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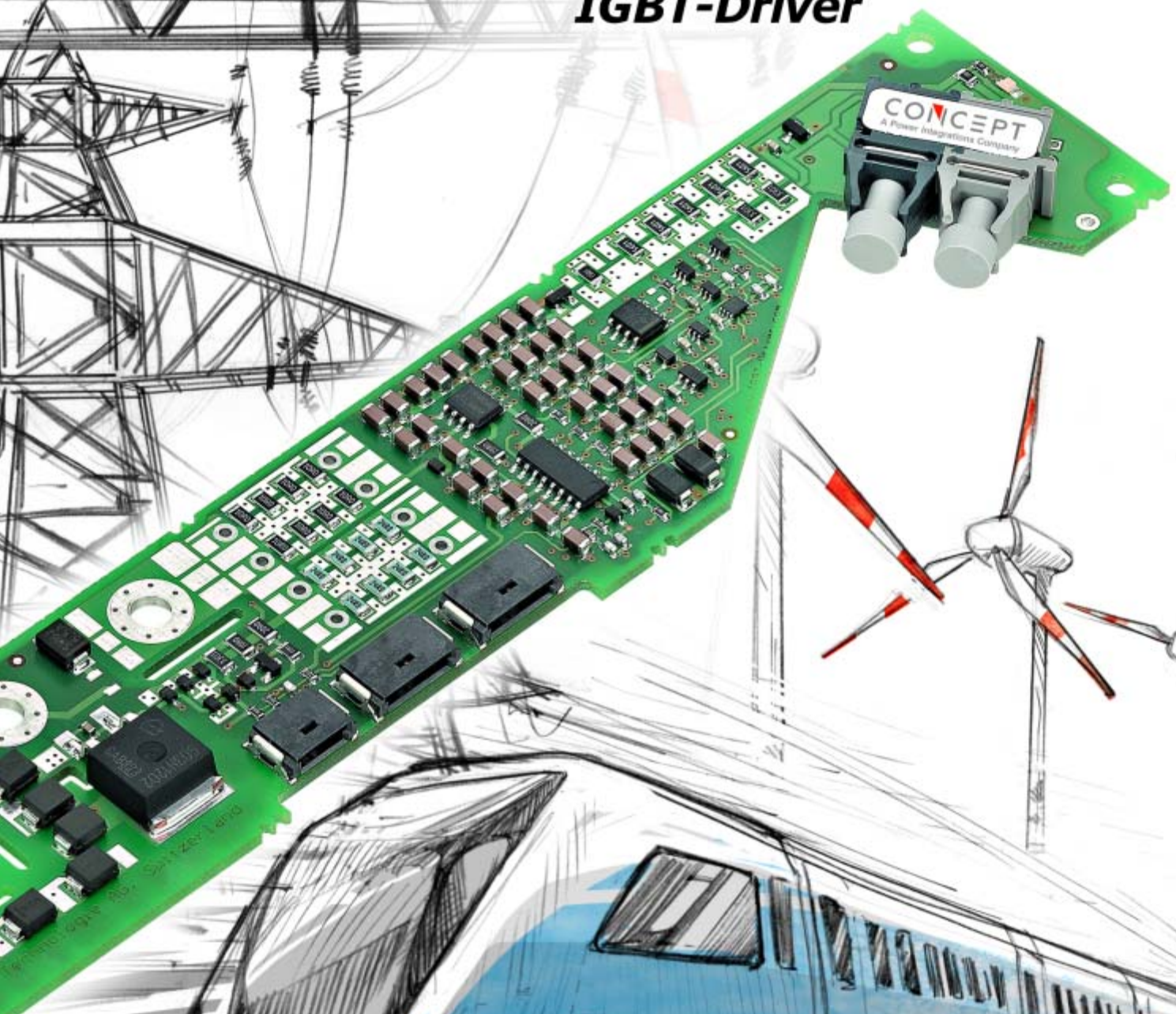
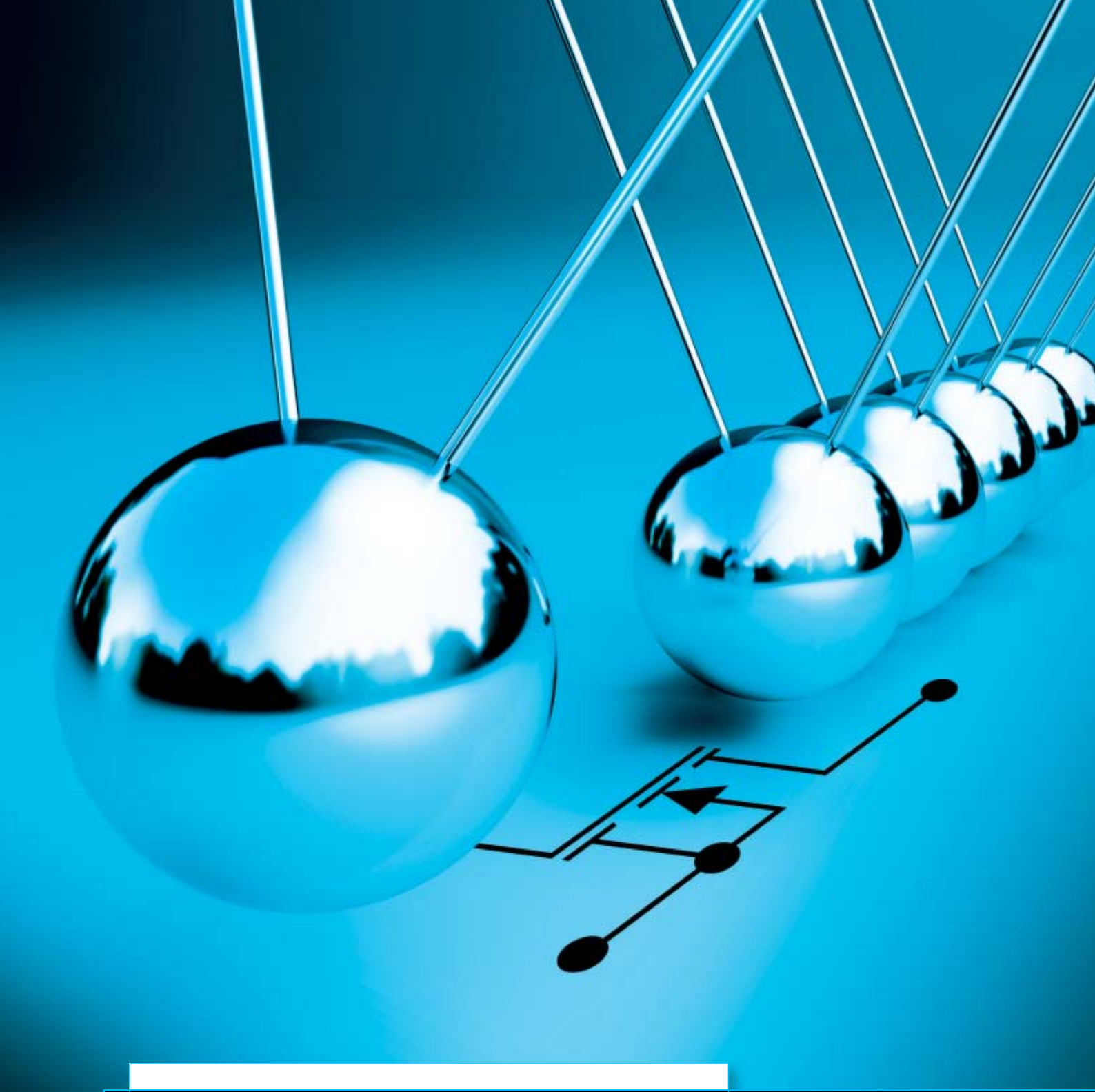
Bodo´s Power Systems®

Electronics in Motion and Conversion

August 2012

SCALEable Compact 4.5kV Plug-and-Play IGBT-Driver





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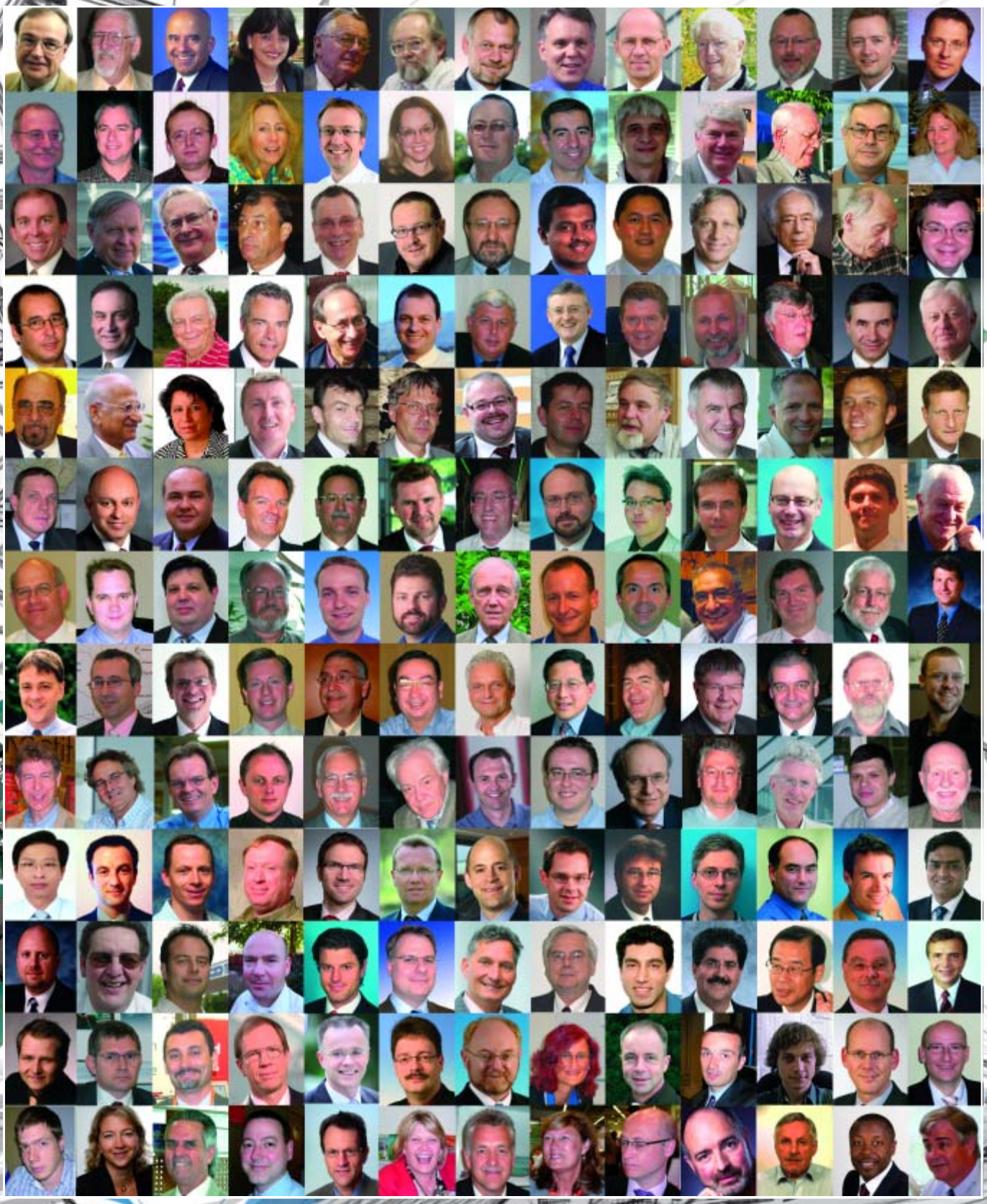
CONTENT

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

powerguru.org



Für unser System Engineering in Deutschland (Ense), suchen wir eine/n

CONCEPT
A Power Integrations Company

CT-Concept Technologie AG ist ein erfolgreiches, weltweit tätiges High-Tech Elektronik Unternehmen mit Sitz in der Schweiz. Mit unserer innovativen Treibertechnologie, haben wir den IGBT-Treiber-Markt revolutioniert und uns in den letzten zwei Jahrzehnten als Weltmarktführer etabliert. Unsere Produkte helfen Energie zuverlässiger und effizienter zu erzeugen, zu verteilen und zu verbrauchen.

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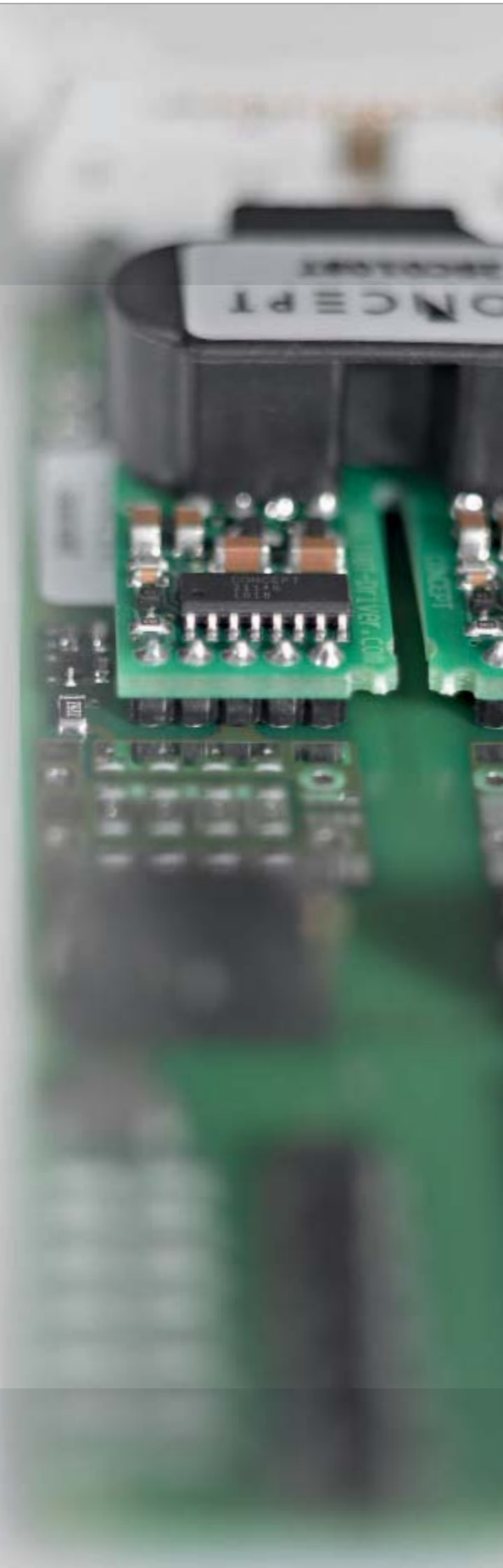
Wenn Sie eine dynamische Persönlichkeit sind, die gerne lernt, Verantwortung übernimmt und Veränderung auch aktiv mitgestaltet, dann freuen wir uns auf Ihre Bewerbung.



Elektroniker/in

Zu Ihrem Aufgabenbereich gehört
- Durchführen von Entwicklungsaufgaben und von Versuchen
- Konstruktives Gestalten von Baugruppen
- Umsetzen von Qualifizierungs- und Testkonzepten
- Weltweiter technischer Support
- Erstellung technischer Unterlagen

Anforderungen
- Ausbildung zum Techniker oder
- Fachhochschul- oder Hochschulabsolvent idealerweise Richtung Leistungselektronik
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- Weltweiter technischer Support
- Erstellung technischer Unterlagen

Anforderungen
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- Mindestens 3 Jahre Erfahrung in einer vergleichbaren Position

Leiterkarten-Layouter/in

Zu Ihrem Aufgabenbereich gehört
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- Entwerfen von Schaltplänen und Leiterkarten-Layouts
- Mitarbeit bei der Entwicklung neuer Produkte
- Evaluierung von Komponenten

Anforderungen
- Techniker oder
- Fachhochschulabsolvent vorzugsweise Richtung Leistungselektronik
- Erfahrung im Entwurf und Layout von elektronischen Schaltungen mittels Protel/Altium
- Gute Kenntnisse der deutschen und englischen Sprache

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- Büromaterialverwaltung

Anforderungen
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Events

EPE PEMC, Novi Sad, Serbia, September 4th-6th
http://epe-pemc2012.com/category/news/

Power Electronics South America, Sao Paulo, Brasilia, September 11-13
www.mesago-online.de/de/PESA/home.htm

Battery Power 2012, Denver Colorado, September 18th -19th
www.batterypoweronline.com

Thermal Management 2012, Denver Colorado, September 18th -19th
www.thermalnews.com/conferences

Power Fortronic, Bologna, Italy September 20th www.powerfortronic.it

LED Professional, Bregenz Austria, September 25th -27th
www.led-professional.com

EU PVSEC, Frankfurt Germany, September 24th – 28th
www.photovoltaic-conference.com

Husum WindEnergy, Husum, Germany, September 18th-22nd
www.husumwindenergy.com

It is Strawberry Season

Half the year has flown by already and now it is time to take a rest, pick strawberries, and recharge for the exciting events this autumn. Hopefully European and World financial affairs will not affect the electronics business. Do we even realize how much of our daily lives rely on electronics to function? Yes, we see kids glued to their handheld and grown-ups moving around with plugs in their ears as if they were being remote controlled, but it's the power systems that are key. While the combustion engines in our automobiles now run efficiently with lower emissions, electric and electro-hybrid vehicles represent the future. Mass transportation is generally focused on electrically powered trains and a highlight of my Shanghai visit was to ride the Maglev, a German design way ahead of its time when it was introduced in 1979. Wind power, electronically controlled, will be the green alternative to burning fossil coal or oil. Thank goodness - we would have a hard time surviving without electric power!

The world will again be meeting at HusumWind in September in Germany, a show that has helped develop the wind-power market. This show had been growing year over year and has become the venue of choice to get a full picture of wind turbine technology and generating systems. Power Electronics South America in Sao Paulo, sponsored by PCIM, will also take place in September along with the LED Conference and Show in Bregenz, Austria and the Photovoltaic Conference and Show in Frankfurt. We have a busy time ahead of us with EPE in Novi Sad, Serbia and more events around the globe – it'll be hard to choose where to be. With the help of Marisa for editorial coverage, our readers will get a picture of all the events that have an important impact on equipment design and the use of advanced power semiconductors.

We will have a strong October and November with conferences and shows, including the industry's leading venue, the bi-annual Electronica in Munich, before we can relax for Christmas.

Visiting the PCIM conference in Asia in Shanghai in June was a special event for me and is covered by a short wrap-up in the magazine along with some of my impressions from the show. The market challenges all of us in industry to develop new relationships. Bodo's Power China started by cooperating with i2i. Serving such a huge market in the local language only makes sense for reaching out to all engineers that need up-to-date technical information. Engineers, worldwide, are a rare breed; a point made by Alfred Hesener of Fairchild in his guest editorial in May. We must do our best to make technical careers attractive to young people and then provide the support necessary to have them focus on power electronics.

The PowerGuru internet platform is growing - it has my past and current articles up for search and retrieval. Cooperating with PowerGuru has been a great step forward - take a look at www.powerguru.org. Industry support for this platform is growing; see Dr. Demmelhuber's Guest Editorial for more detailed information.

Communication is the only way to progress. We delivered twelve issues last year and will continue each month, on time, every time. So far this year we have published 584 pages and, more importantly, 99 technical articles. As a media partner, Bodo's Power Systems is internationally positioned. If you speak the language, or just want to take to look, don't miss our Chinese version: www.bodospowerchina.com.

My Green Power Tip for August:
Whenever possible, before you print out documents, think about reading them on the screen. The screen saves a lot of trees and trees are the lounge of our world, providing us with oxygen from their leaves.

Best regards

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www.lem.com

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Promotion to European Sales Management Team

International Rectifier announced the appointment of Reinhold Theurer as Vice President of European Sales. In his new role, Mr. Theurer will be responsible for overseeing all local and global commercial sales channels as well as sales and revenue for the Europe region and will be based at the company's European sales headquarters in Frankfurt, Germany.
Mr. Theurer previously served as IR's Director of Sales, Central Europe. Prior to joining IR 10 years ago, Mr. Theurer held various management positions in the semiconductor industry. Mr. Theurer holds a degree in Electrical Engineering and Industrial Engineering as well as an MBA from Sheffield Hallam University, U.K.

"With more than 17 years of experience in the semiconductor industry and in his most recent role as Director of Sales, Central Europe, Reinhold has a proven track record of driving demand creation and major design wins, and I am confident that he will continue to grow IR's market leadership position in Europe," said Adam White, Senior Vice President, Worldwide Sales. "
Mr. Theurer succeeds Berthold Duecker who recently retired from his position after 19 years with IR.

www.irf.com

Power Electronics South America Promises Attractive Conference Program

The Power Electronics South America conference which will take place for the first time from 11 - 13 September 2012 in Sao Paulo, Brazil, will showcase the latest trends and applications in power electronics. Offering a host of papers and four keynote speeches, the program also includes six half-day seminars on "IGBT Drive Technologies" and "Trends in Soft Switching Topologies" amongst other topics. Semikron, Fuji Electric, International Rectifier, Infineon and Ericsson are just a few of the companies whose developers will give conference papers on their products.
The presentations will cover the latest advances from components right through to full systems. Reports on power electronics converters, renewable energies and power electronics solutions will form the mainstay of the program.
Four keynote papers on: "Hybrid Electric Vehicles", "Extreme Efficiency Power Converters", "Wireless Power in Power Conversion" and "Energy Storage and HVDC" delivered by internationally recognised experts will offer insight into the future of power electronics.
The international Power Electronics South America conference and accompanying trade fair is the meeting point for experts from industry and industry based sciences in Brazil.

www.mesago.de/pesa

Power-One and International Rectifier Enter into Patent License Agreement

Power-One and International announced that they entered into a non-exclusive, worldwide, Field of Use agreement for Digital Power Technology (DPT) patents from Power-One.
Digital Power Technology drives increased system efficiency, improved design flexibility, faster time to market, decreased footprint size and lower system costs. DPT also enables telemetry capability, providing access to critical information including current, temperature and voltage. Telemetry allows the system to accurately monitor its power consumption and thermal performance, enabling designers to easily engineer key features such as system optimization, fault detection and predictive maintenance features into their end products.
Applications utilizing FPGAs, ASICS, DSPs continue to drive board densities higher, requiring complex power architectures to handle the increasing number of voltage rails and output voltages dropping below 1V. Digital Power Technology is an extremely attractive solution.

www.Power-One.com

www.irf.com

$200 Million Invest in Expansion and Equipment Upgrades for U.S. Facilities

Maxim Integrated Products, Inc. announced a $200 million multiyear investment to upgrade its U.S. wafer fabrication facilities (fabs) in Beaverton, Oregon; Dallas and San Antonio, Texas; and San Jose, California. Maxim will use the multiyear investment to upgrade manufacturing equipment, improve process technologies, convert to newer technology nodes, and assimilate production from recently acquired companies. This investment is consistent with previously disclosed estimates for capital expenditures in Maxim's fiscal years 2012 and 2013.

Maxim employs 9,300 employees worldwide, including approximately 1,000 manufacturing cleanroom workers in its four U.S. fabs.

"Maxim has an extremely talented workforce doing technology development in Silicon Valley and cost-competitive manufacturing in our U.S. wafer fabs, where we make about 50 percent of our products," said Tunç Doluca, President and CEO of Maxim Integrated Products. "We are investing in our U.S. infrastructure to build intellectual property and enable a competitive edge."
Visit Maxim at electronica 2012 hall A6, booth 163

www.maxim-ic.com

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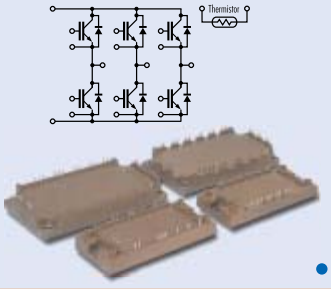
Econo IGBTs

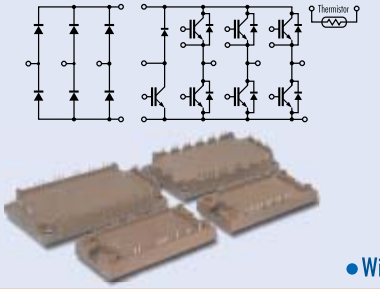
The 6-PACKs



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

● With solder pins ■ With PressFit contacts

The PIMs



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

● With solder pins ■ With PressFit contacts

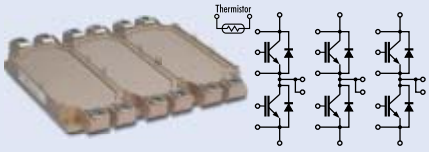
The 2-PACKs

● With Solder Pins

● With Spring Contacts

Package	I_C	1200V	1700V
62 x150 mm	225A	● ●	
	300A	● ●	●
	450A	● ●	●
	550A		● ●
	600A	● ●	

The High Power 6-PACKs



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

Fuji Electric Europe

Fuji Electric Europe GmbH
Goethering 58 · 63067 Offenbach am Main · Germany
Fon +49(0)69-66 90 29 0 ▸semi-info@fujielectric.de
Fax +49(0)69-66 90 29 56 ▸www.fujielectric.de
Products Overview ▸www.fujielectric-europe.de/info/overview.pdf

Global Footprint with Bangalore Design Center

Intersil Corporation a world leader in the design and manufacture of high-performance analog and mixed signal semiconductors, announced it has opened a new design center in Bangalore, India. The center will help develop new integrated circuits, reference designs and provide system-level application support for the company.
Intersil's new state-of-the-art design center is the result of the company consolidating two sites into a spacious, 18,100 square foot facility ideal for test and characterizing the silicon developed in India. Conveniently, the new site is closer to the local IT corridor and shortens the commute for most of Intersil's employees.
"Having a centralized Indian Design Center will not only enhance collaboration amongst employees, but also boost overall productivity within the various teams," said Roger Levinson, vice president & general manager for Intersil's Signal Path Products group. "The Bangalore team will continue to provide key support for Intersil's business in the region's growing market."

www.intersil.com

SPS – Industrial Automation Fair Guangzhou, China 4 – 6 March 2013

With the success of the 2012 edition, SPS – Industrial Automation Fair Guangzhou will be returning once again at the China Import and Export Fair Complex in Guangzhou from 4 – 6 March 2013. The show has proven to become the annual event for regional professionals to acquire solutions for their automation systems. In 2012, over 60 brands from Germany alone as well as 50 from Japan, South Korea, USA and other European countries participated in the event. Exhibitor numbers in total were 438, and for 2013, SIAF expects to welcome over 500 exhibitors and over 26,000 visitors.
Mr Louis Leung, Deputy General Manager of Guangzhou Guangya Messe Frankfurt Co Ltd, one of the show's organisers said: "The fair will deliver more business and value by focusing on one of the automation industries latest trends – motion control devices. We will be forming a special zone on the latest advancements in this sector, as well as organising a seminar, hosted by Prof Dr –Ing. Mario Pacas of Universitat Siegen, one of the most foremost authorities on motion control technology."

www.siaf-china.com

Increased Production of Motor Run and HID Lighting Capacitors

Cornell Dubilier announced that its manufacturing facility in Mexicali, Mexico is poised to take on higher levels of production of both HID Lighting and Motor Run capacitors. "We've been seeing an increase in orders for oil filled capacitors from major North American Companies that have had field problems with Far East capacitor imports and interruptions in supply from domestic suppliers", says Jack Chmura, Product Manager at CDE's New Bedford, MA facility.
CDE has been providing capacitors solutions for HID and motor-run applications for over 40 years. In 2004 CDE expanded its capacity with the purchase of York Capacitor in Winooski Vermont and transferred production to its Mexicali, Mexico facility to obtain a more favorable cost structure. At the time of the purchase of York in 2004 it appeared that the North American market was shrinking as more production shifted to Asia.

www.cde.com

Marketing and Technology Partnership

Methode Electronics, Inc. and AgileSwitch, LLC announced a marketing and technology partnership. As part of this agreement, AgileSwitch, LLC will provide leading edge IGBT gate drives which provide the highest performance for energy conversion inverters and systems. Methode Electronics' Power Solution Group will supply state-of-the-art bus bar architectures and thermal management solutions in combination with local design capabilities and global manufacturing. Methode's Electronics, Inc. has manufacturing facilities in the U.S., Europe and China. Together, the two companies are creating fully integrated sub-system solutions for the power electronics industry.
Speaking about the partnership, AgileSwitch President and CEO Rob Weber commented, "AgileSwitch is delighted to team with a global leader in bus bar architectures and cooling solutions to bring the next generation of power stacks to the market. This agreement will allow our two organizations to provide innovative solutions to renewable energy applications such as solar, photovoltaic, wind, hybrid electric and electric vehicles, as well as high capacity uninterrupted power supply and efficient motor drives."
Methode Electronics' Power Solutions Group General Manager Andrew Urda commented, "Methode Electronics' Power Solutions Group and AgileSwitch can now provide the power electronics industry with new, innovative, high-efficiency integrated power distribution solutions. Our combined solution will provide customers a next generation solution -- today."

www.methode.com

www.AgileSwitch.com

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China Distribution Deal

Richardson RFPD, Inc. announced it has completed an agreement to distribute product from Sapa Group, a global manufacturer of aluminum solutions. Through this agreement, Richardson RFPD is able to support its customers in China with thermal management solutions from the Sapa Profiles (Jiangyin) Co. Ltd plant that opened in February of 2012.

Sapa is the largest aluminum extrusion producer in the world, with operations in Europe, North America and Asia. Sapa partnered with Richardson RFPD as an Asia distributor due to Richardson RFPD's global footprint and ability to offer customers technical solutions in a cost effective manner.

“Richardson RFPD has a long history of supplying their customers with total solutions for power and thermal management requirements," said Steve Jackson, Business Development Manager-Thermal Products for Sapa Extrusions North America. "Richardson RFPD offers the technical knowledge and outstanding customer service that Sapa demands of itself and our partners.”

"We have several loyal customers in China who are manufacturing high power—10kW and above—inverters for various applications," said Kevin Connor, Richardson RFPD's Vice President of Energy, Power & Interconnect. "We know these customers have custom thermal management requirements that we have been unable to address in the past, because we lacked a local manufacturing source. Sapa provides us with the resources necessary to serve our customers needing air-cooled and liquid-cold plate thermal solutions."

www.richardsonrfpd.com

IEEE PES ISGT Europe 2012, October 14 – 17, 2012, Berlin, Germany

The 2012 annual conference IEEE PES ISGT Europe will again be accompanied by an industry exhibition. Experts, stakeholders, and research students from more than 50 countries have submitted contributions on smart grid innovations and energy development for presentation at the conference. The broad participation from this large a number of countries underlines the enormous worldwide significance of the conference topics. All contributions have been reviewed to assure a high quality.

Your participation would allow you to interact directly with the fellow participants, demonstrate your accomplishments and products, and to exchange ideas. Your participation will also be welcomed by the many Ph.D. students that attend the conference. We have initiated a student program that supports participation at the ISGT. This is in line with our broader goal to support work force development and bringing together students and industry in general and at the conference in particular.

www.ieee-isgt-2012.eu

Launch of Technology Site for Smart Grid Technology

Mouser Electronics, Inc., regarded as a top design engineering resource and global distributor for semiconductors and electronic components, launched a technology site on Mouser.com covering Smart Grid Technology. The site is designed to help design engineers find the latest Smart Grid advancements, source product information using block diagram navigation, and access the latest technical resources in as few clicks as possible. The site features new products from industry-leading manufacturers, such as Texas Instruments, STMicroelectronics, Maxim, AVX, Murata, Digi International, EPCOS, and Laird Technologies, to name just a few.

Mouser’s Smart Grid Technology site is a comprehensive resource center covering key areas, including Smart Meter and Smart Home components, plus insightful industry news and developments in Smart Grid. In addition, the site provides extra resources to help spearhead design development such as in depth industry articles and a comprehensive library of technical resources. The site’s streamlined graphical interface is designed to speed navigation. As a result, engineers can quickly narrow in on a set universe of products and information based on defined parameters/engineering standards centered on their specific design needs. To experience the new site and its user-friendly graphical interface, visit http://www.mouser.com/smart-grid-technology.

Kevin Hess, Mouser Vice President of Technical Marketing, shared his thoughts on the new Smart Grid Technology site. “Ultimately, we wanted to create a new technology site that contributes to speeding up the development of a more efficient, greener and more reliable power grid… allowing design engineers to get in and get out with what they need even faster. At Mouser, we realize the one component that’s always in short supply is time. Our Smart Grid Technology site is extremely intuitive, providing useful application information and component selection criteria in a single click.”

www.mouser.com

PCIM Asia 2012 –Records at the New Venue

PCIM Asia 2012 from 19 - 21 June ends with a new record in exhibitor numbers and floor space. With 71 exhibitors on 4,400 square meters in the new venue Shanghai World Expo Exhibition Center it has grown by nearly 50 %. With 4,049 Visitors, this number also increased significantly (2011: 2,967). Besides internationally renowned and leading companies such as Infineon, Semikron, Mitsubishi and Hitachi many more Chinese companies participated. Companies like MacMic, CSR or Star Power have become known in the power electronics community in recent years.

The conference recorded with 371 participants also a very good result. With six technical sessions, keynote presentations and an attractive conversational poster session, it provided a comprehensive program. In addition, special sessions with industry and science presentations on the hot topics solar, wind power or e-Mobility and Charging were especially crowd pullers.

The figures at a glance: 4,400 sqm Exhibition space, 71Exhibitors, 4049 Visitors and 371 Conference attendees. Next PCIM Asia will take place from 18 – 20 June 2013 in Shanghai.

www.pcim-asia.com

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Source: IMS Research "The worldwide market for power semiconductor discretes and modules" 2012

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HUSUM WindEnergy 2014 Already Half Sold-Out

The major companies in the wind industry have decided to go with HUSUM WindEnergy in 2014. Today, a good two years before the leading international wind trade fair in 2014, firm bookings have already been taken for half the exhibition space. Before the 2012 exhibition opens its doors in almost three months, the organisers are completing a variety of infrastructure projects.

In the run-up to the 2012 edition of the international wind industry meeting in September the organisers, Messe Husum & Congress, are taking stock. “We have long been fully booked for this year, and have firm bookings for 50% of the exhibition space for HUSUM WindEnergy in 2014”, says Peter Becker, managing director of Messe Husum & Congress. Various major wind industry businesses have already secured their space for 2014, including international turbine manufacturers such as Samsung, Vestas, Enercon, and Vensys, as well as major suppliers like WKN and Beckhoff Automation.

The construction of a new access road, a logistics hall and a car park for an additional 1,000 cars are ongoing, but will be completed in time for the exhibition in September. “We are investing another 450,000 euros in the exhibition grounds, and we will have no problem at all in coping with the expected 36,000 visitors“, says Peter Becker.

www.husumwindenergy.com

Call for Papers: International Wind Conference COWEC 2013

The VDI Wissensforum is organising the COWEC ("Conference of the Wind Power Engineering Community") to be held for the first time on the 18th and 19th June 2013 in Berlin, Germany. The conference will be staged in English under the technical management of Professor Andreas Reuter, director of the Fraunhofer Institut IWES Bremerhaven and Dr Andrew Garrad, president of GL Garrad Hassan.

The Call for Papers is the starting signal for those interested in speaking at COWEC. The VDI Wissensforum hopes to hear from decision-makers, engineers, scientists and developers from across the entire spectrum of the wind energy industry. This means that all those attending will be afforded an opportunity to find out about new wind power developments at first hand.

The lectures at the two-day conference deal inter alia with the key points being gears, maintenance, energy storage as well as project developments and legal aspects.

On the conference panel judging the quality of the submitted contributions, will be high-power experts from the following firms: Areva Wind, Kenersys, Winergy, GE Power Conversion, LM Windpower and Bosch Rexroth.

www.cowec.de

IDT Distribution Agreement for the EMEA Region

EBV Elektronik, an Avnet Company Integrated Device Technology announced a distribution agreement to promote and deliver products to customers within the EMEA region.

IDT designs, develops, manufactures and markets a broad range of low-power, high-performance mixed signal semiconductor solutions for the advanced communications, computing and consumer industries. IDT holds No. 1 positions in timing, serial switching and memory interfaces, offering a product portfolio that features a fusion of analog and system expertise as well as traditional digital competencies.

“We are looking forward to partnering with an electronics brand as respected as IDT,” said Slobodan Puljarevic, president and ceo of EBV Elektronik. “The IDT portfolio of frequency control products, high-performance timing, communications and power management solutions helps us broaden our technology offering for our customers across EMEA”.

“IDT is pleased to have a strategic relationship with EBV as a distribution partner in EMEA,” said Pietro Polidori, vice president and managing director of IDT EMEA. “We will work together to keep expanding demand creation and market share growth while providing high-performance solutions and world-class support to our customers, ensuring they achieve efficiency in their product designs and time-to-market.”

www.IDT.com

www.ebv.com

Plastic Electronics set for October Co-Location with SEMICON Europa 2012

SEMICON Europa 2012 features more than 40 programs and events to connect you to latest information, ideas, and solutions you need to move your products from the lab to the fab.

450mm, 3D IC, test, MEMS, packaging and more--SEMICON Europa is the most comprehensive microelectronics manufacturing event in Europe--Don't miss it!

With the acquisition of the Plastic Electronics Exhibition and Conference earlier this year, SEMI will again co-locate the event with SEMICON Europa, 9-11 October in Dresden. This co-location of Europe’s largest show for semiconductor and microelectronics manufacturing with the ambitious new trend-setting area of plastic electronics — including Organic and Large Area Electronics (OLAE) manufacturing — provides unique opportunities for exhibitors with technologies covering these markets, as well as for attendees who will have the opportunity to discover products and technologies from a wider and more diverse supplier community. More than 350 exhibitors from over 20 countries are expected at the combined SEMICON Europa and Plastic Electronics events, which also feature over 210 industry leaders speaking on a wide range of topics.

With the OLAE market expected to soar to $58 billion by 2020, the plastic and organic electronics industry has much to gain from a closer association with the traditional microelectronics supply chain as the industry seeks to overcome the technical barriers inherent in printed electronics.

www.semi.org

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Power semiconductor devices

Snap-in and Hybrid Lithium-Ion CarbonCap Cylindrical Ultracapacitors

Cornell Dubilier Electronics, Inc. announced the release of Type CDLC, CarbonCap Double Layer Capacitors, and Type CDHC hybrid ultracapacitors. Cornell Dubilier's lineup of large cell cylindrical ultracapacitors spans 1200 to 3000 farads; snap-in style ultracapacitors from 100 to 600 farads and higher energy hybrid capacitors from 220 to 1000 farads.

CDHC Hybrid Capacitors are half ultracapacitor and half lithium ion battery. These hybrid capacitors store more than twice the energy of typical ultracapacitors and have high cycle life capability compared to batteries. Hybrid capacitors have more power than lithium ion batteries, but less energy storage. By comparison, ultracapacitors have a cycle life capability of a million cycles or more, batteries have a cycle life of around 1000 cycles and hybrid capacitors, more than 20,000 cycles. While the ultracapacitors have a usual working voltage range of 1.3 to 2.7 V, hybrid capacitors operate from 1.0 to 2.3 V. The higher energy of hybrid capacitors makes them especially suitable for use in LED lighting and emergency pulse applications, e.g. operation of electric doors and windows.

Type CDLC CarbonCap Ultracapacitor Cells are available with axial, M12 threaded mounting studs on both ends as well as additional mounting options. The new snap-in units are available in 2 and 4 pin versions and are well suited for wind turbine blade pitch control.

The large ultracapacitors handle back-up and pulse power applications such as grid stabilization. They also excel in transportation applications like automotive subsystems, rail system power and utility vehicles. They provide extended power allowing critical information and functions to remain available during dips, sags, and outages in the main power source. These cells can relieve batteries of burst power functions, thereby reducing costs and maximizing space and energy efficiency. Units with axial cylindrical design enables low ESR and high peak currents with an electrostatic storage capability that can cycle a million charges and discharges without performance degradation.

Type CDLC can work in parallel with batteries for applications that require both a constant power discharge for continual function and a pulse power for peak loads. The CDLC delivers

the peak power thus reducing the peak current from the battery and extending battery life and reducing battery size and cost.

Both series are available now with prices starting at $10.00 each. Full specifications are available at http://www.cde.com. For application support contact Robert Sevigny at rsevigny@cde.com or 508-996-8561 ext. 128.

Cornell Dubilier is a leading capacitor manufacturer with facilities in New Bedford MA, Liberty SC, Mexicali Mexico and Shenzhen China. Dedicated to capacitor solutions for power electronics, it excels with aluminum electrolytic, mica, motor run, and AC and DC plastic film capacitors. The world leaders in welders, UPS systems, motors, drives, avionics, power and military electronics and medical lasers are prominently among its more than 35,000 customers.

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Heat-Spring® Enhances Green Revolution's CarnotJet™ Server Cooling System

Indium Corporation's Heat-Spring® compressible soft metal thermal interface material is now being used in Green Revolution's CarnotJet™ liquid server cooling system.

Green Revolution's CarnotJet™ System is one of the most powerful and efficient computer server cooling systems in the world. With over 100kW of cooling potential per rack, it can reduce a data center's total energy use by 50%. It is used by some of the world's top supercomputer sites.

According to Indium Corporation's Thermal Interface Materials Product Line Manager, Jordan Ross, "Green Revolution's technology uses 100% liquid immersed electronics in a dielectric fluid. Polymer based thermal interface materials will not work in such an environment. Indium Corporation's metal Heat-Spring® enables this technology by providing a stable and highly effective thermal interface."

"The Heat-Spring maximizes the thermal efficiency of CPUs and GPUs installed in the CarnotJet system's dielectric fluid cooling environment," said David Banys, Director of Marketing at Green Revolution Cooling. "Indium Corporation's product gives customers the freedom to submerge servers produced by any OEM."

Green Revolution Cooling produces the CarnotJet™ fluid-submersion cooling system for data center servers. The technology reduces data center cooling energy use by 95% and has installations at five of the top 100 supercomputing sites worldwide.

Indium Corporation is a premier materials supplier to the global electronics, semiconductor, solar, thin-film, and thermal management markets. Products include solders, preforms, and fluxes; brazes; sputter targets; indium, gallium, germanium and tin compounds, and high purity metals; and Reactive NanoFoil®. Founded in 1934, Indium Corporation has global technical support and factories located in China, Singapore, South Korea, the United Kingdom, and the USA.

For more information about Indium Corporation, visit:

www.indium.com

1600000 Volt. Thyristor converters deliver energy to megacities via one single transmission line.

ABB Semiconductors' Phase Control Thyristor has been the backbone of the high power electronics industry since its introduction almost 50 years ago. Its field of application ranges from kW DC-drives and MW rated load commutated frequency converters to GW converters for HVDC transmission.
ABB's thyristor portfolio includes both PCT and Bi-directionally Controlled Thyristor (BCT) press-pack devices with ratings of 1600 V – 8500 V and 350 A – 6100 A.
For more information please visit our website: **www.abb.com/semiconductors**

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Power and productivity
for a better world™

Ceramic Substrate Extends the Life Span of Power Electronic Modules by up to 10X

Until now, the reliability of copper-bonded ceramic substrates used in power modules has been limited by the lower flexural strength of the ceramic that can result in reduced thermal cycling resistance. For applications combining extreme thermal and mechanical stress, such as hybrid and electric vehicles (HEV/EV), the current commonly used ceramic substrates are not optimal. The significant difference in thermal expansion coefficients of the substrate (ceramics) and the conductor (copper) exert stress on the bonding zone during thermal cycling, threatening reliability. At this year's PCIM, Rogers Corporation introduced a new silicon nitride (Si_3N_4) ceramic substrate under its curamik® substrates brand. Due to the higher mechanical robustness of silicon nitride relative to other ceramics, the new curamik® substrate is intended to help designers achieve critical, long-life performance under the demanding operating environments and conditions of HEV/EV and other renewable energy applications.

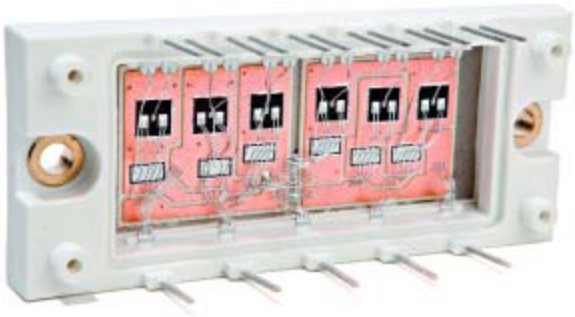

Figure 1: Ceramic substrates, using the DCB and AMB process.

With the growth of HEV/EV and renewable energy applications, designers have struggled to find new ways to ensure reliability of the electronics required to power these new, challenging technologies. With an increase in operating life span of potentially ten times or more relative to other ceramics used in power electronics, silicon nitride substrates provide the mechanical robustness critical to achieving the necessary reliability requirements. The life span of ceramic substrates is measured by the number of repetitions of thermal cycles the substrates can survive without delamination or other failure modes that compromise the function and safety of the circuit. This testing is typically done by cycling the samples from -55° C to 125°C or 150°C.

"In test cycles we have conducted so far, ranging from -55 °C to 150°C, curamik® silicon nitride substrates have shown more than a 10X improvement over substrates typically used in the Automotive segment, especially HEV/EV. From this data, we can expect to see a longer life span for modules using these substrates," reports Manfred Goetz, Product Marketing Manager for curamik® substrates.

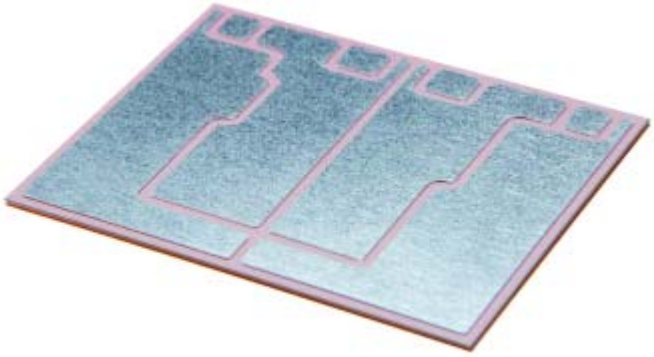

Figure 2: The flexural strength of the new ceramic substrates with silicon nitride is higher than that of Al_2O_3 and AlN

An increased life span is critical in all power module applications where large semiconductor dies are bonded directly to the substrate and it is especially important for SiC and GaN devices, which have higher junction temperatures of up to 250°C. With a thermal conductivity of 90 W/mK, the curamik® silicon nitride substrate exceeds the average other substrates on the market.

The mechanical robustness of the new substrate makes it possible to use a thinner ceramic layer, providing added advantages in lower thermal resistance, increased power density, and lower system cost.

Designers see a big benefit in improved flexural strength compared to Al_2O_3 and AlN substrates. The fracture toughness of silicon nitride even exceeds that of zirconia-doped ceramics, ranging between 6.5 to 7 MPa/√m at a thermal conductivity of 90 W/mK.

The new curamik® silicon nitride ceramic substrate can be produced using both Direct Bond Copper (DBC) as well as active metal brazing (AMB) technology. Recently launched at the PCIM show in Nuremburg, Germany, samples the new high-reliability substrates are available now.

The curamik® brand of copper-bonded ceramic substrates from Rogers Corporation has been trusted by power electronic designers for more than 20 years as the global leader for applications requiring high efficiency and reliability. For more information on curamik® substrates, visit: www.curamik.com

www.curamik.com

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DC link power film capacitors

Next generation inverter designs for renewable energy demand reliable DC link capacitors with higher capacitance values, voltage, and current ratings. Available in new case sizes and ratings, Cornell Dubilier's Type 947D power film capacitors offer the highest bulk energy storage, ripple filtering and life expectancy for wind and solar power inverter designs, as well as electric vehicle applications. Select from hundreds of standard catalog listings, or connect with CDE engineers to develop special designs to your requirements.

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APPLIED VOLTAGE TO 1500 Vdc

RIPPLE CURRENT RATINGS TO 90 A_{rms}

For sample requests or more technical information, visit www.cde.com

CDE CORNELL DUBILIER

Capacitor Solutions for Power Electronics

B2B eCommerce & Social Media: Power Electronics 2.0

Also in the power electronics sector, companies are moving slowly into the New Media. The main challenge is that B2B New Media is not yet a clearly defined science and companies are unsure of how to proceed

By Dr. Walter Demmelhuber, Head of SindoPower International, Co-Founder of PowerGuru, and University lecturer for B2B eCommerce & Social Media at the University of Erlangen-Nürnberg

The main challenge for technology companies is that they are used to a >90% success rate of their development projects. Even when unforeseeable issues occur, more money is poured in and in most cases such projects will be successfull technology-wise although not necessarily from a business case standpoint.

The internet mentality is completely different. It is 'Champaign for everybody' when the success rate is higher than 10% and non-success is so common that one is only associated with failure when a success is never coming up. But this also means that the market introduction is different. One goes in quick and dirty (an absolute horror for engineers), check if there is customer interest and in case of positive feedback, moves fast to improve and expand. Otherwise kill immediately all activities and try again with a different approach.

But what most B2B companies do regarding social media is to create major budgets, do endless internal rounds of what the customers might need, listen to all the knock-out arguments most internal negative persons come up with, ask agencies to create the most polished portals and then are surprised that visitor numbers are low due to lack of interest.

If you visit the Top 100 blogs (unrelated to B2B) worldwide you will find also some of the Top Ugly websites there. But they all have one point in common: they care about the user and discovered what the users are interested in. B2B companies tend to care about their corporate identity, their appearance and the message they want to transmit. That suddenly with the New Media compared to the Old Media the users have the capability to show 'we are not interested in what you are showing us' is scary for the marketing departments should not surprise anybody.

But instead of relying on old marketing measures which are only measurable with difficulty, a new mindset needs to be created taking into account the needs of our customers and readers. If not, very easily leaders in the market can easily monopolize the customer activities online.

Traditionally, customer care is usually split between a 'one-face-to the customer' approach and a customer care which looks after - usually smaller - customers in a centralized way. Nevertheless both customer segments can enjoy an additional customer care approach intensified by online media tools.

An example would be the Online Chat function as provided by Infineon and Semikron, but also by Farnell, Mouser and SindoPower which allows customers to chat in writing directly with sales representatives or engineers. This is a tool typically used by non-native English speakers who have no problem in writing, but in oral understanding when speaking. Towards the customer the big advantage of chatting is that he gets an immediate response; with an eMail, the response time is unclear.

For a company the advantage is that a customer question can be refined immediately to avoid that answers by eMail ping-pong are created which do not cover the customers' requirements. The challenge for companies is to provide a multi-language 24h/5d work shift system. Experience has shown that chat is used by both large and small customers alike.

Especially general product know-how can be made accessible to all customers centrally. One should keep in mind that even the best key account manager knows only several dozen of people within the key account. But there will be hundreds or thousands within the key account who actually require information and do not know whom to contact. So key account micro sites on the company home page can provide customer-specific know-how centrally with additional options for feedback, interaction and requests for personal attention in this closed circle.

An obvious example are configurators and design-support tools many companies make available to their customers online. Even with the most perfect ones customers might have questions while using them. If such tools are not accompanied by real-time applications in case of questions (phone number, chat) then the usability is limited – there is a reason why so many users do not continue a configurator until the end.

The same applies to the general display of company and product information. Compared to the old company websites where information was only stored online, new social tools allow the customers to reach back easily to the company with feedback or requirements and this interaction can be measured with key performance indicators giving guidelines where to improve.

Principally companies can choose to build up their own platforms or use readily available platforms where direct access is possible or registration of users already available (YouTube, Xing, linkedin, Facebook). In the second case one has to keep in mind that such public social media platforms might be blocked within companies due to IT-regulations (typically YouTube, Twitter or Facebook are not available in company networks) and a business use is therefore excluded.

Let's have a look at some examples from large companies active in these areas. Siemens is using YouTube, a closed group called 'Erde 3.0' at linkedin, several blogs and online communities.

Infineon goes this way as well with a whole bunch of measures. A dedicated YouTube channel shows product and company know-how to inform customers; a forum covers social interaction between users and the real-time chat cares for more urgent questions.

Mitsubishi Electric and Weidmüller are using Facebook for promotional purposes.

At Semikron also customers are supported by 24h/5d chat and SindoPower as the eCommerce daughter company sells products via eCommerce; regarding social media activities Semikron has chosen to interact centrally with customers and users in a partnering model. Together with Bodo's Power, Epcos, LEM, Mersen, Proton Electrotex, Semikron, SindoPower and Weidmüller the cooperative platform PowerGuru (www.powerguru.org) was created.

One of the biggest challenges in the power electronics sector is that the user base is limited. Let's assume 100.000 – 200.000 power electronics engineers worldwide. Based on the segment, at most several

thousands are specifically of interest to one's company. Only several hundreds of them come regularly back to your company website and only several dozen of them are really Internet Power Users meaning that they engage regularly in a fruitful intercommunication by online media. The result of this can be seen easily when even very large companies hardly see any activity in their forum.

Companies have several possibilities to move forward in this new terrain:

- form a partnering with established players both in eCommerce and social media and use synergies
- this increases substantially the user base and allows for high interaction probability
- share social media experience between partners and avoid re-inventing the wheel and repeating common mistakes
- pass through the learn curve themselves with a department which acts according to B2B marketing rules
- abstain from B2B online activities, but not because of fear, but due to a limited customer base which is handled better directly

In a nut shell: we are not supposed to be scared of eCommerce, social media or the readers & customers. We should be scared of our own inability to handle new trends! Is it not the dream of all of us that the customers actually interact and come to us on their own initiative? Why are we blocking the doors?

www.sindopower.com

www.powerguru.org

If you are interested in joining PowerGuru as a company to gain more experience in B2B Social Media please have a look at About us or write to: contact@powerguru.org

Electronics Industry Digest

By Aubrey Dunford, Europartners

GENERAL

The worldwide mobile phone market is forecast to grow slightly more than 4 percent in 2012 to nearly 1.8 billion units, the lowest annual growth rate since 2009, so IDC. The slow growth in the overall mobile phone market is primarily due to the projected 10 percent decline in feature phone shipments this year.

SEMICONDUCTORS

Worldwide sales of semiconductors reached $ 24.1 billion in April 2012, a 3.4 percent increase from the prior month, so the WSTS. This marks the largest month-over-month growth for the industry since May 2010. However, sales were 2.9 percent below April 2011. Further, 2012 year-todate sales totalled $ 93.7 billion, a decrease of 5.9 percent from the year-to-date figures at the same time last year.

Semiconductor stockpiles held by chip suppliers increased during the first quarter of 2012, but the rise in inventory for a second straight quarter was driven by the anticipation of higher demand from customers, so IHS iSuppli. Total semiconductor inventory as a percentage of suppliers' revenue amounted to 50.0 percent in the first quarter, up from 47.8 percent in the fourth quarter last year and from 46.1 percent in the third.

Freescale Semiconductor named Gregg A. Lowe president and CEO of the company. Mr. Lowe comes to Freescale from Texas Instruments where he served as senior vice president and manager of the Analog business. Rich Beyer, who previously served as Freescale's chairman and CEO, will continue to serve on the company's board of directors to ensure a smooth transition.

Texas Instruments announced that Senior Vice President Brian Crutcher will head its Analog business, and Senior Vice President Greg Delagi will lead its Embedded Processing business. Crutcher, 39, is a 17-year TI veteran who most recently led the company's Embedded Processing business comprised of microcontrollers and digital signal processors. He replaces Gregg Lowe, who has left TI to become CEO of Freescale.

Delagi, 49, is a 28-year TI veteran who most recently led the company's Wireless business.

Peter Schiefer (46) will assume leadership of Operations at Infineon Technologies as of September 1, 2012. He will report to Dr. Reinhard Ploss, and be responsible for the company's Manufacturing, Supply Chain and Purchasing activities. Dr. Ploss will take over as new CEO of Infineon Technologies as of October 1, 2012. He replaces Peter Bauer, who is resigning from this position due to health reasons. Peter Schiefer will simultaneously give up his position as Head of the Power Management & Multimarket (PMM) Division. As of September 1, 2012, the new head of the division will be Andreas Urschitz (40).

SEMI forecasts an improved growth in fab equipment spending this year--at $ 39.5 billion, a 2 percent year-overyear increase. For 2013, fab equipment spending is expected to reach an all-time record high, with $ 46.3 billion or 17 percent growth from 2012.

Regions planning

to spend the most on fab equipment in 2012 are: Korea (over $ 11 billion), Taiwan ($ 8.5 billion), and the Americas ($ 8.3 billion). In 2013, the largest spending is expected again in Korea (over $ 12.5 billion), the Americas (over $ 11.5 billion), and Taiwan (over $ 8 billion). All product types are increasing equipment spending in 2012 with the largest increase seen in 2012 for Memory and Foundry.

OPTOELECTRONICS

In the face of sharply rising demand for LED-based products, Osram will set up a new plant in Wuxi, China. The new backend facility at Wuxi will install LED chips manufactured in the frontend plants at Regensburg and Penang in their housings.

PASSIVE COMPONENTS

After an increase by 46 percent and a full recovery of the European passives market in 2010 and a further growth by 7 percent in 2011, the experts of the European Passive Components Industry Association (EPCIA) forecast a decrease by 1 percent in 2012. This yields in a market volume of approx. € 4.5 billion. After a tremendous increase of the capacitors market by 64 percent in 2010 there was a further growth by 12 percent in 2011.

OTHER COMPONENTS

Teledyne Technologies, a provider of instrumentation, digital imaging products and software, aerospace and defense electronics, and engineered systems, will acquire LeCroy for approximately $ 291 M. Founded in 1964, LeCroy is a US-based supplier of oscilloscopes, protocol analyzers and signal integrity test solutions with approximately 500 employees worldwide.

Teseq, a Swiss provider of instrumentation and systems for EMC emission and immunity testing, intends to acquire New York-based Instruments for Industry (IFI), a USbased

of solid state and traveling wave tube (TWT) amplifiers. With the future acquisition of IFI, Teseq will expand its product range in the RF amplifier market from 9 kHz up to 40 GHz and up to 10 kW.

DISTRIBUTION

Arrow Electronics has announced the introduction of an online resource that includes a number of tools to help customers manage their procurement and supply of electronic components. Initially available in Central and Northern Europe, MyArrow is a robust, full-featured online portal that provides customers with the ability to manage their orders online. The offering features a powerful suite of online tools that greatly increase productivity and information access by helping customers to organize and streamline their transactions with Arrow.

Avnet Embedded has updated its franchise distribution agreement adding Intel wireless modules to its portfolio of embedded products available to European designers. Avnet Embedded is offering Intel Centrino Embedded Wireless half mini-card PCIe modules supplied ready for systems such as laptops, embedded PCs and the broad range of machine to machine devices.

This is the comprehensive power related extract from the « Electronics Industry Digest », the successor of The Lennox Report. For a full subscription of the report contact:

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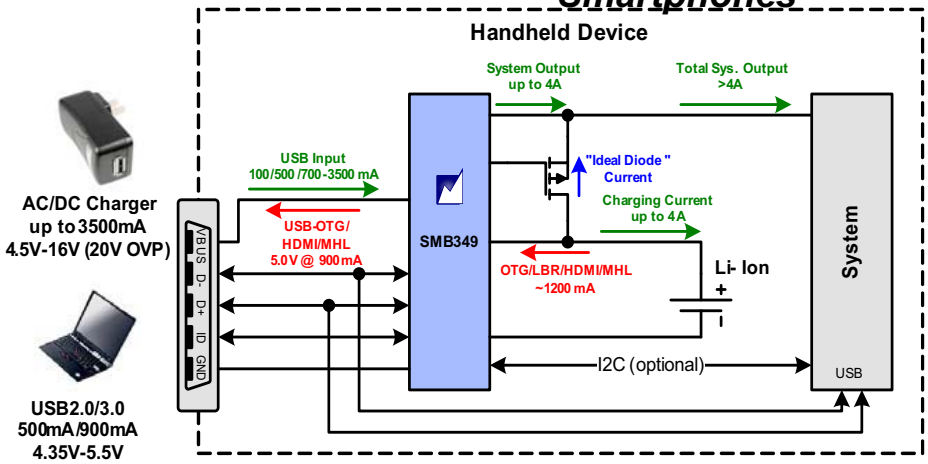

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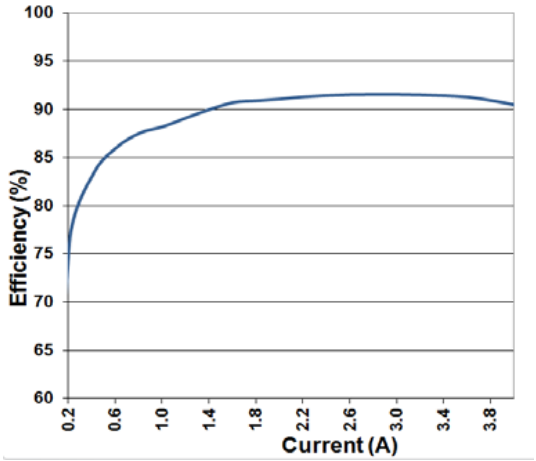

	SMB349	SMB359	SMB347	SMB137C	SMB346	SMB136C
Input Voltage Range (V)*	4.35 to 16 (20)	4.35 to 16 (20)	4.35 to 6.2 (20)	4.35 to 6.0 (18)	4.35 to 6.2 (20)	4.35 to 6.0 (18)
# of Inputs/Outputs	1/2	1/1	2/2	2/2	2/2	1/2
Maximum Charge Current (mA)	4000	4000	2500	1500	1250	1500
Maximum Input Current (mA)	3500	3500	2500	1500	2500	1500
CurrentPath™ Control	√		√	√	√	√
Charge Current Voltage Output	√	√	√		√	
Low-Battery Recovery Mode				√		√
Automatic Power Source Detection **	rev 1.2	rev 1.2	rev 1.1/1.2	rev 1.2	rev 1.1/1.2	rev 1.2
Package	3.2x3.0 CSP-49 5x5 QFN-40	3.2x3.0 CSP-49 5x5 QFN-40	3.0x2.5 CSP-30	3.0x2.5 CSP-30	3.0x2.5 CSP-30	3.0x2.5 CSP-30
Solution Size (mm2)	52	52	32	38	32	35

All chargers have Battery Thermal Protection & JEITA Support, IC Thermal Protection, Auto Input Current Limit, Safety or Watchdog Timers, Programmable Charging Parameters, I2C Interface, USB On-The-Go, TurboCharge™ Mode*

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Energy Harvesting Technology Continues to Advance

By Richard Ruiz, Research Analyst, Darnell Group

Although Energy Harvesting is still considered an emerging technology, products used in energy harvesting systems are now commercially available and are often driven by developments in areas that are, themselves, still considered emerging. Currently, wireless sensor networks (WSNs) are at the forefront of the industry, as the growth of energy harvesting technology parallels the growth of both wireless sensor networks and wireless control systems. Over the past several years, hundreds of thousands of wireless switches have been deployed in buildings and other areas, and the trend towards wireless sensor technology is expected to continue growing.

According to "Energy Harvesting and Related Energy Storage Devices: Worldwide Forecasts" from the Darnell Group, the worldwide energy harvesting sensor node unit market is projected to grow from 42.5 million units in 2012 to 375.2 million units in 2017, at a compounded annual growth rate (CAGR) of 55.0%. (The nodes are the focus of this forecast because they are the devices that require powering.) Not surprisingly, the number of applications that can be powered by some form of energy harvesting technology is also growing and the sensors used in the various applications, industrial process, building automation, environmental monitoring, etc. are becoming more efficient and can now operate with less power.

In contrast to traditional energy technologies, which generate energy remotely before transporting it through electrical cables to the user, harvested energy is collected and used locally. Advanced technical developments have increased the efficiency of devices in capturing trace amounts of energy from the environment and transforming them into electrical energy. In addition, advancements in microprocessor technology have increased power efficiency significantly, effectively reducing power consumption requirements. These developments have fueled an interest in the energy community to develop additional applications that utilize energy harvesting for power.

For example, mechanical vibration/piezoelectric devices, among the most common energy harvesters, have grown much more efficient. The wireless sensors now used are increasingly integrating functions into single chips to minimize power draw. They sleep between measurements to conserve power – and when they do broadcast, they use stripped-down protocols to minimize the amount of information they need to send, and may adjust their range to available power. Additional technologies expected to play an immediate role include photovoltaic, thermoelectric/other, and radio frequency (RF). Although characterized by a relatively higher initial cost when compared to conventional systems, the implementation of energy harvesting technologies may offer significant savings and a faster return on investment (ROI.)

Harvesting energy from a natural source where a remote application is deployed, and where a natural energy source is essentially inexhaustible is an increasingly attractive alternative to inconvenient AC outlets and costly batteries. Although current power levels may seem restrictively small, the operation of the harvesting elements over a number of years can mean that the technologies are broadly comparable with life-long primary batteries, both in terms of energy provision and cost per unit provided. This potential energy source, when designed and installed properly could be available maintenance-free throughout the lifetime of the application. In addition, energy harvesting can be used as an alternative energy source to supplement a primary power source and to enhance the reliability of the overall system and prevent power interruptions.

Building Automation is considered to be one of the key opportunities for energy harvesting technology. One of the reasons is that wireless electronic devices such as occupancy sensors, thermostats and light switches used in building automation systems have eliminated much of the bulky and expensive power and control wiring normally associated with their installation. As an example, key applications of energy harvesting systems are radio sensors used in building automation systems. One of the advantages of a wireless building automation system is that a wireless network utilizing an energy harvesting technique can connect any number of sensors together in a building to reduce HVAC and electricity costs by adjusting the temperature or turning off lights to non-essential areas when the building or rooms are unoccupied, saving both energy and cost.

Other applications expected to benefit from energy harvesting technology include Home Automation, Automotive/Tire Pressure Sensors (TPMS), Environmental Monitoring, Medical, Radio Frequency Identification Devices (RFID), Industrial Process and Military/Aerospace. Each of these applications is expected to see slower growth in the early years, followed by much faster growth later in the forecast period.

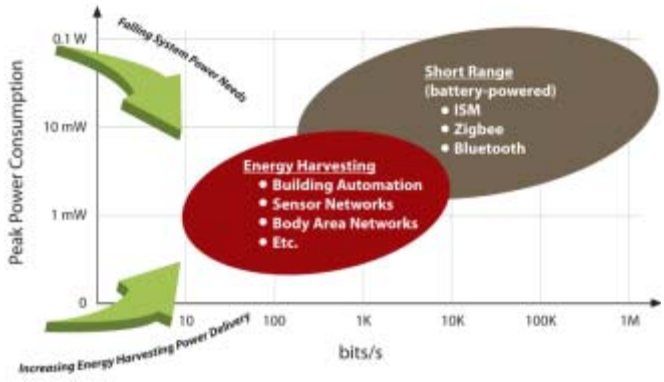

Figure 1: Harvesting requirements

Interestingly, the ability of energy harvesting devices to deliver increasing amounts of energy has grown faster than anticipated and the energy needs of sensors and related electronics has dropped. In fact, in 2011 the National Institute of Aerospace (NIA) demonstrated a multilayer piezoelectric device that can harvest four times more energy than conventional piezoelectric systems. The researchers soon hope to demonstrate harvests of up to 1 watt by the end of 2012.

The costs of energy harvesting systems are also declining as the market finally catches up with the technology. As indicated in the accompanying illustration, falling system power needs and increasing energy harvesting power delivery are converging. This convergence continued throughout the current economic downturn and is expected to continue over the coming years. Those developments are expected to make energy harvesting solutions more economically attractive, resulting in increased growth over the next several years as the worldwide economy recovers.

In addition to the potential economic advantages, wireless energy harvesting sensors are expected to provide an opportunity for building owners to contribute to the "Greening" of the environment. According to the U.S. Department of Energy, buildings consume 39% of the energy and 74% of the electricity produced annually in the United States. For building owners, the adoption of self-powered wireless sensors could mean not only reduced energy costs and tax incentives, but also improved tenancy rates and higher per-square-foot revenue as prospective commercial and residential tenants demand improved energy efficiency.

As an emerging technology, the further development of the energy harvesting market is highly reliant on the adoption of standards and regulations. Their adoption is expected to accelerate the development and implementation of energy-optimized wireless sensors and wireless sensor networks. Standards are also projected to open up new markets and areas of application for energy harvesting solutions.

The trends relating to standards and regulations are also expected to have a significant impact on where energy harvesting is likely to be adopted. The consensus among industry professionals is that a consolidation is expected, since there are still too many standards competing with each other. Although there are a variety of wireless standards used in a number of application areas, there are currently no set of standards which cover every requirement. As an example, WiFi is considered excellent for transporting large amounts of data rapidly into and throughout the internet. Bluetooth technology does well in its niche, which is transporting short range voice data and cell phone networks, while Zigbee maintains a large share of building automation.

The use of efficient power management is also expected to play a key role in the continued development of energy harvesting technologies. Power requirements for wireless devices used in energy harvesting applications must be extremely low, so data has to be transmitted in very short bursts. Over the past several years, a new generation of energy harvesting ICs has introduced a level of performance not possible with the discrete solutions offered just a few years ago. As a result, they have become a catalyst for growth, because they can harvest energy from very low levels of power. The growing levels of performance, coupled with the cost-effective price points of the transducers, microcontrollers, sensors and transceivers, has led to an increase in market acceptance.

The ability to harness maintenance-free energy throughout the lifetime of an application is expected to remain an attractive goal. Combined with the advances in technology, the growing number of applications expected to adopt energy harvesting systems and the continued development of standards, the outlook for the energy harvesting industry is expected to remain positive for the foreseeable future.

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PCIM Asia Shanghai - Bridging Expertise across the World

By Bodo Arlt, editor BPS

I can now proudly say that I have been to Shanghai! It was my first visit and opportunity to experience a new world with a huge demand for efficient communication.

Shanghai is a mega city. A visitor from New York City who we spoke with, commented that he has never seen such a busy place. Seeing the continuous change from old to new, while keeping its history alive, was a great experience. I visited a monastery and saw a Buddha made from 15 tons of silver – one could not help but be impressed. History and some turbulent times have nonetheless kept their respect for the religion and have not touched these places.

Picture 1: Shanghai a mega city

The conference was highlighted by three papers and their authors, all concerning IGBTs and their modular approach. This underlines the important fact that the IGBT has been the work-horse in power applications for drives and conversion. The initial patent by Wheatley and Becke, given to RCA in 1982, will become 30 years old this December and represents an innovation that changed the world of power switching.

Infineon Austria was the winner of the best paper award: **"High Speed 5 IGBT Achieves Platinum Efficiency Standard in Commercial SMPS Applications,"** and was written by Erich Griebl, Infineon Technologies, Germany and Davide Chiola, Giulia Seri, Omar Harmon, Francesco Di Domenico, Matteo-Alessandro Kutschak, Stefan Preimel and Rene Mente of Infineon Technologies Austria.

Abstract: Energy efficiency requirements set by Regulatory Agencies in different regions are steering the adoption of very efficient power semiconductors and enabling smart system solutions in order to meet the efficiency standard. This paper presents the new High Speed 5 IGBT from Infineon Technologies, and demonstrates through extensive application tests its capability to reach similar efficiency ratings of Superjunction MOSFETs in commercial Power Supply units. Advantages and limitations of an IGBT solution in SMPS are finally highlighted.

Fuji Japan won the best paper award on renewable energy: **"1-MW Solar Power Inverters Using New Three-level IGBT Modules Connected in Parallel,"** Kansuke Fujii, Takayuki Kikuchi, Satoki Takizawa, Kazuyuki Yoda and Yasuhiro Okuma, Fuji Electric Co., Ltd., Japan.

Abstract: A multi-level topology is one of the effective approaches to improve the efficiency of power converters. The authors had developed and already presented a 50-kVA UPS using Advanced Neutral-Point–Clamped (A-NPC) topology, which utilizes the Reverse-Blocking IGBT (RB-IGBT) as a bi-directional switch for clamping of its AC output to the DC neutral point. The A-NPC topology is simple and enables low conduction losses of the converters. In this paper, the authors develop a 1-MVA solar power inverters using A-NPC topology. The power unit and control of the solar power inverters using A-NPC IGBT modules connected in parallel, and the evaluation results, are presented.

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Finally, Vincotech China was the winner of the young engineer award: **"Asymmetrical Inductance Utilized for Switching Loss Reduction In Power Modules,"** Michael Frisch, Vincotech GmbH, Germany, Temesi Ernö, Vincotech Kft., Hungary and Roger Chen, Vincotech Asia, China.

Abstract: High efficiency of power conversion circuits is a design goal on its own. At the top end, solar inverter manufacturers compete to develop the most efficient topologies, using components with the lowest power dissipation. But high efficiency is also the key for other inverter aspects. A reduction of component switching losses is the basis for higher switching frequencies, leading to a reduction of the size and weight of passive components. An improvement from 96% to 99% efficiency will reduce the need for cooling by a factor of four. It is obvious that highly efficient circuits are the smartest way to achieve a compact design and the highest power density. The utilization of parasitic inductance and consequent execution some basic rules of power electronics discloses a new power electronics solution based on standard Si components which extends traditional designs. The new power module concept presented combines a low inductive turn-off with the utilization of the parasitic inductance for a reduction of the turn-on losses, and the usage of three level switching circuits with the paralleling of fast switching components with components of low forward voltage drop.

The show and conference was very busy with a large number of attendees and visitors all focused on power electronics. I spent the three days having great conversations with new contacts at companies already represented in my publication and with new ones looking forward to developing their communications strategies with our help.

A few pictures to give you an impression of my busy days at the PCIM Asia in Shanghai:

Picture 2: Prof. Leo Lorenz and myself at the Bodo's Power China booth

Picture 3: Alexander Glos in the Maglev at 430Km/h

My final highlight in Shanghai was a ride on the Maglev train, trains being a hobby of mine, at a speed of 430 Km/h. Back when I was encouraging IGBTs into designs in the early 90's, I remember talking to the design people in Munich about their using them for the linear motor inverters of the Transrapid, which in Shanghai, is called Maglev. The first Transrapid was functional in Kassel, Germany in 1979 – three years ahead of the IGBT invention. I remembered that bipolar transistors were used in the design done in the 70s, but there was no plan for redesigning the inverters to IGBTs due to a lack of volume orders in the 80s. This story goes back to a patent issued to a Mr. Kemper in 1934 and a number of test vehicles from 1971 on. The history in detail can be found on Thyssen Krupp's website here: http://www.transrapid.de.

It took me more than a quarter of a century to see and ride this German engineering highlight in Shanghai, but only seven minutes from the expo to the airport - a record! This is a must-see for everybody visiting Shanghai and interested in the future of transportation.


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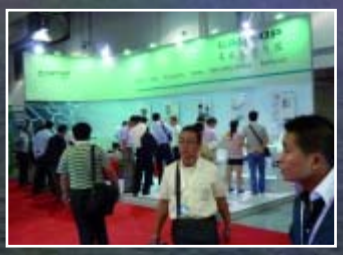


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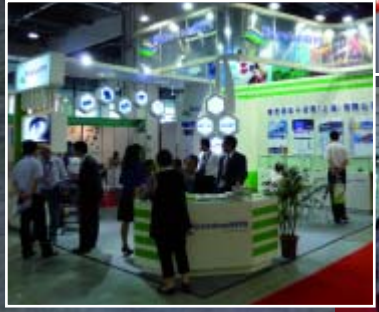


Vincotech

Driving IGBTs in Parallel is Plug-and-Play

A new compact family of IGBT drivers provides better silicon usage and reduces the overall cost of high-power systems

By Olivier Garcia, CT-Concept Technologie AG

High-voltage/high-current drivers are a vital element of power electrical systems. In power converter applications such as traction, HVDC, medium-voltage drives or renewables, the performance of the drivers plays a key part in the overall performance and efficiency of the complete system. A new development in IGBT drivers enables multiple IGBTs to be connected in parallel safely with no setting-up or fine-tuning required.

Controlled power switching at high power levels can be implemented using thyristors, bipolar transistors, power MOSFETs and IGBTs. Up to the mid 1980s thyristors were the dominant technology and still are at extreme power levels of hundreds of MW. Today IGBTs with voltage classes up to 6.5 kV now dominate the power ranges. The technical advantages of IGBTs - high dielectric strength, relatively high current density, ease of driving and good short circuit protection - have made these power semiconductors standard components for almost every power stage rated at 10 kW or more.

The IGBT is a complex device but can simply be explained as a bipolar output transistor driven by a MOSFET input. At higher current levels the conduction losses are much lower than for an equivalent power MOSFET, and without the need for the high base drive current of a bipolar transistor. However, because of the high voltages and currents involved, driving high-power IGBTs is not a simple matter.

An IGBT is turned on with a positive voltage of typically 15 V with respect to the emitter potential applied to its gate. To guarantee turn off it is necessary to bias the gate to approximately -7 V to -15 V with respect to the emitter to overcome the reverse transfer capacitance (also known as the Miller capacitance) which can couple part of the collector voltage to the gate in bridge applications.

Whereas it is relatively easy to drive an IGBT whose emitter is connected to the ground, in a bridge circuit, which is basic to most IGBT applications, the mid-point of the bridge and thus the emitter potential of the high-side switch jumps back and forth between the positive and negative potentials of the supply voltage at speeds of 5 to 25 kV/µs. This results in large potential differences between the upper driver of the half-bridge and the control electronics. The gate driver must operate reliably in the presence of these surges and optimize the conduction and switching losses of the IGBT modules in both normal switching operation and under overload conditions.

Requirements for drivers

The most important requirements to be fulfilled by drivers for high voltage IGBTs can be summarized as follows:

- Galvanic isolation between IGBT and control electronics (signal path and power supply)
- Ability to turn IGBTs on and off inside the IGBT SOA (safe operating area) with minimal switching losses
- Ability to switch the IGBT at the optimal switching frequency (driver output power can be tailored to the target IGBT module)
- Overvoltage protection (reduction of the turn-off overvoltage)
- Monitoring functions such as IGBT short-circuit protection and supply under-voltage detection

Overvoltage protection is the one element central to the design of an IGBT driver.

Turn-off over voltages

The rated blocking voltage of a semiconductor switch must never be exceeded. This requirement must be fulfilled under all working conditions including turn-off transients from over-current or short-circuit conditions. Due to the stray inductances in the layout of the power stage and the high values of the current changes di/dt, overvoltages in the range of hundreds to thousands of volts can be produced. In extreme cases these voltage spikes can reach values higher than the maximum permissible collector-emitter voltage $V_{CE(max)}$. Figure 1 below is the basic active clamping circuit [1] that can guard

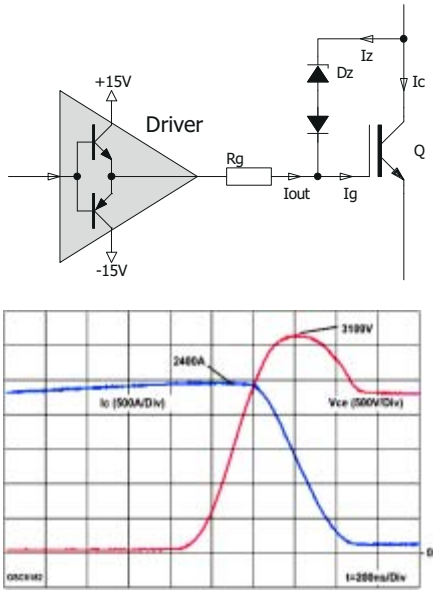

Figure 1 Basic active clamping circuit (top) and its optimized behavior (bottom)

against turn-off voltages exceeding $V_{CE(max)}$.

The transient voltage suppressor diodes Dz between collector and gate cause the IGBT to partially turn on when the collector voltage reaches a pre-defined level. This prevents any further increase of the collector voltage.

Basic active clamping works well for systems with lower technical requirements. Rg(off) must be dimensioned for overload conditions such as turn-off of at double the rated current, short-circuit and a temporarily increased DC-link voltage. In normal operation this results in increased switching losses and turn-off delays. So this simple method is unsuitable for high-power modules and repetitive operation.

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An improved active clamping circuit [2] is shown in Figure 2.

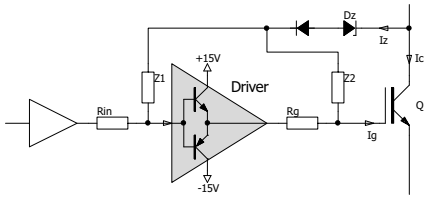

Figure 2: Principle of an IGBT driver with Advanced Active Clamping

Here, the base of the chain of clamping diodes is, as before, connected to the gate of the IGBT, but is additionally connected to the input of a booster stage. The driver voltage is consequently raised as soon as a current flows through the clamping element. The driver stage now no longer draws any current from the clamping element, and the current flowing through the clamping element is now available exclusively for charging the gate. The VCE turn-off overvoltage and the power loss in the clamping diodes can thus be dramatically reduced. This circuit was used successfully in the first generation of SCALE plug-and-play drivers produced by CT-Concept Technologie AG, a specialized manufacturer of high-power drivers based in Switzerland and recently acquired by Power Integrations of San Jose, CA.

Figure 3 shows Advanced Active Clamping (AAC) implemented in practice in a SCALE-2® driver core produced by CONCEPT.

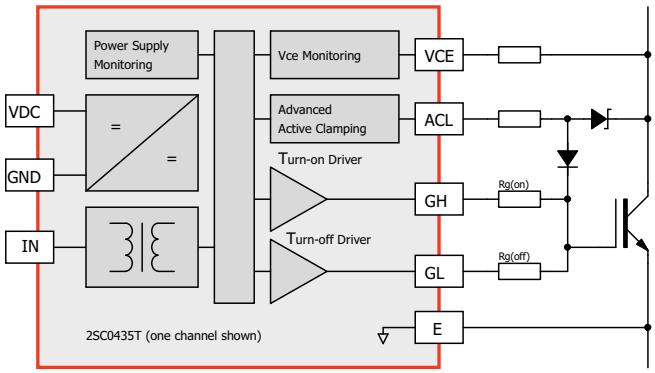

Figure 3: SCALE-2® Integration of Advanced Active Clamping illustrated by the 2SC0435T driver core

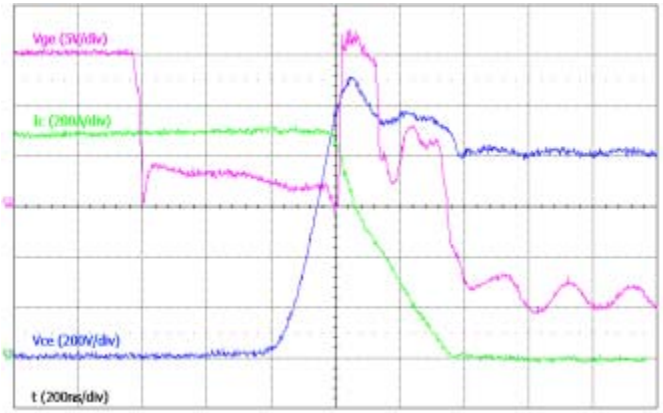

Figure 4: Switching behaviour of a FF450R12IE4 IGBT with the 2SP0320T. V_{dc} = 800V and I_c = 900A, L_{stray} = 68nH

The base of the clamping elements is connected not only to the gate of the IGBT, but also to the ACL input of the SCALE-2® driver ASIC. The gate driver ASIC, implemented in fast analog CMOS technology, continuously raises the output resistance of the turn-off driver stage as the current to the ACL input increases. When the current reaches several 100 mA, the output stage reaches high impedance, so that the driver no longer absorbs any current from the clamping element.

Figure 4 shows the turn-off behavior of the 2SP0320T plug-and-play driver with an IGBT module FF450R12IE4 using SCALE-2® technology with Advanced Active Clamping.

Advanced Active Clamping provides, in addition to the advantages of simple Active Clamping solutions, the following benefits:

- Simple scalability in the voltage class
- Low thermal load of the clamping elements enabling repetitive operation
- Very low value gate resistors possible
- Steep limiting characteristic
- Suitable for all modern high-power IGBT modules
- Minimum switching losses
- Self-adapting system, acts only when needed
- Simply and safely configurable
- Competitive system costs

The system is self-adapting in that once the active clamping behavior has been set, the AAC feedback loop automatically distinguishes between normal switching, where low losses are the primary focus, and short-circuit turn off, where the main emphasis is placed on keeping control of transient overvoltages maintaining a limited current change rate di/dt.

SCALE-2® provides an effective solution for overvoltage protection. The other important requirements for high-voltage IGBT drivers will be considered with reference to SCALE-2® [3].

Short-circuit detection

Short-circuit detection is usually realized in IGBT drivers by monitoring the saturation voltage VCE(sat). The circuit checks if during the first 10µs after turn-on the collector emitter voltage has dropped below a pre-defined level depending on the IGBT type. If the collector voltage does not fall below that level, a short-circuit condition is assumed and the driver will turn off. Figure 5 shows two simple circuits used in SCALE products that provide a collector sense.

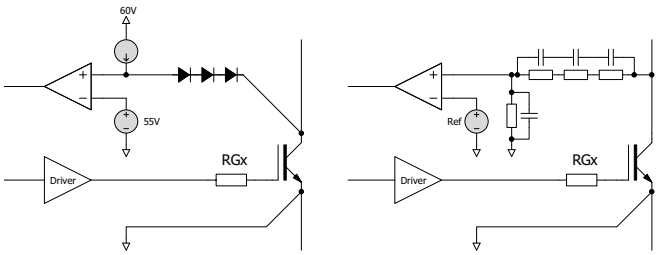

Figure 5: Two collector voltage sense circuits used in high voltage IGBT drivers

The circuit on the left is appropriate for a 3300 V IGBT driver. The current source provides a current of a few mA into the collector of the IGBT. The comparator checks if the collector voltage lies above or below the trip level of 55 V. Higher voltage IGBTs require trip levels of up to 500 V. For these, the circuit on the right would be used. This solution uses a high-voltage divider to scale down the collector-emitter voltage.

The SCALE-2® technology uses a new VCE monitoring circuit that replaces the high-voltage sensing through diodes (see Fig. 3) by a simple resistor chain. Its main advantage is precise, direct voltage measurement allowing any abnormal increase in IGBT saturation voltage to be detected. Direct VCE sensing is no longer influenced by parasitic capacitances of the high-voltage diodes and their pronounced temperature dependence. The dynamic VCE monitoring circuit enables a better fit to the VCE curve of the IGBTs.

The SCALE-2® drivers provide a tightly regulated +15 V gate voltage in IGBT on-state. This feature is particularly advantageous in short-circuit conditions. The high dv/dt values occurring in this failure mode inject considerable amounts of charge into the gate node (Miller feedback). This feedback causes the gate voltage to rise during a short-circuit, resulting in excessively high levels of short-circuit current. This is a dangerous situation for the IGBT module. SCALE-2® drivers use a Schottky diode clamp to limit the gate voltage to safe values (see Fig. 9). The stable 15 V supply absorbs the Miller feedback charge and safe operation of the IGBT is maintained.

Power and speed

The SCALE-2® ASIC chipset, used for example in the SCALE-2® driver cores 2SC0108T and 2SC0435T, introduces a delay of less than 100 ns in the turn-on and turn-off signal paths. This delay time is delivered at a superior repeatability of +/-10 ns including jitter and ageing. A comparison with other technologies such as optocouplers shows that the propagation delay time is typically as high as 500 ns with a mismatch of several 100 ns. Uneven ageing of separate drive channels is a common problem for fiber optics and optocoupler systems. In contrast, SCALE-2® drivers maintain symmetrical switching of the driver channels. The clear user advantage is constant IGBT losses over the lifetime of an inverter, especially in case of parallel connected IGBT modules.

Parallel connection of IGBT modules

In many high-power applications, the required current levels can only be achieved by connecting two or more IGBT modules in parallel. With these configurations, tight control and monitoring of the IGBT modules is essential as any out-of-control failure could have disastrous consequences. The power delivered by each module must balance the other and switching must be synchronized to avoid dangerously high commutation currents.

The property of tightly controlled delay paths provided by SCALE-2® is efficiently used to drive 130 x 140 mm and 130 x 190 mm high-voltage IGBT modules synchronously in the master-slave topology made possible with the following high-voltage driver families from CONCEPT:

- 1SP0635: 1.2 kV - 3.3 kV IGBT modules with 6 kV isolation voltage
- 1SP0340: 4.5 kV IGBT modules with 6 kV isolation voltage
- 1SP0335: 3.3 kV - 6.5 kV IGBT modules with 10.2 kV isolation voltage

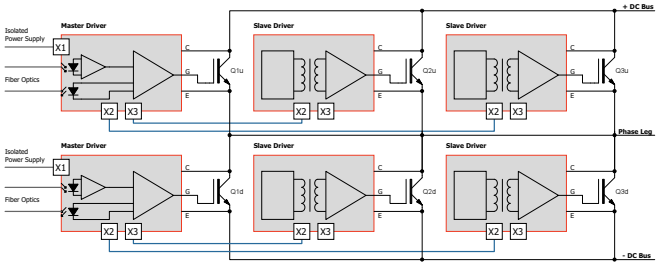

Figure 6: Principle of parallel connection of 1SP0335 drivers with one master and two slaves in a half-bridge configuration (example)

The new family of SCALE-2® drivers from CONCEPT [4] provides a master-slave configuration for IGBT paralleling with plug-and-play ease of implementation. Users need only mount the drivers onto the corresponding IGBT module. The system can then be put into immediate operation with no further development or matching effort. Figure 6 shows the principle of master-slave configuration [5].

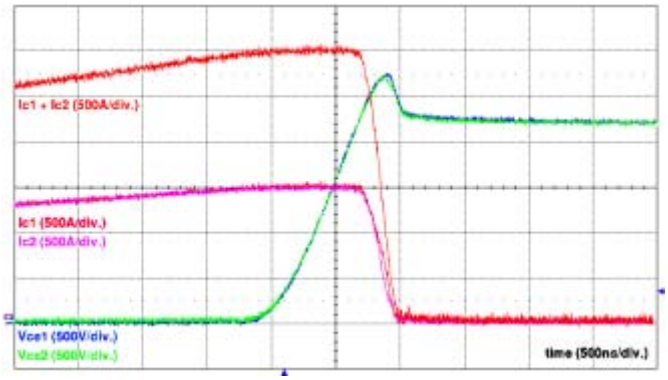

Figure 7: Turn-off of two parallel-operating IGBTs with 1SP0635

The master is equipped with a fiber-optic interface and global fault management. The slaves are connected to the master by a bus cable which distributes the common command signal and the secondary-side supply voltages.

Because of the extremely low jitter and low variance of propagation delay of the SCALE-2® chipset, all IGBTs operate at virtually the same gate-driving voltage as illustrated in Figure 7. The architecture provides unlimited and easy scalability for a wide range of applications and power levels.

Figure 8: 1SP0340V2M0 master driver mounted on a IGBT module

The master-slave architecture provides the following additional advantages in parallel IGBT configurations:

- Dynamic Advanced Active Clamping temporarily allows extremely high DC-link voltages. This is a particular advantage for traction, windmill and solar converters.
- Dynamic short-circuit detection to protect the IGBTs fully from any kind of short-circuit while fully utilizing the collector current capability of both low conduction-loss optimized and fast-switching IGBTs.
- Centralized monitoring of gate-emitter voltages of all individual drivers by the master to ensure correct parallel operation.

The slave modules can only be used in conjunction with the master drivers when parallel connection of IGBT modules is required. Up to three slaves can be connected with one master.

The slave module in Figure 10 illustrates the exceptional level of integration achieved with the overall component count yielding a very high MTBF.

Power supply and electrical isolation

The drivers of the 1SP0335 and 1SP0340 families are modular in the sense that the driver card and power supply (DC-DC converter) are two separate units. The power supply unit is designed as a separate module attached close to the IGBT (see Fig. 11) and is available in different versions up to a specified operating voltage of 12 kV.

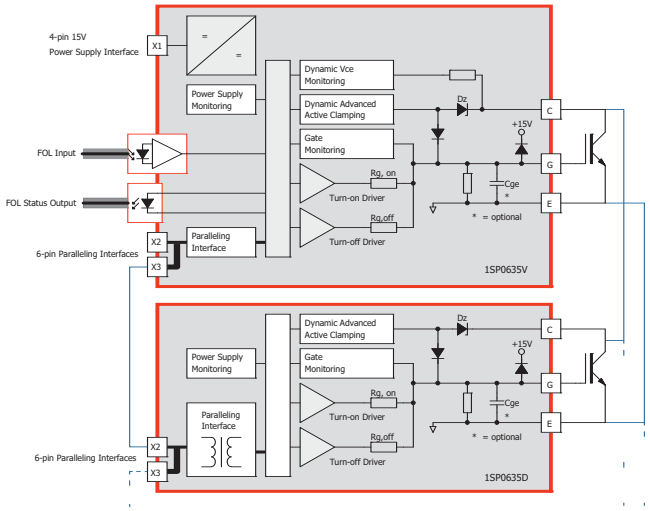

Figure 9: Master slave architecture of SCALE-2® plug-and-play driver 1SP0635

With this modular concept, any driver unit developed to match a specific IGBT module can be used for any required insulation specifications. Only the separate power supply unit must be chosen or adjusted to a specific application. On the basis of this concept, the drivers for IGBTs in the voltage range from 3.3 kV to 6.5 kV can be implemented in 2-level, 3-level and multi-level inverter topologies.

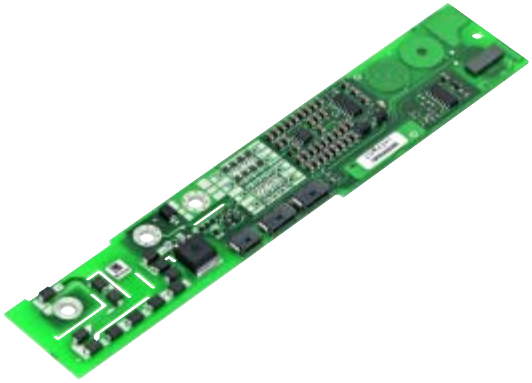

Figure 10: 1SP0340D2S0 slave module

The 1SP0340, the latest member of the high-voltage SCALE-2® driver family, provides a new level of performance and economy driving 4.5 kV IGBTs in a 6 kV isolation package. With performance and functionality optimized at 4.5 kV operation, the 1SP0340 is constructed in a smaller footprint and using fewer components than previously required. Yet the module provides all the advanced features of SCALE-2® - Direct parallel connection, dynamic advanced active clamping, gate-voltage Miller clamping and dynamic desaturation protection.

Plug-and-play design and implementation

All the components required for the optimal and safe driving of the relevant IGBT module such as smallest gate resistors designed to minimize switching losses, gate clamping, etc. are included on the

driver. It includes components for setting the monitoring turn-off trip level and the response time. Its plug-and-play capability means that it is ready to operate immediately after mounting. The user needs invest no effort in designing or adjusting the driver to a specific application.

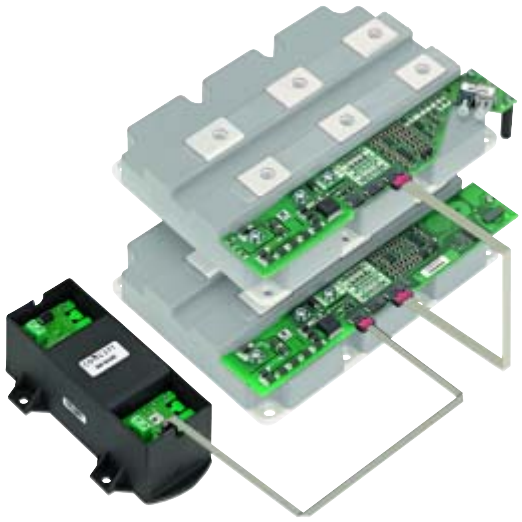

Figure 11: 1SP0340 (right) with power supply ISO5125I (left)

These features enable system designs with higher DC voltages and less derating in parallel operation of IGBT modules, leading to better usage of the silicon and thus lower overall system cost.

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More Reliability by High Integration

The advantages of integrated filter technology

Today, power quality (PQ) filters are critical components in modern power conversion applications. PQ filters are used in traditional motor drives and increasingly in renewable energy applications. These applications often need power converters to adjust the power demand and convert different energy sources for use in existing grid lines.

By Jarkko Salomaki, General Manager Nidecon, jarkko.salomaki@nidecon.com

The purpose of PQ filters is to guarantee the quality of grid voltages without increasing the harmonic content of grid lines, as well as to store energy. Converter performance can be upgraded using technically advanced power quality filters.

PQ filters include LC, LCL and dUdT filters. LCL filters are used between the grid-side converter and grid in order to filter current according to the given grid requirements. Dudt filters are used between the generator/motor and converter in order to reduce overvoltages and common mode currents. Nidecon filters come as air-cooled or liquid-cooled LC, LCL and dUdT filters for currents of up to 2000A.

Increased power density

In any area of electronics, the trend is to deliver better performance yet reduced size. Converters are no exception. Since inductive components are energy storage devices, their volume takes up a significant portion of the converter cabinet. In order to increase the power density of converters, the size of power quality filters must be reduced. Size reduction is achieved by increasing system packaging density, optimizing filter component form factors, and using higher switching frequencies, leading to reduced inductance requirements in the filters. Reduced inductance automatically means smaller filter dimensions.

The power density increase in Nidecon filters is down to the integrated cooling technology: active hidden hot spot removal in air-cooled windings and integrated liquid cooling channels inside the core. Nidecon's novel winding concept enables the height of the core to be reduced. The smaller core also means a significant weight reduction compared to conventional filters. The reduced weight also results in cost savings thanks to reduced material and logistics costs. In Nidecon's air-cooled solutions, the innovative winding concept enables air to flow through the filter, effectively eliminating hotspots (Figure 1). Even if the conventional component surfaces are cooled with liquid or air, local hotspots may still be generated inside the component. For example, a foil winding may have hidden hotspots inside the structure, leading to insulator failure. The core air gaps may have high local loss concentrations due to fringing flux which hits core laminates from the wrong direction, resulting in high local temperature rise and ultimately lamination insulation failure. None of these problems occur with Nidecon solutions.

Integrated liquid cooling reduces filter size because cooling pipes go through the core instead of being on the core surface (Figure 2). There is no need for additional fans because the cooling system is efficient, meaning space is saved. Even though Nidecon filters are smaller and lighter than conventional filters, the output power is the same or even greater. In other words, size is reduced without compromising output power.

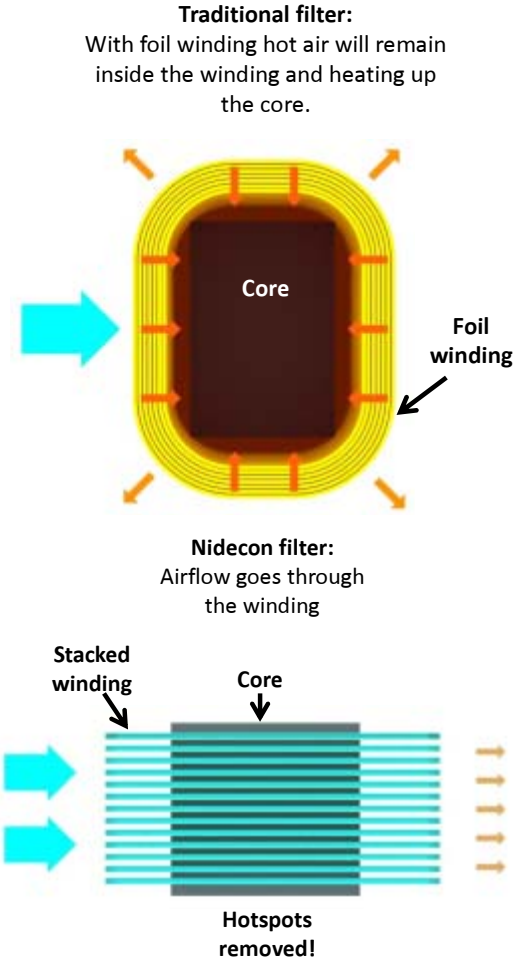
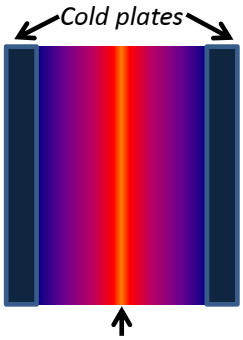


Figure 1: Nidecon forced air cooling concept and comparison to a conventional filter.

•**Cooling pipes are integrated into the core**

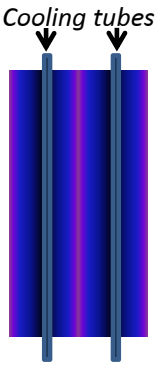
•**Nidecon core is cooled from the inside -> maximum effectiveness!**

Traditional filter:
cold plates on core surface



Hotspot is generated into the middle of the core

Nidecon filter:
Cooling tubes integrated to the core



No hotspot inside the core!

Figure 2: Nidecon filter is so compact it can be assembled into the same stack as the converter (right).

Losses dissipated via the cooling liquid

In addition to a decrease in size, a further benefit of integrated liquid cooling is the fact that filter losses can be transferred to the cooling liquid. Usually, energy lost in the form of heat has to be reduced to a minimum in converters. Losses in LC-part and LCL-part typically amount to 0.2 - 0.65% and 0.5 - 0.8% of the throughput power, respectively. In general, the losses that occur in filters are core and winding losses.

Winding losses consist of both DC losses and additional high-frequency losses caused by skin and proximity effects in the windings. Additional high-frequency losses can be reduced to a minimum by way of novel winding concepts and careful design optimization. Core losses generally consist of load and switching frequency component losses in the core material and can be minimized through suitable material selection and careful design optimization. In Nidecon filters, the core is far smaller than in conventional filters owing to the aforementioned stacked winding system.

As power silicon improves, it becomes increasingly attractive for use in higher switching frequency converter applications. In conventional filters the losses increase as the switching frequency goes up. The new filter concept, in contrast, has reduced losses at higher frequencies. To some extent, the trend towards increased switching frequencies in power converters has been hindered by the limits posed by higher switching frequency operation of traditional choke technology.

With conventional filters, high throughput power and loss densities may easily lead to high temperature rises inside the components. The intention is to use liquid cooled filters to capture these losses in the liquid. The problem, however, is that typically only 60% of the losses will be transferred to the liquid, while the remaining 40% is transferred to the cabinet air. For this reason, additional cooling means are needed for the cabinet air and the power converter suffers derating at high ambient conditions. By using novel integrated liquid cooling concepts, 90 – 95% of losses can be transferred to the liquid, which means that heat convection to the cabinet is kept to a minimum. The resultant lower temperature increases filter lifetime and improves reliability. Lower temperatures also result in increased lifetime for insulating materials and reduce insulation hotspots. Typically Nidecon filters are in class F. Nidecon's innovative cooling concepts enable the use of filters in places where temperatures need both to be controlled and to be low.

The small dimensions of the new Nidecon filter are also favourable with regard to corrosion prevention since there is less surface area that could corrode. In addition, the modular design of the Nidecon filter means that each module in itself is anti-corrosive. Thus, even if a surface does somehow start to corrode, this cannot go any deeper into the filter. Conventional filters that feature laminated cores have problems with corrosion which can penetrate along the laminate between the insulation layers. With the innovative core materials in Nidecon filters, in contrast, corrosion can be prevented.

Mechanical integration

Normally, conventional LC filters require own section inside the converter cabinet. The other common situation is that the L-part of the LC is in one stack, while the capacitors and the other L-part are fitted elsewhere in the cabinet wherever they fit best. These options require feedthroughs between the sections for the liquid cooling and the connections. In addition, more floor space is required since the cabinet needs to be larger.

Owing to the small size and flexible dimensions of Nidecon filters (LC, LCL & dUdT), they can be installed in the same stack, meaning the connections can be kept short and space saved. Their compact dimensions also mean they can be assembled inside a single converter module/cubicle. The filters can be connected to the same liquid cooling as for the converter module, meaning there is no need for feedthroughs. The result is an overall simpler solution.

The Nidecon filter dimensions are flexible thanks to the modular design concept of Nidecon filters. The filter can be fitted in the available space inside the converter cabinet. Depending on the space allocated to the filter, the filter can be designed to be assembled either horizontally or vertically. Thanks to this geometrical flexibility, the converter cabinet can be designed without having to worry about filter space requirements. By integrating Nidecon filters as a standard in Semikron power assemblies, the exact filter space requirements are known and the cabinet size can be optimized. Besides, the customer then has to factor in space for the cabinet only, not both the filter and the cabinet.

Nidecon dUdT filter integrated

liquid cooled LCL Filter

Figure 3: Nidecon filter is so compact it can be assembled into the same stack as the converter (right).

Intelligent connections

Nidecon filters are designed so that they can be fitted directly into the converter module, resulting in cost savings because the copper rails can be kept short. There is no need for complicated horizontal rails, the number of connections can be kept low, and the mechanical assembly of the rails is simpler, too. Rail insulation will be easier, too, since the rails are shorter and no feedthroughs are used. With shorter rails there will be less vibration and, consequently, less mechanical stress acting on the filter. The result of this is increased filter reliability.

A typical problem that occurs with long rails is heat build-up which is then transferred to the cabinet. With shorter rails, this heat transfer is reduced. Another advantage of shorter rails is that there is less area for harmonic currents to spread to and cause heat losses and heat transfer to the cabinet. In drive applications, harmonic currents cannot be avoided but the harm can at least be reduced to a minimum. With long rails also the parasitic components cause possible problems such as EMC noise and overvoltage spikes with fast switching currents. Smaller parasitic parameters are crucial when power density is increased. In addition, longer rails would need fans to cool them down, which would mean more space would be needed. With the compact Nidecon filter and the short connections, there will be less heat development, reduced losses for the overall system, and fewer EMC problems.

Increased reliability thanks to integration

The issues described here affect the reliability of the filter. Two separate components that are reliable on their own are not necessarily reliable when used together. Semikron and Nidecon have solved this problem by integrating the filter into the power stack. The reliability of the entire package is improved because the filter and converter are specifically designed to be used together. It is also easier for the customer to procure the whole package from one supplier, reducing the customer's responsibility and speeding up overall project time on the customer side. Since the filter is integrated into the power stack and the package performance has been tested before delivery to the customer, the customer can take the package straight to the field. The filter is already connected to the power stack, and the cabinet is easy to install in the final application: all the customer has to do is connect the input and output. Integrating the Nidecon filter into a Semikron power assembly module is the next logical development step.

Integration is also important with regard to knowledge transfer: converter designers obtain better knowledge about the ways filters can be used, and filter designers learn more about the conditions in which filters are used. IGBT modules are usually designed for certain switching frequencies. Thanks to this knowledge transfer, the power rating can be optimized more easily since there is more knowledge about how much more power can be generated before a given component reaches its maximum rating. For the customer this means an optimized package with optimized losses or temperature rise for the given load situations.

Co-operation helps expand the knowledge about the performance of the whole package, and the customer can be provided with more specific parameters for optimum package function. The losses of the inductive component alone are difficult to measure, but package losses are easier to identify. As a result, the customer gets more precise data, and Semikron can predict the need for maintenance and ultimately improve package lifetime.

The advantage of integration is that the customer gets an entire package from a one-stop supplier - a package in which the constituent components are designed specifically to work together. Finally, a standardized package comprising power stack with integrated filter also brings about efficiency gains resulting from volume production.

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Increasing IGBT Inverter Power Density

High-temperature capable and low-inductive design

Increasing the power density is a key development factor for power electronic inverter systems. On IGBT chip level the current density was increased by a factor of three in the last 22 years. Progress in the IGBT technology and the utilization of new materials like silicon carbide and gallium nitride will allow more current per mm² in the near future by improved switching performance and higher maximum operation temperature T_{VJ_MAX} . This trend leads to a higher relevance of the system inductance; that can be a limiting factor concerning the maximum switchable current.

By Klaus Vogel, Infineon Technologies AG, Warstein, Germany

Increased IGBT operation temperature

An increase of the IGBT operation temperature T_{VJ} of today's 150°C at IGBT 4 to 175°C at IGBT 5 allows increased power dissipation and a higher amount of switching current per device. This can bring inverter designs with high parasitic inductance to the limit concerning overvoltage peak and oscillations during turn-off. The occurring IGBT collector overvoltage is caused by the stray inductance L_σ and the current slope $\frac{di}{dt}$. This relation is described by the equation $\Delta U = -L_\sigma \cdot \frac{di}{dt}$. The current shape is also dependent on the applied voltage between collector and emitter. Higher voltage applied to the IGBT during turn-off causes an earlier removal of charges from the device and the tail current disappears [1]. This means that the parasitic inductance that causes an overvoltage in turn accelerates the current fall and this again causes a higher over-voltage. In addition, high $\frac{di}{dt}$ and L_σ can lead to oscillations that cause electromagnetic interference (EMI). This is a consequence of exciting a resonant circuit, consisting of the parasitic inductance in the commutation loop and the chip capacitance, by the high frequency components of current and voltage.

Increased current ratings, though, require reduced stray inductance of the commutation loop in total in order to avoid serious problems with voltage and EMI requirements. This requirement may be summarized by the simple constraint L_σ / = constant [1]. If the stray inductance can be reduced to a minimum the switching silicon can be optimized for higher turn-off speed and consequently lower turn-off energy losses. The increase of power losses at turn-on due to lower parasitic inductances [2], [3] has to be compensated with chips having faster turn-on behavior and freewheeling diodes with lower reverse recovery charge.

Low inductive and high temperature capable inverter setup

In the following chapters a new system design will be introduced and compared with a typical 3-phase system with 62mm modules, about 70nH system inductance and a power density of 8kVA/l. The reference inverter stack (6PS0400R12KE3-3F-C4V with FF450R12KE4 modules) is designed with electrolyte DC-Link capacitors, bus bar with strip line geometry and air cooled heat sink. All devices are interconnected with screws; at this point the strip line geometry is interrupted.

The optimum way to reduce the system inductance as much as possible is to keep a strip line structure in the whole system of capacitors, bus bar and module [1]. This is unfortunately not possible with today`s usual devices due to intersectional screw connections caused by the interfaces between the capacitors respectively the power modules and the DC bus bar. These interruptions result in segments with geometry like two-wire connectors and lead to a dominating effect regarding the inductance. For this study a new system design with prototype devices has been designed and the benefits have been evaluated.

The newly developed power module [1] follows the strip line concept, using the principle of a laminar layout and multiple connection points in an interleaved structure to minimize the total system inductance. To contact the module, the proven PressFIT technology [4] of Infineon was used. Arranging pins in a line-wise way allows a very low-inductive and low-resistive connection to the rest of the system. Furthermore this technology has an advantage at high temperature cycling application regarding lifetime compared to solder joint technique [4]. To work with IGBT 5 at T_{VJ_MAX} of 175°C without lifetime restriction the prototype module is based on Infineon`s new .XT technology [5] [6] [7].

Following the idea of avoiding bolt connections [1] a prototype DC-Link capacitor in power capacitor chip (PCC) [8], [9] concept with Infineon`s PressFIT contact has been provided by the company Epcos. The PCC concept has a very low equivalent series inductance (ESL) and low equivalent series resistance (ESR) allowing a high capacitor current per volume. Due to the high voltage capability [8] no series connection of capacitors is necessary. Furthermore this type of device is improved regarding maximum ambient temperature and lifetime compared to electrolyte technology [8], [9].

To interconnect the above mentioned devices a high current PCB with a maximum operation temperature of 150°C and 800µm copper per pole was chosen. This allows a continuous strip line design in the whole power electronic system.

The IGBT driver circuit is positioned mechanically decoupled from the power part of the stack. Converting the study in [5], that evaluated the consequence of an operation at T_{VJ} of 175°, to the worst case ambient temperature of the reference stack a maximum temperature of 90°C on the PCB is expected. Infineon's IGBT driver

2ED020I12FA allows a maximum ambient temperature of 125°C and was chosen to control the IGBTs.

Figure 1 shows the module prototype and the whole inverter system.

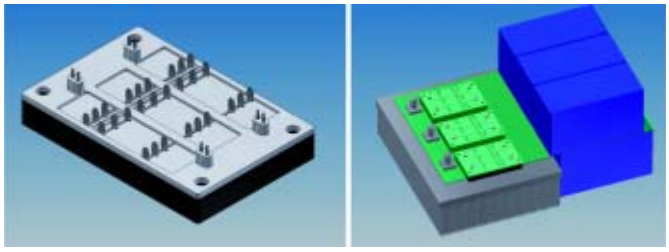
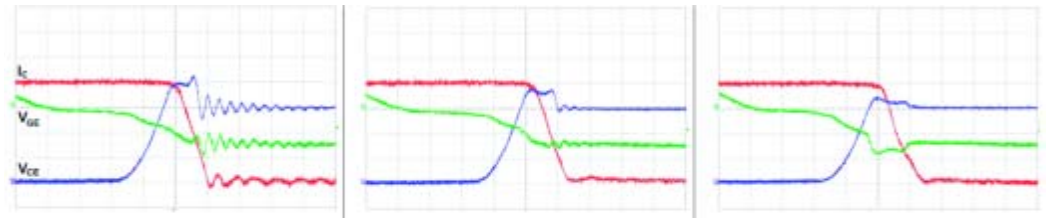


Figure 1: Left side, low inductive IGBT half bridge module prototype with press-fit connections. Right side, B6 inverter system design with low inductive modules and PCC capacitors, connected via a high current PCB using multiple press fit contacts.

Overall, all measures result in a system inductance below 10nH, about 60nH lower than the reference stack. The effect in the turn-off behavior using fast IGBT 3 1200V chips at nominal conditions by different stray inductance values can be seen in figure 2.

Figure 2a depicts the switching behavior of a FF400R12KT3, a 62mm module with IGBT3 fast technology. It is visible, that with a stray inductance of 70nH the fast IGBT3 chip tends to oscillate. The overvoltage is 280V. By reducing the stray inductance to 35nH – figure 2b – respectively with the new low-inductive module to 10nH – figure 2c - the overvoltage is reduced down to 160V respectively 80V. No oscillation occurs in the 10nH setup. The current falls with softer tail due to the lower overvoltage compared to the system with higher inductance.
This low-inductive setup allows the use of faster switching IGBT 5 with higher current carrying capability and reduced power losses.



a) 62mm module in standard setup; in total 70nH.

b) 62mm module in low- inductive setup; in total 35nH.

c) low-inductive module in low-inductive setup; in total below 10nH.

Figure 2: Different switching behavior by different parasitic inductance (blue = V_{CE} [200V/div.], green = V_{GE} [10V/div.], red = I_C [100A/div.]; [100ns/div])

Increased inverter output power

Having reduced the system's commutation inductance to a value of less than 10nH, increased current and power densities enabled by increased junction temperatures may easily be handled. Moreover, even fast switching devices comprising reduced power losses may be implemented without coming into trouble with overvoltage and softness restrictions.

An oscilloscope picture of the turn-off event at 1200A - two times the module nominal current - and increased DC-Link voltage of 800V in the low inductive system is depicted in figure 3.

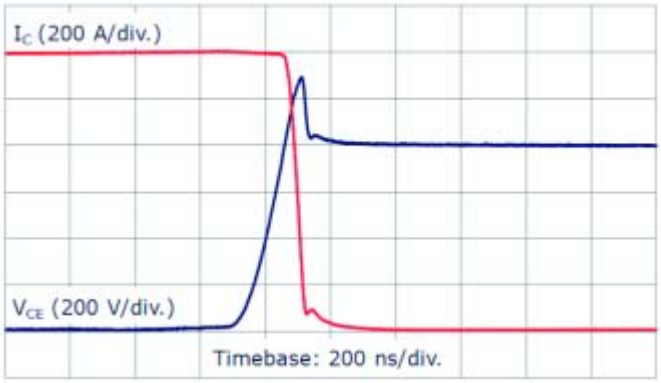


Figure 3: Fast IGBT 5 turn-off at 1200A - two times module nominal current - and 800V DC-Link voltage

It is visible that the fast IGBT 5 at overload condition has still enough tail current, the overvoltage peak has a value of 1090V and no oscillation is visible. A further optimization step on the chip design regarding lower tail current and consequently lower turn off losses is possible.

Figure 4 shows a comparison of the relation between IGBT junction temperatures and output current of the reference stack with IGBT E3 and E4 versus the low inductive prototype with fast IGBT 5 chips and T_{vj_max} of 175°C.

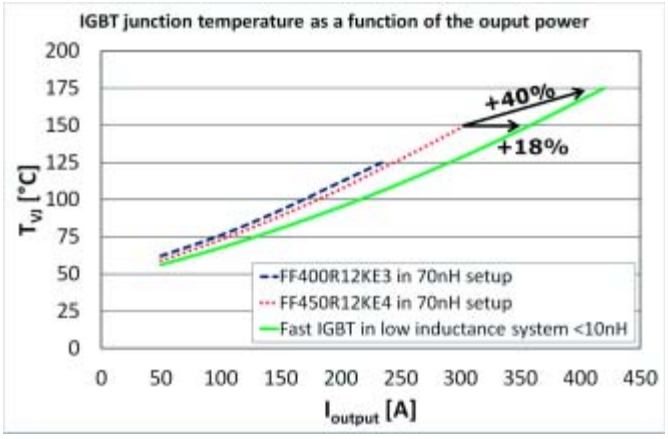


Figure 4: Relation between IGBT junction temperatures and stack inverter output current at different chip technologies and system inductance

It is clear that the new design allows an increase of the output current by 18% as compared to IGBT 4 at TVJ 150°C. The increase of the maximum junction temperature to 175°C result in 40% more current as compared to IGBT 4. The low inductive and high temperature capable stack converter achieved a power density of about 14kVA/l.

Beside this, care must be taken regarding the temperature raise seen at other system components to guarantee that the frequency inverter`s lifetime does not suffer from an elevated temperature.

Conclusion

The increase of the maximum operation temperature leads to higher current capability per chip area. This can bring inverter designs with high parasitic inductance to the limit concerning overvoltage peak and oscillations during turn-off. The application of fast IGBT chips at higher current is only possible with low-inductive module and system design. This is a door opener and requirement for the application of other fast chips like SiC JFET with reduced electrical magnetic interference and lower overvoltage peaks.

The study shows that the usage of chips with optimized energy losses and higher operation temperature resulted in circa 50% higher power density compared to a reference stack with today's state of the art technology. An advance step is possible through further tuning of the IGBT chip design or usage of new die technologies.

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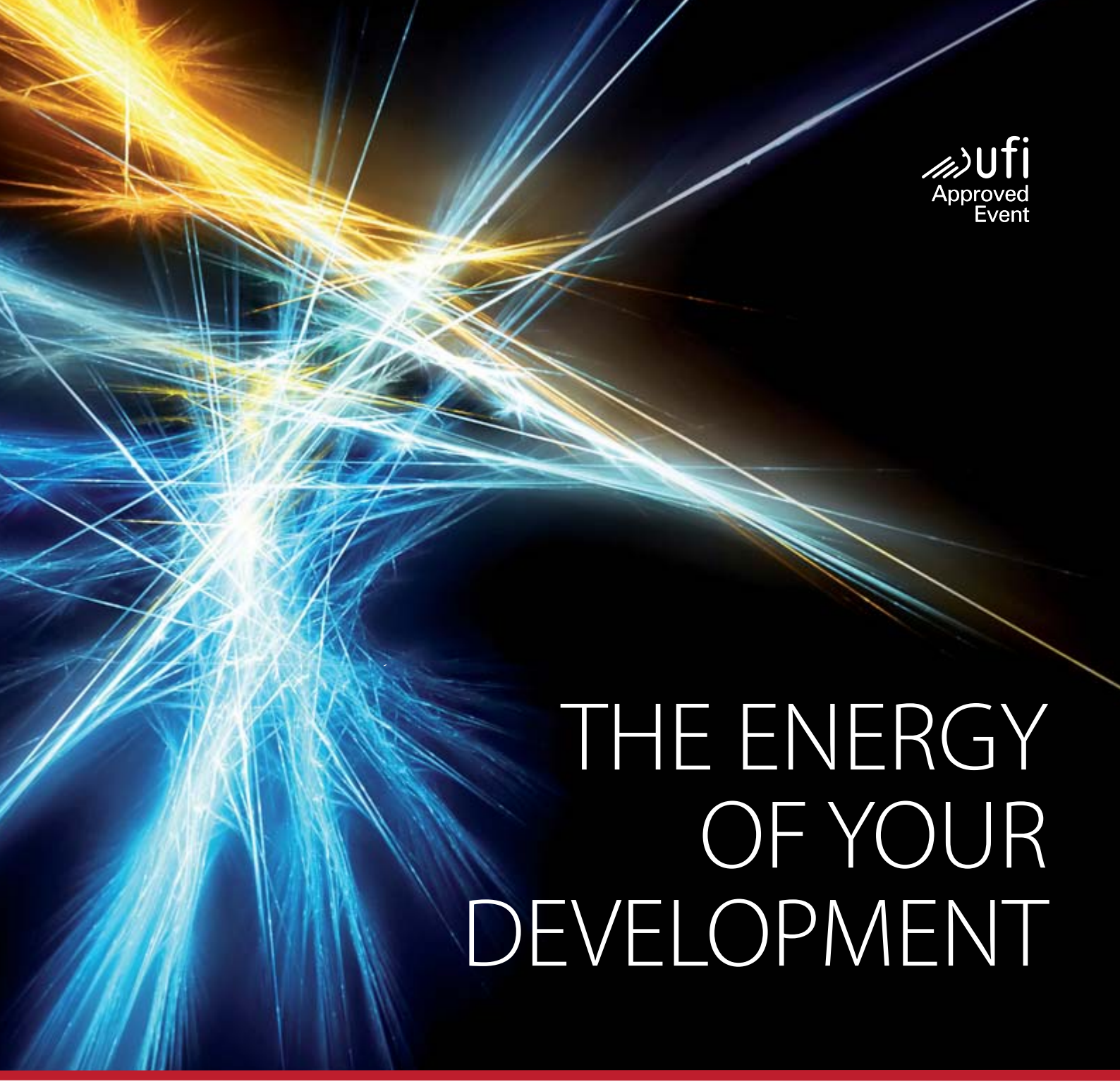

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Fast Acting Fuse for Semiconductor Protection

Protect IGBT, IEGT, IGCT for drives as well as large diode and thyristor

With the birth of semiconductor in the 50´s and their use in power converters the need of protection with fuse came along. Fuses for the protection of semiconductor, known as semiconductor fuse, have grown in demand and performances. Applied for diode and thyristor protection in the early age of power electronics, new fuses have been developed and are currently in service for the protection all power semiconductors like IGBT, IEGT, IGCT for drive application as well as large diode and thyristors for very high current rectifier applications. The goal of this article is to introduce to all readers the fuse basic performances and features.

By Jean-François de Palma, Power Electronics Specification Engineering Manager, Mersen PE Newburyport, MA, USA

Introduction to fuse

Like power semiconductor devices, fuses are technical devices back-up by years of development and testing. When selecting semiconductor fuse, one will have to answer opposite deliverables. We want, during normal operation, low watts, unlimited life time expectancy, low body and terminal temperatures, of course low cost but we also need the fuse to operate as fast as possible, with the minimum let through energy and arc voltage when everything else have failed. As well, power semiconductor fuses are designed to meet a given set of performances specified by international standards like UL, CSA and IEC 60269-4, like body and terminal temperatures rise, arc voltage … as well as customer application requirements, energy let thru by the fuse, commonly known as I2t, life cycle expectancy, connection, fuse operation indicators etc. Many of these fuse performance requirements conflict with each other. Nevertheless new fuse designs as well as new manufacturing processes have helped resolved these conflicting requirements. Furthermore, new simulation tools in addition to Mersen specification field engineers have shorten the fuse selection for demanding power electronic applications like drives and rectifiers.

Basic fuse design technology

A typical semiconductor fuse consists of one or more silver or copper or thrulay (series of silver and copper in a same fuse element) elements enclosed by a fuse body. The elements are either welded or soldered to the fuse contacts/ terminal. The figure 1 depicts a typical fuse technology valid for round or square body designs. The element will be typically surrounded by silica sand commonly called filler. The sand plays a major role in fuse performances. It quenches the arc by absorbing the energy during arcing time and it serves as fuse element cooler during normal operation. The sand conducts the heat away from the element, through the fuse body and to the medium surrounding the fuse. Short fuse will transfer heat more thru the terminal. Long fuse will transfer heat through fuse body. The fuse "savoir faire" is how well you manage the fuse element thermal equilibrium. Running element hot will make the fuse fast to open but subject to premature opening. Running the element at lower temperature will lead a long lasting fuse but when needed, will it protect? Fortunately, we current rate fuses to give the best trade off between clearing, operation and cycle performances.

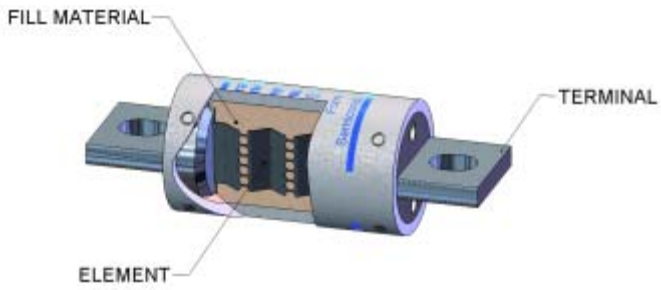

Figure 1: The numbers of notches in series will define the fuse operating voltage and the total cross section of paralleled element will define the rating of the fuse

Basic fuse performances

The fuse is a calibrated current carrying device designed to open under specific conditions. In the figure 1, note the reduced cross-section areas in the element, also called notches. The numbers of notches in series will define the fuse operating voltage and the total cross section of paralleled element will define the rating of the fuse. The element material, mass and notch configuration, along with the surrounding materials, all contribute to the fuse performance. Reduced section path for the current will lead to higher current density thus to higher heat generated at the notches. The total notches cross section will define the pre-arcing I2t needed to melt the fuse element, in

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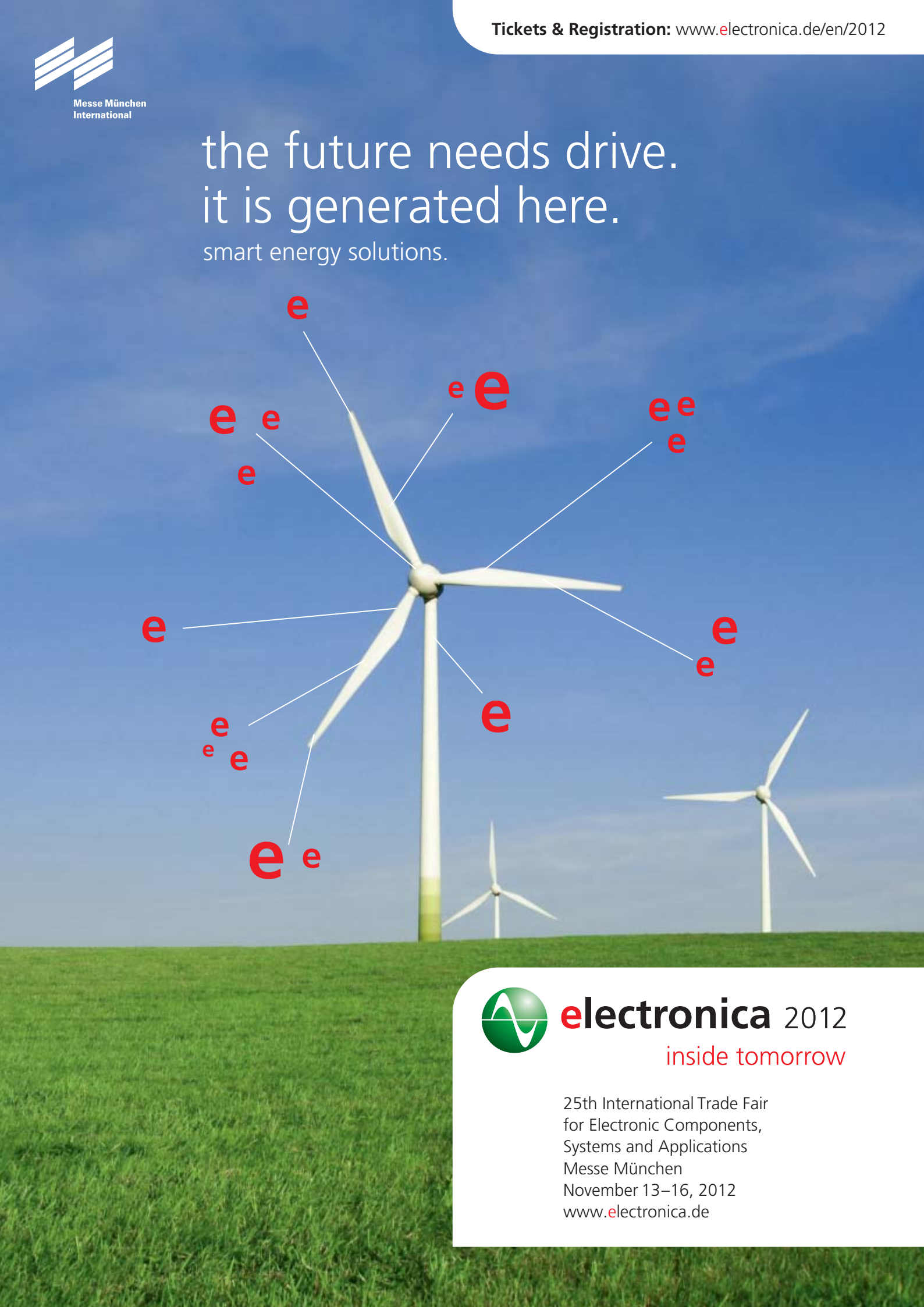

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another word the energy you need to deliver to the fuse to melt the reduced section path. Under sustained over-current, the fuse element generates heat at a faster rate than the filler can conduct it away from the element. If the over-current persists, the element at the notches will reach its melting point. The fuse time current curve, figure 2, is the fuse thermal response undergoing fault current, it gives the fuse melting time versus the fault r.m.s. current. Once the end of the pre-acing time is launched you are only part way to final fuse opening.

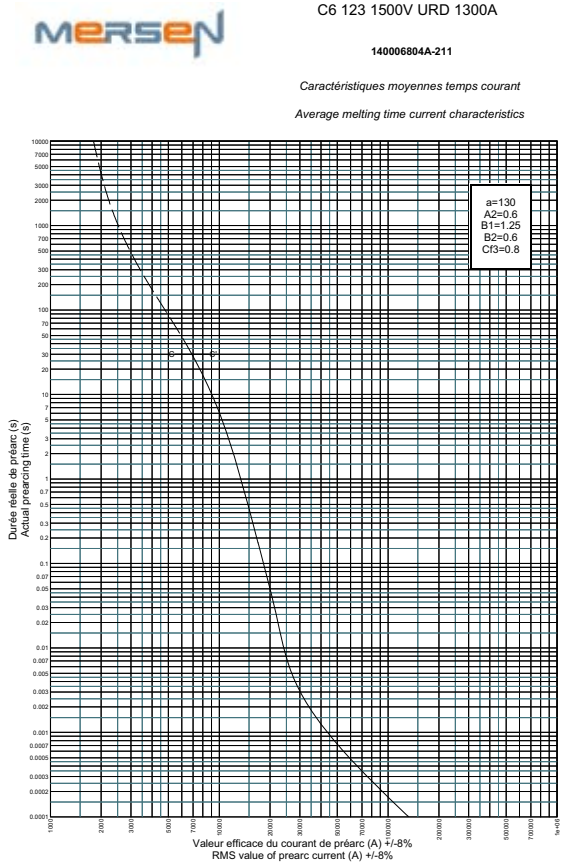

Figure 2: The fuse time current curve

Fuse I2t parameters

Once the end of the pre-arcing time is reached the fuse switches to the arcing mode. The fuse will develop an arc voltage, higher than the source voltage thus will force the current to go down to zero. This period is call the arcing time. During this period fuse will have to dissipate the energy supplied by the source as well as the energy stored in the circuit, mainly ½ LI^2. The total energy let through by the fuse, or known as total I^{2}t, is the result of the sum of the pre-arcing I^{2}t plus the arcing I^{2}t. Those values are supplied for our fast acting semiconductor fuses. The normal condition for short-circuit protection is that the total I^{2}t integral let through by the fuse when clearing the fault must be less than the I^{2}t which produces system damage. For example, for the IGBT's the appropriate value is the level of I^{2}t which causes case rupture.

Example of application

Short-circuit faults in power electronics equipment will cause excessive damage, or in worst case, explosion. Electronic protection against overloads and short-circuits is normally embedded in the new power electronic semiconductors but back-up fuse protection is still needed to ensure safety in the event of failure of these systems or the device itself.

Generic inverter circuit

Figure 3 shows the layout of a typical inverter circuit for generation of a 3-phase variable frequency supply. The capacitor bank is typically several thousands of mF, fed from a DC source. The inductance in the inverter leg can be less than 1mH. In case of semiconductors shoot through the capacitor bank will discharge thru the short circuit path and generate a large fault current that will be cleared by fuses. Alternative locations for the fuses are shown at F1 and F2. Location F1 is the preferred option as the r.m.s. current is lower. This permits smaller current rated fuse size to be used leading to a faster operating protection. However in many circumstances location F2, which requires fewer fuses, may also be satisfactory.

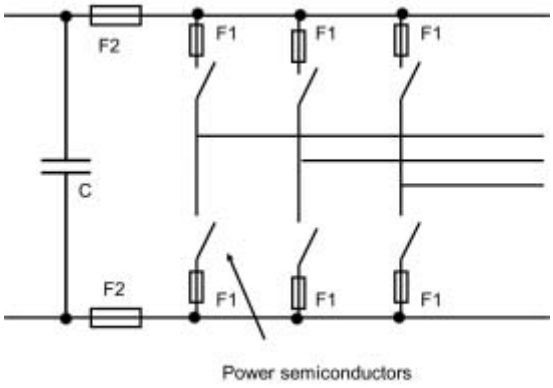

Figure 3: Typical inverter circuit for generation of a 3-phase variable frequency supply

Figure 4: Semiconductor fuses rated at 10kV - 1000 A with low inductance

High voltage semiconductor fuse

Increase of voltage for IGCT and IEGT protection, demand for lower I^{2}t for IGBT protection and large rectifier protection have lead to new rating and new fuse performances. It is not rare anymore to see semiconductor fuses rated at 10kV - 1000 A with low inductance see in figure 4. Fault simulation will help to calculate the melting duration, and will give the total I^{2}t to be compared with the semiconductor housing I^{2}t. If needed for demanding applications our capacitor discharge lab will backup simulation/calculation by true testing. Also Mersen high power AC lab can be used to determine the semiconductor true housing I^{2}t value.

Conclusion

Cost is always a driving factor when selecting a fuse but what is a fuse cost versus containing the fault inside the semiconductor instead of spreading it throughout the entire inverter with the catastrophic risk of explosion. This article has introduced too briefly the semiconductor fuse and much more needs to be shared. I invite all readers to know and understand fuses better. I would like to thanks Cindy, Jean-Louis and Kevin that have contributed to the making of this article.

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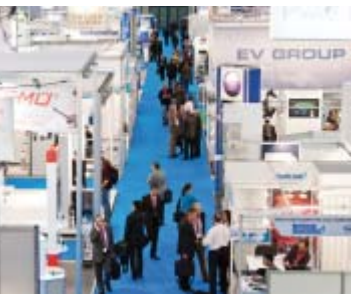

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SuperFET® II a Super-Junction MOSFET that Provides Low EMI

Stable Operation with Excellent Noise Reduction in PFC Applications

Super-Junction MOSFET based on charge balanced technology offer outstanding performance with respect to reduce both on-resistance and parasitic capacitances, which usually are in trade-off. With smaller parasitic capacitances, the super-junction MOSFETs have extremely fast switching characteristics and therefore reduced switching losses.

By Wonsuk Choi and Dongkook Son, Fairchild Korea Semiconductor, HV PCIA PSS Team Bucheon-si Republic of Korea, Application Engineering, E-mail : wonsuk.choi@fairchildsemi.com

Naturally this switching behavior occurs with extremely high dv/dt and di/dt that affect switching performance via parasitic components in devices and printed circuit board. Especially, for super junction MOSFET used in high frequency modern SMPS, it is very difficult to suppress frequency noise and radiated EMI to simultaneously achieve both high switching efficiency and low switching noise. Furthermore, switching noise can lead to some unexpected system or device failures associated with gate oxide breakdown, breakdown dv/dt and latch-up problems in control signal due to severe gate oscillation and high switching dv/dt in various abnormal conditions such as start-up state, overload condition and paralleled operations. To achieve low switching noise, high values of parasitic capacitances or gate resistances are required. Based on recent system trends, improving efficiency is a critical goal; however, using a slow switching device just for reduction of switching noise is not an optimal solution. New generation super-junction MOSFET, SuperFET® II device enables fast switching and low switching noise to achieve high efficiency and low EMI in applications thank to optimized design of SuperFET® II MOSFET.

SuperFET® II MOSFET Technology

It is well known high switching speed of super junction MOSFET is naturally good to reduce the switching losses, but it will give negative effects such as increased EMI, gate oscillation, high peak drain-source voltage on application. One critical control parameter in gate-drive design is the external series gate resistor (R_g). This is dampens down the peak drain-source voltage and prevents gate ringing caused by lead inductance and parasitic capacitances of the power MOSFET. It also slows down the rate of rise of the voltage (dv/dt) and current (di/dt) during the turn-on and turn-off process. But R_g also affects the switching losses in MOSFETs. Controlling these losses is important as devices must achieve the highest efficiency on the target application. Therefore from an application standpoint, selecting the correct value for R_g is very important. SuperFET® II MOSFET employ integrated gate resistor, which is not ESR (equivalent series resistor) but is gate resistor, placed in gate pad, to reduce gate oscillation and control switching dv/dt and di/dt under high current conditions. The value of integrated gate resistance is optimized with gate charge. The gate oscillation of V_{GS}, (V_b) in actual gate of the device is dramatically reduced because voltage drop across gate-source is divided by internal R_g and external R_g. The reverse transfer capacitance, C_{gd} is one of the major parameters affecting voltage rise and fall times during switching. C_{gd} provides a negative feedback effect from the drain voltage, and it must be discharged by the gate drive current supplied through R_g. The oscillations are related to several causes such as high switching dv/dt and di/dt, parasitic C_{gd} and the value of the drain current. The gate charge of SuperFET® II MOSFET is optimized to improve trade-off between switching efficiency and switching noise. Figure 1. shows actual MOSFET dv/dt comparing the fast SJ MOSFETs and SuperFET® II MOSFET during turn-off transient in PFC circuit from 100W to 400W under same driving condition. The linear rise of turn-off dv/dt the fast super junction MOSFET shows that the dv/dt cannot be controlled in the PFC circuit with small gate resistance (3.3Ohm). SuperFET® II MOSFET has reduced increase of turn-off dv/dt compared to the fast super junction MOSFET, but still it is linearly increased under 300W load condition. At full load condition, dv/dt is controlled at 36V/ns which is reduced dv/dt about 30.8%, compared to the fast super junction MOSFET.

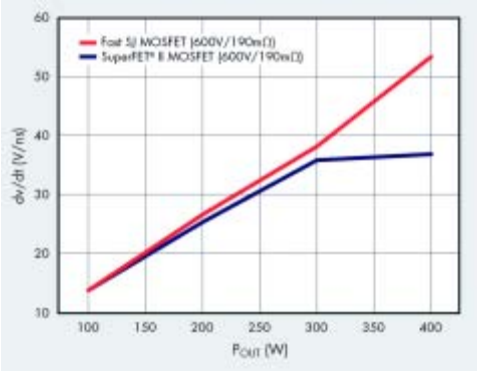

Figure 1: Comparisons of measured dv/dt between the fast SJ MOSFETs and SuperFET® II MOSFET during turn-off transient in PFC circuit (V_{IN}=100V_{ac}, P_O=400W, R_g=3.3Ohm)

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Parasitic Oscillation Mechanism of Super-junction MOSFET

C_{oss} curve of super-junction MOSFET is highly non-linear. These effects will allow an extremely fast dv/dt and di/dt and voltage and current oscillation when super-junction MOSFETs are used as a switching device for PFC or DC/DC converters. Figure 2 shows observed oscillation waveforms in PFC circuit during turn-off transient of super-junction MOSFET. From a general perspective, there are several oscillation circuits which affect the switching behavior of the MOSFET this includes internal and external oscillation circuits. Figure 3 shows a simplified schematic of PFC circuit including both internal parasitics which is given by the parasitic capacitances C_{gs}, $C_{gd\_int.}$ and C_{ds} and parasitic inductances, L_{g1}, L_{d1} and L_{s1} of the Power MOSFET itself and also an external oscillation circuits which is given by the external couple capacitance $C_{gd\_ext.}$ and parasitic inductances, L_G, L_D and L_S of the board layout. Parasitic components are involving switching characteristics more as the switching speed is getting faster. Gate parasitic oscillation occurs in a resonant circuit by internal and external gate-drain capacitance, $C_{gd\_int.}$ and $C_{gd\_ext.}$ and gate inductance, L_{g1} and L_G, when MOSFET is turned on and off. Oscillation voltage in drain-source of the MOSFET passes through gate-drain capacitance, C_{gd} due to parasitic inductance, L_D when MOSFET switching is getting fast, and particularly when it is turned off, and a resonant circuit with gate inductance L_{g1} and L_G is formed. As gate resistor is extremely small, oscillation circuit, Q ($\sqrt{L/C}/R$) becomes large, and when the resonance condition occurs, a large oscillation voltage is generated between that point and C_{gd} or L_G, L_{g1}, and parasitic oscillation is caused. Furthermore, the voltage drop across L_S and L_{s1}, which can be represented by equation (1), was cause by negative drain current in turn-off transient. This voltage drop across stray source inductances, L_S and L_{s1}, generates oscillation in gate-source voltage. The parasitic oscillation can cause severe EMI problem, large switching losses, gate-source breakdown, losing gate control and can even lead to MOSFET failures.

$$\Delta V_{GS} = (L_S + L_{sl}) \cdot \frac{di_d(t)}{dt}$$

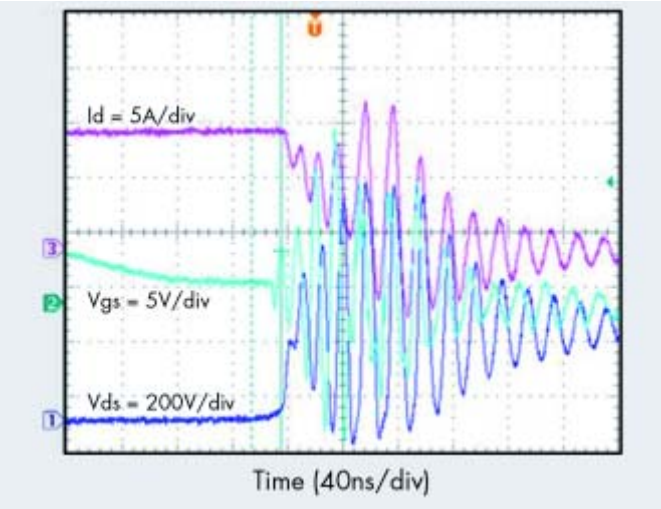


Figure 2: Severe oscillation waveforms in PFC circuit using super-junction MOSFET

Application Benefits of SuperFET® II MOSFET

Experiment results verify the stable operation of SuperFET® II MOSFET and better EMI results in PFC circuit. The measurement were done in a PFC boost stage at the same input voltage, V_{IN}=110V_{AC} and output power level, P_{out}=300W during AC on/off test. Figure 4 present waveforms comparing difference in gate oscillations, V_{GS} (yellow line) at start up between the fast super-junction MOSFET and SuperFET® II MOSFET. With fast super-junction MOSFET, high peak gate oscillation, exceeding 45V, is generated. It causes a over voltage latch-up. Finally, it leads to absent of gate signal of power MOSFET as shown in figure 4 (a). A peak Vcc voltage is greatly reduce dup to 16V and latch-up problem is removed with SuperFET® II MOSFET as shown in figure 4 (b). This oscillation effect can be forced if the output power level is increased or the input voltage is decreased at the same output power. This effect can also happen after an AC line drop out, when line voltage is back, the boost stage charge up the bulk capacitor to nominal voltage. During this time, when the MOSFET turns off, the drain current is quite high. The drain current commutates to the output capacitance, C_{oss} of the MOSFET and charges it up to DC bus voltage. The voltage slope is proportional to the load current, and inversely proportional to the value of the output capacitance. The high dv/dt values lead to capacitive displacement currents due to all the parasitic capacitances around. Together with all the layout and parasitic inductance and capacitances an LC oscillation circuit is created only damped by the internal R_g. Under certain conditions e.g. transient at input voltage or shortcut conditions high di/dt and dv/dt occur, and this leads to unusual switching behavior or worst case damaged devices. Nevertheless, with optimized SuperFET® II MOSFET helps to improve efficiency and also stable operation.

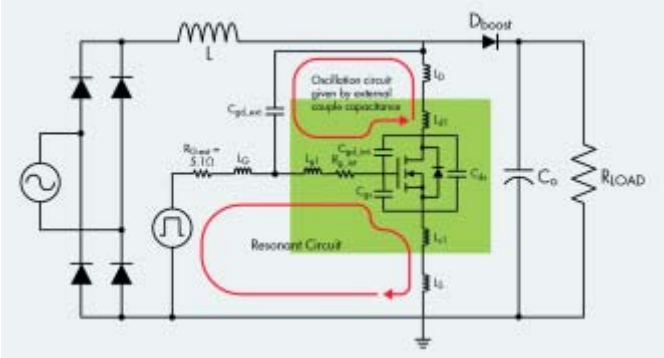


Figure 3: Simplified schematic of PFC circuit with internal and external parasitics of Power MOSFET

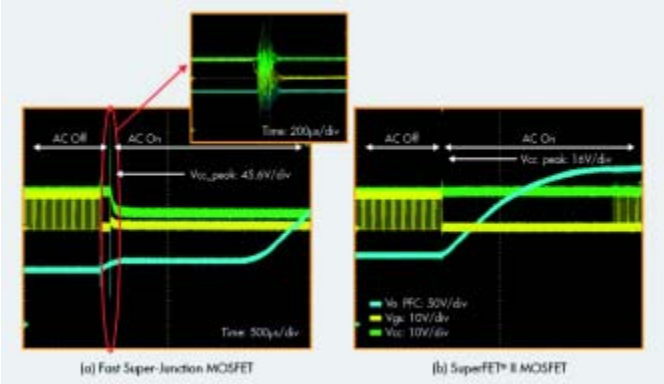
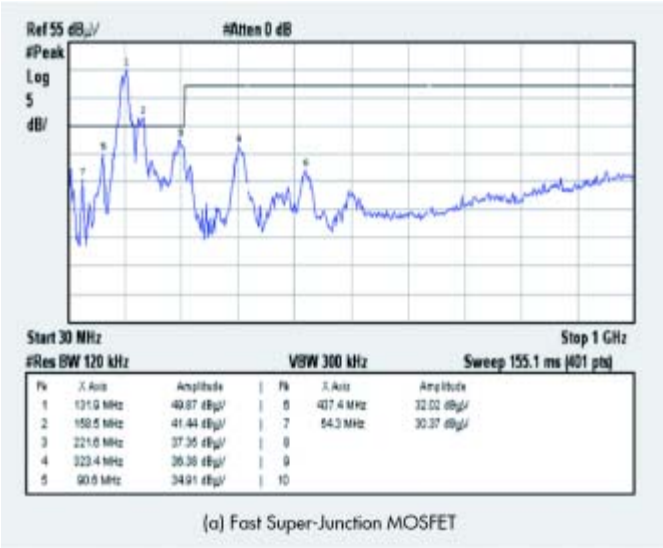


Figure 4: Comparisons of waveforms during start-up state in PFC circuit (V_{IN}=110V_{AC}, P_{OUT}=300W, V_O=380V, 600V/190mOhm SJ MOSFET) (left) The fast super-junction MOSFET (right) SuperFET® II MOSFET

EMI performance of SuperFET® II MOSFET is verified in 400W ATX power supply. Figure 4 show the measured results of radiated EMI noise between the fast super-junction MOSFET and SuperFET® II MOSFET as a PFC switches. SuperFET® II MOSFET can reduce peak drain-source voltage, peak dv/dt and gate oscillation due to soft switching characteristics of SuperFET® II MOSFET. By using SuperFET® II MOSFET, emission level (dBμV) becomes lower in the fre-

quency range from 90MHz to 160MHz. Especially, emission level of SuperFET® II MOSFET is up to 9~10 dBμV lower at 130MHz, compared to the fast super-junction MOSFET as shown in figure 4 (right).



(a) Fast Super-Junction MOSFET

Figure 5: Measured Radiated EMI in ATX Power supply at V_{IN}=110V_{ac}, P_o=400W.
(a) The fast super-junction MOSFET, (b) SuperFET® II MOSFET

Conclusion

As technology of power MOSFET grew more advanced, super-junction MOSFET lead to smaller chip size but more efficient performances. Extremely fast switching super-junction MOSFET is essential choice for higher efficiency but it is not easy to control than previous generations. New super-junction MOSFET, SuperFET® II MOSFETs that optimize switching performance enable to reduce gate oscillation, EMI noise and improved stable operation in high current operation, such as startup up or over load conditions while maximizing switching performances.

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The Time Has Come

Piezoelectric MEMS Oscillators for Industrial Frequency Control

An accurate oscillator lies at the ticking heart of all digital electronics, from consumer multimedia products to industrial automation and monitoring systems, networking and communications infrastructure, and rugged military equipment. Historically, engineers have exploited the resonant properties of quartz to support accurate timing. Unrelenting pressure to increase reliability and performance, smaller dimensions and power consumption, and speed up of logistics are driving timing specialists to develop new materials and technologies.

By Harmeet Bhugra, Integrated Device Technology, Inc.

Piezoelectric MEMS (pMEMS) resonators and oscillators are part of an emerging generation of silicon-based frequency-control devices that deliver a number of advantages such as semiconductor-grade shock and vibration resistance. In addition, semiconductor feature sizes enable large numbers of devices to be fabricated simultaneously on a single wafer, delivering economies of scale. Also, the devices can be housed in low-cost plastic packages, taking advantage of semiconductor-scale integration targeting smaller package footprints providing the opportunity for board-space savings and ongoing miniaturisation. To address oscillator challenges IDT developed ultra-small CrystalFree™ resonators in tiny wafer-level packages (figure 1).

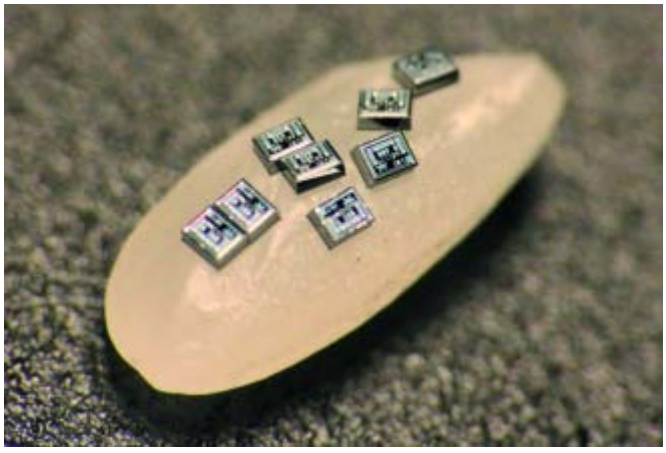

Figure 1: Miniaturised pMEMS resonators combine enhanced reliability and cost-effectiveness with the benefit of passive operation requiring no power source.

Other advantages of pMEMS oscillators include natural compatibility with surface-mount assembly processes and short lead times; this enables suppliers and users (electronic manufacturers) to hold smaller device inventory with reduced risk of supply shortages. As with a quartz crystal, the pMEMS resonator requires no power source, but also has lower insertion losses. In addition, the MEMS resonators do not suffer from activity dips that can impair the reliability of quartz-based devices.

The performance of commercial MEMS oscillators has been advancing steadily over several product generations, moving closer to that of traditional quartz-based devices. The market for the devices - initially driven by small startups, according to IHS iSuppli - is expected to move into a higher gear as established timing companies such as IDT apply greater development resources to further improve performance and extend functionality by improving the design of the oscillator chip. iSuppli's director and principle analyst for MEMS and sensors, Jérémie Bouchaud, has predicted that MEMS oscillators will increase their share of the $4 billion frequency-control market from its relatively low base of $13.5 million in 2010 to $205 million in 2015. This corresponds to a compound annual growth rate (CAGR) of 72.3%.

With the introduction of its 4M series of oscillators in May 2012, IDT introduced the world's first pMEMS oscillators to deliver frequency accuracy and jitter performance needed for high-performance communications, consumer, cloud computing, and industrial applications.

In the design of pMEMS resonators for the 4M series, IDT has combined the strong electro-mechanical coupling of a piezoelectric material with the stability and low damping of single-crystal silicon to create a convenient and cost-effective oscillator family offering high reliability and performance levels. Figure 2 shows a simplified functional block diagram of the 4M MEMS oscillator.

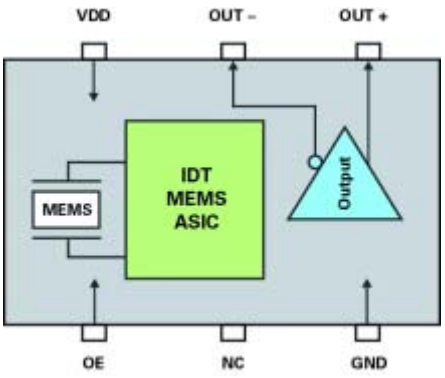

Figure 2: The latest pMEMS oscillators such as the 4M series deliver improved performance and feature integration.

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Jitter performance of sub-ps jitter for the 4M oscillators is comparable with typical crystal oscillators, and frequency accuracy is within ±50ppm. The devices support low-voltage differential signalling (LVDS) and low-voltage positive emitter-coupled logic (LVPECL) at frequencies of up to 625MHz, meeting the stringent requirements of most communications, networking and high-performance computing applications. The oscillator operates from a supply voltage in the range 2.5V to 3.3V. Specified aging stability of ±5ppm makes the devices suitable for use in application areas such as telecom and Internet infrastructure.

The inherent properties of pMEMS technology also allows for higher native resonant frequencies than traditional quartz-based devices, enabling these oscillators to provide higher performance at a competitive price without sacrificing critical specifications. Taking advantage of the small die size and wafer-level packaging, 4M series devices are available in a smaller 5mm x 3.2mm (5032) plastic package, and also offer the choice of a 7mm x 5mm (7050) variant matching the established quartz-crystal form factor.

An oscillator evaluation board (figure 3) helps engineers start new designs and quickly understand how to achieve the best performance from this new type of device.

Figure 3: An evaluation board assists design with 4M series pMEMS oscillators.

IDT also offers pMEMS clock generators such as its CrystalFree™5V series, which combines pMEMS oscillator technology and phase-locked-loop (PLL) techniques to generate high-quality clock frequencies for consumer, computing and embedded applications. By integrating pMEMS technology, these devices eliminate the need for an additional external frequency source, thereby helping improve reliability, reduction in board space and lower system cost. In fact, pMEMS technology enables many novel functions to be integrated in the same package, such as a clock multiplier or divider or a multiple-output configuration.

A further benefit of pMEMS technology is that the oscillator output frequency can be programmed rapidly before the device leaves the factory, with no need for time-consuming or costly fine-tuning. This enables suppliers such as IDT to offer custom frequencies at a competitive price, even at low minimum-order quantities.

Robust Industrial Frequency Control

With the most recent improvements in MEMS oscillators, as seen in the 4M pMEMS family, the technology is now ready to deliver the levels of accuracy and stability needed for precision industrial applications. With changes in the industrial electronics sector, such as widespread adoption of handheld devices offering greater flexibility for workers and helping increase productivity, the high resistance to shock and vibration inherent in pMEMS oscillators is topical and interesting to equipment designers.

Standard quartz devices, in which the crystal is clip-mounted within a metal housing, are regarded as fragile components. A shock of around 50-100g is capable of fracturing the crystal; thus the crystal manufacturers publish storage, packing and shipping guidelines for crystal components that stipulate avoidance of careless handling such as dropping or throwing containers or assemblies, or using excessive force when inserting the components into assemblies.

Crystal manufacturers have developed high-shock products that offer significantly increased resistance to mechanical stresses. Among the techniques employed, minimising the dimensions of the crystal and the size of features such as tuning fork tines effectively reduces mass and internal shear forces. In addition, improvements to mountings and ceramic package technology make further contributions to improving survivability. Today's high-shock crystals are able to survive impacts significantly over 10,000g, with the best achieving over 100,000g for use in extremely demanding military applications.

In contrast, MEMS oscillators offering semiconductor-grade robustness provide high shock resistance in the order of 50,000g without recourse to special construction or packaging techniques. This provides designers with an economical yet robust timing solution, offering long-term reliability in numerous equipment types such as drives for heavy-duty drilling or cutting equipment, motion controls, electronics in transportation systems such as rail traction drives or brake controllers. Designers of automotive electronics, also, can take advantage of the high mechanical robustness offered by pMEMS devices to build modules capable of withstanding continuous high levels of vibration experienced even during normal use by the vehicle owner.

Conclusion

Overall, sub-ps jitter pMEMS oscillators are delivering greater freedom of choice for designers and driving the pace of progress towards smaller, more accurate, competitively priced timing solutions. Ultimately this will allow designers to specify the exact type of device that best suits the end application; choosing from crystal oscillators, CMOS silicon-based oscillators, or piezoelectric MEMS devices to satisfy requirements such as cost, frequency, accuracy, stability, mechanical resilience, size, power consumption and availability.

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Negative Input Resistance and RMS Input Currents

The often unrecognized plagues of dc/dc converters

Many SMPS designers and users of modules will have been puzzled by mysterious wild oscillations and bewildered by their resistance to changes in the regulation loop. DC/DC converters suffer from negative input resistance which can cause wild oscillations and overstressing of components, especially in conjunction with input filters. Also, the high rms input currents of many configurations are often overlooked. These facts are obviously widely unknown.

By Dr.-Ing. Artur Seibt, Vienna

Lately, in several one-day „Seminars“ about dc/dc converters, the speakers made some factually wrong statements revealing they had no notion of the existence of negative input resistance and high rms input currents. Neither during the presentations nor in the texts handed out both were mentioned. The converter input was disregarded, the choice of the capacitors arbitrary, the screen shots of the software tools lacked input parameters. This triggered a survey of seminar papers, data sheets, application notes and hundreds of magazine articles about converters from today to several decades back which yielded only 2 articles of 74 und 78 about NIR! Obviously, its existence and dangers are widely unknown.

Due to the spreading use of SMPS, many engineers from other areas of electronics venture into SMPS design, grossly underestimating the complexity. These days, too many preachers dare to run seminars and write texts about SMPS design who lack expertise and practical experience. In this context, it is noteworthy that seminar and similar texts usually present an odd 30 pages about theoretical loop design without any hint that there are other reasons for instability.

Especially some semiconductor companies are trying for years to persuade customers to dive into SMPS by insinuating all that is needed is their wonder chip, some inductor and a capacitor, and bingo, there is the SMPS! Also, there is an enormous number of modules on the market, their small size and low price deceptive, as most of them require the addition of a sizeable number of components. No data sheet mentions NIR and rms currents, warns the user that he is not free to add to the input whatever he chooses. Often „input filter“ circuits are recommended which cause hefty NIR oscillations.

Professional SMPS design requires the combined and profound knowledge of DC to high frequency amplifier and regulation loop design, sampling systems, nanosecond switching and converter circuits, magnetic components and the ability to design them which also requires knowledge of ferrites, isolation and winding materials, active and passive components, e.c.board layout. A further prerequisite is proficiency in measurement technology.

Origin of NIR in dc/dc converters

By definition a positive resistance absorbs energy, a negative resistance delivers energy. The reason why NIR does not always produce wild oscillations is the prevalent use of aluminum electrolytics, at least in all higher power converters, their rather high ESR often provides enough damping. The vast number of low voltage buck converters use MLC capacitors, hence even minute stray inductances may suffice to cause oscillations, also, as will be shown, the danger rises with decreasing input voltage.

The purpose of a voltage regulator is to maintain a constant voltage across the load. Linear regulators keep the input current constant as it is identical to the output current, they present a constant-current load to the source, the input power rises linearly with increasing input voltage; the input resistance is positive; in transient situations it could become negative. Shunt regulators are constant - resistance loads, their input current rises linearly, the power with the square of the input voltage, their input resistance is positive. DC/DC converters, due to their high efficiency, nearly independent of input voltage, draw an almost constant power; this means that the input current drops with increasing input voltage.

This constitutes a negative input resistance (NIR). A general definition:
All dc/dc converters which draw constant input power for a constant load exhibit a negative input resistance resp. impedance which generates wild nonlinear oscillations unless enough damping in the input circuit is provided.

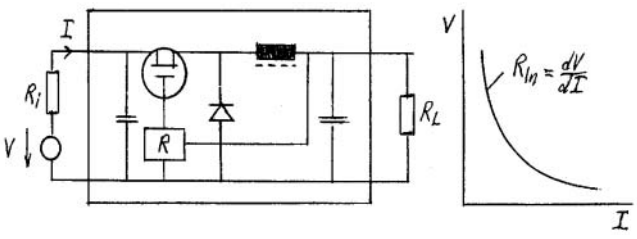

Figure 1: A buck converter with voltage regulation and an internal input capacitor.The averaged input current falls with increasing input voltage resulting in NIR.

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It is material to realize that the existence of NIR does not require an output voltage, current or power regulation loop. It is only necessary that the input power remains constant if the input voltage is changed for a constant output power. The majority of converters display NIR only if a regulation loop is present.which keeps the output power constant.

To prove the point that a loop is not necessary for NIR, consider a flyback in DCM, the output power will be $P = 1/2 \times L \times i_{peak}^2 \times f$. L and f being constant, the power depends only on the peak current with which L will be charged. If that peak current is just kept constant, this will be a constant power converter, variations of the input voltage will have no effect on the output and hence the input power, if the load is a resistor, the voltage will stay constant. This is not to be mixed up with current-mode control because there is no loop. Current-mode control incorporates a comparator fed by a current-dependent signal and the output of the voltage loop error amplifier; there are even two loops. If the charging current can be set with a potentiometer, a linear increase will cause an increase in power by the square, the voltage across a load resistor will rise linearly. This is an entirely open loop system.

For further clarification, consider a converter with a voltage regulation loop where the gain of the error amplifier can be adjusted with a potentiometer from zero to maximum. With the gain set to zero, there is no regulation, the output voltage follows the input, hence this is a constant-resistance load to the power supply, the input resistance is positive. Then the gain is set to its maximum, now this becomes a constant-power load with negative input resistance. At some finite gain, somewhere in between, the input will behave as a constant – current load, this is the point, where the input resistance will change sign; exactly at this point the input resistance will be infinity as it should be for a constant-current input. Hence the input resistance will change with increasing gain from the value of the output load towards positive infinity and come down from negative infinity to a value of negative resistance which will depend as we shall see on the input voltage and the power.

The oscillations caused by NIR have hence not necessarily something to do with the existence and operation of a voltage loop. But interactions may happen: the loop, if it is fast enough, will try to compensate for the changes in input voltage. This is best seen in a buck in CM, because the output voltage depends directly on the input voltage, any changes require a proportional change in duty cycle by the loop. The closer the resonance frequency of the input comes to the bandwidth of the loop (which must be <= 1/10 the switching frequency), the less the loop is able to compensate fast enough. The NIR changes to a negative input impedance. The interactions may become quite complex. The input resonance frequency will then also be visible inside the loop and at the output; it depends on the values of L and Co how much, as they constitute a low pass.

Many converters draw sizeable peak and rms input currents, e.g. the simple buck. With bucks, the rms current depends on the operation mode, DCM or CM, it is safe to always use the formula $I_{rms} = I_{peak} \times \sqrt{\text{Duty cycle}}$. These currents sport also very short rise and fall times, they are awkward loads for the source, so a good capacitor at the input is mandatory in the first place; but this may not suffice, so often an input LC filter is inserted. This can play havoc with the system as will be shown, this means asking for trouble! This can not only create strong wild oscillations but also overstressing of components.

Explanation of NIR

The designation „NIR“ is not well chosen because it is not – like a resistor – a real component, but it describes the behavior or the property of an operating electronic circuit; if the supply is switched off, the NIR disappears. It can be measured with suitable instruments by placing a resistor in parallel which overcompensates the NIR, by subtracting its value from the result, the value of the NIR is obtained.

NIR resp. impedance is by no means new, designers of wide band amplifiers are familiar with this effect since decades, presumably since the 30's. Any emitter follower displays a negative input impedance. This comes about because energy is fed back from the output (emitter) to the input (base) via the base-emitter capacitance, this is a simplified explanation. If there is a resonant circuit in the input, the circuit will oscillate. A capacitance is always present, hence a minute amount of conductor inductance is sufficient to produce very high frequency oscillations.. Of the 3 methods of compensation one can be used with dc/dc converters. In oscillators NIR is desired to overcompensate the losses.

In most cases, a NIR is highly undesirable because it either disturbs the operation of a circuit or renders due operation impossible. NIR means that energy is delivered, often in reverse like in this case. The notion that the input of a power supply can deliver energy may not easily come to mind, in fact NIR may be visualized as a negative current coming out of the input. The wild oscillations can easily be mistaken for regulation loop instability because almost all papers about converters know no other cause. As we shall see, the NIR is highly nonlinear, hence the oscillations are nonlinear and may only occur in certain input voltage/load configurations.

If the designer is not familiar with NIR and did not test all combinations, a SMPS design may well go into production, and the problems show up later. Testing is not enough, though, because calculations have to prove that even a worst case combination of tolerances cannot lead to oscillations.

A numeric example

NIR can best be visualized by a numeric example: consider a voltage source with an internal resistance of 1 ohm; first it supplies power to a resistor and then to the input of a converter, in both cases the output power is assumed to be 4 W.

In the first case a simple voltage divider results: if the source voltage rises, so will the current, the voltage drop across R_i will rise, the source's power by the square.

In the second case the input current will generate an initial voltage drop across the internal resistance R_i, the converter input voltage will be $V_{In} = V_S - V_{Ri}$. If the source voltage rises, the input current will drop, hence the voltage drop across R_i will be reduced. This increases the actual input voltage further, so the input current will drop still more and so on, until a stable state is reached. The regenerative nature is already apparent. The following table shows all parameters for 4 values of input voltage:

V_S	I_S	V_{Ri}	P_{Ri}	V_{In}	% of V_S	P_{out}	- R_{In}
4 V	1.6 A	1.6 V	2.56 W	2.4 V	60 %	4 W	- 1.4 ohms
5 V	1 A	1 V	1 W	4 V	80 %	4 W	- 4 ohms
10 V	0.42 A	0.42 V	0.18 W	9.6 V	96 %	4 W	- 23 ohms
20 V	0.2 A	0.2 V	0.04 W	19.8 V	99 %	4 W	- 98 ohms

Table 1: Parameters for values of input voltages

The NIR shows up readily in these parameters:

1. The power lost in the internal resistance P_{Ri} : it drops with increasing source voltage from 2.56 to 0.04 W, because the current drops. If there were a positive input resistance, the power lost would rise with the square of the current.
2. The power delivered by the source: it drops with increasing voltage from 6.4 to 4 W. If there were a positive input resistance, it would rise with the square.
3. The percentage of the source voltage which arrives at the input, it increases fast from 60 to 99 %. If there were a positive input resistance, this would constitute a voltage divider, i.e., the percentage would remain constant.
4. Clearly, the problem becomes worse for low input voltages and high currents resp. powers, NIR decreases, so the damping becomes more difficult. The message is to use a high input voltage if that choice exists.

If R_i is increased from 1 to 1.5 ohms, the $-R_{In}$ values change to – 2.6 ohms at 5 V, - 22.1 ohms at 10 V, - 97 ohms at 20 V. The reason is that due to the higher voltage drops across R_i the input voltages drop which in turn causes higher input currents which eventually results in still lower NIR values. Here $-R_{In} = +V_{In} / -I_{In}$, this means that, for each stable operating point, the input behaves like a fictitious resistance of that respective value. As shown later, it is a dynamic resistance. The larger R_i becomes, the worse the problem gets. It is now immediately obvious that a series inductance between source and input is fatal, as it acts as a high impedance for any current change. The logic consequence is that an input capacitor is mandatory which can deliver resp. absorb current spikes. This completes a resonance circuit, and it is again apparent that the input will oscillate if the equivalent parallel damping resistance at the input is greater than $|-R_{In}|$. If an „input filter" is added which includes a fairly high amount of inductance, it can not surprise that oscillations are provoked..

There is no way around performing the calculations following, including tolerances and extremes of operating conditions and to test engineering models thoroughly for critical combinations. During oscillations, voltages and currents can easily reach destructive levels which is especially dangerous with today's low voltage active and passive components. Many ic´s are destroyed already above a few volts, one spike can be sufficient.

Calculation of NIR. Input resonance circuit

There are two input resonance circuit configurations: 1. The resonance circuit where the inductance is undesired, it consists of the sum of conductor inductance, source inductance, capacitor ESL, 2. An input filter.

Whether oscillations are sustained or not depends on the quality factor Q, i.e. the ratio L/C resp. (L/C)/R. A high L/C ratio denotes a high impedance circuit and vice versa. If Q is high enough, the impedance

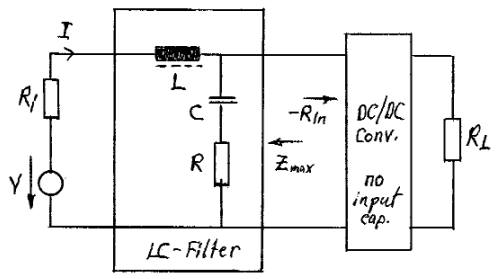

Figure 2: DC/DC converter with an LC input filter.

will peak at the resonance frequency $1/(2\pi \times \sqrt{LC})$. In order to achieve sufficient damping, with given values of L and C, the damping resistance must stay below resp. exceed a maximum/minimum value, depending on whether it is defined as a parallel or series resistance. With aluminum electrolytics, this is often fulfilled by the ESR if only conductor parasitic inductance and ESL are present. Consequently, an ideal capacitor like a MLC type is out of place at the input, but mostly specified for low voltage bucks these days. The trouble is that the oscillations show up strongly in the input current = capacitor current, not so spectacular in the input voltage depending on the capacitance value and type. The current is difficult to measure in SMD circuits. It is hence wrong to assume that lower ESR is always better, this is also true at the converter output as well. It is now evident that capacitors should be placed close to the regulators resp. converters, also for completing the hf circuits. It should be borne in mind that the ESR decreases sharply with rising temperature, hence a converter may remain quiet at room temperature and start to oscillate when it warms up! Also it may only oscillate with high currents i.e. high powers. Regarding aluminum capacitors, the matter is further complicated by the fact that for stability a minimum ESR is necessary while the manufacturers only specify a maximum value at 25°C, they may deliver arbitrarily lower values. Hence a professionally designed circuit cannot rely on capacitor ESR!

NIR is not constant and highly nonlinear. For modern SMPS it can be assumed that the efficiency is almost independent of the input voltage and high, hence the input power will also be independent of the input voltage. Under these assumptions it follows:

$$R_{In} = 1/(di/dv) = -V_i^2 / P_i = -P_i / I_i^2$$

It depends hence on the square of the input voltage, with respect to the current it follows a hyperbola $1/x^2$. If the choice exists, one will select a high input voltage. And the danger rises with decreasing input voltage. A high input voltage with an associated low current is equivalent to a high input resistance. and vice versa. The most critical combination is lowest input voltage together with the highest load; this is equivalent to a generator with a low internal resistance which can deliver a high current into the resonance circuit.

A brief survey of the formulas for a parallel resonance circuit:
The impedance at the resonance frequency
$1/(2\pi \times \sqrt{LC})$ is: $Z_{Max} = (L/C)/R_S$
The quality factor

$Q = (2\pi fL)/R_s$, R_s is the series damping resistance.
$= R_p /(2\pi fL)$, R_p is the parallel damping resistance
$= 2\pi fCR_p = 1/(2\pi fCR_s)$, R_s = ESR
$= 1/d$, d = damping factor

It is immaterial whether the damping resistance is in series with the inductance or the capacitance, the damping rises with increasing resistance. Q decreases with rising capacitance. The lower L/C, the lower Z. It follows that maximum damping is achieved if L/C is kept as low as possible and R_S as high as possible.
There is hence a parallel combination of the Z of the resonance circuit and the input resistance of the converter.
For parallel circuits the conductances are added, their sum inverted:

$$R_{eff} = 1/(1/Z + 1/R_{In})$$

Oscillations at the resonance frequency will occur if the condition for oscillation is fulfilled:

Reff < 0 resp. Z = (L/C)/Rs > RIn.

Expressed differently: the

Condition for stablity: $(L/C)/R_s < R_{In}$

must be fulfilled. If the converter, input voltage, and load are given, instability can only be avoided by decreasing Q resp. L/C or/and increasing the series damping resistances resp. decreasing the parallel damping resistances,

When the sum of the series resistances RSeries = RSource + RL + RConductors can not be neglected, the formula can be extended; no oscillations will occur if the inequality:

$R_E = \eta\ V_i^2 / P_i > (L/C + R_{Series}\ R_C) / (R_{Series} + R_C)$
(η and P independent of V_i)

is fulfilled. For $R_{Series} = 0$ the expression shrinks to the one above.

As R_{In} depends on V_i^2 , the system is nonlinear, hence oscillations will not be sinusoidal, but strongly distorted. L may be current-dependent and C voltage-dependent which complicates the situation. In case the resonance frequency comes close to the bandwidth of the regulation loop, an inductive component is added to the input resistance such that it becomes an input impedance, due to the lagging response. If the frequency of the V_i and P_i changes is above the bandwidth of the loop, further complications arise because beat frequencies with the switching frequency are possible which can cause irregular behaviour.

A professional compensation method:
As outlined before, it is not acceptable that the damping is based on such an unreliable und drifting parameter as capacitor ESR. Adding resistance in series with a high value capacitor would entail undesirable losses. A method used in wideband amplifier design fulfills the purpose without incurring disadvantages: A high quality capacitor such as a MLC or stacked polyester type is connected in series with a non-inductive damping resistor calculated according to the formulas above and placed in parallel to the input (and the high value capacitor which is mostly an electrolytic). The capacitance needed is very low (tenths of µF to a few µF) because the frequencies to be damped are high. This RC combination ensures sufficient damping which is independent of temperature, voltage and age. It has to be placed directly at the converter input, the position of the other capacitor is less critical, but the high current conductor routing has to be correct. At first sight, a parallel circuit of this resistor and the ESR seems to exist, but this is not true: hf currents always seek the loop of minimum impedance resp. inductance, this is through that RC combination, all other loops show higher impedance due to conductor inductance and ESL. This method is also applicable to the outputs of converters and low-drop linear regulators.

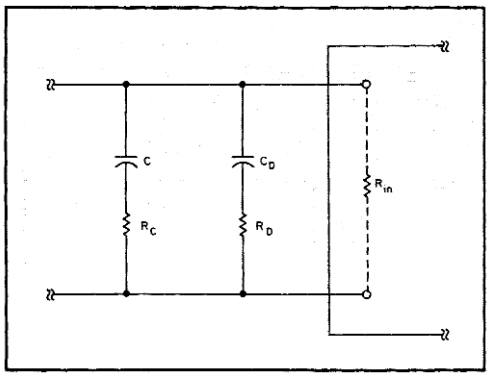

Figure 3: Compensation of negative input resistance or impedance by a non-inductive RC series combination CD + RD directly in parallel to the input. The low capacitance of CD prevents additional losses.

Summary of the methods of avoiding/compensating NIR:
Without exception, there must be a sufficiently large capacitance at the input of each regulator, whether linear or dc/dc converter. As most converters draw high rms currents, the capacitor must be adequately sized.

1. Input voltage as high as possible if that option exists.
2. Low Q , i.e. L small, C large. This implies placement of capacitors close to the input, low inductance conductor routing, minimizing of conductor loop area.
3. High efficiency reduces input power and improves the NIR.
4. Use of the compensation method in Fig. 3.

5. The selection of input capacitors.
Still many 2012 texts recommend „solid tantalum“ as the „best“ capacitors for converter inputs and outputs which is wrong for several reasons: their low ESR is undesirable at inputs and outputs, their data sheets prescribe a minimum of 3 ohms per volt impedance which rules them out across power supplies, their reliability is poor and they usually short out and burn. Their manufacturers hence prescibe fuses to disconnect shorted tantalums. Meanwhile there are better components like polymer types and such of different materials like Niob. The same holds true for „MLCC“, they are excellent regarding their low ESR and ac current capability, but exactly this can cause severe wild oscillations, due to NIR at the input or loop oscillations at the output. Also, those texts never check whether these capacitors can at all take the high ac currents; the suppliers mostly give only a dissipation factor taken at 1 KHz and 1 Vrms which is hardly descriptive of the application in converters.
Also, MLC capacitors are recommended without the warning, given in every data sheet of the Japanese maufacturers, that they should not be stressed beyond half the rated voltage! Larger SMD types are prone to breakage and then burn up.

6. A practical example: Industry dc/dc buck module.
A 48 W – 60 V – 700 mA LED module of an Eastern Asian manufacturer was tested. An input circuit was prescribed which consisted of: 2 x 4.7 uF, a 47 uH inductor in series and a 330 uF/100 V electrolytic at the converter input.
Strong NIR oscillations arose which, as expected, depended heavily on the operating point.

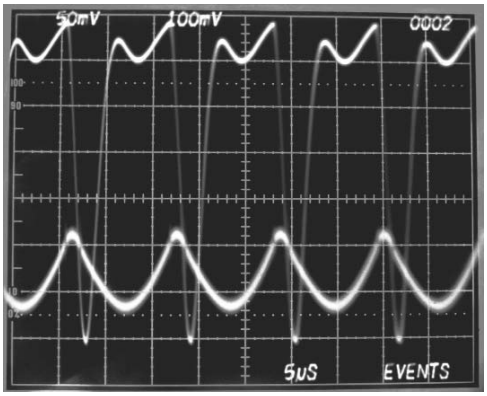

Figure 4: Current at the converter input 0.1 to 0.78 Apeak, 0.1 A/cm, zero at the bottom, appr. 100 KHz, and output voltage ripple 140 mVpp, 100 mV/cm.

With 48 V and a 14.5 W load an average input current of 0.31 A was measured, but at the converter input a rms input current of 0.36 A flowed, also through the 330 uF. Fig. 4 shows the input current and the output voltage ripple. A 330 uF is typically specified for 0.66 to 0.78 Arms, so the size of the 330 uF/100 V was dictated by the ripple current rating with a margin of 50 %.

In another operating point the total peak-to-peak current even amounted to – 0.12 A to + 0.85 A = 0.92 App. In order to prove that these high peak and rms currents were caused by NIR and the prescribed input circuit, the 330 uF was removed and a RC combination of a 1 uF low-inductance stacked mylar cap and a 10 ohm resistor was placed across the input: the pp current shrunk from 920 to 20 mA, the rms current from 360 to 7 mA! The average input current from the source stayed almost constant. The 47 uH series inductor and the 2 x 4.7 uF input capacitors were still in the circuit.

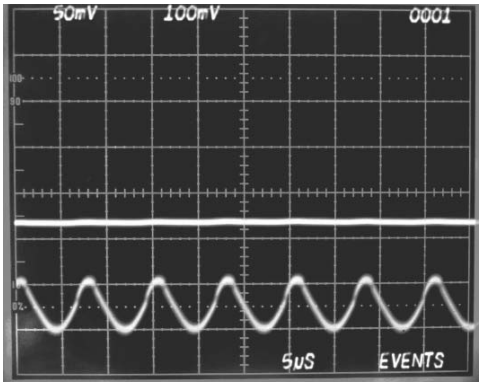

Figure 5: With RC damping: input current, above, same scale 0.1 A/cm, zero at the bottom, and output voltage, 110 mVpp, 100 mV/cm. The residual current ripple is hardly visible.

Figure 5 shows the converter input current with the RC damping. Obviously there is and never was a need for the big 330 uF/100 V electrolytic, it provoked the oscillation and the high peak and rms currents, also by its ESL The series inductor was later reduced from 47 to 2.2 uH, the voltage ripple at the input was a mere 0.16 Vpp on the 48 V dc. The stacked mylar capacitor could be replaced by a smaller MLCC of 1 uF/100 V X7R. The internal circuit of the module is unknown, also whether there is an input capacitor. When the series damping resistor was reduced, the propensity to oscillations rose, eventually they started again.

7. Measurement problems.

The faster the circuits become and the smaller, the worse the measurement problems! Looking at the recommendations given in most recent papers about converters, the expert is shocked! Here at least some important directions.

1. Measurements with voltage probes in fast circuits are only meaningful, if Tektronix probe adapters are used in which all 5 mm probes fit. They are available as screw-in (no. 131-0258-00) and solder-in (no.131-4353-00) versions. They are soldered directly on top of the respective capacitor, the probe is then inserted, the „ground cable“ taken off. This is also the only way to prevent stray magnetic fields from transformers etc. to couple into the loop of the ground lead and cause – often totally – erroneous readings. Alternatively, the special tiny probes for SMD components can be used. The voltage probes must be compatible with the scope inputs, their up to 6 hf adjustments must be carefully adjusted to the input used, for this purpose a pulse generator with a rise time of < 1 ns and a clean top and a special probe-to-BNC adapter (no. 013-0085-02) with a 50 ohm feedthrough termination (e.g.Suhner) are required. If this was not performed, no accurate measurements can be expected. Due to the low maximum voltage specs of most modern active components, it is vital to measure overshoots etc. precisely. The most recent active power components, SiC and GaN JFETs, have no avalanche rating!

Many converters operate at high frequencies up into the MHz range. It has to be borne in mind that passive voltage probes have very low input impedances at high frequencies, down to a few hundred ohms; the „10 Mohms//10 pF“ are valid only to appr. 100 KHz. This means that hf circuits can be affected by contacting a probe, overshoots damped. If this danger exists, active FET probes must be used.

2. In all SMPS designs, a current probe is absolutely indispensable, otherwise the designer remains blind. The DC/AC probe is the proper choice. The AC probes are faster, but they are saturated by dc components and hence rarely usable in SMPS. E.c. board traces have to be cut, a short loop made of hf litz wire is soldered to the ends, both wires run as a strand for as long as is necessary to insert the probe into the loop. The probe must not lie close to inductive components as it might pick up stray fields. The probe has an insertion impedance which may disturb very low impedance circuits. A practical difficulty arises e.g. in dense layouts, when one or more input chip capacitors are directly at the ic pins and there are large copper areas which cannot be cut. Here, the only means is to lift the chip capacitor or the ic pin off the board on one side and solder the loop in between. NB: current probes are always inserted at the ac low end. However, it is feasible to even place the loop in the drain lead of a flyback transistor; there may be some capacitive feed through, though.

There are also various current sensors available which do not require cutting conductors, some are shaped like a pencil and carry a tiny magnetic field sensor in the tip which is just placed upon the conductor; with some effort it can even allow calibrated measurements. The bandwidth is only 5 MHz, but this is mostly sufficient to detect currents, and it is quick.

Wild NIR oscillations will be mainly visible in the input current; depending on the size and quality of the input capacitor and its placement, the voltage amplitude may be fairly low and misleading. If the value of the NIR is very low, then the insertion of the probe may influence the oscillation.

3. Digital Storage Oscilloscopes (DSO’s) do not show the signal, but a more or less distorted reconstruction, and their sampling rates and bandwidths are NOT constant. The actual sampling rate depends on the memory and the sweep speed selected, irrespective of the maximum value. The low and middle priced models mostly have only small memories from 1 to 10 KB; this means in practice, that even a 5 GS/s 500 MHz DSO, at a slow sweep speed for showing mains-related signals, may have only 50 KS/s left! The bandwidth is only 1/10 (not 1/2!) of the sampling rate, hence the 500 MHz shrink to 5 KHz! Of course, this does not appear in advertisements or manuals, but is plainly admitted in other publications of the manufacturers. If the sampling rate is insufficient, all kinds of distortions and artefacts can be displayed which have no resemblance to the signal. For most work on SMPS analog scopes are vastly superior, for elementary physical reasons, they cannot display false signals, and they display the signal itself. Of course, if a DSO shows artefacts, all numeric displays are false.

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High Energy Density DC Link Capacitors for Larger Inverter Systems

Cornell Dubilier announces availability of its Type 947D high energy density DC link capacitors for larger inverter systems. The 947D is an excellent choice for DC link applications where high bus voltage, high capacitance, and high ripple current are required for smoothing and filtering.

Since a fused, segmented metallization pattern is used, the 947D capacitors offer greater open circuit protection and superior control of capacitance loss than competitive types. The pattern is deposited on a low-loss, high-grade polypropylene dielectric. Built-in fuse links limit capacitance loss to a small segment within the capacitor in lieu of the larger areas of uncontrolled capacitance loss observed with non-segmented types.

Available in 130 to 3600 µF and rms current ratings in excess of 100 A, The 947D DC link capacitors are packaged in cylindrical aluminum cases with diameters of 85, 90, 100 and 116 mm. Voltage ratings range from 800 to 1300 Vdc. The heavy duty M8x20 threaded studs or optional M6 threaded inserts are used to connect the high current terminals to the inverter's bus.

With a 200,000 hour life expectancy at nameplate ratings of current, voltage and temperature, the 947D DC Link capacitor will excel at providing reliable filtering and smoothing for today's demanding applications in inverters for wind and solar energy, electric vehicles, motor drives, UPS systems, and more.

www.cde.com

Doubled Current Rating of SiC Diodes in DPAK to 10A

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 doubled the current rating of its DPAK-packaged silicon carbide diodes from 5A to 10A.

The 1200V/10A SDB10S120 features a positive temperature coefficient for ease of paralleling, and temperature-independent switching behavior. Maximum operating temperature is 175degC. Devices also exhibit zero forward and reverse recovery current. Total capacitive charge is 40nC. The true two lead DPAK (TO-252-2L) package has a mounted footprint (nominal) of 9.8x6.6mm and measures just 2.29mm high.

Explains SemiSouth's Senior Vice President of Sales & Marketing, Dieter Liesabeths: "By again extending our leadership position in silicon carbide with these new 1200V/10A diodes we are enabling manufacturers of products such as solar inverters, SMPS, induction heaters, UPS and motor drives – and well as anyone building PFC circuits – to benefit from increased performance and reduced space."

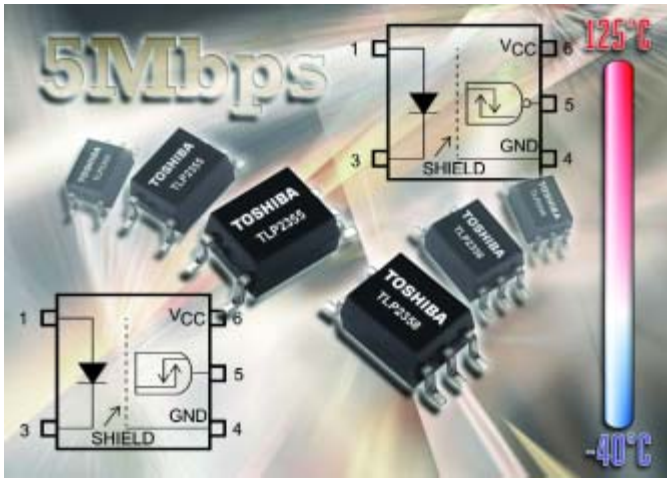
www.semisouth.com

Extended Temperature, Low Current, High-Speed Photocouplers in S06 Package

Toshiba Electronics Europe (TEE) has announced two new photocouplers that will support data rates up to 5Mbps while saving board space and reducing power consumption in industrial designs.

Offering buffer logic and inverter logic configurations respectively, the TLP2355 and TLP2358 logic IC couplers are supplied in compact S06 packages measuring just 7.0mm x 3.7mm x 2.1 mm and they offer guaranteed operation at temperatures from -40°C to 125°C. Designed for industrial applications, the devices are ideal for use in programmable logic controllers (PLCs), measurement and control equipment requiring high-speed digital interfaces, and IPM drives for factory automation systems.

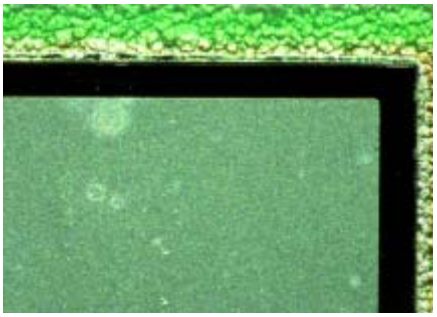
The TLP2355 and TLP2358 can accommodate a wide supply voltage range of 3V to 20V and support low-power operation thanks to a low maximum threshold input current of only 1.6mA. Maximum power supply current is just 3mA. A maximum propagation delay time of 250ns supports high-speed data rates up to 5Mbps.



www.toshiba-components.com

Latest Generation of Cleaners for Power Modules

Zestron, the leading global provider of precision cleaning products and services for the SMT- and Semicon Backend industry, successfully exhibited at PCIM Nuremberg for the first time this year. The focus was on cleaning Power Modules.
For energy-efficiency reasons, modules produced today have ever higher performance requirements with greater packaging density. Accordingly, even the slightest contaminants remaining on the surface in these critical and highly sensitive applications get more and more critical.



To guarantee the highest process reliability, these contaminants must be removed from the substrate and chip surfaces through a cleaning process. At PCIM, ZESTRON presented the latest generation of cleaning agents which were especially developed for Power Modules.
Zestron has already implemented several water-based processes and is ready to support you with the selection or optimization of your power module cleaning application. For further information on “Cleaning Power Modules”, please do not hesitate to contact ZESTRONS’s Application Technology:

www.zestron.com

3kWatts Automotive Grade Power Planar Transformer

Payton has introduced a line of automotive grade Power Planar Transformer available for use in the harsh automotive environment. The transformer is designed to accept 400 Vdc input from a pfc, and provide battery charging voltage on the output at 200 Amps. The total output power is 3000 Watts provided the transformer is mounted on a 90C0 cool plate. The clasp allows an easy way to thermally and mechanically secure the transformer to a cold plate. Switching frequency is 186Khz and the topology is Full Bridge. The total area volume needed is under 6 in3 and the power density is 500 W/in3. The efficiency is better than 99% Different models can be designed in this configuration based on specific technical requirements. Additional models are available with different pin configurations.

www.paytongroup.com

High Voltage Isolated SiC Gate Drivers

ROHM Semiconductor presents its new BM6 family of 2,500 Vrms isolated SiC gate drivers facilitating low-power consumption and small designs. Due to their characteristics, these devices are ideal for the control of inverters and DC/DC converters for solar and automotive applications. Due to their electrical characteristics and high output voltage, they can drive both IGBTs and SiC MOSFETs. Together with ROHM's SiC devices the new series guarantees a stable, high speed operation even in high power regions.

In order to develop on-chip transformer processes, ROHM utilized its proprietary microfabrication expertise. The unique design reduces the size to a compact SSOP-B20W package while eliminating the need for external parts, cutting the mounting area by approximately 50% compared to conventional products. Moreover, the original core-less transformer technology integrates an isolation function ensuring an isolation voltage of 2,500 Vrms.

In addition, multiple protection functions such as thermal shut-down and short circuit protection supporting desat function, fault and load control are included for high reliability, decreasing design effort while further contributing to miniaturization. A soft turn-off function deactivates the inverter in case of desaturation.

www.rohm.com/eu

Optocoupler with Extra-Long Creepage Distance of 14.5 mm and 7500 Vrms Isolation

MSC offers the PS9924 and PS9905 optocouplers from Renesas Electronics. The two new devices are housed in a novel 8-pin Long Shrink Dual In-line Package (LSDIP) and feature an extra-long creepage distance of 14.5 mm minimum and an isolation voltage of 7500 Vrms.

The PS9924 high-speed optocoupler is designed for an extended temperature range from 40°C to +110°C and incorporates an open collector output. The device operates with a supply voltage from 2.7 V to 5.5 V. Thanks to maximum propagation delay times of 75 ns at 25°C and typical values of 40 ns, a maximum communication bandwidth of 10 MBit/s can be achieved. Furthermore, the

PS9924 features a high common-mode transient rejection of minimum 15 kV/µs and typical values of 20 kV/µs, and a current consumption of only 2 mA.

The PS9905 is an optically coupled IGBT driver with a galvanic isolated Gallium-Aluminum-Arsenic (GaAlAs) LED at the input side and a photo diode with signal processing circuitry and power amplifier at the output side. This not only allows high switching speeds but also up to 2.5 A output current. The maximum propagation delay time (tPLH or tPHL) of 0.15 µs is guaranteed over the complete operating temperature range from -40°C to +110°C. The high common-mode transient rejection of minimum 25 kV/µs allows an error-free transmission of the control signals through the isolation layer.

www.msc-ge.com

High Frequency Welding Diodes

Over the years, ABB Semiconductors has worked in collaboration with most of the major welding equipment manufacturers. Through this cooperation, ABB has collected valuable experience in improving diode characteristics to reach optimum reliability and electrical performance. Currently, we are the market leader in the welding diode (WD) business.

ABB welding diodes are press-pack devices specially designed for medium and high frequency welding equipment and optimized for high current rectifiers. Their main characteristics feature low forward voltage drop, excellent surge current ratings, very low thermal resistance and high operating temperature up to 190 °C.

ABB reacts to new trends and the demands of the automotive industry, such as the transition of the WD operation to the high frequency range – up to 10 kHz. To meet these demands, we are introducing a new group of high frequency welding diodes with high current capability combined with excellent reverse recovery characteristics. These features enable operation with high efficiency at frequencies around 10 kHz. Thanks to this innovation, a welding transformer can be built smaller and lighter. Thus, as part of a welding gun, it enables the robot arm to move easier and faster. ABB's new high frequency WDs are available in standard or housing-less (HL) versions.

www.abb.com/semiconductor

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Rugged Automotive-Qualified Power MOSFETs Housed in TO-220 Fullpak

International Rectifier has launched a family of automotive-qualified power MOSFETs housed in a rugged TO-220 fullpak package for automotive applications including BLDC motors, pumps and cooling systems.

The 55V planar devices are available as standard and logic level gate drive MOSFETs in N and P channel configuration, and offer a maximum on-state resistance (Rds(on)) as low as 8mOhm. The TO-220 fullpak package eliminates the need for additional insulating hardware to simplify design and improve overall system reliability. Based on IR's proven planar technology, this new family of MOSFETs available in a TO-220 fullpak package performs well in linear mode and in automotive applications where a rugged, reliable MOSFET is needed to drive highly inductive loads.

IR's automotive MOSFETs are subject to dynamic and static part average testing combined with 100 percent automated wafer level visual inspection as part of IR's automotive quality initiative targeting zero defects. AEC-Q101 qualification requires that there is no more than a 20 percent change in Rds(on) after 1,000 temperature cycles of testing. However, in extended testing IR's new AU bill of materials demonstrated a maximum Rds(on) shift of less than 10% at 5,000 temperature cycles, showing the strength and ruggedness of the bill of materials.

www.irf.com

Condux Plus Foams for Handheld Devices

Rogers Corporation's High Performance Foams Division has introduced a problem-solving material for handheld mobile devices—Condux Plus™ electrically conductive foam. Even in the most complex, compact handheld electronic designs, Condux Plus materials feature excellent electrical conductivity, consistent mechanical properties, and outstanding electromagnetic (EM) shielding capabilities, allowing them to serve as reliable grounding pads for handheld devices in need of enhanced conductivity and shielding performance.

Condux Plus materials, available in several different thicknesses (0.33, 0.53, and 0.73 mm), are designed to provide consistent and reliable connectivity while also offering excellent mechanical stability over time and temperature. The typical compression set for 0.021-in.-thick (0.53-mm-thick) Condux Plus foam, for example, is only 2.5%. This material helps maintain the electrical integrity of the most complex mobile and handheld designs, forming reliable electrical connections and delivering necessary conductivity whether uncompressed or fully compressed. Rogers Condux Plus foam also serves as an excellent EM shielding material, with superb shielding effectiveness (SE) over a wide operating frequency range of 200 MHz to 10 GHz. Condux Plus materials have been tested per IEEE-299 methods to provide a minimum SE of 60 dB, effectively reducing the power of EM fields by more than 99%.

www.rogerscorp.com/hpf

Surface Mount Dc-Dc LED Driver Provides Output up to 700 mA

CUI Inc announced the addition of a new surface mount series to its high efficiency, constant current dc-dc LED driver family. Designed to drive high power LEDs, the VLD25-SMT series provides efficiency levels of up to 96%, current accuracy of ±2%, and an ultra-wide input range of 5.5 to 48 Vdc. The series offers two means of LED dimming: PWM digital dimming and analog dimming control via a trim pot, making it ideal for applications where precise accuracy and brightness control is needed, including signage, transport, consumer electronics, and signaling.

The series is compact, measuring 0.94 x 0.54 x 0.30 inches in a 16-pin SMT package. Available output currents include 300, 350, 500, 600, and 700 mA with an output voltage range of 3.3 to 36 Vdc. The VLD25-SMT series has an ambient operating temperature range of -40°C to +85°C at full load in the 300 mA and 350 mA versions and -40°C to +71°C in the 500 mA, 600 mA, and 700 mA versions. Short-circuit protection and on/off control are standard features. The VLD25-SMT series is available immediately through Digi-Key starting at $7.95 for 1,000 pieces. For quantities over 1,000 pieces, please contact CUI directly for OEM pricing.

www.cui.com

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SiC Schottky Barrier Diodes Featuring the Industry's Lowest VF

Rohm has recently announced the development of second-generation SiC (Silicon Carbide) Schottky barrier diodes ideal for power supply circuits in PV (photovoltaic) power conditioners, industrial equipment, servers, air conditioners, and more. This new series features the industry's lowest forward voltage (VF=1.35V?) – 10% less than conventional products – reducing power consumption considerably.

In recent years SiC has emerged as the successor to silicon for use as a semiconductor material in next-generation devices, particularly in the power electronics sector (i.e. industrial equipment, solar cells, electric vehicles, railways), due to its lower power conversion losses and superior material properties. ROHM has successfully launched mass production of SiC SBDs and MOSFETs in 2010, followed by the industry's first mass production of 'Full SiC' power modules in March 2012. However, although SiC SBDs are now commonly mass-produced on a global scale, their forward voltage remains at around 1.5V, hindering energy conservation efforts. Further reductions in VF are required to minimize power dissipation.

Reducing the forward voltage, however, normally results in an increase in reverse leak current. ROHM overcame this challenge through device optimization and improved manufacturing processes, successfully reducing VF while maintaining low leakage current. In addition, this new series features particularly low forward rise voltage compared with competitor products for improved efficiency during low-load states – where it is commonly used.

www.rohm.com/eu

Wideband LDMOS Transistors

Richardson RFPD announces immediate availability and full design support capabilities for two laterally diffused metal oxide semiconductor (LDMOS) transistors from Freescale Semiconductor, Inc.

The two highly versatile RF power LDMOS FETs feature enhanced ruggedness of 65:1 VSWR and wideband operation over a broad, 1 MHz to 2 GHz frequency range.

The unmatched transistors are capable of delivering full CW rated power over the entire operating frequency range. The combination of integrated stability enhancements and optimized impedances allow for a simpler wideband implementation than previous generations of LDMOS transistors. The devices are housed in Freescale's low thermal resistance packaging and are ideally-suited for applications involving harsh conditions, including HF-UHF transmitters and transceivers, television transmitters, white space data transceivers, aerospace and defense systems, test equipment, and radar systems.

The devices 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 Freescale Wideband LDMOS Transistors webpage.

www.richardsonrfpd.com

High-Accuracy Current Measurement to Electric Vehicle Battery Packs

Transducer specialist LEM announces the CAB high-accuracy current transducer that enables makers of battery packs for Electric Vehicles (EVs) and Hybrid Electric Vehicles (HEVs) to achieve a new level of precision when measuring current flow into and out of the battery. Car makers need this data to maximise the range of the vehicle, to keep the battery in good condition, and to enable use of the optimum size of battery pack.

LEM's CAB transducer offers current measurement capability of up to ±400A, with unlimited overload capacity, and with excellent accuracy: Coulomb-counting error over the driving cycle is reduced to under 0.1%. It is galvanically-isolated and non-intrusive; no electrical connection to the power circuit is needed. This ensures safe operation and, in contrast to techniques that use a sensing resistor in the power feed, generates no waste heat or losses.

The CAB takes the form of a small panel-mounted module measuring just 71 x 52 x 21 mm, excluding mountings, that has an aperture through which the primary (battery feed to the vehicle motors) conductor passes. It operates from the vehicle's 12V power supply, and is rated for operation from -40 to +105 ºC. The CAB transducer transmits its data to the EV/HEV's control circuitry using the automotive-industry standard CAN bus; LEM can supply variants that deliver data via other bus and interface standards, on request.

www.lem.com

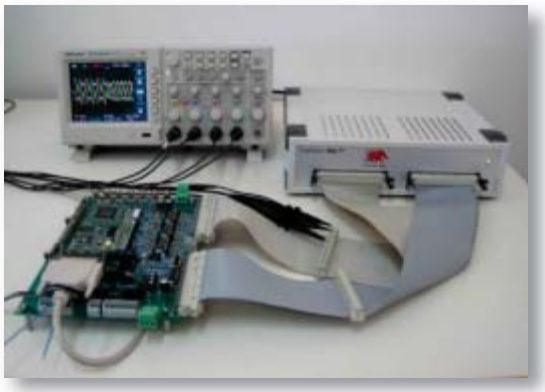
WEB SITE: WWW.EPE-PEMC2012.COM | INVITATION (PDF VERSION)

Dear prospective industry partners!

It is our pleasure to invite you and your company to join us at the EPE-PEMC 2012 ECCE Europe conference an exposition. This conference and exposition gives your company an excellent opportunity to present its technology and its products to industry and academia.

In order to maximise the benefit to Industrial Exhibitorrs three related events are organised:

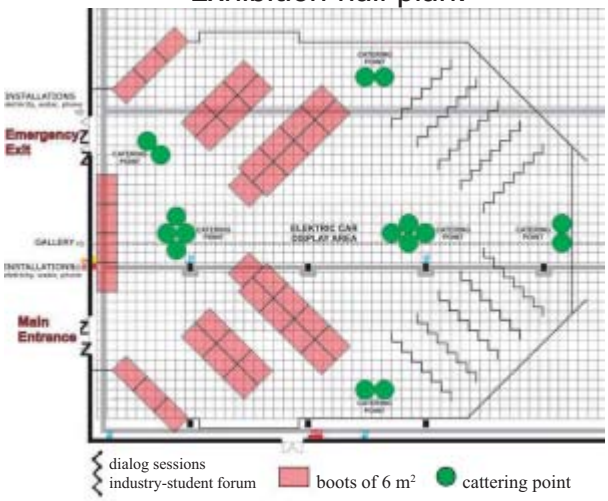
Industry-Student Forum (Sep. 3, 2012): The Industry-Student Forum at the EPE-PEMC 2012 ECCE Europe is a platform for bringing together companies looking for young, talented power electronics engineers and interested PhD/MSc students in the final phase of their studies. Participating students will present themselves with a poster with their CV. Companies will present their profile and employment opportunities to the students in the form of a booth. The Industry-Student Forum will be organized in cooperation with the European Center for Power Electronics (ECPE) and will be held together with the conference tutorials on 3. September 2012 (please see Tutorials and Industry-Students Forum schedule). This joint event provides a unique opportunity for students to learn about newest developments from the world-wide recognized power electronics experts and to meet young promising candidates.



Industry Panel Sessions (Sep. 4-6, 2012): The industry panel sessions provide an opportunity for companies to give a presentation about the latest technology achievements of their company. These sessions present a unique and much appreciated venue for highlighting new technological developments, products and services of the company in a classroom-style format. The sessions are held in the afternoons of the days of the conference.
The presentation time for each company will be 15-20 minutes.

Exhibition (Sep. 3-5, 2012): The representatives from the industry, technical books & journals publishers, future conference organizers, will present their products and their programs, enhance exchange of idea between academia and industry, and meet potential clients and partners. With a limited number of conference supporting packages and a limited number of exhibition space available, we are recomending you to choose your exhibition package earlier. Priority for booth selection will be given on first come, first served basis. Please see exhibition hall plan and customize your package on the conference web site: www.epe-pemc2012.com

Exhibition hall plan:



Why EPE-PEMC?

The conference is one of the most important of its kind in Europe. It brings together outstanding professionals in the field of Power Electronics and Motion Control from the leading research centers around the world. EPE - PEMC'2012 will be no exception and will create oportunities to renew and strengthen professional contacts of all participant, and it will highlight the multidisciplinary character of Power Electronics and Motion Control and show its vast scope of applications.
The EPE – PEMC'2012 conference in Novi Sad Serbia attracted over 400 high quality publications from 60 countries worldwide. The papers cover 15 topics important for the development of the filed of PE and MC and will be presented in more then 20 sesions. One of the important parts of the EPE-PEMC conference is the industry participation from the companies that conduct basic and applied research in cooperation with universities as well as the manufactures of power electronics components and systems, renewable energy technologies, mechatronics systems, adjustable speed drives, automation technology (hardware and software solutions), R&D companies specialisingspecializing in various fields of power electronics applications and end users of this technology.

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ZMOTION™ 20-Pin Occupancy Detection MCU with Sensing Technology

Zilog, a wholly-owned subsidiary of IXYS Corporation and a pioneer supplier of application-specific, embedded microcontroller (MCU) system-on-chip (SoC) solutions for the industrial, telecommunications, automotive and consumer markets, today introduced its latest motion sensing and control technology ideal for occupancy detection applications, including customer sensing, lighting control, and other energy management applications.

Zilog's ZMOTION™ MCU features advanced occupancy sensing technology that combines a high-performance MCU with unique embedded software specifically designed for products based on Passive Infrared (PIR) motion detection. The ZMOTION MCU ships with built-in software-based motion detection algorithms. These motion detection algorithms comprise the PIR engine and run in the background of the MCU, while control and status of the engine is accessed through a software Application Programming Interface (API). These APIs allow users to create their own application specific software while taking advantage of the PIR technology thereby providing a dramatic improvement in both sensitivity and stability over traditional motion detection designs. Zilog's PIR technology is also scalable to many market segments including lighting control – for which it is especially suited – and to solar-powered, off-grid, motion-activated LED lighting as well as HVAC control based on occupancy, access control (doors and gates), escalators, vending machines, displays, proximity activation, power management, occupancy sensing, and many additional applications.

www.zilog.com

Molded SMD Power Inductor Caters for Superior Saturation Currents

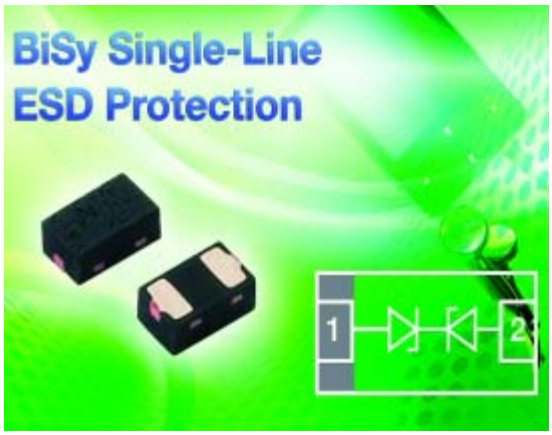
SMD power inductor with high saturation current and compact design: The new high-performance, space-saving SMD power inductors series WE-LMHI is distinguished by high nominal and saturation currents. A special iron powder mixture prevents the saturation of the core across the entire operating range. It also provides magnetic shielding, which reduces the leakage field to a minimum and even eliminates acoustic noise.

Würth Elektronik provides the new series in five sizes (4020, 7030, 7050, 1040 and 1335) and thus covers a wide range of inductance values from 0.1 µH up to 22 µH. As a result of the molded design, nominal currents of up to 25 A and saturation currents of up to 70 A are possible. A wide temperature range from –40°C to +125°C is specified.

Areas of application for the WE-LHMI series include DC/DC converters in high-current power supplies to power FPGAs, POL converters, motherboards, graphics cards and battery-operated equipment. All products are on stock. Samples are free of charge.

www.we-online.com/LHMI

Bidirectional Symmetrical Single-Line ESD Protection Diode



Vishay Intertechnology, Inc. announced a bidirectional symmetrical (BiSy) single-line ESD protection diode that offers low capacitance of 14 pF in the ultra-compact LLP1006-2L package.

With a small 1.0 mm by 0.6 mm footprint and an extremely low profile of 0.38 mm, the VCUT07B1-HD1 is designed to reduce the board space required for ESD protection in portable electronics, including notebook computers and smartphones.

At the working voltage of ± 7 V, the diode offers a high isolation to ground characterized by a low leakage current of < 0.1 µA. Any transient voltage signal exceeding the reverse breakdown voltage of 7.3 V minimum at 1 mA will be clamped or shorted to ground. The device features a maximum clamping voltage of 15 V at 4 A.

The short leads and small size of the LLP1006-2L package enable a diode with very low line inductance, allowing fast transients such as ESD strikes to be clamped with minimal over- or undershoots.

www.vishay.com

SMPD Products for Motor Drives, UPS and Inverters

IXYS announced that it is extending the Surface Mount Power Device (SMPD) range to include products that provide the essential building blocks of the power semiconductors for power electronic motor drive systems, the inverter for power supplies and UPS, and the power stage for micro inverters and inverters.

The IXYS SMPD has been in volume production since its introduction a year ago, is an innovative power module which can be easily surface mounted on a Printed Circuit Board (PCB) using standard pick and place and reflow soldering process.

This new range of products is targeted to provide SMPD modules for each of the rectifier, brake and inverter stages of a motor drive or micro-inverter system which can be located separately on the PCB to facilitate reduced heat sink size, weight and cost. The SMPD advantage allows faster assembly cycles and the chip scale packaging reduces material waste inherent in single module solutions.

By using a simple combination of the above products, a motor drive system or micro-inverter with optimized silicon content up to 11kW in power rating can be achieved with a faster time to market and minimal investment due to standard surface mount assembly processes currently existing in normal PCB assembly lines.

www.ixys.com

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www.cowec.de

Industry's Lowest Operating Power Widebody 10 MBd Digital CMOS Optocoupler

Avago Technologies announced the ACNW261L ultra low power 10 MBd digital CMOS optocoupler. The ACNW261L consumes less power when compared to other 10 MBd optocouplers in the market, and is designed for high voltage insulation requirements.

In renewable energy generation systems, industrial, medical equipment, and electrical equipment used in harsh environments applications, there may be requirements to support internal system communication speed of 10MBd with lower power consumption and high insulation voltage. The ACNW261L is the lowest power consumption 10 MBd optocoupler on the market with reinforced insulation working voltage of 1414 VPEAK. Supply current is under 1.5 mA over the –40 °C to 105 °C temperature range. Both 3.3 V and 5.0 V applications are supported. The input LED current was designed

to be a low 4 mA.

The ACNW261L features input-to-output insulation voltage of 5000 VRMS. With reinforced insulation the new optocoupler meets the IEC 607475-5-5 working voltage requirement of 1414 VPEAK, internal clearance of 1 mm, external creepage of 10 mm and external clearance of 9.6 mm. By using an internal Faraday shield the ACNW261L has excellent common mode transient rejection performance of 20 kV/µs minimum, 35 kV/µs typical, at 1000 V common mode voltage.

In addition to exceptional electrical and market leading performance that is guaranteed over the –40 °C to 105 °C temperature range, functional features increase application versatility, system reliability and performance. An enable pin sets the CMOS output stage to a high impedance state for bus interface versatility. Slew rate controlled output ensures stable rise and fall times over temperature and operating conditions, an especially important feature for parallel interface applications. The ACNW261L operates from 3.3 V or 5.0 V power supply voltage.

www.avagotech.com

First Multi-Cell, Multi-Chemistry Battery Gas Gauge for Lithium Batteries

Texas Instruments introduced the first in a family of multi-chemistry, multi-cell battery management gas gauge circuits with TI's proprietary Impedance Track™ capacity measurement technology. The

bq34z100 power management chip is the first gas gauge in the industry to support a wide range of lithium-ion and lithium iron phosphate chemistries in 2- to 16-cell battery packs, extending battery run-time in applications like medical instruments, power tools, e-bikes and uninterruptible power supplies (UPS). TI also plans to introduce new gauges this year to support lead acid, nickel cadmium and nickel metal hydride chemistries. For more information, samples and evaluation module, visit: www.ti.com/bq34z100-pr-eu.

Today's multi-cell lithium battery designs in portable industrial and medical equipment need a more accurate way to measure remaining battery capacity. The bq34z100 battery gauge leverages Impedance Track technology, which uses charge voltage measurements, battery characteristics and properties to determine a battery's state-of-health and maintain up to a 94-percent accurate capacity measurement for the entire life of the battery. The circuit also works independently of series-cell configuration, and can reduce power consumption through an external voltage translation circuit.

Download TI's Battery Management Solutions Guide: www.ti.com/bmsguide-pr-eu.

www.ti.com

ADVERTISING INDEX

Pre-Applied Thermal Interface Material (TIM)

The Infineon-qualified solution

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

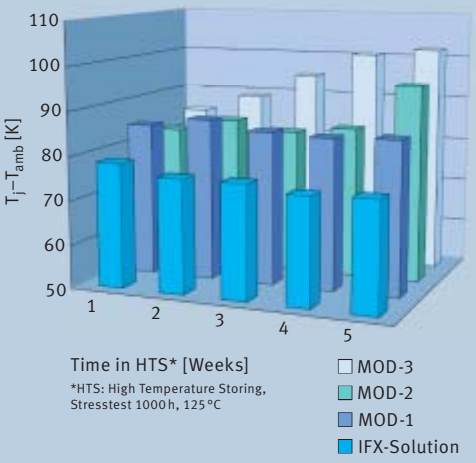
TIM does not only provide the lowest thermal resistance, it also fulfills the highest quality standards given for power modules to achieve the longest lifetime and highest system reliability.

Main Features

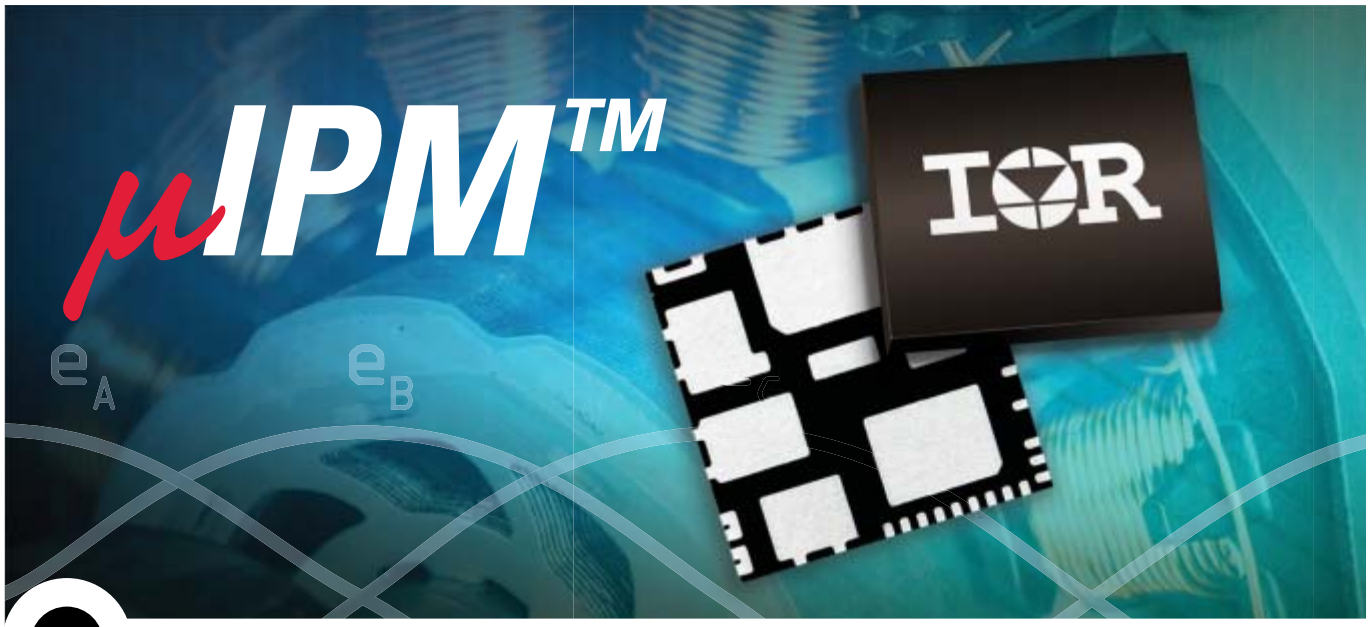
- Best in class thermal resistance
- Pre-applied to Infineon Modules
- Dry to the touch
- Optimized for dedicated Infineon Modules

Benefits

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



www.infineon.com/tim



Innovative Power Module Reduces System Size

µIPM™ Power Modules Deliver up to 60% Smaller Footprint

Specifications:

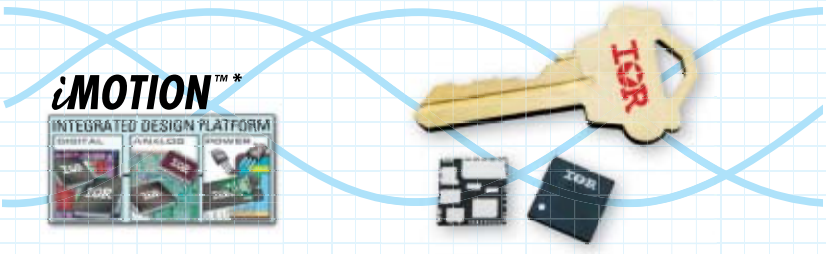
Part Number	Size (mm)	Voltage	IO (DC@ 25°C)	Motor Current**		Motor Power VO=150/75VRMS	Topology
				w/o HS	w/HS		
IRSM836-024MA	12x12	250V	2A	470mA	550mA	60W/72W	3P Open Source
IRSM836-044MA	12x12	250V	4A	750mA	850mA	95W/110W	3P Open Source
IRSM836-025MA	12x12	500V	2A	360mA	440mA	93W/114W	3P Open Source
IRSM836-035MB	12x12	500V	3A	420mA	510mA	108W/135W	3P Common Source
IRSM836-035MA	12x12	500V	3A	420mA	510mA	100W/130W	3P Open Source
IRSM836-045MA	12x12	500V	4A	550mA	750mA	145W/195W	3P Open Source

Features:

- 3-phase motor control IC
- 12x12x0.9mm PQFN package offers up to 60% smaller footprint
- Eliminates the need for heat sink
- DC current ratings from 2A to 4A
- Voltage range of 250V – 500V

µIPM™ Advantages:

- Shortens design time
- Shrinks board space requirements
- Simplicity - Eliminates Heat Sink
- Replaces more than 20 discrete parts to deliver a complete motor drive stage
- Slashes assembly time and cost
- Simplifies procurement and inventory management
- Reference design kits available for quick evaluation on any 3-phase motor



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or visit us at www.irf.com

International
IOR Rectifier
THE POWER MANAGEMENT LEADER

* IR's iMOTION™ (ai mo shan), representing the intelligent motion control, is a trademark of International Rectifier
** RMS, Fc=16kHz, 2-phase PWM, ΔTCA=70°C, TA ≈ 25°C