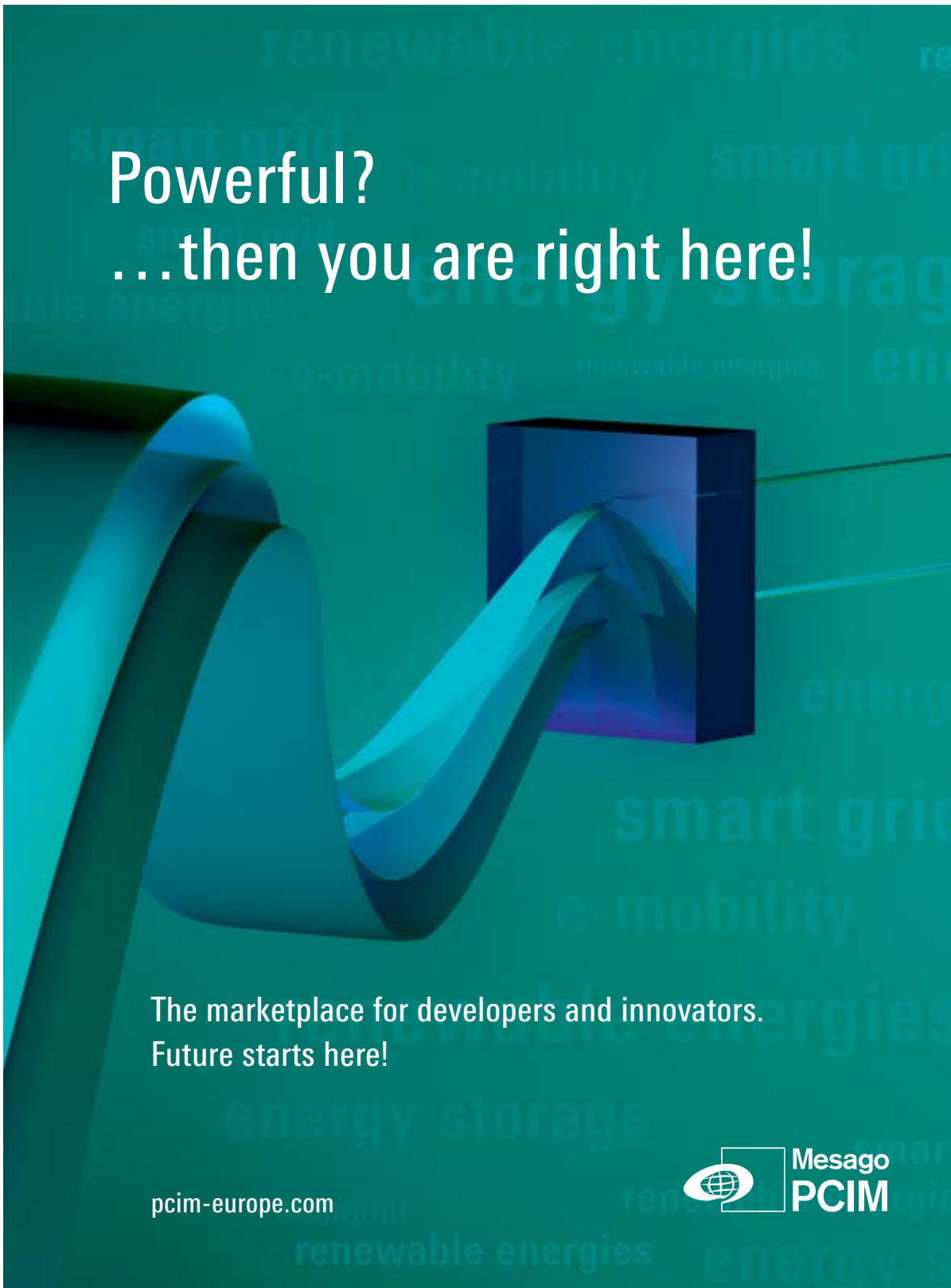


The result was amazing: after 24 hours, 3 MOSFETs had died into a short.

Figure 4: SRB set up for 300 MOSFETs

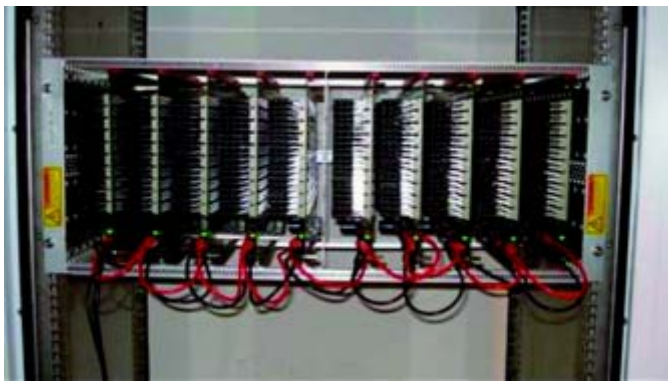


Figure 5: Ten PCB stack for 3000 MOSFETs

After this we lowered the voltage and experienced a lower failure rate. To test for the low required failure rates at a well de-rated bus voltage, we ended up making special PCBs which accommodate some 300 MOSFETs each.

Ten such PCBs are stacked in a rack for a total test capacity of 3000 MOSFETs.

For the application, we established a target failure rate of 100 FIT per MOSFET, where 1 FIT corresponds to one failure in 10^9 hours. To see at least 5 failures for sufficient statistical evidence, a test time of

$$t\ [h] = \frac{5\ [failures]}{3000\ [devices] \cdot 100\ [FIT] \cdot 10^{-9}[\frac{\frac{failures}{device \cdot h}}{FIT}]}$$

Vds	failures	device hours	FIT
620	1	21092576	47
650	12	12894707	931
680	2	2632145	760
700	9	4232786	2126
750	32	6502112	4921
750	7	932141	7510
800	7	799667	8754
900	9	60074	149815
950	8	2808	2849003
1000	1	273	3663004
1100	4	780	5128205

Table 1: Terrestrial test results

or about 100 weeks is required. Since two years is somewhat long for practical purposes, we accepted to use the measured trend in failure rate as a function of applied voltage to provide an acceleration factor of 10 so that significant results could be obtained in less than a quarter.

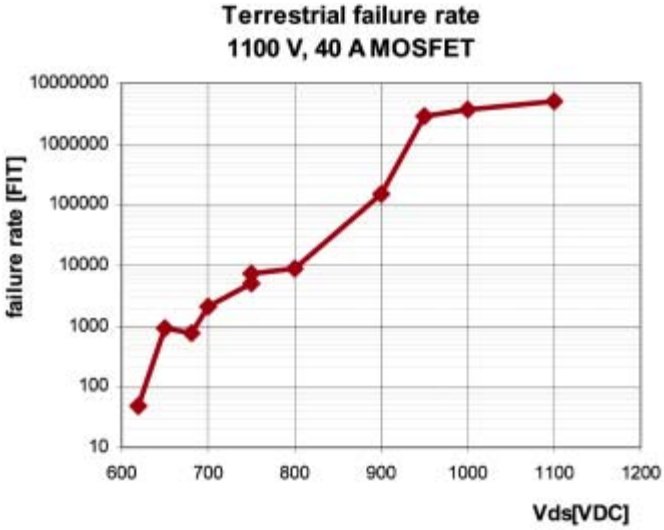


Figure 6: Terrestrial failure rate

Results

Thus we were able to establish the following data on a 1100 V, 40 A rated device.

Note that, thanks to the large number of components in the set up, nearly 50 million device hour's worth of test data have been accumulated so far (!). The orange areas indicate where the FIT rate should be used carefully due to the low number of events.

The testing is normally done at room ambient temperature. However, in some tests we increased the temperature to 80°C and found that, counter intuitively, the failure rate *improved* by nearly a full order of magnitude.

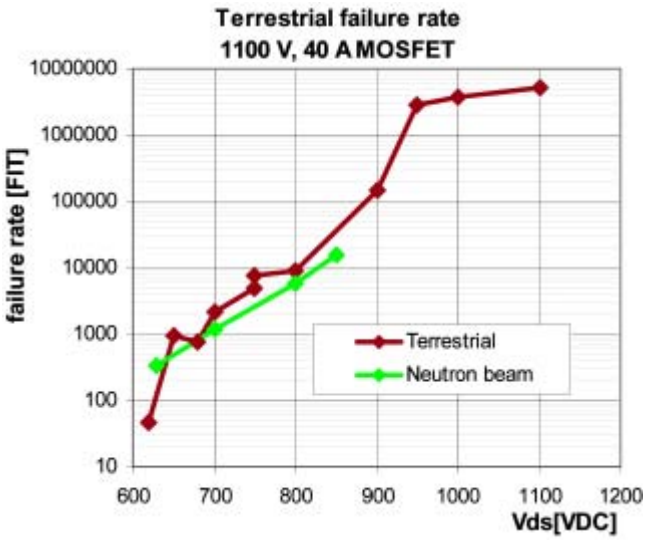


Figure 7: Neutron beam vs terrestrial results

Final proof

To positively identify cosmic rays as the actual root cause, we put our 3000 MOSFET setup in a limestone cave in the South of the Netherlands, where cosmic rays are filtered by some 20 meters of soil and stone. The conditions otherwise resembled the laboratory with an ambient temperature of 20°C and a relative humidity of 70%. Based on the earlier laboratory results some 20 failures were to be expected at a voltage of 750 VDC, *but the failure rate dropped dramatically to zero failures in 8 weeks*.

Particle accelerator testing

Even with 3000 MOSFETs a significant amount of time is needed to get reliable data. To improve on this we performed some tests at particle accelerators at the Svedberg Laboratory in Sweden and the Rutherford-Appleton Laboratory in the UK. Both facilities use a cyclotron to accelerate protons to a maximum energy in excess of 100 MeV. This proton beam is directed onto a tungsten target where the protons kick loose a secondary beam of neutrons with a spectral energy content that resembles the terrestrial cosmic radiation environment, albeit at a much higher flux. In this way several years of terrestrial life time can be tested in mere minutes, and only a few hours are needed to test for the required low failure rates.

The neutron beam results show four data points based on 5, 7, 10 and 4 events, representing reasonably sound statistical significance. The results match the laboratory test results rather well. The neutron line also suggests that, in the area of interest between 630 VDC and 850 VDC, the failure rate improves by a factor 10 for every decrease of 130 V of VDS. Such information would be very useful in a datasheet!

Conclusion

We have been in contact with all major high MOSFET suppliers about the effects of cosmic rays. All acknowledge the phenomenon and some even test for it. However, the data sheets still do not provide any data on failure rate that can be expected in a terrestrial application even though, in many applications such as ours, failure rate is in fact dominated by cosmic rays. Through our testing, we have demonstrated that two test methods are readily available to establish realistic data, to enable a user to make the trade off between the desired failure rate and the required de-rating for different parts. Armed with such data, we can serve society with more reliable power electronics.

More reading

[1] J. van Duivenbode and B. Smet, “An Empiric Approach to Establishing MOSFET Failure Rate Induced by Single-Event Burnout “, EPE-PEMC 2008, p. 102-107

[2] A. Griffoni, J van Duivenbode e.a., “Neutron-Induced Failure in Super-Junction, IGBT, and SiC Power Devices”, RADECS 2011

www.tue.nl

www.asml.com

Smart LED Lamp Driver IC Solves Small-Space Dimming Challenges

Fairchild Semiconductor developed the FL7701 Smart Non-isolated Buck LED Driver with power factor correction (PFC). The device uses a digital technique that allows it to automatically detect the AC input voltage condition, allowing it to create a special internal reference signal that results in high power factor correction.

The FL7701 will also work from a DC input voltage condition, automatically sensing AC versus DC input voltage conditions. The traditional technique of using a transformer in an MR application incurs additional losses with the transformer conversion; this traditional inefficient method can now be replaced using the FL7701 connected directly to a DC or AC off-line input.

www.fairchildsemi.com

650V IGBT4 Modules for High Performance and Ease of Design

Infineon Technologies introduces a new series of PIM and sixpack modules featuring 650 V IGBT4 ranging from 50 A up to 200 A. The modules are available in EconoPIMTM and EconoPACKTM 2 and 3 housings. Relying on PressFIT technology, fast and solderless assembly combined with highest reliability levels can be achieved. Solder pin versions are equally available.

Performance and ease of design are the main benefit of these new products: 650 V blocking voltage allows for more safety margin during operation. 10 µs short circuit robustness allows using a standard driver design at optimized cost. Leading on-state and switching losses help to further boost efficiency.

EconoPIM™ and EconoPACK™ 650 V IGBT4 modules perfectly complement existing 1200 V and 1700 V IGBT4 Econo solutions for drives inverters up to 690 V.

www.infineon.com

Dual Synchronous DC/DC Regulator is AEC-Q100 Qualified for Automotive

Intersil introduced a space-saving, AEC-Q100-qualified dual synchronous step-down DC/DC regulator featuring a 2.25MHz switching frequency to minimize solution size.

The ISL78228 dual step-down DC/DC regulator provides two independent 800mA outputs. Its 3mm x 3mm package and 2.25MHz switching frequency enables very small power solutions for a variety of space-constrained automotive and industrial applications. A 2.75V to 5.5V input voltage range

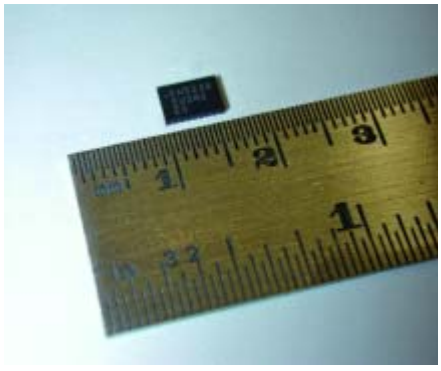
permits powering from common 3.3V or 5V automotive module supply rails. Internal current-mode compensation provides fast transient response, allowing 100% duty cycle for low dropout and eliminates the need for external compensation components.

Each channel has an independent enable pin and output voltage programming down to 0.6V. Built-in 2ms digital soft-start minimizes inrush current, while the device's low 30uA quiescent current minimizes standby power consumption.

www.intersil.com

DC-DC Converter for Embedded Computer-on-Modules

Enpirion, the leading innovator of the industry's smallest point-of-load DC-DC converters, announced a new member of its power IC portfolio targeted at embedded computing as well as solid-state drives (SSDs). The Enpirion EN5339 a 3 Amp power system-on-a-chip (PowerSoC) integrates the controller, power MOSFETs, compensation network and inductor into one highly compact solution that significantly reduces the traditional engineering analysis and design effort associated with discrete DC-DC converter designs. Its small solution footprint and slim profile offers Enpirion's wide base of customers – who develop diverse form factors such as Ultra COM Express, PC104, Qseven, ATCA Advanced Mezzanine Cards



(AMC), Compact PCI and others – an important new alternative. The EN5339 has already landed more than 20 design wins ahead of its official market release.

The EN5339 fits into a 55 mm2 solution area with a 1.1 mm profile – setting the bar for the smallest 3 Amp solution available. High-density embedded computer-on-modules, in particular, require this small area and often a low profile to enable bottom-side PCB mounting. Keeping up with the demands of embedded, industrial and storage applications, the EN5339 enables a 20 percent solution footprint reduction and 40 percent lower profile compared to previous Enpirion 3 Amp products.

www.enpirion.com

Highly Integrated, Smart Meter Power Regulator Eases Design

Maxim Integrated Products introduces the MAX17497, a one-chip solution for all the power requirements on the communications and metrology boards in smart meters. A high level of integration eases design, adds flexibility, increases accuracy, improves reliability, and lowers the total solution cost and footprint. This single power regulator is ideal for smart meter/smart grid applications as well as factory automation.

The MAX17497 has been designed and optimized as a multioutput solution specifically for industry's leading smart meters. It supports all the power-supply requirements for both the smart meter's communications board and the metrology board.

www.maxim-ic.com/Smartergrid

8:1 Input DC Switching Regulator Series

CUI Inc announced the addition of an ultra-wide input 500 mA model to their V78 switching regulator series. The V78W-500 series has been designed as a high performance alternative to linear regulators. Unlike linear regulators, this series does not require a heat sink, making it ideal for applications where board space is at a premium and energy efficiency is a concern.

The V78W-500 series offers efficiencies up to 95% in a compact SIP package measuring 11.50 x 9.00 x 17.50 mm. Units are pin out compatible with industry standard LM78XX linear regulators and come in both straight and right angle pin configurations. The series boasts an input range up to 9~72 V, regulated output voltages of 3.3, 5, 6.5, 9, 12, 15 and 24 V dc, and an operating temperature range of -40 to +85°C. The non-isolated converters also include short circuit protection, over temperature protection, and an MTBF of 2 million hours.

www.cui.com

Automotive-Qualified AUIRS2332J600 V Gate Drive IC Simplifies Design

International Rectifier has launched the AUIRS2332J 600 V three-phase gate driver IC for automotive high-voltage motor drives for electric (EV) and hybrid electric vehicle (HEV) applications.

The AUIRS2332J, high-voltage, high speed power MOSFET and IGBT driver features three independent high- and low-side referenced output channels. Proprietary HVIC technology enables ruggedized monolithic construction with logic inputs compatible with CMOS or LSTTL outputs, down to 3.3V logic. The new device also offers an integrated ground-referenced operational amplifier to provide analog feedback of the bridge current via an external current sense resistor, current trip function, and open drain FAULT signal to indicate over-current or under-voltage shutdown. The IC is housed in a PLCC44 package, providing higher creepage distances between high voltage pins, simplifying PCB layout.

www.irf.com

Z+ Series of Programmable DC Power Supplies 33% Smaller

TDK-Lambda UK, a group company of the TDK Corporation, introduces the Z+ Series of programmable DC power supplies. Offering high efficiency, flexibility and reliability, these high-density, 2U format benchtop and rack mounted power supplies are designed to meet the demands of a wide variety of ATE and OEM applications.

The first unit to be introduced is the Z+400; providing 400W of output power, models are available with output voltages up to 100Vdc and output current up to 75A. The Z+400 is 33% smaller and 40% lighter in weight than the previous generation ZUP range and other similar mature products on the market and thus offers a 49% increase in power density – 200, 600 and 800W units in the same size dimensions will be added to the Z+ Series early in 2012. The standard models are only 70mm wide, so up to 6 units can be accommodated in a 19" rack. Options for front panel output terminals and a dual unit housing are available for bench use.

www.uk.tdk-lambda.com/zplus

Dual-Output Gate Driver Evaluation Board from SemiSouth

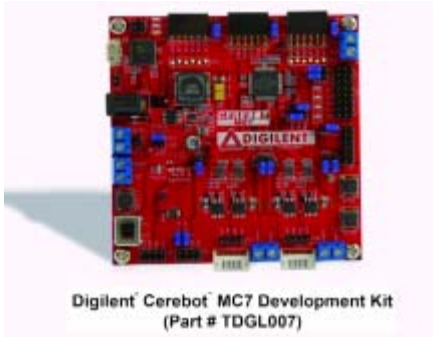
SemiSouth Laboratories has announced the SGDR2500P2, a dual-output, two-stage, opto-isolated gate driver board intended for use with power electronics modules that incorporate SemiSouth's vertical-trench junction field-effect transistors (VJFETs) as the primary switches. The board provides electrically isolated high-side and low-side outputs with peak current levels of +20/-10 A, enabling fast switching speeds and yielding record-low switching energy losses.

The SGDR2500P2 is optimized for the high-speed, hard switching of specific power modules such as Microsemi's 1200 V, 100 A half-bridge, APTJC120AM13VCT1AG, but can also be used as a time-saving evaluation board for projects in the development or qualification stage.

www.semisouth.com

Embedded Motor Control Development Kit

Microchip announces the availability of a development kit for embedded motor-control designs based on the Microchip dsPIC33 Digital Signal Controller (DSC). The Digilent® Cerebot™ MC7 Development Kit addresses the growing interest in embedded motor control from the academic and hobbyist markets, and is ideal for learning about microcontrollers and real-world problem solving. The kit includes a demonstration board that provides four half-bridge circuits, eight RC servo-motor connectors, the ability to use Digilent Pmod™ peripheral modules, and an integrated programming/debugging circuit that is compatible with Microchip's free MPLAB® IDE. Example applications include university classes in embedded systems and communications, final-year student projects, and a wide range of other academic and hobbyist projects, including advanced robotics. The four half-bridge circuits in the Cerebot MC7 board are rated for 24V at up to 5A. These half bridges can be used to control two brushed DC motors, two bi-polar stepper motors, one brushless DC motor, and one uni-polar stepper motor. An onboard 5V, 4A switching regulator, with an input voltage of up to 24V, simplifies operation of the board, enabling it to operate from a single power supply in embedded applications such as robotics.



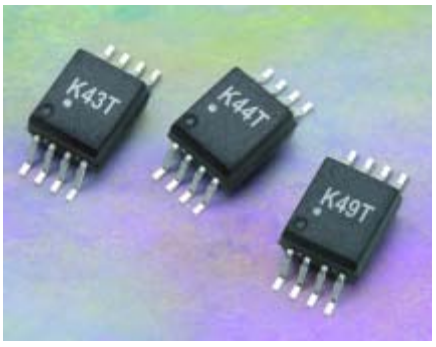
Digilent® Cerebot™ MC7 Development Kit
(Part # TDGL007)

www.microchip.com

Low-Power Digital Optocouplers with Robust High-Voltage Performance

Avago Technologies announced three new digital optocouplers optimized for use in onboard chargers and other high-voltage systems in hybrid and electric vehicles. The new ACPL-K4xT optocouplers are qualified to AEC-Q100 grade stress test requirements for automotive applications. The devices offer robust working voltage performance up to 1140V, allowing standardization of battery management solutions for mid-voltage car batteries, high-voltage bus and truck batteries, and even future high voltage battery topologies.

The ACPL-K4xT devices are part of the Avago R2Coupler™ family of optocouplers with reinforced insulation for reliable signal isolation, which is critical for onboard chargers for plug-in electric vehicles and other automotive and high-temperature industrial applications. Onboard chargers take in high-voltage, high-current supply to charge quickly, demanding robust isolation of up to 8kV peak transients. The reinforced insulation of the optocouplers meets these stringent requirements, delivering safe electrical signal isolation over a wide operating temperature range from -40 to +125° C. Additionally, the devices' small surface-mount package meets the 8mm creepage and clearance distance required for high-voltage safety regulations.



www.avagotech.com

Handheld OTDRs for Network Maintenance Applications

Two new testers designed specifically for the system maintenance of passive optical networks (PONs) have been added to the Yokogawa AQ1200 Series of handheld optical time-domain reflectometers (OTDRs).

The new AQ1200B and AQ1200C OTDR carry out measurements at the maintenance wavelengths of 1625 nm and 1650 nm, respectively, and are optimised for in-service PON testing of FTTx access networks. Each single-wavelength model incorporates a 1310/1550nm cut filter to reject unwanted in-service signals, and will carry out accurate measurement through high-port-count (1 x 32 or 1 x 64) splitters.

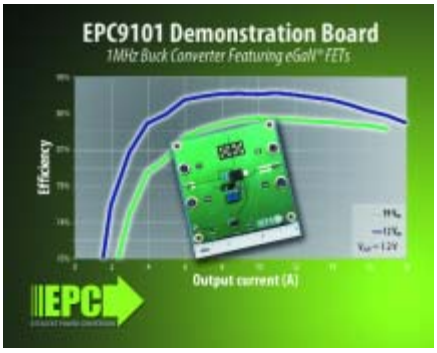
Options include a choice of three different optical power meters, including one for PON applications, a 1625 or 1650nm light source function, a 650nm (red) laser for visual fibre inspection, and an Ethernet PING test function.

www.tmi.yokogawa.com

www.yokogawa.com

Buck Power Conversion Demonstration Board Featuring eGaN® FETs

Efficient Power Conversion Corporation (EPC) introduces the EPC9101, a fully functional buck power conversion demonstration circuit. This board is an 8 V-19 V input to 1.2 V, 18 A maximum output current, 1MHz buck converter. It uses the EPC2014 and EPC2015 eGaN FETs in conjunction with the recently introduced National LM5113 100V half-bridge gate driver from Texas Instruments. The LM5113 is the industry's first driver designed specifically for enhancement mode gallium nitride FETs. The EPC9101 demonstrates the reduced size and performance capabilities of high switching frequency eGaN FETs when coupled with this dedicated eGaN driver.



The power stage footprint of the EPC9101 circuit is only 8mm x 16mm (about 0.2 square inches) and about 8mm high when taking components from both sides into consideration. Despite its small size, the board has a peak power efficiency of 88% and is capable of delivering 18 amps of current at 1.2 volts.
A Quick Start Guide, http://epc-co.com/epc/documents/guides/EPC9101_qsg.pdf, is included with the EPC9101 demo board for reference and ease of use.

www.epc-co.com

'Mini8' Ballast Control IC Reduces Component Count

International Rectifier introduced the IRS2526DS 'Mini8' compact fluorescent lamp (CFL) ballast control IC that offers full programmability, and a high degree of accuracy and control for all lamp types. Available in an 8-pin SO-8 package, the new feature-rich IC reduces component count, simplifies circuit design and increases efficiency in a compact footprint.
The IRS2526DS features a 600 V half-bridge control circuit working at 50 percent duty-cycle and variable frequency for driving the resonant mode lamp output circuit. The high accuracy oscillator is controlled by a single analog-to-frequency input pin used to set the different operating frequencies of the ballast.

Complete fault protection circuitry is also included for protection against such conditions as mains interrupt or brown-out, lamp non-strike, lamp filament failure and end-of-life. The new device also incorporates an internal frequency dither to reduce conducted EMI, ignition control to reduce inductor size, and end-of-life detection.
The IRS2526DS is the third generation ballast IC from IR and utilizes the proven technology also featured in the previously released IRS2580DS 'Combo8' that combines a full featured fluorescent ballast with power factor correction (PFC) controller in a compact 8-pin package. The new IRS2526DS is targeted at applications that do not require PFC or utilize an external PFC controller.

www.irf.com

Power Management for 14-rail PMIC for Infotainment and Cluster Applications

Texas Instruments introduced the industry's first automotive power management integrated circuit (PMIC) to support 14 power voltage rails. As the industry's first automotive PMIC with more than 10 rails, the TPS658629-Q1 provides all the power supply functions and reduces board space for infotainment, navigation and LCD/TFT cluster applications by integrating multiple regulated power supplies, system power management and display functions in one small package.
14 rail capability: the TPS658629-Q1 has 3 DC-DC Buck Converters, 11 LDOs, four programmable PWM outputs, two RGB LED drivers and one WLED driver to support the next generation of infotainment and cluster power requirements. The I2C interface enables control of a wide range of subsystem parameters. Internal registers have a complete set of status information, enabling easy diagnostics and host-controlled handling of fault conditions.

www.ti.com

Compact, Integrated IGBT Technology for Induction Heating

Toshiba Electronics Europe has expanded its family of compact, integrated IGBTs with a high-speed switching device that will simplify the design and reduce the component count in cooking appliances and other induction heating applications.

Optimised for voltage resonance inverter switching, the new 1200V N-channel, 'enhancement mode' GT40QR21 comprises an IGBT and a reverse recovery freewheeling diode monolithically integrated into a single, compact device. Maximum current ratings are 40A at 25ºC and 35A at 100ºC and the IGBT can operate with extended junction temperatures of up to 175ºC.
Toshiba's GT40QR21 is designed for very high speed switching – typical IGBT fall time (tf) and turn-off time (toff) with a collector current of 40A are just 0.2µs and 0.4µs respectively, while typical reverse recovery time (trr) for the freewheeling diode is 0.6µs (IF = 15A). Typical collector-emitter saturation voltage (VCE(sat)) is rated at just 1.9V (IC = 40A).
Supplied in a TO-3P(N), TO247-equivalent package the IGBT has dimensions of 15.5mm x 20.0mm x 4.5mm and a maximum junction-to-case thermal resistance (Rth(j-c)) of 0.65ºC/W.

www.toshiba-components.com

High Power DC/DC-Converters for Railway Applications

Recom extends its PowerlinePLUS-family with the RPR-series, which is specifically tailored to the requirements of railway applications. These very compact converters work under extreme operating conditions without derating and are designed for input voltages up to 160VDC.
The EN50155 (Electronic equipment used on rolling stock) specifies high requirements for information systems and electronic components used in railway engineering. This also applies for DC/DC-converters, which have to function as reliable power supplies for many years. Extreme conditions such as heat, cold, shock and vibration have to be met – exactly the environment that the RPR-series from Recom have been designed for. The RPR-converters work with full power at operating temperatures of -45°C to > +85°C without derating (Tx). The efficiency is >89%. These converters are very robust and EN61373 tested for 10G shock and vibration in all three axes. The series is power rated with 20, 30, 40 and 50 watts. They cover a wide input voltage range of 12 to 36, 25 to 75 and 40 to 160VDC. Single output voltages of 3.3, 5, 12, 15 and dual output voltages of ±12, ±15 and ±24VDC are available as standard.

www.recom-electronic.com

Common Mode Inductors Offer Superior EMI Suppression

With advanced magnetics designed to eliminate common noise to all lines in power supply designs, the new CMT-8100 Series Common Mode Inductors from Triad Magnetics feature rugged construction and materials for high-temperature applications in demanding electronics operating environments.
Highly dependable CMT-8100 Series Inductors are used in various types of power supplies to eliminate noise common to all lines. They offer excellent EMI suppression over a wide frequency spectrum and a high current capacity. Meeting VDE, IEC, UL, and CSA requirements, they minimize AC line transmitted interference often created by high frequency switching power supplies. Normally placed close to the input power source, the compact CMT-8100 Series inductors are constructed with reliable UL rated materials.

www.triadmagnetics.com

Introduction of T8 Transformers for LED Tube Lighting

Wurth Electronics Midcom introduces the all new T8 transformer series, specifically designed for T8 sized tube LED applications. These transformers are built using two new packages developed by Wurth Electronics Midcom, which are the only transformer packages in the industry designed specifically for the T8 bulb form factor.

The patent-pending designs feature innovative, half-rounded cores to maximize core cross-sectional area. Up to 30W power is available on the through-hole design and 20W on the surface-mount packages. Both package styles provide high efficiency and low leakage inductance. The shielded construction and rounded cores provide excellent EMI performance, with an operating temperature ranging from -40°C to 125°C.
Applications include the T8 tube lighting, in flyback topology, with functional, basic, supplementary or reinforced isolation.

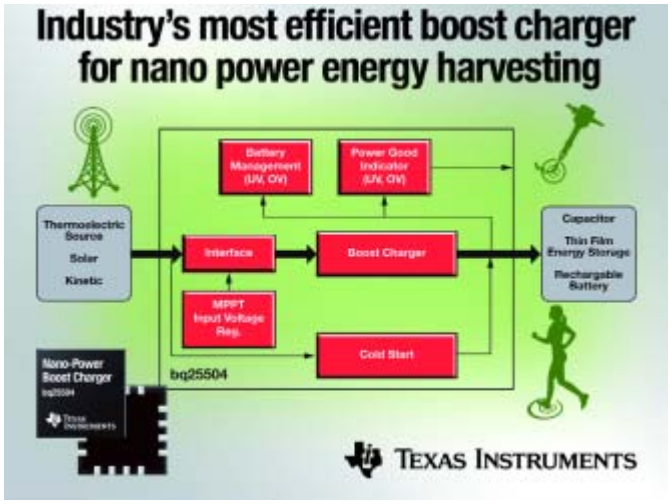
www.we-online.com/midcom

GaN HEMT Amplifier Delivers World's Highest PAE of 67% to Replace Bulky TWTAs

Mitsubishi Electric is introducing an internally matched GaN HEMT power amplifier for C-band satellite communication, which offers a power-added efficiency (PAE) of 67%. This is the world's highest PAE rating as it is more than seven points higher than the rating of conventional C-band GaN amplifiers. Mitsubishi Electric achieves this record figure by placing individual harmonic tuning circuits in front of each GaN HEMT cell on the substrate. Basically this means that every GaN HEMT is controlled via an optimised harmonic tuning circuit consisting of a MIM capacitor and a spiral inductor. In addition, the PAE is improved by the GaN HEMT's second harmonic impedance providing a highly-accurate input control. The new device delivers a high output power of more than 100W or, respectively, 50dBm.

www.MitsubishiElectric.de

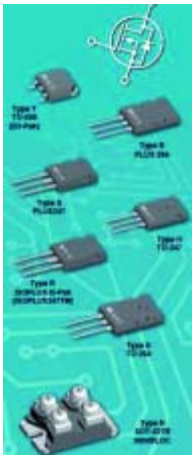
Highly Efficient Boost Charger IC for Nano Power Energy Harvesting



Texas Instruments introduced its next generation of power management integrated circuits (ICs) for energy harvesting. The highly efficient boost charger for nano (ultra low) power energy harvesting manages the microwatts to milliwatts of power generated from a number of sources, such as solar, thermoelectric, electromagnetic and vibration, and stores the extracted energy in various storage elements, including Li-ion batteries and super capacitors. The bq25504 also includes circuitry to protect the energy storage element from over voltage and under voltage conditions and to kick-start the system when the battery is deeply discharged. For more information or to order samples of the bq25504, visit:

www.ti.com/bq25504-preu

Device Power Switching Performance, Energy-Efficiency, and Reliability



IXYS Corporation announced the launch of its latest generation of Q-Class products with the introduction of its new Q3-Class HiPer-FETTM Power MOSFET family. Available with drain-to-source voltage ratings of 200V – 1000V and drain current ratings of 10A – 100A respectively, the presented devices provide the end-customer with a broad selection range of power switching solutions that demonstrate exceptional power switching performance, enhanced device ruggedness, and high energy efficiency. The superior performance and energy savings of these new devices allow for the development of more energy efficient and reliable power subsystems in high-power, high-performance applications such as industrial switch-mode power supplies, DC-DC converters, power factor correction circuits, server and telecom power systems, solar inverters, arc welding, plasma cutting, battery chargers and induction heating.

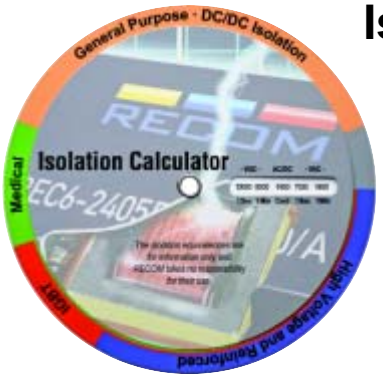
www.ixys.com

Driver for LED Street Light Fixtures

Microsemi Corporation unveiled a new LED driver designed specifically for North American street light installations. The efficient LXMG221D-0700040-D2F™ LED driver eliminates bulky step-down transformers typically used in street light fixtures in these markets, providing a single-step conversion from 347VAC or 480VAC down to less than 57VDC as typically required by LED fixtures. This allows manufacturers to design lighter fixtures, which can lower product development and transportation costs. Unique features include integrated fault detection and management functionality which enable operators to respond more quickly to light fixture failures.

www.microsemi.com

Isolation Voltage Calculator Disc



RECOM's new "Isolation Calculator" is a handy tool to facilitate the comparison of isolation voltages. The "smart disc" in CD size makes complicated calculations unnecessary and saves time. A window in the disc shows voltage equivalents for VAC or VDC isolations rated for 1 second, 1 minute or continuous working. In addition, the useful tool uses a color code to indicate the typical required isolation voltages in common applications such as general purpose, IGBT or medical electronics. Once the equivalent isolation rating has been found, the disc can be flipped over to show matching DC/DC-converters on the back.

This practical rotary calculator is available free of charge on the website:

www.recom-electronic.com

High Temperature and High Reliability Isolated Gate Driver for High Density Power Converters

CISSOID launched HADES®, the first isolated gate driver solution designed to drive high temperature power transistors, specifically (but not exclusively) Silicon carbide (SiC) and Gallium nitride (GaN) fast-switching devices.

With HADES®, system engineers can develop power converters that are 5 times smaller and lighter than before, with better efficiency. They will also get power converters able to operate in high temperature ambiance if required. No matter what the ambient temperature is, the life time of the system will be an order of magnitude longer than traditional solutions.

HADES® has been designed to drive seamlessly Silicon Carbide (SiC) power transistors, which have low switching losses. HADES® can switch them at high frequencies, which means smaller and lighter passive and magnetic components.

HADES® is a reference design and an Evaluation Board delivered with full documentation. It can drive two SiC MOSFET power switches on a DC bus voltage up to 1200V. The Reference design is scalable up to +/-20A gate current, while the Evaluation Board features +/-4A.

www.cissoid.com

ADVERTISING INDEX

High Power IGCTs. Wherever high performance is needed.

IGCTs manufactured by ABB Semiconductors are thoroughly tested for their static and dynamic performance. Certain devices switch up to 20MW of power during testing. This ensures reliable operation in high power applications such as medium voltage drives and trackside power supply. For more information please visit our webpage: www.abb.com/semiconductors

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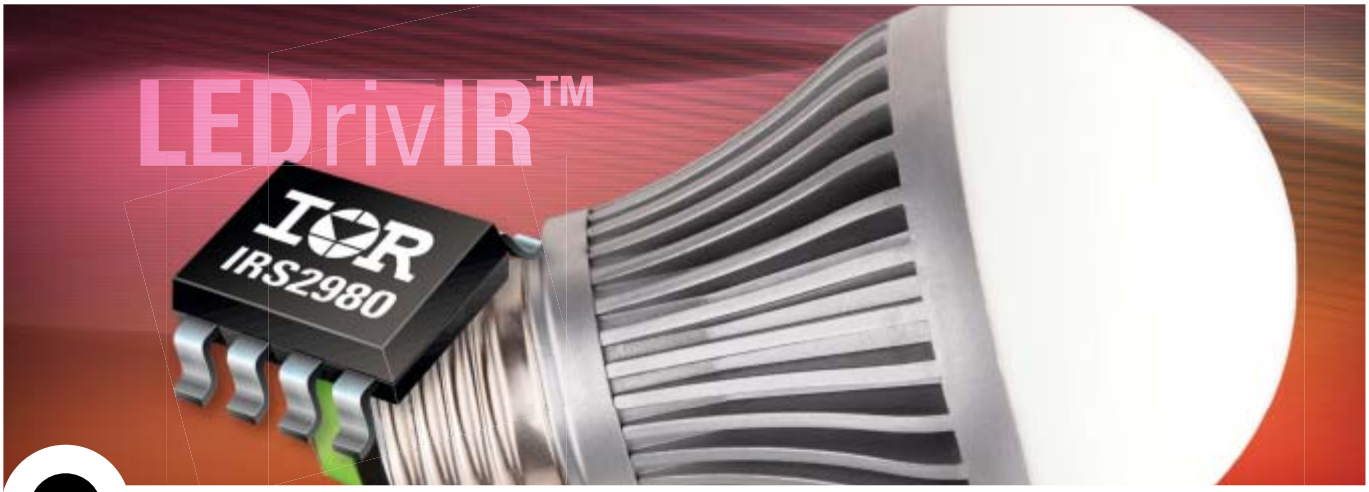
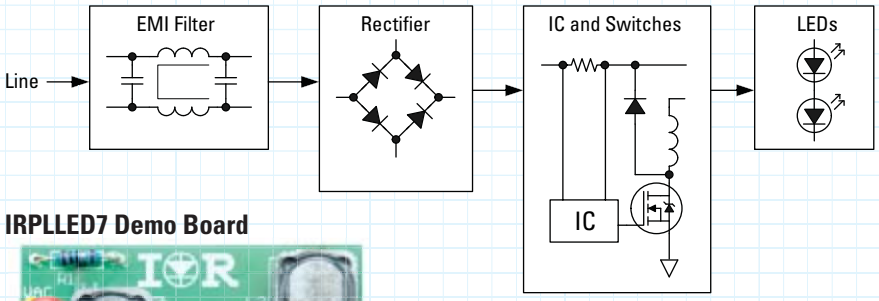
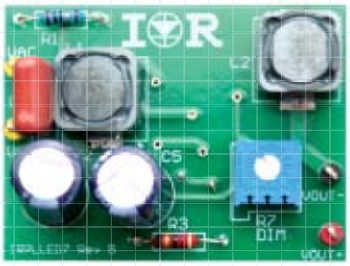
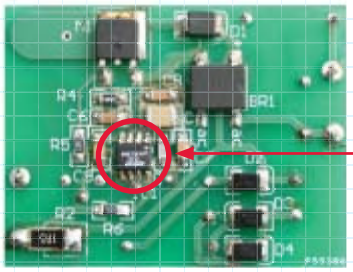


High-Voltage Buck Control ICs for Constant LED Current Regulation



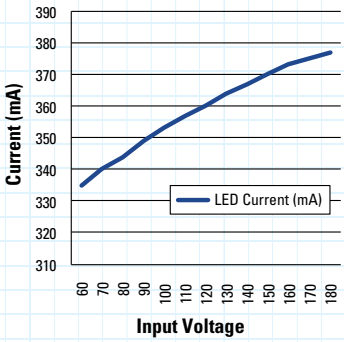
IRPLLED7 Demo Board





LEDrivIR™
IRS2980

LED Current vs Input Voltage



Features

- Internal high voltage regulator
- Hysteretic current control
- High side current sensing
- PWM dimming with analog or PWM control input
- Free running frequency with maximum limiting (150kHz)

Benefits

- Low component count
- Off-line operation
- Very simple design
- Inherent stability
- Inherent short circuit protection

Specifications

- Input Voltage 70V to 250V (AC)
- Output Voltage 0V to 50V (DC)
- Regulated Output Current: 350mA
- Power Factor > 0.9
- Low component count
- Dimmable 0 to 100%
- Non-isolated Buck regulator

Part Number	Package	Voltage	Load Current Regulation	Startup Current	Frequency
IRS2980S	SO-8	600V	+/-5%	<250 µA	<150 kHz
IRS25401S	SO-8	200V	+/-5%	<500 µA	<500 kHz
IRS25411S	SO-8	600V	+/-5%	<500 µA	<500 kHz

For more information call +49 (0) 6102 884 311
or visit us at www.irf.com

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