

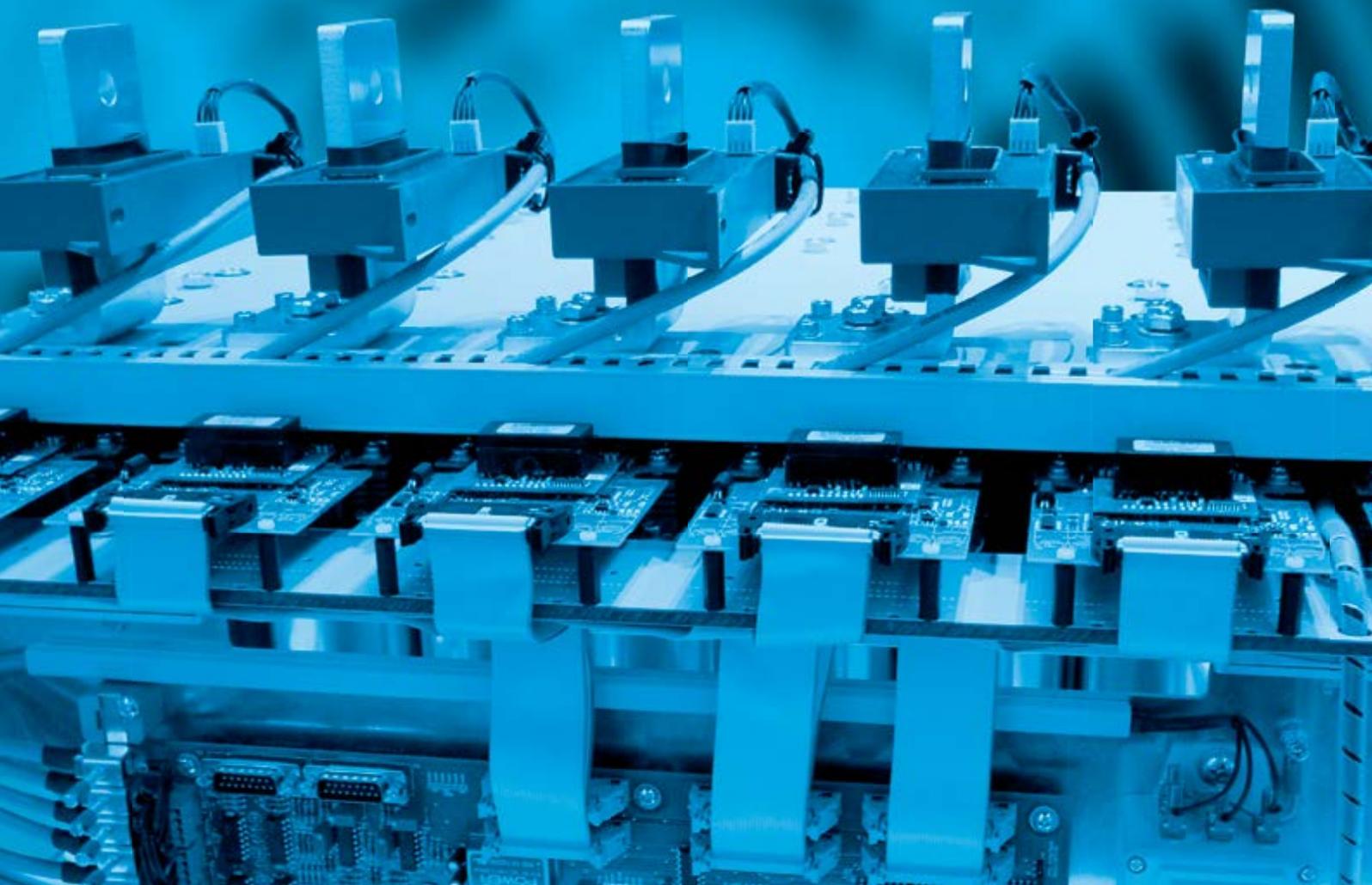
Bodo's Power Systems®

Electronics in Motion and Conversion

December 2014



The VARIS™ concept – flexible power based on a modular concept



VARIS™ – the modular inverter system

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



- IGBT classes: 1200 V or 1700 V, up to 1400 A
- Parallel connection
- Air or water cooling
- Compatible rectifier VARIS™ R
- Compact and powerful with VARIS™ XT

engineered by

GVA
Power Electronics

Welcome to the House of Competence.

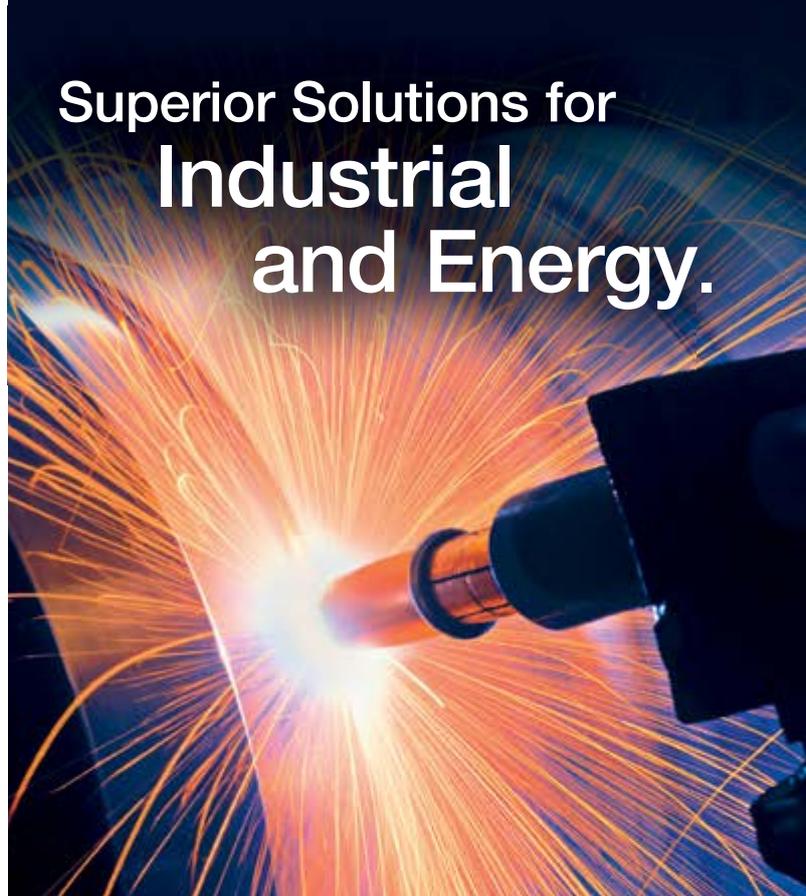
Read online and search for key subjects from all articles in Bodo's Power Systems by going to Powerguru: www.powerguru.org



Viewpoint	4
The Boxes are Open and Toy Trains are Running Again	
Events	4
News	6-12
Blue Product of the Month	14
Microchip Development Tool Competition <i>Microchip</i>	
Guest Editorial	16
Youthful Power Electronics <i>By Braham Ferreira, Professor at TUDelft and elected IEEE PELS president (2015-6)</i>	
Market	18
Electronics Industry Digest <i>By Aubrey Dunford, Europartners</i>	
Market	20-21
Developments in the AC-DC External Power Supply Market <i>Richard Ruiz, Research Analyst, Darnell Group</i>	
Technology Driving Markets	22-23
eGaN® Technology: Transforming the Future <i>By Alex Lidow Ph.D.; Efficient Power Conversion</i>	
Cover Story	24-28
Enhanced Trench IGBTs and Field Charge Controlled Diode <i>By Liutauras Storasta, Chiara Corvasce, Maxi Andenna, Sven Matthias, Raffael Schnell and Munaf Rahimo, ABB semiconductors</i>	
Design and Simulation	30-33
LLC Resonant Converter Simulation Using PLECS <i>By Munadir Ahmed, Plexim Inc. and Min Luo, Plexim GmbH</i>	
IGBTs	34-35
Kelvin Emitter Configuration Further Improves Switching Performance of TRENCHSTOP™ 5 IGBTs <i>By Vladimir Scarpa and Fabio Brucchi, Infineon Technologies AG</i>	
Digital Power	36-39
Digital Power Comes of Age <i>By Mark Adams, CUI Inc; Patrick Le Fèvre, Ericsson Power Modules; Steve Pimpis, Murata</i>	
Power Management	40-43
Tiny Power Components for Wireless Charging, Step Down Conversion and "Always On" Devices <i>By Wolfgang Patelay, Freelance Journalist Bodo's Power Systems</i>	
Technology	44-47
Active Vibration Control in Ultrasonic Wire Bonding Improving Bondability on Demanding Surfaces <i>By Dr.-Ing. Michael Brökelmann, Hesse GmbH</i>	
Test and Measurement	48-49
Automated Acoustic Inspection for IGBT Modules <i>By Tom Adams, consultant, Sonoscan, Inc.</i>	
Lighting	50-51
More Light with Less Power <i>By Wolfgang Patelay, Freelance Journalist, Bodo's Power Systems</i>	
New Products	52-64

www.bodospower.com

Superior Solutions for Industrial and Energy.



- | | | | |
|--|---|--|---|
| | Aluminum electrolytic capacitors for high ripple currents | | Common-mode chokes for high currents |
| | PFC products for energy saving and power quality | | Varistors and surge arresters for over-voltage protection |
| | EMC and sine-wave filters for currents up to 8 kA | | High reliability power capacitors |
| | X and Y capacitors for EMI suppression | | Output chokes up to 1500 A |



- | | | | |
|--|--|--|--------------------------------------|
| | Various types of MLCCs for highest reliability | | High reliability SMT power inductors |
| | Pulse transformers for LAN interfaces | | Large ferrite cores |

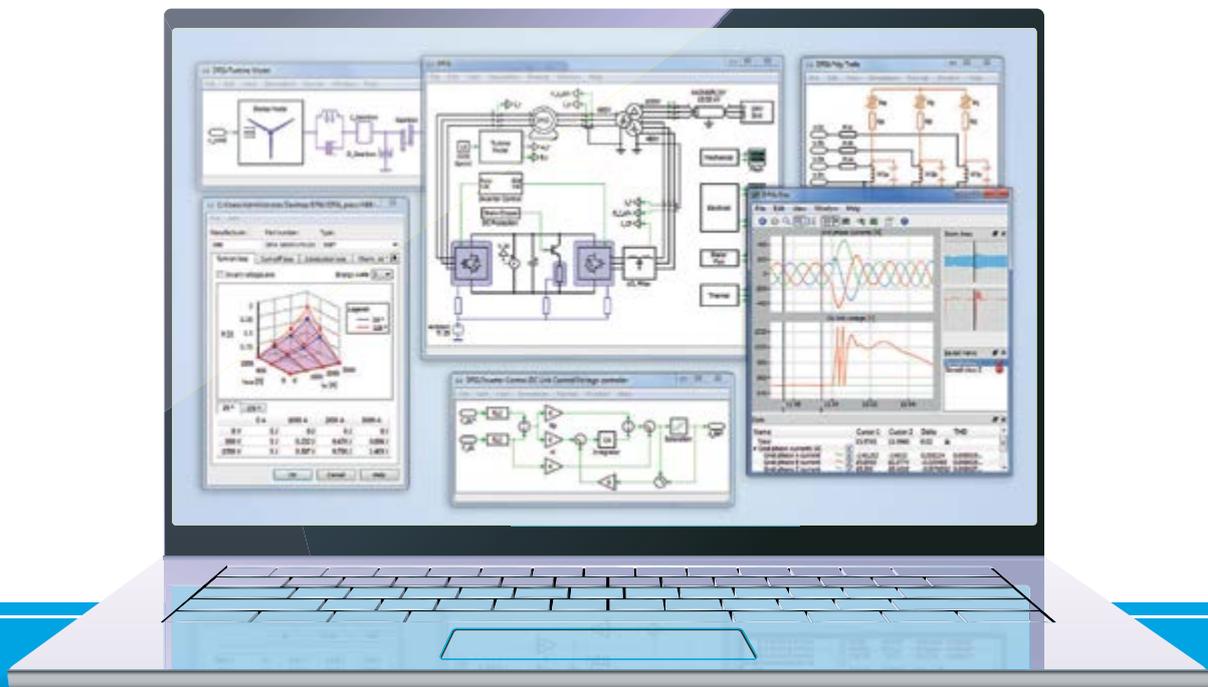
www.tdk.eu · www.epcos.com

The Gallery



plex

THE SIMULATION SOFTWARE PREFERRED
BY POWER ELECTRONICS ENGINEERS



MODELING DOMAINS

- ▶ Electrical
- ▶ Control
- ▶ Thermal
- ▶ Magnetic
- ▶ Mechanical

KEY FEATURES

- ▶ Fast simulation of complex systems
- ▶ Code generation
- ▶ Frequency analysis
- ▶ Available as standalone program or Simulink blockset

Get a free test license
www.plexim.com/trial

Bodo's Power Systems®**A Media**

Katzbek 17a
D-24235 Laboe, Germany
Phone: +49 4343 42 17 90
Fax: +49 4343 42 17 89
editor@bodospower.com
www.bodospower.com

Publishing Editor

Bodo Arlt, Dipl.-Ing.
editor@bodospower.com

Senior Editor

Donald E. Burke, BSEE, Dr. Sc(hc)
don@bodospower.com

Corresponding Editor

Dipl.-Ing. Wolfgang Patelay
Wpatelay@t-online.de

UK Support

June Hulme
Phone: +44(0) 1270 872315
junehulme@geminimarketing.co.uk

Creative Direction & Production

Repro Studio Peschke
Repro.Peschke@t-online.de

Free Subscription to qualified readers

Bodo's Power Systems
is available for the following
subscription charges:
Annual charge (12 issues)
is 150 € world wide
Single issue is 18 €
subscription@bodospower.com

circulation  print run 24 000

Printing by:

Druckhaus Main-Echo GmbH & Co KG
63741 Aschaffenburg, Germany

A Media and Bodos Power Systems
assume and hereby disclaim any
liability to any person for any loss or
damage by errors or omissions in the
material contained herein regardless
of whether such errors result from
negligence accident or any other cause
whatsoever.

Events

Embedded World 2015,
Nuremberg, Germany, February 24-26
www.embedded-world.de

APEX 2015,
San Diego, CA, Feb. 24-26
<http://www.ipcapexexpo.org>

ESARS 2015, Aachen, Germany,
March 3-5 www.esars2015.org/

APEC 2015, Charlotte, NC, March 15-19
www.apec-conf.org/

New Energy Husum 2015,
Husum Germany, March 19-22
www.new-energy.de/new_energy/de/

EMC 2015, Stuttgart, Germany, March 24-26
www.mesago.de/en/EMV/home.htm

The Boxes are Open and Toy Trains are Running Again

It is Christmas time again, and I have fond memories of my toy trains. Engineers often played with technical toys when they were children, and electric trains inspired a number of them, including me. And the fascination is still there. Our grandson, soon to be five, looks at my vintage trains with respect. He knows they have been running almost as long as I have. My parents, mostly my father, also got me interested when I was a five. Mine are HO, the most popular size, meaning "Half Zero", a size started by Marklin over 100 years ago, while Lionel in the US continued with Size O.



I was involved in the early applications of the IGBT, as I have related in previous viewpoints. I met Frank Wheatley through my frequent interactions with the engineering group, and must have mentioned my passion for toys. One day, Frank pulled me aside, opened the trunk of his car, and said, "These are for you," and gave me a set of Lionel size O. These memories come around at Christmas time. Frank passed away last month, and I have lost a friend who could have been my father. We had many enjoyable discussions of life and technology during my visits to Mountaintop, PA. In addition to the tales of his inventing the IGBT, he told me about his life, and that his greatest satisfaction came from having designed an amplifier that enabled a child to hear for the first time. I plan to take Frank's diesel and steam locomotives out for a ride. From the early days on, electronics have improved all of our lives, and have helped the handicapped.



I've just returned from the electronica in Munich, the platform for the world to show what is currently available and what will drive the next level of design. And sps ipc drives in Nuremberg has shown the practical solutions for drives and the control of industrial applications.

Communication is the only way to progress. We delivered nine issues this year, and December marks 140 technical articles published year to date, amongst 870 pages. They are all archived on my web-site and also retrievable at PowerGuru. Bodo's Power Systems serves readers across the globe. If you speak the language, or just want to have a look, don't miss our Chinese version: www.bodospowerchina.com.

My Green Power Tip for December:

It is Christmas time, and we should open ourselves to peace and freedom for our one world.

It is a time to help the poor. We must remove the fences and borders between people. We need to fight for education for all, particularly the young, as it is the most important factor for peace and freedom.

Merry Christmas

KEEP UP WITH THE TIMES



LF xx10 Current transducer range Pushing Hall effect technology to new limits

To save energy, you first need to measure it! To maximise energy savings, you need to measure the current used accurately!

By using the most advanced materials available, LEM's new LF xx10 transducer range breaks new ground in accuracy for Closed Loop Hall effect transducer performance. LEM ASIC technology brings Closed Loop Hall effect transducer performance to the level of Fluxgate transducers and provides better control and increased system efficiency, but at a significantly lower price.

Available in 5 different sizes to work with nominal currents from 100 A to 2000 A, the LF xx10 range provides up to 4 times better global accuracy over their operating temperature range compared to the previous generation of Closed Loop Hall effect current transducers.

Quite simply, the LF xx10 range goes beyond what were previously thought of as the limits of Hall effect technology.

- Overall accuracy over temperature range from 0.2 to 0.6 % of I_{PN}
- Exceptional offset drift of 0.1 % of I_{PN}
- Fast response time less than 0.5 μ s
- Higher measuring range
- 5 compact sizes in a variety of mounting topologies (flat or vertical)
- Immunity from external fields for your compact design
- 100 % fully compatible vs LEM previous generation
- -40 to +85 °C operation

www.lem.com

At the heart of power electronics.



Small and Medium Wind Systems – Microgrids and Minigrids

The World Wind Energy Association (WWEA) and New Energy Husum are pleased to invite all small and medium wind stakeholders to participate in the 6th World Summit for Small Wind (WSSW2015), taking place in Husum/Germany on 19, 20 and 21 March 2015, in parallel with the New Energy Husum Trade Fair 2015 (19- 22 March 2015).

The New Energy Husum trade fair is the leading trade fair for small-scale wind technology. The fair features the grass roots energy transition, and will be focussed on own consumption of renewable energy, alternative mobility with electric vehicles, and energy-efficient and ecological building and renovation.

The main theme of the 6th WSSW is Small and Medium Wind Systems – microgrids and minigrids based on 100% renewable energy. The summit is aimed at jointly exploring more ways of wind power application and flexible matching means to meet market demand on islands.

www.small-wind.org

SEMICON Europa 2014 Brings the Supply-Chain Closer Together



From Heinz Kundert, the SEMICON Europa President:

The big picture in microelectronics was very clear at SEMICON Europa 2014. Consolidation will continue as the race to new technologies and applications will move on. The exhibitors, events and special pavilions at SEMICON Europa 2014 clearly demonstrated the strengths of Europe's microelectronic ecosystem.

SEMICON Europa in Grenoble enriched potential business for exhibitors and attendees beyond equipment and materials by showcasing new opportunities of nontraditional markets such as design tools (EDA), Packaging, Components or Systems in Imaging, Medtech, Power Electronics, Plastic Electronics, Security and more.

www.semi.org/europe

EPE 2015 ECCE Europe is Approaching fast

It will take place from 8 - 10 September 2015, in Geneva, Switzerland. Get prepared for the Exhibition around the Conference.

For its 2015 edition, more than 1200 participants are expected.

Do not miss the opportunity to present your activities, services and products at EPE'15 ECCE Exhibition.

ABB is the main industrial sponsor of the EPE'15 ECCE conference, recently joined by Mersen, GaN Systems, ECPE, Opal-RT, Advanced Motor Tech.

Do not hesitate to contact us, you can also follow this link to find further information about the sponsorship:



<http://event-epe2015.web.cern.ch/content/sponsors-exhibitors>

Working with Intel to Enable a Wire-Free World

Integrated Device Technology (IDT) announced it is working closely with Intel on the development of wireless charging solutions to accelerate the delivery and adoption of the nascent technology. As silicon and solutions leaders in wireless charging, the two companies expect to bring a new generation of wireless capabilities that make charging consumer products easier than ever. Based on magnetic resonance technology, these capabilities will enable the charging of multiple devices simultaneously and through chargers built into objects such as tabletops. This collaboration is the latest step in IDT's drive to deliver relief from the worry of running out of power, the clutter of wires, and the need to travel with chargers. The two companies, both board members of the Alliance for Wireless Power (A4WP), will define, design and manufacture next-generation solutions that comply with the A4WP magnetic resonance standard. The new technology will offer the ability to charge both lower and higher power devices, from wearables and phones to tablets and PCs. The companies expect to have their technology in products in 2015.

"Intel's 'No Wires' vision will free consumers of dealing with power cables and deliver the easiest, most convenient way to charge all their devices, at home, at work and on the go," said Sanjay Vora, vice president and GM of User Experiences for Intel. "We are excited to have

IDT partner with us on bringing A4WP-based wireless charging to the market quickly and successfully." "Intel and IDT together will deliver a new level of wireless charging capabilities to an increasingly un-wired world," said Arman Naghavi, vice president and general manager of the Analog and Power Division at IDT. "Working closely together, we are fundamentally changing the way people power up their devices." IDT is a supplier of wireless power transmitter and receiver solutions for wireless charger applications, addressing all major standards and technologies with an extensive portfolio of standards-certified products. The company has proven expertise in both magnetic induction and magnetic resonance technologies, and actively participates in the Wireless Power Consortium (WPC), Power Matters Alliance (PMA), and Alliance for Wireless Power (A4WP) as a board member. It has introduced a number of innovative and award-winning products, including the first true single-chip transmitter, the highest-output-power single chip receiver, and the first dual-mode receiver IC compatible with both WPC and PMA standards. Prominent industry players have recognized this leadership and partnered with IDT as their silicon vendor for next-generation wireless power solutions.

www.idt.com



Capacitors for Power Electronics



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



**CORNELL
DUBILIER**

www.cde.com

Expert to Present at SMTA Space Coast and Tampa Bay Expo & Tech Forum



Indium Corporation's Ed Briggs, senior technical support engineer, will present at the SMTA Space Coast and Tampa Bay Expo & Tech Forum on Dec. 4 in Kissimmee, Fl. Briggs' presen-

tation, Meeting Future Stencil Printing Challenges with Ultra-Fine-Powder Solder Pastes, discusses a statistical comparison of the transfer efficiency of different solder powder particle sizes, specifically types 3, 4, 5, and 6; and reviews observations of post-reflow results in both harsh and optimal conditions.

Briggs is an SMTA-certified process engineer. He earned his associate degree in chemical technology from Mohawk Valley

Community College, where he received the Douglas J. Bauer Award for Excellence in Chemistry. In addition, he earned his Six Sigma Green Belt from Dartmouth College. Briggs joined Indium Corporation in 1990 and has held a variety of positions in production and technical support.

www.smta.org

www.indium.com

Synapse Design launches Power Saving Cloud Computing Platform

Synapse Design, SOC and ASIC design services partner serving tier-one system and semiconductor companies, announced its Cloud hardware platform based on a Freescale T4240 network processor and natively running OpenStack Icehouse. The Cloud hardware platform is a configurable design targeted at medium to high performance cloud appliance storage and compute markets. "As the amount of



data being pumped into the cloud continues to grow exponentially, we saw an opportunity to leverage our expertise in the storage domain and have developed a cloud platform that could lower the cost per terabyte over a three-, five- and seven-year period," said Satish Bagalkotkar, President/CEO & Co Founder of Synapse Design. Mike McKean, Senior Director for Synapse Design Embedded Systems efforts added: "Our implementation provides 50 percent lower power for

the same compute performance while enabling increased networking throughput with advanced hardware techniques. Deploying this solution at scale will save power when compared to competing architectures with equivalent compute performance. One of our key enablers is a fully embedded Linux distribution that we have integrated specifically for this environment."

The Synapse Design platform is massively configurable, with the initial reference platform having 24 processing threads, four 10GbE channels, eight 1GbE channels and supporting 96TB of SSD storage with currently available drive technology. Compute and storage instantiations with a large variety of configurations can be enabled easily and a variety of host and drive side interfaces are available. The company has a strong heritage in data storage device and systems design and is well positioned to help datacenter customers achieve greater performance and value through intimate knowledge of flash and rotating media subsystems. Reducing power in the data center while maintaining or even increasing compute capability helps to decrease overall total cost of ownership. Building on open source tools further reduces these development costs. Better insight means better predictability.

<http://www.synapse-da.com>

Architects of Modern Power Consortium Select Intersil Digital DC/DC Controllers

Intersil Corporation (NASDAQ: ISIL), a leading provider of innovative power management and precision analog solutions announced that three of its digital DC/DC controllers have been incorporated into digital point-of-load (POL) DC/DC converters developed by the founding members of the Architects of Modern Power (AMP) consortium. These converters provide high current loads for high-end FPGAs and ASICs employed in densely populated power supplies in servers, storage equipment and basestations.

Intersil's DC/DC digital controllers support the AMP Group's micro-Amp 20 to 25A and megaAMP 40 to 50A standards. These new standards were announced separately today by the AMP Group, and establish common mechanical and electrical specifications for the development of advanced power conversion technology for distributed power systems.

"Architects of Modern Power selected Intersil's digital controller technology for our microAmp and megaAMP module standards because they provided the most advanced feature set on the market," said Mark Adams, AMP Group spokesperson. "Simply converting one voltage to another voltage is no longer an option for our customers. Now, perfect voltage conversion under all conditions is required. Intersil's digital power technology helps us achieve this."

"We're excited the Architects of Modern Power consortium have adopted Intersil's innovative digital power solutions," said Mark Downing, senior vice president of infrastructure and industrial power products at Intersil. "Intersil is at the forefront of digital power, and continues to deliver controllers that push the higher efficiency, current density and transient response performance that our customers' applications demand."

Intersil offers a comprehensive family of digital power controllers that provide 4.5V to 14V input voltage rails and scalable output current from 6A to over 300A. Intersil DC/DC controllers provide industry leading digital power features, including automatic compensation, pin-strap current sharing, and Intersil's proprietary DDC (digital DC) bus for inter-controller communication. The DDC bus enables system-based sequencing, fault management and current sharing with other Intersil digital power devices, all on a single wire.

www.ampgroup.com

www.intersil.com



Pre-Applied Thermal Interface Material (TIM)

The Infineon-qualified solution



With the ongoing increase of power densities in power electronics the thermal interface between power module and heatsink becomes a larger challenge. A thermal interface material, especially developed for and pre-applied to Infineon's modules outperforms the general purpose materials available.

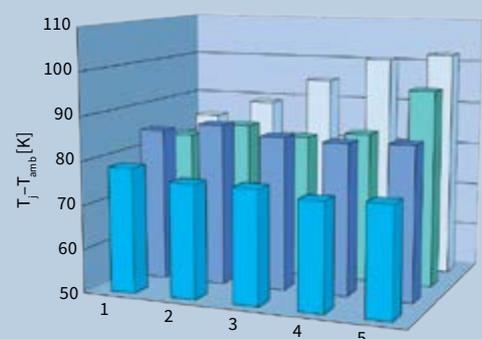
TIM does not only provide the lowest thermal resistance, it also fulfills the highest quality standards given for power modules to achieve the longest lifetime and highest system reliability.

Main Features

- Best in class thermal resistance
- Pre-applied to Infineon Modules
- Dry to the touch
- Optimized for dedicated Infineon Modules

Benefits

- Reduced process time in manufacturing
- Simplified mounting
- Increased system reliability
- Increased system lifetime
- Optimized thermal management
- Improved handling in case of maintenance



Time in HTS* [Weeks]
 *HTS: High Temperature Storing, Stresstest 1000h, 125°C

□ MOD-3
 ■ MOD-2
 ■ MOD-1
 ■ IFX-Solution

Opening the new RECOM Company Headquarter



You will find them in almost all electronic products, but only few people realize how much know-how and development work are concentrated in RECOM's power converters, switching regulators and LED drivers. During the last 20 years, this medium sized owner managed company has become a leading supplier of power modules on a worldwide basis – innovative products from Austria. Subsidiaries

in Frankfurt, New York, Singapore and Shanghai, as well as an automated production center located in Taiwan, are managed and steered from the newly conceived „Think Tank“ in Gmunden.

This new company center also brings a new concept to Austria. „ We offer a platform for innovation and contact to the power world“ is how the CEO, Karsten Bier, explains the company philosophy and the new 3,000m² (30,000 sq.ft.) building offers sufficient space to live and breathe this vision. „This is why the doors of the EMC, Test and Quality Laboratories, which cost two million dollars to implement, are also open to industrial customers and students of Austrian and German universities. The idea is to implement a „RECOM-Campus“, including the availability of apartments, in this high tech, low-energy building. Additionally, we will open 300 m² of office space to help start-ups and cooperating partners to further enhance the flow of information“ says Karsten Bier.

After years of above average growth, it became necessary to expand RECOM's capacities in all areas. The guideline for the architects and

the design team were to establish an innovative building with architectural clarity. Added value was to be created not only for employees, but for the complete customer, business partners and the local scientific community Eco-system. Easy access to high value equipment



for internal and external users was part of the charter. The concept eventually realized by the architects Kollmann & Mayrhauser in cooperation with the designer Andrea Bier followed modern and effective principles of architectural space. The optimized symbiosis between technology, design and workspace provides a creative and productive atmosphere. The ecologically aware design uses state-of-the-art technology to help preserve and sustain valuable natural resources.

www.recom-electronic.com

New Application Lab in Korea

Alpha, the world leader in the development and production of electronic soldering materials, today announced the addition of a new application lab in Korea. The lab will focus on trial or evaluation testing of products for new projects and supports Alpha's mission to provide superior technical support to their valued customers.

Equipment at the new application lab includes an SMT Printer, Reflow Machine, X-section, Thermal Shock Chamber, Solder Paste Inspection Machine and Chip Mounter Machine.

„Many key customers have already visited the lab and have conducted as many as 10 trial production runs with our products for their new projects,“ said S.S. Park, Technical Services Director for Alpha Korea. „In addition, we are offering training courses at the lab for new CTS

(Customer Technical Service) engineers so our staff remains current on how best to address and resolve technical issues in the field.“

The new application lab in Korea will help Alpha's customers save significantly by shortening the amount of time it normally takes to get a project up and running and also by training the CTS support in advance to ensure delivery of expertise and quality while on the production floor.

For more information on Alpha's global service capabilities and vast product offering, visit

www.alpha.alent.com

ECPE Calendar of Events 2015

Tutorials and Workshops in the first half of 2015:

- ECPE Tutorial 'EMC in Power Electronics'
2 – 3 March 2015, Lausanne, Switzerland
Chairmen: Prof. E. Hoene (Fraunhofer IZM), Prof. J.-L. Schanen (G2ELab)
- ECPE Workshop '6th ECPE SiC and GaN User Forum'
20 – 21 April 2015, Warwick, UK
Chairmen: Prof. P. Mawby (Univ. of Warwick), Prof. A. Lindemann (Univ. of Magdeburg) and Technical Committee
- ECPE Lab Course, EMC Optimised Design (Parasitics in Power Electronics)
27 – 28 April 2015, Berlin, Germany
Course Instructor: Prof. E. Hoene (Fraunhofer IZM)
- ECPE Tutorial 'Power Semiconductor Devices & Technologies'
29 - 30 April 2015, TBD
Chairman: Prof. D. Silber (Univ. of Bremen)

- ECPE Tutorial 'Power Electronics Packaging'
June 2015, Hamburg, Germany
Chairmen: Prof. U. Scheuermann (Semikron), T. Harder (ECPE)
- ECPE Workshop 'µPower Electronics/PowerSoC: Powering Low-Power Systems'
16 – 17 June 2015, Munich, Germany
Chairmen: Prof. B. Allard (INSA de Lyon), Prof. J. Cobos (UPM), Prof. C. O'Mathuna (Tyndall)
- ECPE Tutorial 'Thermal Engineering of Power Electronic Systems - Part I (thermal design and verification)
21 – 22 July 2015, Erlangen, Germany
Chairmen: Prof. U. Scheuermann (Semikron), D. Malipaard (Fraunhofer IISB)

On the ECPE website you always find the up-to-date information on the ECPE Events:

www.ecpe.org

Energy Conversion Congress and Exposition (ECCE 2015), Montreal, Canada

The IEEE Industry Applications and Power Electronics Societies are pleased to announce The 7th Annual IEEE Energy Conversion Congress and Exposition (ECCE 2015), which will be held in Montreal, Canada, on September 20 - 24, 2015. ECCE 2015 is the pivotal international conference and exposition event on electrical and electromechanical energy conversion. ECCE 2015 will feature both industry-driven and application-oriented technical sessions, as well as industry expositions and seminars. ECCE 2015 will bring together practicing engineers, researchers and other professionals for

interactive and multidisciplinary discussions on the latest advances in various areas related to energy conversion. Please visit <http://2015.ececonferences.org> for more information or contact the ECCE 2015 Technical Program Chairs at ecce2015tpc@gmail.com. Key dates are: Jan 15 for extended digests submitted via website; Feb 16 for Tutorial proposals; and March 31 for Special Session proposals.

<http://2015.ececonferences.org/>

Design a Custom Electric Motor Drive using COTS Components

Custom electric motor drive system design is a complex process and the goal of this new ebook is to give you guidelines to make it easier. While there exists many publications on the market regarding specific elements of electric motor drive design (such as electric motor design, power stage design, control design, etc.), very few address the whole process from a practical point of view. In this ebook, Alizem's Dr. Marc Perron shares its field experience of this narrow and complex field of power electronics applications with a particular focus on the challenges related to embedded motor control software.



Topic addressed In this ebook are:

- reasons to design a custom electric motor drive,
- reasons to use COTS components,
- anatomy of an electric motor drive system,
- how to plan the software development,
- how to develop the embedded motor control software,
- five steps process of an electric motor drive development and
- how Alizem can help.

Whether you are a project manager, a system / mechanical / electrical / software engineer, you will find in this document relevant informations to help you achieve your objectives faster and easier. Download this ebook for FREE at

www.alizem.com

Hitachi Europe Limited,
Whitebrook Park,
Lower Cookham Road,
Maidenhead. SL6 8YA.
+44 (0)1628 585261
nHPD2@hitachi-eu.com

HITACHI
Inspire the Next

HPE²

Web-based Automotive Electronics Solutions Interface to Enhance Safety and Improve Reliability

Power management company Eaton unveiled efforts by its Electronics Division to enhance the safety of automotive electronics with a multi-tiered initiative to meet the industry's growing demand for highly reliable, superior magnetics, supercapacitors and circuit protection products. The initiative features a web-based Automotive Electronics Solutions (AES) portal designed to accelerate specifications and selection of components based on a wide range of individual automotive systems and requirements. Eaton is supporting AES with new safety-certified products, manufacturing technology advancements and doubling of production capacity. It also includes the expansion of research and development.

"Eaton's Electronics Division is committed to meeting ever-more stringent demands of the automotive industry as new safety standards are introduced and requirements for high-performance and reliability expand," said John Janis, Vice President and General Manager for Eaton's Electronics Division. "Eaton is recognized globally as a leader in power management components. With the constantly growing number of electronics systems in vehicles today and their individual and diverse safety and power requirements, we've designed Automotive Electronics Solutions to make the process of selecting the right component more intuitive."

The AES tool provides an online guide that helps designers identify the products they need by selecting a particular system or application area of the vehicle. The resource identifies the following application areas:

- Infotainment/telematics;
- Airbag control unit;
- Power doors, window lift, mirrors, seat control;
- Port power / USB hub;
- Engine start;
- Engine and powertrain control module;
- Electronic power steering / electric parking brake;
- Headlamp, tail lamp, interior lighting;
- Digital instrument cluster;
- Advanced driver assistance system.

Introduction of AEC-Q200-certified power products enhances Eaton Electronics Division's position in the automotive sector. The Automotive Electronics Council Component Technical Committee has defined the AEC-Q200 as common electrical component qualification

requirements. Components meeting these specifications are suitable in harsh automotive environments and Eaton has tested these new products to ensure they meet the standards.

The MPIA4040, HCMA0503, HCMA0703, HCMA1305, HCMA1707 and DRAQ127 are new inductors from the Coiltronics product family that are manufactured to rigorous automotive standards in TS16949 certified factories. The MPIA4040 product line offers automotive grade, high current, high frequency, miniature power inductors made of composite material offering AEC-Q200 Grade 3 (-40°C to 85°C) compliance and 125°C maximum total temperature operation for both interior and exterior applications. The HCMA products are high current power inductors made of a powder iron core material that offers high current carrying capacity and low core losses. This product line is also certified AEC-Q200 Grade 3. The DRAQ127 products are an addition of several inductance values to broaden the offering of this automotive-grade shielded drum core inductor series. These devices are typically used in interior, exterior and under-the-hood applications with a 165°C maximum total temperature operation, tested to AEC-Q200 Grade 1.

Eaton's PowerStor HV Series Supercapacitors are now qualified to meet major automotive OEM test standards with an extended operating temperature range of -40°C to 85°C. The HV series offers high capacitance and ultra-low ESR. Applications range from active shutters to safety systems for door locks and communications.

The Bussman CC12H High I2t Chip fuse series (1A-5A) has been extended to meet AEC-Q200 standards. Eaton has expanded the existing product line down to 750mA and from 6A to 20A to meet requirements for infotainment and engine control unit applications. Over the last two years, Eaton has reinforced the reputation of Coiltronics, Powerstor and Bussmann product families by investing in state-of-the-art manufacturing equipment to improve the reliability of the products. It has also grown research and development efforts so that these products deliver performance and reliability even as system specifications change and become more demanding. And the expansion of capacity means that Eaton can be a reliable supplier in volume production systems. Sample of Eaton products are available at www.eaton.com/elx or can be purchased from Mouser or DigiKey.

www.eaton.com

Comprehensive Suite of Solution for Lighting Applications



FCI introduced a comprehensive suite of solutions for Lighting applications. The FCI suite of products consisting of Wire-to-Board, Wire-to-Wire, Wire-to-Panel and Board-to-Board configurations, are suitable for a variety of lighting applications such as retrofit lamps, indoor/outdoor fixtures, signage, specialty lighting and lighting controls. The solutions support a range of current rating and voltage rating requirements, as well as a wide range of operating temperature range. RotaConnect™, Terminal Blocks, Universal Contacts and the newly launched Minitex Pwr™ and Griplet™ are highly suitable interconnects for the Lighting market.

"FCI is fully committed to support the Lighting market with our comprehensive suite of products. We want to create a one-stop shop for all lighting applications. We endeavor to introduce more innovative solutions for this market in the near future," comments Fabrizio Stango, Commercial Portfolio Director at FCI.

For more information about our solutions for the LED and Lighting application or for a copy of the Lighting Application brochure, please contact us at communications@fci.com.

www.fci.com

SIMPLE SWITCHER

Synchronous

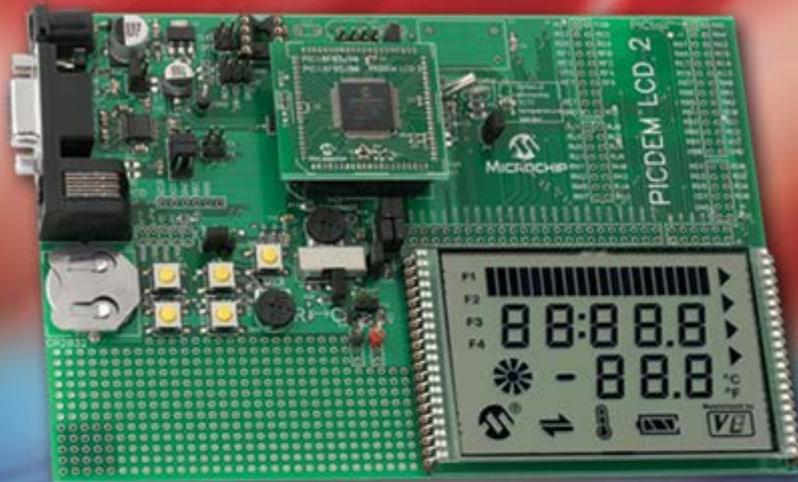
design made easy

- Easy layout for EMI and thermal performance
- Best-in-class design tools
- Simple scalability from 500mA to 3A, 36V to 60V

www.ti.com/simpleswitcher



Win a PICDEM LCD 2 Demonstration Board from Microchip



PICDEM™ LCD 2 Demo Board (Part # DM163030)

Bodo's Power is offering you the chance to win a PICDEM LCD 2 Demonstration Board. The PICDEM LCD 2 Demonstration Board (DM163030) shows the main features of Microchip's 28, 40, 64 and 80-pin LCD Flash PIC microcontrollers including the LCD voltage booster and contrast controller. It is populated with the PIC18F87J90. A sample LCD glass display is included for custom prototyping. The glass features 7-segment displays, wipers, thermometers, star bursts, and other common icons.

Some of the applications included are: a voltmeter, which measures the voltage of the on board potentiometer and displays a voltage between 0.00V and 3.30V on the LCD, a thermometer that measures

the voltage of the thermistor and continuously displays the temperature in both Celsius and Fahrenheit. The Timer/Clock function showing hours:minutes:seconds with a moving second hand, using on board 32 kHz watch crystal. Also, when using the PIC18F87J90 family of devices the LCD module can be configured as a charge pump and software contrast control is activated.

For the chance to win a PICDEM LCD 2 Demonstration Board, please visit <http://www.microchip-comps.com/bodo-lcd2-dev> and enter your details in the entry form.

www.microchip-comps.com/bodo-lcd2-dev

World wide support in English by

Bodo's Power Systems®

www.bodospower.com

Asian support in Mandarin in China

Bodo's Power Systems®
China

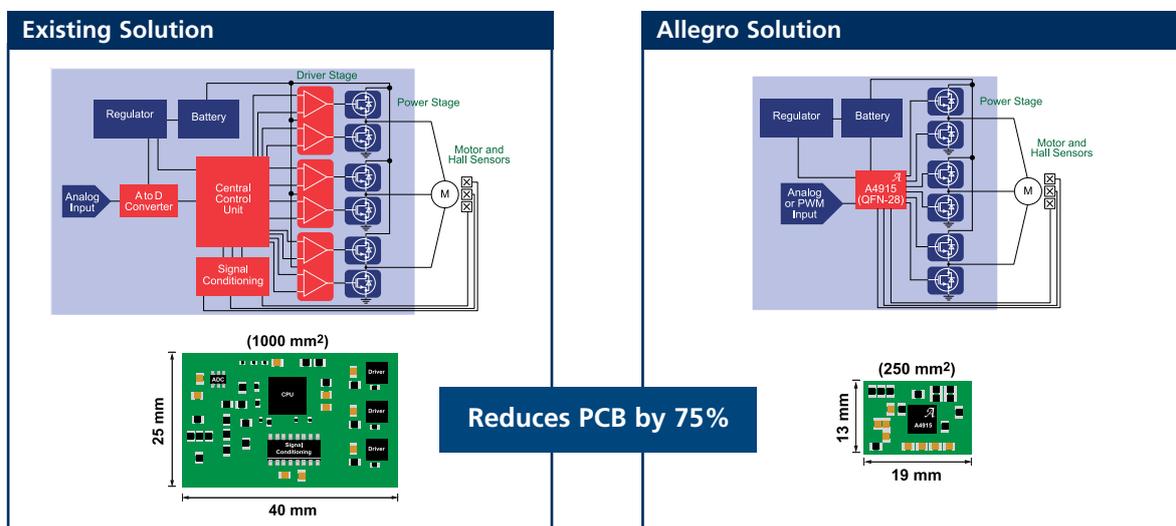
www.bodospowerchina.com

Allegro BLDC Motor Controllers Simplify Designs



Flexible solution supports designs with or without micro or DSP

The Allegro A4915 Three-Phase MOSFET Driver's innovative SPEED input and fully integrated block commutation delivers simple speed control of a BLDC motor with a single analog voltage.



Representatives

ALLREM
94616 Rungis Cedex, FRANCE
Tel: +33 (0) 1 56 70 03 80
E-mail: info@allrem.com

SSG Semiconductor Systems GmbH
D79856 Hinterzarten, GERMANY
Tel: +49 (0) 7652-91060
Website: www.ssg-de.com
E-mail: mail@ssg-de.com

Consystem S.r.l.
I-20144 Milano, ITALY
Tel: +39 02 4241471
Website: www.consystem.it
E-mail: support@consystem.it



MicroSystems Europe Ltd

www.allegromicro.com/camp1183

Youthful Power Electronics

By Braham Ferreira, Professor at TUDelft and elected IEEE PELS president (2015-6)

Computer Engineering is 60 years old. Power Systems and Telecommunications are even older. Forthcoming out of these disciplines the original electrical engineering societies were founded 130 years ago, including the VDE in Germany, IEE in the United Kingdom and the AIEE in the USA. Power Electronics is comparatively young. Despite the fact that power electronics started with the development of the mercury arc rectifier that was invented by Peter Cooper Hewitt in 1902, it only recently emerged as a discipline that can stand on its own feet. This was triggered by the spurt in technology development of power semiconductor devices that occurred in the early eighties. Power MOSFETs, Schottky diodes, GTOs and IGBTs made it possible to build reliable, efficient and affordable converters for many applications and ever improving micro-computers made it possible to do advanced real-time digital control of electrical machines. By the end of the eighties power electronics emerged as a distinct discipline with its own journals and conferences. Last year the IEEE Power Electronics Society celebrated its 25th anniversary and this year the European Power Electronics Association became 25 years old.

For the next two years it will be my privilege to serve as President of IEEE PELS, taking over the reins to steer the professional society during a period when many exciting things are happening in the development and application of power electronics. It is a great honour to become the second European in the history of the Power Electronic Society to take up this position. I look forward to strengthen the collaboration between PELS and European institutions such as the EPE Association and ECPE when my term that starts on 1 January 2015.

Acronym puzzle

The last four years I have been closely involved with conferences and it intrigued me how challenging it can be to come up with an acronym for an event or organisation that is unique and does not twist the tongue. Power electronics related acronyms generally make use of a set of seven letters, "A", "C", "E", "I", "M", "P" and "S" and the acronyms have a special ring about them if you say it loudly. Have you once seen the puzzlement on the face of a friend or a colleague that is not an engineer when you tell him to which conference you are going? You can see the question in their eyes; "Where do these nerdy names come from?"

The largest common denominator is "PE", standing for power electronics, and is present in almost all acronyms: EPE, ECPE, PEMC, PESC, SPEC, APEC, PEAC, PEDES, ICPE, IPEC and IPEMC. The PELS global conference and European acronyms have two "E"s; ECCE, EPE, ECPE while PCIM is the outlier as the only conference that does not have an "E" in its name. Asian conferences all start with an "I" which stands for international: ICPE, IPEC and IPEMC. "A" stands for application and the two conferences, one in the US and the other in China use the same letters in a different sequence: APPEC, PEAC. The meaning of "S" is the most inconsistent because in PESC it means specialist, in SPEC it indicates Southern and in PEDES it means system.



<http://ewi.tudelft.nl/epp>



IEEE ENERGY CONVERSION CONGRESS & EXPO



MONTREAL, CANADA | SEPTEMBER 20-24, 2015

Important Author Dates

January 15th, 2015: Digest submitted via the website
May 1st, 2015: Notification of acceptance or rejection
July 1st, 2015: Final papers with IEEE copyright forms

Other Important Dates

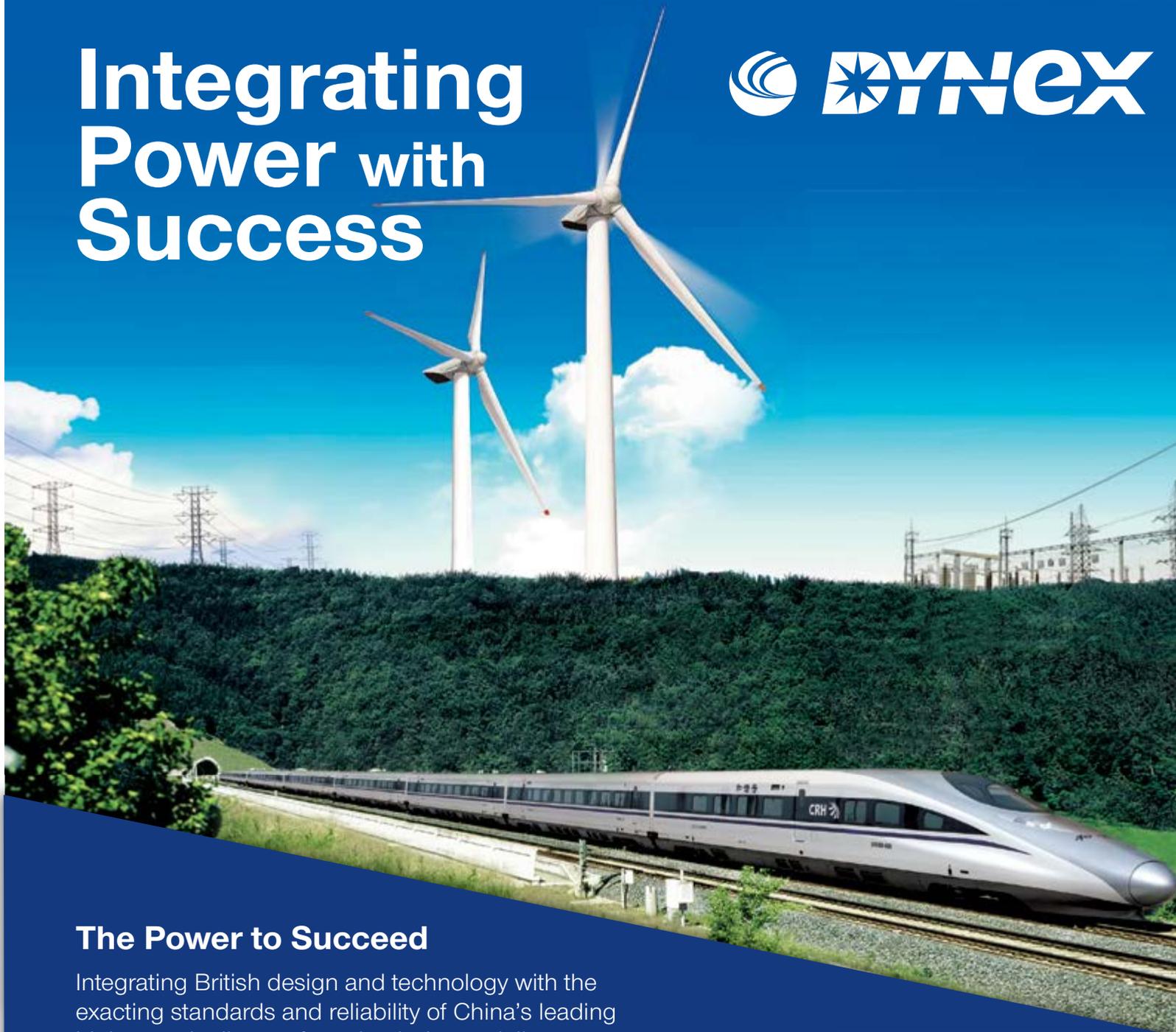
February 16th, 2015: Submission of Tutorial proposals
March 31, 2015: Submission of Special Session proposals



IEEE ENERGY CONVERSION CONGRESS & EXPO
 MONTREAL, CANADA | SEPTEMBER 20-24, 2015

The Seventh Annual IEEE Energy Conversion Congress and Exposition (ECCE 2015) will be held in Montreal, Canada, on September 20 - 24, 2015. ECCE 2015 is the pivotal international conference and exposition event on electrical and electromechanical energy conversion. To be held for the first time outside USA, ECCE 2015, in Montreal, Canada, will feature both industry-driven and application-oriented technical sessions, as well as industry expositions and seminars. ECCE 2015 will bring together practicing engineers, researchers and other professionals for interactive and multidisciplinary discussions on the latest advances in various areas related to energy conversion. Please visit <http://2015.ecceconferences.org> for more information or contact the ECCE 2015 Technical Program Chairs at ecce2015tpc@gmail.com. For exhibiting at ECCE 2015, please contact Exhibition Chair, Steve Sprague at ssprague@protolam.com. For more about Montreal and its surrounding areas, please visit <http://www.tourisme-montreal.org/>.

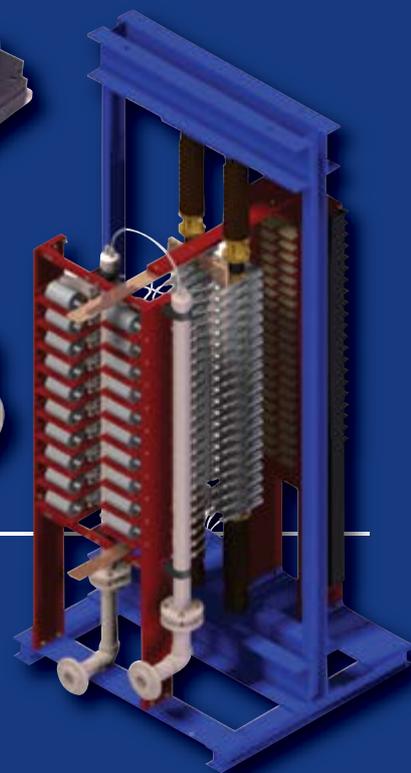
Integrating Power with Success



The Power to Succeed

Integrating British design and technology with the exacting standards and reliability of China's leading high speed rail manufacturing industry delivers the best in high power semiconductor components and assemblies.

Dynex and CSR Times Electric working together to bring our customers the power to succeed.



Products	Current/A	Voltage/V
High power IGBT/FRD modules	100 ~ 3600	1200 ~ 6500
Phase Control Thyristors	300 ~ 6800	1400 ~ 8500
Rectifier Diodes	400 ~ 10000	1400 ~ 8500
GTO	600 ~ 4000	1300 ~ 4500
Assemblies	As per customer's requirements	



www.dynexsemi.com

T: +44 (0)1522 502 901 +44 (0) 1522 502 753

E: power_solutions@dynexsemi.com

ELECTRONICS INDUSTRY DIGEST

By Aubrey Dunford, Europartners



Makers and startups, not tech providers, consumer goods companies or enterprises, will drive acceptance, use and growth in the Internet of Things (IoT) through the creation of a multitude of niche applications, so

Gartner. Gartner predicts that by 2017, 50 percent of IoT solutions (typically a product combined with a service) will originate in startups that are less than three years old. Individuals and small companies that span the globe are developing IoT solutions to real-world, often niche problems. They are taking advantage of low-cost electronics, traditional manufacturing and 3D printing tools, and open-and closed-source hardware and software to create IoT devices that improve processes and lives, says Gartner.

SEMICONDUCTORS

Measured in euros, European semiconductor sales were € 2.393 billion in August 2014, a 0.4 percent decrease over July and an increase of 8.3 percent versus August 2013, so the WSTS. On a YTD basis, semiconductor sales increased by 6.1 percent in euros versus the same period in 2013.

Microchip Technology, a provider of microcontroller, mixed signal, analog and Flash-IP solutions, warned that its quarterly sales would be about 3 percent below its expectations. Samsung Electronics announced a plan to construct a new semiconductor fabrication plant in the company's Godeok Industrial Complex in Pyeongtaek to meet growing demand for advanced semiconductor products. Construction on the 790,000m2 site will begin during the first half of 2015, and operations are scheduled to begin sometime during the second half of 2017.

China has implemented national policies to expedite the development of its domestic IC design and semiconductor manufacturing. Taiwanese semiconductor foundry UMC will participate in a joint venture company focused on 12" wafer foundry services with Xiamen Municipal People's Government and Fujian Electronics & Information Group. Worldwide semiconductor capital spending is projected to total \$ 64.5 billion in 2014, an increase of 11.4 percent from 2013, so Gartner. Equipment spending will increase 17.1 percent, at \$ 39.2 billion, as manufacturers pull back on new fab construction and concentrate on ramping up new capacity instead.

OPTOELECTRONICS

Toyoda Gosei and Osram have extended their agreement which allows the companies to use each other's patents for specific light emitting diode, including white LED, and laser technologies. The original agreement of 2007 allowed both Osram and Toyoda Gosei significantly more freedom to develop, manufacture and market new products without fear of unintentional violations of patents. By facilitating research at both companies, new developments in LED technology were enabled, including an acceleration of research to improve the luminosity of LEDs. The new agreement extends the scope of the patents covered by the original 2007 agreement, to include patents filed after the execution of the original agreement.

PASSIVE COMPONENTS

TE Connectivity has completed the previously announced acquisition of Measurement Specialties, a supplier of sensor technologies including pressure, vibration, force, temperature, humidity, ultrasonics, position and fluid, for a wide range of applications and industries. The acquisition of Measurement Specialties for approximately \$ 1.7 billion, expands TE's sensor business significantly, and builds on their strength in harsh environment applications. Measurement Specialties will be included as part of TE's Transportation Solutions segment.

Germany's total PCB revenues in August recorded its highest sales since the pre-crisis year of 2008, so the ZVEI. Total sales went up by 3.1 percent in August year-on-year. Cumulative sales from January to August were up by 2.9 percent compared to the same period last year. In terms of incoming orders, August 2014 figures were up by 13 percent from last year. Cumulative sales from January to August were up by 2.9 percent compared to the same period last year. Cumulative orders from January to August were up by 10.3 percent compared to the same period last year. Book-to-bill ratio fell back to 0.98.

OTHER COMPONENTS

The Electronic Design Automation (EDA) industry revenue increased 6.3 percent for Q2 2014 to \$ 1757.9 M, compared to \$ 1653.4 M in Q213, so the EDA Consortium. Sequential EDA revenue for Q214 increased 0.7 percent compared to Q114, while the four-quarters moving average, which compares the most

recent four quarters to the prior four quarters, increased by 5.8 percent.

Three power supply manufacturers announced the formation of a new power industry consortium, the Architects of Modern Power (AMP). The founding members are CUI, Ericsson Power Modules and Murata – all global players developing advanced power conversion technology for distributed power architectures. The aim of the alliance is to create the most technically advanced, end-to-end distributed power solutions – a complete ecosystem of hardware, software and support. This summer, Alpha opened its new Die Attach Applications Center in Langenfeld, Germany, dedicated to serving the requirements of the LED/optoelectronics and power semiconductor markets. This facility offers opportunities for European and other global companies to run their assemblies on the latest die attach equipment using advanced Alpha sintering, soldering, and polymer technologies.

DISTRIBUTION

Powered by one of the industry's most comprehensive components database and interactive design capabilities, Arrow Electronics is offering parts.arrow.com, its first fully integrated online product life cycle services engine for electronics parts. Available via arrow.com in German, French, Italian, Spanish and English, users can meet their electronic component needs through an intelligent search of millions of parts from hundreds of suppliers by using comprehensive features, such as product selectors, cross referencing and Bill of Material capabilities. Arrow's web tool provides engineers with interactive reference designs and advanced design applications for faster development cycles. Once users are finished designing using the interactive features, they can generate a Bill of Materials and purchase the parts, all without having to leave the site. Design engineers globally can collaborate on shared designs securely using messaging and live updates, as well as with Arrow's technical experts.

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

www.europartners.eu.com

Our team at the Nuremberg site is currently looking to recruit a

Electrical Engineer as Marketing Content Specialist (m/f)



We are an innovative company with 2,900 employees worldwide. With our power modules and systems, we have been a key presence on the international market for more than 60 years, and our qualified and motivated staff are essential to this success. At our headquarters in Nuremberg, where 1,300 of our employees are based, we develop new products and technologies for application areas such as renewable energies, energy-efficient motor drives, industrial automation systems, power supplies and commercial vehicles.

About the role

- Research/writing/editing of English language materials
- Research, write and edit press materials, marketing materials, online content for product promotion and business development to align and harmonize messaging and drive consistency across all external communications
- Support regional teams in managing the governance process required for the distribution of press releases, key message documents and other promotional material as required
- Support the Marketing Team in the review, production and governance of group marketing materials as required to support brand building and key marketing events
- Align and manage workflow to reduce duplication of effort and streamline processes and standards in content development and translations
- Internal approval and signoff of press releases and posting/archiving of materials
- Ensure group-wide adherence to communications disclosure policy associated with material and promotional releases
- Appropriate issuance of press releases via news agency and WebsiteUploading of promotional content onto web and social media platforms

About you

- University degree in electrical engineering or marketing/communication and several years of experience as technical writer in the field of electrical engineering
- Excellent English writing skills at native level; good German language skills, additional French skills helpful
- Ability to write for different media
- Hands-on work ethic / ability to work in a team but also with minimal supervision when required
- Expertise in writing from source and editing copy and news, for advertising, promotion and other marketing objectives online and in print
- Up-to-date familiarity with the use of the internet, online communication and social media in promotion and brand building
- Very strong organization, project management and time management skills
- Ability to grasp technical terms and turn into readable copy

We look forward to receiving your application, preferably by email. Please include your earliest start date and your salary expectations, together with the reference number:

▶ 14AF0096B

Contact: Matthias Engel
SEMIKRON Elektronik GmbH & Co. KG
Sigmundstraße 200,
90431 Nuremberg, Germany
E-Mail: jobangebote@semikron.com
www.semikron.com

Developments in the AC-DC External Power Supply Market

Richard Ruiz, Research Analyst, Darnell Group

Led by a number of traditional applications within the communications, computers and consumer segments as well as a number of emerging applications, the outlook for the external ac-dc power supply market is expected to remain strong over the next several years increasing from \$10.7 billion in 2014 to \$14.9 billion in 2019, a compounded annual growth rate (CAGR) of 6.9%. Although considered one of the more conservative markets with little change in technology when compared to the embedded ac-dc and dc-dc power supply markets, external power supplies are poised to experience a number of significant opportunities and developments in technology and materials over the next several years.

One of the more interesting opportunities for external power is the emergence of digital power. Traditionally, external ac-dc power supplies have not been considered one of the “best” markets for digital power management and control. Composed of adapters and battery chargers primarily for portable devices, they are not part of the high-end, distributed power systems, which are better suited to digital control. However, the “added functionalities” that enable increased efficiency (and thus meet certain rating systems and regulations) are starting to open this market for digital power management, particularly at the IC level.

As an example, CamSemi offers the C2160 PSS controller ICs that are aimed at high-volume, universal input application rates at 1W to 8W, including chargers for mobile phones, digital cameras, handheld games and other portable devices, along with external power adapters. These devices are designed to help manufacturers comply fully with the latest efficiency requirements, including the 5-star rating system for mobile phone chargers. The key to the PSS controllers’ performance is a proprietary, patented method of measuring the circuit’s output voltage and current level

Drivers for digitally controlled external ac-dc power supplies are coming primarily from standards and regulations mandating stricter power supply requirements. With the emphasis on increased energy efficiency, manufacturers have the flexibility to offer power adapters that can communicate changes in power requirements, such as higher or lower voltage, or to shut off completely when not in use.

Regulators in both the US and the European Commission (EC) have proposed minimum efficiency requirements for offline power supplies. In fact, the EC’s Integrated Product Policy (IPP) program and the world’s top five cellphone makers have introduced a voluntary five-star energy rating system for mobile device chargers, making it easier for consumers to determine which ones use the least energy. This rating system covers all chargers currently sold by Nokia, Samsung, Sony, Ericsson, Motorola and LG Electronics, and ranges from five stars for the most efficient chargers down to zero stars for the units consuming the most energy.

There is also an opportunity to use USB 3.1 and another other standards to promote digital control in external ac-dc power supplies. For example the UPAMD/P1823 is a standards working group

sponsored by the Microprocessor Standard Committee (MSC) of the IEEE Computer Society. The project was authorized by the IEEE Standards Association Standards Board in June of 2010. Specifically, the Universal Power Adapter for Mobile Devices (UPAMD™) standard defines a power delivery connection between a power adapter and a power-using device in the 10 Watt to <240 Watt range.

A communications link between the power adapter and the mobile power-using device is also defined in this standard. The communications may be used to coordinate the power delivery and provide identification between the power adapter and the device. While intended for portable computing and entertainment devices, this standard may also be used with other mobile devices in offices, homes or vehicles.

The increased power level of USB 3.1, along with power being delivered to multiple devices, could drive the need for programmable control of battery chargers and adapters. With such functionality already being a “preferred” mode of control in certain dc-dc converter applications, it will eventually migrate into external ac-dc power supplies, as well.

Chip makers and power supply manufacturers now have the technology needed to undertake the transition from clunky black bricks and wall warts to sleek, efficient digital power adapter architectures capable of exchanging information between the power source and the load and adjusting power use according to product need.

Another area of interest is advancement in standby power management. It is generally accepted that the energy consumed by external chargers left plugged into an outlet while disconnected from the end product – accounts for a substantial portion of the energy consumed by mobile devices. The only means of eliminating this waste has been with a mechanical switch, a feature rarely found on mobile-device power supplies. To address this, a number of semiconductor companies have introduced products designed specifically to both lower costs and reduce standby power in consumer electronic devices.

Dialog Semiconductor offers a digital pulse width modulation (PWM) controller that was designed to efficiently drive low-cost, 10W power bipolar junction transistor (BJT) switches to reduce the BOM cost in 5V/2A smartphone adapters and chargers. The company’s iW1679 allows designers to replace field effect transistors (FETs) with lower-cost BJTs and address the market trends for lower standby power and higher light-load and active average efficiency in smartphones, media tablets and consumer electronic products.

The use of the Dialogs iW1679 enables designers to meet or exceed the emerging global energy standards, including the stringent European CoC Version 5, which is anticipated to require 76% active average efficiency and high light load efficiency down to 10% loads, as well as the proposed U.S. DOE regulation, expected to require 79% active average efficiency, and the Energy Star EPS 2.0, which will require 73% active average efficiency.

In addition, technology developed by Texas Instruments (TI) is also expected to contribute to the reduction in standby power. In March of 2014, Texas Instruments introduced two flyback power solutions that claim the highest energy efficiency and lowest standby power consumption for 5-100W ac-dc power supplies. The UCC28910 700V flyback switcher and UCC28630 high-power, green-mode controller with primary-side regulation (PSR) both achieve sub-30mW standby power and expand TI's portfolio of flyback controllers covering a power range of ac-dc adapters and power supplies used in personal electronics, printers, white goods and smart meters.

Additional areas to watch are advances in technology, components and materials, in particular advanced semiconductor materials such as Gallium Nitride (GaN) which is expected to have an impact on the power supply market over the forecast period. The Adoption of GaN technology will have a major effect on the external power supply market over the next several years, as the technology promises both smaller and more efficient ac-dc power supplies and dc-dc converters.

According to GaN Systems, a Canadian manufacturer of power conversion semiconductors for cleantech applications, GaN devices offer five key qualities that make it unique: high dielectric strength, high operating temperature, high current density, high-speed switching and low on-resistance. These traits are due to the properties of GaN, which when compared to silicon, offer ten times higher electrical breakdown characteristics, three times the bandgap, and exceptional carrier mobility.

However, the current challenge faced by GaN technology remains cost, as an expensive and extensive process is required to grow a GaN crystal or wafer on which transistors and integrated circuits (ICs) can be fabricated. A number of companies are exploring the use of GaN technology in a variety of areas and once the process is implemented on a large enough scale, the cost should eventually come down.

The adoption of GaN technology is expected to have an effect on the external power supply market over the next several years. The California-based startup Transphorm has developed power electronics technology based on gallium nitride, a semiconductor that wastes far less power than the silicon components used in conventional devices. Not only are these electronics more efficient,

they can also do without some of the bulky cooling systems.

For example, the company hopes to reduce the size of the charger bricks required by laptops today—or eliminate them altogether by incorporating the necessary electronics into the computer itself. The more compact design is also important for automobile applications, where space is limited and weight is important to fuel efficiency. Transphorm believes it can reduce wasted electricity by 90%.

A startup called FINSix has developed laptop power adapters that are 75% smaller than their conventional counterparts. The technology employed could also be used to improve the efficiency of a wide variety of devices and appliances, including washing machines and air conditioners.

The FINSix adapter is GaN-based and is currently expensive at \$79.00 per unit (Retail for a PC) which is about 7 or 8 times as expensive as a common notebook power supply. However, if they can they bring down the cost into the same \$/W as today's designs it will have a transformative effect on the ac-dc adapter industry. The 65W power adapter operates at 30-100MHz and can be used to charge a variety of laptops or other devices such as smartphone or tablets (it comes with a 2.1A USB connector)—it can even charge more than one device at a time.

FINSix's power adapter is called the Dart and is an after-market charger that can work with a variety of laptops and other devices. This GaN-based device shrinks power electronics by increasing the frequency at which these devices operate. The higher the frequency, the smaller the device can be. Ordinarily, higher frequencies also reduce efficiency.

However, researchers at MIT and FINSix developed a way to recycle much of the energy that's normally lost inside a power adapter, improving efficiency and making it practical to use frequencies 1,000 times higher than those used in conventional power adapters. Production of the North American Dart (US prongs) will begin in the fall of 2014.

Due to the sheer size of the overall external ac-dc power supply market it is an attractive opportunity for digital power supply manufacturers and is projected to see considerable advancement over the next several years.

VARIS™ — small components with big power



- Flexible combinations of the phase components
- Inverter power rating from 290 kW to over 1.4 MW
- Air or water cooling
- Also as boost or buck converter

engineered by

GVA
Power Electronics

Welcome to the House of Competence.

www.darnell.com

December 2014

www.bodospower.com

Phone +49 (0) 621/7 89 92-0
VARIS@gva-leistungselektronik.de
www.gva-leistungselektronik.de

eGaN[®] Technology: Transforming the Future

By Alex Lidow Ph.D.; Efficient Power Conversation

KEY TAKE AWAYS

- Transformative technologies, like the eGaN[®] technology developed by EPC, change entire industries.
- eGaN technology has resulted in devices 5-10 times better than silicon counterparts, enabling large new applications like envelope tracking and wireless power. And, this is just the beginning. eGaN technology can be 1000 times better than silicon – changing the game in several industries.
- eGaN technology will evolve from discrete transistors to single-chip integrated circuits to complete systems-on-a-chip, significantly increasing performance and value-added to the market.

In Issues 4 and 5 of Technology Driving Markets, we discussed a few applications enabled by eGaN technology: Envelope Tracking, Wireless Power, and LiDAR. Each of these will make a major difference to the consumer in the next few years.

But this is just the beginning.

eGaN FETs today are only available as discrete transistors, with performance a mere 5-to-10 times the best commercial silicon. What happens when several devices are integrated to create a system on a single chip, as we discussed in issue 6 of Technology Driving Markets? What happens when the performance of that chip is 100 times better than silicon?

In this issue we will look out 5 to 10 years and see how a transformative change in semiconductor technology is transformative to our world in almost every way.



Transforming Space

Power converters used in harsh environments, such as space, high-altitude flight, or high-reliability military applications must be resistant to damage or malfunctions caused by radiation. eGaN FETs today perform 40 times better electrically while being able to withstand 10 times the radiation compared with the aging Rad Hard power MOS-FET. This enables entirely new architectures for satellite power and data transmission.

Elon Musk, CEO of SpaceX, has set as his mission to reduce the cost of putting objects in space by a factor of 10. With eGaN technology applied to satellites we can reduce the size of the electronics, eliminate the shielding required, and greatly improve the performance of the data communications. This eliminates solar panels, makes the entire system smaller and lighter weight, and extends the life of the satellite.

A factor of two reduction in weight is within our reach with today's technology, whereas a factor of 10 is possible when eGaN technology is used to produce entire systems on a single chip. Multiply the impact of SpaceX with eGaN technology and we will change the way we use space and accelerate the exploration (and possible colonization?) of our universe.



Transforming the Machine Interface

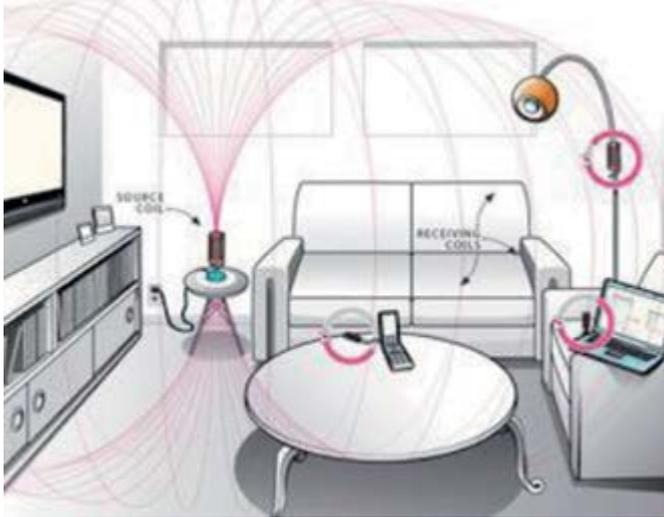
LiDAR uses high speed pulsed lasers to rapidly create a three dimensional image or map of a surrounding area. One of the earliest adopters of this technology was the Google "driverless" car. Today's eGaN FETs are enabling new and broader applications such as 3D printing, real-time motion detection for video gaming, computers that respond to hand gestures as opposed to touch screens, and fully autonomous vehicles. As eGaN technology evolves, LiDAR can be further improved in both resolution and cost.

Projects are already underway to include "3D Awareness" in our cell phones. Imagine if phones could understand the space around us. We will be able to get directions in a new, more comprehensive way. An iPhone today can provide the location of the building you desire, but with LiDAR, 3-D mapping could lead you straight to a specific office.

Transforming the Use of Electricity

Wires suck. Today, we need wires to supply power to our ever-growing collection of electrically powered gadgets. For those gadgets that are so completely indispensable, we need to take them with us at all times, and they need batteries that must be recharged all-too-frequently.

Expected in 2015, wireless power systems using eGaN technology will begin to unload this wired burden by providing energy wirelessly to charge cell phones and tablets. By integrating thin transmission coils in the floor tiles and the walls of buildings and homes, the need for wall sockets will be eliminated altogether! This same wireless power technology can be used to charge electric vehicles when parked over a transmitting coil embedded in the floor of a garage.



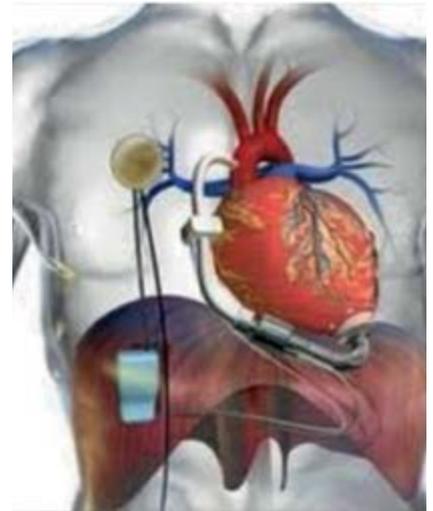
A project is underway to embed wireless chargers at bus stops. Eventually, in a one-minute stop, a bus can get enough charge to drive a mile to the next bus stop. This could eliminate the need for most of the heavy batteries and overhead electrical systems that burden electric buses today.

Transforming Medicine

We are all getting older every day, and, as we age, we develop more opportunities for frailties and chronic health problems. Today there are major advances in fields such as implantable systems, imaging, and prosthetics that are enabled by eGaN technology.

Wireless power is already having an impact on implantable systems such as heart pumps. Beyond just artificial hearts, many other medical systems can also benefit. As Dr. Pramod Bonde of the University of Pittsburg Medical Center speculated, “[wireless power] can be

leveraged to simplify sensor systems, to power medical implants and reduce electrical wiring in day-to-day care of the patients.”



But it's not just eGaN technology in wireless power that is transforming medicine. Imaging technology is also improving by leaps and bounds! The resolution of MRI machines is being enhanced through the development of smaller and more efficient sensing coils using eGaN FETs and ICs. Diagnostic colonoscopies are about to become a thing of the past due to today's eGaN FETs. These types of non-invasive imaging breakthroughs significantly reduce the cost of health care through early warning and non-invasive diagnostics. As we integrate entire systems on a single eGaN chip, miniaturization and image resolution improves the standard of care while medical costs come down.

eGaN Technology — Transforming the Future

In this issue of Fast Just Got Faster, we talked about a few of the transformations that will be enabled as eGaN technology evolves. EPC is taking the 5-10 times gap in performance between eGaN FETs and MOSFETs and improving it to a 1000 times gap. This technology will also apply to integrated circuits made in eGaN technology.

EPC is pursuing parallel paths – discrete power semiconductors and (soon) fully integrated circuits that initially will form building blocks for multiple applications, but will ultimately evolve into complete systems-on-a-chip for very high performance, low cost, and high value-added applications like the ones discussed above.

The eGaN journey has just begun!

www.epc-co.com

Our Power Inductor family from
small and filigree to
LARGE and POWERFUL



No “next generation” issues!

- Available from stock
- Free samples within 24 hrs
- Design kits with free refills
- Software tools for product selection
- On-site Design-In consultations
- IC reference designs



Enhanced Trench IGBTs and Field Charge Controlled Diode

The Next Leap in IGBT and Diode Performance

Future generations of IGBT modules will employ Enhanced Trench ET-IGBTs and Field Charge Extraction FCE diodes capable of providing higher level of electrical performance in terms of low losses, good controllability, high robustness and soft diode reverse recovery.

By Liutauras Storasta, Chiara Corvasce, Maxi Andenna, Sven Matthias, Raffael Schnell and Munaf Rahimo, ABB semiconductors

Despite the fact that the Insulated Gate Bipolar Transistor (IGBT) and antiparallel diode have experienced over the past two decades important breakthroughs with respect to the device process and design concepts which resulted in clear leaps in device overall performance, further development work is underway to achieve the next level in terms of higher power densities, improved controllability and robustness. In this article, we will first briefly discuss the current IGBT and diode development trends while focusing on the next generation technologies; namely the Enhanced Trench IGBT (ET-IGBT) and Field Charge Extraction (FCE) diode. Then, the new device concepts and their electrical performance will be demonstrated for the 3.3 kV voltage class.

IGBT and diode future development trends

The main three IGBT development trends today are targeting higher power densities with (a) Enhanced Trench ET-IGBTs, (b) higher operating temperatures above the traditional 125°C mark and (c) IGBT/Diode integration solutions referred to as Reverse Conducting RC-IGBT or Bi-mode Insulated Gate Transistor (BIGT). In the BIGT case, the single chip approach provides improved performance especially with respect to the limitations due to the restriction in available diode area depending on the given application requirements. Nevertheless, the traditional IGBT/Diode two chip approach remains as an important development path for many mainstream applications. Today, state-of-the-art high voltage devices with a similar loss performance employ Enhanced Planar IGBT (EP-IGBT) or Trench IGBT MOS cell concepts on Soft Punch Through (SPT) structures. However, for lower voltage devices rated below 2 kV, in addition to trench IGBTs, advanced ET-IGBTs are already an established technology. Furthermore, the ET-IGBT concept is also capable of providing the next step in loss reduction for high voltage IGBTs. Figure 1 demonstrates the on-state $V_{ce(sat)}$ loss reduction of a 3300 V IGBT for the same turn-off losses E_{off} achieved with the new ET-IGBT MOS cell on the same bulk SPT platform. However, it is important to point out that the trench based IGBTs, especially for higher voltage ratings, exhibit an inherently high effective gate input capacitance when compared to planar based devices which results in less controllability for optimum switching performance during IGBT turn-on. Overcoming this negative aspect combined with the lower losses of the ET-IGBT will provide an ideal solution for the next generation high voltage IGBTs.

For the fast diode part, the losses and reverse recovery softness remain as a critical performance target for matching the performance of the new ET-IGBTs. The Field Charge Extraction (FCE) concept

demonstrated that soft recovery performance under extreme switching conditions combined with low losses could be achieved while having no drawbacks on other electrical parameters.

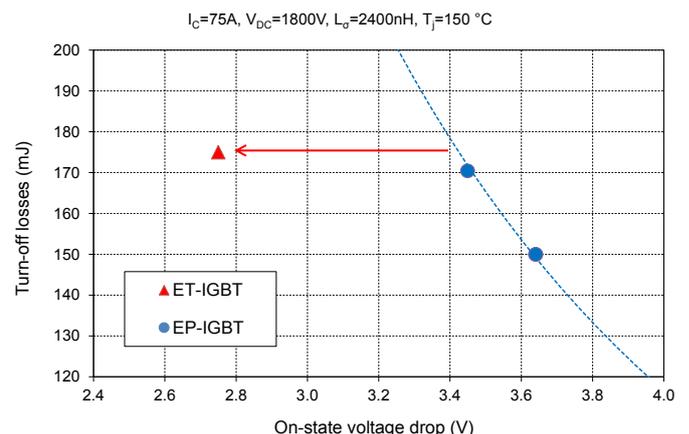


Figure 1: 3.3kV IGBT trade-off curve between on-state voltage drop and turn-off losses. Comparison between the enhanced trench (ET) and enhanced planar (EP) structures

The ET-IGBT concept

The main approach followed for the realization of the ET-IGBT concept with the targeted enhanced carrier concentration near the trench emitter for lower losses is based on the introduction of a striped active Trench MOS Cell with an n-enhancement layer. In order to reduce the effective input capacitance for improved switching controllability, the focus is on the optimization of the regions between the active cells, which contribute strongly to the device effective input capacitance value during switching. By eliminating gate regions between the active cells as shown in the cross section in figure 2, we allow for a low effective gate emitter input capacitance compared to state-of-the-

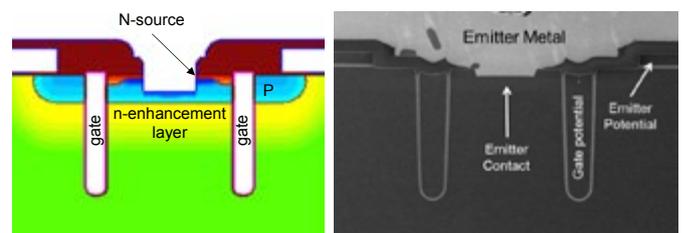
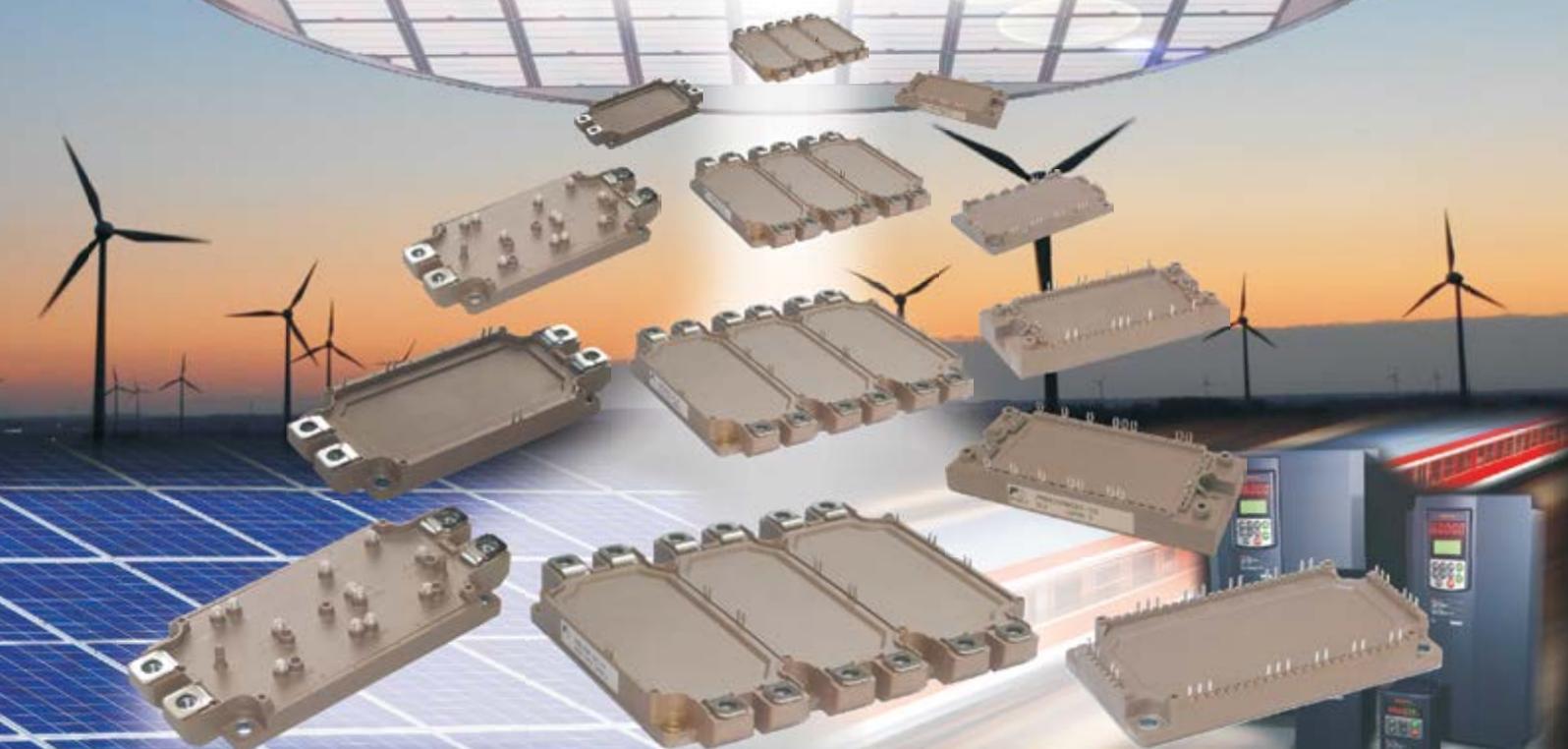


Figure 2: ET-IGBT MOS Cell concept

Fuji's Chip Technology

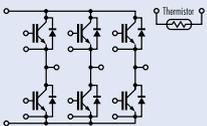
The Independent Way V-Series IGBTs



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

Econo IGBTs

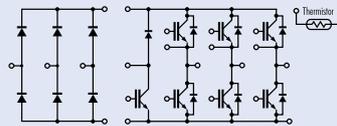
The 6-PACKs



Package	I _c	600V	1200V	1700V
45x107.5 mm	50A	● ■	● ■	
	75A	● ■	● ■	
	100A	● ■	● ■	
62 x 122 mm	100A		● ■	●
	150A	● ■	● ■	●
	180A		● ■	
	200A		● ■	

With ● Solder pins ■ PressFit contacts

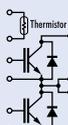
The PIMs



Package	I _c	600V	1200V
45x107.5 mm	25A		● ■
	35A		● ■
	50A	● ■	● ■
	75A	● ■	
62 x 122 mm	50A		● ■
	75A	●	● ■
	100A	● ■	● ■
	150A	● ■	● ■

With ● Solder pins ■ PressFit contacts

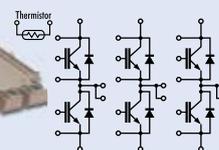
The 2-PACKs



Package	I _c	1200V	1700V
62 x 150 mm	225A	● ■▲	■
	300A	● ■▲	■
	450A	● ■▲	● ■
	550A		● ■▲
	600A		● ■▲

With ● Solder pins ■ PressFit contacts ▲ Spring contacts

The High Power 6-PACKs



Package	I _c	1200V	1700V
150 x 162 mm	225A	●	
	300A	●	●
	450A	●	●
	550A	●	

art trench IGBT designs while providing optimum reverse blocking capability. The lower on-state losses of the 3.3 kV ET-IGBT provides potentially a 20% increase in the rated current capability compared to the EP-IGBT generation.

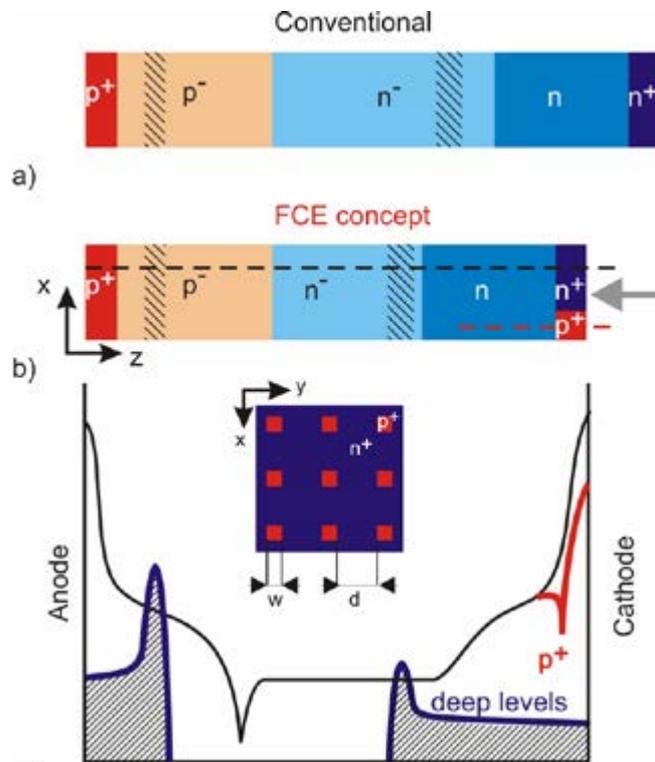


Figure 3: The combination of FCE and FSA concepts (a) and (b) cross sections, (c) doping profile

The FCE diode concept

For the new diode, a combination of the Field Charge Extraction (FCE) concept and the well-established Field Shielded Anode (FSA) design is utilized as shown in figure 3 when compared to a conventional design. The thickness of the n-base plays a key-role for the overall loss generation where low-loss diodes require a thin n-base design. However, further reductions of the thickness of the n-base region have been typically restricted by the snappy reverse recovery behavior of the resulting diodes. By introducing small p-doped areas at the cathode side of the diodes as shown in figure 3, a field-induced carrier injection process is enabled during the recovery phase, which generates inherently soft diodes. Therefore, the n-base of a 3.3 kV rated diode can be thinned by 10% while the blocking capability is maintained by increasing the resistivity without compromising soft reverse recovery. The benefit of this approach is a 20% improvement on the technology curve. Moreover, the robustness of these inherently soft diodes has been improved due to the absence of large overshoot voltages during reverse recovery.

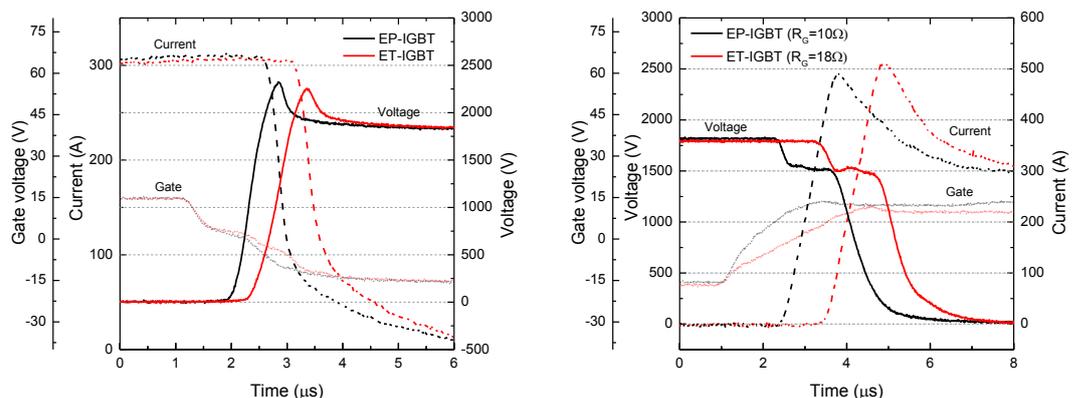


Figure 5: 300A/3.3kV module Turn-off (left) and Turn-on (right) waveforms (1800V, 300A, 150°C).

3.3 kV ET-IGBT module prototypes

3.3 kV ET-IGBT and FCE-diode chips were manufactured with an active area of approximately 1 cm² per chip with a defined rating of 75 A for the IGBT and 150 A for the diode. The chips were employed in a standard high voltage insulated module (140 x 70) mm² having a dual configuration as shown in the inset of figure 4. Each IGBT/diode part in the dual package consists of a single substrate containing 4 x ET-IGBTs and 2 x FCE-diodes. The resulting current rating of the module is 300 A compared to today's 250 A for an equivalent EP-IGBT.

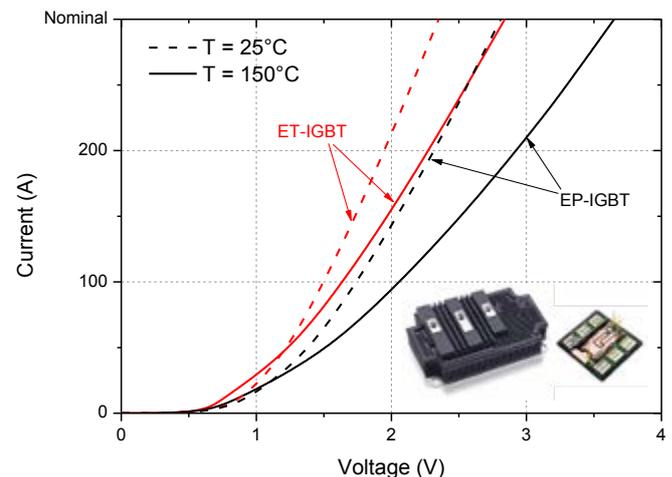


Figure 4: 300A/3.3kV ET-IGBT module output I-V characteristics at 25°C and 150°C.

The modules were tested electrically under static and dynamic conditions. Figure 4 shows the on-state characteristics for the ET-IGBT at 25°C and 150°C and compared to the EP-IGBT. The ET-IGBT module exhibits much lower static losses compared to the EP-IGBT together with strong positive temperature coefficient for safe paralleling of chips. At the rated current of 300 A, the ET-IGBT design has a $V_{ce(sat)}$ of 2.75 V compared to 3.55 V for the EP-IGBT at 150°C.

Figure 5 show the nominal turn-off and turn-on switching waveforms for both ET-IGBT and the reference EP-IGBT, respectively. The test conditions were kept the same to better evaluate the device performance. The devices were switched against an applied DC-link voltage of 1800 V and a rated current of 300 A at 150°C with a gate emitter capacitance of 47 nF. The stray inductance was 600 nH and the turn-off gate resistance was 9Ω while the turn-on gate resistance varied per design as indicated. The turn-off losses E_{off} of the ET-IGBT were at around 650mJ compared to 600 mJ for the EP-IGBT. However, larger variations were obtained for the turn-on losses E_{on} where the

Medium voltage A HIGH-WIRE ACT?



Medium voltage components for power electronics

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



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

engineered by

GvA
Power Electronics

Welcome to the House of Competence.

ET-IGBT was at 860 mJ albeit with a different gate resistor compared to 910 mJ for the EP-IGBT. The total switching losses for all tested devices were approximately at the same level just below 1.5 J. The FCE-diode reverse recovery performance can also be seen in the IGBT turn-on waveforms. The controllability of the ET-IGBT is illustrated in figure 6 when plotting the turn-on parameters ($I_{C,max}$, E_{on} and di/dt) against the variation in the gate resistance.

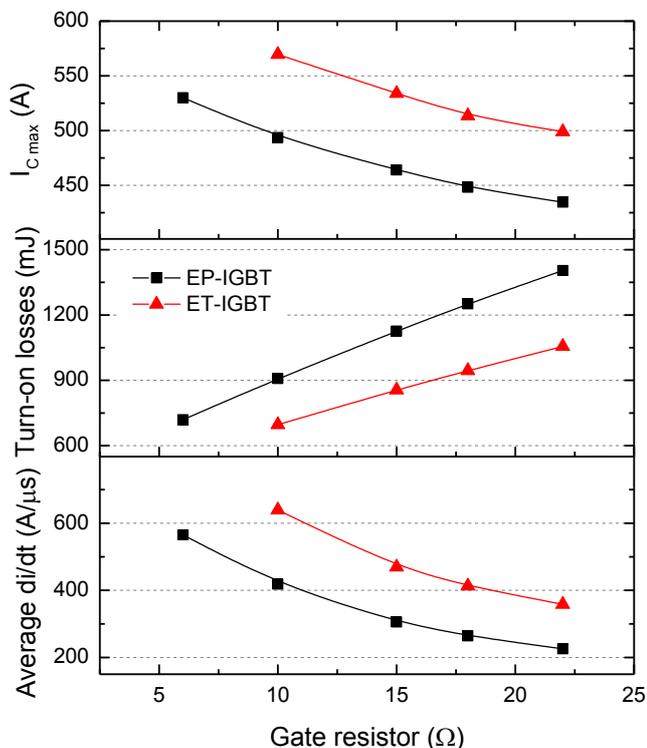


Figure 6: Effect of varying the gate resistance on the turn-on parameters (1800V, 300A, 150°C).

The FCE diode softness was also tested under the same circuit setup but at the critical softness conditions with a lower current of 15 A and a lower temperature of 25°C as shown in figure 7. The FCE diode clearly shows very soft recovery performance under these extreme conditions when compared to the standard diodes exhibiting a typical current snap-off along with the associated high overshoot voltage.

ET-IGBT Turn-off and Short Circuit SOA Performance

The turn-off (RBSOA) behavior was tested for two paralleled chips under high current and voltage conditions. For the RBSOA, the ET-IGBT was tested against a high DC-link voltage of 2500 V and the maximum achieved switchable current is approximately 5x and 4x the nominal current at 25°C and 125°C, respectively as shown in figure 8. The device enters and withstands both stress conditions known as dynamic avalanche and Switching Self Clamping Mode SSCM at 25°C. At a temperature of 125°C, the device experiences stronger dynamic avalanche as expected due to the higher levels of carrier concentrations which results in a lower but still sufficient turn-off capability.

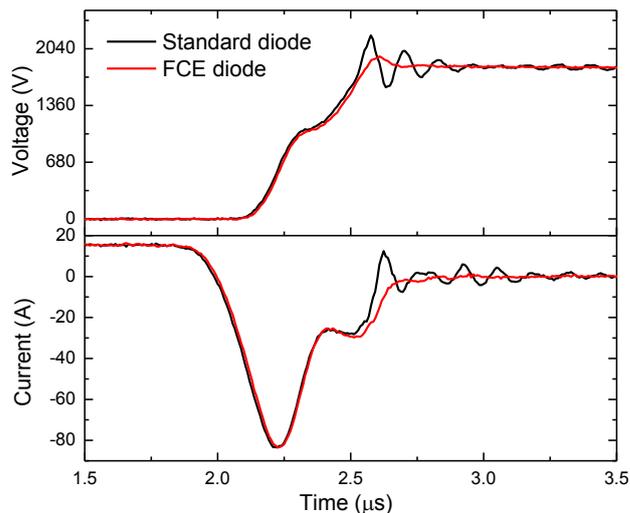


Figure 7: 300A/3.3kV module reverse recovery (1800V, 15A, 25°C).

The single chip ET-IGBT short circuit test was carried out at 1800 V and 25°C and the resulting waveforms are shown in figure 8. At a short circuit current level of around 300 A, a smooth and stable behavior was obtained for pulse widths of at least 15 μ s.

With the above SOA performance, it is encouraging that the improvements achieved for lowering the on-state losses of the ET-IGBT have not compromised the device robustness, which is strongly required especially when targeting higher power densities for the next generation HiPak and LinPak modules.

www.abb.com/semiconductors

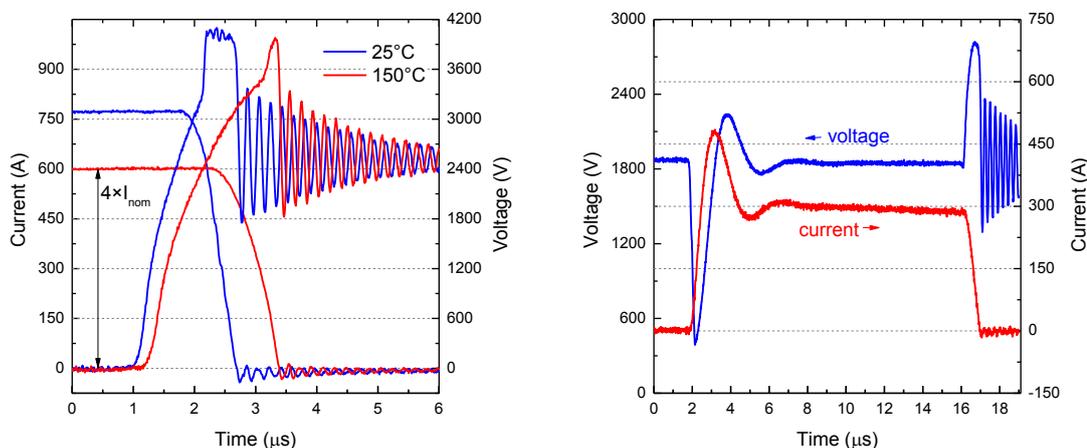
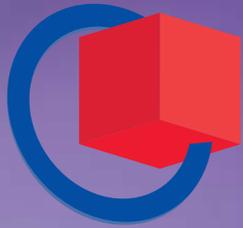


Figure 8: 3300V ET-IGBT Turn-off RBSOA (2500V, $R_g=33\Omega$, $L_s=2400nH$, $V_{ge}=20V$) and short circuit SOA (1800V, $t_{sc}=15\mu s$, $V_{ge}=15V$, $R_g=33\Omega$, $L_s=2400nH$, $T=25^\circ C$) waveforms

Register now and
make sure of your tickets!
embedded-world.de

Nuremberg, Germany
24 – 26.2.2015



embedded world 2015

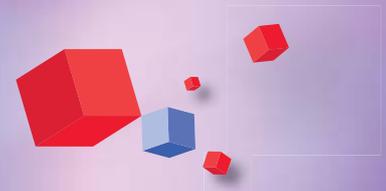
Exhibition & Conference

... it's a smarter world

THE gathering of the embedded community!

The world's biggest event for embedded technologies gets players
in the embedded sector talking to each other.

Be there too when the priority is on cultivating contacts and networking
at international level and setting trends.



Media partners

elektroniknet.de

computer-automation.de

energie-und-technik.de

MEDIZIN-UND-elektronik.DE

Markt & Technik
DIE UNABHÄNGIGE WOCHENZEITUNG FÜR ELEKTRONIK

**DESIGN &
ELEKTRONIK**
KNOW-HOW FÜR ENTWICKLER

elektroniknet.de
Elektronik
Fachmedium für industrielle Anwender und Entwickler

Elektronik
automotive
Fachmedium für den Automobilbau

**ENERGIE
& TECHNIK**
Fachmedium für Energieeffizienz

Computer &
Automation
Fachmedium der Automatisierungstechnik

MEDIZIN & elektronik
Fachmedium für Elektronik in der Medizintechnik

Trade fair organizer

NürnbergMesse GmbH

Tel +49 (0) 9 11.86 06-49 12

visitorservice@nuernbergmesse.de

Conference organizer

WEKA FACHMEDIEN GmbH

Tel +49 (0) 89 2 55 56-13 49

info@embedded-world.eu

NÜRNBERG MESSE

LLC Resonant Converter Simulation Using PLECS

Soft-switching capabilities of resonant converters allow for power supplies with smaller packaging and higher power density. PLECS is a simulation tool developed for power electronics engineers that offers very efficient and robust modeling of power supplies with multi-physical domains and associated controls. In this study, a full-bridge LLC converter with variable-frequency operation and multi-domain interactions is investigated.

By Munadir Ahmed, Plexim Inc., and Min Luo, Plexim GmbH

Introduction

Efficient converters capable of delivering high power with a small footprint have become a necessity for front-end isolated DC/DC converters in power supplies. Operating these converters at high switching frequencies enables engineers to reduce the size of the magnetic and capacitive components. With tight packaging, thermal management is an important design consideration to ensure the semiconductor devices are operated in the safe region. The LLC converter is an attractive topology for such applications with its ability to soft-switch the semiconductor devices, reducing overall system losses.

PLECS is a multi-domain modeling platform for simulating power electronic systems. In addition to using behavioral power semiconductor models to achieve high simulation speed, the PLECS thermal and magnetic domains assist with the design of LLC converters, and facilitate component dimensioning and control parameter tuning. Also, the high-fidelity MCU peripheral modules, discussed in [1], allow engineers to easily implement variable-frequency PWM generators. In this article the design of a full-bridge LLC converter with variable-frequency operation is discussed. Simulation results representing converter operation under voltage control are provided. Thermal results confirming the safe operation of the semiconductor devices are also shown. The PLECS magnetic domain allows engineers to size the converter for a desired saturation point and verify the region of operation on the B-H curve through simulation.

LLC resonant converter model in PLECS

Figure 1 shows a full-bridge LLC resonant converter modeled in PLECS. The AC-side of the full-bridge is connected to the primary side of a high-frequency transformer via a series-connected inductor and capacitor. The magnetizing inductance of the transformer, along with the inductor and capacitor, form the LLC resonant tank. The secondary side of the transformer is connected to a full-wave diode rectifier to convert the AC transformer output to a high-ripple DC voltage that is then filtered to provide a low-ripple DC voltage output.

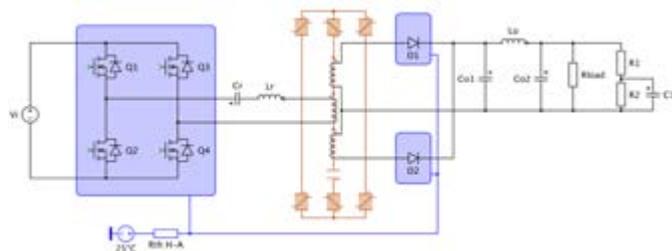


Figure 1: LLC resonant converter

Operation of LLC converter and estimating switching losses

The LLC converter is often operated under zero-voltage switching (ZVS) operation where the FETs (e.g., Q1) are turned on when the current is still flowing in its anti-parallel diode (e.g., D1). Therefore, only the forward voltage drop of the diode is applied to the FET, which is small compared to the DC input voltage. This results in negligible turn-on loss in the device and contributes to the reduction of overall losses. During ZVS operation, the FETs are turned off in a region where they conduct current. This results in hard-switching of the devices, generating turn-off switching losses, as shown in Fig. 2.

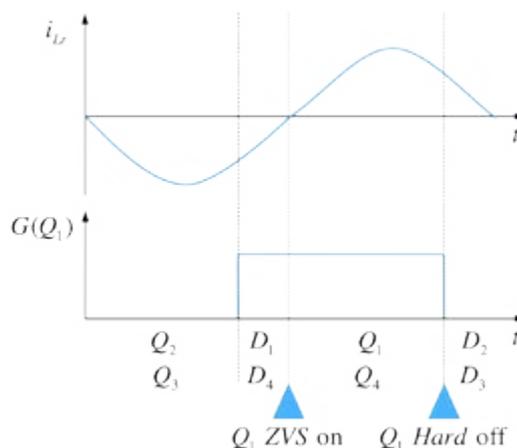


Figure 2: Zero-voltage switching scheme

PLECS uses ideal switches to model the power semiconductors, and switching losses are calculated using look-up tables. The data is input as energy loss as a function of blocking voltage, conducting current, and junction temperature. During the soft-switching turn-on event, zero switching losses are simulated, while the hard-switching turn-off switching losses are calculated from the circuit dynamics as a turn-off energy impulse. The look-up table approach for simulating switching losses was shown to have good correlation with hardware measurements in [2].

During turn-off and turn-on events, the body capacitor of each FET is charged and discharged, respectively. For circuits where the FETs (not the reverse diode) experience hard-switching during turn-on, the charge stored in the body capacitor is dissipated through the FET, adding to the switching losses. These losses can be captured in simulation (without adding a capacitor parallel to the FET) by simply

esars: 2015

3rd International Conference on
**Electrical Systems for Aircraft,
Railway, Ship propulsion and
Road Vehicles**

Aachen - Germany
march 3-5
2015



UNIVERSITÀ
DEGLI STUDI DI TRIESTE




EDX Energy Research Center
ACS | Institute for Automation
of Complex Power Systems



including them in the look-up tables for the losses. When measuring the switching energy losses of FETs for certain operation points to generate the loss look-up table, it is important to include the charge stored in the FET body capacitor in the loss measurements. A major advantage of ZVS for FETs, in addition to eliminating turn-on losses, is that the energy stored in the body capacitance is recycled into the circuit [3], assuming there is enough blanking time between turn-off of Q1/Q4 and turn-on of Q2/Q3. Therefore, in soft-switching topologies operated with ZVS, turn-off losses can be overestimated by 10 to 20 % [4], if the effects of the capacitive elements are not reflected in the loss look-up tables.

Variable-frequency modulation

Frequently, to generate PWM signals in simulation, a duty cycle value is compared against a fixed-frequency triangular waveform. Such simplified models have inherent limitations in comparison to the functionality provided by real MCU peripheral modules. As a result, the system model fidelity is substantially reduced and effects critical to the power controls may be lost or inaccurately simulated. In [1] we discussed the efficient modeling of high-fidelity peripheral modules. A characteristic of these models is the ability to operate the high-fidelity PWM peripheral module with variable-frequency. The frequency and duty cycle are provided as inputs to this peripheral module. These inputs are sampled to update the PWM signal for the next switching period. The user can dynamically update the frequency and duty cycle in simulation, and therefore efficiently implement a variable-frequency modulator, as is needed for an LLC converter.

Modeling of magnetic device

Conventionally for dynamic circuit simulation, the magnetic devices are modeled directly in the electrical domain, in which magnetic coupling between windings are realized either with mutual inductances or ideal transformers and magnetizing inductances. However, the electrical equivalent circuit bears little resemblance to the physical structure of the magnetic component. For example, parallel flux paths in the magnetic structure are modeled with series inductances in the equivalent circuit. PLECS provides magnetic modeling capabilities based on the permeance-capacitance approach [5], allowing the user to build up a magnetic circuit to represent the iron core geometry and windings allocation intuitively, as well as include nonlinear effects

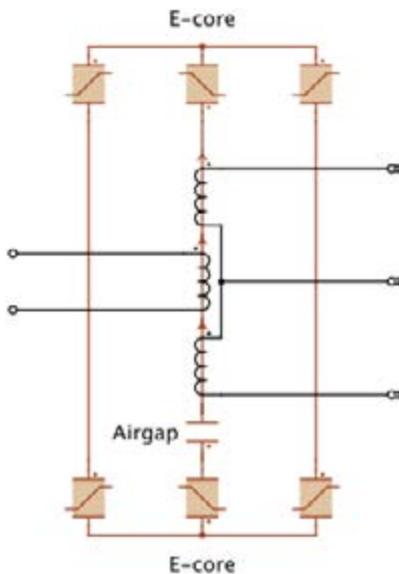


Figure 3: High-frequency transformer model using saturable magnetic elements in PLECS

such as saturation. In the LLC resonant converter presented here, the high-frequency transformer model is composed of two E-shape core components with an air-gap on the middle leg, and three windings, as shown in Figure 3. The geometric parameters of the iron core in this example are per the “E70/33/32” device specification from EPCOS, while material parameters regarding the saturation effect come from the B-H curve in the ferrite N87 datasheet. The winding turns values are chosen to achieve the expected magnetization inductance.

Simulation results

A 200 VDC input is connected to the DC-side of the full-bridge. A slew rate is applied to the converter to limit the rate of change in output voltage during a change in the reference voltage. Additionally, a soft-start algorithm is employed to limit the rate of change in commanded voltage during startup. This is reflected on the startup transient as the output voltage incrementally ramps up. After the soft-start, a voltage controller is used to control the switching frequency of the full-bridge. The system reaches the desired 300 VDC output after 20 ms. The thermal system has a smaller time constant, reaching steady state after 40 ms. Figure 4 shows the transient simulation of the LLC converter from startup.

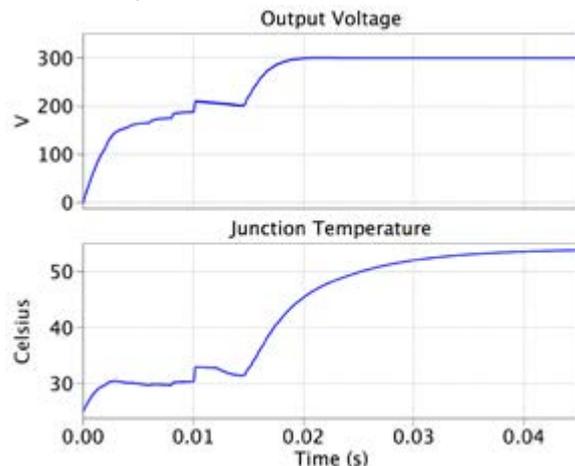


Figure 4: Startup transient simulation result for LLC converter

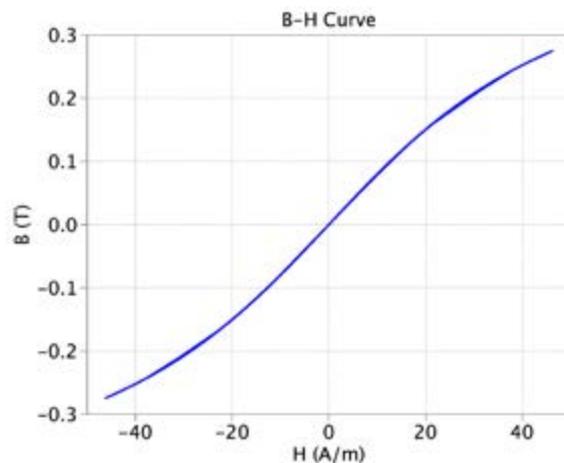


Figure 5: Operating region of the saturable core

Figure 5 shows the operating points of the core on the B-H curve during a transient simulation to steady state. Engineers can size their magnetic component using the saturable core component to operate the system at the desired point of the B-H curve.

ZVS of the FETs allows the converter to be operated with reduced switching losses, as the anti-parallel diode conducts the current when the turn-on gating signal is applied. The FET starts to conduct as the current direction becomes positive through the device. This results in zero turn-on switching losses. The FET is turned off at an instant when current is flowing through the device, resulting in hard-switching and turn-off switching losses. Figure 6 shows the gating signal and current of Q1. When the current is less than zero the anti-parallel diode is conducting. Figure 6 also shows the switching energy losses. There are no switching losses due to the soft-switching during turn-on of Q1 but the 0.3 mJ energy impulses reflect the turn-off losses due to hard-switching. The body capacitor's energy storage is not included in the look-up table for this model; therefore the turn-off loss yields a maximum 20 % overestimate, as previously discussed.

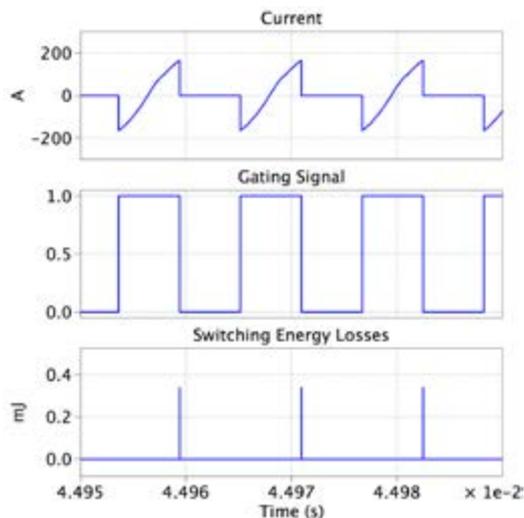


Figure 6: Steady-state waveforms showing current through Q1 and D1, FET gating signal and switching losses

Conclusion

The modeling and simulation of a resonant LLC converter has been presented in this article. PLECS permits analysis of transient effects from multiple physical domains in a single system model without excessive simulation times. This provides an effective and accurate means to investigate and address issues related to compact power supply design. Further, high-fidelity peripheral models allow designers to simulate the LLC under variable-frequency operation. Such comprehensive models provide power electronic designers with more insight into the system before hardware is built, leading to time and cost savings.

www.plexim.com

Reference

- [1] Prausse, F.; Ahmed, M., "Efficient Microcontroller Peripheral Modeling with PLECS", Bodo's Power Systems, July 2014 Issue, pp. 34-37
- [2] Munk-Nielsen, S.; Tutulea, L.N.; Jaeger, U., "Simulation with Ideal Switch Models Combined with Measured Loss Data Provides a Good Estimate of Power Loss", IEEE Industrial Application Conference, vol. 5, 2000, pp. 2915-2922
- [3] Erickson, R.; Maksimovic, D., "Fundamentals of Power Electronics", 2nd Edition, Springer, 2001, Chapter 19
- [4] "A More Realistic Characterization of Power MOSFET Output Capacitance Coss", International Rectifier Application Note, AN-1001
- [5] Allmeling, J.; Hammer, W.; Schönberger, J., "Transient simulation of magnetic circuits using the permeance-capacitance analogy", IEEE 13th Workshop on Control and Modeling for Power Electronics (COMPEL), 2012, pp.1-6

www.electronicon.com

Scan me!

Your ideas – Our design

Large capacitors are often the most economical option for your high-power application. ELECTRONICON has over 75 years of experience in capacitor manufacturing and more than 70 years of experience in film metallization processes. This expertise puts us in an ideal position to service any capacitor requirements for applications up to 25kVDC/10kVAC and beyond:

- Leakage-free and vibration-proof thanks to dry construction and solid impregnation
- Reliable pressure monitoring for safe failure mode
- Up to 950A(rms) and 700kA(peak) achieved by SINECUT™ windings
- Stable cylindrical windings with SecuMet™ metallization for enhanced life and reliability

Custom-designed to meet your requirements. Just ask.

ELECTRONICON®
always in charge

ELECTRONICON Kondensatoren GmbH · Keplerstrasse 2 · Germany - 07549 Gera
Fon: +49 365 7346 100 · email: sales@electronicon.com · web: www.electronicon.com

Kelvin Emitter Configuration Further Improves Switching Performance of TRENCHSTOP™ 5 IGBTs

TO-247 4pin package with Kelvin emitter enables faster commutation, improving the switching behavior of the 650V TRENCHSTOP™ 5 IGBTs. Dynamic losses are reduced by 20% in comparison to standard TO-247 package, thus increasing the overall system efficiency and enabling the IGBTs to operate at lower temperature.

By Vladimir Scarpa and Fabio Brucchi, Infineon Technologies AG

Recent improvements in the IGBT technologies have reduced the switching losses of the devices considerably. This has been achieved through changes in the structure of the IGBT chip. Figure 1 presents a comparison of switching energies of discrete 50A rated IGBTs from different technologies. The IGBT and the co-packed diode technologies are indicated at the bottom of Figure 1, as well as the year in which they have been brought to the market. The energy has been measured in a switching cell, using a device from the same family and of identical current rating as counterpart.

A deeper look inside Figure 1 reveals how impressively the turn-off energy of the IGBTs has decreased in the recent families. This has been achieved by decreasing the fall time of the current during turn-off, thus removing the tail current almost completely.

Switching Energy of 50A rated IGBTs in TO-247 @ $I_{sw}=25A, T_c=25^\circ C$

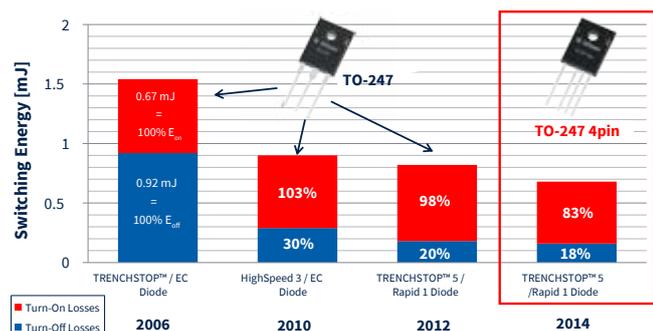


Figure 1: Switching losses of 50A rated IGBT devices, switching conditions: $I_C=25A, T_j=25^\circ C$

On the other hand, turn-on energy has practically not changed. One of the main reasons for this is the fact that the turn-on behavior of the IGBT is strongly depending on the counterpart diode and its amount of reverse recovery charge. Actually, the amount of recovery charge tends to increase when the diode is combined with a faster IGBT, thus increasing the switch's turn-on losses.

To achieve a considerable reduction of turn-on losses, the TO-247 4pin package is now being introduced for devices of the TRENCHSTOP 5 family. This package contains an extra emitter pin to be connected exclusively to the control loop and has already been successfully used in combination with super junction MOSFETs from

CoolMOS™ C7 technology[1].

With the Kelvin emitter configuration, the switching speed is increased further. Consequently, the switching losses are reduced in both flanks, even if the same counterpart diode remains in use. As one of the advantages, the adoption of the TO-247 4 increases the overall system efficiency and allows the IGBT device to operate at lower temperature.

The Kelvin Emitter Configuration

In standard through-hole packages, as for instance TO-220 or TO-247, each lead pad resembles a parasitic inductance. The inductance from the emitter pad in particular is a part of both, power and control loops.

The power loop also includes the parasitic inductances coming from the collector lead and from the PCB tracks which connect the switching devices to the DC-link capacitor. The gate loop contains the inductances coming from the gate lead and from the PCB tracks which con-

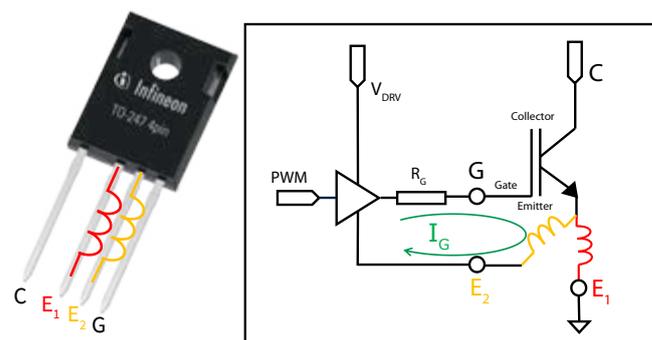


Figure 2: IGBT connection in Kelvin emitter configuration

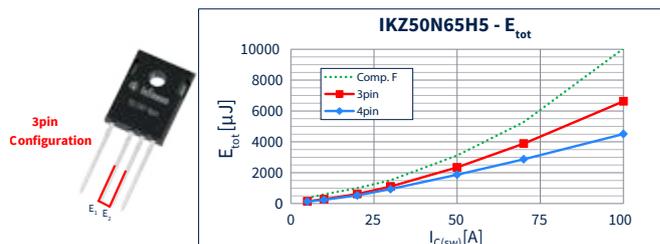
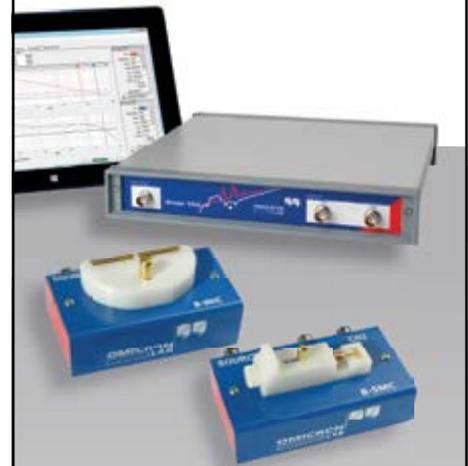


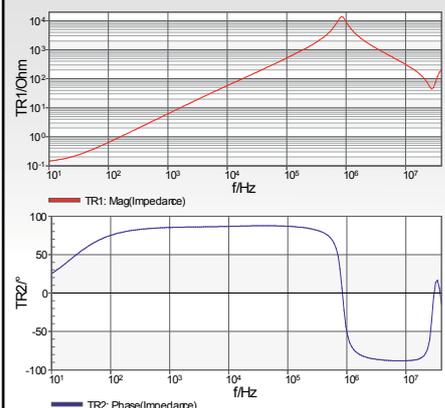
Figure 3: Total switching energy of an IKZ50N65EH5 in both, 3pin and 4pin configurations

Analyze Your Passive Components!



Easily measure impedance using the **Vector Network Analyzer Bode 100** in combination with impedance test fixtures for SMD and THT components.

Measure **impedance, leakage inductance, capacitance, ESR, resonance frequency** and more from **1 Hz to 40 MHz**.



Get hands-on experience with the Bode 100!
www.omicron-lab.com/lab

nect the gate and emitter pads to the gate resistor and the gate driver. During transitory conditions like the turn-on or turn-off of the IGBT, the parasitic inductances will induce voltage drops that will make the effective voltage over the device pins different from the effective voltage over the die pads.

The voltage attenuation given by the emitter lead inductance L_e causes a reduction of the effective gate to emitter voltage. It can be quantified as the value of L_e multiplied by the change rate di/dt of the emitter current. Due to this attenuation, the commutation time is extended, leading to higher switching losses.

The newly introduced TO-247 4 package has an extra connection to the IGBT's emitter, labeled E_2 in Figure 2. This point shall be connected to the gate driver. Also known as Kelvin emitter terminal, this pin is not subject to the attenuation coming from the power loop. The current coming from the IGBT's collector is solely conducted by the power emitter lead E_1 .

Another difference from the TO-247 4 package is the pin-out, which is different from the standard TO-247 3.

This is done to keep the creepage distance between the high voltage pins. In addition, the pins which are connected to the power loop, C and E_1 , are put side by side, so are those for the control loop E_2 and G.

Electrical Switching Performance

Without the attenuation of the gate voltage coming from the power emitter, the switching of the IGBT becomes faster than in the standard TO-247 package. To quantify the benefit of the Kelvin emitter configuration during turn-on, the IGBT IKZ50N65EH5 has been used as the device under test (DUT). It is a 50A rated IGBT from the TRENCHSTOP™ 5 family in a TO-247 4pin package. In the first set of tests, the emitter pins E_1 and E_2 have been connected. The output of the gate driver has been connected to pins G and E_1 . This emulates the standard TO-247 package and is referred to as 3pin configuration. In the second set, pins E_1 and E_2 have been connected as in Figure 2. This is referred to as 4pin configuration. A device available on the market with the same rated current inside a standard TO-247 package has been included for reference.

The total switching losses measured in the three tests is presented in Figure 3. The advantage of the Kelvin emitter configuration is more prominent for the highest currents. These are the conditions where highest current change rates are expected. Therefore, the lead inductance will attenuate the gate voltage the most in the 3pin configuration.

Figure 4 presents the difference in switching energy between the 3pin and 4pin configurations as a function of the switching current. The benefit of the Kelvin emitter therefore can be quantified in absolute values so as in percentage to the standard 3pin configuration.

From Figure 4, it is possible to deduce that in applications where the current is higher than the rated current of the IGBT, the switching loss reduction can be higher than 20%. This often is the case in Uninterruptable Power Supplies (UPS) and welding machines. For applications where the current is typically around half the IGBT's current rating, like for example photovoltaic inverters or switch mode power supplies (SMPS), the benefit is slightly lower, i.e up to 15% lower switching losses.

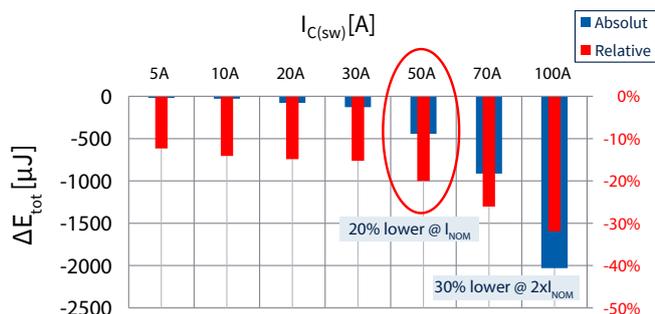


Figure 4: Switching energy reduction from 4pin configuration in both, absolute and relative values

Further information

For further hints on how to fully exploit the advantages of the TO-247 4 package, please refer to the dedicated application note [2].

References

- [1] Infineon Technologies AG: AN 2013-05, "CoolMOS™ C7 650 V Switch in a Kelvin Source Configuration"
- [2] Infineon Technologies AG, Application Note "TRENCHSTOP™ 5 IGBT in a Kelvin Emitter Configuration"

www.infineon.com

Digital Power Comes of Age

This article looks at the evolution of distributed power architectures since the introduction of the first high-frequency switching DC-DC converter modules back in 1984. It describes the factors that have driven this evolution and highlights some of the most significant innovations along the way.

*By Mark Adams, CUI Inc; Patrick Le Fèvre, Ericsson Power Modules;
Steve Pimpis, Murata*

We then consider advances in digital power in the last few years and where power technology needs to take us if the growing power demands of data networks and storage systems are to be met with minimum environmental impact. Finally, we highlight the opportunities for 'competitive collaboration' to drive innovation in the digital power supply industry - the engineering benefits it brings to power systems designers, the commercial benefits to companies that consume power supplies, and the opportunity to mitigate the potentially negative environmental impact of our growing demand for digital information in all its forms.

Distributed power architectures now dominate in the design of power systems for high performance datacom and telecom networks, and data center equipment. The change from centralized power - a simple AC-DC power supply, perhaps with battery backup, feeding the cards in a system rack - came about by necessity. Semiconductor operating voltages decreased as ever-smaller process nodes were developed to boost the processing power of ICs. The ICs became more powerful and their lower operating voltages meant that higher current was demanded. Long printed circuit board tracks would mean unacceptable I²R losses, reducing power system efficiency, so distributed power architecture became the norm. This trend is continuing. Since the 1980s the power demands of data centers have risen from 300W to 1200W per board and some forecast that it will reach 5kW by 2015 as network IP traffic grows dramatically over the next few years.

The economics of creating distributed power systems were transformed back in 1984 when a group within Sweden's part of Ericsson AB, Ericsson Components – RIFA Power (later to become Ericsson Power Modules) launched the PKA series of DC-DC converters. The introduction of the PKA, described by Ericsson as 'the world's first high frequency DC-DC switching power supply', meant that engineers no longer had to design relatively expensive and complex circuits from discrete components. They could now use a compact board-mounted module on each card, adding just a few external filtering and decoupling components, to create much more efficient and effective power systems. The use of power modules also delivered marked improvements in system reliability. This was particularly important for those designing communications networks, where the target for operating life was sometimes 25 years or more.

Typically, the front-end AC-DC unit would have a -48V output and a DC-DC power module on each card would convert this to 12V or 5V, or a combination of both, to provide the correct operating voltage for semiconductors in the system. 3.3V semiconductors then started to appear and today we're down to 0.9V for many with some processors drawing up to 90A current at full load.

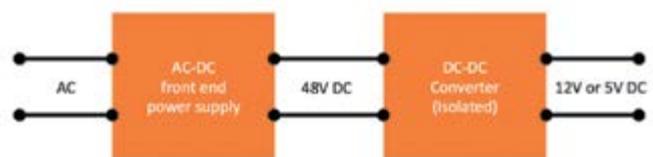


Figure 1: Early distributed power solutions adopted a two-stage conversion with a typical intermediate bus voltage of -48V and a single output at 12V or 5V

The larger the differential between the input and output voltage(s) of a DC-DC converter, the less efficient the conversion process. It soon became clear that for maximum system efficiency it is desirable to handle the last conversion very close to the load i.e. the processor, FPGA or other device. Power supplies used in this final conversion are point of load (POL) converters. In addition to boosting efficiency, placing power converters as close as possible to their loads prevents instability due to stray impedances in long PCB tracks or system wiring. Datel, which was acquired by Murata as part of the Power Electronics Division of C&D Technologies in 2007, was an early pioneer of isolated DC-DC converters and POL modules during the 1980s and 1990s.

Distributed power architectures can be implemented in a number of different ways, using regulated or unregulated bus voltages. As systems became more complex, demanding a number of different voltages, perhaps 12, 5, 3.3, 2.5 and 1.2V, power system designers began to adopt intermediate bus architectures (IBA) around 15 years ago. Here, the AC-DC power supply feeds an IBA converter at perhaps 24V or -48V. The isolated IBA converter outputs 5 to 14V DC and feeds the required number of POL converters.

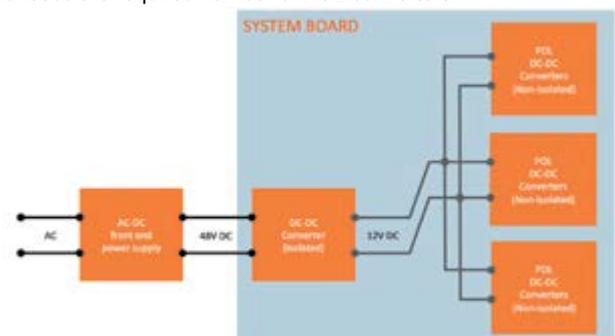


Figure 2: The proliferation of supply rails at the board level has resulted in an intermediate bus architecture (IBA) that requires multiple POL converters on the system board

30th ANNIVERSARY 1985-2015

APEC[®] 2015

March 15 -19, 2015

Charlotte Convention Center
Charlotte, North Carolina

The Premier Global Event
in Power Electronics[™]

Visit the APEC 2015 website
for the latest information:

www.apec-conf.org



Distributed goes digital

The demand to provide sophisticated power management functions, including the sequencing of power supplies with controlled ramp rates as required by large FPGAs, along with a desire to reduce board space and the number of external components are the drivers that have led power system designers to increasingly turn to digital power over the past decade. Key to this are the power management ICs from companies like Texas Instruments, who introduced the industry's first digital signal processing (DSP) development kit specifically for power supply applications back in December 2002.

However it has been the development of off-the-shelf digital power converter modules that has accelerated the adoption of digital power in the last five years. The first of these came to the market in 2008 in the form of Ericsson's BMR453 intermediate bus converter. Digital converters have much in common with their analog counterparts, including similar power switches and output filters. However, the inner control loop provides digital flexibility for tailoring power delivery to the application and enabling the power systems to dynamically adapt to changes in operating conditions in real time. Communications, monitoring and control are implemented over the industry-standard PMBus.

Digital control is particularly important in improving the efficiency of data network power systems. The power drawn by networking equipment increases with data throughput. At times of low data traffic, the network is operating well below capacity, power supplies are operating well below their maximum load and processors can run at lower clock speeds.

At low loads the power supplies are relatively inefficient, resulting in excessive energy consumption and waste heat generation, with undesirable technical, financial and environmental consequences. By implementing a digital control loop encompassing both intermediate bus and POL converters, the intermediate bus voltage can be varied dynamically in response to varying loads. The input voltage to the POL converters is reduced under low load conditions, which increases conversion efficiency at low loads.

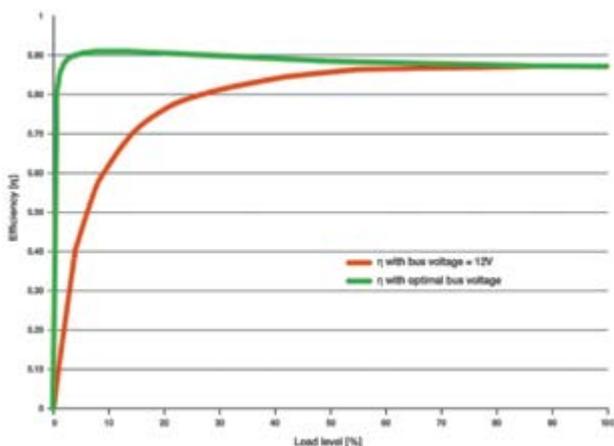


Figure 3: Digital power is particularly effective for improving efficiency under low-load conditions SOURCE - Ericsson (EGG October 2014)

Some digital power devices offer a dynamic voltage scaling (DVS) function to save energy. If the demand for computing power is low, both the clock frequency of the processor and its supply voltage can be reduced. DVS is usually implemented as an open-loop function with a look-up table holding pre-determined combinations of frequency and supply voltage.

More advanced than DVS, adaptive voltage scaling (AVS), adopts a closed loop, real-time approach that adapts the supply voltage precisely to the minimum required by the processor, depending on its clock speed and workload. This technique also compensates automatically for process and temperature variations in the processor.

Most switching power supplies use a closed control loop with negative feedback from output to input. A compensation network is needed to adjust the frequency response of the loop to achieve the optimum transient response without compromising stability. The design of the compensation network can be a time-consuming task involving considerable trial and error. Even then, the performance of the components in the network can change with variations in temperature or due to ageing. In 2010, CUI Inc, a North American company, was the first manufacturer to develop and launch non-isolated POL converter modules featuring auto-compensation, a digital function that completely eliminates this problem.

Using digital power modules also simplifies or enables many other aspects of power system design including active current sharing, voltage sequencing and tracking, soft start and stop, and synchronization.

The drive for standardization

As DC-DC power modules have become more widely adopted, there has been a drive towards some level of standardization of products from different manufacturers. Customers, concerned about supply chain reliability, demanded second sources for products, leading to trade associations being formed by power supply and component vendors to address this issue.

Typically however, the alliances formed in this space succeeded in little more than agreeing to standard footprints and pin-outs for certain categories of power converter, such as non-isolated and isolated DC-DC converter modules. While this has enabled a degree of interchangeability between products from different manufacturers, there has not been full consensus with respect to how all of the electrical functions of converters are implemented, making it less than straightforward to swap out one product for another. This is particularly true for digital power, which adds another layer of complexity to the challenge of ensuring compatibility between solutions.

More significantly, in 2004, Artesyn Technologies, Astec Power, and a group of semiconductor suppliers: Texas Instruments, Volterra Semiconductors, Microchip Technology, Summit Microelectronics, and Zilker Labs, formed a coalition to develop an open standard for a communications with a protocol dedicated to power systems. This was the birth of the industry standard for power subsystem management known as PMBus.

Not all has been 'plain sailing' and despite good intentions and a number of positive moves, there were issues that stalled developments by other manufacturers. Most notable was the patent infringement lawsuit issued by Power One in 2005 to protect the Z-Bus technology used in its POL regulator ICS for monitoring and controlling power supplies. This held back the widespread adoption of PMBus for around four years, until the use of licensing royalty agreements became routine for such technology.

Most recently power supply companies have been coming together once again to address these issues, particularly the more challenging requirements of digital power. In July 2011, CUI announced a cooperative agreement with Ericsson Power Modules and in September that year demonstrated a new family of POL modules that are pin and

function compatible with Ericsson's BMR46X series of converters. A year later, CUI entered into a license agreement with Ericsson for the latter's 3E Advanced Bus Converter family, allowing it to offer customers an intelligent intermediate bus converter to pair with its portfolio of POL products. The companies agreed at that time to cooperate on a common standard for digital intermediate bus converters going forward. In July 2014, Murata and Ericsson announced a technical collaboration agreement with the goal of accelerating the adoption of digital power products by offering customers fully compatible products from each company.

Meeting future needs

According to the Ericsson Mobility Report, annual IP traffic will reach 7.7 zettabytes by the end of 2017, up from 2.6 zettabytes in 2012. Video communications, cloud-based services and the interconnection of physical objects, dubbed the Internet of Things (IoT), are the primary drivers of this unstoppable growth. This will place even greater demands on data network power system designers and fully exploiting the functional and efficiency benefits provided by digital power devices is the only way that they will be able to rise to the challenge. Furthermore, the technology that started in datacoms and telecoms is proliferating into other industries and applications as advanced processors and FPGAs become commonplace, such as in medical, industrial, and test/measurement equipment. This is creating the need for a simple, intuitive, multisource solution across the board. The challenge is to achieve "perfect power conversion, under all conditions, all of the time". Hence there is pressure on power supply manufacturers to accelerate their rate of innovation to the extent that much deeper collaboration will be needed.

To this end, CUI, Ericsson Power Modules and Murata, founded the Architects of Modern Power (AMP) Consortium in October 2014. The goals of the Group go far beyond the ambitions or achievements of established trade associations in the power industry. AMP Group will be characterized by deep collaboration between the firms in developing leading-edge digital power technology, in terms of both functionality and efficiency. Common standards will encompass mechanical, electrical, communications, monitoring and control specifications. Members will focus on developing products that deliver high efficiency power conversion under all operating conditions and provide supply chain security to customers through true plug-and-play compatibility between their products.

www.ampgroup.com

www.cui.com

www.ericsson.com

www.power.murata.com

PROGRAMMABLE DC POWER



Magna-Power's high frequency IGBT-based programmable DC power supply line spans 1.5 kW to 2000 kW+ with hundreds of models to target a variety of different applications.

Using a Magna-Power supply is as simple or sophisticated as the application demands with front panel control, 37-pin isolated analog-digital I/O and a computer interface. Remote programming is supported through a variety of development environments by a provided National Instruments LabVIEW™ driver, IVI driver and SCPI command set over RS232, **LXI** TCP/IP Ethernet, IEEE-488 GPIB and USB.

Designed and manufactured in the USA. Available worldwide.

www.magna-power.com



	SL Series	XR Series	TS Series	MS Series	MT Series
Power Levels	1.5 kW, 2.6 kW, 4 kW	2 kW, 4 kW, 6 kW, 8 kW, 10 kW	5 kW to 45 kW	30 kW, 45 kW, 60 kW, 75 kW	100 kW to 2,000 kW+
Package	1U Rack-mount	2U Rack-mount	3U to 9U Rack-mount	Floor Standing	Floor Standing
No. of Models	54	70	80	80	65
Voltage Range	0-5 Vdc to 0-1,000 Vdc	0-5 Vdc to 0-10,000 Vdc	0-5 Vdc to 0-4,000 Vdc	0-5 Vdc to 0-4,000 Vdc	0-16 Vdc to 0-4,000 Vdc
Current Range	0-1.5 Adc to 0-250 Adc	0-0.2 Adc to 0-600 Adc	0-1.2 Adc to 0-2,700 Adc	0-7.2 Adc to 0-4,500 Adc	0-24 Adc to 0-24,000 Adc

Tiny Power Components for Wireless Charging, Step Down Conversion and “Always On” Devices

Texas Instruments used electronica 2014 in Munich to showcase its broad portfolio of new products corresponding to the slogan coming from the Jack Kilby Day “TI technology is fundamentally changing the way we live our lives – from wireless charging to autonomous vehicles, from smart cities and factories of the future to concussion sensors and bionic eyes”. And power is needed in all of these areas- therefore this article describes the news in power management presented at the exhibition.

By Wolfgang Patelay, Freelance Journalist Bodo's Power Systems

Delivering power management innovation for ultra-low power designs, Texas Instruments introduced the industry's smallest, lowest power linear battery charger and a tiny, fully integrated DC/DC power module, which consumes only 360nA of quiescent current, to help extend battery run-time in wearable electronics, remote sensors and MSP430 microcontroller-based applications. The new bq25100 single-cell Li-Ion charger comes in a 0.9-mm by 1.6-mm WCSP package, and achieves a solution half the size of existing charger solutions. The device supports input voltages up to 30 V, and allows accurate control of fast-charge currents as low as 10mA or as high as 250mA, and precise charge termination down to 1mA to support tiny Li-Ion coin batteries. It also can support a leakage current of less than 75nA to extend standby operation. Designers also can add wireless charging capability to small portable and wearable applications by pairing the bq51003 2.5-W, Qi-compliant wireless charging receiver with the bq25100 linear charger on the same board. The bq51003 is an advanced, integrated, receiver IC for wireless power transfer in portable applications. The device provides the AC/DC power conversion while integrating the digital control required complying with the Qi v1.1 communication protocol. Together with the bq500210 transmitter controller, the bq51003 enables a complete contact-less power transfer system for a wireless power supply solution. By using near-field inductive power transfer, the receiver coil embedded in the portable device receives the power transmitted by the transmitter coil via mutually coupled inductors. The AC signal from the receiver coil is then rectified and regulated to be used as a power supply for down-system electronics. Global feedback is established from the secondary to the transmitter in order to stabilize the power transfer process via back-scatter modulation. This feedback is established by using the Qi v1.1 communication protocol supporting up to 2.5W applications. The device integrates a low-impedance full synchronous rectifier, low-dropout regulator, digital control, and accurate voltage and current loops.

Smallest Li-Ion linear charger

Only 75 nA quiescent current and 1 mA termination



Figure 1: The bq25100 is targeted for ultra low-power designs

Both devices are featured on the new design reference board TIDA-00318 which is suitable for low power wearable device including a Qi compliant wireless receiver (bq51003) and ultra low current 1 cell Li-Ion linear charger (bq25100). It features an ultra small size (5x15mm²) capable of low charging currents down to 10mA and up to 250mA with support of termination currents as low as 1mA. Current design is designed for 135mA charge current application.

Step-down converter modules

The new TPS82740A und TPS82740B step-down converter modules support 200mA output current with 95 percent conversion efficiency and consume only 360nA of quiescent current during active operation and 70nA during standby. The tiny modules rely on a fully integrated, 9-bump MicroSiP package, which incorporates a switching regulator, inductor and input/output capacitors to achieve a solution size of only

PCIM

EUROPE

International Exhibition and Conference
for Power Electronics, Intelligent Motion,
Renewable Energy and Energy Management
Nuremberg, 19–21 May 2015

Power meets electronics—
Join the PCIM Europe!



Your market place for power electronics



More information at +49 711 61946-0
pcim@mesago.com or pcim-europe.com

mesago
Messe Frankfurt Group

6.7mm². The TPS82740 is according to TI the industry's first step down converter module featuring typically 360nA quiescent current consumption. This new DCS-Control based device extends the light load efficiency range below 10 μ A load currents. It supports output currents up to 200mA. The device operates from rechargeable Li-Ion batteries, Li-primary battery chemistries such as Li-SOCI₂, Li-MnO₂ and two or three cell alkaline batteries. The input voltage range up to 5.5V also allows operation from an USB port and thin-film solar modules. The output voltage is user selectable by three voltage select pins (VSEL), within a range from 1.8V to 2.5V (TPS82740A) and 2.6V to 3.3V (TPS82740B) in 100mV steps. The TPS82740 features low output voltage ripple and low noise. Once the battery voltage comes close to the output voltage (close to 100% duty cycle), the device enters no ripple 100% mode operation preventing an increase of output voltage ripple. In this case the device stops switching and the output is connected to the input voltage. The integrated slew rate controlled load switch with a typical ON-resistance of 0.6 Ω distributes the selected output voltage to a temporarily used sub-system.

Energy savings to "always-on" smart meters

Hundreds of millions of smart meters around the world continuously draw power from the grid to measure energy use and provide feedback to the utility. Even though meters consume relatively small amounts of power that is not charged to the customer, when you multiply the amount of energy needed to power the devices, it makes sense to minimize the energy consumed. Therefore Texas Instruments is expanding its portfolio of high-voltage power solutions for offline AC/DC designs and introduced a 700V switcher with the industry's lowest quiescent current of less than 100 μ A – half the power consumption of existing solutions. The UCC28880 controller integrates a 700V power MOSFET and high-voltage current source, increasing overall energy efficiency of "always-on" non-isolated power systems with output currents up to 100mA, such as smart meters, home automation equipment and white goods. The controller integrates the controller and a 700-V power MOSFET into one monolithic device. The device also integrates a high-voltage current source, enabling start up and operation directly from the rectified mains voltage. The low quiescent current of the device enables excellent efficiency. With the UCC28880 the most common converter topologies, such as buck, buck-boost and flyback can be built using a minimum number of external components. The UCC28880 incorporates a soft-start feature

for controlled start up of the power stage which minimizes the stress on the power-stage components.

The circuit integrates a 700-V MOSFET, start-up current source and internal current sensing in a tiny 7-pin SO package size of 29.4mm². Additionally, no external compensation is needed which further reduces component count and board space. High-voltage pins are segregated to one side of the package, which maximizes separation between low and high voltage pins. Along with current limit function, the controller inductor current runaway protection helps protect against under load short-circuit conditions to ensure design reliability. The device provides over-temperature protection with hysteretic re-start for safe operation. The high voltage switcher reduces system cost and minimizes the overall size of the power supply, while maintaining high efficiency and system performance.

An offline AC/DC reference design PMP8550 based on the UCC28880 enables designers to quickly design a low-cost, low-power non-isolated high-side buck converter with a total solution size of 38mm by 32mm by 22mm that supports 13V, while generating up to 100mA of output current. The reference design features a buck converter with integrated switch and can be used in numerous industrial applications. The design's schematic, CAD files and test results are available for download. The reference design uses the UCC28880 low power, low cost, off-line buck converter with integrated 700V MOSFET to generate a non-isolated 13V/120mA output from a universal AC line input. Thanks to its hysteretic mode, no loop compensation is needed reducing BOM count to 23 components producing a small single sided, double layer board which can be used in numerous industrial applications such as smart meters, home automation equipment and white goods.

New family of 36-V and 60-V converters

Also introduced were seven Simple Switcher regulators that simplify wide VIN synchronous power supply design and help engineers create energy-efficient, electromagnetic interference (EMI) compliant products. The easy-to-use LM43600/1/2/3 and LM46000/1/2 DC/DC converters feature an input voltage range of up to 60 V for high reliability in rugged systems, and 27mA of standby current that minimizes power consumption at light load. The unique synchronous power stage architecture reduces radiated emissions for EMC compliance

Integrated 700-V switcher with lowest quiescent current

- Cuts quiescent power consumption in half
- Reduces solution size and BOM cost

TEXAS INSTRUMENTS

Figure 2: The UCC28880 high-voltage switcher delivers energy savings to "always-on" smart meters and home automation designs

SIMPLE SWITCHER® converters make synchronous design easy

dB μ V

Vertical Polarization

Horizontal Polarization

EN 55022 Class B Limit

Evaluation Board Emissions

Frequency (MHz)

- Easy layout for EMI and thermal performance
- Best-in-class design tools
- Simple scalability from 500 mA to 3A, 36V to 60V

WEBENCH Design Center

TEXAS INSTRUMENTS

Figure 3: Simple Switcher DC/DC regulators enable quickly design energy-efficient, EMI-compliant systems

in a variety of industrial, automotive and communications applications. Synchronous rectification with integrated high-side and low-side MOSFETs simplifies design while improving efficiency, EMI and solution size. Programmable switching frequency up to 2.2 MHz allows for smaller external components.

The LM43600, LM43601, LM43602 and LM43603 synchronous regulators support an input voltage range from 3.5V to 36V and generate output currents of up to 0.5A, 1A, 2A and 3A, respectively. The LM46000, LM46001 and LM46002 support an input of 3.5V to 60V and output currents of up to 0.5A, 1A and 2A. The converters integrate compensation, control features and MOSFETs to reduce the bill of material (BOM) by up to seven components. The 16-pin, 5-mm by 6.4-mm thermally enhanced HTSSOP package is pin- and footprint-compatible across the product family and is scalable for reuse across various applications. EMI-optimized pin placement simplifies printed circuit board (PCB) layout for CISPR 22 class B EMC compliance. The regulators are fully supported in the Webench online design tool, helping designers generate, optimize and simulate a wide VIN design, and then export that design to a CAD program.

www.ti.com

InDUR
by STS

Follow the trend

Miniaturise your power choke

double current density double energy density half volume

How? Just scan this code!

www.sts-trafo.de

STS
Induktivitäten

Profit from More than 40 years experience in general and power electronics

Design of complete or parts of SMPS, lamp ballasts, LED ps, D amplifiers, motor electronics, amplifiers, measuring instruments, critical analog hardware. Experience with SiC and GaN. EMI expertise. Minimum design times and favorable costs due to experience and a large stock of SMPS components.

ASSISTANCE with your own designs in any design phase. **DESIGN** approvals, failure analyses, **REDESIGNS** to weed out problems or to reduce cost.

SEMINARS, ARTICLES AND BOOKS. Translations of technical and other critical texts
German - English, English - German, French - German, French - English.

Former manager of R & D / managing director in D, USA, NL, A.
Consultant and owner of an electronics design lab since 23 yrs.
140 publications resp. patent applications, inventor of the current-mode control in SMPS (US Patent 3,742,371).
Names and business affairs of clients are kept strictly confidential.

DR.-ING. ARTUR SEIBT

Lagergasse 2/6
A1030 Wien (Vienna)
Austria

Tel.: +43-1-5058186
Fax: 5037084
Mobile: +43-699-11835174
email: dr.seibt@aon.at
<http://members.aon.at/aseibt>

Active Vibration Control in Ultrasonic Wire Bonding

Improving Bondability on Demanding Surfaces

Ultrasonic wire bonding is an established technology for connecting the electrodes of microelectronic devices as well as power electronic modules.

Bonding on demanding surfaces like connector pins embedded in plastic frames can be challenging. A new approach for suppressing unwanted vertical vibrations by an active vibration control can improve bondability

By Dr.-Ing. Michael Brökelmann, Hesse GmbH

Introduction

Typically an aluminium wire connects the electrodes of a power semiconductor with the corresponding electrodes of a substrate. The wire is bonded to the electrode surface by an ultrasonic friction welding process.

Due to the very high requirements concerning quality and reliability of the electric connections, a very precise control of the process is required. Continuously increasing machine speeds intensify this demand. Another challenge is bonding on demanding surfaces, like slim connector pins embedded in plastic frames, other soft underlayers like overhanging (stacked) dies, or poorly supported lead frames.

Objective

The ultrasonic transducer is a key component of a wire bonding machine. It generates the power for the bonding process in the form of mechanical vibrations in the ultrasonic frequency range. It is driven in a longitudinal eigenmode, which due to the asymmetric mounting of the bonding tool is typically not perfectly symmetric and shows residual vibrations orthogonal to the main bonding direction. Beside this eigenmode additional orthogonal vibration modes exist as well as eigenmodes of the substrate or the bond pad base. In conjunction with the nonlinear process dynamics this can lead to fluctuating normal forces in the friction contact and a disturbance of the bonding process.



Figure 1a/b: New IDE Actuator mounted on an ultrasonic transducer

Another aspect is important for copper wire bonding, a technology presently becoming more and more important. Because copper wire needs higher bond forces and vibration amplitudes the risk of damaging the chip or underlayers is increased compared to aluminium bonding. Therefore supplying perfectly horizontal ultrasonic vibrations and reducing vertical vibrations is desired.

The aim of this study is to show the capability to suppress or at least reduce unwanted vertical vibrations during operation by the use of special control actuators and a proper vibration control method. Reducing process variance and increasing bonding stability and reliability are adjacent objectives. This research was done within the large-scale integrating project HIPER-ACT (Novel technology for high-performance piezoelectric actuators), funded by the European Community's Seventh Framework Programme FP7/2007-2013 under grant agreement n° 212394 (hiperact.org). Within this project a new technology for piezo-actuators with InterDigitated Electrode Technology (IDE) has been developed. These piezo-actuators were used in the technology demonstrator for vibration damping in ultrasonic bonding (see. Figure 1).

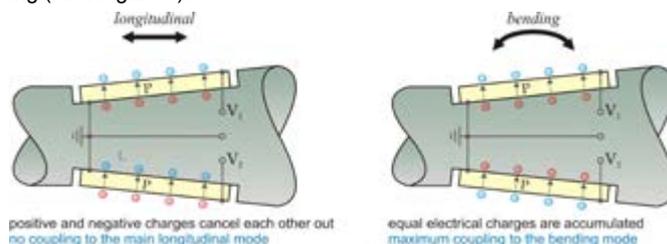


Figure 2: Principal of operation for control actuators

Approach

A novel prototype transducer is developed, which is capable of suppressing orthogonal vibrations using additional piezoelectric control actuators. It is required that these actuators do not influence the main longitudinal vibrations, but only act on the orthogonal vibrations. This is achieved by using a special configuration of the control actuators. Two of these are mounted on the top and bottom sides of the transducer body. The polarisation of the control actuators is chosen like depicted in Figure 2. In free longitudinal vibration the electrical charges on the electrodes of the top and the bottom actuator cancel each other out (Figure 2 left: $V_1 + V_2 = 0$). In bending vibration one piezoelectric ceramic is 'stretched' while the other ceramic is 'compressed'. Because of the opposite polarisation the full piezoelectric effect can be used in this case (Figure 2 right: $V_1 = V_2$). Therefore applying a voltage to the control actuators induces a pure bending or vertical movement of the transducer body without effecting the main longitudinal vibration. By this means an optimal coupling is achieved for the orthogonal bending mode while the coupling to the longitudinal mode is zero.

PCIM

ASIA

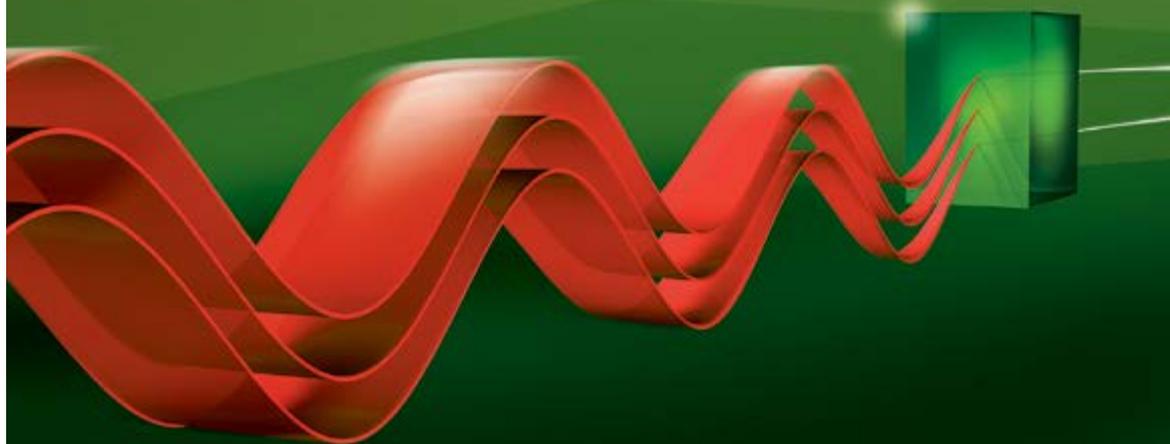
International Exhibition and Conference
for Power Electronics, Intelligent Motion,
Renewable Energy and Energy Management

Power for Efficiency

24 – 26 June 2015

Shanghai World Expo Exhibition and Convention Center
Shanghai, China

www.pcimasia-expo.com



Mesago PCIM GmbH
Tel: +49 711 61946-62
Fax: +49 711 61946-93
pcimasia@mesago.com

mesago
Messe Frankfurt Group

 **messe frankfurt**

Active and passive vibration control techniques

Within the first part of this project a proof of concept demonstrator has been built. This includes the evaluation of different vibration damping techniques – a piezoelectric shunt damping technique and an active open-loop control. To investigate and set up these techniques a suitable model is essential. Therefore the ultrasonic transducer has been described by a finite element model, which can be used to calculate the dynamic vibration behaviour of the transducer. The FE-model has been validated by frequency response measurements. Additionally a modal reduction of the finite element model to the two most relevant eigenmodes is made. The system is then described by a model with two degrees of freedom (2-DOF model) which can describe longitudinal and bending motions. This model is essential to calculate the optimal parameters for both the active vibration control and the passive damping technique. These investigations and the model equations are reported in detail in [1] and [2].

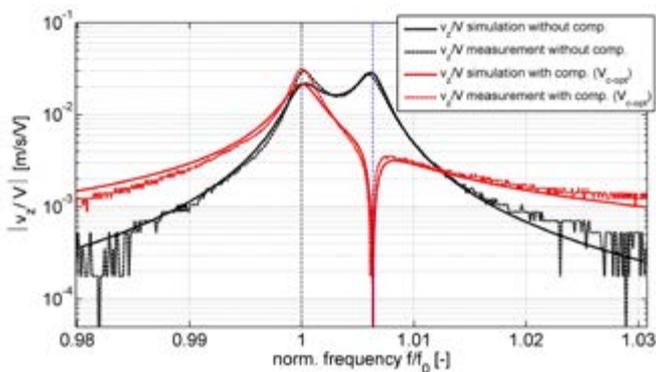


Figure 3: Active vibration compensation of free vertical tool vibrations

For the active open-loop control the optimal voltage amplification and phase shift with reference to the driving actuators are calculated using the 2-DOF model. With these parameters the vertical vibrations at the tool tip should be fully compensated. This was proven experimentally for the free vibration steady state. Figure 3 shows the frequency response characteristics for the vertical vibrations of the tool tip measured via laser doppler vibrometry. In this example a parasitic mode exists beside the main mode. The optimal control parameters for this specific frequency (norm. frequency 1.006) were calculated and the

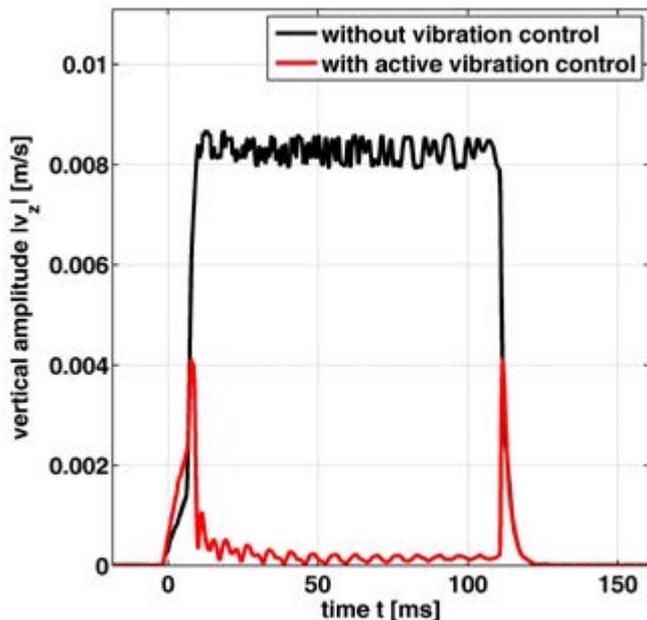


Figure 4: Active vibration compensation with friction contact of the tool

system behaviour was measured again. The correlation between calculated and measured characteristics is very good. The predicted “total” compensation was validated with a maximum reduction of the vertical vibrations of more than two decades (s. Figure 3).

For the passive vibration damping technique, a passive inductance-resistance (LR)-circuit is connected to the electrodes of the piezo-ceramics, in simulations as well as on the prototype. This passive damping technique does not require external power and is inherently stable. For proper operation the network parameters must be tuned precisely. Measurements of the free vibrations and of the frequency response showed a strong damping effect and a decrease of the vertical vibrations by a factor of more than 10. However, a total suppression is not possible with this technique.

To study the active vibration control technique, initial experiments were conducted without wire. In this case, other than in the bonding process, there is a steady friction contact at the tool tip. Figure 4 shows that the active control can reduce the basic harmonic completely in this case. But the investigations also revealed that because of the nonlinear friction force characteristic higher harmonics of quite low amplitude remain.

Full scale bonding test

In order to perform a full scale bonding test, a bonding machine was equipped with a two channel ultrasonic driving system and two power amplifiers as well as a special software to control both channels. It was proven that both proposed damping techniques – shunt damping and active vibration control – are capable to improve the vibration behaviour during bonding significantly, especially in difficult circumstances, e.g. on poorly supported surfaces.

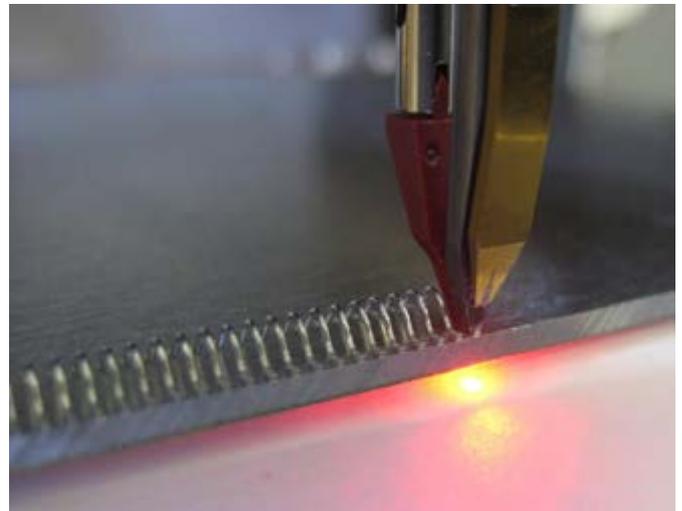


Figure 5: Measuring vertical vibrations below the bonding spot by laser

Figure 5 shows a test specimen in which an aluminium plate was intentionally mounted so that the bonding area was overhanging and not supported in order to make the bonding process especially prone to vertical vibrations.

The passive shunt damping technique with a tuned LR-network shows a significant damping effect and reduces the vibration amplitude by about 50%. But its frequency bandwidth is quite small, which means that the optimal inductance value must be met quite accurately. Possible frequency changes during operation due to temperature and power dependency of system parameters have to be considered. The

VARIS™ XT – compact and powerful

advantages of the passive shunt damping technique are its simplicity and inherent stability. No additional hard- or software is necessary. But its lower damping performance and the sensitivity towards parameter deviations are limiting its application.

The very profound advantage of the active feed-forward vibration control strategy is its possibility to realize an almost complete suppression of orthogonal vibrations at any desired operating fre-

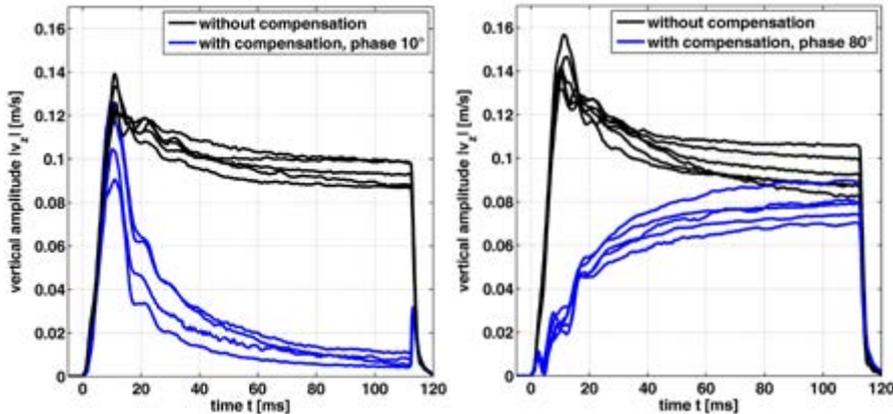


Figure 6: Full scale bonding tests of the active vibration control method, compensation of vertical tool vibrations at bonding start (opt. phase 80°, left) and at bonding end (opt. phase 10°, right)

quency. But for this considerable more control effort and a high voltage supply for the control actuators are necessary. It was found that because of the nonlinear time-varying bonding process the optimal control settings are not fixed, but a function of the process and thus time-varying. As depicted in Figure 6, especially the phase angle has to be adapted to gain full compensation during the entire bonding process. A vertical vibration sensor, e.g. integrated into the control actuators, can enable the set-up of a closed loop control in order to suppress the vertical vibrations in any case.

An additional promising observation during the test was a reduction in the standard deviation of the measured signals. With active vibration control the natural fluctuations of the process seemed to be decreased. Further studies and tests have to confirm this.

Conclusions

The passive vibration damping system can be incorporated with low effort into a serial machine, leading to a reduction of vertical vibration of about 50%. With an active vibration damping system an almost complete compensation of vertical vibration is possible. For this an additional sensor has to be incorporated and a closed loop control is necessary. For applications with extended demands this extra effort could be reasonable and such a system could be implemented in future machines to reach optimal performance.

Literature References

- [1] Brökelmann, M.; Neubauer, M.; Schwarzendahl, S. M.; Hesse, H.-J., Wallaschek, J., "Active and Passive Vibration Control of Ultrasonic Bonding Transducers", Proceedings of ACTUATOR 2012, 13th International Conference on New Actuators, Bremen, Germany, 18-20 June 2012.
- [2] Neubauer, M.; Brökelmann, M.; Schwarzendahl, S. M.; Hesse, H.-J., Wallaschek, J., "Optimization of bond transducer vibrations using active and semi-active control", Proceedings of SPIE Vol. 8341, Active and Passive Smart Structures and Integrated Systems, 2012.

<http://www.hesse-mechatronics.com/>

- Six freely interconnected IGBT half bridge modules
- Approx. 2 MW inverter output power
- Interface board for control, feedback and sensors

engineered by

GVA
Power Electronics

Welcome to the House of Competence.

Automated Acoustic Inspection for IGBT Modules

High-power IGBT modules have long needed a non-destructive method to inspect for internal structural defects such as voids, non-bonds, delaminations and cracks. The best time for such inspection is after assembly but before encapsulation, which prevents re-work. X-ray won't find all of these defects, but the ultrasound of acoustic micro imaging systems will.

By Tom Adams, consultant, Sonoscan, Inc.

For a long while IGBT modules could not be inspected by acoustic systems, because of the water that couples the scanning ultrasonic transducer to the module. Module makers feared that even the slightest residue left after the water had evaporated could turn into leakage paths at the high power levels involved.

Two years ago Sonoscan solved this problem for laboratory acoustic systems by inverting the transducer and placing it underneath the IGBT module, where it can scan the bottom surface of the heat sink. Along with the transducer came an upward-pumping water jet to maintain a constant column of water between the transducer and the bottom surface of the heat sink just above it. The design of the system made it impossible for water to reach the exposed power die and circuitry at the top of the module.

System designers have now taken this concept to its logical next step by putting together the first automated acoustic system (patents pending) for inspecting IGBT modules. Like other acoustic microscopes designed for the production environment, this automated system can achieve higher throughput than a laboratory system because of superior handling of the parts - in this case, IGBT modules.

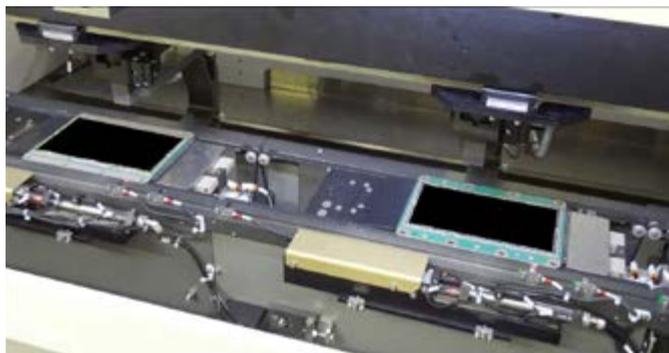


Figure 1: With doors open, the two IGBT modules are seen. The scanning transducers are out of sight beneath the modules.

Unlike laboratory systems, the automated system can be provided with automated loaders and unloaders to handle the IGBT modules. This means that it can be integrated directly into the production line. Modules to be inspected are stacked at one end of the system, which has two stages and two transducers to achieve higher overall throughput. In Figure 1 modules are masked to preserve the identity of the manufacturer. The transducers that one would expect to see just above the two PCBs are out of sight, one beneath each of the

boards, and are upside down. Because the system is automated, the operator need only put the stack of modules to be inspected in place and activate the software recipe for inspecting this type of module. No human attention is needed from this point on.

An automated mechanical system loads two IGBT modules onto their respective stages and the scanning process begins. In some systems already in use, the only depth of interest in the modules is the solder layer binding the heat sink to the ceramic rafts above the heat sink. The targets here are voids, non-bonds, delaminations and cracks - important because these defects will block heat from reaching the heat sink and being dissipated from the module. The result could be overheating and failure of the module.

During scanning the transducer sends thousands of pulses of ultrasound per second through the water column and into the surface of the heat sink. Each of the thousands of x-y coordinates where ultrasound is pulsed each second will be represented in the acoustic image by a pixel whose color identifies the intensity of the echo. Ultrasound is reflected by material interfaces, and well bonded interfaces between production materials typically reflect some portion of the pulse and transmit the rest across the interface. The reflected portion - the echo - is typically of moderate amplitude and will create a pixel that is some shade of gray. A material interface that is uniformly gray in an acoustic image is what an engineer typically wants to see.

What he does not want to see is a bright red feature, where the color red indicates that >99.99% of the ultrasonic pulse has been reflected as an echo. In a monochromatic acoustic image, these highest-amplitude echoes are bright white; they are often pseudocolored bright red

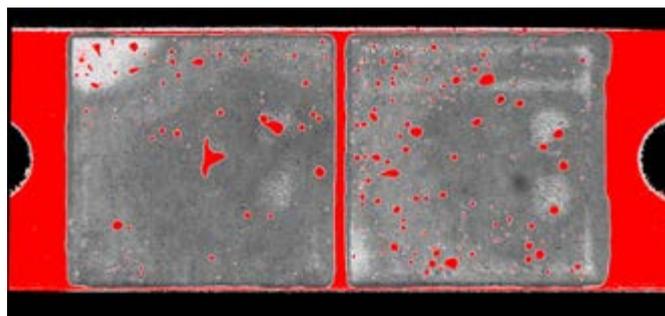


Figure 2: In this acoustic image, gray regions identify two ceramic rafts; red features in these regions are voids, non-bonds, delaminations or cracks in the solder layer.

(as here) for greater visibility. This type of echo is characteristic of the interface between a solid production material and a gas such as air, or a vacuum. The vast difference in material properties of air and, say, copper causes the essentially total reflection of ultrasound.

This is what is seen in Figure 2, a segment of the acoustic image of a fairly large IGBT module. The gray square features are the acoustic image of the interface between the solder and two ceramic rafts below. The ultrasound was pulsed through the heat sink; heat sinks themselves are typically lacking internal features. The red features within the gray squares are areas where solder is either missing or not bonded to an adjacent surface.

The data that is collected during scanning is analyzed immediately. The system's Digital Image Analysis™ (DIA) software will measure the total area of the voids in the solder above each ceramic raft. The accept/reject criteria, defined by the user, may call for a module to be rejected if the total area of voids is, for example, >2% of the area of the raft. Criteria may also take into account the x-y location of a defect - a void that is not directly under a die is not as serious as one that is. At the end of the scanning process, accept modules are stacked in front of the system, while rejects are stacked at the back. The acoustic data and images may be stored locally, in the system's computer, or in the user's Factory Information System.

The inspection process is thus carried out rapidly and with minimal human intervention. A technician will later examine the images of the reject modules to see which ones are candidates for rework, but no one needs to examine the images of the good modules.

The simplest inspection process, described above, is not the only alternative. In some instances, the inspection time can actually be reduced by using a recipe to scan only the significant regions of the module, and to skip the regions that do not have solder, die attach, or a die.

This inspection process described to this point is suitable for inspecting a single layer of interest, such as the solder. But the user of the system may be concerned with defects at more than one level within the module. Typically the critical defects are voids in the solder layer and in the die attach material. Both can block heat and thus pose the risk of module failure.

Both the solder layer and the die attach layer can be imaged at the same time during scanning, without increasing the scan time. A scanning recipe is used that sets a gate for the solder layer - meaning that it accepts for imaging of the solder layer only those echoes whose arrival time indicates that they were reflected by a material interface between the heat sink and the raft. A second gate is set for the die attach material, which will use for imaging only those echoes that originated between the top of the raft and the bottom of the die.

The result of gating on two depths of interest is two acoustic images, one for the solder layer and one for the die attach layer. All that has changed is that software picks up two echoes from each pulse instead of one. The process takes no longer, and lets the user cover two potential trouble spots. Voids in the solder layer will be bright white. Voids in the die attach layer will also be bright white, but these echoes must travel through the solder layer on their way to the transducer. If there are voids in the solder layer, they will appear in the die attach image as black acoustic shadows because they blocked some of the ultrasound reflected from the die attach layer. It is possible, of course, that a void in the die attach layer will not be seen because a void in

the solder lies directly between it and the transducer, but a module that has such a problem is very likely already a reject.

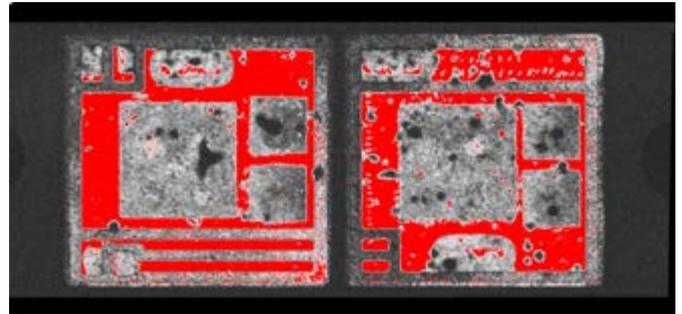


Figure 3: Made during the same scan as Figure 2, this image shows small red die attach voids at the largest of the three die.

The acoustic image in Figure 3 covers the same area as Figure 2, but was gated on the fifth of six depths within the IGBT module. The red defects seen in Figure 2 are here seen as black features because the ultrasound returning from the fifth depth is blocked by these voids. Thus the three-pronged void in the center of the left portion of Figure 2 is black in Figure 3. The depth that Figure 3 is gated on includes the interface between the ceramic raft and the die attach material. The small red features within the area of each die are voids in the die attach.

One benefit of gating, and especially of setting rather narrow gates, is that the tilting of ceramic rafts becomes more visible. If one region of a raft is actually displaying part of the solder layer, part of the die attach, then the raft is tilted and is a potential contributor to overheating.

What this new automated system provides is the ability to nondestructively inspect the internal features of IGBT modules at a high throughput rate according to the user's definitions of accept and reject. Aside from startup, it operates without a technician to give the user higher module quality.

Contact information:
Sonoscan, Inc.
2149 E. Pratt Blvd.
Elk Grove Village IL USA 60007
Phone: 847 437-6400
Fax: 847 437-1550
E-mail: info@sonoscan.com

www.sonoscan.com

World wide support in English by
Bodo's Power Systems®
www.bodospower.com

Asian support in Mandarin in China
Bodo's Power Systems®
www.bodospowerchina.com China

More Light with Less Power

Report from LpS 2014

The LED professional Symposium + Expo 2014 (LpS 2014) took place from September 30th to October 2nd in Bregenz, Austria. 58 multidisciplinary expert talks, 5 hands on workshops and 2 tech-panels were hosted to inform the visitors about all aspects of LED lighting. Close to 100 companies were exhibiting and launching new innovations and products to the SSL marketplace. This article introduces some of them related to power.

By Wolfgang Patelay, Freelance Journalist, Bodo's Power Systems

Lighting systems based on LED and OLED technologies promising great power savings but their design is also challenging. Preferred solutions have to incorporate the latest technologies, smart systems, new standards, advanced functionalities and new user behaviors. Therefore, a holistic design and engineering approach is required in order to develop successful LED Lighting Systems for the future. Therefore integrated designs formed the core of the LpS 2014 Symposium and Exhibition for Integrated LED Lighting System Designs program. All lectures, workshops and tech-panels were linked to this central theme. Experts from various disciplines came together to present, discuss, exchange and explore best practices and develop new lighting concepts and designs for optimized environments. The new approach that was implemented this year intentionally links theory and practice. The first two days of the Symposium feature inspiring lecture presentations in four parallel sessions and are followed by an interactive third day full of workshops and discussions to foster information exchange and practical applications. The most important trends and visions in future LED lighting systems, materials and manufacturing, light sources, reliability and lifetime, engineering of LED optics, electronics and smart lighting as well as design with LEDs and OLEDs were covered in the 58 lectures presented by international experts from industry and research.

The third day of the LpS featured five workshops and two tech-panels, which run on five parallel tracks. Topics like Visual Perception, Luminary Design, 3-D Printed Optics, LED driver designs for Smart Lighting and Zigbee for wireless lighting solutions were discussed and demonstrated. Prof. Mehmet Arik, known as the "Edison of the 21st century", was opening the workshop series with his keynote about "Breakthrough Technologies and Strategies in SSL Developments – Thermal Management of LEDs". The lighting industry is facing a shift from wired towards wireless connectivity, driven by several trends. The way people control devices is changing. New value added functionalities in automation are becoming more common and enhancing the customer experiences. Additionally, wireless technology is now available at low prices. Consequently, a unified approach is required to enable system compatibility. Therefore the Connected Lighting Alliance (TCLA) has defined the ZigBee Light Link standard as the preferred common open standard for wireless controlled lighting, which was introduced and discussed in detail at their workshop.

The exhibition space was extended this year for 100 exhibitors such as Samsung, Cree, Infineon, Wago, Fischer, Bayer Material Science, Arrow and OEC. The reputation of the fair is growing and leading

companies are increasingly using the LpS as a platform for their European or global product launches. This year the following companies (in alphabetical order) presented amongst other things new products.



Figure 1: LCL230R-AC lamp reduces maintenance costs in buildings due to the high reliability and long life

Auer Lighting was introducing their light guides made of borosilicate glass using injection-molding technology. This technology resists heat better than the plastic counterparts. Glass light guides are used in applications with high-power LEDs, e.g. automotive and stage lighting. They help to achieve the desired light distribution and colour mixing. Especially with high-power LEDs, temperatures easily can exceed the maximum operating temperatures of plastic materials like acrylic, PC, and silicone. Beyond its supreme thermal stability, the borosilicate glass SUPRAX 8488 offers low thermal expansion and zero water absorption allowing for precise light guidance along difficult environmental conditions. Auer Lighting offers customized light guides as well as standard solutions.

BQ Ceramics was showing their first ceramic-coated metal core PCB with integrated heat sink, which offers superior thermal conductivity at reasonable costs. The Polar Light technology is the first ceramic coated MC-PCB with integrated heat sink and superior thermal conductivity, specifically developed for LED applications. It allows LEDs to be placed in direct contact with the ceramic coated aluminum PCB. The concept provides superior thermal conductivity, whereby the heat generated directly underneath the High Power LEDs is very effectively dissipated to the ambient, resulting in a junction temperature that is

up to 30°C lower than on a traditional MC-PCB. The BQ Polar Light reduces the number of components in the light engine. Fewer components mean less material and fewer assembly steps. Combining these aspects, Polar Light enables applications that need more light emitted from compact spaces, offering design flexibility at lower cost.

Data Link presented a new lamp designed with their new patented planar and AC LED technology. The AC LED technology has enabled that the LCL230R-AC lamp has a minimum of components and no electronic parts that are susceptible to aging. Additionally this lamp can endure millions of power cycles and has a very long life. Flush Mount Ceiling Lamp is low energy alternative to incandescent and Compact Fluorescent bulb. LCL230R-AC provides a large luminous flux of at least 1400 lumens, while its consumption is only 16W and has a real lifespan of over 60,000 hours. The lamp has a very pleasant white light suitable for domestic dwellings and residential market, with colour temperatures available from warm white 2700K to neutral white 4000K depending on the application. This lamp has thermal management due to the large surface cooler that allows the low LED junction temperature of maximum 65°C. The lamp is thermally protected, which means that at higher ambient temperatures reduce the intensity of light and prevent overheating of the LED and shorten lifespan.



Figure 2: The LED driver LC-XT has a power factor of > 0.96

ELT introduced two new driver product lines: The LC-XT, which is characterized by very low current output ripple (2%) and low THD (< 10%) and the LC-UN universal voltage multi-power LED drivers. LC-XT is a solution up to 1400mA and 150W. In addition, there is a specific option for 90W. >The driver shows a long life time of 50,000 hours at $T_c = 75^\circ\text{C}$ and $T_a = 60^\circ\text{C}$. ($T_a \square 40^\circ\text{C} / + 60^\circ\text{C}$). The LED driver is implemented with very high quality components used in the automotive industry, so it works properly at $\square 40^\circ\text{C}$. The LC-XT has a surge protection of 6kV and an extra protection, the ITP.

The universal voltage multi-power LED drivers of the LC-UN series feature 4 models which differentiate in form factor and power. LC-A-UN drivers feature an input voltage range of 110 – 277V for loads up to 25 W regulated from very low loads (<10W). The drivers are class II and SELV and therefore especially suited for down-light applications. LC-E-UN series drivers have the same input voltage range for loads up to 50 W. They are suited for COBs and down-light applications (class I, class II and fan switch on option) and outdoor IP67 lighting

NEW VIEWS TO NEW WORLDS

ViPS-40

User-friendly
Interface

Digitally
Controlled

PC
Compatible



VMI's Newest, Digitally Controlled
40kV High Voltage Power Supply

SPECIFICATIONS

INPUT VOLTAGE RANGE: 6VD.C. - 10VD.C.
OUTPUT VOLTAGE (TUBE): -4kV TO -40kV
FILAMENT VOLTAGE MAX.: 2VRMS
@ 0 TO 300mA
OUTPUT CURRENT MAX.: 200UA
OUTPUT POWER MAX.: 4W

PHYSICAL DIMS

6.5" LENGTH X 2.1" WIDE
X 1" HEIGHT
165MM LENGTH X 53.3MM WIDE
X 25.4MM HEIGHT



www.VOLTAGEMULTIPLIERS.COM

(P) 559.651.1402

(F) 559.651.0740

fixtures which can incorporate IP20 drivers (possible lightning protection). Various currents are available, easily adaptable for particular COBs from specific customer. The drivers show high efficiency both electrical (90□91%) as well as luminous (ROC <2%). LC-D-UN drivers show also the same input voltage range but for loads up to 90 W and in "slim" format. They are class I devices for indoor linear lighting and feature the same high efficiency of the LC-E-UN-Series. The LC-C-UN drivers feature a different input voltage range of 110 – 240 V for loads up to 60 W. They are linear class I devices for indoor lighting which do not require a slim format (driver height 28mm). Its efficiency is electrical up to 87% and luminous ROC <2%.

LUXeXcel announced both the launch of a new additive manufacturing platform that delivers high speed and precision as well as the introduction of a new clear material "LUX-Opticlear", allowing high quality optics manufacturing up to 20mm in height in 3 D printing process. With these new capabilities, this process is ready to compete with injection molding for the production of small and mid-sized series of optical components. The company now offers a fast and effective service for prototyping, iterating and the manufacturing of optics, cutting out the need for costly and inflexible tooling.

www.LpS2014.com

1 W DC-DC Converter 35% Smaller Height Profile

Murata announced the NXE1 series of low cost 1 Watt DC-DC converters from Murata Power Solutions. Measuring only 12.7 x 10.4 x 4.8 mm these ultra compact converters have a profile at least 35% lower than the 7 mm height industry norm making them suitable for use in even the smallest space constrained designs. Also, unlike other



isolated surface mount DC/DC converters available in the market the NXE1 has the benefit of being manufactured using automated processes that greatly improve overall product reliability and delivering consistent performance characteristics.

Other space-saving features of the NXE1 include a transformer that is embedded in the substrate. Together all the innovative design and fabrication features of the NXE1 contribute to Murata being able to price the series at least 50% below other similar devices making what is believed to be the lowest cost isolated SMD 1 W DC/DC converter available.

At launch the first model in the series has +5 VDC input & output with other 3 VDC input versions available shortly. Input to output isolation is up to 3 kVDC.

With an industry standard pin compatible footprint the series is ideal for a replacement product in existing designs as well as for new compact applications. Short circuit protection is standard and the series can be used across the full industrial temperature range from -40 to +85 degrees C.

Certification to the internationally recognized UL60950 safety standard for IT and commercial equipment is pending.

www.murata.com

800V DTMOS-IV Super Junction MOSFET

Toshiba Electronics Europe (TEE) has introduced the first 800V power MOSFET based on its high voltage DTMOS IV super junction technology. The TK17A80W uses Toshiba's state-of-the-art single epitaxial process and is ideally suited to equipment that requires high reliability, power efficiency and a compact design. Applications will



include power supplies and adapters, fly back converters and LED lighting equipment.

Compared to multi epitaxial processes, Toshiba's Deep Trench technology delivers lower ON-resistance (RDS(ON)) at higher temperatures. It also offers reduced turn-off switching losses (EOSS) than previous technology generations. The combination of reduced increase in RDS(ON) at high temperatures and reduced EOSS provides higher efficiency for power supplies and assists designers in minimizing system size.

DTMOS IV enables faster switching performance by reducing parasitic capacitance between gate and drain. Typical CISS for TK17A80W is only 1450pF (@VDS=300V, f=100kHz). Maximum ratings are 800VDSS, ± 30 VGSS and 17A drain current. Maximum RDS(ON) is 0.3 Ohm.

The TK17A80W starts mass production in the fourth quarter of 2014 in a fully isolated TO-220SIS package. Samples are available now. Further performance options and TO-220, DPAK and IPAK packages will follow.

www.toshiba-components.com

Introduction of Three 20W Power Amplifiers

Richardson RFPD, Inc. announced immediate availability and full design support capabilities for three new 20W power amplifiers from Wavelex.

The 50-ohm, unconditionally stable PAs operate from a single DC power supply and cover down to 820 MHz and up to at least 890 MHz.

They feature infinite load VSWR protection and a minimum of 50% power added efficiency, and they are SMA-connectorized and packaged with precision machine housings in Wavelex's WP-1M package. Wavelex products are 100% production-tested on all minimum and maximum electrical specifications.

The PAs are suitable for GSM mobile infrastructure and fixed wireless communication applications. The WPA08-35B, WPA08-53A, and WPA0810A are part of a new family of 17W to 25W power amplifiers from Wavelex.

wavelex



Available from

RichardsonRFPD
An Avnet Company

AVNET
RF & Power

www.richardsonrfpd.com

25 mOhm/1700 V Silicon Carbide Transistors Released

GeneSiC Semiconductor, a pioneer and global supplier of a broad range of Silicon Carbide (SiC) power semiconductors today announces the immediate availability of a family of low on-resistance 1700V and 1200 V SiC Junction Transistors in TO-247 packages. The use of high voltage, high frequency, high temperature and low on-resistance capable SiC Junction Transistors will increase conversion efficiency and



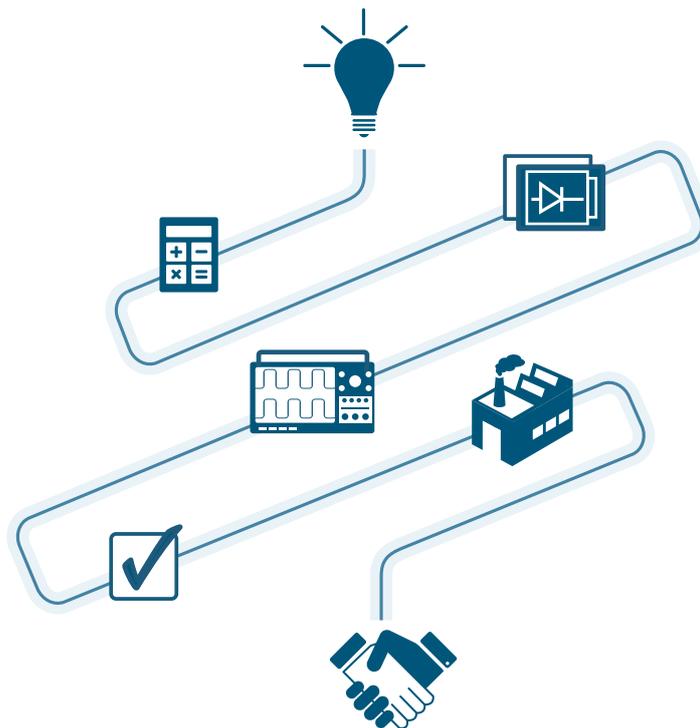
reduce the size/weight/volume of power electronics applications requiring higher bus voltages. These devices are targeted for use in a wide variety of applications including DC microgrids, Vehicle Fast chargers, server, telecom and networking power supplies, uninterruptable power supplies, solar inverters, Wind power systems, and industrial motor control systems.

SiC Junction Transistors (SJT) offered by

GeneSiC exhibit ultra-fast switching capability (similar to that of SiC MOSFETs), a square reverse biased safe operation area (RBSOA), as well as temperature-independent transient energy losses and switching times. These switches are gate-oxide free, normally-off, exhibit positive temperature

co-efficient of on-resistance, and are capable of being driven by commercially gate drivers, unlike other SiC switches. Unique advantages of the SJT in contrast to other SiC switches is its higher long term reliability, >10 usec short circuit capability, and superior avalanche capability

<http://www.genesicsemi.com/commercial-sic/sic-junction-transistors/>



With you from start to finish.

We understand that electronic product design is a journey with many challenges. As a leading manufacturer of power supplies, we are with you from start to finish, collaborating to ensure that your next project is a success. **Let us be your power expert.**



Novum®
Advanced Power



Ac-Dc
Power Supplies



Dc-Dc
Converters

World wide support in English by
Bodo's Power Systems®
www.bodospower.com

Asian support in Mandarin in China
Bodo's Power Systems®
www.bodospowerchina.com China



www.cui.com/PowerExpert

Dimmable 25W and 35W LED Drivers

RECOM expands its already robust portfolio of dimmable LED drivers with the addition of two new 3-in-1 dimmable LED drivers: the 25W RACD25-A and the 35W RACD35-A. Each series features 3-in-1



dimming, allowing the modules to be dimmed with an analog signal (1-10V), PWM, or external resistor. These drivers round out RECOM's already comprehensive portfolio of dimmable LED drivers, and fulfill the demand for midrange LED power supplies.

Due to a wide input voltage range (universal AC input 90-305VAC), these versatile drivers are well-suited for power grids worldwide. Each is available in 1 of 5 different types of output current, ranging from 350mA to 2100mA, making them capable of powering a wide range of CoB LEDs.

Each unit offers an excellent power factor (>0.98 at 120VAC, >0.93 at 240VAC and >0.9 at 277VAC) and an efficiency of more than 81% for the RACD25-A and 83% for the RACD35-A. Both modules are just slightly larger than a deck of cards (102x73.5x33mm), and integrate easily into almost any application.

Fully protected against short circuit, overload, and over-temperature, these units carry double-isolated wires and come housed in IP67-rated casing, making the drivers environmentally versatile, usable both indoors and outdoors, in damp and in wet areas. Ideal applications include general lighting, public buildings, retail, outdoor lighting, architectural lighting, and bathrooms.

The new RACD25-A and RACD35-A 3-in-1 dimmable LED driver series are UL8750 and EN61347 certified, and also comply with the European harmonics standard EN61000-3-2 Class B. Each driver is backed by a 5-year warranty.

www.recom-lighting.com

Configurable Output Voltage DC/DC Converters for IGBT and MOSFET gate drive

Murata announced the MGJ3 and MGJ6 series of configurable output voltage, high isolation DC/DC converters from Murata Power Solutions. These 3 Watt and 6 Watt surface mounted devices are optimized for use as high-side and low-side gate drivers in IGBT and



MOSFET bridge circuit designs. Providing triple output voltages of +15, +5 and -5 VDC, these converters provide optimum switching of IGBT drives for best overall system efficiency. In addition, the outputs are configurable to suit a number of different circuit requirements such as +15 and -5 VDC or +20 and -5 VDC.

Both the MGJ3 3 Watt and the MGJ6 6 watt converters are available with a choice of wide input voltages around nominal +5, +12 or +24 VDC inputs. The input ranges cater for 4.5 to 9 VDC (+5 VDC nominal), 9 to 18 VDC (+12 VDC nominal) and 18 to 36 VDC (+24 VDC nominal).

The MGJ3 measures 23.11 x 22.61 x 14.65 mm and the MGJ6 is 31.24 x 22.61 x 14.65 mm. Both series can operate over the wide temperature range from -40 to +105 degrees C. Short circuit and overload protection features ensure a robust operation during system fault conditions. Other control inputs include an enable pin to facilitate power saving and a frequency synchronization input that aids EMC filter design. Typical applications for the MGJ series include use in motor drives, traction control drives and wind turbine generators.

www.murata.com

Analogue Front Ends offer High Accuracy for Single-Phase Smart Meters

Microchip announces the completion of its high-accuracy, 1-8 channel, single and poly-phase MCP391X energy-measurement Analogue Front End (AFE) family. The new MCP3919 and MCP3912 members integrate three and four channels of 24-bit, delta-sigma Analogue-to-Digital Conversion (ADC), respectively, with industry-leading accuracy of 93.5 dB SINAD, -107 dB THD and 112 dB SFDR for precise signal acquisition and higher-performing end-products. These are the optimal numbers of channels for single-phase energy meters with neutral monitoring (3-channel); or single-phase, three-wire energy meters (4-channel). The high level of integration on the new AFEs also includes a low-drift voltage reference, programmable gain amplifiers, phase-delay compensation and Cyclic Redundancy Check (CRC).

As the energy-metering infrastructure is being upgraded worldwide, designers are demanding increased AFE accuracy and integration to develop the latest generation of smart meters. These features are also required by the designers of advanced power-monitoring systems for applications such as server power supplies and power distribution units, electronic circuit breakers, smart power strips and other data-acquisition products in the industrial, commercial and consumer markets. Microchip's newest AFEs improve application performance with their industry-leading accuracy, high integration and optimal number of channels for single-phase energy measurement. Additionally, the high AFE accuracy facilitates energy-meter calibration, which reduces production costs.



Microchip also announced two new tools to aid in the development of energy systems using these latest AFEs. The MCP3912 Evaluation Board (ADM00499) and MCP3919 Evaluation Board (ADM00573) can each be purchased today for \$129.99.

The MCP3912 and MCP3919 AFEs are both available today for sampling and volume production. Both AFEs are offered in 28-pin QFN and SSOP packages.

www.microchip.com/AFE-Page-102114a



Danfoss

The future power of performance is electric
take tomorrow's cars to the next level

Danfoss Silicon Power IGBT Modules

Today's designers must cut CO₂ emission without sacrificing driving pleasure, cost and reliability. With our new super-cool, robust power modules, we're helping take tomorrow's performance cars to the next level.

With its state of the art, highly automated, ISO/TS 16949 certified production facility in Flensburg Germany, Danfoss is equipped to support these new technologies for series vehicles as of 2015.

Call us to learn more about how we can help you electrify driving pleasure.

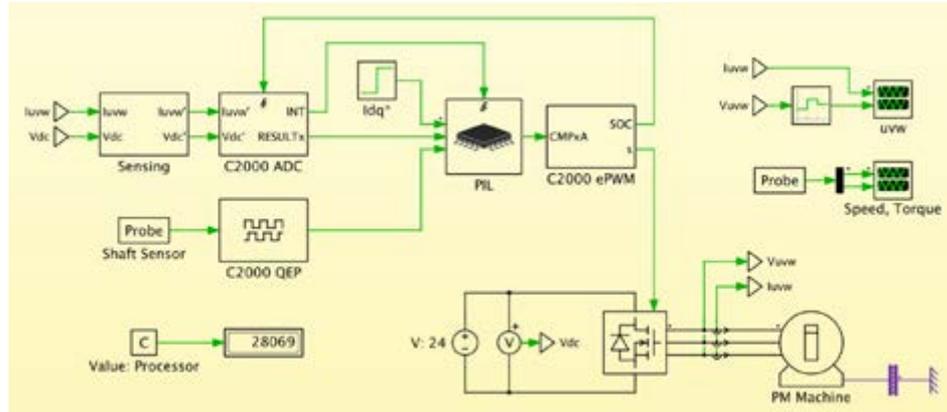
Danfoss Silicon Power GmbH
Husumer Strasse 251 24941 Flensburg, Germany
Tel. +49 461 4301-40
E-mail: dsp-sales@danfoss.com

www.powermodules.danfoss.com

Processor-in-the-Loop (PIL) Simulation with PLECS

Plexim introduces the Processor-in-the-Loop (PIL) Simulation with PLECS. When developing embedded control algorithms engineers often wish to test their code by executing it inside a circuit simula-

tor. With the PLECS PIL package, this can be done by tying actual code executing on real hardware into the virtual world of a PLECS model. Instead of reading the physical sensors, values calculated by



the simulation tool are used as inputs to the embedded algorithm. Similarly, outputs of the control algorithms executing on the processor are fed back into the simulation to drive the virtual environment. This approach can expose platform-specific software defects such as overflow conditions and casting errors. PIL simulations can also detect and analyze potential problems related to the multi-threaded execution of control algorithms, including jitter and resource corruption.

www.plexim.com

Gallium Nitride Devices Poised to Become Core Technology

GaN Systems Inc, a leading developer of gallium nitride power switching semiconductors, says gallium nitride is set to take off dramatically and will become the core technology in power electronics within the next three years. Founded a mere seven years ago, GaN Systems has developed an unparalleled range of gallium nitride, high power transistors based on its unique Island Technology® design. These new GaN devices offer significant advantages over traditional silicon MOSFETs and IGBTs and usher in smaller, lighter and more efficient power electronics in numerous industrial, consumer and automotive applications such as datacentre power supplies, notebook travel adapters, air conditioning motors and electric vehicle battery chargers and traction electronics.

smaller and at lower cost than tradition design approaches. The fast switching and dense current-carrying capability of Island Technology® devices is further enhanced by GaN Systems' compact, near chip-scale GaNPX™ packaging, which has no wire bonds, minimizing inductance and thermal resistance and increasing reliability. The third technological innovation at the heart of GaN Systems products is Drive Assist™, on-chip drivers that simplify circuit design, remove Miller driving issues and improve switching speed.

"Power system engineers around the world concur that the availability of GaN transistors may be the single most important advance since the IGBT became available in the 1990s. The ability to decrease power losses by 50%-90% or to reduce the size and weight of a system up to one quarter of its original size will alter the way power systems are designed and used. GaN Systems' industry-leading GaN power transistors are enabling this transition to begin. We have brought the broadest GaN product offering to the global marketplace with unique technology that enables it to be incorporated easily into the next generation of power electronics." says Jim Witham, CEO GaN Systems.



The Ottawa-based company is exhibiting at Electronica 2014 for the first time and is showcasing the most comprehensive range of gallium nitride devices available on the global market with current ratings from 8A to 250A. Based on the company's core IP, Island Technology®, these power switching semiconductors incorporate the wide-bandgap and superior switching speed, temperature, voltage and current performance of gallium nitride into a unique structure that maximizes wafer yields and produces highly efficient transistors up to four times

high-tech district, so we could increase our laboratory space tenfold, ensure our R&D facility incorporates state-of-the-art custom facilities and the dedicated power and cooling systems needed to fully explore higher power applications and accelerate new product development and testing."

www.gansystems.com

The perfect place
to do business



See you at HUSUM Wind!
15 – 18 September 2015 in Husum, Germany



in co-operation with



Partners of HUSUM Wind 2015



Book your stand now!



HUSUM
Wind

The German
Wind Trade Fair
and Congress

www.husumwind.com

1200V Gen8 IGBT Family Delivers Benchmark Efficiency and Ruggedness

International Rectifier introduced a new generation Insulated Gate Bipolar Transistor (IGBT) technology platform. The Generation 8 (Gen8) 1200V IGBT platform utilizes IR's latest generation trench gate field stop technology delivered in industry standard TO-247 packages to



offer best-in-class performance for industrial and energy saving applications.

The novel Gen8 devices are available with current ratings from 8A up to 60A with typical $V_{CE(ON)}$ of 1.7V and a short-circuit rating of 10 μ s to reduce power dissipation, resulting in increased power density and superior robustness.

"With the development of this new benchmark technology and state-of-the-art IGBT silicon platform, IR underlines its decades of commitment to the advancement of power electronics technology. Our goal is to achieve 100 percent inverterization of all electric motors for a more efficient use of electric energy and a greener environment," said Alberto Guerra, Vice President Strategic Marketing, IR's Energy Saving Products Business Unit.

The new technology offers softer turn-off characteristics ideal for motor drive applications, minimizing dv/dt to reduce EMI, and over-voltage, increasing reliability and ruggedness. A narrow distribution of parameters offers excellent current sharing when paralleling multiple IGBTs. The thin wafer technology delivers improved thermal resistance and maximum junction temperature up to 175°C.

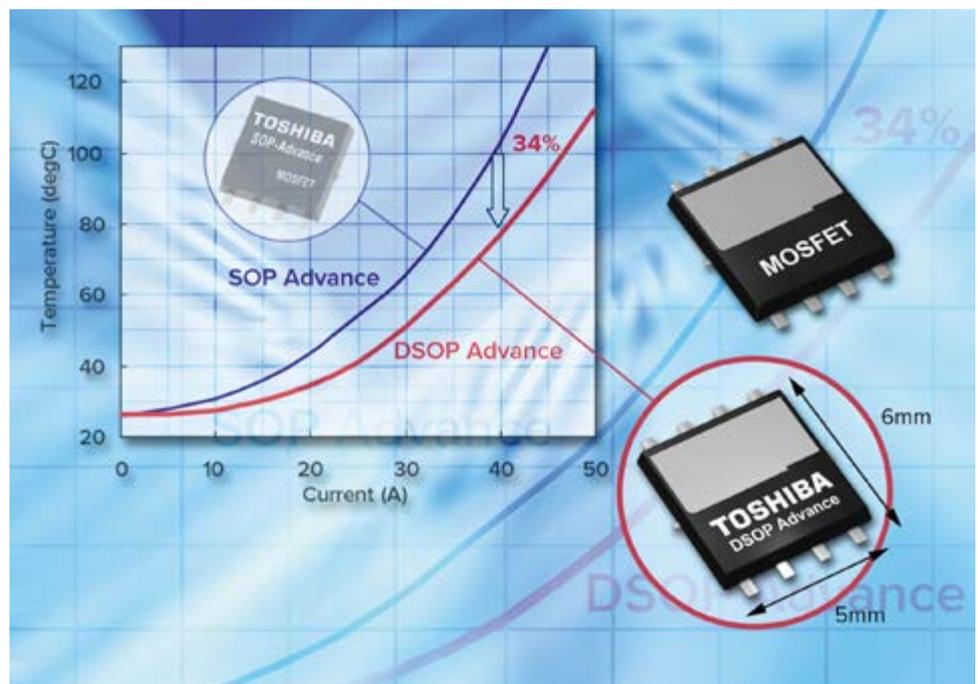
www.irf.com

Low-Voltage MOSFET Family with Dual-sided Cooling Packages

Toshiba Electronics Europe (TEE) has announced that its high-efficiency, low-voltage MOSFET technologies are now available in ultra-compact DSOP Advance package options. The new packages offer dual-sided cooling to significantly improve heat dissipation. This will help designers of high-component-density applications to minimise the PCB temperature and improve performance without board space penalties.

The DSOP Advance package shares the same 5mm x 6mm footprint as a SOP Advance device. In comparative tests operating temperatures – when used in conjunction with a suitable heatsink - for 30V MOSFETs were reduced by more than 34% at currents above 30A. In addition, in some designs the reduced thermal resistance of a DSOP Advance package may support elimination of a heatsink.

Toshiba will offer DSOP Advance packages with its existing UMOS VIII-H and its new UMOS IX-H families of MOSFET technologies. These technologies combine industry-leading on resistance ($R_{DS(ON)}$) ratings with low output capacitance to deliver ultra-efficient switching performance. DSOP Advance options will be available for a number of MOSFETs with voltage ratings between 30V and 100V initially.

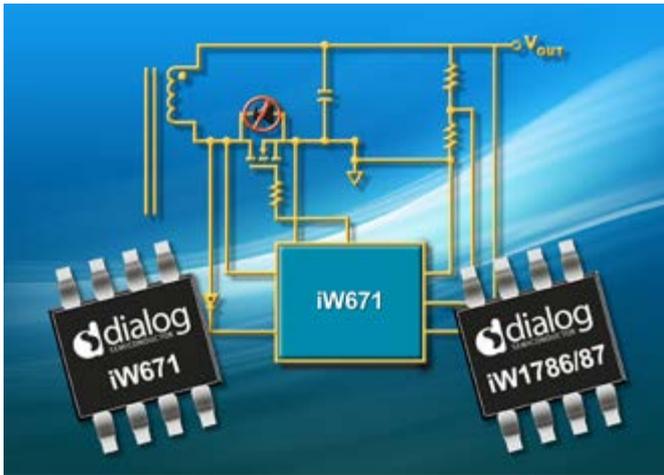


Target applications for the new DSOP Advance MOSFETs will include high-power density, high-performance switching designs including synchronous rectification circuitry in servers and telecoms power supply equipment, as well as power tools.

www.toshiba-components.com

AC/DC Product Portfolio includes now Synchronous Rectifiers

Dialog Semiconductor launched its iW671 synchronous rectifier designed to enable small, higher power adapters for mobile devices. The device replaces the secondary-side Schottky diode used in conventional power supplies with a more efficient MOSFET and works with Dialog iW1786 or iW1787 primary-side controllers to deliver efficiency greater than 88%. This enables the higher power density needed for more powerful, small form-factor adapters without exceeding thermal limits.



Conventional power supplies use Schottky diodes to rectify the output voltage (change the AC voltage to a DC voltage). When replacing the Schottky diode with a synchronous rectifier, the voltage dropped across the switching MOSFET is less than the forward voltage of the

Schottky diode, thereby reducing power loss. However, conventional synchronous rectifiers still require a Schottky diode to be used in parallel as they need to turn off when approaching the zero crossing to eliminate the risk of shoot-through, which can overheat and potentially destroy the power supply. The iW671 uses the proprietary digital control technology of Dialog to eliminate the need for the parallel Schottky diode. Synchronous rectification also leads to an efficiency improvement of approximately 4% at 5V, resulting in the high >88% full-load efficiency for higher power operation in a small form-factor without overheating the power supply.

The iW671 is designed to work for 15W or 50W output power, ultra-low no-load standby power consumption of <15mW (iW1786) and <30mW (iW1787) and high efficiency, enabling chargers and adapters to meet stringent global energy standards including the final 2014 U.S. DOE and European CoC version 5, tier 2 regulations.

Power supplies for electronic products continue to consume power when plugged in but not in use. To achieve low standby power, these power supplies typically enter a low standby operating mode. However, when a load is applied, they need to "wake up" quickly to keep the output voltage from dropping too low. Dynamic load response (DLR) is determined by the speed at which the system wakes up and responds to changes in the power load. Typical adapter and charger design approaches achieve low standby power and high efficiency at the expense of slow wake up (i.e. slow DLR performance). The iW671 enables ultra-fast DLR for quicker recovery from low-power standby mode by integrating an adaptive voltage position monitor that detects the flyback converter output voltage undershoot.

www.dialog-semiconductor.com/

Power Your Recognition Instantly

Based in Munich, Germany, ITPR Information-Travels Public Relations is a full-service consultancy with over a decade of experience in the electronics sector. As a small exclusive agency, we offer extremely high ROI, no-nonsense flexibility and highest priority to only a handful of companies.

Strategical Support

Corporate/Product Positioning, Market/Competitive Analysis, PR Programs, Roadmaps, Media Training, Business Development, Partnerships, Channel Marketing, Online Marketing

Tactical PR

Writing: Press Releases, Feature Articles, Commentaries, Case Studies, White Papers
Organizing: Media Briefings, Road Shows, Product Placements in Reviews and Market Overviews, Exhibitions, Press Conferences

Monitoring and Research: Speaking Opportunities, Editorial Calendars, Feature Placement, Media Coverage, Competitive Analysis

Translations: Releases, By-Lined Articles, Websites, etc.

Call or contact us today for a free consultation on how PR can dramatically affect your company's bottom line.

ITPR Information-Travels Public Relations
Stefanusstrasse 6a, 82166 Gräfelfing-Munich, Germany
Tel ++49 (89) 898687-20, Fax ++49 (89) 898687-21,
electronics@information-travels.com

www.information-travels.com



Microcontroller Family Provides Closed-Loop Digital Control and Safety Monitoring

Microchip announced expansion of its 8-bit PIC® microcontroller (MCU) portfolio, with the peripheral-rich, low-pin count [PIC16\(L\)F161X](#) family. These new MCUs introduce and expand the offering of Microchip's Core Independent Peripherals (CIP), which were designed to reduce interrupt latency, lower power consumption and increase system efficiency and safety, while minimising design time



and effort. These peripherals also reduce system complexity by eliminating the need for additional code and external components. Hardware-based peripherals offload timing-critical and core-intensive functions from the CPU, allowing it to focus on other critical tasks within the system.

The PIC16(L)F161X PIC MCUs offer the Math Accelerator (Math ACC) with Proportional Integral Derivative (PID), which provide completely Core Independent calculations, with the capability to perform 16-bit math and PID operations. The family also includes the Angular Timer (AngTmr), which is a hardware module that calculates the rotational angle in functions, such as motor control, TRIAC control, or Capacitive Discharge Ignition (CDI) systems. Regardless of speed, the AngTmr allows recurring interrupts at a specific rotational or sinusoidal angle without using the core's computation. The CIPs can be configured to perform a host of given functions that increase execution speeds and decrease software requirements. Offloading these functions frees up the CPU to do other tasks, consumes less programme memory, and reduces the overall power consumption of the MCU.

www.microchip.com/PIC16_LF161X-Family-Product-Page-111114a

The InnoSwitch Family Revolutionizes Switch-Mode Power-Supply Design

Power Integrations announced a new class of power-supply ICs. The InnoSwitch™ family of highly integrated switcher ICs combines primary, secondary and feedback circuits into a single, worldwide safety-rated, surface-mount package. With InnoSwitch ICs, designers can easily exceed all global regulatory standards for efficiency and no-load consumption, while minimizing component count and providing highly accurate constant voltage and constant current up to 25 W. The InnoSwitch family is ideal for smart mobile device chargers and adapters for a wide range of applications such as set-top boxes, networking equipment and computer peripherals.

Inside the new device, highly accurate secondary-side direct voltage and current measurements are communicated across the safety isolation barrier using high-speed digital FluxLink™ technology. This proprietary new feedback technique permits precise control without the need for a bulky optocoupler, while avoiding the performance compromises inherent in primary-side regulation (PSR), such as limited accuracy and efficiency and poor transient response versus no-load consumption. Furthermore, unlike primary-side regulated switchers, InnoSwitch-based secondary-side regulated (SSR) designs are inherently less sensitive to the tolerance of external components such as transformers, diodes, resistors and capacitors. This dramatically increases manufacturing yield and reduces total power supply cost. Now, mobile device chargers up to 5 A can have a total component count as low as PSR designs, with accurate CV and CC control (+/- 3% and +/- 5% respectively) and low voltage ripple. With high operating efficiency and <10 mW no-load consumption, the ICs easily comply with efficiency standards such as the California Energy Commission, European Union Code of Conduct (CoC) Version 5, Tier 2, and the upcoming US Department of Energy standards (DoE 6), which will become mandatory in February, 2016.

InnoSwitch power-supply ICs include a high-voltage power MOSFET, primary-side controller, FluxLink feedback technology and a secondary-side controller with synchronous rectification (SR). By combining

the SR function with the secondary-side master controller and by leveraging the speed of the FluxLink communication channel, the SR switch timing is optimized for maximum efficiency. The fast communication link also ensures highly reliable SR operation, eliminating shoot-through in either discontinuous conduction mode (DCM) or continuous conduction mode (CCM), even during transient loads and fault conditions. Effective SR operation in both DCM and CCM modes is especially beneficial in adaptive-voltage charger applications.



InnoSwitch ICs start up using bias current drawn from a high-voltage current source connected to the DRAIN pin, eliminating the need for external start-up components. An external bias winding reduces no-load and increases system efficiency during normal operation. The ICs also include comprehensive system-level features such as output over-voltage protection, overload power limiting, hysteretic thermal protection and frequency jitter to reduce EMI.

<http://www.power.com/innoswitch-ch>

World wide support in English by

Bodo's Power systems®www.bodospower.com

Asian support in Mandarin in China

Bodo's Power systems®www.bodospowerchina.com

China

Expanded Family of 650V SiC Diodes

Richardson RFPD, Inc. announced the availability and full design support capabilities for five new 650V silicon carbide (SiC) Schottky diodes from Cree, Inc.




Available from




The devices represent an expansion to Cree's family of Z-Rec™ 650V Junction Barrier Schottky (JBS) diodes that previously included 10A, 8A, 6A and 4A 650V diodes in TO-220-2 packages.

The entire line of JBS diodes offer zero reverse recovery current, zero forward recovery voltage, high-frequency operation, temperature-independent switching behavior, and extremely fast switching. They are ideally suited for switch mode power supply, power factor correction, solar inverter, motor drive, and electrical vehicle charger applications.

www.richardsonrfpd.com

YOU CAN'T COPY EXPERIENCE



PRECISION AND POWER RESISTORS



We invented the Manganin® resistance alloy 125 years ago. To this day, we produce the Manganin® used in our resistors by ourselves.

More than 20 years ago, we patented the use of electron-beam welding for the production of resistors, laying the foundation for the ISA-WELD® manufacturing technology (composite material of Cu-MANGANIN®-Cu). We were the first to use this method to manufacture resistors. And for a long time, we were the only ones, too.

Today, we have a wealth of expertise based on countless projects on behalf of our customers. The automotive industry's high standards were the driving force behind the continuous advancement of our BVx resistors. For years, we have also been leveraging this experience to develop successful industrial applications.

The result: resistors that provide unbeatable excellent performance, outstanding thermal characteristics and impressive value for money.



ISABELLENHÜTTE

Innovation by Tradition

Isabellenhütte Heusler GmbH & Co. KG

Eibacher Weg 3-5 · 35683 Dillenburg · Phone +49 (0) 2771 934-0 · Fax +49 (0) 2771 23030

sales.components@isabellenhuetten.de · www.isabellenhuetten.de

Optocouplers in 14.2mm Wide Creepage and Clearance for High Voltage Applications

Avago Technologies announced a new family of 14.2mm optocoupler devices, the ACNT-Hxxx, designed for high voltage applications. The ACNT-Hxxx family consists of three major product series: the ACNT-H3xx, high efficiency gate drive optocouplers for driving IGBTs; the ACNT-H6xL, low power 10MBd digital optocouplers for system control and data communications; and the ACNT-H79x, high linearity isolation amplifiers for current and voltage sensing applications.



ACNT-Hxxx Highlighted Features and Benefits: Safety Approvals for CSA, UL and IEC, IEC/EN/DIN EN 60747-5-5: VIORM = 2,262 Vpeak, UL1577: VISO = 7,500 Vrms, Robust, reliable and fail safe reinforced

insulation, 14.2mm Creepage and Clearance, Industry's highest insulation voltage in compact 14.2mm SSO-8 package, Meets stringent system and equipment regulatory requirements

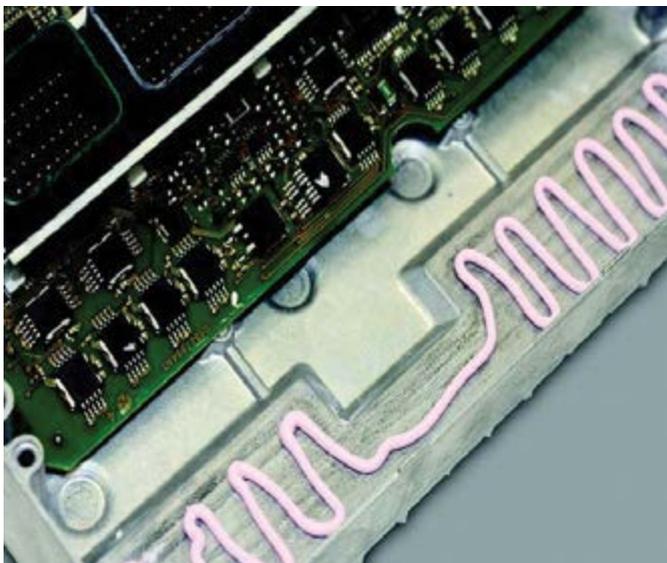
High Gate Driving Current and Noise Immunity (ACNT-H3xx), Minimum 2A output current for driving IGBT, Minimum 40kV/μs CMR at VCM = 1.5 kV minimizing erroneous signals in driving IGBT in noisy environment, Low Power Consumption (ACNT-H6xL), Less than 20 mW, Industry's lowest power 10MBd optocoupler in compact 14.2mm SSO-8 package, Excellent Linearity and Gain Accuracy (ACNT-H79x), Advanced sigma-delta A/D modulation technology with full differential isolation
0.05% linearity and -50ppm/°C gain drift for enhanced accuracy.

"High-voltage power systems today require chip-level components to support well insulated and noise-immune large signals to minimize copper wiring costs while maintaining optimal power efficiency", said Kheng-Jam Lee, marketing director of Avago's Isolation Products Division. "Avago has stepped up to the challenge with the introduction of a new 14.2mm optocoupler family. With the industry's highest insulation voltage in compact SSO-8 footprint, the ACNT-Hxxx is the most complete and cost-effective set of high-voltage optocoupler solutions on the market today addressing a wide range of high power industrial applications including inverters, motor drives and power supplies."

www.avagotech.com

Thermal Management Solutions with THERM-A-GAP™ Gel with Conductivity Extensions to 6 W/m-k

As more and more high performance electronics are utilised across a wide range of applications, it has stimulated a growing need to provide new innovative thermal materials that can effectively manage the heat dissipation challenges. In line with this need Parker Chomerics is constantly evolving its range of THERM-A-GAP™ thermally conductive dispensing gels in order that customers can maintain both system performance and reliability. As the market leader in this domain Parker Chomerics has recently extended its range of gels



to offer thermal conductivity up to 6 W/m-k and typical applications include high performance devices requiring minimal thermal resistance, ranging from automotive electronic control units (ECUs), power supplies and semiconductors, through to memory/power modules, microprocessors/graphics processors, flat panel displays and consumer electronics.

Heat generated by high performance devices must be removed to the ambient environment to maintain the junction temperature of components within safe operating limits. Often this heat removal process involves conduction from a package surface to a heat spreader that can more efficiently transfer the heat away. The spreader has to be joined carefully to the package to minimise the thermal resistance of this newly formed thermal joint.

Typical thermal interface materials include THERM-A-GAP™ gels, which are supplied as pre-cured, single component compounds that can be dispensed over the heat generating package or component. These materials are silicone-based formulations loaded with conductive fillers, which are cross-linked to form a low modulus gel.

The latest additions to the innovative THERM-A-GAP™ family, are setting new benchmarks in performance as they need only ultra-low compression force to conform over irregular interfaces and can be applied to single devices with minimum bond-line thickness as well as to multiple devices with variable Z-axis tolerances. The gel structure provides superior long-term thermal stability and reliable performance over conventional greases, which suffer from pump-out and dry-out issues.

www.parker.com/chomerics

LeaXield™ EMC Filters Minimizes Earth Leakage Currents

TDK Corporation presents the EPCOS LeaXield™ active filter module – a completely new solution for the minimization of earth leakage currents in power drive systems with frequency converters. Leakage current can cause RCDs (residual current device) to trip. In some applications this means that RCDs with low thresholds such as 30 mA cannot be used, or only with substantial additional expense. The LeaXield active filter module is connected between the RCD (residual current device) and the EMC input filter of the converter in standard three-phase industrial power grids and does not require an additional power supply.



LeaXield detects the common-mode currents on the load-side via a current sensing transformer. An amplifier generates an inverse of the leakage currents and feeds them to the power line via a capacitor network. This produces almost complete cancellation of the leakage currents. LeaXield is now designed for rated currents of up to 150 A for 3-phase grids at frequencies of 50/60 Hz and a rated voltage of 520 V AC. The new active filter can be used in systems with leakage currents of up to 1000 mA.

Besides minimizing earth leakage currents, LeaXield active filter modules can also improve the EMC performance of power drive systems in the range up to around 500 kHz. The new active filter module achieves typical common-mode attenuation values of up to 30 dB at 4 kHz, 40 dB at 10 kHz, and 15 dB at 150 kHz.

The EPCOS LeaXield module can be retrofitted into existing converter-based installations in order to improve their EMC and the RCD compatibility of the power drive system. Moreover, LeaXield circuits can be integrated into new EMC filter solutions in order to downsize the expensive current-compensated filter chokes.

www.epcos.com

emv



International Exhibition with Workshops
on Electromagnetic Compatibility (EMC)
Stuttgart, Germany, 24 – 26 March 2015

Take the chance to step into the European market!
Save the date and come to Germany to be part
of Europe's marketplace for electromagnetic
compatibility.

Further information:
web: e-emc.com
phone: +49 711 61946 63
email: emv@mesago.com

mesago
Messe Frankfurt Group



The 1st Power Analyzer

... that lets you have it both ways.

**Two paths.
One measurement.
In half the time.
Zero compromises.**

The **LMG670** with its unique **DualPath** architecture is the long-awaited solution to a well known dilemma. When optimizing designs for power applications with high-frequency content, engineers were forced to choose between analysis on the full power spectrum or a specific portion only. Simultaneous measurements were impossible. To filter, or not to filter - that was the question.

DualPath is the answer.



Up to 7 channels · DC – 10 MHz · Accuracy 0.025% · 500 µA to 32 A
3 mV to 1000V · Touchscreen · Gbit-Ethernet · DVI/VGA interface

Experience the new **LMG670** with **DualPath** live at:

- Motor & Drive Systems 2015 January 21-22 (Orlando, FL, USA)
- APEC 2015 March 15-19 (Charlotte, NC, USA)
- EMV 2015 March 24-26 (Stuttgart, Germany)

ZES ZIMMER (Headquarter): +49 6171 628750 · sales@zes.com
ZES ZIMMER Inc. (US): +1 760 550 9371 · usa@zes.com
www.zes.com

Low Profile Polymer Capacitor Family

Panasonic Automotive & Industrial Systems has introduced a new low profile version of its SP-Cap range of speciality conductive polymer aluminium capacitors. Measuring just 0.9mm above the PCB, the devices (LR & SR series) are rated from 2V up to 6.3V with capacitance values of 68 to 220µF. Capacitance tolerance is ±20% (120Hz / +20degC).

Polymer capacitors present several advantages over other electrolytic devices", explains Melanie Raimann, European Product Manager for Polymer Capacitors at Panasonic. "Thanks to their ultra-low ESR values, polymer capacitors have a low impedance near their resonance point which helps to smooth ripple voltage in power circuits. Polymer capacitors, unlike ceramic devices, suffer no capacitance drifts due to temperature changes and DC bias, so they remain stable over time. Lastly, polymer capacitors have a self-healing capability that eliminates failures due to cracking in the dielectric layer caused by

electrical or mechanical stresses."

Panasonic has also announced several other enhancements to the SP Cap devices. The company has upgraded the ripple current rating of the range, which can now handle up to 10.2Arms at 45degC, two and a half times higher than previous devices. Devices are also now available with up to 25V working range and focus devices in the family now feature an extended life to 2000 hours at 105degC that enables an application endurance of 10years at an ambient temperature 70degC.

Finally, several devices in the family will be available on smaller 500 piece reels to help with flexibility and prototyping requirements. A catalogue detailing all Panasonic's new SP-Cap polymer aluminium capacitors can be freely downloaded at:

http://industrial.panasonic.com/jp/i/29880/SPC_E/SPC_E.pdf

Advertising Index

ABB Semiconductor	C3	EMV	62	Magna	39
Allegro	15	esar	31	Omicron	35
APEC	37	Fuji	25	PCIM Asia	45
CDE	7	GvA	C2+21+45	PCIM Europe	41
CUI	53	Hitachi	11	Plexim	3
Danfoss	57	Husum Wind	57	Semikron	19
Dr. Seibt	43	Infineon	9	STS	43
Dynex	17	IR	C4	Texas Instruments	13
ECCE	63	Isabellenhütte	61	VMI	51
electronicon	33	ITPR	58	Würth	23
embedded	29	Lem	5	ZES Zimmer	64



HiPak. Hot applications require innovative solutions.



Flicker from steel smelters is compensated with multi-level voltage source SVC (Static VAR compensation) taking advantage of ABB's innovative HiPak IGBT modules, eg the new 3,300 volt 500 ampere dual module.

Demanding high-power applications such as traction inverters, medium voltage drives, wind turbines, HVDC and FACTS benefit from the high reliability of ABB's HiPak modules.

ABB's family of HiPak modules are available from 1,700 to 6,500 volt as single IGBT, dual / phase-leg IGBT, chopper and dual diodes. All modules feature low losses combined with soft-switching performance and record-breaking Safe Operating Area (SOA).

For more information please contact us or visit our website:

www.abb.com/semiconductors



StrongIRFET™ Rugged, Reliable MOSFETs

Specifications

Package	$B_{V_{DS}}$ (V)	I_D @25°C (A)	$R_{DS(on)}$ max @ $V_{GS} = 10V$ (mΩ)	Q_g @ $V_{GS} = 10V$ (nC)	Part Number
PQFN 5x6	25	100	0.95	56	IRFH8201TRPbF
	25	100	1.05	52	IRFH8202TRPbF
	30	100	1.1	58	IRFH8303TRPbF
	30	100	1.3	50	IRFH8307TRPbF
	40	100	1.4	134	IRFH7004TRPbF
	40	85	2.4	92	IRFH7440TRPbF
DirectFET Med.Can	40	85	3.3	65	IRFH7446TRPbF
	30	192	1.3	51	IRF8301MTRPbF
	40	90	1.4	141	IRF7946TRPbF
D²-Pak	60	114	3.6	120	IRF7580MTRPbF
	40	195	1.8	150	IRFS7437TRLpBf
	40	120	2.8	90	IRFS7440TRLpBf
D²-Pak 7pin	60	120	5.34	86	IRFS7540TRLpBf
	40	195	1.5	150	IRFS7437TRL7PP
	60	240	1.4	236	IRFS7530-7PP
D-Pak	40	90	2.5	89	IRFR7440TRPbF
	60	90	4	86	IRFR7540TRPbF
TO-220AB	40	195	1.3	300	IRFB7430PbF
	40	195	1.6	216	IRFB7434PbF
	40	195	2	150	IRFB7437PbF
	40	120	2.5	90	IRFB7440PbF
	40	118	3.3	62	IRFB7446PbF
	60	195	2.0	274	IRFB7530PbF
TO-247	40	195	1.3	300	IRFP7430PbF

Features:

- Ultra low $R_{DS(on)}$
- High current capability
- Industrial qualified
- Broad portfolio offering

Applications:

- DC Motors
- Inverters
- UPS
- Solar Inverter
- ORing or Hotswap
- Battery Packs

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

International
IOR Rectifier
THE POWER MANAGEMENT LEADER