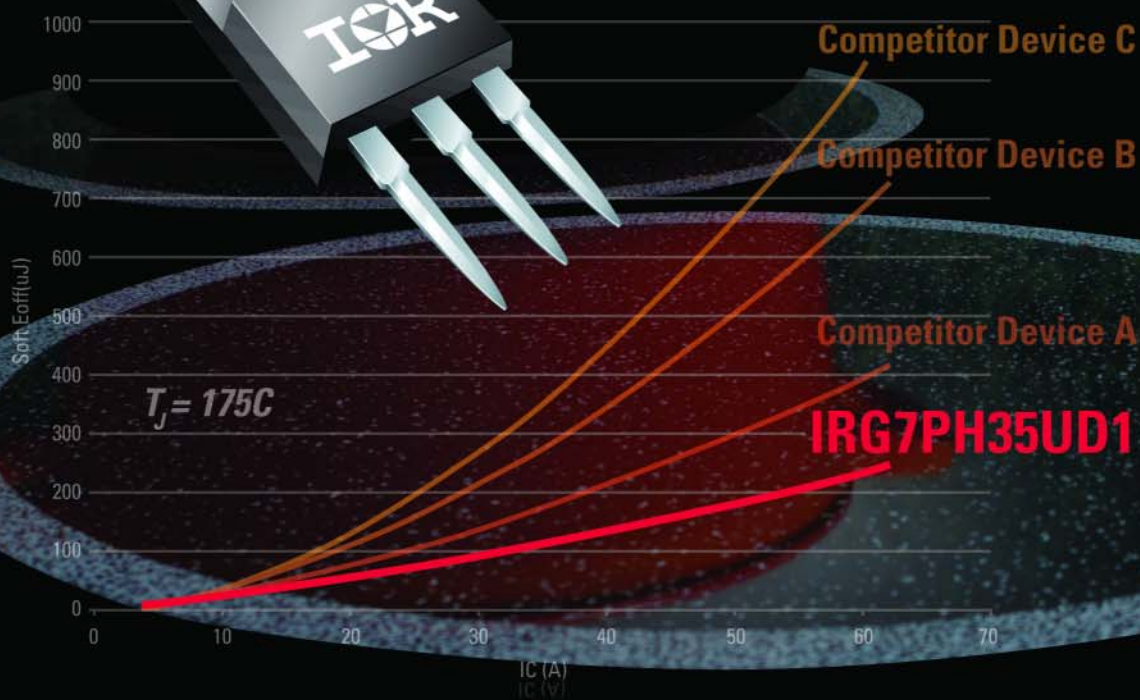
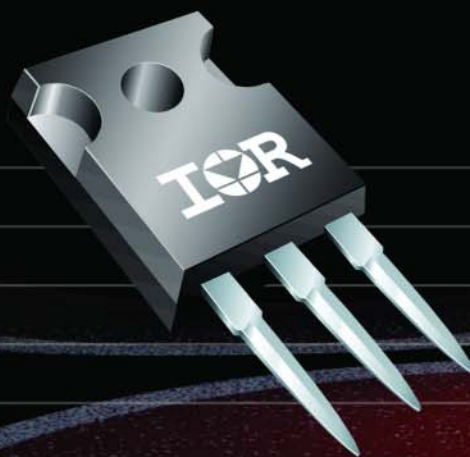


Bodo's Power Systems®

Electronics in Motion and Conversion

April 2012



IOR International Rectifier

PCIM
EUROPE



Nuremberg, 8 - 10 May 2012

Preview

Ferraz Shawmut
is
now

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info.sbm@mersen.com

Nuremberg Germany
Hall 12 Stand 444



Hannover Germany
Hall 13 Stand F77



ENERGY UNDER CONTROL



- Power Capacitors
 - Capacitors for Power Electronics
 - Induction Heating Capacitors
 - Reactors (Inductors)
 - Capacitor Banks
 - Components for PF Correction
- PCIM Booth 12-444**

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Green Innovators of Innovation



www.lsis.biz



LSIS Power Module Solution

- 2 Pack IGBT 50~400A / 600~1700V
- 2 Pack MOSFET 30~60A / 500~900V
- 4 Pack IGBT/MOSFET 50~100A / 600~1200V
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- 2 Pack, 6 Pack MOSFET 100~1000A / 75~150V
- CIB 6~50A / 600~1200V
- Welding Machine • UPS / SMPS
- Inverter (Motor Drive) • Induction Heating
- PV Inverter • Electric Vehicle/ Bike • Wind Power

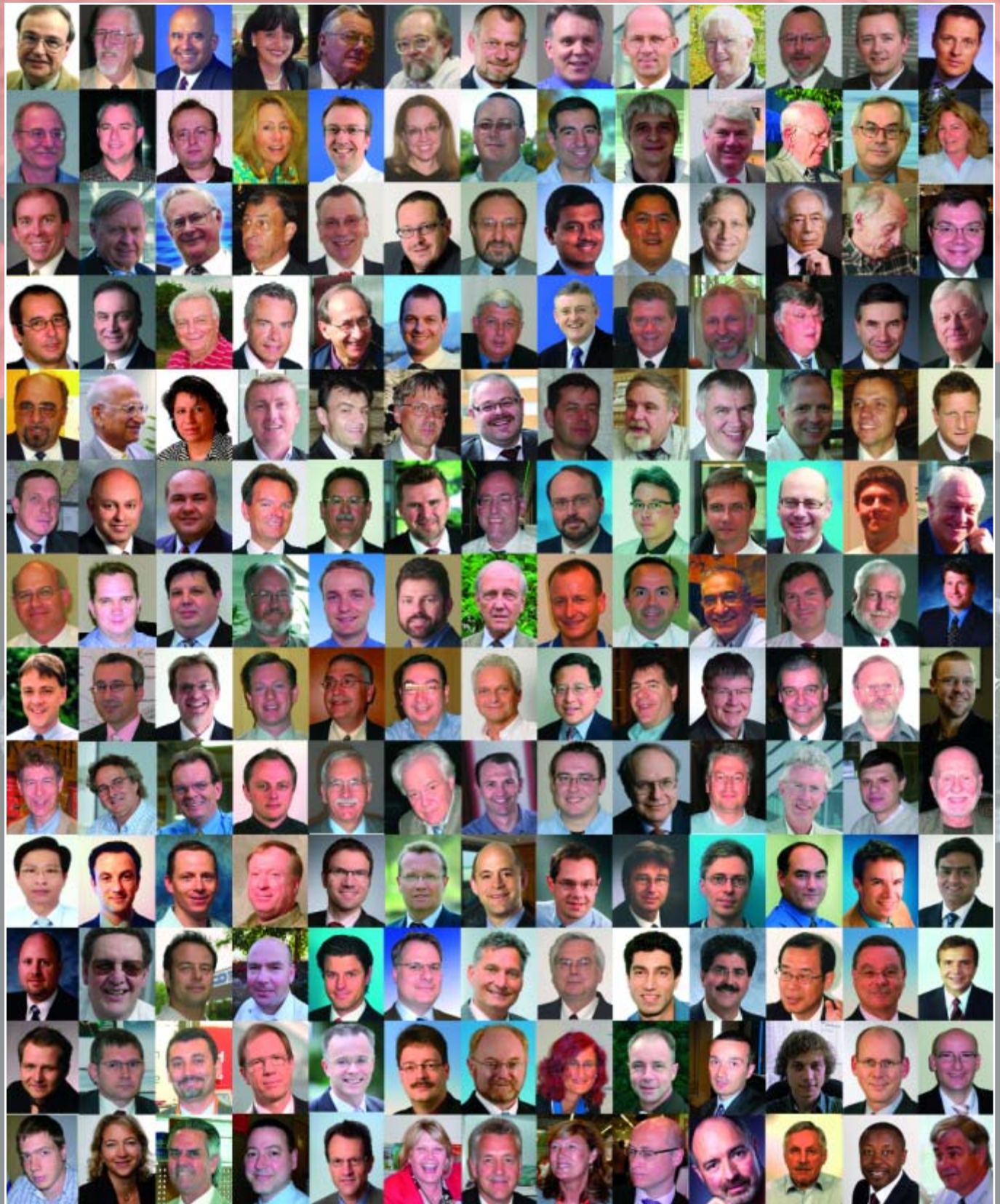
PCIM Booth 12-211/12-408



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The Gallery



Expansion of Munich Technology Development Centre



The extended focus comprises

- Device and process simulation
- High Power Package development
- Technologists and Application experts for SuperJunction and Wide Bandgap Materials
- Automotive High Voltage Technical Marketing

Packaging Development Engineer

Job description:

You will be responsible to investigate new materials for the power semiconductor packaging, develop new packaging technologies and processes. You will define the design of new power semiconductor packages based on requirements from different applications in terms of functionality, quality and costs. Moreover you will support the assembly lines in the assessment and introduction of new assembly processes and equipment.

Job requirement:

We are looking for highly innovative and self-motivated individuals with a Master or PhD degree in Microsystems Technology, Material Science or Physics. At least 4 years experiences in the design of power semiconductor packages are desired. Mechanical and thermal simulation skills, experience with 3D mechanical CAD experience is of advantage.

HV Technical Product Marketing Manager

Job description:

Work with automotive OEM's and suppliers to understand EV/HEV projects, requirements, and timing. Develop Fairchild product roadmaps for HV IGBT's, MOSFET's, Rectifiers, and Gate Drivers aligned with business strategy and opportunities and interface with Technology Development to coordinate technology roadmaps. Develop business cases for product developments and champion through the process. Launch new products, manage roll out and promotions to achieve objectives. Interface with automotive sales, providing product technical training and support.

Job requirement:

We are looking for innovative and self-motivated individuals, Master degree in Electrical Engineering, Physics or similar is a must, business background and Automotive experience is an advantage. At least 3 years of professional experience required.

We offer:

Start-up spirit in highly inspirational and expanding team in Munich; space for fundamental and scientific research; very competitive, performance oriented compensation schemes; high strategic impact and visibility within a global company.

The newly formed R&D centre, located in Munich, provides opportunities to new members to closely work with existing global Fairchild Technologists in US, Sweden and Korea, as well as to work in partnerships with Research institutes and hand selected partnership programs with competitors.

Device Simulation/Technology Experts

Job description:

Development and architectural innovation for Fairchild's next generation High Voltage power devices including IGBT, SuperJunction FETs, SiC and GaN devices. You will be closely collaborating with teams in Sweden, US and Korea for process and package development.

Job requirement:

We are looking for highly innovative and self-motivated individuals, Master or PhD degree in Electrical engineering, Physics or similar. At least 3 years of professional experience required.

Application and Marketing Manager, Silicon Carbide Technology

Job description:

You will be adding value to the systems of our customers, and at the same time realize and enabling the true value of Fairchild's SiC components. You are a strong driver and will develop yourself towards a leading role and towards truly technology based business and market development. Your knowledge of manifold approaches on power stage design impacts the rest of the system, e.g. cooling, control and filtering will enable novel power conversion designs to make use of the superior performances of our silicon carbide components.

Job requirement:

We are looking for highly innovative and self-motivated individuals with Master or PhD degree in Electrical engineering, Physics or similar. You have collected a solid background as power electronics designer in the power conversion industry and a deep understanding of power devices and converter systems. At least 5 years of professional experience required. The location of this role could be either Kista/Sweden or Munich/Germany.

PCIM Booth 11-320

Contact:

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Events

eCarTec Paris,

France, April 3rd-5th www.ecartec.de

expoelectronica,

Moscow Russia, April 11th-13th
<http://expoelectronica.primexpo.com>

Forum Battery,

Aschaffenburg Germany, April 18th-19th
www.batteryuniversity.eu

PCIM Europe,

Nuremberg Germany,
May 8th 10th www.mesago.de/de/PCIM

SMT Hybrid,

Nuremberg Germany, May 8th 10th
www.mesago.de/de/SMT/home.htm

Simulation in Automotive Lightweight,

May 9th-10th
www.vdi.de/simulationlightweight

Sensor + Test,

Nuremberg Germany, May 22nd-24th
www.sensorfairs.de

SiC work shop,

Kista Sweden, May 27th-28th
www.b2match.com/isicpeaw2012/

Nuremberg in May

PCIM Europe in Nuremberg, together with
SMT Hybrid Packaging, will highlight the
synergy between power components, mod-
ule manufacturing, and applications - May
8th, 9th and 10th will be busy days. Tutorials
start even earlier, on the 6th. The days after
Easter will fly by while we're all getting ready
for these conferences.

As in past years, I will have a podium dis-
cussion at the Forum meeting room in Hall
12, Booth 670, on Wednesday the 9th from
12:20 to 13:20. This year's topic is "Efficient
DC/DC Conversion." Experts from the semi-
conductor industry will present a compre-
hensive message and then engage with the
audience for questions and discussion – last
year it was a very lively interaction. Differing
opinions and a spirited debate about the
best solutions helps round out our under-
standing of the subject.

Engineers have the skills to develop more
efficient solutions, consistent with an envi-
ronmentally friendly approach (and it is the
utmost task of politicians to support these
activities). We in the profession need to
encourage young people to embrace engi-
neering as a career which offers both intel-
lectual and societal satisfaction. The March
cover story by Mr. Bresch did a great job of
highlighting this. We must all support
schools in teaching physics to the students.
Planting must be done while the ground is
receptive. We engineers need to actively
involve children in what we do every day to
give them a taste of how interesting this pro-
fession can be.

Engineering work usually has a long-term
effect, an aspect that is sometimes missing
in our children's education. Classes are
mostly scheduled in one hour segments but
longer term projects in our schools could
help show kids what it takes to reach out for
a design objective and then complete it – in
months or even years. I remember spending
weeks as a child setting up my trains in our
living room prior to Christmas, and as Easter
approached it was the other way round -



cleaning the equipment and getting it back
into the boxes. All those boxes are still in my
cellar, always ready for my grandnephews to
explore. Most young people today have
computer games and try to get satisfaction
by fighting with the animation. Do they get
what they expect? Is it all too quick and
easy?

Take your kids to technical shows and help
them explore their world at these events.

Communication is the only way to progress.
We delivered twelve issues last year and will
continue this year each month, on time,
every time. So far this year we have pub-
lished 256 pages, and as a media partner
Bodo's Power Systems is internationally
positioned. Do not miss seeing our first Chi-
nese version: www.bodospowerchina.com.

My Green Power Tip for April:

Your next watch should be a mechanical
automatic one. Think of how many batteries
will be saved over the life of your watch. This
will help reduce waste.

See you, and hopefully your kids,
in Nuremberg

Best regards

**Future precision.
Future performance.
Now available.**



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- Low offset and gain drift
- High Accuracy @ +85° C
- Access to Voltage Reference
- Analog Voltage output

www.lem.com

PCIM Booth 12-402

At the heart of power electronics.

ECPE Calender of Events

PCIM Europe 2012, Conference and Exhibition, 8 - 10 May 2012, Nuremberg, Germany
International Conference on "Power Electronics, Intelligent Motion, Power Quality"
Website: PCIM 2012, Conference Programme: Conference Programme PCIM 2012

ISPSD 2012, Symposium, 3 - 7 June 2012, Bruges, Belgium
The 24th IEEE International Symposium on Power Semiconductor Devices and ICs
Website: ISPSD 2012, Conference Programme: Conference Programme ISPSD 2012

EPE-PEMC 2012, Conference and Exposition, 4 - 6 September 2012, Novi Sad, Serbia
15th International Power Electronics and

Motion Control Conference and Exposition
Website: EPE-PEMC 2012

LpS 2012, Symposium, 25 -27 September 2012, Bregenz, Austria
2nd LED professional Symposium + Expo
Website: LpS 2012, Call for Papers: Call for Papers LpS 2012

ESREF 2012, Symposium, 1 - 5 October 2012, Cagliari, Italy
23rd European Symposium on Reliability of Electron Devices Failure Physics and Analysis
Website: ESREF 2012, Call for Papers: Call for Papers ESREF 2012

EDPC 2012, Conference and Exhibition, 16 - 17 October 2012, Nuremberg, Germany

2nd International Electric Drives Production Conference and Exhibition

Website: EDPC 2012, Call for Papers: Call for Papers EDPC 2012

Furthermore, we would like to draw your attention to the following ECPE event:

ECPE Tutorial Power Semiconductor Devices & Technologies
19 - 20 March 2012, Barcelona, Spain

The ECPE Calendar of Events 2012 with all ECPE Workshops and Tutorials is available for download on the ECPE website:

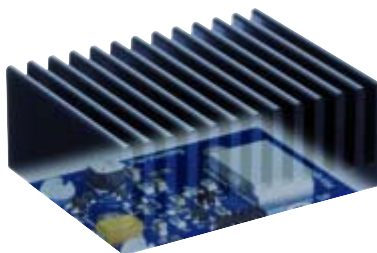
PCIM Booth 12-470

www.ecpe.org

Pan-European Distribution

Arrow Electronics and Micropelt have signed an agreement that will enable Arrow to offer Micropelt's full range of thermoelectric energy-harvesting semiconductor devices and systems to its customer base throughout Europe. A key focus area will be the fast-growing energy-harvesting application sector where low-power devices derive energy for their operation from the environment.

Based in Germany, Micropelt uses its patented scalable thin film microstructuring platform technology to produce thermoelectric devices for cooling, thermal cycling and



energy-harvesting applications. The technology, which turns heat (temperature differences) into electrical energy, enables com-

ponent size to be minimised while maintaining high-power density levels. A typical application is in autonomous wireless sensor networks and micro actuators where Micropelt's thermogenerators can match or exceed the energy level supplied by battery packs without the lifecycle costs associated with battery replacement and maintenance.

www.arrow.com

www.micropelt.com

Convenient Online Selection Tool for LED Driver Reference Designs

Power Integrations launched an online selection tool that enables users to rapidly identify the best power supply reference design for their LED lighting application. The LED Design Selector allows engi-

neers to enter simple selection criteria and provides the best choice from Power Integrations' library of reference design options for LED lighting.

Starting with basic decisions such as application and power level, the LED Design Selector enables users to quickly and easily see the filtered, optimized results. For example, the new LED Design Selector eliminates the laborious process of screening multiple designs while evaluating the effect of isolated vs. non-isolated topology or power range. After new data are entered, the best solutions are immediately displayed, enabling the designer to make a rapid and informed choice.

Comments Andrew Smith, product marketing manager for LED lighting applications at Power Integrations: "The LED Design Selector is ideal for lighting designers working to optimize their LED driver based on multiple electrical and physical design requirements. Using the new tool, engineers can quickly identify the best design approach and clearly understand the design trade-offs."

The LED Design Selector is available at

www.powerint.com/en/applications/led-driver-ics/led-design-selector



PCIM Booth 11-304

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Reactor

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- Reduction of commutation notches
- Protection of motor drive electronics
- Limitation of inrush currents
- Improve power factor



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- Low inductance
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- Evenly distributed capacitance
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- Low thermal resistance
- Corrosion resistance of cooling channels
- Connector stable construction for high clamp force



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Film Capacitor

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- High ripple current capability
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www.eagtop.com

PCIM Booth 12-481

Reactor/Water Cooling Reactor/Braking Resistor/Braking Unit/Laminated Busbar/Filter/Film Capacitor

Jeffrey Grudzien as Vice President of Advanced Circuit Materials Division



Rogers Corporation announced the appointment of Jeffrey Grudzien as Vice President of its Advanced Circuit Materials Division, replacing Michael Bessette, who is retiring after 37 years with the Company.

Grudzien joined Rogers in 2000, and has served as Vice President of Global Sales & Marketing for the past 4 years. Previously he served as Director of Asia Sales, Corporate Director of Marketing, and Marketing Director for the High Per-

formance Foams Division of Rogers Corporation.

In his new role, Grudzien will be responsible for managing the performance, strategic direction and growth of Rogers' Advanced Circuit Materials business, and guiding the division's commercial and technology development of next generation high frequency materials. His appointment is effective immediately.

"Jeff has demonstrated outstanding customer and market focus leadership for Rogers over the past 12 years," commented Bruce Hoechner, Rogers' President and CEO, "and I am confident he will provide strong global leadership for our Advanced Circuit Materials business while helping to lead its continued growth in the future."

Grudzien holds a B.S. degree in Chemical Engineering from the State University of New York at Buffalo. He will make his home in Chandler, AZ.

PCIM Booth 12-410

www.rogerscorp.com

50 years innovating in magnetic



On Friday
March 2nd of
1962 was a
sunny day in
Barcelona,
like today.

That was the

day on which an industrial and pushing Catalonia, which received constant migration, some enterprising, and experienced, which had been a few years before factory equipment of Radio and Television, Lavis, form a company to manufacture Electronics-assemblies and components, hence Premo. The spirit of the founding partners, Mr. Vila, Mr. Soteras and Mr. Palau, was continued a decade and a half later by Mr. Gazo and Mr. Rodriguez, who maintain values and culture but make the company to an international player with aspirations of excellence and distinction until 2006. Since then, we have continued to refine and innovative global profile of our company, positioning it in the most important worldwide technology sectors with RFID and the Electric Vehicle.

A company is its people, who are more than 600 and thousands people who were, their environments, customers and suppliers, their physical surroundings, economic and social development. Main objective, often repeated by Rodriguez is last. We have done it 50 years and we worked to get it 50 more, with the commitment of all. Congratulations to all, Congratulations to Premo.

www.grupopremo.com

www.bodospower.com

T&M Manufacturer Starts EU Operations



Rigol Technologies Inc., Beijing, is one of the worldwide leaders in test and measurement instrumentation. Headquartered in Beijing, China, the company was founded in 1998 and employs

more than 400 people, including over 100 R&D engineers.

Effective October 1st, 2011 Rigol Technologies Inc., Beijing, China has started their European sales and support operations in Puchheim near Munich, Germany. Wolfgang Bartels was assigned Managing Director of the newly founded Rigol Technologies EU GmbH and runs a team of administration and inside sales, as well as customer sup-

port, product training and application consulting in pre and after sales support.

The customer sales and support center not only offers technical support including pre sales consulting, but also programming support and commercial consulting. To provide instant availability of devices, there will be also a warehouse in Puchheim.

Rigol Technologies EU GmbH as one of the first Chinese manufacturers of T&M products is committed to offer high quality devices and to provide local customer service and support. The European organisation will now rapidly build up and enhance support to European markets and customers.

<http://eu.rigol.com>

Listing to the NASDAQ Capital Market

CUI Inc's parent company, CUI Global, Inc. announced that the company is now listed and trading on the NASDAQ Capital Market. In conjunction with that listing, the company has completed a \$10,000,000 equity raise with the assistance of its US Investment Banker, Merriman Capital, Inc. and its London advisor, Prosdocimi Ltd.

The proceeds of the raise will be used by the company for working capital; to pay down and retire certain corporate debt; and to rapidly bring its new Vergence™, Novum® Advanced Power, and Solus™ Power Topology Technologies to the marketplace.

In celebration of the listing, the company, its officers and directors, along with shareholders, presided over the NASDAQ closing bell

ceremonies on Friday, February 17, 2012.

"This equity raise and the up-listing represent significant milestones for CUI Global and its shareholders," remarked the company's president and CEO, William Clough.

"These funds will enable us to retire yet more debt and to dramatically speed up the development and commercialization of our leading-edge natural gas and electronics technologies."

"Our listing on a national exchange as prestigious as the Nasdaq Capital Market will broaden our shareholder base and increase visibility for our achievements moving forward," concluded Clough.

www.cuiglobal.com

Online Design Tool for LED Lighting

Infineon Technologies enhanced its online design solution Infineon Light Desk, adding additional features and the support for a new series of AC/DC off-line LED drivers.

The Infineon Light Desk is an interactive, cloud-based design and verification environment that enables selection and configuration of LED driver ICs in a broad range of applications. Using the Infineon Light Desk, design engineers can identify the LED driver ICs that meet their specific system requirements. For the selected LED driver, the tool creates a custom design displayed in an interactive web schematic. Users can analyze the design performance by running system simulation models based on the Transim WebSIM® remote simulation technology.

With the offered redesign functionality users can optimize the proposed LED driver design. Infineon Light Desk offers to download instantly the Bill of Material for the final

design as well as a comprehensive design summary report that includes design data, schematic and simulation results. Users can save designs for future reference as well as collaborate on designs with other users within a secure shared workspace. Additionally, the tool has an offline simulator SimT powered by SIMetrix/SIMPLIS: The simulator allows users to run their reference designs offline which enhances the simulation time. Users can directly download the simulator from the Infineon Light Desk. The Infineon Light Desk already supports custom designs for new high power DC/DC LED driver ICs (ILD series) as well as linear LED driver ICs (BCR3x and BCR4x series) for general lighting applications.

PCIM Booth 12-415

www.infineon.com

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THICK FILM & METAL FOIL RESISTORS

UP TO 750 W



DIRECT WATER-COOLED

UP TO 3 KW



HIGH ENERGY DISC & PRESS-PACK

UP TO 80 KJ

VISIT US AT PCIM B418 HALL 12

SEMIKRON Acquires the Finnish Company Nidecon

SEMIKRON International, a leading manufacturer of power semiconductors, took over the Finnish Company Nidecon Technologies Oy, as of December 29, 2011. Nidecon is a specialist in power quality filter technology for drives and renewable energies and has its headquarter in Vantaa, Finland.

Nidecon's product portfolio includes LC/LCL filters, dUdT filters, common mode reactors and harmonic chokes for passive power factor correction. The current range covers 4A to 2000A.

SEMIKRON aims to integrate Nidecon's innovative power quality filters into power semiconductor solutions and to provide local production in the seven SEMIKRON Solution Centers located in France, China, Korea, USA, Brazil, India and South Africa.



Dirk Heidenreich, CEO SEMIKRON International GmbH (l), and Jarkko Salomäki, CEO of Nidecon Technologies Oy. (r)

Nidecon's CEO Jarkko Salomäki states: "Belonging to the global SEMIKRON group, Nidecon can take advantage of SEMIKRON's production facilities, sales channels

and packaging technologies." "Nidecon's product range is quite complementary to Semikron's product portfolio", says Dirk Heidenreich, CEO of SEMIKRON International GmbH. "It opens up new opportunities for the integration of power electronics components." New proprietary technologies enable Nidecon to reduce the typical filter size by 35% to 50%. Therefore, these innovated technologies are ideally suited for SEMIKRON power semiconductor solutions with integrated semiconductors, cooling, DC-link capacitors and driver electronics.

PCIM Booth 12-415

www.semikron.com

www.nidecon.com

Fraunhofer ISE Inaugurates Solar Hydrogen Filling Station

On March 2, 2012, the Fraunhofer Institute for Solar Energy Systems inaugurated a solar hydrogen filling station. Sponsored by the Ministry of the Environment Baden-Wuerttemberg, the publically accessible filling station serves not only as a demonstration platform but also represents a milestone in the progressive network of hydrogen filling stations being set up in the State of Baden-Wuerttemberg.

The energy transformation with the significant expansion of renewable energies needs hydrogen both as a long-term storage and as fuel for the mobility sector. Using electricity generated from solar or wind power, hydrogen is produced by means of electrolysis. Once tanked with hydrogen in a fueling



time of about only 3 minutes, fuel cell cars can travel a distance of more than 400 km. The hydrogen filling station in Freiburg is one of the few stations that exhibits the

entire value chain – starting from electricity generated from renewable energy, through electrolysis and ultimately to refueling the vehicle with hydrogen. Since its founding, Fraunhofer ISE has been working on electrolysis technology, hydrogen for use in fuel cells and on hydrogen as electrical energy storage for renewably generated power. The hydrogen filling station serves as a reference project for the researchers in their quest to develop emission-free mobility for the future. Equally interesting are electrolyzers which operate as flexible loads.

www.ise.fraunhofer.de

Hands over the Innovation Award and Young Engineer Award for the first time

In co-operation with the European Center for Power Electronics (ECPE e.V.), the SEMIKRON Foundation will be handing over the SEMIKRON Innovation Award and the SEMIKRON Young Engineer Award for the first time ever at this year's conference on Power Electronics PCIM in Nuremberg. Dirk Heidenreich, CEO of SEMIKRON International GmbH, and Prof. Dr. Leo Lorenz, President of the European Center for Power Electronics (ECPE), will be presenting the awards at 11:00 a.m. on Tuesday, 8 May in the forum of the power electronics fair PCIM in Nuremberg.

The SEMIKRON Innovation Award merits outstanding project, product and service

innovations, as well as innovative concepts in the area of power electronics in Europe. The SEMIKRON Foundation merits innovations with considerable potential to deliver social benefits, such as the improvement of energy efficiency, conservation of resources, sustainability and environmental protection. In future, these awards will be presented annually at the European power electronics fair held in Nuremberg, "PCIM Europe". The award-winners are selected in conjunction with the European Center for Power Electronics (ECPE). The award carries EUR 10,000 in prize money. The Foundation will also be awarding the Young Engineer Award, which carries EUR 3,000 in prize

money and goes to young engineers under the age of 30 for excellence in the area of power electronics. The criteria for the Young Engineer Award are the same as those for the SEMIKRON Innovation Award. The winners are chosen by an independent 5-man jury comprising well-known representatives from the areas of research and industry. Entrants may be individuals or entire development teams. Entries must include a description of the innovation and set down the social benefits the innovation will deliver.

PCIM Booth 12-415

www.semikron.com

Buy a RACT20 LED Driver and Get Free Admission to Light+Building

RECOM invite you to visit us, for free, at the the world's largest lighting trade fair Light+Building in Frankfurt, Germany. Send a copy of your sales receipt or order confirmation of any RACT20 module and you will receive free entry to the fair.



By sending your sales receipt or order confirmation of RECOM's RACT20 constant current LED drivers to lighting@recom-electronic.com you will receive a voucher which will enable free online registration. It will authorise you to enter the world's biggest lighting trade fair, a saving 16 EUR! From April 15th to 20th 2012 the fair takes place in Frankfurt/Main in Germany. There you will find RECOM's state of the art AC/DC and DC/DC LED drivers and entire information about the extensive product portfolio.

The TRIAC-dimmable LED driver RACT20 series are the latest addition to our RECOM product portfolio. The constant current LED drivers work with a wide range of dimmers and avoid flickering and flashing even at low output loads. The RACT20 series are available in 230V and 115V versions with output currents between 350mA and 1A. RECOM is proud to feature a warranty up to 5 years on all LIGHTLINE LED drivers.

www.recom-electronic.com

Continuing Manufacturing 8051/80C51 Microcontrollers

Microchip Technology Inc. announced that it will continue to manufacture legacy 8051/80C51 MCUs that provide pin-for-pin-compatible replacements for most of those recently placed under "End-of-Life" (EOL) notification by NXP. Included are drop-in replacements for NXP's P89LV51RB2/C2/D2 and P89V51RB2/C2/D2 EOL series of 80C51 8-bit microcontrollers. Microchip's April 2010 acquisition of Silicon Storage Technology, Inc. (SST) included a legacy 80C51 MCU business, which Microchip has continued to support.

Microchip has a cross-reference document available on its Web site, as well as data sheets and a product brief, at <http://www.microchip.com/get/18D1>. NXP's P89LV versions are 3V MCUs, and are 100% compatible with Microchip's SST89V MCUs. Likewise, NXP's P89V versions are 5V MCUs, and are pin-for-pin compatible with Microchip's SST89E microcontrollers.

As with all 8051-compatible microcontrollers, Microchip's 80C51 MCUs can be used with many third-party development tools that are widely available.

PCIM Booth 12-561

www.microchip.com/get/18D1

www.bodospower.com

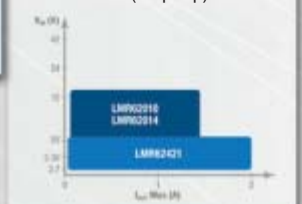
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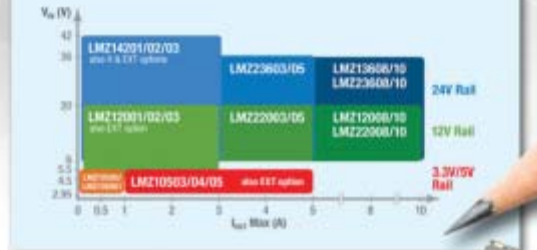
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World's First True Single-Chip Wireless Power Transmitter and Highest-Power Single-Chip Receiver Solution

IDT's Wireless Power Transmitter Reduces Footprint by 80 Percent and Solution BOM Cost by 50 Percent While High-output Receiver Reduces Charging Time for Use in Advanced Wireless Charging Applications

Integrated Device Technology, Inc. the Analog and Digital Company™ delivering essential mixed-signal semiconductor solutions, today announced the world's first true single-chip wireless power transmitter accompanied by the industry's highest-power single-chip receiver solution. IDT's highly integrated multi-mode transmitter reduces board footprint by 80 percent and solution bill-of-materials (BOM) cost by 50 percent compared to existing solutions. The complementary multi-mode receiver outputs twice the power of commonly used solutions, cutting charging time in half.



The IDTP9030 and IDTP9020 comprise a wireless power transmitter and receiver solution designed to meet the Wireless Power Consortium (WPC) Qi standard, which ensures interoperability with any other device meeting the WPC Qi standard. Both transmitter and receiver are capable of "multi-mode" operation, supporting both the Qi standard as well as proprietary formats for added features, improved safety, and increased power output capability. Built-in protocol detection enables dynamic switching between Qi and proprietary modes, creating seamless transitions and a trouble-free user experience. These devices can be used in a myriad of mobile applications for convenient and effortless battery charging.

"IDT is the first to offer a true single-chip wireless power transmitter IC solution to address a projected \$3.3B wireless power market," said Arman Naghavi, vice president and general manager of the Analog and Power Division at IDT. "IDT's new transmitter reduces application footprint from 1800 mm² to 360 mm² and consolidates the

function of nine ICs into one, enabling our customers to develop more compact and cost-effective products. In addition, our proprietary multi-mode capability offers benefits beyond the limits of the Qi standard by enhancing foreign object detection for improved safety and increasing output power for faster charging time."

The IDTP9030 is the most highly integrated wireless power transmitter available today. It combines the features and functionality of dozens of discrete components into a simplified, cost-effective, and highly efficient solution. The integration drastically minimizes the application footprint and component count, enabling customers to design and deploy more compact, cost-efficient, and conveniently located wireless charging stations. These charging stations may be deployed virtually anywhere, including homes, offices, libraries, stores, public waiting areas, automobiles, airports, and airplane seats.

The IDTP9020 is a high-efficiency single-chip wireless power receiver. In Qi mode, the device delivers up to 5 watts to the system. When used with the IDTP9030 transmitter in a proprietary configuration, it can deliver up to 7.5 watts, making the device suitable for powerful mobile devices, such as tablets, smart phones, digital cameras, GPS units, and headsets. When used in tandem, the IDTP9030 and IDTP9020 become the industry's most efficient end-to-end wireless power solution, resulting in reduced energy costs and faster charging time.

The IDTP9020 and IDTP9030 also feature proprietary multi-layered foreign object detection (FOD), utilizing sophisticated multi-parameter algorithms to assure a high level of safety while avoiding FOD false alarms. Coupled with over-temperature, over-voltage, and over-current protection, IDT's solution offers the most comprehensive suite of protection features on the market, ensuring safe and reliable operation. In addition, the receiver includes support for charging the battery via USB cable when a wireless charging station is not available, eliminating the need for external USB adaptor switches in mobile devices.

Pricing and Availability

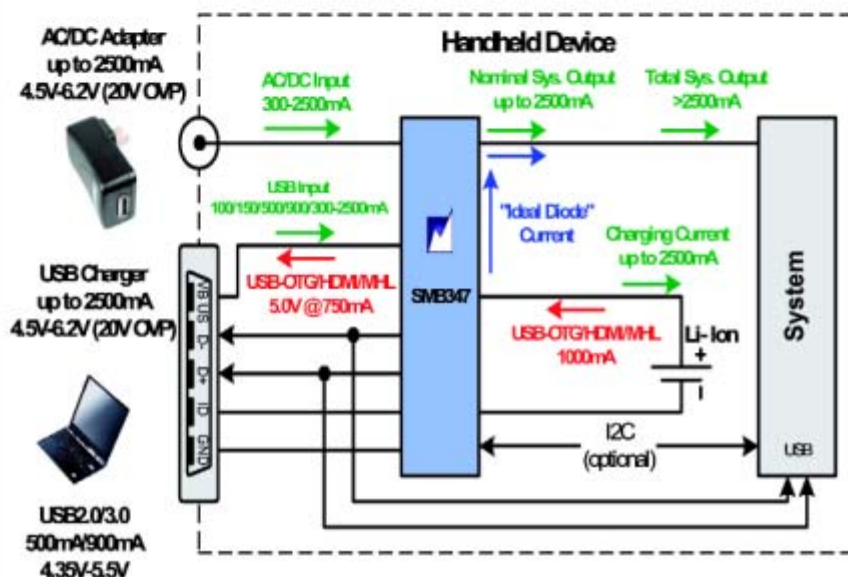
The IDTP9030 and IDTP9020 are currently sampling to qualified customers. They are available in 48-lead 6 x 6 mm VFQFN (IDTP9030) and 56-lead 7 x 7 mm TQFN (IDTP9020) packages. The IDTP9030 and IDTP9020 are priced at \$4.70 and \$3.60 each for volumes of 10,000 units, respectively. For more information, visit

www.idt.com/go/wirelesspower

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SMB347 Features

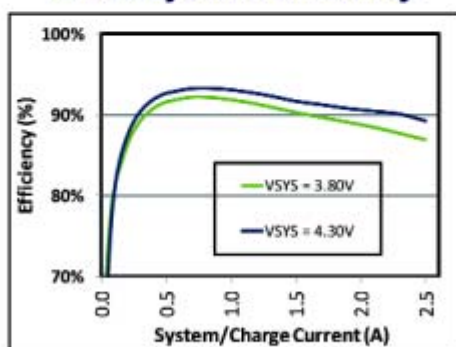
- Dual Inputs - AC/DC/USB2.0/3.0
- Dual Output CurrentPath™ for low/dead battery with 'ideal diode'
- +3.6V to +6.2V Input (+20V OVP)
- USB BC1.1/1.2 Source Detection
- Programmable Input Limit to 2.5A
- Automatic Input Limit Detection*
- Programmable Charge Current to 2.5A
- Integrated 5V USB-OTG Boost Output
- TurboCharge™* for 40% Faster Charging
- Robust Safety: JEITA/IEEE1725 Support
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# of Inputs/Outputs	2/2	1/1	2/2, 1/2	1/1	1/1
Maximum Charge Current (mA)	2500/1250	1200	1500	1150	1250
Battery Thermal Protection	HW JEITA	HW JEITA	SW JEITA	✓	
USB Charging Spec	rev 1.1/1.2		rev 1.0	rev 1.0	
Package (mm)	3.0x2.5 CSP	2.2x2.0 CSP	3.0x2.5 CSP	2.2x1.9 CSP 4x4 QFN	2.2x1.9 CSP

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Online Tool Simplifies Power Supply Design and Reduces Time-to-Market

Intuitive User-Interface Delivers Complete Designs in Seconds

Intersil Corporation, a world leader in the design and manufacture of high-performance analog and power management semiconductors, announced the newest version of its popular web-based design tool for power management products.

Designed for easy use, the iSim™v4.0 for switching regulators follows its predecessor iSim V3 for Integrated FETs, and adds new advanced capabilities for selecting, simulating and optimizing single-phase PWM controllers with external FETs, allowing users to complete designs in minutes.

The new version of iSim permits users to input requirements for their power supply and also configure the schematic for desired switching frequency, soft-start and other options. Designers can quickly generate a complete prototype design without delving into datasheets and application notes for design equations or to complete a series of iterative optimization steps. Automating the power supply design process provides a fast and easy way to simulate electrical performance, control loop stability and efficiency.

Features:

- Lets users modify compensation components and shows changes in closed loop response on the fly
- Designers can review efficiency graphs and power loss distribution across components
- Main schematic page's dashboard summarizes the solution's key performance parameters: efficiency, bandwidth, phase margin, cost and total footprint

For more advanced power supply designers, iSim v4.0 offers a 'Custom Design' section that allows users to enter specific performance targets for the power supply and auto-



matically select industry-standard component values to meet those targets. The custom design also lets users select power MOSFETs that can be optimized for total power supply efficiency and lowest junction temperature in the system. The result is a robust design and a complete bill of materials from DigiKey that can be ordered online.

iSim v4.0 takes advantage of Intersil's wide portfolio of models built on the SIMPLIS® simulation engine for switch mode power supply design. Schematics can be also downloaded and run on the iSim:PE™ desktop simulator, a powerful and free offline schematic capture and simulation tool.

Pricing and Availability

Both iSim v4.0 and the iSim:PE™ desktop simulator are available free-of-cost from

Intersil at <http://www.intersil.com/iSim>. Also, please take a look at this video for more information: <http://www.intersil.com/Videos/applications/isim.asp>

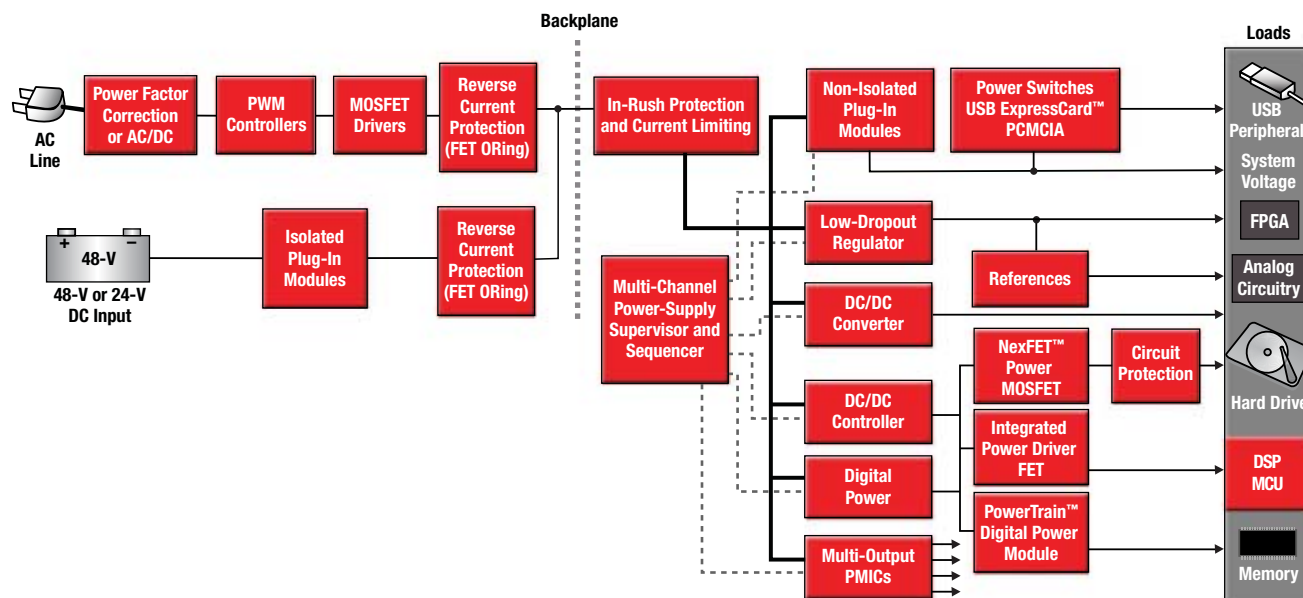
About Intersil

Intersil Corporation is a leader in the design and manufacture of high-performance analog, mixed-signal and power management semiconductors. The Company's products address some of the fastest growing markets within the communications, computing, high-end consumer and industrial electronics markets. For more information about Intersil or to find out how to become a member of our winning team, visit the Company's web site and career page at:

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Device	Description
UCD9220	Two-channel, quad-phase, digital controller
UCC28070	Single-chip, interleaved, multi-kW power factor correction controller
TPS2420/1	3-V to 20-V, 5-A circuit protection
TPS23754/6	PoE + controller + high-efficiency DC/DC converter
TPS2500	1.8-V to 5.5-V boost converter + current-limiting switch
TPS51315	3-V to 14-V, D-CAP™, Eco-mode™, 10-A sync FET converter
TPS54160	3.5-V to 60-V, 1.5-A synchronous buck SWIFT™ converter with Eco-mode
TPS54620	4.5-V to 17-V, 6-A synchronous buck SWIFT converter
TPS53126	4.5-V to 24-V, D-CAP2™, dual-output, synchronous buck controller
TPS40192	4.5-V to 18-V, 10-pin, synchronous buck controller with Power Good
CSD16411Q3	High-efficiency, N-channel NexFET™ power MOSFET

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Towards the Ideal Diode - Innovation Leads to Power System Efficiency Gains

By Doug Bailey, VP Marketing, Power Integrations

Designers are increasingly being tasked with achieving once-unthinkable levels of efficiency in all manner of systems, from motor drives to PFC circuits. In these circumstances, a fresh look at the entire system—identifying even the smallest possible opportunities for efficiency gains—is called for. This is perhaps why, in recent years, we have witnessed considerable innovation in even the simplest of active components. In particular, the diode industry has made significant technical advances.

The performance of diodes, despite their superficial simplicity, is often a key factor in overall system performance, and systems such as PFC, motor drives, DC-AC inverters, bridge converters and DC-DC converters all place great stress on diodes. However, with the emergence of diode technologies based on compound semiconductor materials like silicon carbide and gallium nitride, as well as novel architectures like merged PiN-Schottky rectifiers, designers now have much more to consider when it comes to diode selection. Designers versed in the subtle performance trade-offs and parasitics of the new diodes can optimize circuit efficiency and/or achieving meaningful reductions in overall system cost, size, weight and complexity.

No single company dominates this space. Naturally, the big diversified power giants are continuing the evolution of their product



offerings, but smaller specialists are more than holding their own through process and product innovation and strong applications culture. This is one reason why Power Integrations, despite our name, decided to invest in select, best-in-class discrete technologies, first with the acquisition of QSpeed – now our brand for our merged PiN-Schottky rectifier diodes – and then 18 months ago by taking a significant stake in SemiSouth Laboratories, a leader in silicon carbide technology.

QSpeed diodes use a unique silicon-based process to combine an extremely low reverse recovery charge (QRR) with a very soft recovery waveform. Together, these features help designers optimize the efficiency and EMI performance of their power conversion circuits. QSpeed diodes are ideal for continuous conduction mode (CCM) boost power factor correction (PFC) circuits, and as output diodes for hard-switching applications. In PFC circuits, QSpeed diodes can provide an overall switching performance that is comparable to silicon carbide diodes at much lower cost.

On the other hand, there are some applications—for example, solar and wind inverters, hybrid/electric vehicles—whose very viability depends on exceptionally efficient power conversion and where even slight efficiency gains have tremendous payback. In these cases silicon carbide is often the right choice.

With all these new technologies now available, we as an industry need to support design engineers so that they choose the right diode for their application. In power switching applications, the behavior of the rectifier diode as it transitions from conducting to reverse biased varies greatly between differing technologies, so diode selection is more complicated than just simple rectification. Which takes us back to my original theme: in today's power-electronics environment, even the simple things—perhaps especially the simple things—need looking at afresh.

At Power Integrations we believe that we have some of the most efficient power converter ICs that industry can offer. By extending this leadership into vital, discrete power components we hope to free designers of parameter restrictions so that they can continue to do what they do best: be creative and deliver top-of-the-line products for power efficiency and performance.

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ELECTRONICS INDUSTRY DIGEST

By Aubrey Dunford, Europartners



GENERAL

Reports of counterfeit parts have soared dramatically in the last two years, presenting huge challenges for electronics manufacturing and especially the military and aerospace industry.

From OEMs to contract manufacturers and from component suppliers to component buyers, supply chain participants in 2011 reported 1,363 separate verified counterfeit-part incidents worldwide, a fourfold increase from 324 in 2009, so IHS. This marked the first time the reported number of incidents in a single year exceeded 1,000, a total that could encompass millions of purchased parts. The surge over the past two years is the latest development in a rapidly escalating global supply chain trend toward increased counterfeiting and piracy of global products, with counterfeit part reports having risen by nearly a factor of 700 over the last decade.

SEMICONDUCTORS

TowerJazz, an Israeli specialty foundry supplier, announces signing a binding MOU with a leading Indian infrastructure conglomerate, to build and operate a 300mm facility in India. This will enable the company a roadmap to long term 300mm wafer size, 90nm analog technology and companion chips in deep submicron technologies (6545nm). TowerJazz 2011 revenues were a record \$ 611 M, an increase of 20 percent compared to 2010. Net loss narrowed substantially to \$ 19 M, compared with a net loss of \$ 42 M in 2010, and \$ 120 M in 2009.

Plessey has acquired CamGaN, a University of Cambridge spin-out formed to commercialise novel technologies for the growth of gallium nitride (GaN) high-brightness LEDs on large-area silicon substrates. The acquisition will enable Plessey to exploit synergies with its 6-inch processing facility in Plymouth, England to produce HB LEDs based on CamGaN's proprietary 6-inch GaN-on-silicon technology.

Texas Instruments names Chris Allexandre vice president of Europe regional sales and applications. In his new role, Allexandre will implement the TI sales strategy in Europe and drive revenue growth, while managing relationships with TI's distributors and channel partners.

An additional investment of £ 50 M will be spent to keep the UK at the forefront of research into graphene. About 200 times stronger than steel yet only one atom thick, graphene is the strongest and thinnest material ever measured, and also the world's most conductive material. It has a wide range of potential uses, including electronics, flexible touch screens, sensors and in composite materials. The investment will help establish the UK as a graphene research and technology 'hub', funded through the Engineering and Physical Sciences Research Council (EPSRC) and the Technology Strategy Board (TSB), that will lead to the rapid commercialisation of graphene technologies in the UK. The University of Manchester has been confirmed as the single supplier invited to submit a proposal for funding a new £ 45 M national institute, £ 38 M of which will be provided by the UK Government.

Fairchild Semiconductor, a global supplier of power and mobile products, and Infineon Technologies announced the extension of their compatibility partnership to encompass Fairchild's 5x6mm power stage asymmetric dual MOSFET package.

OPTOELECTRONICS

Samsung's LCD business will be spun off from Samsung Electronics and become a wholly-owned subsidiary. Then, the new corporation will consider adopting various restructuring measures including a merger with Samsung Mobile Display and S-LCD. Currently, the display market is undergoing rapid changes with OLED panels expected to fast replace LCD panels to become the mainstream, so Samsung. So, adopting measures for change and innovation, including business restructuring, are essential to improve competitiveness for Samsung's display business. Samsung's LCD division made an operating loss of 750 billion won (\$ 666 M) last year.

PASSIVE COMPONENTS

Ioxus, a US-based manufacturer of ultracapacitor technology for transportation, alternative energy, medical, industrial and consumer product markets, has acquired Power Systems, a Japanese manufacturer of flexible, slimpack electric double layer capacitors (EDLCs) with an extensive customer base in the Asia-Pacific region. With Power Systems' proprietary high-power flat cell design, Ioxus gains the technological building blocks for creating flexible ultracapacitor energy storage solutions. Ioxus offers ultracapacitors and hybrid capacitors ranging in size from 100 Farads to 3,000 Farads.

OTHER COMPONENTS

BASF has acquired Ovonic Battery, a subsidiary of Energy Conversion Devices. Ovonic is the inventor of the NiMH technology. All major producers of NiMH batteries are currently working under license from Ovonic. Ovonic will be managed under BASF's new global business unit "Battery Materials," which was launched on Jan. 1, 2012, to integrate the company's current and future battery materials-related activities within a single operating unit.

DISTRIBUTION

Arrow Electronics announced the successful completion of the acquisition of TechTurn, a provider of electronics asset disposition services in Texas that specializes in the processing and sale of technology devices that are returned or recycled from businesses and consumers. TechTurn has 135 employees. The company's sales are expected to exceed \$ 50 M in 2012. Arrow Electronics and Micropelt have also signed an agreement that will enable Arrow to offer Micropelt's full range of thermoelectric energy harvesting semiconductor devices and systems to its customer base throughout Europe. Based in Germany, Micropelt produces thermoelectric devices for cooling, thermal cycling and energy-harvesting applications.

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.

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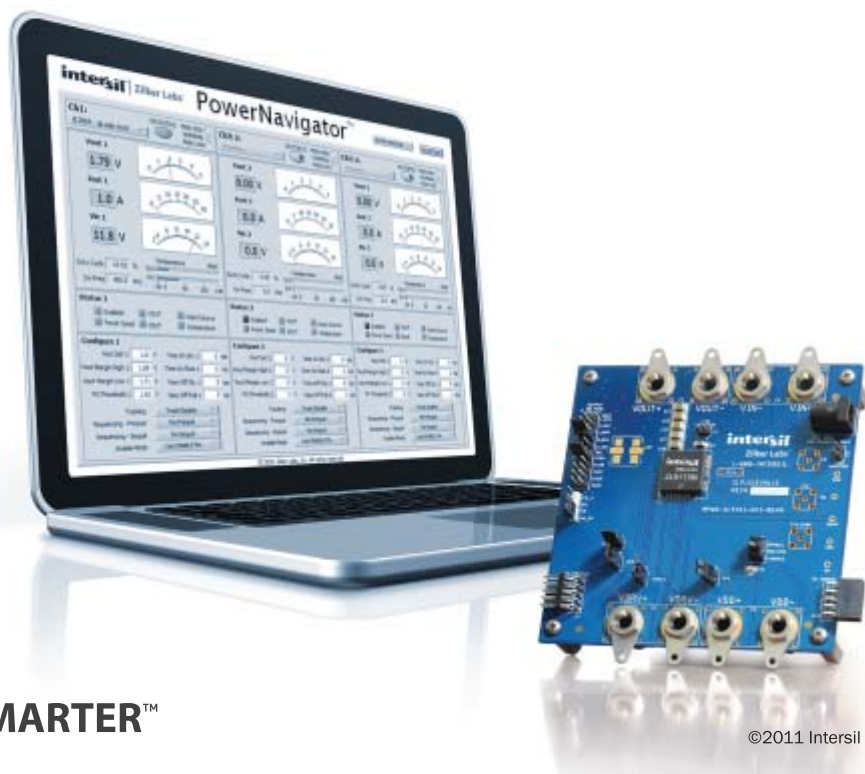
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Data Centers Drive Killer Power Apps

By Linnea Brush, Senior Research Analyst, Darnell

Finding a “killer app” for power supplies is a bit like putting the cart before the horse: Does power drive applications, or the other way around? As a rule, system makers – and the various equipment they produce – have led the way for power supply manufacturers. This has produced large volume markets such as computers, mobile phones, and the latest portable media devices. And now, a new type of application is providing opportunities for power – but on a different scale: buildings. Specifically, facilities that need to increase their efficiency and bring down energy costs.

Data centers are considered one of the best opportunities in this regard. In fact, they are dependent on many of the “most emerging” power supply technologies. They are the reason many of these technologies were developed in the first place. Data centers meet many of the requirements that lead to “breakthroughs” in power systems and architectures: They consist of high-volume devices such as blade servers and storage systems; they need to be highly efficient in their use of power; and the facilities must keep energy costs down. They are also large facilities found all over the world, and they are not likely to become obsolete any time soon.

As a result, many power supply companies have targeted their products to the equipment used in data centers. This is not new. What is new are the powering architecture changes that provide opportunities at the facility level, rather than at the device level. This includes digital power management, power and energy measurement, and dc powering of buildings.

Many of these facility trends are taking place in Asia and will be part of the upcoming Darnell’s Power China conference, being held May 15-16 in Shanghai, China. For example, energy management systems are being implemented in a variety of facilities, but not all of these systems are “critical” or complex enough to require dynamic power measurement and control. Data centers, however, are one of the applications where such power monitoring and measurement are both needed and cost-effective. Advanced power measurement functions are expected to find good market opportunities in distributed power systems found in these facilities.

Data center infrastructure management (DCIM) is the integration of information technology (IT) and facility management disciplines to centralize monitoring, management and intelligent capacity planning of a data center’s critical systems, and it is expected to help drive the need for advanced power measurement functions in power systems, such as embedded ac-dc power supplies.

At the plant/facility level, a data center has power feeding both IT equipment (servers, storage and network equipment) and infrastructure support equipment (building automation, primarily, including cooling, lights, security, and so on). The power entering the building has to be diverted to both the IT equipment and the support equipment. Not all equipment will be running at full load, and energy efficiency becomes a problem. Reducing the losses in the power system and ensuring that all the equipment is getting the “proper” amount of power can be achieved through power measurement systems. This goes beyond simple “standby” or “on-off” modes, with multiple devices requiring complex coordination.

Power distribution units (PDUs) read power at the rack/system levels. Minkels, a European producer of integrated data center solutions for cooling, power distribution and housing, has seen a significant rise in the importance of power distribution within their data center product portfolio. This is reflected, in particular, by a spectacular increase in demand for “intelligent” Rack PDUs, which enable remote management of energy consumption in data center racks.

The company sees a higher market demand for intelligent Rack PDUs as a “logical consequence of increased attention for energy efficiency in server rooms.” Intelligent Rack PDUs have more functionality than traditional PDUs, facilitating a more detailed zoom of the data center, making it possible to measure the power consumption at the server level. Such intelligent products provide tools for direct energy consumption management by gathering information via intelligent modules, Power Usage Effectiveness (PUE), or by remote reading of the PDU and switching the server on and off through a software connections. These types of products represent a “first step” in the demand for increased power measurement functionality in data centers.

Digital power management is also part of almost all energy management solutions, since “intelligent” data communication is an essential feature of these systems. Accuracy of data acquisition and power measurement is challenging from a number of perspectives. For instance, a data center may only need to be “accurate enough” but still cost-effective: going above 3% accuracy may involve a significant cost-adder. In general, digital power and control will help enable the next generation of advanced power measurement functions.

Another emerging area of opportunity is dc-powered data centers. These types of buildings have the advantages of strong standards activity, supporting government regulations, and a number of demonstration facilities. The evolution from ac to dc building power is expected to require new equipment designs that accommodate emerging standards, safety considerations and new delivery systems. This includes connectors, lighting fixtures, power distribution units, and energy storage devices.

For example, Delta Electronics recently launched a state-of-the-art data center dc power solution that includes a complete product portfolio of dc UPS systems, PDUs, and server power supplies for more energy-efficient data center applications. Other companies making products for data centers include Emerson Network Power and Nextek Power.

The adoption of dc building power is global, with developments occurring in Europe, North America and Asia. For instance, a recent dc power standard in China mandates that all telecommunications facilities and data centers adopt 240Vdc power. The retrofits will not involve any change in the existing 230Vac power supplies – the supply voltage will simply be switched to 240Vdc, saving a few percentage points of energy consumption. This is a near-term “bandage” to gain small but immediate efficiency improvements, but it is expected that in the longer-term, China will also adopt the 380/400Vdc standards being developed in other parts of the globe.

In cooperation with other industry associations and standards-making bodies, the EMerge Alliance is currently working on a 380Vdc standard designed for data centers and other critical facilities. In 2011, The EMerge Alliance formed a new technical standards committee for data centers, and is now advancing a 380Vdc power standard. The Alliance is working with the European Telecom Standards Institute (ETSI) and other standards organizations to align on 380Vdc as a standard for data centers.

The specific type of data center facility most likely to benefit from the adoption of dc power includes smart grid data centers, designed to provide intelligent energy management across systems and facilities; containerized data centers, which can be delivered to a site and plugged into power; mission critical facilities that call for reliability in the high nines; data centers that require integration with renewable sources of energy such as PV; high-density data centers that require a small "footprint"; data centers that operate as part of a microgrid and other new and special purpose data center facilities.

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*By Jorge Cerezo, Sr. Applications Engineer,
International Rectifier Corporation*

Induction heating (IH) is a well-known technology and very commonly used for cooking appliances. All IH cooking appliances operate using "the electromagnetic induction phenomenon: an AC current flowing through a circuit (i.e. the heating coil) generates a variable magnetic flux, thus causing eddy currents to occur in a secondary circuit (i.e. the load to be heated). Due to the Joule effect, the electric energy caused by the induced current is converted to heat." [1]

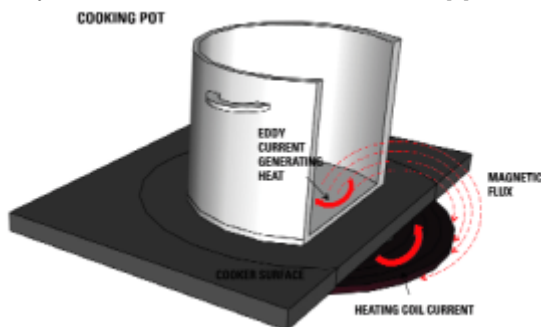


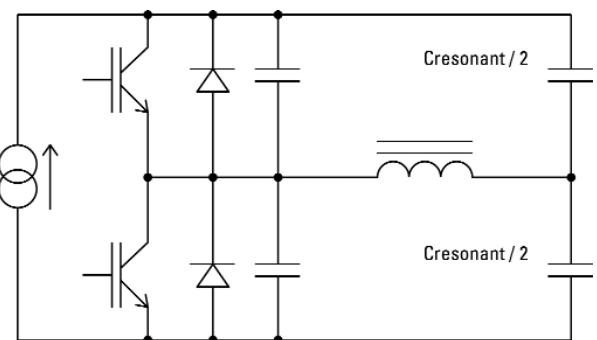
Figure 1: Electromagnetic induction phenomenon in IH cooking appliances

Despite their higher initial cost compared to gas or electric cooking appliances and the need for special pans made of ferromagnetic materials, IH cooking appliances present benefits such as high energy efficiency, fast and safe cooking, and easy to clean cooktops that have made them popular around the world.

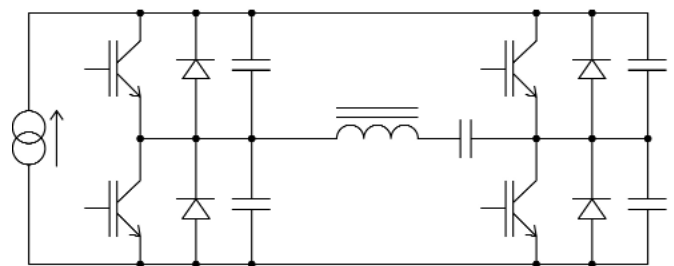
Since energy efficiency is one of the main objectives of IH cooking appliances, resonant converter topologies are mostly used due to soft switching operation (zero-current switching ZCS or zero-voltage switching ZVS) considerably reducing the converter switching losses and EMI generation.

In high-end IH cooking appliances; with power levels on each hob ranging from 1.2kW to ~3.0kW, the half-bridge and full-bridge series resonant converters (figure 2) are the most common topologies used. Yet, their large component count, heat sink size, and complex control schemes increase the cooker cost limiting their possibility to reach the low-end markets. As a result, and despite its limited power level and other potential drawbacks, the single ended parallel resonant

converter has become an important alternative to the series resonant topologies and it is already largely used on IH single hob cooktops and rice cookers.



Half-Bridge Series Resonant Converter



Full-Bridge Series Resonant Converter

Figure 2: Typical converters used in high-end IH cooking appliances

The Single Ended Parallel Resonant Converter

The single ended parallel resonant (SEPR) converter (basic schematic and operating waveforms are shown in figure 3), consists primarily of a parallel inductor and capacitor resonant tank network, formed by L_r and C_r in the schematic; typically a single IGBT/Diode Copack device, and a small capacitor, shown as C_f , placed to help as an EMI filter and to provide a path, together with the Diode for the inductor's resonant current flow. The main power source of this converter is the rectified, but not filtered, line voltage to achieve near unity power factor at the mains voltage.



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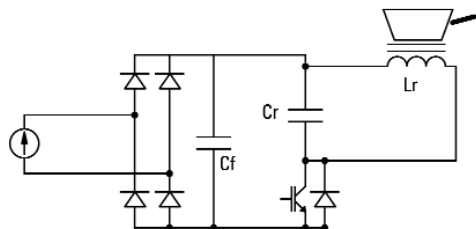
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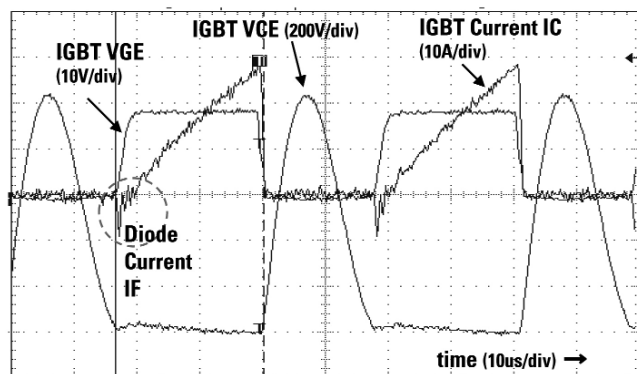
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For power levels close to 2.0kW, and for a reasonable IH cooker design, voltages up to or above 1200V and currents close to 60Apk must easily be supported by the converter as shown in the operating waveforms' figure. A switching frequency control scheme is typically used, operating from ~20kHz to 60kHz switching frequencies in order to avoid acoustic noise; starting at the higher frequency for soft start operation and reaching the maximum power at the lower frequency.



Single Ended Parallel Resonant (SEPR) converter



SEPR converter's operating waveforms

Figure 3: Single Ended Parallel Resonant (SEPR) Converter's basic schematic and operating waveforms

Operation of the SEPR Converter

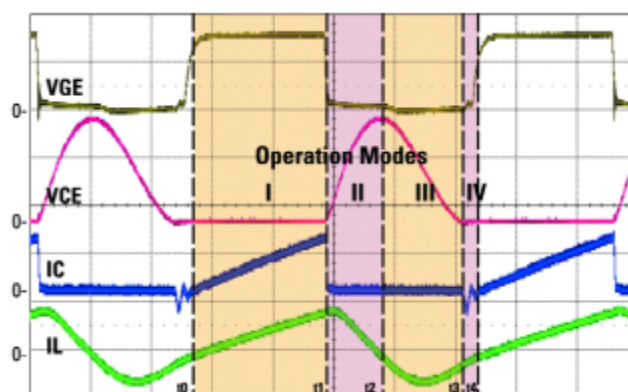
The typical waveforms of the IGBT's Gate and Collector voltages, VGE and VCE; Collector current IC, and resonant inductor current IL are shown in figure 4. In addition, figure 4 shows IL's flow during a full converter's operation cycle to help the operation's explanation.

Mode 1 (t0-t1). At first, the IGBT Q1 is turned-on at ZVS condition and current flows through the resonant Inductor Lr from the rectified line voltage.

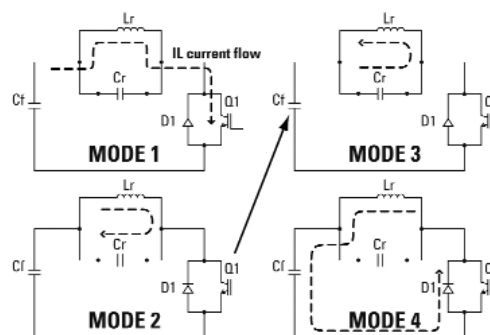
Mode 2 (t1-t2). The IGBT is turned-off at the desired peak current, then the resonant Inductor's current starts to flow through the resonant Capacitor Cr, concluding when total inductor energy is transferred. At this point, the maximum resonant voltage is present in the resonant Capacitor Cr, and, therefore, the IGBT is blocking the maximum VCE voltage. If this is not considered during converter design, VCE voltage can be large enough to damage the IGBT.

Mode 3 (t2-t3). The Capacitor Cr resonates and the current flows through the resonant Inductor Lr in opposite direction, even after total Capacitor energy is transferred. The Capacitor Cr current stop when its voltage is equal to the supplied voltage.

Mode 4 (t3-t4). The Inductor's resonant current flows through Capacitor Cf and Diode D1. It is during this time when the IGBT's VGE voltage is applied. When total inductor energy is stored again on capacitor Cf, the IGBT starts conduction turning-on at ZVS condition and the process is repeated.



Typical IGBT and Inductor V-I waveforms



Sequence of operation modes

Figure 4: SEPR converter's operation process

Key Parameters of IGBT and Diode for SEPR Converter

The majority of IGBT manufacturers have released 1200V IGBTs specific to IH applications and soft switching applications, mainly in Trench technology including reverse conducting IGBTs with monolithic body diode. The released IGBT's nominal currents and packages are mostly targeting the induction cooking appliances market requirements (see table 1).

Typical SEPR IH Cooker Requirements	
Output Power	Up to 2.2kW
Input Voltage	100V - 220V
Switching Frequency	20kHz - 60kHz
IGBT Device Requirements	
Power Device	Copak IGBT + Diode
VCE Range	≥ 1200V
IC @ 100C Range	15A - 30A
Package	TO-247

Table 1 Typical SEPR IH Cooker and IGBT device requirements

For the proper IGBT selection on SEPR converter consider the following facts: in this converter the power losses are due to the IGBT's VCE(ON) and soft turn-off energy (EOFF) losses. The IGBT operates at soft switching conditions as shown in figure 5; the turn-off switching losses are due mainly to the typical IGBT's "tail" current because of the low dv/dt produced by the resonant capacitor, reducing the losses significantly. At turn-on, there are no losses due to the zero voltage switching condition generated by the previous conduction of the Diode. Therefore, both the VCE(ON) and "tail" current performance are the significant parameters for the IGBT; the right balance of these parameters is important to reduce power losses for this converter.



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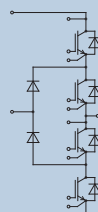
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The degree of efficiency for the two 3-level topologies, NPC1 and NPC2, has to be evaluated depending on the switching frequency.

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- EconoPACK™ 4 NPC1 topology for high switching frequencies (approx. $f_{sw} \geq 12$ kHz)

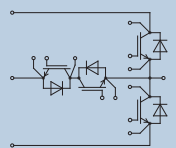
NPC1 topology

- 650V IGBT4
- Optimized for $f_{sw} \geq 12$ kHz
- Portfolio
 - F3L200R07PE4
 - F3L300R07PE4



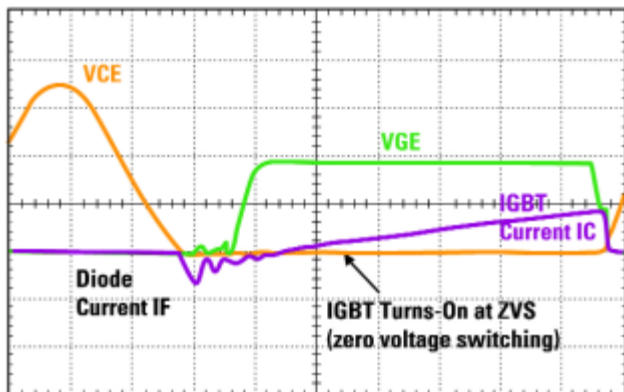
NPC2 topology

- 650V/650V IGBT4
- 650V/1200V IGBT4
- Optimized for $f_{sw} < 12$ kHz
- Portfolio
 - F3L400R07PE4_B26
 - F3L300R12PT4_B26
 - F3L400R12PT4_B26

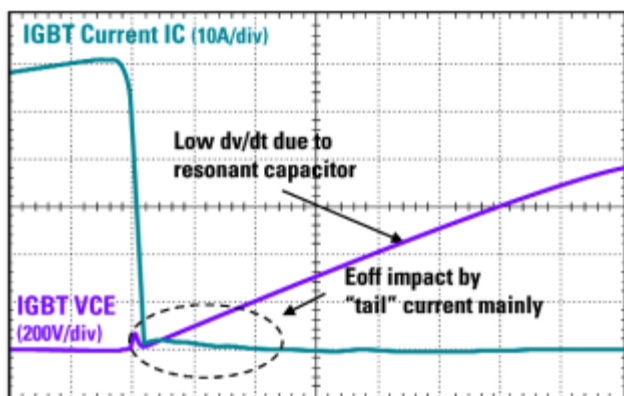


It is important to note that soft turn off energy is not related to the EOFF during hard switching included in most IGBT datasheets. This makes device comparison more difficult because a major contributor to losses in this application is not specified in datasheets. Figure 6 shows the disparity between soft switching losses as measured and hard switching losses specified in a datasheet.

For correct Diode selection on SEPR converter, the following facts should be considered: the Diode's losses are due mainly to the forward voltage drop V_F , and the forward recovery voltage V_{FR} . The Diode has no Reverse Recovery Losses on this converter because it turns-off at ZVS condition, and this is because the IGBT is already ON during this stage, as shown in figure 7. Also, the Diode commutated OFF at low di/dt , typically lower than 10A/us; this helps to have a smaller reverse recovery current. This means that during a short period of time, Inductor current is shared by the IGBT and Diode's reverse recovery current. Attention needs to be taken with the Diode's forward recovery voltage V_{FR} , because it could be a significant parameter if it is not optimized for this application. The Diode's losses are significantly smaller compared to IGBT's losses if it is adequately selected and optimized for this application.



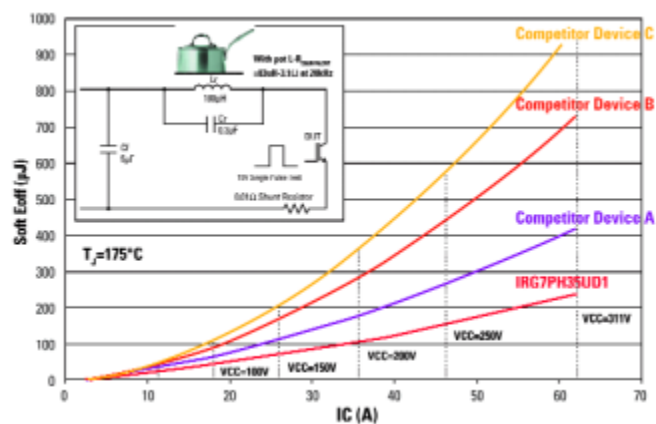
IGBT's turn-on detail



IGBT's turn-off detail

Figure 5: IGBT's switching performance on SEPR Converter

The importance of the key parameters mentioned is exemplified in the chart on figure 8. This chart shows the IGBT Copack devices' power losses performance on an IH cooker using SEPR converter. These devices have been released specifically for this application, however, the poor performance of the key parameters discussed have a significant impact on the final results. In this case, two competitor devices with higher nominal current, 25A and lower VCEON than IR's 20A IRG7PH35UD1 device, show significant higher power losses in the IH cooker application. The performance of competitor

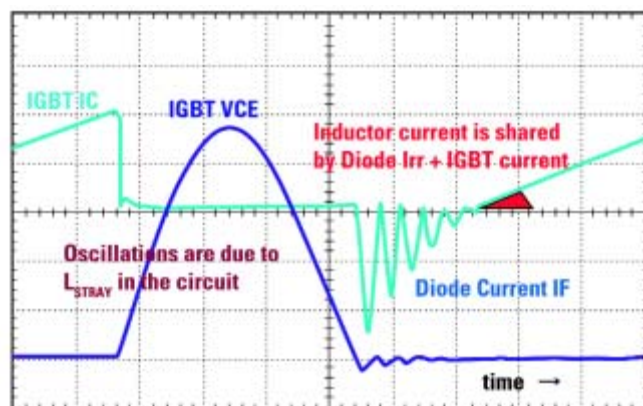


Soft EOFF comparison at typical application test conditions

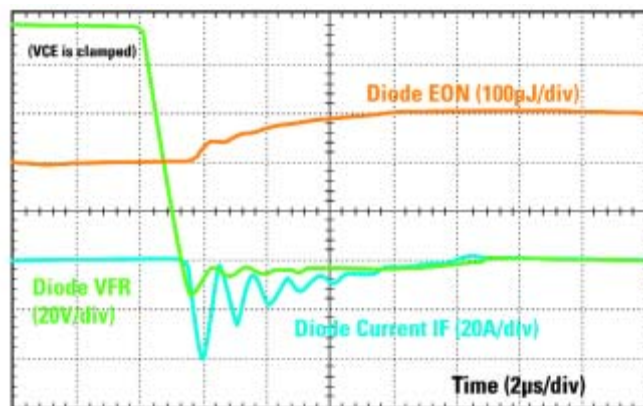
Device	Datasheet Hard Switching E_{OFF} (Typical)	
	Test Conditions	E_{OFF} (mJ)
IRG7PH35UD1	$IC = 20A$, $VCC = 600V$, $VGE = 15V$, $RG = 10\Omega$, $T_J = 150^\circ C$	1.12
Competitor Device A	$IC = 20A$, $VCC = 600V$, $VGE = 15V$, $RG = 15\Omega$, $T_J = 175^\circ C$	1.65
Competitor Device B	$IC = 20A$, $VCC = 600V$, $VGE = 15V$, $RG = 10\Omega$, $T_J = 125^\circ C$	0.86
Competitor Device C	$IC = 20A$, $VCC = 600V$, $VGE = 15V$, $RG = 10\Omega$, $T_J = 175^\circ C$	1.97

Datasheet's hard switching information comparison

Figure 6: Example of disparity between datasheet's hard switching EOFF vs. soft switching EOFF



Diode's turn-off detail



Diode's forward recovery at turn-on

Figure 7: Diode's performance on SEPR Converter

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device "A" is an example of the importance of optimizing the diode for this application; it shows significant larger power losses, around 15W higher than IR's device and this is due to its poor Diode's forward recovery voltage performance. Competitor device "B", with large turn-off "tail" current performance, shows around 5W higher power losses than IR device. These are two examples of poor application performance due to improper device key parameter's definition.

SEPR IH Cooker's Improved Reliability with Robust IGBT

In SEPR converter there is a direct inter-dependence between maximum achievable output power level and peak collector voltage VCEpk. Any increase in the input voltage will increase the output power and hence the VCEpk. Therefore, the IGBT device should be defined based on maximum stress levels, which occur at the peak of the rectified 50 or 60Hz line voltage as shown in the figure 9.

The typical IH cooker's power level on the market is around 2kW maximum using 1200V VCE rating IGBTs. As mentioned, for power levels close to 2kW, VCEpk voltages up or above 1200V have easily to be supported by the IGBT, because making use of higher voltage IGBT increases significantly the cost and power losses in the system, due to the typical higher VCEON parameter per same die size area as a function of IGBT's voltage increase.

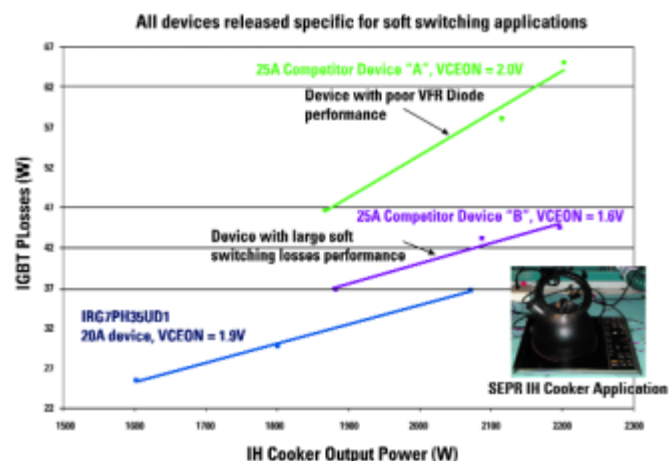
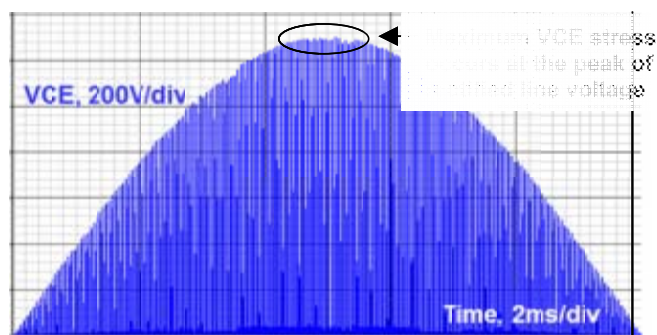


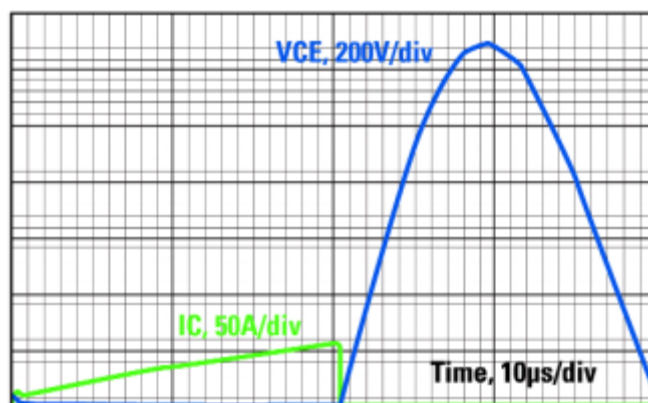
Figure 8: Example of IGBT device's key parameters importance for SEPR converter

At present, a big issue for SEPR IH Cookers is the large field failure rate due to the mains voltage transients. In countries like China or India for example, where these IH cookers are very popular, the mains voltage transients can reach up to 20% from nominal value, generating easily IGBT's VCEpk voltages higher than nominal 1200V and hence, damaging the IGBT. For this reason, and for specific 1200V rated IGBT, IH cooker's manufacturers prefer higher voltage capacity than nominal 1200V VCE to be safe during the mains voltage transients.

Also, in order to reduce the IGBT's power losses, the majority of IH cookers with SEPR converter use Gate voltage VGE = 18V to 21V as shown figure 10. This Gate voltage is close to the VGE maximum rating for some IGBT devices. Check for example the competitor "A" devices in figure 10, they have a 20V Gate voltage maximum rating only; too low for the typical Gate voltage of the SEPR IH cooker.



VCE performance during 50Hz semi-cycle



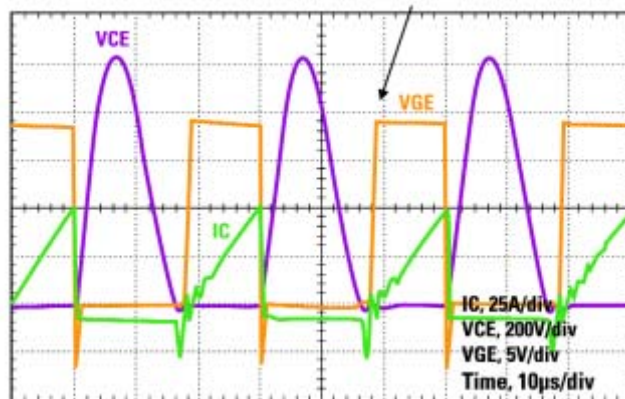
Detail of maximum VCE stress

Figure 9: IGBT's maximum VCE stress voltage in the SEPR IH cooker

1200V Devices Released Specific for Soft Switching Applications		VGE Maximum Rating
IR	IRG7PH35UD1	+/- 30V
	IRG7PH42UD1	
Competitor "A" Devices		+/- 20V
Competitor "B" Devices		+/- 25V

Gate voltage VGE maximum Ratings

Typical IH Cooker Waveforms, VGE ~ 19V



Typical VGE performance

Figure 10: IGBT's VGE voltage in the SEPR IH cooker



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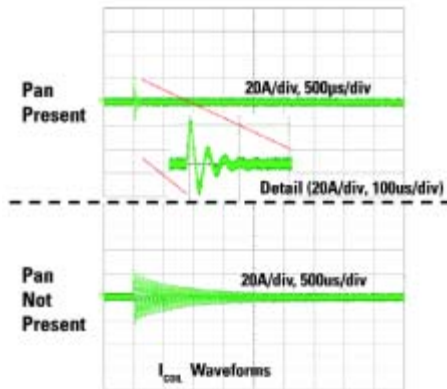
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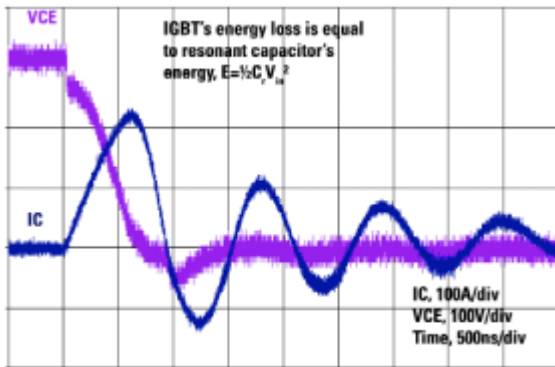
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Another IGBT parameter to take into consideration for a reliable SEPR IH cooker is the Forward Safe Operating Area (FSOA). All SEPR IH cookers have a pan detection control that detects no pan or small pan situations. The majority use the single pulse method, shown in figure 11, for the pan detection. Basically, this method detects the number of resonant pulses to decide a no pan situation on the cooker. Under this method, a large peak current is generated when the IGBT is not fully ON as shown figure 11. This event occurs as well at the power startup and in both cases this is due to the initial charge of the resonant capacitor. Because of this, some manufacturers undertake special qualification procedures for the IGBTs such as reproducing the pan detection pulse for millions of cycles. In addition, with regards to the FSOA parameter, it is common in the SEPR IH cooker to observe turn-on losses when ideally they should be zero as previously discussed. This issue significantly increases the IGBT's power losses as shown in the waveform samples in figure 12. In this specific case, the IGBT's power losses at 800W output power is 42%



Pan detection's single pulse method



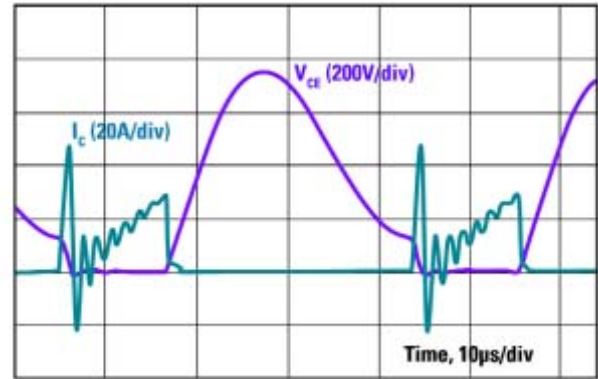
IGBT's VCE and IC during single pulse's pan detection or at power startup

Figure 11: IGBT's performance during pan detection and at power startup

Part Number	Package Type	VCES	Nominal Current	VCES transient	VGE	VCE(ON) I NOMINAL V_{CE}=15V V_{GE}=15V T_J=25°C	EOFF (Hard Switching) I NOMINAL V_{CE}=600V V_{GE}=15V R_{GE}=10Ω T_{Jmax}	T _{Jmax}	Typical Applications
IRG7PH35UD1PbF	TO-247AC	1200V	20A	1300V	+/-30V	1.9V	1120uJ	150°C	IH Cooktops IH Rice Cookers Microwave Ovens Welding Machines Copy Machines
IRG7PH35UD1-EP	TO-247AD								
IRG7PH42UD1PbF	TO-247AC	1200V	30A	1300V	+/-30V	1.7V	1936uJ	150°C	
IRG7PH42UD1-EP	TO-247AD								

Table 2: IR's 1200V IGBTs specific for Induction heating and soft switching applications

higher than 2100W where no turn-on switching losses are present. This is mainly caused due to the intrinsic variable load of the system, causing capacitor voltage not to come down to zero following resonance mostly at low power levels or to a VCE zero crossing control issue. In summary, for this specific turn-on, pan detection and power startup conditions that robust IGBT's FSOA is important for improved SEPR IH cooker reliability.



IGBT's IC & VCE at 800W Output Power



Detail of IGBT's IC & VCE

Figure 12: Example of typical IGBT's turn-on losses for SEPR IH cooker

IR's 1200V Devices Specific for IH and Soft Switching Applications

In summary, the proper selection of the IGBT device's key parameters results in a very efficient and reliable SEPR IH cooker. By following these guidelines, IR has released two 1200V IGBT Copack devices specific to IH cooker's requirements, optimizing the key parameters for best performance and enabling lower cooker's power losses. Their improved ruggedness with parameters such as guaranteed 1300V transient voltage capacity, 30V VGE rating, and robust FSOA, reduce or even eliminates the impact of typical field failure issues improving the cooker's reliability.

References

- [1] A. Beato, C. Bocchiola, and S. Frattesi. "Modeling and design of the half-bridge resonant inverter for induction cooking application". 14th IEEE Mediterranean Conference on Control and Automation, MED '06.

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Operation Features of Power Semiconductor Devices

The base of the structure of the semiconductor devices is the semiconductor element defining its electrical parameters and characteristics. The semiconductor element must be well protected from the influence of environment, that's why it's fitted into housing ensuring sealing and mechanical strength of the whole structure.

By S.Strigunov, Proton-Electrotex JSC

Structure of Power Semiconductor Devices (PSD)

Based on the exterior structure of the PSD housing, they can be divided into stud, with flat base (flanged), disk and module.

Stud structure of PSD, the base of which is produced of copper and screw bolt to ensure electric and thermal contact with heat sink by means of definite rotational moment. Thyristors with flat base of the housing have copper flange for mounting the device with screw bolts to the heat sink. The housing covers in both types of thyristors are glass-to-metal or ceramic-metal. The upper power lead can be produced as metal (copper) braided cord (wire end).



Figure 1: Stud structure of PSD

Disk (press-pack) structure of PSD is designed to improve its resistibility to thermal-cycle impacts, because it doesn't have soldered and alloyed connections, which give the inner elements with different thermal expansion coefficient the possibility to move independently of one another. Though, if PSD is in unbound state, such structure cannot ensure secure electric connection of the inner elements with each other – there's even a possibility of total absence of the contact. Testing and operation of PSD of disk type are forbidden without equipment producing external regulated clamping force. Any impact of electric voltage on uncompressed device leads to destruction of semiconductor element or damage leading to shortage of its life span. Value of gripping axial force is one of parameter of PSD. The most suitable device ensuring the necessary clamping force is a standard heat sink. Its structure ensures even distribution of force over the whole surface of PSD electrodes and doesn't lead to warpage.



Figure 2: Disk structure of thyristor without heat sink

Module structure of PSD – hybrid integral devices consisted of two power semiconductor elements. Structure of the housing is developed in such a way to fully satisfy the customers' demands. During production of the modules the most suitable elements are picked for every particular housing – from small A type to D as well as A, C, E and G. During production of modules the following schemes of two elements connection are used: antiparallel, parallel with common cathode and parallel with common anode.

Structure of module consists of:

- metal base, where copper is used to conduct heat to the heat sink;
- ceramic disk, which is heat-conducting electrical insulator between live parts and the base. Due to this, several modules can be installed into group heat sink without additional insulation;
- one or several semiconductor elements connected with each other by copper busbar according to one of the commutation schemes;
- plastic protective case with electrical leads

All module types have a standard structure what simplifies mounting.

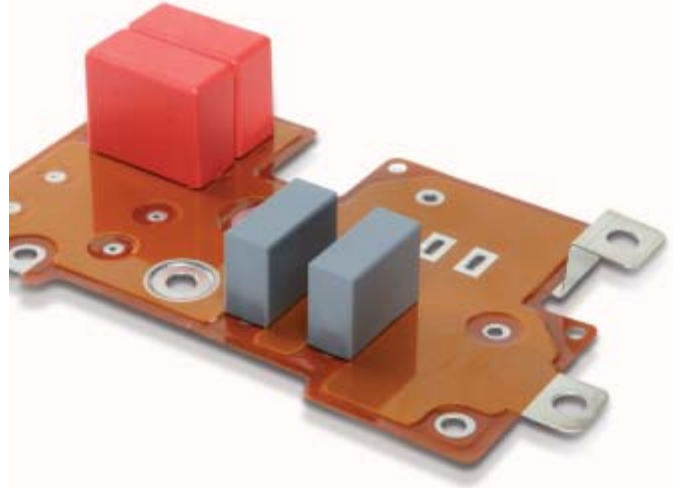
General Recommendations on PSD Application

High importance during development of converter installation has the right choice of PSD type. During calculation processes the developer has to take into consideration several important things, which can influence the normal operation of converter. These are occurrence of inadmissible overvoltage during commutation, presence of inadmissible overloads of current with indirect and direct interlocking, overheat of device due to temperature increase inside of converter because of overheat of power element in the scheme, weak control signal, pres-

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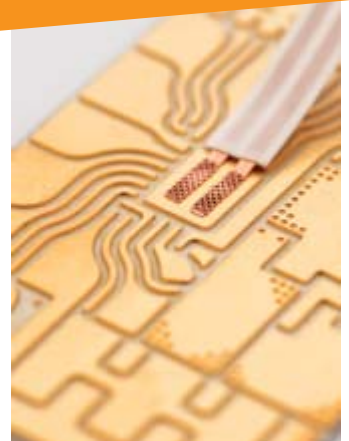
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ence of disturbances in control circuit of thyristors and so on. Disregard of any of these things causes problems in normal operation of converter. Despite the importance of this question, nowadays there are no instructional guidelines for choosing PSD during development of converters. Moreover, the following common rules of operation should be considered:

- In all cases of usage it's recommended to avoid operation of devices at their limits of all parameters. Safety factor should be determined depending on necessary degree of reliability of converters;
- during replacement of the failed device the device with similar characteristics should be picked;
- Parallel and series connection of same type devices is admissible only with observance of certain conditions;
- Mounting of devices with heat sinks should be done according to the certain conditions;
- Resistibility of devices to climate and mechanical impacts as well as operating temperature range for certain devices are described in datasheets. It's admissible for devices to operate at higher temperatures of environment on condition of current load decrease according to the datasheets.



Figure 3: Module structure of PSD

Series and Parallel Connection of PSD

Series Connection

Connecting thyristors or diodes in series it's necessary to achieve even distribution of blocking (direct and/or reverse) voltage in steady-state condition and dynamic modes, especially at thyristors' switching-on and recovery of blocking characteristics during switching-off of thyristor or diode.

The reasons due to which there's a possibility of uneven voltage division can be the following:

- Difference in off-state and/or reverse currents in series connected devices as a result of natural mechanical tolerance and/or different operating temperatures as a result of, for example, various cooling conditions (on the average changing the temperature by 8 °C leads to two times change of leakage). Overvoltage occurs in thyristors with lower leakage current.
To level-off the voltage in this mode switching-on of by-pass high-ohm resistors parallel to each semiconductor device (diode or thyristor) is being used. The higher are conditions to leveling-off of voltage in this mode, the lower should be values of by-pass high-ohm resistors.
- Variation of turn-on time of separate thyristors series connected in branches leads to redistribution of voltage between switched-on

earlier and switched-on with delay thyristors. Overvoltage occurs in thyristors switched-on with delay.

To level-off voltage in this mode high power control pulses with steep leading edge are used, which lead to decrease of delay time of thyristor switching-on and to minimizing influence of this effect on voltage distribution.

Presence of snubber RC circuits parallel to each device positively influences because probably up to the moment of switching-on direct voltage was applied to the thyristors, before which as well were charged the snubber capacitors, voltage on which at first moment after switching-on of thyristor is applied and ensures evenness of voltage distribution.

- Difference of reverse recovery charge value in series connected devices leads to such a thing that in the moment of recovery such devices take reverse voltage in different time. Overvoltage occurs in thyristors that have lower reverse recovery charge.
In such cases snubber RC circuits are being used as well switched on parallel to each semiconductor device. In this case $\Delta V = \Delta Q_{rr} / C$, where C – value of snubber capacity switched on parallel to device. Thus, to minimize the values of snubber capacitor it's necessary to organize semiconductor devices in groups with defined percentage of maximum deviation of reverse recovery charge in group. As a rule the defined percentage equals 10% or 5%.

Parallel Connection

Connecting thyristors or diodes in parallel it's necessary to achieve even distribution of load current on devices. To solve this task it's necessary to ensure operating conditions identity and voltage-current characteristics of each semiconductor device from the parallel connection.

To achieve identity of operating conditions it's necessary to follow these steps:

- Structural disposition of parallel branches has to provide balance of resistances of conductor lines including fuses.
- For all devices in parallel connection the conditions of cooling should be the same.

As a result of natural mechanical tolerance of voltage-current characteristics of semiconductor devices it's necessary to take the following measures to level them off:

- In series with each semiconductor device it's necessary to install reactive or ohmic current divider.
- Group semiconductor devices in accordance with static losses in spot (according to V_{tm} value on operating current).
- In schemes without current dividers it's necessary to install semiconductor devices that have maximum close values of slope resistance of linearized voltage-current characteristics.
- During development of converters that have parallel connection of semiconductor devices it's necessary to consider that operating currents should be above the point of inversion of voltage-current characteristics. In this case leveling-off of currents in parallel branches will be done automatically.
- To minimize the influence of turn-on time of separate thyristors and as a result uneven distribution of current in branches in instant of time it's necessary to use high power control pulses with steep leading edge, which leads to decrease of delay time of thyristor switching-on and minimization of influence of this effect on current distribution in parallel branches.
- In schemes where high voltage thyristors are used, that are produced on big diameter silicon elements (over 56 mm), and with presence of high inductance in power part, which limits speed of



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power current change, it's additionally necessary to consider distribution time of switched-on condition of thyristor. This is connected with the fact that high power thyristors in instant of time switch on in the limited area close to control electrode, after that in short period of time longitudinal propagation of on-state occurs.

Parallel and Series Connection of PSD

Peak current and blocking voltage of PSD are limited and it is often necessary to connect PSD of one type in groups in order to enlarge the capacity of the equipment under development. The main connection types are the following:

- Parallel – used when it is needed to increase peak current;
- Series – used when it is necessary to increase maximum blocking voltage;
- Mixed - parallel + series.

When connecting thyristors and diodes in parallel it is necessary to achieve equal distribution of load current among the devices. It is needed to provide operating conditions identity of power semiconductor devices and equality of voltage-current characteristics taking into consideration the scatter of technological parameters.

To accomplish this task the following is required:

- To install inductance or ohmic current dividers in parallel with each semiconductor device;
- To select semiconductor devices according to static losses in the operating point (according to $V_{TM(FM)}$ at operating current). It is worthy of note that a certain technological scatter of PSD parameters always exists.
- While designing converters with parallel-connected semiconductor devices it is recommended to choose operating currents that are above reversals points of voltage-current characteristic of power semiconductor devices. In this case current equalization in parallel paths is carried out automatically as in the voltage-current characteristic area lying above the reversals point negative feedback operates, in other words when junction temperature increases its resistance increases and direct current diminishes resulting in junction temperature decrease.
- In order to minimize the influence of separate thyristors turn-on time and as a consequence nonequilibrium current division in branches in the very beginning it is necessary to use a strong gate-pulses with high di/dt leading to decrease of thyristor turn-on delay time and to minimization of this effect influence on current division in parallel branches;
- In schemes where high voltage thyristors are used, that are produced on big diameter silicon elements (over 56 mm), and with presence of high inductance in power part, which limits speed of power current change, it's additionally necessary to consider distribution time of switched-on condition of thyristor. This is connected with the fact that high power thyristors in instant of time switch on in the limited area close to control electrode, after that in short period of time longitudinal propagation of on-state occurs;
- packaging of parallel branches should provide the equality of conductor lines resistance including fuses;
- refrigerating conditions for all the devices entering the connection should be equal.

When connecting thyristors or diodes in series it is necessary to strive to the equal sharing of blocking voltage (forward and/or reverse) both in steady-state condition and in dynamic modes that is at thyristors startup and blocking conditions recovery at the time of a thyristor or a diode turning off. The reasons for nonequilibrium distribution of blocking voltages can be the following:

- The differences of leakage in the series-connected devices in consequence of natural parametric scatter and/or different operating temperatures due to, for example, different refrigerating conditions (for information, at the average, 8 °C temperature change leads to the change of leakage twofold). Excess voltage emerges in the devices with lower leakage current value;
- The spread of turn-on time of separate thyristors connected in series in branches leads to redistribution of voltage among thyristors having been turned on prior and those that are turned on with delay. Excess voltage emerges in the thyristors that are turned on with delay.

The scatter of reverse recovered charge values in the series-connected devices leads to the situation that in the moment of recovery such devices accept reverse voltage in different time. Excess voltage emerges in the thyristors with lower reverse recovered charge value.

The ways of blocking voltage distribution equalization are the following:

- To minimize the influence of leakage current irregularity of series-connected power semiconductor devices, bypass high-value resistors are turned on in parallel to each semiconductor device (diode or thyristor). The higher the requirements to voltage equalization in this mode are, the lower bypass resistors value should be;
- Imbalances of blocking voltages-sharing that arises from the spread of reverse recovered charge values of power semiconductor devices are minimized by using RC snubber-circuits turned on in parallel to each semiconductor device. The higher snubber capacity value turned on in parallel to the device is the lower imbalances of blocking voltage distribution are. However the capacity increase is not always rational, that is why the selection of devices for the series connection according to reverse recovery charge is required. As a rule the spread of charges is equal to 5% and 10%.

The spread of power semiconductor devices turn-on time is minimized by application of strong gate-pulse with high di/dt leading to decrease of thyristor turn-on delay time and minimization of this effect influence on voltage division. The presence of snubber circuits in parallel to each device makes positive influence as before turning on certain direct voltage has been applied to thyristors, the same voltage is applied to snubber capacitors. At the first moment after the thyristor turning on the voltage of snubber capacitors is applied to the thyristor and provides voltage distribution steadiness.

Parallel-connected or series-connected power semiconductor devices contain a wide range of power converters. While designing, maintaining and repairing it is important to consider above mentioned requirements and peculiarities of device group turning on. It will allow using power semiconductor device resource to the maximum extent possible, developing and designing reliable and long-wearing equipment.

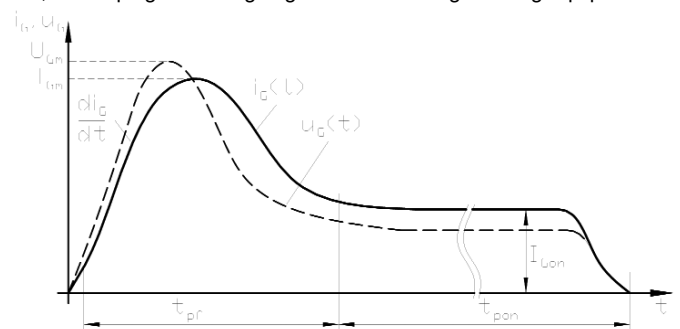


Figure 4 – Diagrams of current and voltage

Control Features of Power Thyristors

Thyristor is a bipolar semiconductor, which is controlled by current, that's why driver block should provide current pulse of the desired form flowing into the circuit control electrode – thyristor cathode.

Below are the conditions for the most frequent cases of thyristors usage. In case of special application it's recommended to turn to the specialists of Proton-Electrotex JSC for advice.

Standard forms of circuit current and voltage are shown in figure 4.

I_{Gon} – rate of inflow current;

$I_{Gon} = (3 \div 5) \cdot I_{GT}$;

I_{GT} – trigger gate direct current (parameter is taken for minimum operating temperature at which the thyristor will be in operation).

I_{GM} – peak of accelerated impulse;

$I_{GM} = (10 \div 12) \cdot I_{GT}$.

di_G/dt – gate current rate of rise;

$di_G/dt \geq 1 \text{ A}/\mu\text{s}$;

For values di_G/dt there are no upper limits.

t_{pf} – length of accelerated control pulse;

$t_{pf} = (2 \div 3) \cdot t_{gd} \approx 10 \mu\text{s} \div 20 \mu\text{s}$;

t_{gd} – time delay;

For low operating temperature it's recommended to choose higher control pulse duration.

t_{pon} – inflow current impulse time;

$t_{pon} = (3 \div 5) \cdot t_{gt} \approx 50 \mu\text{s} \div \infty$;

t_{gt} – turn-off time, depends on device connection circuit;

durability t_{pon} is defined by character of load and conditions of performance circuit, where thyristor is located. Current in time t_{pon} function as thyristor insurance if there is a possibility to lower anode current to the value of hold-on current.

It is not recommended to simultaneously have direct control current and reverse voltage anode-cathode.

To minimize the influence of conductor inductance on rate of rise of control current it's necessary that off-load voltage of control driver has to be around $15 \div 30 \text{ V}$.

Peak reverse control voltage to increase noise immunity level of thyristor (control electrode is negative to cathode) should be lower than 5 V .

Operating point of control electrode load should be located in the zone of optimum control, exactly it shouldn't come outside the curve corresponding maximum admissible power of losses on the control electrode with defined durability and control pulse relative duration, and shouldn't get into the zone of unwarranted switching-on of thyristor. Voltage-current characteristic of control electrode is shown in the corresponding materials of thyristor.

Driver block is mounted closer to thyristor, braid the control wires. It's also necessary to take measures to exclude control wires' contacts with surfaces that have high potential, or influence of rapidly changing electromagnetic field to avoid the influence of electromagnetic noise on drive circuit.

To ensure reliable performance of thyristor, minimum anode current, on which thyristor is switched on, should be higher than the defined value, depending on device type and can vary from several amps up to several tens of amps.

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Reliability of Thyristor Technology

One of the inherent advantages of power semiconductors is increased reliability. Since the introduction of silicon technology in the 1960s, applications have grown from consumer products to heavy industrial products and, more recently, to demanding traction, aerospace and military applications. The reason for the wide acceptance of thyristor technology in expanded applications is its increased dependability.

By Ronald J. Yurko, Powerex Rectifier/Thyristor Business Unit Manager

Powerex thyristor technology is based on a foundation of industry leadership and expertise originating from its founding companies Westinghouse Semiconductor, General Electric and Mitsubishi Electric.

Demanding applications require semiconductor manufacturers to continue to invest in new technologies to ensure long-term reliability. The heart of this investment has been improving process controls for phase control thyristors to eliminate traditional failure mechanisms. Due to the growing demand for energy efficiency, the thyristor remains unmatched for performance, cost and reliability. Advantages drawn from the simplicity and compactness of these devices allow for continued demand in new applications, such as wind energy and small DC drives rated at a few kW to converters for HVDC rated at several GW.

For example, a Powerex SCR may be used in a crowbar application at an average DC voltage of 2600V. The failure rate from published curves would be 700 FIT, which is equivalent to a MTTF of 163 years of continuous application. If that same SCR were used in a traction application in a fleet of 25 locomotives, with each locomotive using four SCRs, an MTBF for any of the 25 locomotives to fail would be 163 years X .01 or only 1.63 years. In less demanding applications, where the voltage varies, time must be considered. For a chopped DC device performing at 50% duty, the failure rate would be half the value. In order to reduce failures, power electronic engineers can rely on a set of tools that ensure long-term reliability including:

- Proper SCR selection
- Employing simulation tools
- Proper mounting procedures
- Failure analysis tools used to ensure corrective action
- Measurement of device characteristics
- Understanding the specific application

Proper SCR Selection

Proper SCR selection must start with establishing the peak amplitude of nominal line voltage. For example, on a 600V AC line:

$$V_{O(max)} = V_{line} * \sqrt{2} = 660V * \sqrt{2} = 933V$$

A voltage rating with an overshoot factor of 2.5 should be used.

$$V_{DSM} > 933V * 2.5 = 2333V \rightarrow V_{DSM} = V_{DSM} = 2600V \text{ selected SCR}$$

Next, the best 2600V device must be selected from the manufacturer. The devices differ in size and current rating. The maximum allowed case temperature is selected from the device's data sheet. In a six-pulse, three-phase rectifier, each SCR carries 1/3 of the DC current,

so a 120-degree conduction angle (rectangular pulse) is sought on the device data sheet. $I_{T(av)} = 1/3 * I_D = 1/3 * 3600A = 1200A$. With this known average on-state current, the selected SCR's specified case temperature (T_C) for a given maximum junction temperature (T_J) can be read from the datasheet. The selected device under these conditions will support a device specific I_{TSM} surge current.

Employing Simulation Tools

Simulation software has become widely used in the industry to properly design power electronics and minimize failures. Circuit modeling is an essential tool in the design of power electronic applications. Both the on-state forward voltage drop and transient thermal impedance of high power SCRs and diodes are complex functions. The on-state forward voltage drop can be modeled by ABCD parameters. The transient thermal impedance has been shown to be well represented via four or five exponential terms representing the significant transient thermal time constants of the device. Powerex offers STARSim to its design engineers to quickly evaluate a given device in proposed or existing power electronic applications.

The Pspice waveforms for the Powerex T9G0 withstanding a 17000A single cycle surge is illustrated in Figure 1. Note that not only is the current waveshape through the SCR displayed but also the V_{tm} , power dissipation and, most importantly, the selected virtual junction temperature (T_J) waveforms. This simulation tool prevents failures in the design stage prior to building a stack.

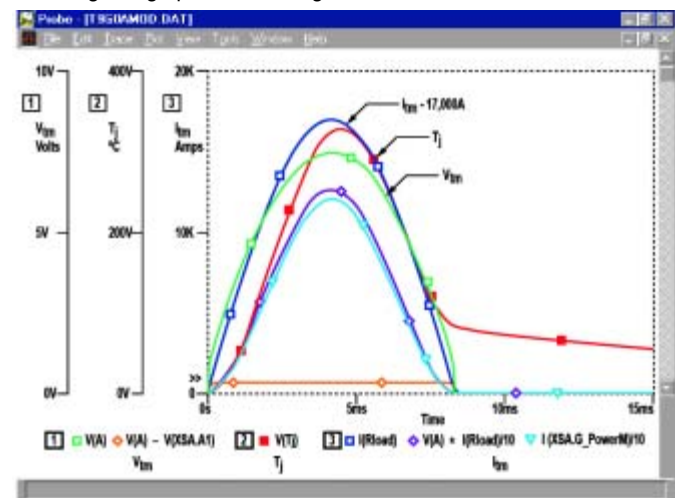


Figure 1: Pspice Waveforms for T9G0 SCR

Proper Mounting Procedures

Heat sink selection, cooling and RC snubber design are all pre-

scribed by understanding the SCR datasheet. Many failures related to a device in an application can result in spite of selecting the correct conditions, and not exceeding the maximum case temperature, if the device is not properly mounted. Improper assembly techniques can lead to catastrophic failures. The amount of heat involved requires proper mounting to prevent excessive temperature rise or damage to the silicon. Proper mounting and surface preparation should be discussed with the manufacturer. The condition of the sink mounting surface is one of the most important details to be aware of during this process. Flatness, clamping force, surface finish and proper thermal compounds are all prescribed by Powerex to ensure long-term reliability.



Figure 2: Failure Due to Mounting Error Exhibits Silicon Melt on Cathode

Mounting pressures have been determined by empirical tests. Lowering the suggested mounting force can result in overheating while higher values can crack silicon or damage internal components. Mounting forces must be understood to ensure long-term reliability.

An SCR failure resulting from improper clamping would exhibit surface burns on the silicon. When a clamp does not exert uniform pressure on the SCR due to a parallelism error, poor heat dissipation occurs and eventual overheating. Presence of partial contact patterns on the cathodes contacts and surface burns on the failed SCR clearly indicate incorrect assembly which would lead to excessive operating temperatures. Indications of surface burns consistent with low clamping force are always identified with a correct failure analysis.

Figure 2 photos of failed semiconductors exhibit exposed copper in the bottom of the alignment hole, indicating that the alignment pin was too long or improperly inserted in the heat sink. The long alignment pin was the cause of the failure. Severe pitting due to arcing on the cathode and the anode suggest under-clamping. The improperly inserted alignment pin also caused the under-clamping.

Failure Analysis Tools

A number of factors exist that may lead to a failure. The device design and manufacturing controls are under the direction of the manufacturer. An active quality control program is employed to uti-

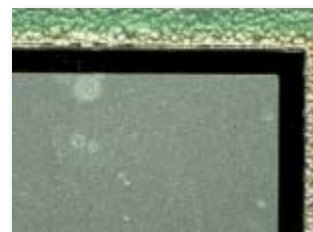
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lize the latest techniques to ensure reliability. Contamination in the silicon bulk region and contaminants on the junction surface or exposed during encapsulation are the manufacturer's responsibility. Entrapped ionizable contaminants can and do cause gradual changes in a device.

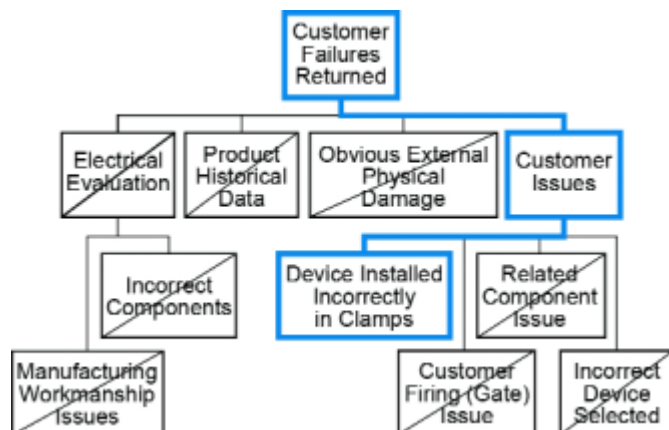


Figure 3: Solution Tree Analysis

At Powerex, tools such as a SEM (Scanning Electron Microscope) are employed to detect these issues in processing. Failure analysis includes 8D corrective action approaches to determine root cause and corrective actions needed. Figure 3 illustrated this solution tree analysis process.

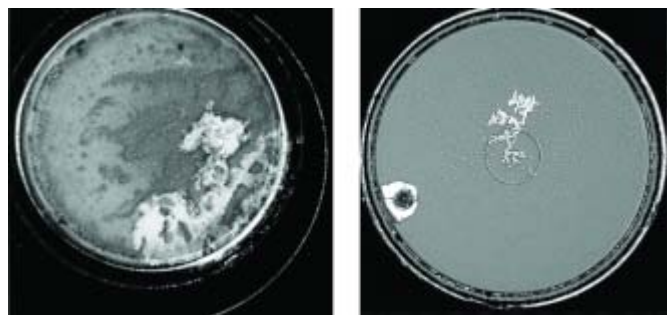


Figure 4: Examples of Acoustic Images of a Diode and an SCR that Overheated Due to Poor Thermal Dissipation

The latest investments at Powerex include acoustic micro imaging systems that can detect voids in power semiconductors. In thyristor processing, silicon wafers are bonded to molybdenum anodes with an aluminum alloying process at high temperatures. New nondestructive tools, such as acoustic imaging, allow process engineers to monitor alloying, thereby detecting and preventing temperature increases during power dissipation in an application. Many causes of voids, as shown in Figure 4, have been detected and eliminated with the introduction of in-line monitoring.

Although voids are controlled, the effect is greatly mitigated by double-sided cooling of both sides of the silicon. Residues left on the anode surface cause alloying voids. With excellent process controls, a completely void-free alloy becomes possible when precautionary measures are taken to reduce the amount of oxides present on the alloy surfaces. Heating rate and soak temperature are essential process parameters to avoid voids. With the use of Sonoscan imaging, engineers produce more reliable thyristors today than ever before. Alloyed thyristor technology has proven advantages over floating silicon technologies where thermal run-away leads to stress related gate area and edge failures due to temperature gradients in the construction. Improved alloying processing controls application

advantages, allow Powerex thyristors to outperform dry interface construction floating silicon technology.

Measurement of Device Characteristics

SCRS cannot be constructed without consideration for silicon contact area and improved thermal impedance. The size of the cathode area has a direct influence on current carrying capability and better forward drop performance. As the SCR employs materials of greatly different coefficients of thermal expansion, the device will see temperature excursions in its application. Control over device component tolerances and finishes are necessary. Calibration of test equipment temperatures and test parameters must be closely controlled. Non-triggering devices usually are related to breakage of gate leads in the assembly. Solder fractures can occur in soldered devices.

The most typical failure modes are electrical due to di/dt , over voltage, dv/dt , thermal run-away, surge or a forward or reverse bias. Di/dt is by far the most prominent application problem for SCRs. It results from current and power density issues during turn-on that lead to hot spots in the device. Application specific di/dt guidelines result in proper device selection and a good gate drive. These types of failures are best discussed with the manufacturer. There are two kinds of di/dt failure modes: thermal fatigue and thermal runaway. Both failure mechanisms can be handled adequately by design. The failure period must be controlled by limiting the initial speed of plasma spreading and the length of the turn-on line for both the first and second triggering. Higher di/dt ratings result in smaller active areas, lower current ratings, lower surge ratings and higher thermal resistance. As with many semiconductor trade-offs, di/dt needs to be understood for the intended application.

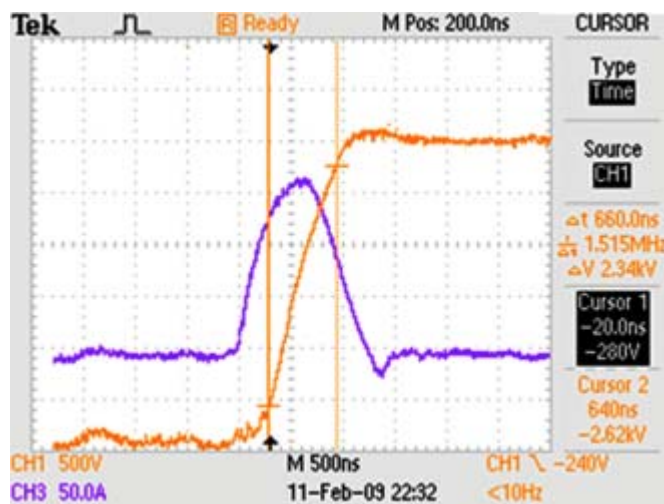


Figure 5: Dv/dt Waveform

It is possible to turn on a SCR without exceeding the device V_{drm} with the gate open circuited. If a transient voltage is applied across the anode to cathode, a current will flow through the forward bias junctions. This will turn on the SCR, which is undesirable. Over temperature leads to thermal run-away in leakage current in the blocking state. As temperature climbs over the rated junction temperature, the leakage current flowing at the blocking voltage can lead to power loss. In the worst case scenario, this will melt silicon as the power generated can no longer be dissipated. New testers that accurately measure dv/dt capability and blocking voltages at higher temperatures are employed to ensure long-term reliability. Figure 5 shows a tester's result of a dv/dt waveform.

Surge testers are employed to ensure that an SCR is able, while operating within its junction temperature rating, to handle a surge current of considerable magnitude without failure. When the rated surge occurs, the junction temperature will rise above the rated junction temperatures. This time is typically short and, due to the thermal constant of the device, the heat generated is difficult to dissipate. If the surge repeats, the device may not have time to cool within its rated temperature. Powerex engineers can detect surge related failures upon examination. Figure 6 depicts a Powerex surge test circuit employed to validate reliability.

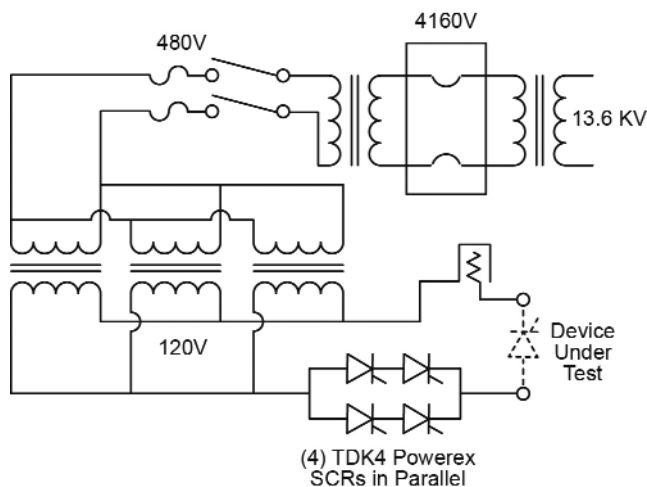


Figure 6: Surge Test Circuit (30kA) Powerex ITSM

Understanding the Specific Application

When a selected device cannot meet the application total blocking voltage capability, SCRs must be connected in series to provide sufficient safety margin. The $I_{R(rec)}$ specification is the magnitude of reverse recovery current. This is the peak reverse current flowing through the SCR when it is turning off. Part of this current is transferred into the RC snubber network, resulting in a reverse recovery transient voltage spike. This voltage spike must be less than the device rated voltage or it will fail. Increasing the recovery current spec will result in an increase in transient voltage. Customers will typically ask, "Is there enough safety margin in this application such that we will not cause a higher failure rate by this specification increase?" Series applications SCRs are matched on $I_{R(rec)}$ based on:

- 125°C (Hot) testing
- $\Delta I_{R(rec)}$ matching = a string of SCRs as determined by application
- Avoids Q_{RR} / Q_{RA} estimation and inaccuracy
- Demonstrated success at multiple customers over many years of service

Powerex provides matched SCRs for series-connected stacks by providing serialized data with the shipped thyristors. The automated test sequence employs barcode scanners, as shown in Figure 7, to capture parametric test data for storage, record retention and sorting of SCRs for shipment. For increased current ratings, serialized data allows Powerex to match on-forward drop to meet customer requirements.

In conclusion, selecting the correct SCR from the manufacturer begins with a thorough review of the application that will



Figure 7: Barcode Scanner

allow the power semiconductor manufacturer to employ simulation tools and software to predict device behavior in the conditions outlined. Advances in quality control techniques, semiconductor processing methods and nondestructive testing capabilities have come a long way to improve device reliability for the ever-demanding role of thyristor technology.

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Keep Your Distance

Voltage proof of electrolytic capacitors

Aluminum electrolytic capacitors ("electrolytic capacitors," "e-caps") are important components in many power electronics devices today. Ever-increasing requirements for energy efficiency, expanding use of renewable energy and the growing proportion of electronics in automotive applications have driven the wide use of these components.

By Dr. Arne Albertsen, Jianghai Europe Electronic Components GmbH

In many applications, service life and reliability of the device depend directly on the corresponding parameters of the electrolytic capacitors [4]. In previous publications [1], [2] the author focused on the topics of life time prediction and reliability (also touching the dependence of these quantities on the operating voltage). The present article explains the reasons for the limited voltage rating of capacitors and shows the voltage ranges that must be kept to ensure safe operation.

An important parameter when selecting an e-cap is its voltage proof, which is usually given as rated, operating, or surge, or in special cases, as transient voltage. Exceeding the voltage proof - even if this is done only for a few milliseconds - may lead to immediate failure of the capacitor or decrease its performance for the remaining lifetime. In many applications, the highest ever occurring voltage load cannot be predicted. Examples for possible causes of increased voltage stress compared to the normal operating voltage are:

- Voltage spikes due to switching transients from inductive loads
- Feedback from free-wheeling motors
- High-impedance generators with varying loads
- Unbalanced load conditions or phase connection errors or dropout of a single phase
- Connection error (error in the wiring, power supplies, e.g. at construction sites)
- (destructive) over-voltage tests, e.g. UL508C "Breakdown of Components Test"

One approach is to select the rated voltage of the capacitor such that it lies far above the expected maximum voltage in the application. However, this approach contradicts the common targets of miniaturization and cost optimization. To successfully minimize the "safety margin" without sacrificing reliability, a thorough understanding of both the properties of the circuit to be designed and the capacitors to be deployed is required. In order to characterize the properties of the circuit completely, measurements in addition to simulations are useful ("to measure" means "to know"). To illustrate the definitions and boundaries of the voltage proof capability of electrolytic capacitors, we first consider construction and manufacturing of these electronic devices.

Design and manufacture of electrolytic capacitors

Aluminum electrolytic capacitors combine voltage proofs ranging from several volts to about 750 Volts and a wide capacitance range from 1 μF to above 1 F, while offering a compact size. A highly roughened anode foil is being completely covered by a thin dielectric layer and contacted by an exact fitting cathode, the electrolyte liquid. (Figure 1).

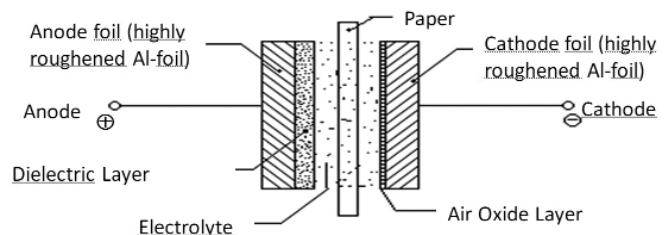


Figure 1: Construction of an aluminum electrolytic capacitor

The manufacture process of e-caps comprises the following major production steps:

Etching – high purity aluminum foils of thickness 20 ~ 100 μm are the base material for the later anode- and cathode foils. The etching enlarges the total surface area of the anode material up to a factor of 140 (Figure 2), compared to their geometric surface. Even at this early stage in the production process it is determined whether the capacitor will later be able to meet the high requirements in terms of voltage stability, reliability, long lifetime, and ripple current capability in professional industrial applications. The manufacturer has to decide at this point, whether a low product price is essential, or whether he recognizes the importance of the pore structure for the performance in the application and the product quality. The latter causes sometimes considerable extra costs in materials and processes, but it ensures a stable quality product. The pore structure of the anode material in connection with the experience of the manufacturer (and not only the forming voltage) identifies a responsible quality manufacturer.

Forming – the anode foil bears the dielectric layer of the e-cap and consists of aluminum-oxide (Al_2O_3). It is deposited on top of the roughened anode foil by an electrochemical process called anodic oxidation or forming. The quality of the forming, i.e. the homogeneous and complete coverage of the surface area is essential for the high reliability of the components during operation. The further the forming voltage is above the rated voltage, the smaller becomes the probability of dielectric breakdown. Typical values for the ratio of forming voltage vs. rated voltage of Jianghai electrolytics range between 1.25 (low voltage) and 1.60 (high voltage). The thickness of the dielectric layer is approximately 1.4 nm/V; this amounts to about 900 nm for an e-cap with 450 V voltage proof (this is less than 1/100 of the thickness of a human hair).

Slitting – the etched and formed foil comes on so-called mother rolls of about 50 cm width. By slitting, the mother rolls are cut into the widths needed for the anode and cathode material.

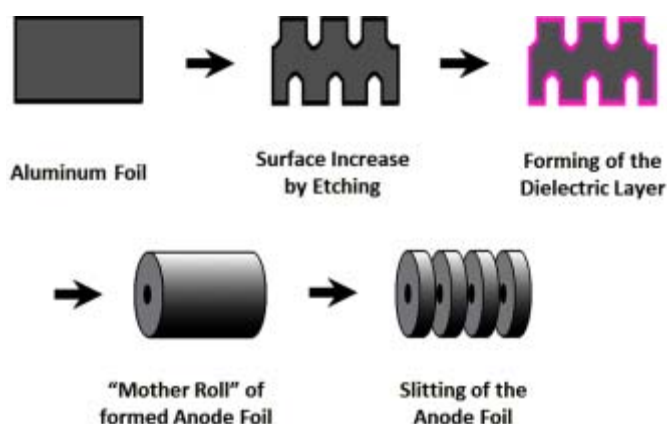


Figure 2: Process steps for the preparation of the anode foil

Winding – attachment of electrical contact tabs to the foils (stitching, cold welding) and winding of anode, paper (spacer, multi-ply if needed), and cathode foil. The selection of the paper and the structures of the cathode foil have a significant influence on the subsequent performance of the component. The construction of the wound cell and the current path through the internal and external connections determine also the parasitic inductance. Although it is often desirable to protect the power semiconductors by deploying capacitors with low inductance, the capacitors may be negatively affected by brief voltage spikes themselves. It should therefore be judged case by case whether using low-inductance capacitors is reasonable.

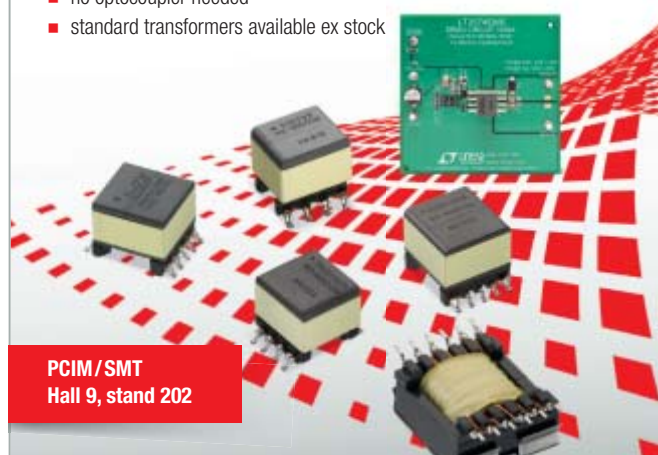
Impregnation – the pores of the spacer paper in the wound cell and the complete surface area of the anode foil are covered by electrolyte, the liquid cathode.



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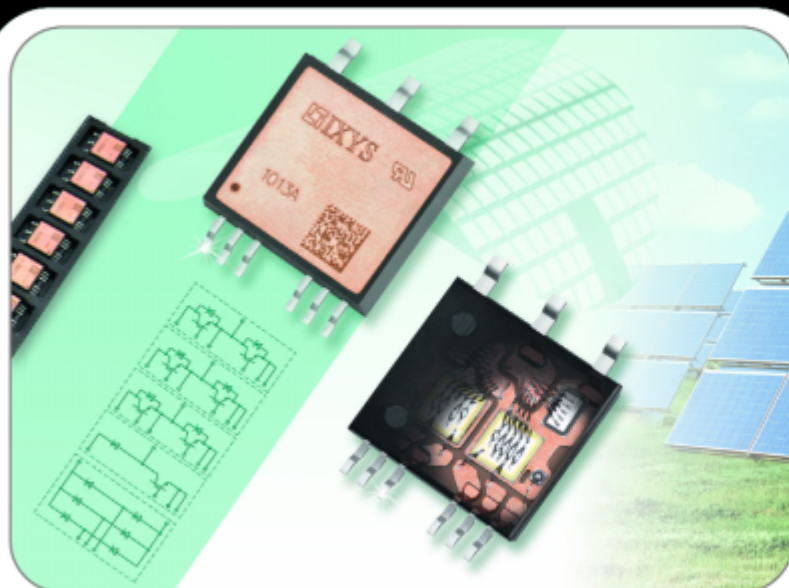


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Assembly of the capacitor wound cell into the can, electrical connection between contact tabs and soldering or screw terminals and riveting of the can for a tight seal.

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Post-forming („Burn-in“) to heal the cut edges of the foil. Main reasons for the post-forming are unformed and cut edges of the anode foil, cracks in the oxide layer that appear during winding, and (to a lesser extent) damages at the joints of the connecting tabs.

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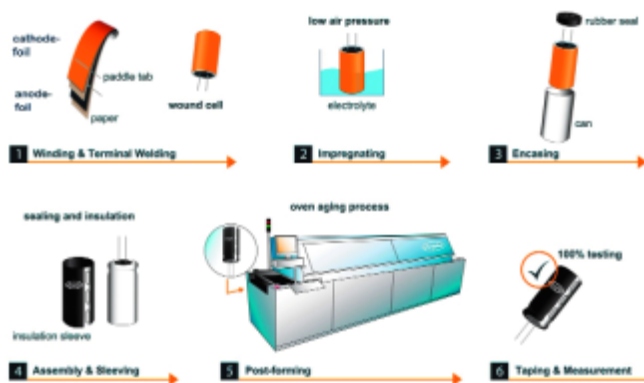


Figure 3: Process steps from the pre-material to the capacitor

In particular the process steps of forming and post forming have great influence on the reliability of e-caps under operation. Jianghai pursues the target of maintaining a sufficiently high distance of the forming voltage from the rated voltage and a reasonable dwell-time during post-forming to ensure high reliability. As the forming voltage is commonly not indicated in the datasheets, the final user of the components has a hard time to use this parameter as a performance indicator. By asking the e-cap supplier and by comparing the leakage current ratings, the end user may draw his conclusions with respect to the design philosophy of the e-cap manufacturer. In times of rising material and energy prices, even some well-known manufacturers resort to lowering the forming voltages of running series. From a quality perspective, Jianghai considers these “cost-optimization measures” being not acceptable.

Definitions of voltage proof

Even a single occurrence of a voltage out of the permissible range (green and yellow-colored areas in Figure 4) can already lead to permanent damage of the electrolytic capacitor. For safe and reliable operation of electrolytic capacitors, the following definitions are therefore of central importance.

Reverse voltage (IEC 60384-4, 4.15)

Aluminum electrolytic capacitors as polarized components must always be connected with correct polarity. Applying reverse voltage would mean that the thin (air-) oxide layer on the cathode would take over the task of the dielectric film. Since this oxide layer is very thin, it typically has only a “dielectric strength” of 0.7 ~ 3 volts. Exceeding this voltage triggers an electrochemical reaction that grows the oxide layer on the cathode foil, which is associated with the formation of hydrogen gas and heat. A reverse voltage may (depending on the voltage and power supply) lead to the destruction of the component due to overheating, overpressure and dielectric breakdowns. Therefore, Jianghai does not allow any operation of capacitors under reverse voltage conditions (red area on the left in Figure 4).

Rated Voltage (IEC 60384-4, 2.2.3 ~ 2.2.5)

The rated voltage is printed on the capacitor and specified in the datasheet. It represents the maximum value in the entire temperature range of the electrolytic capacitor. The continuously applied operating voltage on the capacitor (including any superimposed alternating voltage) shall not exceed the value of the rated voltage. The peak value of superimposed ac and dc voltages must always be located in the green area of Figure 4, while the maximum permissible ripple current must not be exceeded.

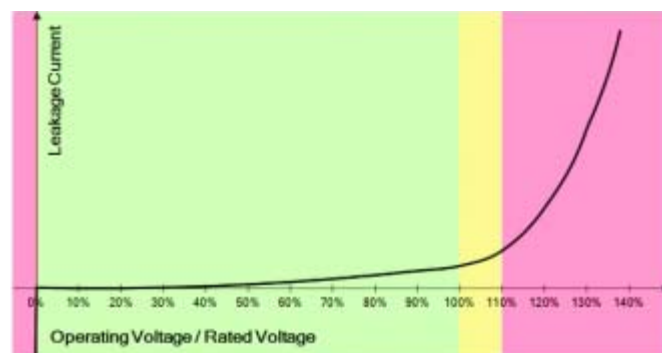


Figure 4: Typical course of the leakage current vs. operating voltage for a high-voltage capacitor

Surge Voltage (IEC 60384-4, 4.14)

The surge voltage indicates the maximum voltage value that may be applied during the life at a frequency of 1000 cycles (each with a dwell time of 30 seconds and a pause of 5 minutes and 30 seconds) without causing any visible damage to the capacitor or a capacitance change of more than 15%. For capacitors suited for elevated requirements (the normal case in professional industrial applications), a maximum of five tests per hour at upper category temperature is conducted. For capacitors with a rated voltage of up to 315 volts, a surge voltage of 1.15 times the rated voltage applies, and for capacitors with a rated voltage exceeding 315 volts, a surge voltage of 1.10 times the rated voltage applies (yellow area in Figure 4). Jianghai safeguards the surge voltage strength by carefully reforming at a sufficiently high post-forming voltage. If smaller surge voltages are shown in the data sheets, this may be an indication for a cost-optimized manufacturing process (shorter times and / or lower post-forming voltages in the oven)

Impaired surge voltage performance may also be the result of inadequate pore structures, which were initially furnished with a high dielectric strength (and thus hard to distinguish from components of higher quality while being new), but over the life these capacitors exhibit a larger drift in the parameters and therefore tend to be more susceptible to damage by surge voltage. Even if these components can be exposed to very high allowable current profiles, any unexpected voltage surge may cause a sudden capacitor failure.

Transient Voltage (IEC 60384-4, 4.22)

Transient voltages range above the specified operating voltage range given in the data sheet (red area on the right in Figure 4). Nevertheless, electrolytic capacitors can in principle withstand very high, short-term, transient voltages, if the energy content is low. Voltages beyond the surge voltage lead to high leakage currents and a voltage limit similar to a zener diode [3]. When the electric field strength is too high for the electrolyte, it can directly cause a short circuit. But even if the electrolyte withstands the applied voltage, electrochemical processes lead to a further formation of oxide on the surface of the anode foil, accompanied by heat and hydrogen gas formation, and after a certain time, the safety vent will be engaged.

If in an application transients are expected, Jianghai has the technical possibilities for the optimization of anode foil, electrolyte, and paper in order to provide a specific solution within the physical limits. Since almost all of the materials and process steps have an effect on the stability of the component and its dielectric strength, there are complex interactions of all parameters involved in the design of the components. Jianghai offers its customers a close collaboration to develop optimal solutions for engineering and procurement.

Summary

By their individual voltage proof, aluminum electrolytic capacitors influence the reliability of the electronic devices they are mounted in. A thorough knowledge of some of the key parameters of these components is necessary to ensure the reliable design of electronic devices.

The definitions of voltage proof and the most important influence factors on voltage proof are explained. As a practical tool, a qualitative graph of permissible and forbidden voltage ranges hints helps as a guideline to the successful application of electrolytic capacitors.

The applicability of the general guidelines depends on the specific product type and the particular application. Consultations with the supplier are essential to get guidance throughout the design project and to confirm any estimates.

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- [3] Imam, A.M., Condition Monitoring of Electrolytic Capacitors for Power Electronics Applications, Dissertation, Georgia Institute of Technology (2007)
- [4] Venet, P., A. Lahyani, G. Grellet, A. Ah-Jaco, Influence of aging on electrolytic capacitors function in static converters: Fault prediction method, Eur. Phys. J. AP 5, 71-83 (1999)

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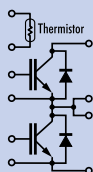
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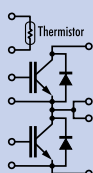
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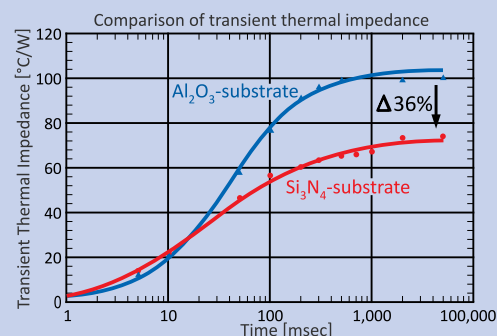


Ic	1200V	1700V
225A	●	
300A	●	
450A	●	
550A		●
600A	●	

225A	●	
300A	●	●
450A	●	●
550A		●
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Designing for Quality

Setting the industry standard

The power electronics industry is conservative by nature, and this is by no means a coincidence. The consequences of failure in medium and high voltage power switching applications are simply unacceptable, and this is reflected in the cautious adoption of new technologies. Applications such as traction drives, HVDC, medium voltage industrial drives and wind turbine inverters are all alike in setting high standards of acceptance for innovative new products.

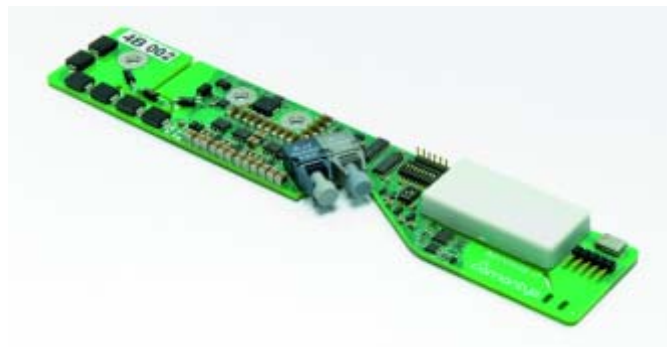
By Andy Matthews, VP Operations, Amantys Ltd

Amantys has a vision for the Intelligent Power Switch – a product that integrates the power transistor, gate drive and microprocessor in a tightly coupled device, delivering significant system benefits over existing techniques.

However, before introducing such a radically different approach, the first challenge the company faced was to build relationships - and revenues - by demonstrating it has the right skills, capabilities and quality processes to bring such change with products the industry already deploys.

The company has therefore introduced its first family of gate drive products – the Amantys Power Drive – implementing familiar products with enhanced performance and a greater rigour of design practice in order to win that acceptance.

Building such a reputation is founded on quality at every stage of the product development process. This begins with understanding market requirements, defining reliability lifetime targets, and flowing through design practices, to verification and test.



Market requirements and design targets

In developing the Amantys Power Drive, the company took a very deliberate approach to setting design criteria to meet specific performance targets, driven against clear requirements defined by a major industry OEM and IGBT module suppliers.

They highlighted particular improvements they wanted to see over an existing commercially available product, including better isolation, faster start-up and recovery times, and a gate drive with physical dimensions to fit within the footprint of the IGBT power module. In

addition, there was a demand for a gate drive that could drive multiple vendors IGBT modules with a single configurable drive.

These requirements formed the targets for the product and used as the acceptance targets in EVT (Engineering Verification and Test) for form, fit and function of the eventual product.

It should be remembered that the primary function of a power transistor gate drive is to switch power safely, and in a way that protects the IGBT during abnormal system events. Testing and certification therefore becomes not only a question of performance and quality, but also of safety.

As part of this process, the team employed various design techniques. This included a rigorous component de-rating analysis, a comprehensive DFMEA study (Design Failure Modes Effect Analysis) to achieve performance and lifetime targets over the entire environmental envelope, and of course, the usual performance simulation for design envelope headroom, reliability and product lifetime.

This design methodology led directly to the adoption of surface mount MELF components in place of standard 2W resistors, to deliver better power density and longer lifetime at the extremes of the required operational specification.

DFMEA quantifies the likely severity and frequency of occurrence for each failure mode, including how well the design is able to detect each cause of failure, and how the design will perform in each instance.

As well as defining and guiding a logical design process, the process provides the design team with a traceable document for on-going design and development, and a vehicle for continuous product improvement and development.

Product verification

The next stage of development is verifying the product's performance and quality through a combination of in-house and external third party tests.

When choosing to self-certify and in order to test worst case scenarios, companies must have adequate testing facilities to expose their products to conditions beyond their stated operation limits.



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In-house testing

A series of tests are performed at Amantys including functional performance, life-time and reliability tests, and in-house certification.

As part of its investment in power electronics, the company has installed and commissioned a High Energy Test (HET) facility at its Cambridge headquarters. The Power Drive family has been tested for Reverse Bias Safe Operating Area (RBSOA), Type 1 SCSOA (Short Circuit SOA) and Pseudo Type 2 SCSOA using this facility.

In addition, the products have passed HTOL (High Temperature Operating Life) at - 95°C operational temperature and thermal cycling from -30 to +85°C.

Amantys has performed this characterisation for each of the IGBT Modules in its Power-drive Partnership Programme and provides a graph of Safe Operating Frequency at different temperatures and gate resistor settings.

Third party testing

In addition to the Amantys in-house testing and verification, there are a series of third party tests undertaken. This includes accelerated stress testing techniques - HALT and HASS: Highly Accelerated Life Test/Stress

Tests		Conditions
Functional Bench Testing	Normal operational & at corners	25°C Low Voltage tests only
High Energy Test	RBSOA Double pulse	125°C IGBT
	Type 1 SCSOA	125°C IGBT
	Pseudo Type 2 SCSOA	125°C IGBT
Lifetime and reliability	HTOL	95°C operational
	Thermal Cycling	-30 to +85°C
	Damp heat	85°C, 85% relative humidity Static and operational
PSU Performance	Efficiency	0 to 7.5W
	Regulation	0 to 7.5W, 14.5V to 15.5V input
	Isolation	Partial Discharge: IEC61287 Hipot: 14kVDC
	Thermal shock	-50°C to +125°C

Table 1: Test matrix summary

Screen - in keeping with best practices in the automotive industry. These tests identify product failure modes in a matter of hours or days, compared to traditional test methods that may take weeks or months.

Product certification

Certification of components is a grey area, with both self-certification and industry body accredited options available to companies. But what is the driver behind certifying your products? What should we, as an industry, be striving towards at all times? Certification is not a matter of displaying a logo or stamp on your product; it is about ensuring quality processes throughout your entire design cycle, as already described - to provide cus-

tomers with the highest quality product to suit their specific needs.

These needs vary according to the region into which products are sold. In the US, there is an insistence on tight regulation of certification through industry bodies and this is a legal requirement. However, throughout the EU it is currently legally permissible to have no third party certification.

A trusted and recognised EU option is the CE marking, indicating product compliance with EU legislation and enabling free movement of products within the European market. By stamping the CE mark on a product a manufacturer is declaring - on one's sole

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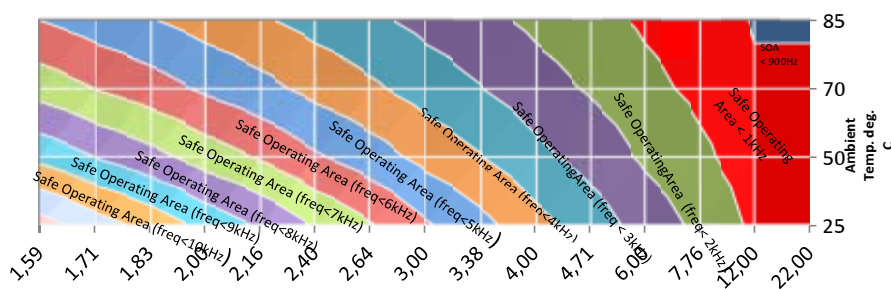


Figure 1: Safe Operating Frequency at different temperatures and gate resistor settings

responsibility - conformity with all of the legal requirements to achieve CE marking. This mark allows the product to be sold throughout Europe, but this does not constitute a 'quality' marker, and is usually self-certified by the company, with supporting documentation done in-house.

Amantys is taking a more thorough approach by seeking external accreditation of its HET facility for manufacturer type testing. Further than that, the product will also be tested and certified externally both for CE and UL standards for Europe and the US respectively, thus adding independent recognition and endorsement from an external body.

Bring something to market that the industry already knows, build it better and more rigorously than incumbent sellers, and then test and prove the product performance and reliability. The Amantys Power Drive is tested up to 14kV isolation, has faster start-up and recovery times (without a 1 sec dead-time), fits within the footprint of a 190mm x 140mm IGBT module, and drives multiple IGBT modules.

The interest we see from OEMs and IGBT module manufacturers suggests our product and design approach is gaining the reputation we're seeking.

Limit	Value
Lower operating temperature limit	-70°C
Lower destruct temperature limit	< -70°C ¹
Upper operating temperature limit	+110°C
Lower destruct temperature limit	> +115°C ²
Operating vibration limit	45g _{rms}
Destruct vibration limit	> 45g _{rms} ³

Operating limits: The last chamber set point at which the test item is fully functional
Destruct limits: The last chamber set point that causes an unrecoverable failure.

¹ The test was limited to -70°C; hence the destruct limit is less than -70°C

² The test was limited to +115°C; hence the destruct limit is greater than +115°C

³ The maximum vibration level achieved was 45g_{rms}; hence the destruct limit is greater than 45g_{rms}

Table 2: Environmental Test: operating and destruct limits for test results

When it comes to the certification of electronic products, there is the added layer of discussion surrounding whether the components themselves should be certified, or whether the final system is most important. By ensuring that our drives are certified this allows a much faster route to market, but also places quality control at the forefront of company practice and procedure.

A new player in power electronics

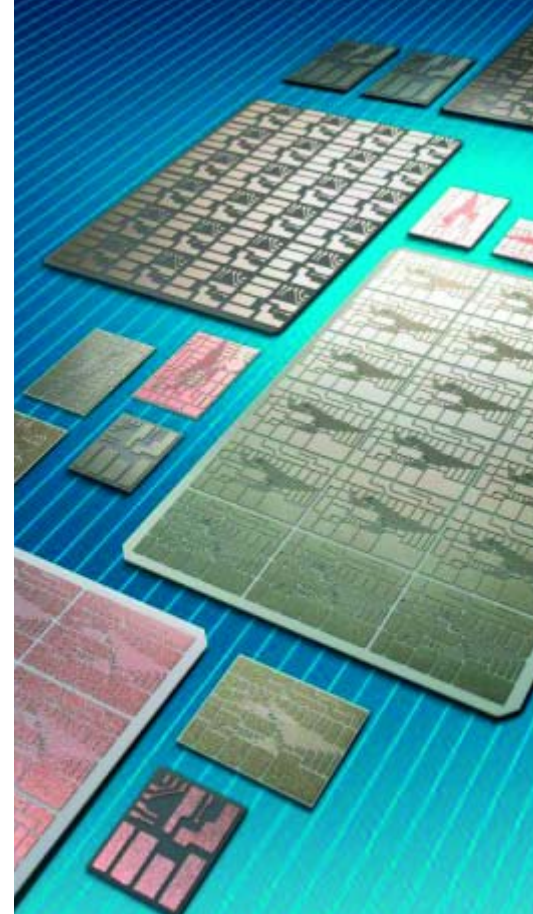
This cautious nature of power electronics is reflected in the relative scarcity of new entrants to the industry. Amantys is one company that has a very clear view of the credentials needed to gain credibility in this sector, and this is reflected in the company's philosophy and approach to entering the market.

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SoC Enables Measurement and Diagnostics for High-Power Monitoring



Maxim Integrated Products introduces the 78M6631, a Teridian™ 3-phase power measurement system-on-chip (SoC) that embeds power monitoring into high-load applications. This fully self-contained and customizable energy measurement system offers a full range of measurement and diagnostics, and results in ease of design and reduced costs. The 78M6631 is suited for a wide variety of applications requiring 3-phase power and quality measurements, including industrial panels and motors, solar panel inverters, storage power supplies, and data centers.

"In end markets that require 3-phase energy

monitoring, there is great demand for accurate energy measurement," said Jay Cormier, Maxim Integrated Products Director, Energy Measurement & Communications.

"Having the ability to monitor energy usage in applications that require 3-phase power can have a substantial impact on the energy consumption and efficiency in data centers, factories, and buildings. To reduce downtime, the 78M6631 enables measurement, diagnostics, and optimization of point-of-load problems before a potential equipment failure."

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Thru-Hole AC Line Filter



Renco Electronic, an international electronics manufacturer based in Rockledge, Florida fills the hole left by Panasonic in the market. Renco Electronics has announced the release of its latest Thru-Hole AC Line Filter, the RL-9750 Series. Characterized by a new, innovative design with 2,500 Hi-pot, the RL-9750 Series aims to raise durability and performance standards in order to meet customer demands.

Tailored for medium wattage AC-DC power supplies, the series is designed for line to neutral safety clearance. In addition, the RL-9750 features dielectric withstanding voltage rated at 2500 VAC line-to-line. Other particulars include an operating temperature range of -40°C to +130°C, a high impedance readings at applicable frequency. RL-9750 Series is ideal for use in fly back converters, AC-DC converters, pushpull converters and bridge and circuits. Economically priced at \$0.90 per unit, the RL-9750 comes packaged in trays (quantities vary) and delivers optimal filtering performance in its compact, 30 mm profile.

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Wide Range of Solutions for Power Conversion and Distribution

Rogers Corporation, represented by its Power Electronics Solutions (PES) Business Group, has shown some of its more popular products for power electronics applications at the APEC 2012 conference and exhibition. The Rogers PES Group consists of Power Distribution Systems (PDS) and curamik® units; both have featured their high-performance power electronics products at APEC 2012.

Rogers PDS is had launched new technology at APEC 2012 with RO-LINX® PowerCircuit™ busbars, which provide multifunction

capability in a single, compact form factor. PowerCircuit busbars can distribute power and signal lines or have components mounted on the busbar structures—saving space and weight. These three-dimensional (3D) capable structures are ideal for a wide range of power distribution applications in EV/HEVs, wind/solar power, and variable-frequency-drive (VFD) markets.

PowerCircuit busbars are solder-process compatible, and the highly integrated structures help engineers in the design of power and control circuitry while maintaining small

circuit footprints. In addition, PDS will demonstrate the benefits of their industry-standard RO-LINX series of laminated busbars, known for reliable long performance and safety in demanding applications. RO-LINX busbars provide engineers with elegant solutions in a variety of markets, including mass transit and electric propulsion, industrial drives, renewable energy, and defense/aerospace markets.

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High-Speed Optocouplers with High Isolation Voltage

MSC offers two new high-speed optocouplers, the PS9123 and the PS9324, from Renesas Electronics. The new optocouplers feature a high communication bandwidth of 10 Mbit/s, a maximum isolation voltage of 5 kVrms and an extended operating temperature range from -40°C to +100°C for the PS9123 series and up to 110°C for the PS9324 series.

The PS9324 series has an open collector output and the maximum propagation delay time is specified as 75 ns at 25°C. The PS9123 series comes with a totem pole out-



put, offering shorter propagation delay times as low as 65 ns at 25°C. The maximum pulse width distortion [tPHL tPLH] is less than 35 ns for the PS9324 series and less than 50 ns for the PS9123 series.

Furthermore, for operation in noisy industrial environments, the high-performance optocouplers have an internal shield providing a common-mode transient immunity (CMTI) of minimum 15 kV/μs and typical values of 20 kV/μs.

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Industrial Microcontrollers and Comprehensive Range of Tools

Infineon Technologies AG has launched its XMC4500 series, the company's first 32-bit industrial microcontrollers using the Cortex™ M4 processor from ARM®. Samples of the XMC4500 microcontrollers, will go into high-volume production in May 2012. Complementing the product are development tools providing comprehensive support: In addition to Infineon's free DAVE™ 3 development environment, a full range of tools is available including compilers, debug-



gers, software analysis and Flash programming tools, an extensive range of software solutions and consulting services by reputable providers. The XMC4500 series is suited particularly for use in electric drives, solar inverters and the automation of manufacturing and buildings.

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Demo Board Show Casing SiC JFETs in Cascode Half-Bridge Configuration

SemiSouth Laboratories, Inc., the leading manufacturer of silicon carbide (SiC) transistor technology for high-power, high-efficiency, harsh-environment power management and conversion applications, has announced a demo board SSJHB12R085-1 showing the operation of its SiC JFETs in a cascode half-bridge configuration. Enabling a quick evaluation of the SJD120R085 JFET, the demo board platform is suitable for many applications including boost, buck, inverter and PSU half-bridge power stage designs. In the cas-

code configuration, the JFET is driven via a source-connected MOSFET, allowing existing, commercially available MOSFET drivers to be used.

Normally-on SJD120R085 1200 V power JFETs enable high-speed switching, are compatible with standard gate drive circuitry, and feature a positive temperature coefficient for ease of paralleling. The JFETs have a high saturation current (27A), low on-resistance per unit area (85 m² max), and improved switching performance.

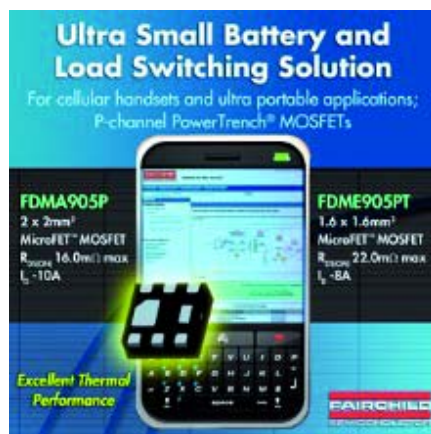
The demo board comes complete with Gerber files and a BOM to allow users to build their own circuits. Comments Dieter Liesabeths, VP of Sales and Marketing: "Our SiC JFETs have industry-leading performance and we are committed to supporting them with the best available design tools."

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www.semisouth.com

Single P-Channel PowerTrench® MOSFETs, Small Size, Low Ron

Fairchild Semiconductor now provides designers of cellular handsets and other ultra-portable applications P-Channel PowerTrench® MOSFETs to meet their needs for a small sized battery or load switching solution with excellent thermal characteristics. The FDMA905P and FDME905PT feature a MOSFET with low on-state resistance. These devices offer exceptional thermal performance for their physical size, and are also well suited to linear mode applications. For more information and to order samples, visit: <http://www.fairchildsemi.com/pf/FD/FDMA905P.html>, <http://www.fairchildsemi.com/pf/FD/FDME905PT.html>



FDMA905P: 2mm x 2mm MicroFET™ package offers low profile – 0.8mm maximum; Guaranteed low $R_{DS(ON)}$ (MAX $R_{DS(ON)} = 16m\Omega$ at $V_{GS} = -4.5V$, $I_D = -10A$); Offers excellent thermal performance ($R_{\theta JA} = 52$ degree C/W)
FDME905PT: 1.6mm x 1.6mm Thin MicroFET package offers ultra low profile – 0.55mm max; Guaranteed low $R_{DS(ON)}$ (MAX $R_{DS(ON)} = 22m\Omega$ at $V_{GS} = -4.5V$, $I_D = -8A$); Offers excellent thermal performance ($R_{\theta JA} = 60$ degree C/W)

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www.fairchildsemi.com

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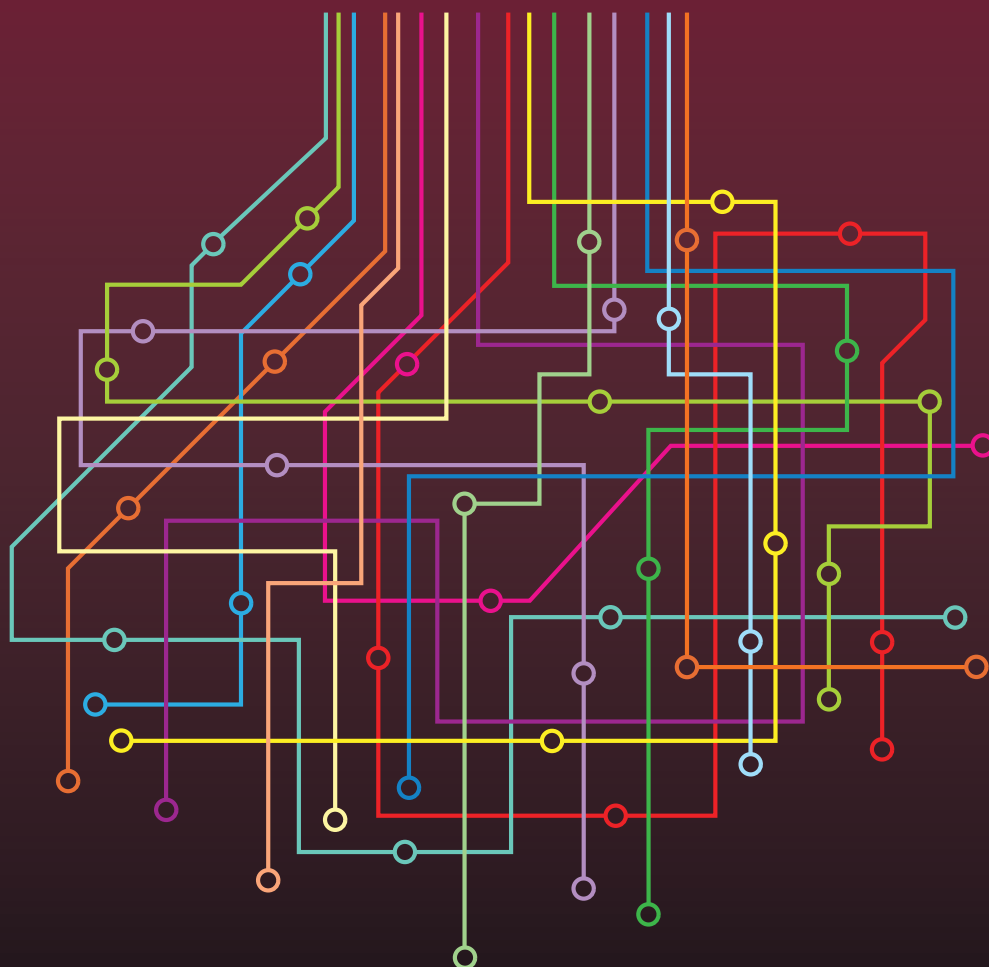


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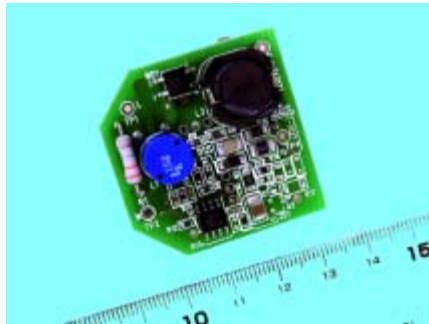
Go to:

coronafree.bicron-magnetics.us
for a Bicron Gate Drive Transformer Selection Guide (PDF) showing performance specifications and dimensions for all platforms

LED Driver IC with Built-In Dimming

Renesas Electronics announced the availability of its new driver IC, the R2A20135SP. The driver IC is designed for high-accuracy, high-efficiency LED lighting systems, and features an on-chip dimming function and a 40-percent size decrease for the mounting area, making it an ideal solution for LED lighting fixture manufacturers. Renesas will also provide an evaluation board with the new driver IC installed on it to provide development support for system designers. Renesas also offers a lineup of high-performance power MOSFETs for use with driver ICs for LED lighting systems as well as kit solutions featuring both types of devices.

LED lighting systems combining low power consumption, high efficiency and long service life have gained considerable attention in recent years amid worldwide efforts to save power and reduce emissions of carbon dioxide. LEDs have come into widespread use in industrial and commercial equipment, as well as in lighting fixtures for outdoor and house-



hold use. The market for such products is expected to continue to grow substantially. Samples of Renesas Electronics' LED driver IC will be available starting in March 2012. Mass production is scheduled to begin in June 2012 and is expected to reach 5,000,000 units per month in December 2012.

www.renesas.eu

Full-Bridge PWM Motor Driver IC

The A4973 from Allegro MicroSystems Europe is a full-bridge motor driver IC that is designed for bidirectional pulse-width-modulated (PWM) current control of DC motors at continuous output currents up to ± 1.5 A and operating voltages up to 50 V.

sion diodes, and crossover current protection. Special power-up sequencing is not required. The A4973 includes synchronous rectification which lowers IC power dissipation and reduces the need for external Schottky diodes.



With the "enable" input held low, the "phase" input controls load current polarity by selecting the appropriate source and sink driver pair. The "mode" input determines whether the PWM current-control circuitry

operates in a slow current-decay mode (with only the selected source driver switching) or in a fast current-decay mode (with the selected source and sink both switching). A user-selectable blanking window prevents false triggering of the PWM current-control circuitry. With the "enable" input held high, all output drivers are disabled. A "sleep" mode is provided to reduce power consumption.

Internal circuit protection includes thermal shutdown with hysteresis, transient suppress-

www.allegromicro.com

www.bodospower.com

April 2012

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High Reliability DC Link Power Film Capacitors

Richardson RFPD, Inc. announces immediate availability and full design support capabilities for a line of high reliability DC link power film capacitors from Spectrum Advanced Specialty Products ("Spectrum"). The 55DC Link Series is ideally suited for power inverter applications which require superior life expectancy under the harsh operating conditions of wind and photovoltaic installations. The capacitors utilize segmented, self-healing metallized polypropylene for a life expectancy greater than 100,000 hours and feature high capacitance density and ripple current capabilities that make them an ideal replacement for electrolytic capacitors. They offer low Equivalent Series Resistance (ESR) and Equivalent



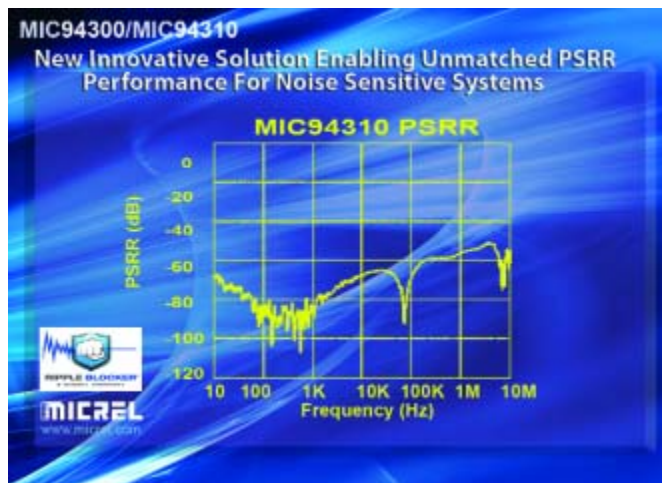
Series Inductance (ESL), are compact and cost effective, and are tested to the environ-

mental specifications of MIL-STD-202. Key features of the 55DC Link Series include: Capacitance Range: 160 iF to 680 iF standard (others available upon request); Capacitance Tolerance: +/- 10% standard; Rated Voltage: 900 to 1300 VDC; Operating Temperature Range: -55°C to +85°C standard (+105°C upon special request); Test Voltage Between Terminals: 150% rated voltage for 10 sec; Test Voltage Between Terminals and Housing: 5kVDC for 10 sec; Enclosure/Construction: aluminum housing, brass terminals with dry resin, UL 94V-0 encapsulant RoHS Compliant.

PCIM Booth 12-235

www.richardsonrfpd.com

Reducing Switching Regulator Output Ripple



Micrel, Inc. announced the Ripple Blocker family comprising the MIC94300 voltage follower output and the MIC94310 fixed output, low-dropout (LDO) IC. The MIC94300 /MIC94310 were developed to provide more efficient noise suppression for today's highly sensitive data and image capturing systems. The MIC94300 integrates a low-RDS(ON), current-limit switch and a low-pass filter that passes DC and blocks the AC component of the input voltage. The MIC94310 is a high-performance, low dropout regulator that offers better PSRR performance from DC to 5MHz than discrete solutions. Both ICs feature an active-high enable pin for power sequencing. The series is currently available in volume, and pricing starts at \$0.24 for 1K quantity for the MIC94300 and \$0.27 for the MIC94310.

www.micrel.com

Conductive Form-in-Place Gasket Selector Guide Solve Housing EMI Shielding Challenges

Chomerics Europe - a division of Parker Hannifin, has introduced a comprehensive new selector guide for its range of CHOFORM form-in-place (FIP) conductive gaskets. The range of materials provide lowest total cost of ownership solutions for the EMI shielding of



enclosures with small section and complex patterns in applications such as medical electronics, automotive, telecoms, consumer, plus marine and aerospace.

The materials included in the selector guide use either thermoset or RTV curing systems in combination with a wide range of conductive particle technologies to offer designers a choice of cost versus shielding performance options to best match their application needs. Chomerics' corrosion resistant FIP materials provide protection against galvanic activity and can eliminate the need for nickel or tin plating and secondary environmental gaskets.

For outdoor, harsh environment applications, CHOFORM 5572 and 5557 that use Silver / Aluminium (Ag/Al) and Silver / Nickel (Ag/Ni) fillers respectively, provide an ideal high temperature, high corrosion resistance solution. CHOFORM 5506 and 5519 that utilise a Silver / Copper (Ag/Cu) filler are more suitable for less demanding indoor applications. CHOFORM 5519 has a very low Shore A hardness meaning it offers the most effective solution for equipment where low closure forces are needed.

www.parker.com/chomerics

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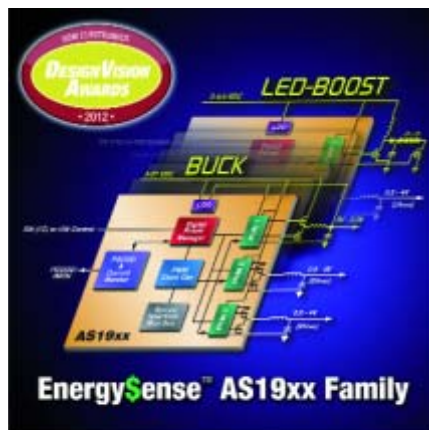


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Energy\$ense™ Family Wins 2012 DesignVision Award

Akros Silicon Inc., a premier supplier of leading-edge intelligent energy management ICs, announced that its Energy\$ense™ family of multi-output, digital DC/DC power management unit (DPMU) ICs has won the 2012 DesignVision Award in the "Semiconductor Components and ICs" category. The DesignCon technical committee, including 130 engineers and industry editors, evaluated products from hundreds of entries to choose the



Akros' Energy\$ense™ Family Wins 2012 DesignVision Award



winners, who were recognized at an awards ceremony at DesignCon 2012 in Santa Clara, Calif.

The 10 pin-compatible DPMUs comprising the AS19xx family come in different combinations of synchronous buck, boost and LED-drive converter configurations. Features include real-time power measurements and power-subsystem health monitoring, high efficiency (94% peak) and ultra-low standby current (<10uA), digital power control (via I2C) for selectable power operating modes, fast transient-handling capability for implementing adaptive power profiles, built-in spread-spectrum clocking for EMI management, and built-in sophisticated PWM-dimming for battery-draining LED-backlight displays.

Energy\$ense DPMUs are suitable for a wide range of applications. These include 4G LTE residential gateways and femtocells, portable consumer products, NAS and media hubs, Internet-TV and IPTV set-top boxes, automotive infotainment systems, solid-state lighting, communication equipment with cluster-power or intermediate bus architectures, and many others.

www.akrossilicon.com

Pair of GaAs pHEMT Digital Phase Shifters

Richardson RFPD, Inc. announced the immediate availability and full design support capabilities for two newly-released additions to the family of GaAs pHEMT digital phase shifters from M/A-COM Technology Solutions Inc. (M/A-COM Tech). The MAPS-010146 and MAPS-010166 are, respectively, 4- and 6-bit packaged devices that maintain low phase error and minimal attenuation variation over the full 360-degrees and 8-12 GHz frequency range.

Both new devices feature a built-in CMOS driver in a 4mm, 24-lead PQFN surface mount package that allows for serial or parallel control and low power consumption, and both devices operate using positive and negative voltage supply. The devices are targeted for communication antennas and phased array radar applications, making them excellent candidates for commercial weather radar applications and military ground-based distance-measuring radar applications.

Common configurations are in stock and available for immediate delivery. To find more information, or to purchase these products today on the Richardson RFPD website,



please visit the M/A-COM Tech Digital Phase Shifters webpage. The devices are also available by calling 1-800-737-6937 (within North America); or please find your local sales engineer (worldwide) at Local Sales Support. To learn more about additional products from M/A-COM Tech, please visit the M/A-COM Tech storefront on the Richardson RFPD website.

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www.richardsonrfpd.com

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Dual 3A and Single 6A Programmable Integrated Buck Regulators

Summit Microelectronics has expanded its family of programmable DC-DC integrated circuits with the SMB206A and SMB210A. These new products bring cost-effective digital power control to high-volume digital consumer systems as well as general purpose applications.

Like the entire SMB20X family, the SMB206A and SMB210A support advanced power management for "green" and ENERGY STAR® applications. These include a wide range of multimedia consumer and broadband/SoHo applications such as digital LCD/LED/plasma/IP televisions, digital cable/satellite/IP set-top boxes

and media gateways, broadband cable/DSL modems, wireless SoHo routers and switches.

The SMB206A/SMB210A are dual/single-output integrated DC-DC buck regulators combining Summit's digital programmability with dense integration, ultra-compact size, and cost-effective bill-of-materials (BoM) necessary for mass-market consumer products. With a serial digital interface and on-board non-volatile memory, the SMB20X family can be easily configured during development and re-programmed in system by host software. The result is a flexible, digitally controlled power supply design that is easily customizable without tedious hardware design cycles or complex microcontroller-style GPIO-based control. They can also be programmed by fixed resistors and purchased as standard products with fixed voltages. The integration of advanced power control functions eliminates external components and cost, improves functionality and performance, and minimizes development time.

"Summit continues to expand its line of programmable power products with the SMB206A and SMB210A DC-DC regulators," stated Abid Hussain, Summit vice-president of marketing and applications. "The unprecedented combination of flexibility, integration, reduced BoM and solution size brings true digital power management to high-volume, cost-sensitive consumer applications and enables advanced power-saving techniques to meet stringent ENERGY STAR and other "green" energy-saving standards".

www.summitmicro.com



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Dual Power Supply Control LSI for Solar and Battery Driven Devices

LAPIS Semiconductor, a ROHM Group Company, has developed the power controlling "ML9077/ML9078 series" LSIs for small sized electronics using dual power supplies like solar panel and batteries such as coin battery. These LSIs provide stable power supply to electronic components like microcontrollers by controlling the switching between the primary/secondary (rechargeable) batteries and solar panels as well as perform the charge control of power supplied from the solar panels to the secondary battery.



Energy generation by solar panels have been already adopted as power source in the area of small sized electronics such as clocks, calculators, weather stations, remote controls, cycle meters, compact games and others, for postponement of battery life or elimination of battery. Additionally, safety functions such as voltage control of the power supplied to the microcomputer, protection of abnormal current to the battery as well as control circuits have to be considered as well.

www.rohm.com/eu

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Bicon Corp. USA, introduces at PCIM Europe VoltBoss, its third-generation corona-free, 93+% efficiency transformers. Bicon VoltBoss works in system voltages of 1KV-30KV; at power levels of 5VA-15KVA; and with operating frequencies of 50Hz-1MHz.

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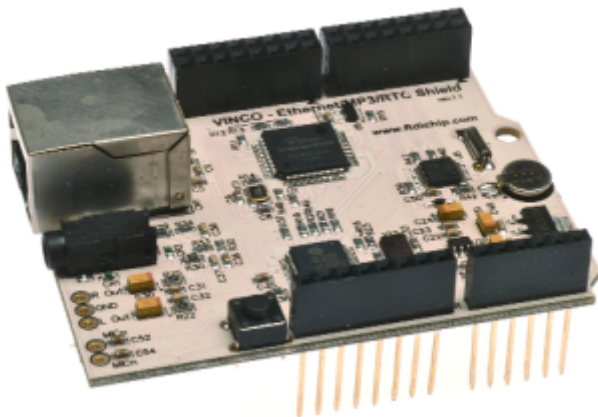
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Ethernet-to-USB, MP3 audio codec & real-time clock functionality to Vinco platform

Furthering market progression of the widely praised Vinco platform, USB solutions specialist Future Technology Devices International Limited (FTDI) has announced the introduction of its new multi-function application board (shield). By combining the Vinco development platform, with targeted application support, such as MP3 audio codec, Ethernet-to-USB bridge and real-time clock (RTC), engineers can jump-start their development.



This latest shield offering incorporates a VLSI VS1053b codec for the decoding of various audio files (Ogg Vorbis, MP3, AAC, WMA, FLAC, WAV and MIDI), Ethernet connectivity, plus an RTC feature using NXP Semiconductors' PCF32123 timing device.

Designed to connect directly to the Vinco development/prototyping board, the shield enables the Vinco's Vinculum-II (VNC2) dual-channel USB host/device controller IC to access an Ethernet port via a Wiznet W5100 chipset. The W5100 converts Ethernet data into SPI data (and vice versa). The SPI port is a slave to the VNC2 SPI master. A set of 4 LED indicators on the shield show the nature of the

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Ethernet traffic, so that engineers can determine whether the shield is receiving data, transmitting data, is in full duplex, or is experiencing data collisions. The shield also has a hardwired TCP/IP stack that permits 10Mbit/s or 100Mbit/s data transfer over the Ethernet link, so the system it is incorporated into can be networked with other systems.

www.ftdichip.com

16-Channel Temperature Input Module Extends Electromechanical Testing Capabilities

A 16-channel temperature/voltage plug-in input module for the Yokogawa DL850 ScopeCorder has been added to the range of electrical and physical input modules available for this versatile instrument.



The new module extends the electromechanical testing capabilities of the DL850 ScopeCorder by allowing it to be used for a wide range of applications where parameters such as voltage and current need to be measured simultaneously with physical parameters such as temperature.

The 16-channel temperature/voltage input module and its external scanner box will find use in many electromechanical processes where temperature change or heating is expected and needs to be monitored along with electrical parameters and physical ones such as pressure and strain. By configuring the ScopeCorder with multiple input modules, a portable measuring device with up to 128 channels can be configured to suit any R&D, service or maintenance task. Typical applications include tests on domestic electrical appliances, inverters and electric drives.

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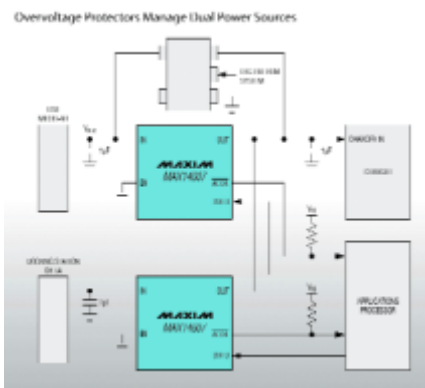
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www.yokogawa.com/eu/pcmsoftware
Tel: + 31 (0) 88 464 1000
e-mail: tmi@nl.yokogawa.com.



Overvoltage Protectors Use Reverse Bias Blocking



Maxim Integrated Products Inc. announced the MAX14606/MAX14607, advanced overvoltage protectors which handle up to 3A of continuous current for today's high-power electronics. Reverse bias blocking protects a portable device from damage caused by multiple power sources supplied simultaneously. The MAX14606/MAX14607 are optimized to protect the internal components of portable electronics such as tablets, smartphones, and portable media players. The MAX14606/MAX14607 features reverse bias blocking capability so that two power

sources can be safely interfaced simultaneously without damage to either one. In this design two integrated back-to-back FETs prevent the voltage applied at the intended output from feeding back into the input. Without this reverse bias blocking, users are forced to use multiple discrete, space-consuming external components to protect the end equipment.

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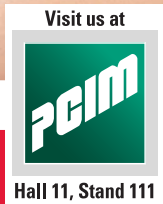
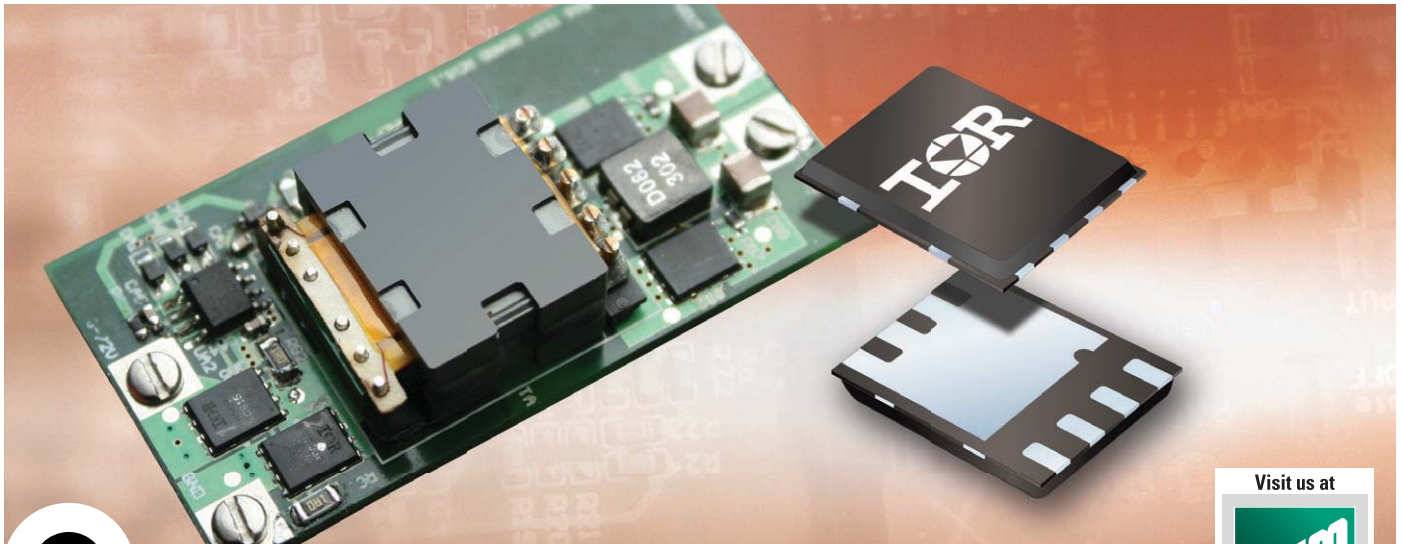
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IRFH5104TRPBF	PQFN 5x6mm	40 V	100 A	3.5 m Ω	53 nC
IRFH5204TRPBF	PQFN 5x6mm	40 V	100 A	4.3 m Ω	42 nC
IRFH5006TRPBF	PQFN 5x6mm	60 V	100 A	4.1 m Ω	67 nC
IRFH5106TRPBF	PQFN 5x6mm	60 V	100 A	5.6 m Ω	50 nC
IRFH5206TRPBF	PQFN 5x6mm	60 V	89 A	6.7 m Ω	40 nC
IRFH5406TRPBF	PQFN 5x6mm	60 V	40 A	14.4 m Ω	21 nC
IRFH5007TRPBF	PQFN 5x6mm	75 V	100 A	5.9 m Ω	65 nC
IRFH5207TRPBF	PQFN 5x6mm	75 V	7 A	9.6 m Ω	40 nC
IRFH5010TRPBF	PQFN 5x6mm	100 V	100 A	9.0 m Ω	67 nC
IRFH5110TRPBF	PQFN 5x6mm	100 V	63 A	12.4 m Ω	48 nC
IRFH5210TRPBF	PQFN 5x6mm	100 V	55 A	14.9 m Ω	40 nC
IRFH5015TRPBF	PQFN 5x6mm	150 V	56 A	31 m Ω	33 nC
IRFH5215TRPBF	PQFN 5x6mm	150 V	27 A	58 m Ω	20 nC
IRFH5020TRPBF	PQFN 5x6mm	200 V	43 A	55 m Ω	36 nC
IRFH5220TRPBF	PQFN 5x6mm	200 V	20 A	100 m Ω	20 nC
IRFH5025TRPBF	PQFN 5x6mm	250 V	32 A	100 m Ω	37 nC

Logic Level Gate Drive

Part Number	Package	Voltage	Current	$R_{DS(on)}$ Max. @4.5V	Q_g Typ @4.5V
IRLH5034TRPBF	PQFN 5x6mm	40 V	100A	3.2 m Ω	43 nC
IRLH5036TRPBF	PQFN 5x6mm	60 V	100A	5.5 m Ω	44 nC
IRLH5030TRPBF	PQFN 5x6mm	100 V	100A	9.9 m Ω	44 nC

Features

- Low thermal resistance to PCB (down to <0.5°C/W)
- High Current Package – up to 100A continuous
- 100% RG tested
- Low profile (<0.9 mm)
- Industry-standard pinout
- Compatible with existing surface mount techniques
- RoHS compliant containing no lead, no bromide and no halogen
- MSL1, industrial qualification

The IR Advantage

- Increased power density
- Increased reliability
- Multi-vendor compatibility
- Easier manufacturing
- Environmentally friendlier

For more information call +49 (0) 6102 884 311

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