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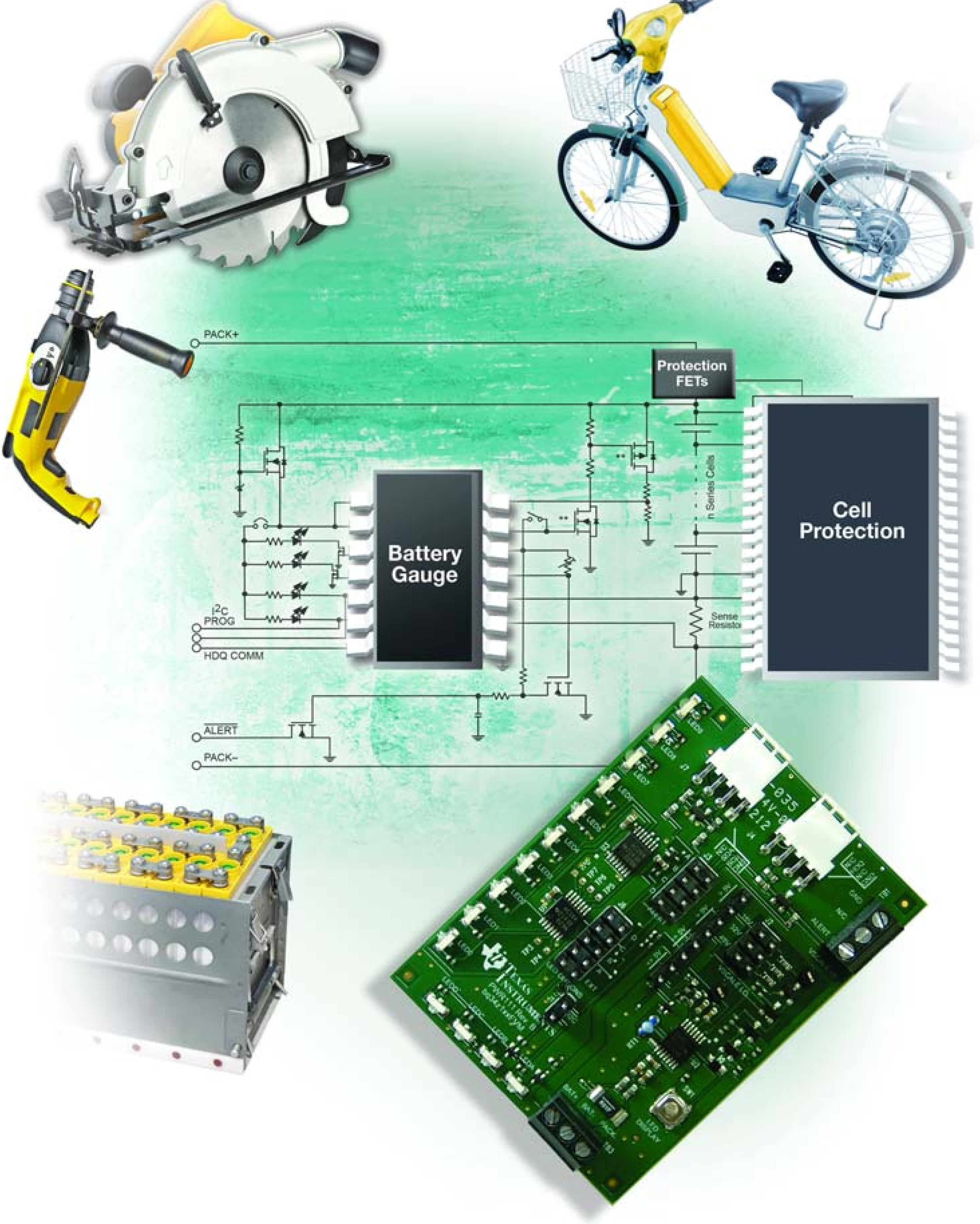
Bodo´s Power Systems®

Electronics in Motion and Conversion **October 2013**



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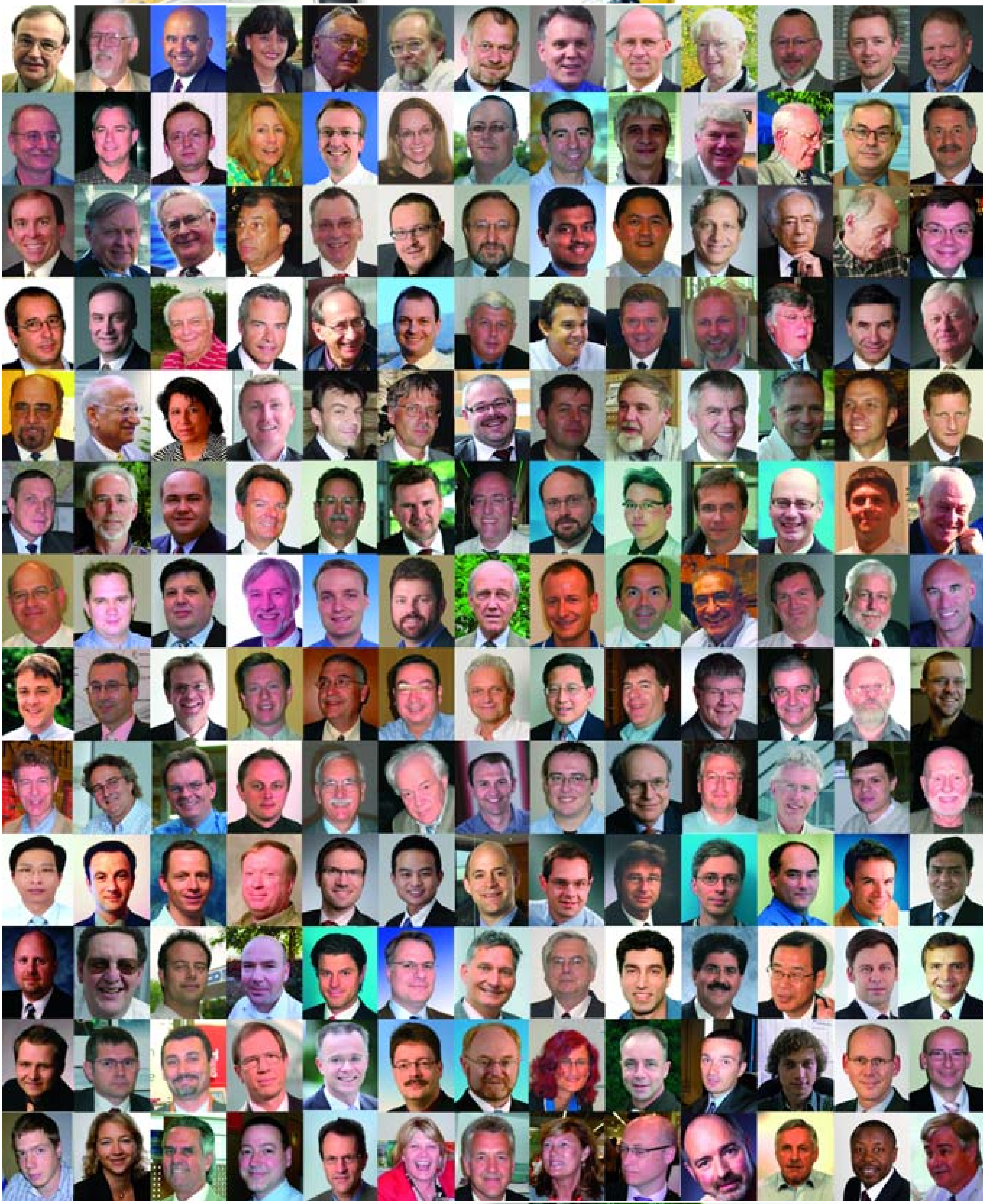
The Gallery



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Events

SEMICON Europa 2013,
Dresden, Germany, October 8th -10th
www.semiconeuropa.org/

INTELEC 2013,
Hamburg, Germany, October 13th -17th
www.intelec2013.org/

Distribution Automation Europe,
London, UK, October 14th-15th
www.smi-online.co.uk/utility/uk
/distribution-automation-europe

eCarTec 2013,
Munich, Germany, October 15th -17th
www.ecartec.com

E DPC 2013,
Nuremberg, Germany, October -29th-30th
www.mesago.de/de/EDPC/

productronica 2013,
Munich, Germany, November 12th – 15th
http://productronica.com/de/home

Texas in September

The Darnell Energy Summit in Fort Worth brought together leading industry experts to present and discuss technology for power electronics, green buildings, and the grid.

GaN is continuing its progress in replacing silicon applications. Applications with GaN and SiC are more efficient than conventional silicon solutions, and in some areas enable designs that have not before been possible. These can be more compact, withstand higher temperatures, and be better physically integrated as such systems rarely require special cooling provisions.

Next year's APEC conference will again be in Fort Worth. March, as opposed to September presents us Northern Europeans with more tolerable temperatures. In Texas, air conditioning is a must, and it consumes a significant portion of the overall market for electricity, as it does across most of the country.

Increasing the use of renewable energy sources, or "green energy" as it is called, must be our goal to keep our life and the life of future generations safe here on our planet. We cannot be choosing cheap, dirty energy, such as high-risk generated nuclear power. Fukushima is back in the headlines and is polluting the ocean with contaminated water. Europe has taken resolute steps towards renewable energy. Wind and solar have a dominate position and the industry is working on power systems to store excess energy for later use. Texas now produces over 9% of its electricity requirements through wind sources, with an installed capacity of 12.2 GW. The U.S. is at 60GW with over 3% of its overall consumption. So progress is underway. Meanwhile, the 80,000 wind driven water pumps, traditionally used in Texas, keep on pumping.

In the future, a smarter grid will be able to smooth out peak demands. Every home can contribute to an environmentally friendly approach through smart controls and decentralized generation. Any refrigerator, water heater, washing machine or dishwasher with intelligent communications can become an active part of reduced peak demand. Utility

companies, heretofore a monopoly supplier, will need to adjust as consumers become more independent with their own energy sources, and the grid in a supporting role.

Getting to the smart grid will need a lot of good standards and regulations, and innovations to functionally bring the technology available together. There must be an open standard that all appliance manufactures can include in their equipment, along with incentives for the consumer. There must be good communications, much more robust than forums or chatting on e-mail, for safe and convenient systems. We have the electronic solutions to move ahead.

Communication is the only way to progress. We delivered twelve issues last year and will continue this year, each month, on time, every time. With this October issue, we've now published 110 technical articles amongst 672 pages total. As a media partner, Bodo's Power Systems provides you with readers across the globe. If you speak the language, or just want to have a look, don't miss our Chinese version: www.bodospowerchina.com.

My Green Power Tip for October:
Reduce your electrical consumption instantly by turning down or unplugging electrical equipment that has not been in use for a while. If it is older stuff, the stand-by current may be significant. We ourselves have the power to make things happen, little by little.

Best Regards

High-Reliability Solder Alloy Reduces Drop-Shock Performance by 800 Percent

Indium Corporation will feature its new technology platform using the SACM™ Solder Alloy at Surface Mount Technology Association International (SMTAi) October 15-17 in Fort Worth, Texas.

SACM™ is a high-reliability solder alloy that offers drop-shock test performance far superior to other SAC alloys, without compromising on thermal cycling. Its low silver content makes it a cost-effective solution for portable electronics.

The platform consists of Indium8.9 Series solder pastes using Indium Corporation's patent-pending SACM™ solder alloy technology for board-side interconnect, and SACM™ solder balls (spheres) for package-level interconnect.

SACM™ is doped with manganese and contains less silver than other Pb-free alloys. Manganese provides increased strength. The reduced silver content provides a more stable cost structure, especially beneficial for cost-sensitive applications.

Indium Corporation will be exhibiting at booth 318.

www.indium.com/SACM

LED Drivers are CB, RCM and ENEC Certified

RECOM Lighting is a world-wide company with a global clientele. While many customers accept the usual CE or UL8750 certificates, there are some regions that require additional compliance to their own domestic standards and regulations. Therefore RECOM Lighting has selected the LED drivers RACD03, RACD06, RACD12, RACD20, RACT20 and RACV30 for additional certification to the internationally recognized IEC standards (CB report), RCM for Australia and New Zealand (ACMA) and the voluntary quality mark for Europe (ENEC).

The CB reports cover the IEC 62384 performance requirements and IEC 61347-2-13 safety requirements for electronic control gear for LED modules. These two norms are the primary international standards for LED

drivers. The RCM (Regulatory Compliance Mark) shows compliance with the local standards in Australia and New Zealand. The ENEC mark (European Norms Electrical Certification) demonstrates compliance with the relevant European safety and performance standards (EN61347-1, EN61347-2-13 and EN62384). The testing must be carried out by an accredited European certification institute. For this certification, RECOM chose UL Europe.

With these certifications, customers can have more confidence in the safety and performance of RECOM's LED driver products, knowing that they have been independently assessed and approved for sale worldwide.

www.recom-lighting.com

Maxim to Acquire Volterra Semiconductor

Maxim Integrated to acquire Volterra Semiconductor for $23 per share Transaction valued at $605 million equity value; $450 million enterprise value Maxim expects transaction to be immediately accretive to GAAP EPS, excluding special items Volterra product portfolio increases Maxim's leadership position in integrated power management Adds talented engineering team with proven track record of success

Maxim Integrated Products, Inc. announced it has entered into a definitive agreement to acquire Volterra Semiconductor Corp. for $23 per share, which represents a 55% premium to Volterra Semiconductor's closing share price on August 14, 2013. The transaction value is approximately $605 million equity value or $450 million net of Volterra's cash position of approximately $155 million.

Volterra is an industry leader in high-current, high-performance, and high-density power management solutions. The company develops highly integrated solutions primarily for the enterprise, cloud computing, communications, and networking markets. Volterra's portfolio of highly integrated products enables better performance, smaller form factors, enhanced scalability, improved system management, and lower total cost of ownership.

www.maximintegrated.com

www.volterra.com

Reference Design for LED Drivers for Streetlight Control

IXYS Corporation, a manufacturer of power semiconductors and integrated circuits (ICs) for energy efficiency and power management applications, today announced the release of a reference design and demonstration board for a 200W AC LED Driver with Power Line Interface in collaboration with Echelon Corporation. Applications include remotely controlled and monitored municipal and private-installation lighting with remote control convenience features. This integrated reference design simplifies and reduces the cost of adding power management and control features to lighting installations. By specifying drivers based on this design, end customers deploying LED street lighting can enjoy an additional 30% energy savings and extend asset life relative to deploying LED lights with no controls.

The 200W AC LED Driver Demonstration Board integrates Zilog's Z8F2480 MCU and Echelon's ISO 14908.3 based PL3120 powerline transceiver module in a 200W AC LED driver to remotely turn LEDs on and off, regulate LED brightness, and provide information to the host about power consumed by the driver in addition to input voltage, load current, power factor, and LED board temperature values.

www.echelon.com

www.ixys.com

Inventor of IGBT Honored

C. Frank Wheatley will be inducted into the New Jersey Inventors Hall of Fame in October 2013, honoring his pioneering developments in solid state circuits and devices, including the invention of the Insulated Gate Bipolar Transistor (IGBT). In this Hall of Fame are such notables as Edison, Einstein, Zworykin, Bardeen, Brattain, and Shockley, etc. The State of New Jersey has a long history of successful research institutions; Edison Laboratories, Bell Labs, RCA Labs, that continues today in University and commercially sponsored R&D, so the fraternity of inventors so honored is impressive. The IGBT has been at the heart of many power electronic contributions to our advanced society. The United States Patent by Becke and Wheatly in 1982, "Power MOSFET with Anode Region" was the seminal event at the beginning of these contributions. Wheatley is the holder of 56 other US Patents, and has delivered over 150 professional papers, 40 of them at IEEE Conferences. The Award Ceremony will be held on October 17, 2013.

www.njinvent.org/index

Power Seminars Focus on Engineering Energy Efficiency

To help designers meet this challenge, Fairchild Semiconductor is pleased to begin its eighth season of worldwide technical power seminars in September 2013 in Europe with 13 locations.

The power seminar focus for 2013-2014 range from: Advanced or emerging power technologies (critical design issues of LLC resonant converters, current shaping strategies for buck PFC), design issues in key applications (low-voltage dc-dc converters, high power HB-LEDs) and design examples (rapid-iteration flyback design).

The seminars are ideal for engineers looking for the latest advancements in power supply design, as well as those looking for a refresher. The attendees will receive in-depth theoretical and practical discussions on each topic and pros and cons of different solutions to improve energy efficiency and system performance. Each of the presentations is accompanied by a technical paper with the full in-depth treatment of the topic for reference.

www.fairchildsemi.com

Würth Elektronik: Focus on Fundamental Research

New Electronic Design & Application Center in Munich, Germany

One and a half years after opening the Innovation Office in Aschheim close to Munich, Würth Elektronik eiSos expands its Munich location and moves to the Garching Business Campus. Würth Elektronik eiSos with the Würth Electronics Midcom subsidiary officially opened its local Design & Application Center north of Munich in Garching on 09.09.2013. The office is home to laboratory, offices for research and development engineers, sales and multimedia facilities; it offers sufficient space for dynamic growth. "The rapid growth in employees and projects that we have been able to acquire here within a very short time, confirms Munich as the ideal location," commented site managers Fabian Kuttenkeuler and Oliver Opitz.

The focus areas are both Wireless Power Transfer and Energy Harvesting applications as well as developing the new MagI³C Power Modules. In addition, the first customer-specific passive components will be developed by Würth Electronics Midcom at the new location. The aim is to establish a development team for customer-specific transformers for customers from the EMEA area. Additional local and international specialists are currently being recruited for the location. The Design Center offers the engineers from various nations and specialist fields space for ideas to develop new passive and active components and gives Sales direct access to customers and IC manufacturers located in the Munich area.

www.we-online.de

450mm Session at SEMICON Europa 2013

As the semiconductor industry continues to make progress in preparing for the next wafer size transition, Europe has been proactive in engaging its semiconductor equipment and materials companies through the formation and efforts of the European Equipment and Materials Initiative for 450 mm (EEMI450).

In order to ensure this latest wafer size transition is facilitated in both an effective and efficient way, the need to collaborate and cooperate with other consortia on a global scale is paramount. This 450 mm session will focus on European and Worldwide 450 mm achievements, and how consortia, OEMs and IDMs, along with the help of governments and funding agencies, are working together to achieve this challenging wafer size transition for the industry.

www.semi.org/europe

New Generation of Management

The SEMIKRON group has taken a further step in the realignment of its top management, as part of which Peter Sontheimer has been appointed as a new member of the SEMIKRON Management Board starting November 2013. The 45-year-old has held various management positions at Vincotech over the last 16 years and his many years of industrial experience have made him an expert in power electronics. Along with Harald Jaeger (Operations and R&D) and Thomas Dippold (Finance and Central Functions) he will be responsible for Sales, Product Management and Marketing.

www.semikron.com

EPC8000 Family Blurs the Line between Power and RF Transistors

Efficient Power Conversion Corporation has extended its family of high-speed, high performance enhancement mode transistors with the introduction of the EPC8000 family of products. With the introduction of these eGaN® FETs, power systems and RF designers now have access to high performance gallium nitride power transistors with switching frequencies into the multiple GHz range, enabling innovative designs not achievable with silicon.

Cutting new ground for power transistors, these 3rd generation devices have switching transition speeds in the sub nano-second range, making them capable of hard switching applications above 10 MHz. Even beyond the 10MHz for which they were designed, these products exhibit very good small signal RF performance with high gain well into the low GHz range, making them a competitive choice for RF applications.

“We are very excited about how our innovative new family of eGaN FETs will change the industry. These products take EPC and gallium nitride transistor technology to a level of performance that enables applications that were previously beyond the capability of MOSFETs. We now have eGaN FETs that can be used in both power semiconductor and RF applications,” said Alex Lidow, EPC’s co-founder and CEO.

Products in the family are available with on-resistance values from 125 mΩ through 530 mΩ, and three blocking voltage capabilities, 40 V, 65 V and 100 V. These new transistors have several new features that further enable designers to take full advantage of the high performance gallium nitride FETs have to offer. These features include reduction in Q_{GD} thereby reducing voltage transient switching losses, improved Miller ratio providing high dv/dt immunity, low inductance pads for improved connection to both gate and drain circuits, orthogonal current flow between the gate and drain circuits for enhanced CSI reduction, and a separate gate return connection also for enhanced CSI reduction.

Examples of applications benefiting from the low power, compact, high frequency EPC8000 family of devices include hard-switching power converters operating in the multi-megahertz range, envelope tracking in RF power amplifiers, and highly resonant wireless power transfer systems for wireless charging of mobile devices.

The EPC9027, featuring the EPC8007 devices and the LM5113 gate driver IC from Texas Instruments in a half bridge configuration, is available now. Additional development boards will be available to support designers in evaluating and incorporating other EPC8000 family products into their power conversion systems.

EPC Part No.	Voltage	Max. $R_{DS(ON)}$ (mΩ) (V_{GS} = 5V, I_D = 0.5A)	Min. Peak Pulsed I_D (A) (25 °C, T_{pulse} = 300 µs)
EPC8004	40	125	7.5
EPC8007	40	160	6
EPC8006	40	250	3.8
EPC8008	40	325	2.9
EPC8009	65	138	7.5
EPC8005	65	275	3.8
EPC8002	65	530	2
EPC8003	100	300	5

Table: EPC8000 Family Product Specifications

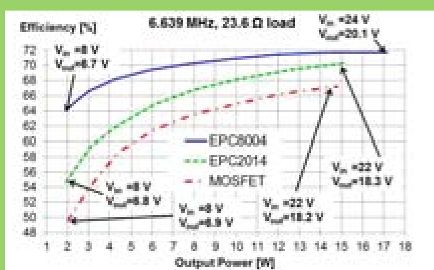


Figure 2: Wireless Power Transfer

Design Example: 42 V to 20 V, 20 W buck Converter for Envelope Tracking operating at 10 MHz.
The EPC8000 family of devices is capable greater than 10 MHz operation. Efficiency of both 5 MHz and 10 MHz operations is shown in figure 1. With mobile communications traffic increasing by 70% in 2012 and over 10x by 2017, power efficiency in RF transmitters will be critical. Envelope tracking provides a dramatic increase in RF power amplifier systems.

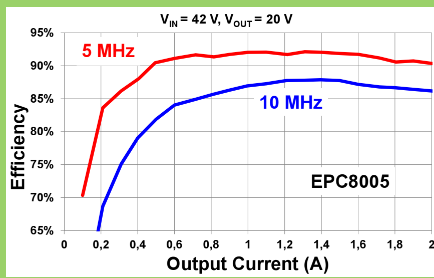


Figure 1: Envelope Tracking

Design Example: Wireless Power Transfer (15 W, 6.8 MHz Class D Amplifier)
One of the most exciting applications to emerge in the past few years is wireless energy transmission. The figure 2 shows the efficiency performance of the wireless energy transfer demonstration board when operating with the coils centrally aligned and spaced 1 inch (25 mm) apart from each other.

Evaluation units of the EPC8000 family of products are immediately available in 10-piece packs through Digi-Key Corporation.

Design Information and Support for eGaN FETs:

- Download EPC eGaN FET datasheets at http://epc-co.com/epc/Products.aspx
- EPC9027 Quick Start Guide: http://epc-co.com/epc/documents/guides/EPC9027_qsg.pdf
- Application Note: "Introducing Family of eGaN FETs for Multi-Megahertz Hard Switching Applications"

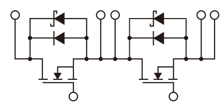
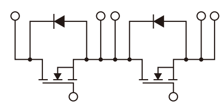
http://epc-co.com

Choose ROHM SiC Products for Your Power Component Needs

Class-leading SiC power components are available in a range of output currents.
From SiC ingots to finished components, we offer a one-stop production and development system that guarantees a stable supply of high-quality SiC power products.

■ Full SiC Power Modules

Specifications: 45.6×122×17mm(Including pins)

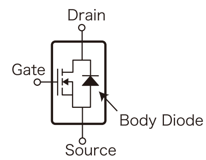
BV_{DSS}	I_D max	Structure: Half-Bridge Circuit
1200V	120A	BSM120D12P2C005 
	180A	BSM180D12P2C101 

■ SiC MOSFETs

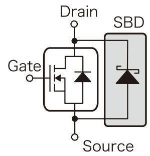
TO-247

BV_{DSS}	$R_{DS(on)}$	I_D max
1200V	80mΩ	35A

SCT Series
SiC-MOSFET



SCH Series
SiC-MOSFET+SiC-SBD
Integrated Package



■ SiC Schottky Diodes

TO-220AC 2L

V_R	I_F
650V	6~20A
1200V	5~20A

TO-220FM 2L

V_R	I_F
650V	6~20A

TO-247

V_R	I_F
650V	10~20A *1 20~40A *2
1200V	5~20A *1 10~40A *2

*1: 1 pin *2: overall package

D2PAK

V_R	I_F
650V	6~10A

■Next-Generation SiC Power Modules (Under Development)

Applications: EV/HEV, industrial equipment, etc.

ROHM SEMICONDUCTOR

ROHM Co.,Ltd.
www.rohm.com

The Fundamentals of Sustainable Growth Drivers in the Power Semiconductor Market Remain Valid

By Claus Panzer, Infineon

Energy Efficiency, Mobility and Security are the three central challenges in modern society where semiconductors play a major role by helping to save energy and increase convenience as well as safety in our daily life. Growing population and increasing wealth continue to drive the worldwide consumption of energy.

Urbanization for example, drives the market for traction as well as electric and hybrid vehicles. The number of commuters in, into and between large cities is growing which in turn increases the number of metro- and intercity trains. In construction, also driven by urbanization, a lot of cranes, welding machines and other electronically-driven/assisted equipment is needed as well as elevators, escalators and air-conditioning systems in new buildings. All these applications use power semiconductors to operate safely and at highest efficiency. Not just commercial buildings, but in-home appliance applications become more environmental friendly, thanks to power semiconductors.

Industrial production is also moving to higher levels of automation to improve quality and lower cost. Therefore, the share of electronically controlled motors is increasing. Electric motor drive systems across millions of pumps, fans, air/liquid compressors, servo drives, commercial heating and air conditioning units account for roughly 50 percent of worldwide electricity consumption. In fact, electric motor drive systems are the single largest user of electrical power and account for twice the energy usage of lighting applications.

Also part of the equation are governmental initiatives like the European EcoDesign Directive, aimed at improving the environmental performance of energy related products. They support the inverterization of production equipment and many other applications and produce yet more demand for power semiconductors.

In total, about one third of the energy consumed worldwide is electricity, and the trend is rising. China, for example, will add more than 1500 GW to its total power generation capacity, to reach about 2700 GW by the year 2030. Electricity consumption there will grow by five percent or 88 GW per year, which is equivalent to adding the UK's total installed capacity each year. Obviously, installed capacity will grow further, but it is also true that a key "source" for the future is energy efficiency. This is one reason that more efficient power semiconductors like IGBTs play an increasingly important role in the electricity supply chain from energy generation, energy transmission and energy consumption.

While the market for bipolar power semiconductors was relatively flat in the past decade, the market for IGBTs grew more or less constantly until a big drop in 2008, which marked the first ever decline for this device category. This was followed by record growth until the end of 2011 and downturn again in 2012. This higher volatility may now be the rule instead of the exception.

We have also seen solar and wind generation grow to be a significant source of demand for power semiconductors, beside traction, home appliance, industrial power supply and the dominating drives applications. Supported by government incentives, feed in tariffs, and infrastructure programs, renewable energies and traction were a major contributor to the market growth. This, however, also turned out to be very dynamic because of the dependency on those supports.

In addition to structural change driven by applications there was also a regional market transformation. China is now the largest market for IGBT components worldwide. Market demand there for IGBT modules and discrete components is primarily driven by power consumption intensive industries, which could save up to 30 percent of energy costs when using inverters, by the central government's railway network expenditure, by the emerging home-grown renewable energy sector, and by nation-wide incentives to promote the purchase of energy-efficient appliances.

The majority of Chinese IGBT demand is still served by foreign suppliers but local manufacturers are gaining momentum. For traction, energy generation and transmission related applications, big (partially state-owned) companies are establishing themselves in the market, whereas smaller and medium size local companies achieved a significant share by entering from the low end sector.

Though the market stays very fragmented, starting from the low end, some application areas are becoming more mature and in conjunction with more suppliers the share of commoditization will grow. Customer proximity, support and flexibility will become more important.

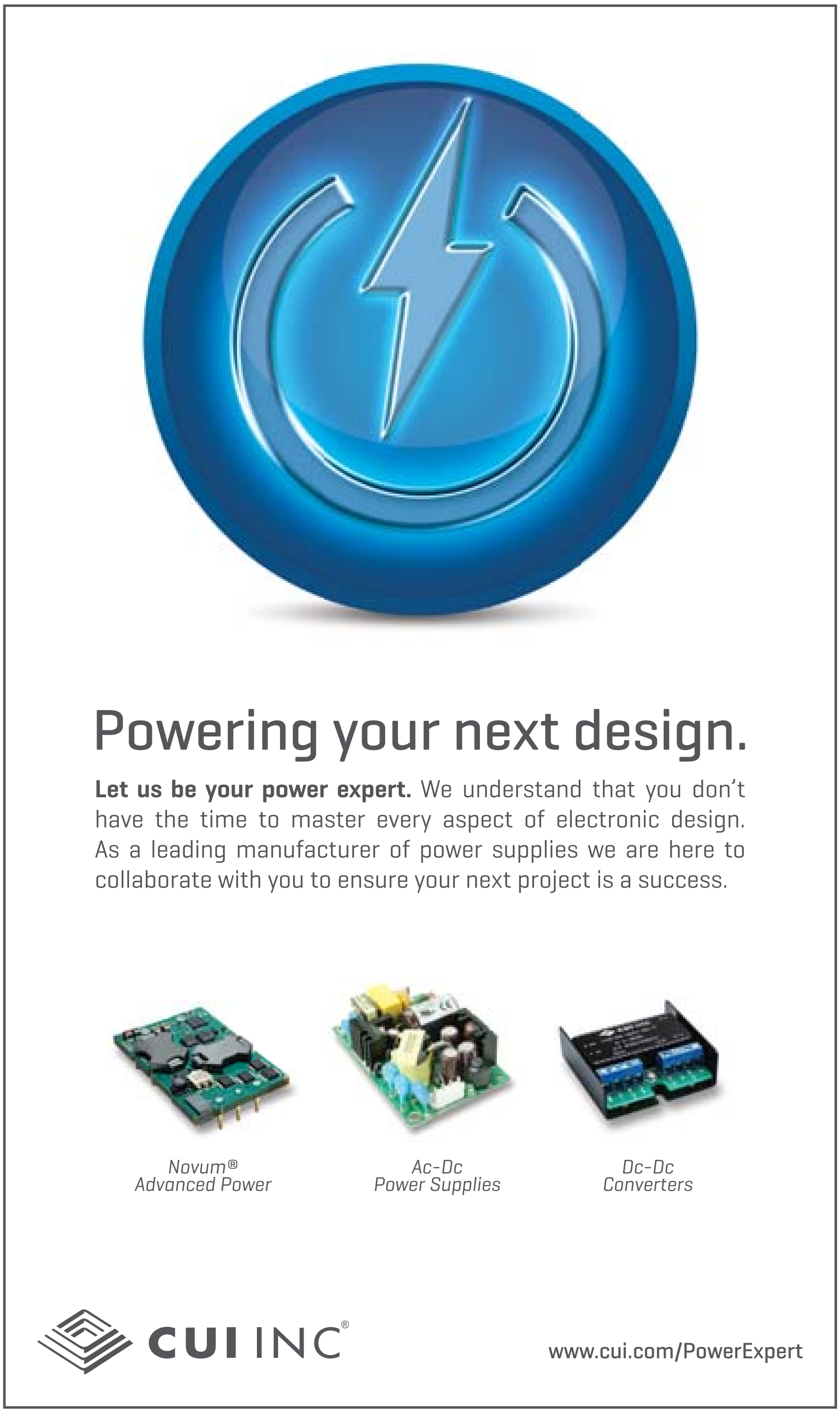
For the majority of applications, power density, reliability and quality will remain the differentiating factors. In depth system understanding offers added value to the customer through defining the best product technologies, functionality, and performance. Many applications will become more specifically demanding, like wind offshore vs. onshore, or might see structural changes and local specifications, like solar manufacturer preference for string inverters in Europe and central inverters in Asia. System expertise, leading chip and package technologies as well as global presence are needed to follow these requirements without increasing complexity. Beside optimal performance, standard processes and products are still required in order to achieve system cost benefits.

New applications like energy storage, electric vehicle charging and region specific applications are arising. A comprehensive product- and technology offering, again based on system expertise, is needed to support these segments.

The world of power semiconductors is changing. New players and business models, especially in Asia, are seen in the market. The market is also becoming more dynamic and demanding due to application and regional specific growth drivers. New technologies like SiC will both enable new applications and take share from current products. But also new IGBT generations will substantially increase efficiency and lower system cost in combination with optimized inverter designs. The combination of innovative new technologies and ongoing productivity improvement will support growth in existing application segments and enable fast entry of new applications.

For all these reasons the growth drivers for our business are still intact, and they will stay intact. We can truly state that the long-term societal challenges related to energy efficiency, mobility and security translate into a sustained market growth for power semiconductors.

www.infineon.com



Electronics Industry Digest

By Aubrey Dunford, Europartners

SEMICONDUCTORS
Worldwide sales of semiconductors reached $ 74.65 billion during the second quarter of 2013, an increase of 6 percent from the first quarter, so the WSTS. This marks the largest quarterly increase in three years. Global sales for June 2013 hit $ 24.88 billion, an increase of 2.1 percent compared to June 2012 and 0.8 percent higher than the May 2013 total.

Maxim Integrated Products has entered into a definitive agreement to acquire Volterra Semiconductor, a supplier of high-current and high-density power management solutions. The company develops highly integrated solutions primarily for the enterprise, cloud computing, communications, and networking markets. The transaction value is approximately $ 605 M equity value or $ 450 M net of Volterra's cash position of approximately $ 155 M.

Japanese Group Renesas has appointed Gerd Look as President and CEO of Renesas Electronics Europe. Look, currently General Manager of Renesas Electronics Europe's Automotive Business Group, will assume his new role on 1 October 2013. Since its establishment in the merger of April 1, 2010, Renesas Electronics, the world's number one supplier of microcontrollers and a supplier of system-on-chip and discrete analogue and power devices, has reduced its fixed costs of approximately 20 percent.

Micrel, a supplier of linear and power solutions, LAN and timing and communications solutions, will acquire the business of Discera, a Californian provider of silicon timing solutionse stablished in 2001.

Dialog Semiconductor has completed the transaction to acquire iWatt, a provider of digital power management ICs, for a cash payment of approximately $ 310 M, with additional contingent consideration of up to $ 35 M, based on achieving future revenue targets.

Worldwide silicon wafer area shipments were 2,390 million square inches during the second quarter 2013, a 12.3 percent increase from the previous quarter, so SEMI. New quarterly total area shipments were 2.3 percent lower than second quarter 2012 shipments.

OPTOELECTRONICS
The over-supply of LCD panels that occurred in June 2013 has caused panel makers to be more conservative in their TFT LCD display-panel shipments and revenues, so NPD DisplaySearch. Worldwide LCD panel shipments (9.1" and larger) reached 340 million in 1H'13, with $ 37 billion in revenues. Earlier this year, panel makers' 2013 targets totaled 710 million units, but this estimate has since been lowered by 7 percent to 698 million units.

Despite a major surplus in the light-emitting diode (LED) market, top suppliers are increasing their capital spending and production because of government incentives and in order to cash in on an expected boom in the lighting business, so IHS. The spending and boosting of utilization rates alike are occurring despite a glut of supply that has plagued the market since 2010. The surplus started when LED suppliers made major investments in capacity in 2010 and 2011. Given the rising investments in manufacturing equipment, the acute LED oversupply already in existence is expected to continue through 2016. The supply of LEDs, measured in terms of manufactured die, is expected to exceed demand by 69 percent in 2013 and in 2014. The glut will decline slightly to 61 percent in 2015 and then to 40 percent in 2016.

PASSIVE COMPONENTS
Molex has signed definitive agreements to acquire FCT Electronics Group. Based in Munich, the company produces custom mixed-layout connectors and cable assemblies. FCT Electronics Group has manufacturing operations in Germany, the Czech Republic, Thailand and the United States.

OTHER COMPONENTS
Efore, a Finnish company which produces demanding power products, has signed an agreement to acquire the Italian-based Roal Electronics. The purchase price of equity amounts to € 9.7 M. Sixty-percent of the purchase price is paid in cash and 40 percent in Efore shares.

Emerson announced an agreement to sell a 51 percent stake in its embedded computing and power business to Platinum Equity. Emerson will receive $ 300 M in cash and will retain a 49 percent noncontrolling interest in the business, which will operate as an independent company.

EMS PROVIDERS
Following a financing arrangement, the Swedish contract manufacturer Inission becomes Incap's largest shareholder with approximately 26 percent of its total share capital. The comprehensive arrangement includes an option for Inission to combine and unite its business operations with Incap. Post-merger Incap-Inission will be able to achieve annual revenue in excess of € 100 M while earning a profit within the next two years.

DISTRIBUTION
European distribution bookings in Q212 grew by 1.6 percent compared to the previous quarter and by 10.2 percent when compared to the same period in the previous year, so the IDEA (International Distribution of Electronics Association). European distribution billings in Q213 declined by 0.5 percent, when compared to the previous quarter and grew by 2.3 percent compared to Q212. Sector specific billings changes in Q213 compared to the same period in 2012 were: semiconductors grew by 2.8 percent; passives grew by 3 percent; electro-mechs and other components were almost the same. At 1.03:1 the Q213 overall book-to-bill ratio showed an increase from Q112 (1.01).

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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Darnell's Energy Summit – "Efficiency isn't Enough"

By Jeff Shepard, President Darnell Group

The Keynote and Plenary speakers at the recent Darnell's Energy Summit, hosted 9-12 September, in Richardson, Texas, all pointed in a common direction when discussing the future of the power electronics industry. Opening the Summit, Scott Barbour, Executive Vice President with Emerson and the Business Leader of Emerson Network Power (Systems) summed up that common theme when he observed, "efficiency isn't enough."

"We demand all information on every device we own, everywhere we go. Fast. To accommodate, industries are not only demanding more power than ever, but they are seeking new levels of efficiency in the power chain and new, more environmentally responsible sources of generation. Once disparate industries from IT to telecommunications and content delivery are converging at record pace. Energy delivery and management, too, has become a melting pot," Mr. Barbour continued.

"Both ac and dc power are viable options in facilities of all types and are bringing new energy-saving possibilities to micro grids. And the intelligence to see and control that energy use doesn't stop at the outlet. Smart Grid innovations are magnifying the energy savings made possible by the visibility and control now possible within a building's walls. Effectively monitoring and managing energy has become the key. And there are large and growing opportunities in meaningful and timely analytics," Barbour concluded.

Brian Patterson, Chairman of the EMerge Alliance and General Manager of Armstrong World Industries built on the themes started by Barbour and painted a picture of "The EMerge Vision: Creating the Enernet." Patterson described a future where advanced components and new architectures "do for power what the Internet did for information networking." He spent a few minutes describing the future use of HVDC in utility grids, but quickly drilled down to local dc micro grids as the key to the future Enernet.

"DC power will fundamentally change the way power is distributed in buildings," according to Patterson. Combining integrated designs with on-site renewable energy (such as photovoltaic generation), local energy storage to enable grid independence and system intelligence to control and monitor energy generation and use on a local (micro grid) basis has the potential to move us to net zero energy buildings.

Patterson continued with the following description of the U.S. Depart of Energy's Zero Energy Commercial Buildings Consortium's goals: Begin DC Microgrid Demonstrations in 2013. By 2030 all new commercial buildings will be zero energy users. By 2040 50% of all commercial building stock will be zero net energy structures. And by 2050 all commercial buildings in the U.S. will be zero net energy users.

The morning Plenary session was closed by Kurt Yeager, Vice Chairman of the Galvin Electricity Initiative and the Perfect Power Institute. As the former President of the Electric Power Research Institute, Mr. Yeager is especially well positioned to address his topic of, "DC Microgrids – Challenges & Opportunities." One of the chief goals identified by the efforts to develop dc microgrids is to "convert buildings from Power Pigs into Power Plants," according to Mr. Yeager.

He identified numerous specific benefits from the3 successful development and deployment of dc microgrids including: The ability to optimize distribution performance and service value and local optimization of dc power. Seamlessly integrating the supply of electricity and the demand for electricity. Providing the most user-friendly consumer empowerment for the use of electricity and local generation and storage. Opening the door to entrepreneurial innovation and enabling local green enterprise zones.

Yeager called dc microgrids, ""The ultimate example of energy democracy by diversifying supply infrastructure ownership." He further identified over $1 trillion in annual benefits for the U.S. economy from the deployment of dc microgrids. And he claimed that the initial investment needed to realize those benefits is a relatively modest $25 billion.

Opening the afternoon Plenary session at Darnell's Energy Summit, Alex Lidow, CEO and co-founder of Efficient Power Conversion Corporation (EPC) his vision of, "GaN: Crushing Silicon One Application at a Time." He pointed to wireless power transmission and envelope tracking in RF power systems as two of the key applications for GaN power devices.

Then he provided delegates with a "sneak preview" of the next-generation of GaN devices to be introduced by EPC. Called 'Gen 3' these new devices will feature higher-frequency operation (1-3 GHz), higher-voltage capabilities (up to 600V) and more functions on a chip such as a monolithic half-bridge configuration including drivers on a single chip.

A highlight of Lidow's talk was the introduction the EPC2016 as the newest member of EPC's family of eGaN® enhancement mode gallium nitride power transistors. The EPC2016 is a 3.36 mm-square, 100-VDS, 11A device with a maximum RDS(on) of 16 milliohms with 5V applied to the gate. This GaN power transistor delivers high performance due to its ultra-high switching frequency, extremely low RDS(on), exceptionally low QG (5.2 nC, maximum) and in a very small configuration.

Compared to a state-of-the-art silicon power MOSFET with similar on-resistance, the EPC2016 is much smaller and has many times superior switching performance. Applications that benefit from eGaN FET performance include high-speed dc-dc power supplies, point-of-load converters, class D audio amplifiers, and high frequency circuits.

Key specifications include: QG typical of 3.8nC, QG maximum of 5.2 nC, QGS typical of 0.99 nC, QGS maximum of 1.5 nC, QGD typical of 0.70 nC, QGD maximum of 1.4 nC, QOSS typical of 20 nC, QOSS maximum of 30 nC, VTH typical of 1.4, QRR of 0 nC, ID Pulsed of 45A, and ID of 11A.

"The EPC2016 is an excellent complement to our existing family of eGaN FETs. The lower gate charge and output capacitances significantly reduce the switching losses in power conversion applications," Lidow noted. Within a few years, not only will GaN devices outperform conventional silicon power switches, they will be lower in cost, driving silicon to the brink of extinction, according to Lidow.

Continuing the theme of advanced power conversion and power management technologies, Randy Malik, Senior Member Technical Staff and Distinguished Inventor with IBM talked about, "Leveraging Digital Power Management in Tomorrow's DC-Powered Data Centers ." As the first step toward the data center of the future, Malik described the energy consumption payoffs from the effective use of digital signal processors (DSPs) in digital power conversion and management.

Those benefits include: Unity Power Factor implementation for 3 Phase Boost Regulators, Faster response for Boost Regulators, Efficiency Improvements, DSP is the most cost effective way to monitor, control and measure power, Power Consumption drastically reduced due to the implementation of complex algorithms which are possible by DSP usage. And reliability improvement due to the operating of the components at the least stressed conditions in real time operating conditions.

After pointing out the current benefits from the use of digital power, Malik gave the delegates to Darnell's Energy Summit the challenge to design future data centers with a power usage effectiveness (PUE) of less than one! The lower the PUE, the better and today's typical data center has a PUE of over 1.8.

Today, an advanced datacenter may achieve a PUE of 1.33; enabled through the use of variable-speed drives for the cooling system, high-efficiency power converters, dc power distribution, and so on. Replacing traditional cooling systems with water cooling reduces the need for air movement and the associated motor drives, improving the PUE up to 1.09, according to Malik. He then challenged the audience by stating that future datacenters would have integrated photovoltaic energy generation, lights-out operation, and other advanced design and operational techniques to produce PUEs of less than 0.75! A goal recently thought to be impossible.

The 20123 Darnell's Energy Summit was a combined event featuring the Tenth Darnell Power Forum (DPF '13) plus the Fifth Green Building Power Forum (GBPF '13) plus the Fourth Smart Grid Electronics Forum (SGEF '13). DES '13 featured the next-generation of power electronic devices, architectures and systems. Each of the individual events maintained its unique identity and continued to serve different groups of stakeholders. These co-located events successfully brought together thought leaders across the areas of advanced power electronics, energy management, micro grids, the smart grid, and related topics of global importance. Planning has already begun for an even larger edition of Darnell's Energy Summit in 2014.

http://EnergySummit.darnell.com/index.php

Bringing Intelligence to Battery Management for Industrial Applications

Lithium-Ion (Li-Ion) battery technology first emerged in the early 1990s as the preferred high-performance solution for portable computing applications. By the end of the 1990s, it had become the battery of choice for mobile phones as well.

By Upal Sengupta, Staff Applications Engineer and Rajakrishnan Radjassamy, Business Development Manager, Battery Management Solutions, Texas Instruments

Introduction: 20 years of Li-Ion battery evolution
Li-Ion far exceeded the energy density of the NiCd / NiMH cells that had been available in the past, and were ideal for products that needed to be light enough to carry anywhere and last for many hours in typical use conditions. For over a decade, however, this high-performance battery technology was restricted primarily to low- and medium-power applications. While Li-Ion had extremely high energy density (watt-hour capacity) and light weight, it was relatively expensive and required precision electronic circuitry to manage and maintain the batteries within each pack (or system).

In more recent times, new variations on the traditional Li-Ion cell formulations have succeeded in developing batteries that are optimized for new and more diverse applications. Using a combination of mechanical design enhancements, new materials and chemistries, as well as improved manufacturing methods, we now have many different types of Li-Ion cells to choose from. Some are still ideal for low- and medium-power applications due to their high energy density, which means long life for continuous use. Others have been designed for extremely high-current discharge and charge rates, or much higher service life for long term performance.

Anode / Cathode variations used in Li-Ion cell designs									
Cathode Material (LI+)	Li -CoO_2	Li -Mn_2O_4	Li - $FePO_4$	Li - NMC	Li - NCA	Li - CoO_2 - NMC	Li - MnO - NMC	Li - CoO_2	Li - CoO_2
Anode Material	Graphite							Hard Carbon	LTO ("Titanate")
V_{MAX}	4,2	4,2	3,6	4,2	4,2	4,35	4,2	4,2	2,7
V_{MID}	3,6	3,8	3,3	3,65	3,6	3,7	3,75	3,75	2,2
V_{MIN}	3	2,5	2	2,5	2,5	3	2	2,5	1,5
Note: Different cell types will also have different capacity, cycle life, and current capability (not shown). Specific performance parameters can be optimized as required for different applications.									

Table 1: Different types of Li-Ion cells available today.

We are now able to select cells that have the "right" performance parameters optimized for specific applications, ranging from the traditional portable computer and mobile phone applications to higher power industrial terminals, scanners, handheld instruments, cordless power tools, electric vehicles, and large scale (stationary) server power backup applications. On the electronics front, the formerly exotic precision circuits required for Li-Ion applications are now readily available as standard components from multiple sources.

Precision electronics are critical for all Li-Ion applications
In the early days of Li-Ion cells, the electronic designs required for battery management was of some concern to equipment designers. Unlike the familiar NiCd / NiMH and lead-acid systems, Li-Ion cells could not tolerate any amount of overcharge, and could be easily damaged if they were discharged too heavily as well. Highly accurate external circuitry was required to ensure that the battery was recharged fully – but not overcharged on each use cycle. Furthermore, as Li-Ion batteries were used primarily in computing or data-centric applications, an additional category of circuit, known as the battery fuel-gauge, was required. It warned the user of impending end-of-life when operating from the battery so that any critical data (work-in-progress) could be saved before the system shut down.

The original battery monitoring circuits simply checked the battery's voltage and compared it to one (or more) pre-determined levels to decide (roughly) if the battery was full, nearly empty, or somewhere in between. This method is only accurate at very light-load currents (or during rest times where the battery is idle) because voltage readings vary significantly with load due to the internal resistance of the battery. A more accurate gauging method involves the technique known as coulomb counting. Coulomb counting measures the milliamp-hours taken from (or restored to) the battery, and maintains a running total of the battery capacity based on an initial reference point (starting from full or empty).

Over the years, the technology associated with battery fuel-gauging has been developed and refined to the point where we can accurately determine the instantaneous capacity (state-of-charge, or SOC) of the battery to within +/– 1% under most conditions. The most accurate method of battery-gauging (Impedance Track™) involves taking measurements of the cell voltage when at rest (open-circuit voltage or OCV), and comparing that to a known table of values (the Chemical ID Table). The Chemical ID table correlates a particular OCV to a particular SOC for a specific type of battery chemistry. Starting from a known SOC value, if the battery is charged or discharged, as current is flowing in either direction, the coulomb-counting circuit can then keep track of the milliamp-hours that are put into (or taken out of) the pack. The next time the pack is in an idle state, a second OCV reading (corresponding to a different SOC level) can be taken. Because we already know how many milliamp-hours correspond to the difference between the two SOC levels, we can now accurately determine the total effective capacity of the battery pack. Since we also know the present state of charge (SOC2) relative to the total available capacity, we can determine the remaining capacity in mA-Hr units as well. See Reference 4 for a more complete description of the impedance track algorithm.

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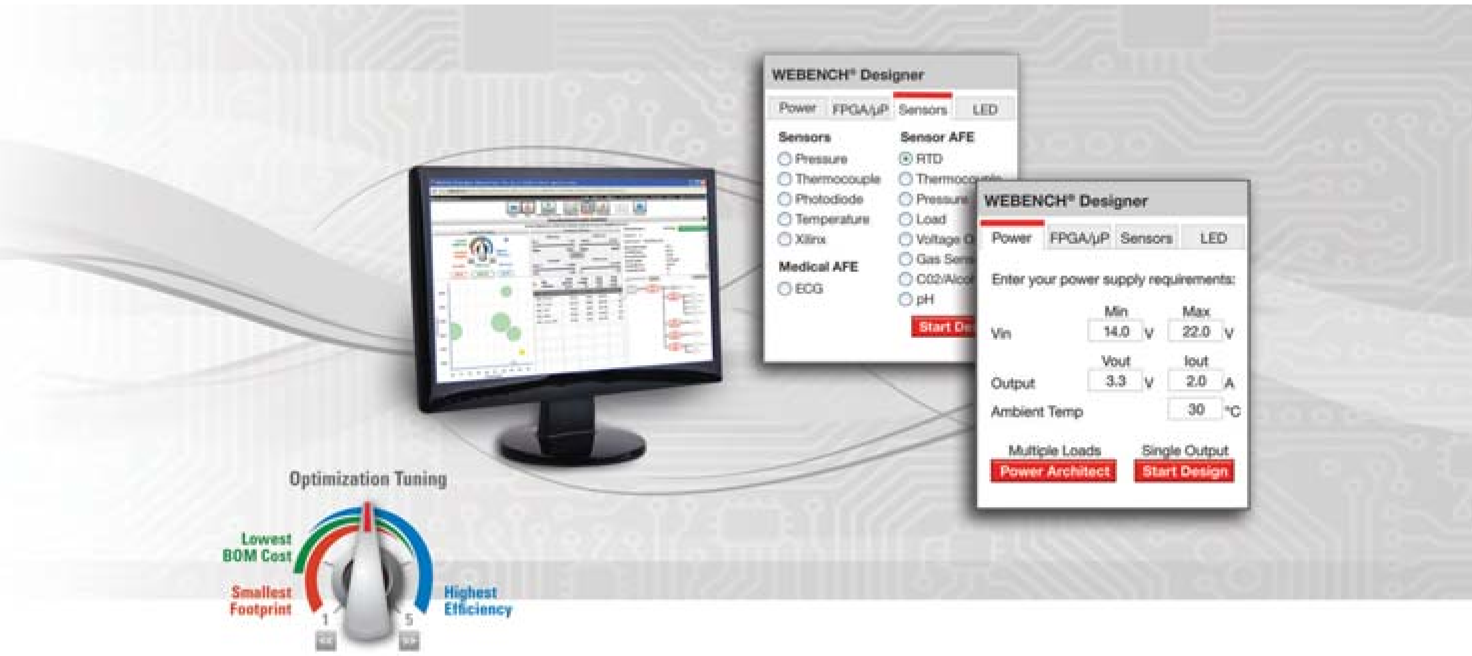

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In addition to SOC, we also want to keep track of the battery's state-of-health (SOH). SOC indicates how much charge is left before a recharge is needed, while SOH indicates when a battery will have to be replaced. For example, consider a battery which has a total fully-charged capacity (FCC) of 10 Amp-Hr to begin with. If the pack has an SOC value of 70%, there will be 7 Amp-Hr of remaining capacity available for use. As the pack ages, its effective full-charge capacity gradually decreases. After several hundred cycles, it may have a new (measured / calculated) FCC of 8.5 Amp-Hrs. This means that the pack, even after a full recharge, cannot deliver as much energy as it did when it was new. This example indicates a SOH figure of 85%. Many applications require battery replacement for SOH values lower than 75% to avoid sudden or unexpected battery failure.

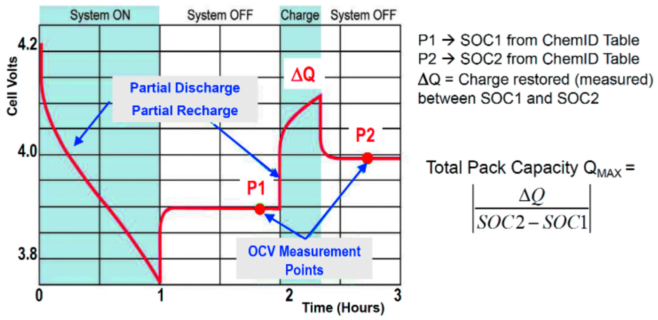

Figure 1: Impedance track capacity monitoring method

How is Li-Ion different for industrial versus consumer applications?

For consumer applications, from a battery and battery management point of view, the primary emphasis has been to develop power sources that are as small as possible while providing an adequate amount of energy. Battery management circuitry has evolved to provide the highest possible level of integration, and often can be reduced to just one (possibly two) small application-specific IC devices. An example of a multicell battery pack circuit is shown in Figure 2. All necessary functions are implemented in a single device. In our example, we used the bq20z65, with an optional redundant secondary protection device also shown.

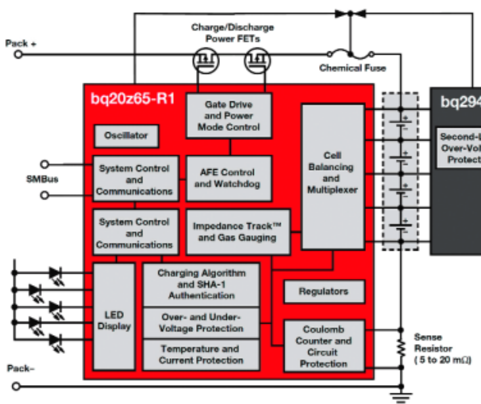

Figure 2: Typical single-chip portable computer battery management implementation

The concept of industrial applications spans an enormous range of systems with widely varying requirements. In general, we think of industrial applications as requiring more rugged, robust power sources with a high level of reliability, typically at higher power levels. The critical parameters for battery performance may vary with the specific application. In a power tool, for example, the use pattern involves intermittent short bursts of very high current discharge, separated by relatively long rest periods. In this application, high-current capability (from several Amps to 10s or 100s of Amps) is actually a more important parameter than long-term energy density. A typical user may have multiple battery packs for a tool, and will use one battery while recharging the other. When the first pack is drained, the user can swap packs to minimize down time and continue to work. Note that a high-precision battery gauge is relatively less important in this application, as there is no need to be concerned about loss of data if the tool is momentarily shut down.

The power required is achieved by using larger cells and/or stacking them in larger series/parallel combinations. Some typical cell / pack configurations for representative consumer and industrial applications are shown in Table 2.

	Typical battery pack configurations (series x parallel cells)	Typical cell capacity (mA-Hr)	Typical pack capacity (Watt-Hr)	Typical discharge rate relative to pack capacity ("C")
Mobile Phone	1s x 1p	1500 – 3300	5 – 12	< C/3
Tablet	1s x 2p, 1s x 3p	2200 – 3300	15 – 30	< C/5
Ultrabook / Notebook PC	2s x 2p – 4s x 3p	3000	65 – 130	< C/2
Power Tool	5s x 1p, 6s x 2p, 10s x 2p	2000 – 3000	50 – 200	> 2C; peaks > 20C
E-Bike	7s x 1p – 12s x 2p	3000	75 – 250	> 1C
Medium power UPS (Server Backup)	10s x 2p – 12s x 4p	2000 – 3000	200 – 500	> 2C
Hybrid Electric Vehicle	> 60s, 2p – 4p	> 3000	> 10,000	Peaks > 2C; restricted depth of discharge

Table 2: Typical / approximate Li-Ion pack configurations and capacities for different applications

For industrial applications with higher cell count, a multichip battery management solution must be considered. When large numbers of cells are used for a battery pack, the sheer number of inter-cell connections makes a single-chip gauge/protection circuit somewhat impractical. As a result, the analog functionality (cell-balancing and protection) is often implemented in one or more (high voltage) components, while the intelligence (fuel-gauging and capacity reporting) is implemented in a separate (primarily digital) IC. External voltage regulation also may be required for the circuitry used in high-voltage packs as (Figure 3).

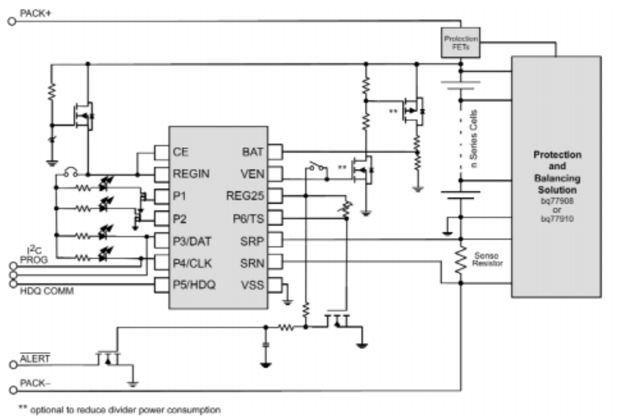

Figure 3: Typical large battery-pack management using the bq34z100 gauge plus external protection and balancing

Additional care is required in the design of larger battery packs. Higher power levels mean greater safety hazards in case of a failure or potential abuse condition such as overheating, short circuit, overload, or overcharge. If multiple Li-Ion cells in series are used, cell-balancing is a critical concern. If cells in a series pack are not individually monitored and balanced on a regular basis, it is possible for them to diverge from each other to the point where one cell will fail catastrophically, rendering the entire pack useless. Cells can diverge from each other for a number of reasons – either due to initial capacity variations (due to manufacturing tolerances), impedance variation, different initial SOC values, or exposure to different temperature levels (localized heating within a large pack). If the cells are charged and discharged repeatedly without re-balancing, the mismatch (separation between cells) gradually increases with each cycle (Figure 4).

The test data in Figure 4 shows how imbalance can grow over time as the cells are repeatedly cycled. The data shows the individual cell voltages of three cells in a three-series pack. Two cells are very closely matched – see the green and yellow traces that look almost like a single trace on the graph. The third cell is at a lower voltage, shown in pink. The pack is shut off whenever any cell falls to 3.0V, the minimum safe voltage. For each discharge, the single weaker cell will be the reason that the battery dies. Each time it is recharged, the two strong cells reach the full level (4.2) before the weak cell does. The two strong cells actually start to go into the overcharge range before the overcharge safety circuit interrupts the current at about 4.25V per cell for the strong cells. But at this point, the weak cell is not even full. So, on the next discharge, it already starts off behind the others, and once again is the first one to be drained and force a system shutdown. As the charge/discharge cycling continues, the weak cell continues to get weaker because it is charged up to a lower SOC each time. When cells are operated in an unbalanced state, the overall pack performance suffers, and the stronger cells may be subjected to overcharge abuse as shown here.

Here is a recap of some key issues associated with larger battery packs: Large battery packs mean higher voltages and currents. Load and charge current can vary over a wide range and protection FETs must be sized appropriately. Systems may have separate paths for charging and discharging, for example, power tools. Also, larger battery packs may have uneven temperature distribution during use. Uneven heating of cells leads to potential cell imbalance in the pack. As a result, multiple temperature sensors may be required for safety. Note that cell-balancing is critical.

Load and battery may be physically separated, such as with motorized equipment. Long cables will result in high inductive spikes when loads are enabled and disabled. Additionally, all battery management circuitry must be designed to handle transient overvoltage. This could be twice the maximum battery voltage or more.

Lead-acid technology is still important

Lead-acid batteries have been in use since 1859 and are still popular due to their rugged design, low cost, and better recycling infrastructure [1]. They have been the battery of choice for automotive applications such as starting-lighting-ignition (SLI) and for vehicular applications such as boats, forklifts and golf carts that involve deep discharge. With the proliferation of data servers and remote wireless base stations, battery backup has become indispensable and again lead-acid batteries have been the preferred choice for systems with high-power requirements. In all of these applications, it is essential to monitor and report the battery's SOC and SOH instead of just monitoring the battery terminal voltage. For battery backup applications, it is critical to know whether the battery can deliver the required power when called upon for service since there would be significant impact from loss of mission-critical data or wireless coverage.

As mentioned, a simple battery voltage measurement does not provide an accurate SOC of SOH indication under varying charge/discharge current and temperature conditions. The biggest impact comes from the chemical kinetics during battery charge and discharge. To get a reasonable estimate of the SOC from voltage measurement, the battery needs to rest for at least a few hours to attain equilibrium before the OCV, for example, no-load voltage, can be measured. The Battery Council International (BCI) recommended values for a 12V lead-acid starter battery are shown in Reference 2. While an approximate SOC can be assessed at rest state, it is not possible to continuously assess it during charge and discharge by voltage measurement. Also, it is not possible to assess SOH with just terminal voltage measurement since it does not fully reflect the impact from battery aging.

Measuring specific gravity (SG) of the battery electrolyte is another approximation method that is applicable to the flooded lead-acid battery type. But this method also suffers from lack of SOH information due to temperature effects, stratified electrolyte concentration, and from the need for the electrolyte to stabilize before taking the SG reading.

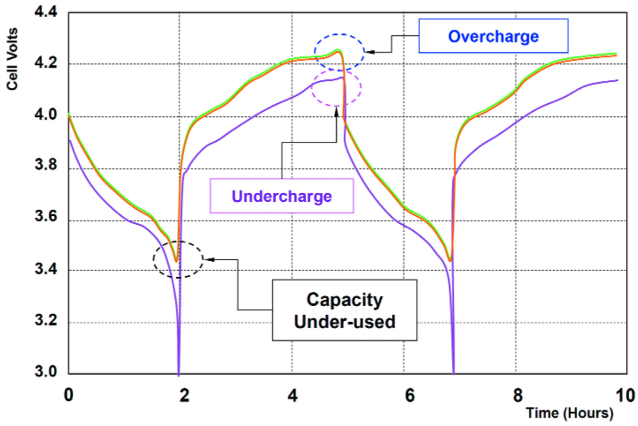

Figure 4: Cell imbalance increases with repeated cycling

Given the limitations of the above methods, there is a need for a battery management solution that automatically can make the required measurements and report both SOC and SOH accurately. TI's latest lead-acid gas gauge, the bq34z110, applies the Impedance Track™ gauging method to accurately monitor and report battery SOC and SOH [3].

Conclusions

Lithium-Ion battery technology has evolved to where it can now be used for a variety of applications beyond low-power consumer electronics. High-power cells and larger pack sizes are available, along with electronic battery management solutions optimized for larger packs. Industrial applications are finally able to take advantage of the high capacity and light weight offered by Li-Ion technology. In some cases such as chainsaws or outdoor power tools, even small gas engines can be replaced by lightweight, high-power batteries to enable easier and cleaner operation. For any application using Li-Ion batteries, precision electronics is required to ensure safe and reliable operation.

Approximate SoC	Average specific gravity (SG)	Open circuit voltage (OCV)
100%	1,265	12.65V
75%	1,225	12.45V
50%	1,19	12.24V
25%	1,155	12,06
0%	1,12	11.89V

Table 3: BCI Standard for SOC estimation of a starter battery with antimony. Readings taken at 26°C and battery rested for 24 hours after charge or discharge. [2]

For stationary or vehicle applications where low cost and durability is more important than light weight, the lead-acid battery systems remain popular. Adding smart capacity monitoring to these systems allows the end-users to be aware of their battery SOH, and know when the batteries need to be replaced or serviced. This also can simplify the maintenance aspect of large industrial battery applications.

References

1. Lead Acid Batteries, Battery Council International: http://batterycouncil.org/?page=Lead_Acid_Batteries
2. How to Measure State-of-Charge, Battery University: http://batteryuniversity.com/learn/article/how_to_measure_state_of_charge
3. Fuel Gauge for Lead-Acid Batteries: www.ti.com/bq34z110-ca
4. Download bq20z65datasheet: www.ti.com/product/bq20z65-ca.
5. Impedance TrackTM Gas Gauge for Novices, Application Report (SLUA375), Texas Instruments, January 2006: http://www.ti.com/lit/an/slua375/slua375.pdf
6. The Tail Wagging the Dog (Battery Selection Criteria), by Upal Sengupta, Battery Power, January 10, 2013: http://www.battery-poweronline.com/main/blogs/the-tail-wagging-the-dog/

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SiC MOSFET-Based Power Modules

Utilizing split output topology for superior dynamic behavior

The body diode reverse recovery charge of a SiC MOSFET is lower than that of an Si MOSFET, but still not as beneficial as with SiC Schottky diodes. As the switching performance demands for new wide band-gap components increases, so do the requirements for the commutation process. The split output topology provides an additional tool to reduce turn-on losses and boost cross-conduction suppression.

By Michael Frisch, Vincotech GmbH, Biberger Str. 93, 82008 Unterhaching (Germany)

The standard half-bridge topology's limitations

The standard half-bridge topology (see Figure 1) in power modules has its drawbacks for fast switch-ing applications.

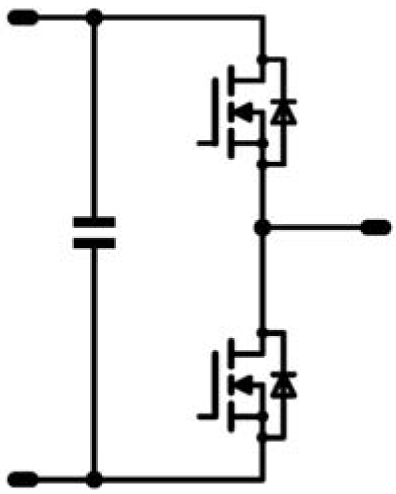

Figure 1: Half-bridge circuit with SiC-MOSFET

The body diode's reverse recovery current

If the body diode is used for freewheeling, the body diode's reverse recovery current increases switching losses (see Figure 2-1). The reverse recovery load (Q_{RR}) of SiC MOSFETs is far superior to that of Si MOSFETs. However, it is still significant for high frequency applications >50 kHz. The reverse current increases turn-on losses in the SiC MOSFET.

Output capacitance

The output capacitance of SiC-MOSFETs is relatively high. In a low inductive environment, the active MOSFET has to switch the capacitive load (see Figure 2-2) of the device, which is turned off. This in-creases turn on losses and EMI.

Cross conduction

SiC MOSFETs are designated for ultra fast switching, which causes high dV/dt at turn-on in half-bridge configurations. The voltage at the output changes from DC- to DC+ at turn-on of the high-side MOSFET. The parasitic capacitor between the drain and gate of the low-side MOSFET will induct a voltage (see Figure 2-3) into the gate of the low-side MOSFET, which could trigger a parasitic turn-on. This will cause additional significant losses.

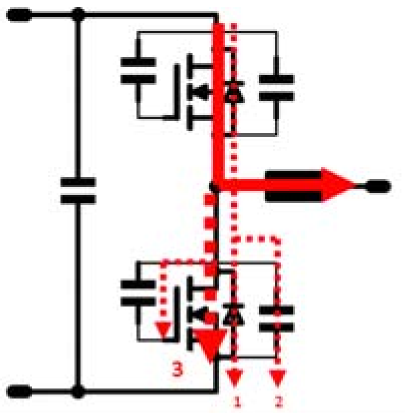

Figure 2: Parasitic action between the high-side and low-side MOSFET

Introducing the split output topology

The idea here is to separate the commutation circuit of the positive and negative half-wave or, in the case of a bidirectional DC-DC circuit, between the forward and backward conversion. The half-bridge is divided into one positive and one negative BUCK circuit (see Figure 3).

The commutation loop remains low inductive, whereas the low-side and high-side MOSFETs are separated by the inductance of the external interconnection and optional inductance connected at the output. This inductance helps transcend the half-bridge circuit's limitations.

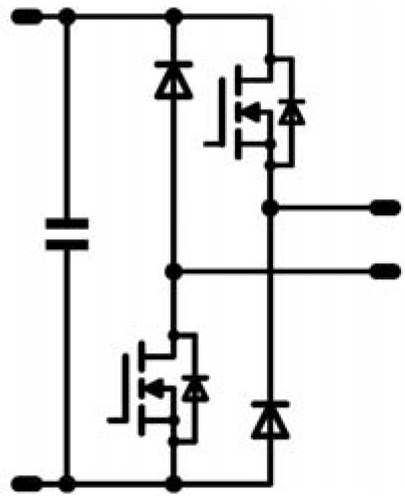

Figure 3:
Half-bridge with split output topology

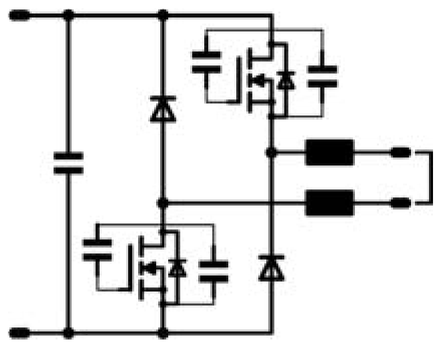

Figure 4: The split output interconnection's stray inductance severs the parasitic connection be-tween the high-side and low-side MOSFET.

The split output allows the body diode with the additional SiC diode to be deactivated. In contrast to a configuration with an Si MOSFET, the voltage drop of the body diode in SiC MOSFETs is higher than in SiC diodes. The SiC diode takes the reverse current and prevents any reverse recovery charge in the body diode of the SiC-MOSFET. The inductance at the split output (Figure 4) decouples

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Microcontrollers • Digital Signal Controllers • Analog • Memory • Wireless the high-side from the low-side MOSFET. In the case of a SiC MOSFET, the external interconnection's parasitic inductance already reduces the negative action of the output capacitance and cross conduction. At turn-on, the SiC MOSFET faces only the SiC diode with extreme low Q_{RR}. At turn-off, the commutation loop is closed with low induction via the SiC diode and the capacitor.

Synchronous rectification

In high-efficiency applications, the body diode's freewheeling efficiency improves with the MOSFET's synchronous turn-on in reverse direction, which reduces the voltage drop. This operating mode is fea-sible in a split output topology with very low or even just parasitic inductance at the output. This mode affords engineers the opportunity to reduce the size of the SiC diode to its pulse current limit. The output inductivity will delay the reverse conduction in the MOSFET by several ns.

SiC power module solutions with split output technology

The benefits of the split output have inspired a product definition that makes use of this design con-cept.

Module configuration with split output for 2-level operation

Three positive and negative BUCK circuits are combined in one module (see Figure 5) for universal use.

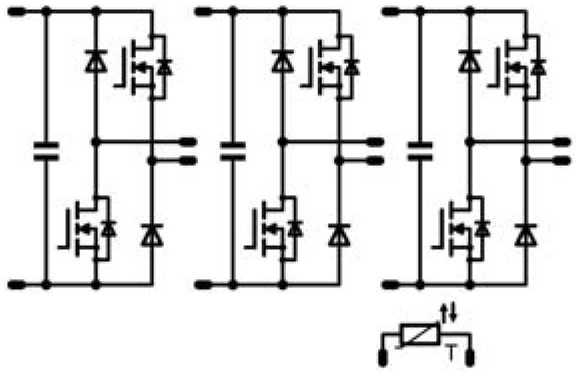

Figure 5: Module definition with a triple split output, half-bridge configuration and integrated DC-capacitors

The three circuits are not connected, which allows them to be used flexibly as individual circuits and to attach shunt resistors for current sensing. The integrated DC capacitor provides the low inductance required for the high turn-off speed of <10ns switches. This configuration may be used as a:

- bidirectional DC/AC 3-phase inverter
- or a 3-channel bidirectional DC-DC.

The successful flow 0 housing (see Figure 6) with Press-fit interconnection was chosen for this circuit's packaging.

Figure 6: Vincotech flow 0-package with Press-fit interconnection

Module configuration with split output for 3-level operation

Switches with split outputs may also be separated in mixed voltage NPC (MNPC) topologies (see Fig-ure 7). In this case, the commutation loops are sited between the DC voltages and the neutral conductor. All connections between components in the commutation loop are low inductive, although the ex-ternal interconnection's inductance is used between the high side and low side.

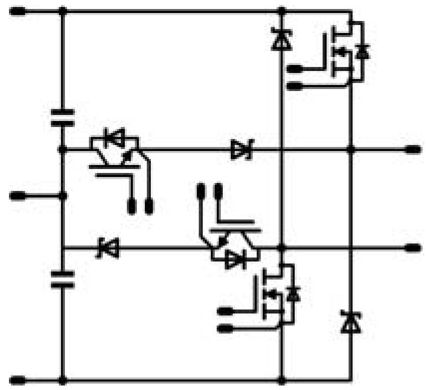

Figure 7: The flowMNPC 0-SiC module's circuit with a split output

A phase leg is integrated into a *flow 0* package as pictured here.

Performance and efficiency

The split output topology transcends all the limitations of a SiC MOSFET. The efficiency calculated from the measured switching characteristics (see Figure 8) confirms that the tested SiC MOSFET is able to outperform the SiC JFET.

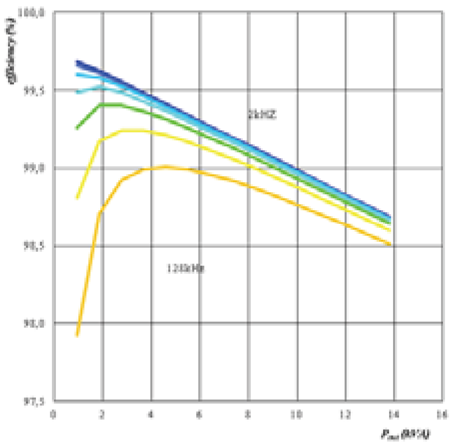

Figure 8: Efficiency per phase of a three-level flowMNPC 0 SiC module with 53 mΩ SiC BUCK MOSFETs

The inverter efficiency in an MNPC topology will achieve >99% efficiency at f_{PWM} = 64 kHz. The maxi-mum efficiency at 16 kHz is 99.5%.

Conclusion

The split output topology installed at the module level negates the limitations of the SiC MOSFET. The module behaves in inverter applications in the same way as in a boost circuit. This makes it possible to achieve better performance and efficiency than with a SiC JFET or SiC BJT – and enjoy the added advantage of MOSFET technology's simple gate drive circuit.

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How to Deal with TRENCHSTOP™ 5 IGBT in Power Applications

While the main market for power applications is still seen in the drives segment, other segments focusing on higher switching frequency ranges gained importance. UPS, Photovoltaic, and Welding Applications, to name a few, have grown significantly in size in recent years.

By Fabio Brucchi, Infineon Technologies AG, Austria

In order to respond to the respective needs, Infineon recently developed and released the TRENCHSTOP™ 5 IGBT technology especially focusing on the above mentioned field of applications.

This technology enables power system manufacturers to achieve much higher switching frequencies compared to previous Trench Field-Stop IGBT technologies.

This article provides some basic information and general hints on how to deal with Infineon's TRENCHSTOP™ 5 IGBT technology in typical power applications improving performances without impacting the product reliability.

TRENCHSTOP™ 5 main characteristics and performances

Starting from the former HighSpeed3 technology, Infineon's TRENCHSTOP™ 5 technology (TS5) allows for achieving unparalleled switching frequencies. This improvement has been possible thanks to the features, implemented within this new technology. They are:

- faster switch-off capability
- lower forward voltage $V_{CE(sat)}$ and lower turn-on losses E_{on}
- reduced device input capacitance and gate charge.

Furthermore, to respond more specifically to customer needs, the TS5 technology has been divided into the two different variants F5 and H5, respectively:

- F5 (IK_40N65F5) is the extremely fast version, best fit in combination with SiC diodes; needs split $R_{G(on)}$ and $R_{G(off)}$ and predestined to be used in applications having excellent layout routing with a total stray inductance less than 20…30nH.
- H5 (IK_40N65H5) is the fast version, intended for industrial applications like Welding, UPS and Solar and best to be used in systems having a good layout routing with a total stray inductance in the commutation loop less than 30…60nH. It can be used in combination with ultrafast silicon diodes.

Table 1 shows a summary of the main parameters of the F5 and H5 IGBT variants compared to former HighSpeed3 IGBT.

A change in key parameters shows up in a reduction of rise and fall times down to 30%, accompanied by a gate charge decrease of 60%. The device's capacitance C_{oess} is now reduced up to one third and C_{ress} is diminished by about 85%.

	Parameter	Conditions	Values			Unit
			IK_40N60H3 High Speed 3	IK_40N65F5 TS5 - F5	IK_40N65H5 TS5 - H5	
Static Characterist.	BV_{CEs}	V_{GE}=0V, I_C=2mA, Min.	600	650	650	V
	I_C	V_{GE}=15V, T_{vj}=25°C, I_C=40A	80	74	74	A
	I_C	V_{GE}=15V, T_{vj}=100°C, I_C=40A	40	46	46	A
	$V_{CE(sat)}$	I_C=40A, V_{GE}=15V, RT, Typ	1,95	1,65	1,6	V
	$V_{GE(th)}$	V_{CE}=V_{GE}, I_C=500µA	5,1	4	4	V
	g_{fs}	V_{CE}=20, I_C=40A	24	50	50	S
Input Char.	C_{ies}	V_{CE}=20V, V_{GE}=0V, f=1MHz	2,19	2,5	2,5	nF
	C_{oes}		112	50	50	pF
	C_{res}		64	9	9	pF
	Q_G	V_{CC}=480V, I_C=40A, V_{GE}=15V	223	95	95	nC
Dynamic Charact.	$t_{d(on)}$	V_{CC}=400V, I_C=20A, T_C=25°C, V_{GE}=0V/15V, $R_{G(on)}$=$R_{G(off)}$=15Ω, $L_σ$=45nH, $C_σ$=40pF, Typ.	19	21	21	ns
	t_r		33	10	11	ns
	$t_{d(off)}$		197	140	140	ns
	t_f		21	8	8	ns
	E_{on}		610	300	270	µJ
	E_{off}		290	130	160	µJ

Table 1: Comparison between 600V 40A HighSpeed3 IGBT and 650V 40A H5/F5 IGBT variants in TRENCHSTOP™ 5 technology

Switching characteristics

High switching speed technology does not automatically mean best performances in every application. It should be considered that in several cases, especially when using TS5 IGBT solutions, it is not possible to replace former high-speed IGBT technologies 1:1 with TS5, without providing any layout improvements.

To get the highest benefits from these fast switching technologies, PCB, DCB or IMS layout designs must have extremely narrow current compensation paths to get the lowest parasitic. The free-wheeling diode (FWD) and the gate loop have to be optimized as well. Moreover, the isolation materials and related thicknesses must be carefully selected to avoid EMI related issues and limitations on the maximal achievable dv/dt, which would limit the maximum switching frequency accordingly.

In situations where these two factors are not considered or underestimated, fast switching technologies may even lead to higher losses and limitations, both in turn-on and in turn-off.

Turn-off improvements

One third of the fall time than previous HighSpeed3 IGBTs, per same output current in the same application leads to three times higher di/dt. This effect may induce over-voltages which lead to additional power losses and modification of the trajectory in the switching locus.

An application with 50nH parasitic inductance, previously driven at 1kA/µs, with TS5 may experience a di/dt as fast as 3kA/µs, leading to a voltage overshoot of 150V. In this case, the 50V added to the minimum $V_{(BR)CEs}$, now rated 650V, helps to reduce the electrical stress due to voltage overshooting. Practical countermeasures to be used in the design in order to avoid undesired effects during turn-off include:

- PCB, DCB or IMS have to be designed with very good current compensation loops.
  A system design having stray inductance L_σ < 30…50nH, including leads in case of discrete device, is strongly recommended.

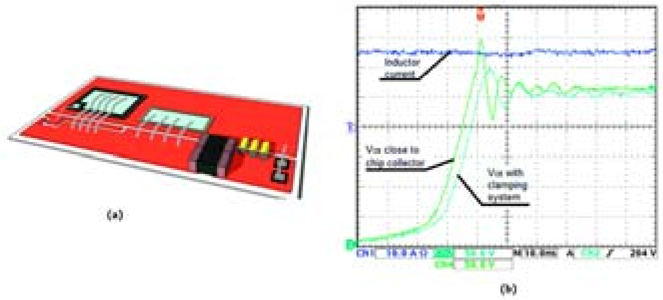

Figure 1: Recommended solution with a possible clamping network to be placed as close as possible to the IGBT/FWD. 40A/650V TS5 F5 IGBT turn-off at T_c=25°C. V_{CE} measured with clamping system (cyan, 50V/div). V_{CE} in standard conditions, R_G=10Ω, V_{GE}=15V/0V

V_{GE} [V]	R_G [Ω]	Reference: V_{GE}=+15V/0V, R_G=10Ω	
		E_{off} difference [%]	ΔV overshooting difference [%]
+15V / 0V	18	+ 10.9	- 22.6
+15V / -5V	18	- 40.8	- 48.4
+10V / -12V	55	- 32.8	- 53.6
+10V / -12V	89	+ 11.5	- 63.9

Table 2: E_{off} losses comparison in a layout having a L_σ=56nH at different driving conditions

- Introduction of Clamping Circuits
  Capacitor clamping or also other alternative clamping structures, placed as close as possible to the device, are strongly recommended. Energy recovery clamping or C-D clamping structures with SiC diode are possible options. An example of DCB substrate with integrated clamping structure and related waveform improvements are shown in Fig. 1.a and b.
- Introduction of Passive Gate Network
  Splitting the gate resistance into $R_{G(on)}$ and $R_{G(off)}$ usually helps to relief stress and avoid further power losses.
  Eventually introduction of a small gate-emitter capacitance improves control ability, but oscillations must be kept at tolerable levels and in this case a damping series resistor R_{GE} might be helpful.
  In some situations, a small ferrite beat directly at the gate pin might help to filter undesired oscillations at very high frequencies.
- Negative gate voltage with a slightly increased $R_{G(off)}$.

In case of relatively large parasitic inductance, a good compromise might be to increase $R_{G(off)}$ and to drive at the gate using negative voltage.
E_{off} and ΔV overshooting for an IKW40N65H5 was measured in a welding machine application at I_c=20A, T_{amb}=25°C, V_{CE}=360V, L_σ=56nH. In Table 2, are listed the results at different V_{GE} and R_G values, using per reference E_{off}=131µJ and a voltage overshooting ΔV=97V resulting from a condition of V_{GE}=+15V/0V and R_G=10Ω. Within this approach and using proper $R_{G(off)}$ vs. V_{GE} compromise, it is possible to reduce E_{off} and to reduce voltage overshooting, also avoiding parasitic turn-on.

Turn-on improvements

IGBTs historically suffered from high E_{off}. But now, TS5 offers a dramatic reduction of E_{off} losses. Therefore, the attention of the designers is recently focusing on E_{on}.

One third of the rise time than previous HighSpeed3 IGBT technology may reflect in oscillations and large I_{RRM} on the paired FWD. In some conditions, this may lead to higher E_{on}, EMI and RF emissions. Practical countermeasures to be used in the design in order to avoid undesired effects during turn-on include:

- Selection of a FWD with optimized reverse recovery performance. Test results using the same TS5 F5 IGBT at different diode combinations can be verified in Figure 2.c.
- Splitting the gate resistance in $R_{G(on)}$ and $R_{G(off)}$.
- Selection of the proper package when using TS5 in discrete components.
  4-Leads-PTH and SMD packages at high current ratings as shown in Figure 2.a and Figure 2.b should be preferred since offer great benefits in $t_{(on)}$.

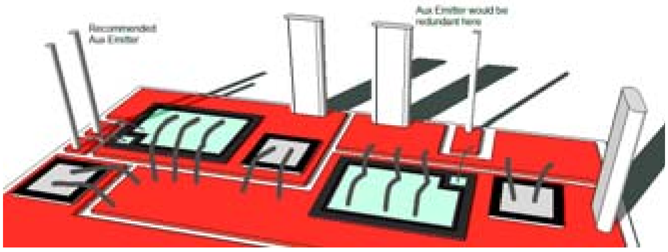

Figure 3: Example of a DCB layout with, and without, auxiliary emitter terminal

- Shorten the IGBT/FWD power loop. Especially in DCB and IMS module design.
- Use auxiliary emitters, especially in DCB or IMS design, mainly for the top side IGBT.
  Figure 3 shows an example of DCB design which uses an auxiliary emitter on the top side IGBT.
- Use an integrated clamping circuit very close to the device, especially on DCB and IMS solutions.
- Avoid the use of double stitch or butterfly bonding between IGBT and FWD, rather prefer solutions as depicted in Figure 1.a wherever possible.
- Multiple paralleling is not recommended, but in case of necessity, use separate gate network and buffers close to the gate of the device.

Introduction of the above mentioned countermeasures allow to fully exploiting the potential and the high performances of Infineon's new TRENCHSTOPTM 5 IGBT technology.

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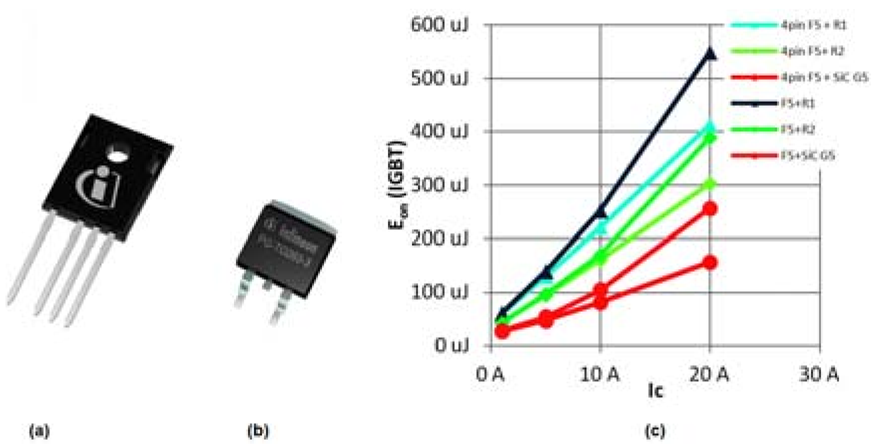
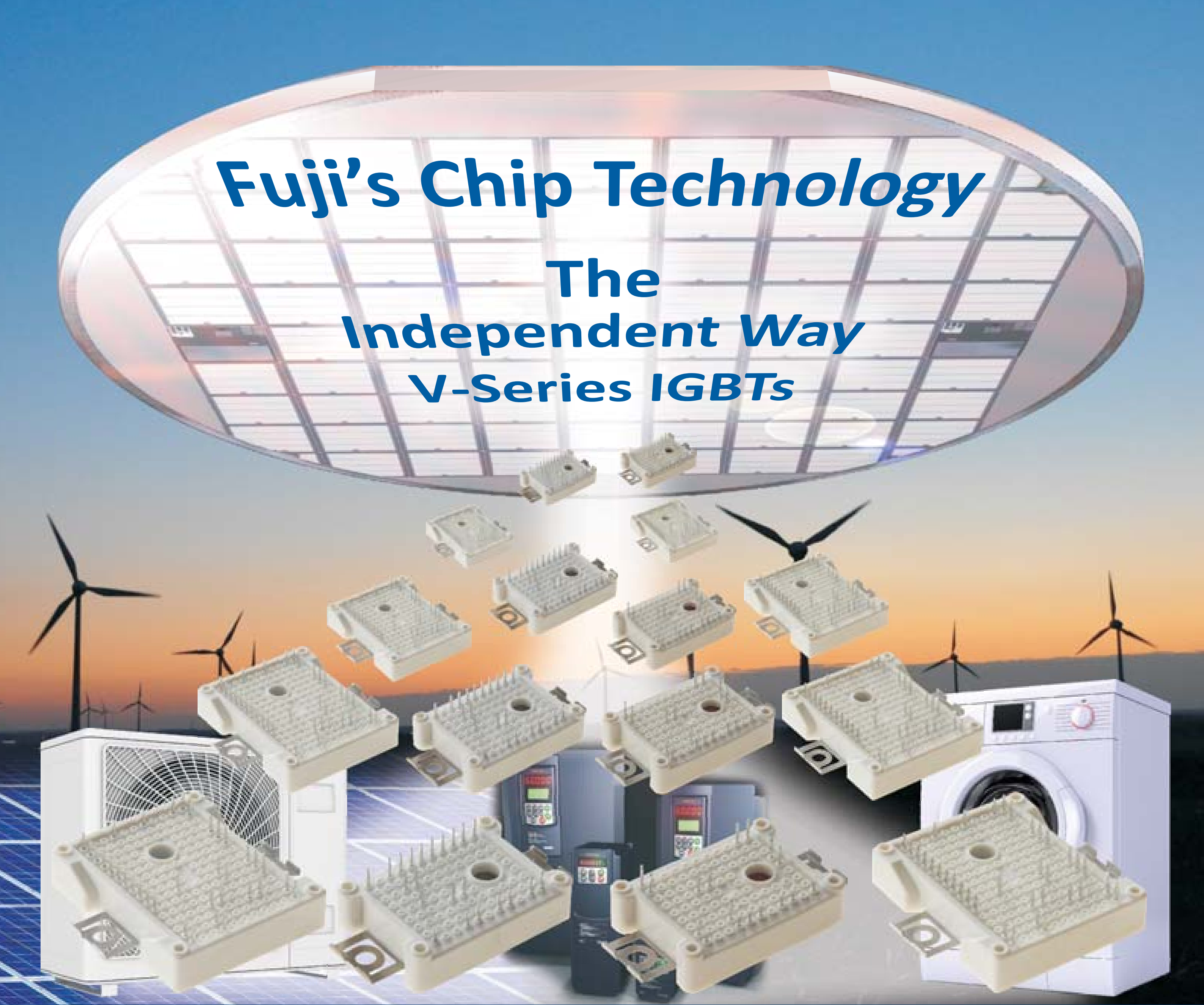


Figure 2: (a) TO-247-4 Leads package, (b) TO-263 (D²Pak) package, (c) Turn-on switching losses of a 650V 40A IGBT F5 device at T_C=100°C, R_G=10Ω and V_{GE}=15V at different combinations of package and FWD (R1=Rapid 1, R2=Rapid 2, SiCG5=Silicon Carbide diode 5th Generation).



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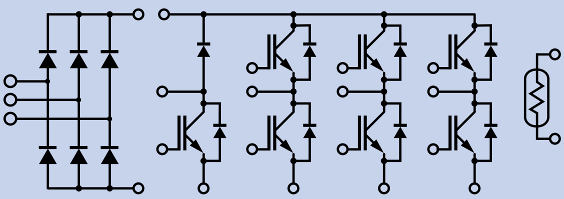

✶ 6-Pack configuration is under development

With solder pins

Package	I_C	600V	1200V
 12 33.8 48	10A	●	●
	15A	●	●
	20A	●	
	30A	●	
 12 56.7 48	15A		●
	25A		●
	35A		●
	50A	●	

With PressFit contacts

Package	I_C	600V	1200V
 12 33.8 48	10A	●	●
	15A	●	●
	20A	●	
	30A	●	
 12 56.7 48	15A		●
	25A		●
	35A		●
	50A	●	

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Multiphysics simulation for designing laminated busbars

Improvement of IGBT characteristics switching at higher frequencies has been a decisive factor in the development of smaller, more efficient power electronics converters. Today, the lowest possible system inductance is paramount to push today's state-of-the-art converters to their peak performance.

By Antoine Gerlaud, Mersen St Bonnet France, Tom Giuliano, Mersen Rochester USA and Fabrice Hamond, Mersen, St Sylvain d'Anjou France

Introduction

Improvement of IGBT switching characteristics at higher frequencies has been a decisive factor in the development of smaller, more efficient power electronics converters. Today, the lowest possible system inductance is paramount to push state-of-the-art converters to their peak performance.

Laminated bus bars are a response to this goal. High switching frequencies will result in significant commutation losses if stray inductance is not kept at very low levels. Mutual inductances can be minimized by thinning and bringing conductors as close together as possible. Furthermore, laminated bus bar helps to incorporate all components of a power module into a single structure, which will contribute to cost effectiveness and efficiency. Converters will be more compact, as well as faster and easier to assemble, resulting in an optimal design for manufacturability (DFM). As well, the bus bars will eliminate the likelihood of installation errors. Compared to the traditional cable, bus bar will improve heat dissipation and keep the converter cooler while carrying the same level of current. Overall, laminated bus bars offer a great deal of benefits to the power electronics converter design engineers, especially if their design is integrated in the early stage of the project.

MERSEN (formerly ELDRE) is a specialist of custom designed bus bars with over 60 years of technical expertise. Historically, products were developed based on hand calculations, and a comprehensive know-how. However, as designs are becoming increasingly more complex, analytic calculations become impossible to solve, especially from the thermal point of view. To shorten time to market, while maintaining top quality and controlled costs i.e. the right material and/or thickness for the application addressed, thermal simulations are becoming a deciding tool when developing a custom laminated bus bar.

Why use simulation?

The most reliable way to make sure that a bus bar respects its specifications is to build a prototype and test it in operating conditions. But as reassuring this solution would seem, it also present several drawbacks. The metal cutting and surface finishing are unique to each design. The tools used to bend some intricate shaped products have to be tailor-made. The insulating material layers have to be specially crafted for the tested geometry. The matrix used to laminate the assembly has to be tailor-made as well… All those adding costs cause the global price to increase for a bus bar that might not be validated by the tests.

Building a prototype is also time consuming, due to the number of various specialized operations involved, and can sometimes be incompatible with the client deadline. Once the prototype has been finalized, running the test itself is not so easy, especially as the worst case scenario has to be investigated. High temperature, complex or high current electrical client conditions might not be easy to recreate. Oversized constructions do not fit in a typical environmental chamber. The test can therefore turn out expensive and add unnecessary study time.

That's why simulation is a handy tool to boost development processes. By adding pre-test steps in the conception phase, design flaws can be spotted and eliminated before going through the prototype manufacturing process. Overheating areas or overly thick plates are not always clear to determine by calculations.

Computer generated temperature maps are very appealing and easy to understand: “a picture is worth 1000 words”. It is more encouraging for the client to get preliminary tests results before ordering a prototype, and to have a back and forth exchange to adjust its initial design. However, simulation is not meant to replace tests entirely. The quality of the calculated results is only as good as the input data and understanding of underlying physics.

Simulation process

Mersen is using COMSOL Multiphysics, a finite element software. Finite element method is based on iteratively solving equations locally until reaching whole stability. One of its main strong points is that it can be used to solve partial derivative equations modelling different physics simultaneously.

COMSOL is structured as a modular platform, with a basic version addressing typical physical phenomenons such as structural mechanics, heat transfers, electric currents, laminar fluid mechanics, acoustic, etc... More specialized (and optional) modules range from corrosion study to plasma physics. This tool is used by both study engineers and researchers, and the underlying equations can be controlled to an in-depth level.

- Most simulations start with a 3D geometry model provided by the client, usually in the form of a .stp file. If necessary, the design is modified, for clearance or creepage distance for example, or if the thickness of the conductive material is obviously not adapted. Some time, several possible geometries are investigated.

- As it was said earlier, the physical equations are solved locally. To be able to take into account the geometry, we have to divide spatial domains (or surfaces in the case of a 2 D problem) into small meshes, for whose knots we will calculate the value of each studied variable at each iteration (in the case of a stationary study) and each time (in the case of a transient study).

An adapted mesh is mandatory, as a too coarse mesh might hinder the convergence of the simulation, and as the number of elements and knots is limited by the system memory and computing capacities. In COMSOL the mesh is built automatically, depending of the physics used in the model. However, in the case of laminated bus bars, this operation can sometimes be problematic, because we are dealing with very thin and wide layers, not counting drawing mistakes. Redrawing parts and de-featuring the original model is often necessary to get an exploitable mesh.

The next step is very important: defining the physics involved.

In the case of our thermal simulations, we are aiming to prevent the bus bars from reaching high temperature caused by joule heating, for example 105°C being the typical PET limit or a limit set by the end customer.

The current distribution is determined according to client specifications. The easiest way to model it is to calculate currents RMS values and to treat them as direct currents. With this approach, we can set a stationary model of current repartition. When currents gets more complex, especially in the case of currents of different frequencies going through different inputs or outputs, a transient model is required to account accurately for the fact that currents of different frequencies doesn't add up directly. The electrical phenomenon time scale being different than heat transfers time scale, a transient study has to be conducted to calculate the current density map before the stationary heat transfers study.

Current density leads to heating. Cooling is usually accounted for by three phenomenons. The first is conduction, and is done by solving the heat equation. The second is radiative heat transfers calculated from Stephan-Boltzmann law. Plastic is radiating much more than oxidized metal, which is radiating more than polished metal. The third is convection and is less straightforward.

Furthermore, simulating a complete air volume with fluid mechanics is possible, but memory and computing power can be expensive. Meshing the air is again very difficult, as the air mesh has to be continuous with the bus bar mesh. The finite element method is also not the best to solve this kind of problem. The best way to address it swiftly is usually to calculate mean heat transfer coefficient depending on temperature, based on the client operating conditions.

However, fluid mechanics is used in the case of water-cooled bus bars, by modelling laminar water flows in the pipes. Conduction means a water cooled bus bar will take the heat away from the circuit.

Of course, well defined material properties and current condition are paramount to run an accurate simulation. Simulation can, in fact, vary significantly, depending on environmental conditions (temperature, pressure, etc.), the metallic alloys and dielectric materials (PET, Nomex, Kapton, etc.) used. To achieve an accurate simulation will require clear understanding of the final application.

Examples

As we saw earlier, the thermal simulations can be used in a numerous situations. The earlier the simulation is integrated to a project the better, see example fig-1 and fig-2. Numerical calculation can also intervene later in the product life time. For example, to determine causes for product failure, or to study if a given design could be used for another application and/or higher current rating and/or surrounding temperature conditions. The main goal is to validate if the proposed design meets the client specifications. High current density zones can be spotted with little calculation, but evaluating the temperature reached by the bus bar is much more difficult.

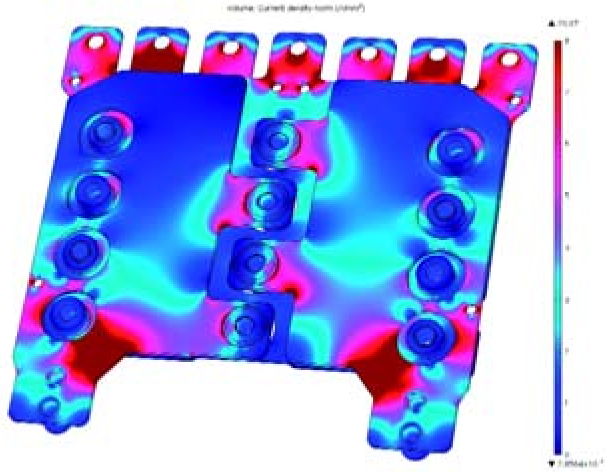

Figure 1: Simulation is integrated to a project

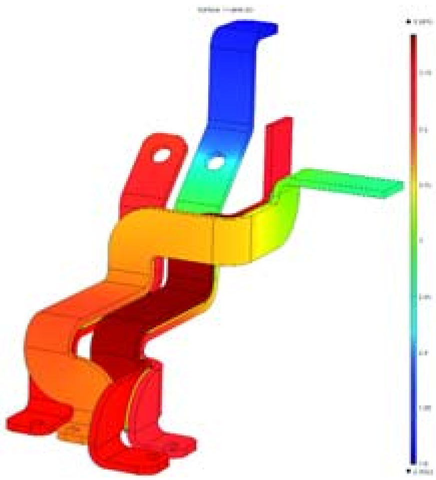

Figure 2: Simulation is integrated to a project

The client is usually not a bus bar specialist so adjustments can also be proposed to reduce heat that exceeds allowable temperature rise. Propositions such as: increasing cross sectional thickness as well as increasing the conductor width in high current density areas. As shown in fig-3 a design change will help removing hot stop on bus bar. Conversely, if the bus bar has been designed with too much caution, a cheaper and thinner version can be studied to offer a more attractive price.

The material can also be a decisive factor. Aluminium is cheaper and has a better conductivity / mass ratio than copper. Aluminium is a choice often proposed during quotation. Simulations are perfect to provide precise information to the customer. Having accurate and detailed information on each available solution is extremely valuable when determining a thickness/material couple for a prototype.

As shown in fig-4, we learned earlier, the possibility of using a water-cooled laminated busbar can also be investigated, which can provide an alternative design option. The simulations have been compared to real tests and typical differences of less than 2 K have been measured. More variations can be found for very small bus bars or near electrical connections areas where the kind of wiring chosen for the test has a significant influence on simulated results. A poorly chosen connector can heat the product or conversely act as a heat sink, and not match the simulation.

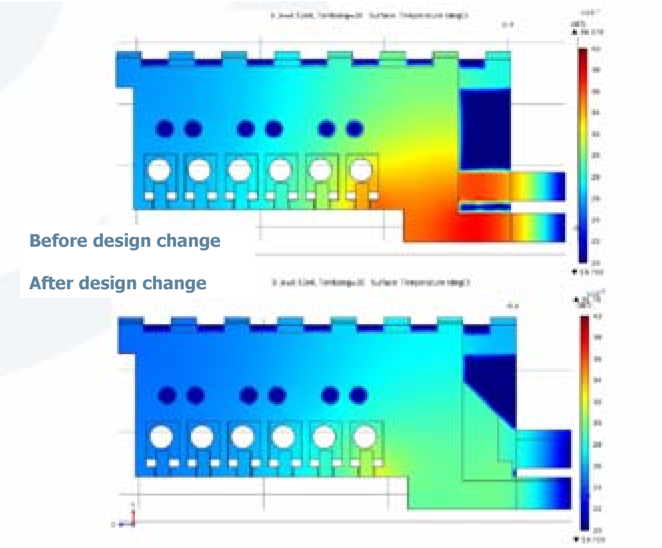

Figure 3: Design change will help removing hot spot

Future development

Thermal simulations are only the beginning. Multiphysics modelling has a wide range of applications. Electromagnetic effects, such as the skin effect, or mutual inductance effects can be modelled and studied for applications implying high frequency/high intensity currents. Information valuable for the customer, such as the stray inductance of the product, can be calculated by Mersen.

Conclusion

We still have to keep in mind that cost, size and weight continue to be primary requirements in the world of power electronic applications. Smaller size leads to lower cost, lower parasitic inductance therefore lower watt dissipation, permitting higher converter operating frequency thus reducing the size of the capacitor and inductor passive components. Mersen thermal simulation offer is significant to support this goal in bus bar design. Our thermal modelling approach has been confirmed through physical measurement. Overall, our method is reliable and able to provide a high level of added value to a client/bus bar producer relation. Also, Mersen thermal bus bar offering will reduce customer product time to market by decreasing drastically the number of necessary prototypes.

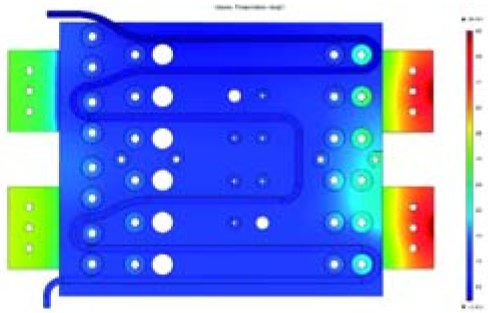

Figure 4: Water-cooled laminated busbar can provide an alternative design option

Mersen cooling, bus bar and fuse bundle offer is helping our customer achieve this goal. Our high thermal performance heat sink combined with our bus bar design capabilities and simulation will help compact the size of the cooling plate thus the bus bar and ultimately the converter. Again, a passive components specialist like Mersen and its newly implemented specification team of engineers brings much added value to the converter design if integrated in the project at an early stage.

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Power Block Innovations Enhance Synchronous Buck Converters

Dual MOSFETs in PQFN packages, containing optimized synchronous and control MOSFET devices, enable designers to enhance the efficiency and power density of synchronous buck converters. A new evolution of the dual PQFN package featuring a single-clip connection to both MOSFETs, called power block, introduces an innovative internal structure that further increases efficiency while also helping improve EMI performance and enhance reliability

By Steve Oknaian, International Rectifier Corporation

Synchronous Buck Design and Optimization

As energy efficiency becomes an increasingly important consideration in the design of networking and communications equipment, such as servers, storage, routers, switches and base stations, engineers have adopted synchronous buck converters to increase the efficiency of the power system. Point-of-load converters are examples of such systems.

Unlike a conventional buck, the synchronous buck converter utilizes a MOSFET (synchronous FET) in place of a conventional freewheeling diode. Due to zero voltage switching of this synchronous FET and its low on-state voltage drop, switching losses and losses due to high voltage drop of the conventional diode are eliminated.

To help streamline design, semiconductor vendors have positioned newer families of pairs of devices, optimized for control and sync FET sockets, which allow designers to take advantage of advanced high-efficiency packages such as Power Quad Flat No-lead (PQFN) in various sizes such as 3x3mm, 4x5mm, or 5x6mm. Examples include IR's IRFH4234 and IRFH4210D in PQFN 5x6, for control FET and sync FET application respectively. These devices feature low gate resistance and Miller charge, for use as the control FET, and ultra-low on-state resistance required of a sync FET, and an integrated Schottky diode displaying low conduction and reverse-recovery losses.

Moreover, dual devices combining both the control FET and sync FET in a single package now enable engineers to further simplify circuit board designs and build smaller converters offering greater power density. Many power semiconductor manufacturers offer dual PQFN devices.

Dual MOSFET Package Design

In a conventional dual PQFN package, the sync and control FETs are placed side by side with the drain connections both facing down and connected directly to exposed drain pads on the leadframe (LF) underside. The source connections on the top-side of each die are connected to the leadframe source pads via copper clips. Figure 1a illustrates the cross section of a two-clip dual PQFN package. Although the copper clip technology enhances thermal performance compared to more mature package technologies, such as dual SO-8, typical two-clip devices do not have optimum pin-outs for minimizing system parasitic inductance and are not economically structured for optimal heat dissipation.

Figure 1a: Conventional two-clip dual PQFN package construction featuring individual clips connected to sync (LS = Low-Side) MOSFET and control (HS = High-Side) MOSFET, (LF=Leadframe).

IR's new family of power block devices utilizes a proprietary single-clip dual PQFN package, as shown in figure 1b, which overcomes these disadvantages. By connecting the control FET (HS MOSFET) source and the sync FET (LS MOSFET) drain with one clip, this package architecture improves performance and minimizes package parasitics. By allowing the source connection pad of the sync FET to be positioned closer to the drain connection pad of the control FET, the single-clip package achieves optimum input bypassing between input and ground of the synchronous buck circuit. This patented [1] implementation of the sync buck FET combination in one package has been implemented in IR's portfolio since 2006, originally in iPowIR products and more recently in IR's award-winning PowIRStage products.

Figure 1b: Advanced single-clip dual PQFN package

The key to realizing these improvements lies in flipping the sync FET such that its source is in contact with the leadframe. In addition, to further reduce the effect of the overall package/parasitic inductance on switch-node ringing, and so allow faster switching, a separate source connection links the control FET to the gate-driver return. This additional source connection eliminates the adverse effect of common source inductance on the switching performance of the control FET.

Common source inductance is defined as the inductance shared by the gate-driver current path and the main power transfer path. It can be a combination of the package inductance and/or PCB trace inductance. In a synchronous buck topology, the high-side MOSFET is hard-switched. With hard-switching, the switching loss is proportional to the turn-on and turn-off time intervals. Increasing turn-on and/or turn-off time will increase the converter's switching losses. The control FET common source inductance, represented by Q1 LS in figure 2a, increases the turn-on and turn-off times. When the control FET is trying to turn on, the drain-to-source current in the control FET increases, and a positive voltage (VLS) proportional to the rate of MOSFET current increase is induced across the common source inductance. This induced voltage reduces the effective gate-to-source voltage, which slows down the MOSFET turn-on. During turn-off the rate of MOSFET current increase is in the reverse direction, which induces a negative VLS voltage across the common source inductance that effectively prevents the control FET from turning off quickly.

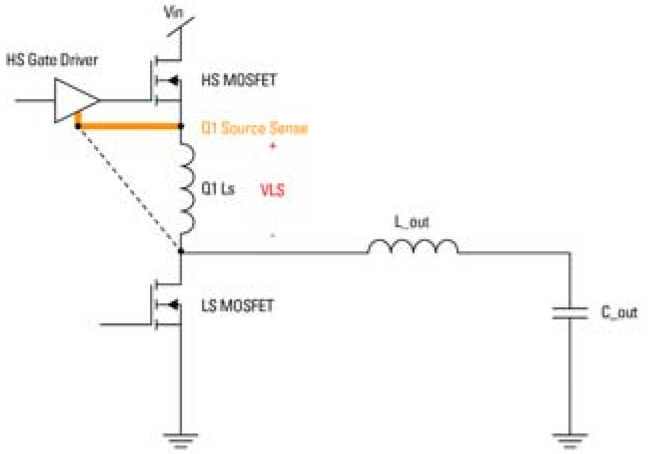

Figure 2a: Control FET common source inductance in a synchronous buck converter

The additional source connection provided by IR’s power block devices eliminates the effect of common source inductance, thereby improving switching performance, by allowing the gate-driver voltage to be applied directly to the source bypassing the connection through the package and the PCB. This source connection is highlighted in figure 2a.

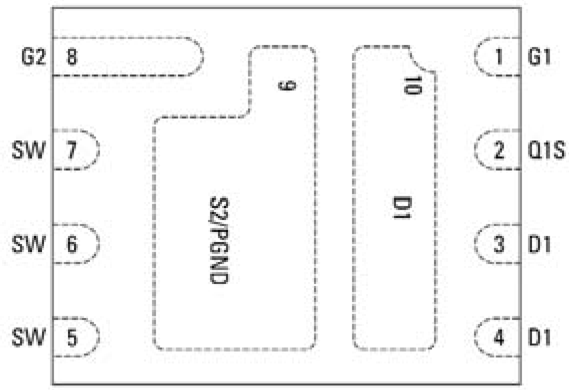

Figure 2b: IR power block bottom view

Figure 2b shows the bottom view of IR power block. It is pin 2 (Q1S) which is designated for connection to the driver return.

Figures 3 and 4 illustrate the effectiveness of the source sense connection by comparing the switching waveforms and efficiency achieved with and without the source sense. Figure 3 shows that the switching time is shorter when the source sense wire is connected, while figure 4 shows a significant improvement in efficiency when the system is operated with the source sense connection.

Optimized Pin-Out

The pin-out configuration of IR's power block family allows the designer to minimize the input bypass current path, thereby reducing the parasitic inductances associated with the MOSFET package and PCB traces. This greatly reduces switch-node ringing caused by resonance between the parasitic inductances and the MOSFET's output capacitance, enabling the designer to meet system EMI requirements, improve thermal management and select devices having lower breakdown voltage.

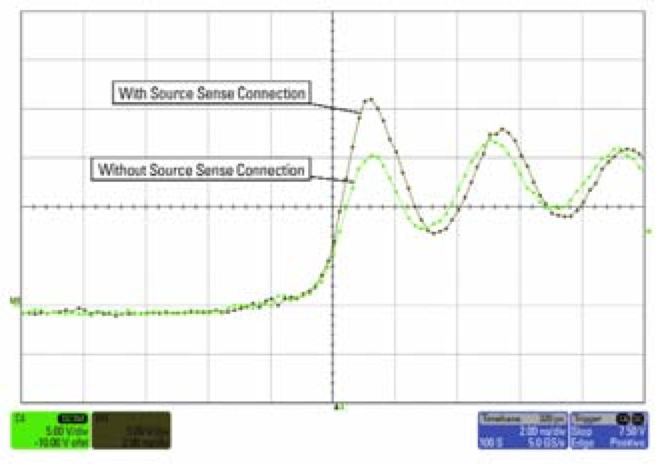

Figure 3: Switch-node waveform comparison with and without source sense connection

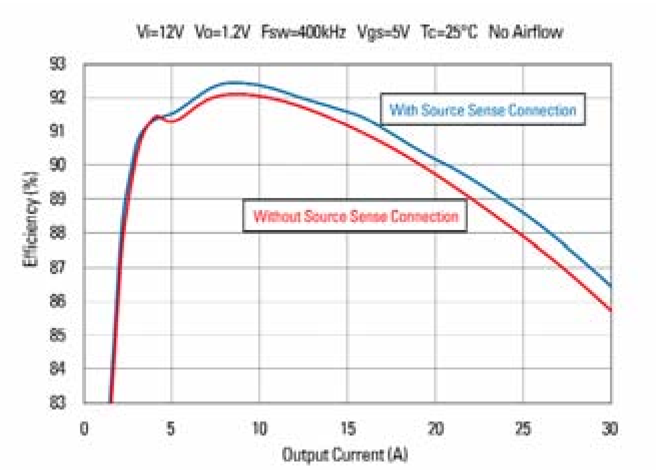

Figure 4: Efficiency comparison with and without source sense connection

From the thermal management point of view, the single-clip package allows the synchronous FET source to be in direct contact with the PCB, creating a path of low thermal impedance for optimal heatsinking.

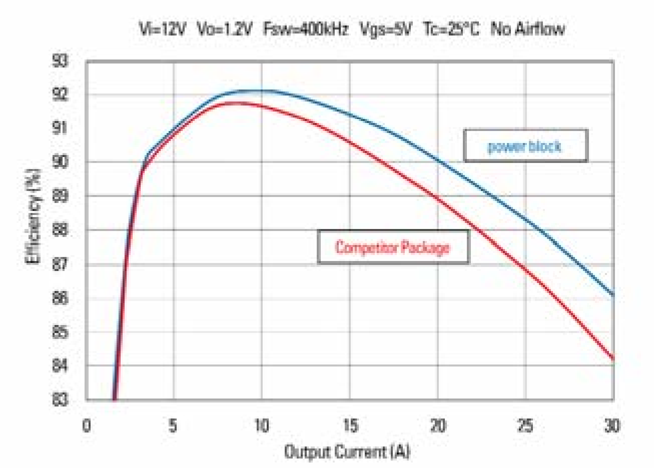

Figure 5: Electrical comparison: efficiency of conventional two-clip package vs IR's single-clip power block

Figure 5 shows the effects of the single-clip package on electrical and thermal performance by comparing single-clip and conventional two-clip devices containing control and sync FETs with identical parameters. Since the MOSFETs are identical, any differences in performance are due to the package design and the pin-out. The performance of the single-clip device shows a striking advantage over the conventional two-clip dual-MOSFET package, boosting efficiency by as much as 1% while also reducing the operating temperature by 13°C.

Conclusion

The internal structure of the single-clip dual PQFN power block allows the source pad of the sync FET to be positioned between the input and switch-node pads resulting in improved bypassing, reduced electrical losses and increased thermal performance. In addition, the unique return connection pin from the low-power control FET source to the driver enables increased switching speeds. IR's power block devices in this package, containing pairs of MOSFETs optimized for synchronous buck applications, are being used in a variety of single-output and multiphase applications to improve performance, efficiency and reliability.

[1] Christopher Schaffer, "High power MCM package" US Patent No.: 6,946,740,B2, issued Sep 20, 2005

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EconoPACK™ 4

The world standard for 3-level applications

The EconoPACK™ 4 is an optimized module for 3-level applications like

- Uninterruptible Power Supply
- Solar Inverter
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where a robust design, high efficiency and less harmonics are needed.

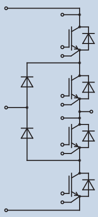
For these applications starting with 50 kW up to 125 kW, the EconoPACK™ 4 can be used to build up one phase. For higher power ratings modules can be switched in parallel. All modules are equipped with the state-of-the-art IGBT4. Further information are available on request.

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

- EconoPACK™ 4 NPC2 topology for low and medium switching frequencies (approx. $f_{sw} < 12$ kHz)
- EconoPACK™ 4 NPC1 topology for high switching frequencies (approx. $f_{sw} \geq 12$ kHz)

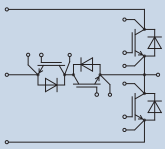
NPC1 topology

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



NPC2 topology

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



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Using Advanced Active Clamping to Facilitate Simple, Safe and Reliable IGBT Driving in Multi-Level Topologies

The Advanced Active Clamping (AAC) functionality implemented in CONCEPT's SCALE™-2 technology allows multi-level converter topology designs to be simply and safely driven. In the event of an IGBT short circuit, all IGBTs no longer have to be turned off in a dedicated sequence to avoid excessive IGBT collector-emitter voltages. Instead, the AAC function limits the maximum collector-emitter voltage of the IGBTs to a safe level, enabling the IGBTs to be simply turned off as soon as the fault condition is detected. This advanced functionality is illustrated using analysis performed on a 2SC0108T2D0-07 (650V/1W/8A) driver core (Figure1).

By Olivier Garcia, CT-Concept Technologie GmbH

Multi-level converters

Multi-level and especially 3-level converters in a neutral-point clamped (NPC) topology (Figure 2 right) are an interesting alternative to 2-level converters (Figure 2 left) in many applications including solar, wind power or traction converters [1]. In solar applications, 3-level converters allow lower voltage IGBT modules to be used to achieve the same output voltage and power. Also, the total harmonic distortion (THD) of the output current and voltage as well as the size of passive components such as output inductors or DC-link capacitors can be reduced. The overall system efficiency can also be optimized.

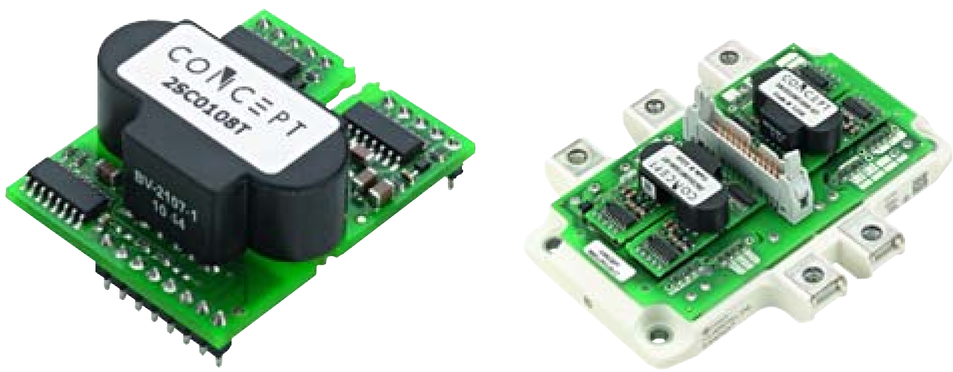

Figure 1: 2SC0108T2D0-07 driver (left) and 2SC0108T2D0-07 driver (right) on a driver board used to drive a 3-level NPC IGBT module

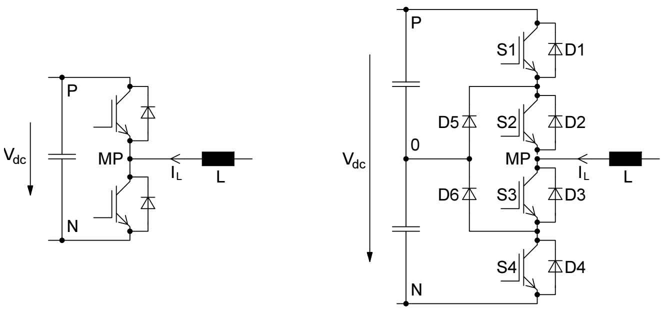

Figure 2: Half-bridge 3-level NPC topology (right) versus half-bridge 2-level topology (left)

However, specific commutation sequences must usually be employed, because the IGBTs are designed to withstand only half of the full DC-link voltage in the off-state. Without the aforementioned specific commutation sequences, the full DC-link voltage may be applied to a single switch, leading to its destruction unless specific counter-measures are used. This is especially likely in the case of an IGBT short circuit. CONCEPT's Advanced Active Clamping functionality – a feature of the company's SCALE-2 technology - efficiently addresses this issue.

Advanced Active Clamping (AAC)

Active Clamping has been widely used for many years to limit the collector-emitter voltage of an IGBT during the turn-off event [2]. The IGBT is partially turned on as soon as its collector-emitter voltage exceeds a pre-defined threshold. The IGBT is then maintained in linear operation, thus reducing the fall rate of the collector current and therefore the collector-emitter over-voltage.

Basic Active Clamping topologies implement a single feedback path from the IGBT's collector through transient voltage suppressors (TVS) to the IGBT gate (see Figure 3 left). In SCALE-2's Advanced Active Clamping (AAC) from CONCEPT, feedback is also provided to the driver's secondary side at pin ACL (see Figure 3 right): as soon as the voltage on the right-hand side of the resistor R1 increases due to the active clamping activity, the turn-off MOSFET of the driver connected to GL is progressively switched off [3]. This reduces the charge that flows away from the IGBT gate to COM over the turn-off gate resistor $R_{g,off}$. The result is a reduced IGBT turn-off over-voltage ΔV_{ce} as well as reduced TVS losses [4].

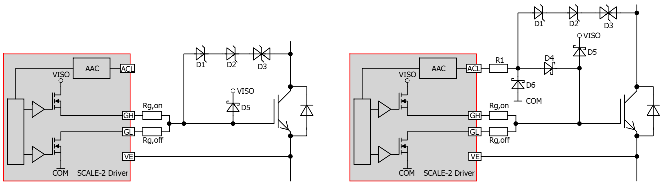

Figure 3: External circuit for Basic Active Clamping (left); Advanced Active Clamping (AAC) using SCALE-2 technology (right)

Effectiveness of AAC in 3-level Topologies

Thanks to the powerful $V_{ce,peak}$ voltage limitation provided by AAC, dedicated turn-off sequences no longer need to be applied in the event of IGBT short-circuits in 3-level or multi-level topologies. As soon as an IGBT driver detects a fault condition (e.g. IGBT short circuit), it turns off the corresponding IGBT module immediately regardless of its position in the converter topology, and a fault signal is transmitted to the user interface within about 450ns. If an incorrect turn-off sequence is then applied, the AAC safely limits the maximum V_{ce} voltage of the corresponding IGBT. The host controller needs only to apply a common turn-off pulse to all IGBTs to avoid thermal overload of the IGBT drivers.

To illustrate this concept, measurements were performed using an Infineon F3L200R07PE4 650V/200A 3-level NPC1 IGBT module with CONCEPT's 2SC0108T2D0-07 SCALE-2 driver. 2SC0108T2D0-07 drivers belong to CONCEPT's 2SC0108T driver family and include the following extra features when compared to the basic 2SC0108T2A0-17:

- AAC is implemented
- The susceptibility to magnetic fields has been dramatically decreased to allow safe operation directly on top of IGBT modules, as shown in Fig. 1, right.
- The reference voltage for desaturation protection is set to a fixed value of 9.3V.

The typical TVS breakdown voltage is set to 479V at 1mA/25°C to allow a maximum DC-link voltage V_{dc} of 870V (both half DC-link voltages are set at the same value for all measurements).

As an example, a short-circuit path is introduced between the middle point MP and the neutral point 0 in the topology of Fig. 2 right. The measurement shown in Fig. 4 is performed with the maximum DC-link voltage V_{dc} of 870V. Initially, all switches are in the off-state (a). IGBT S3 is then turned on (b). The half DC-link voltage of 435V is applied to IGBT S4 (V_{ce4}), and no short-circuit current flows. When S4 is turned on (c), the short-circuit current I_{c4} increases through S3 and S4 until IGBT S3 de-saturates, followed a little later by S4. A dedicated turn-off sequence would require turning off IGBT S4 prior to S3. But in our example, S3 is turned off first (d). Without protective measures, the short-circuit current would commutate to the diodes D1 and D2 in Fig. 2, leading to the full DC-link voltage of around 870V being applied to S3 (V_{ce3}) - considerably exceeding the maximum IGBT voltage capability. Fig. 2 clearly shows the voltage limitation of V_{ce3} to a maximum value of 500V during the full turn-off phase (d). When the short-circuit current is completely turned off, the half DC-link voltage of 435V is applied to IGBT S3 (e).

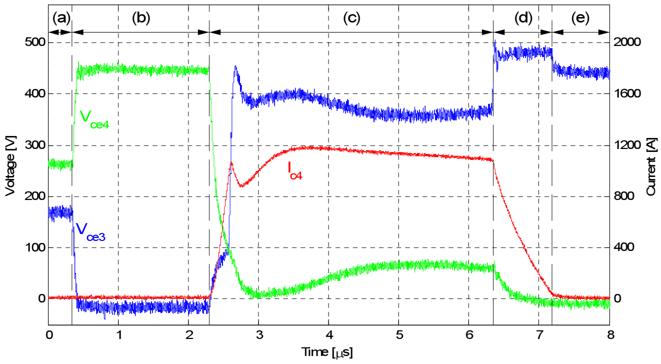

Figure 4: "Incorrect" turn-off sequence during short circuit between MP and 0

Conclusion

SCALE-2 driver cores, such as the 2SC0108T2D0-07, enable highly compact driver designs, and the example clearly demonstrates the effectiveness of the SCALE-2 technology's Advanced Active Clamping feature in limiting the maximum IGBT collector-emitter voltage in 3-level NPC topologies when an incorrect turn-off sequence is applied. Therefore, a dedicated turn-off sequence no longer needs to be applied which simplifies the short-circuit management of multi-level converters and allows standard 2-level IGBT gate drivers to be used in multi-level topologies without any modification or additional circuit elements. The host controller needs only to apply a common turn-off pulse to all IGBTs in the system as soon as an IGBT short-circuit is detected. AAC offers passive and efficient protection against IGBT collector-emitter over-voltages of any kind at any time.

References

[1] Zhang Xi, Uwe Jansen, Holger Rüthing: "IGBT power modules utilizing new 650V IGBT3 and Emitter Controlled Diode3 chips for three level converter", PCIM Europe, Conference Proceedings, Nuremberg, 2009.

[2] Heinz Rüedi, Peter Köhli: "SCALE Driver for High Voltage IGBTs", PCIM Europe, Conference Proceedings, Nuremberg, 1999.

[3] Description and Application Manual for 2SC0108T2Dx, CONCEPT.

[4] Olivier Garcia, Jan Thalheim, Nils Meili: "Safe Driving of Multi-Level Converters Using Sophisticated Gate Driver Technology", PCIM Asia, June 2013.


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Bus Bar and the High Power Card Edge (HPCE®) Family

Power Solutions for Today's Leading Technologies

Power connectors and conductors are akin to the blood vessels of electronics – they are essential in bringing technologies to life and indispensable to all electronic designs. In order for electronic devices to function, whether it's simple or complex power distributions, they will need a network of power solutions that are able to provide predictable, repeatable and reliable electrical performance. In addition to these basic requirements, power products also need to be compact, robust, cost effective and modular as engineers across all sectors strive to create smaller, cheaper and more scalable equipment and devices.

By Yu Dong, FCI Portfolio Director for Power Solutions

Given the demands of the ever-evolving power connected world, it is increasingly critical for electronic design engineers to understand the characteristics of the different power connector and conductor categories. This enables them to identify the power solutions that are optimal for their designs and at the same time meet the stringent mechanical requirements for varying applications.

Bus Bars – The Ideal Power Conductor for IT and Renewable Energy Technologies

A bus bar is an electrical conductor made of several layers of stamped and formed copper sheet. Each layer is individually insulated so that the bar can distribute current, AC or DC, at different voltages. Its superior performance and ability to reduce design complexity production cost make them the ideal power solutions across many rapidly growing technology sectors, such as IT and renewable energy.

Figure 1: BusBar

Cabinets

One of the major applications that uses bus bar solutions are IT cabinets, including transmission cabinets and data storage system cabinets, as they are superior and a more cost effective replacement as compared to cables. This is because laminated bus bar conductors are made of wide, thin copper sheet which allows it to dissipate heat more efficiently than circular cables. This critical geometric characteristic allows bus bar to carry more current than cables for a given cross section and enables them to support the latest data and transmission applications.

The bus bars are also neater, more elegant and easier to install than the cumbersome "daisy chain" harness for cables. The cleaner designs enable shorter time-to-market cycles and easier control and maintenance to ensure the uptime of the apparatus in the cabinets.

Backplanes, PCBs and Motherboards

Laminated bus bar solutions are also commonly used to replace traces and power layers on backplanes, PCBs and motherboards. Bus bars are capable of carrying much more current than that of a normal trace and engineers usually replace trace on a PCB by fastened or soldered the bus bar conductors to it to act as a solder trace.

For conventional backplanes, the distribution of high current on a backplane (>100A) is usually costly because of the additional and usually thick copper layers required. With a large current capacity, a bus bar mounted to the backplane can easily replace the costly power layers without undermining the performance of the backplane.

Beyond the IT Sector - Renewable Energy Generators and Electrical Mobility

Besides the IT sector, bus bars are also commonly used in many of today's leading renewable energy applications. In decentralized energy generation systems, such as solar or wind generators systems, the bus bar serves as a key platform for power semiconductor devices used in power inverter and converter. Power converters enable the connection of an individual energy generation system to the electric grid and ensure high quality of grid voltage and frequency. In addition, with working voltages up to 4kV, low impedance and inductance as well as and large capacitance, these power solutions are optimal for renewable energy generators.

In the rapidly evolving automotive world, electrical transportation is fast becoming the alternative technology of choice for passenger vehicles as well as light delivery vehicles. Needless to say, the need for reliable current distribution is paramount to both performance as well as safety. That is where bus bars come in. Coupled together with their inherent ability to generate less voltage loss compared to traditional wire cabling, optimize space, as well as provide long term reliability in harsh environmental conditions, it is no wonder that bus bars have found their place in today's most advanced hybrid and electrical vehicles.

The bus bars' advanced thermal and electrical performance as well as its ability to optimize space, reduce cost, and accelerate time to market, make these components valuable assets to support existing IT, renewable energy and e-mobility applications. In addition, its advanced design and versatility will also provide engineers with the foundation to design the next generation of equipment and devices.

The HPCE® Family – Compact, Low Profile Power Interconnect Solutions

Space constraint is one major concern that most engineers face when it comes to designing networking or server equipments. Often needing to fully utilize every spare inch within the rack, the components that go into the build needs to not only be efficient and reliable, but also compact as well. The newly introduced HPCE® Family, which includes the High Power CardEdge Connector, the Board-To-Board (BTB) Connectors as well as Cable Assemblies, provides all that. With a profile height of just under 7.5mm, these components not only save space, but improve electrical performance as well because of their better heat dissipation. What's more, these performance benefits do not compromise to the current carrying capability of the HPCE® Family. The innovative contact geometry design, coupled with advanced material and plating methods ensure that the parts are able to perform at the current density of up to 200A/inch.

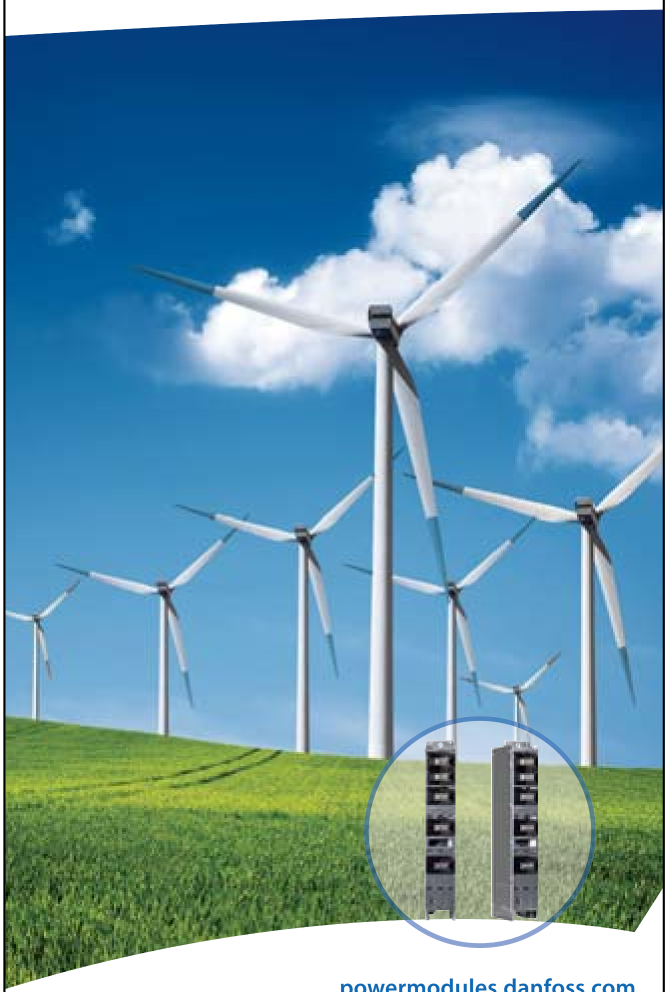
This series of products are forecasted to continuing growing. This is attributed to 1U and 2U chassis-based systems are doubling-up, and also the market's demand for more compact that components that restrict less airflow, allowing for better cooling of the overall system.

Servers and Data Storage Equipment

Aimed at server and storage power supply applications where current density, power efficiency and airflow are key design considerations, the HPCE® Family offers a compact and highly ventilated housing design that enhances heat dissipation. These features are critical in servers and data storage applications as it helps to prevent overheating, thus increasing the availability and reliability of these equipment. This also helps to reduce the amount of cooling needed for the equipments, which in turn helps to increase the energy efficiency of the server and data storage system.

HPCE® connector provides increased linear current density and is able to support 9A power contact beam without exceeding a 30°C temperature rise in still air. This characteristic is a significant 30% improvement over conventional PCE solutions. In addition, these solutions offer the highest current density and lowest contact resistance, which reduce power loss through the connector, in the PCE market. All these factors are critical considerations for IT engineers when assessing power connectors for their equipment designs. What's more, the single-piece HPCE® offers a cost effective alterna-

Figure 2: HPCE® High Power CardEdge Connector



tive to the two-piece (receptacle mating to plug) solution, giving engineers the opportunity to lower cost by using a cheaper, albeit less robust, one piece solution.

The HPCE® BTB connector utilizes a mainstream two-piece design. The right angle header is readily available to mate to the right angle or vertical receptacle, allowing design flexibility in various data storage system architectures. A low profile height maximizes airflow efficiencies for effective system cooling and integrated guide features make it ideal for blind mating applications.

The HPCE® cable, on the other hand, is widely adopted in many server and data storage applications. They provide more flexibility for high power (20-40A), mid/low power (10-20A & 5-10A) and signal requirement, making it an integrated solution in servers and data storage equipment. HPCE® cables also allow flexible configurations to cater to different designs and mechanical requirements. They are able to provide a maximum 13 terminals for high power cables, 16 terminals for mid power cables, and 38 terminals for low power and signal cables. IT engineers will be able to customize and find the most optimal power cable solution for a wide spectrum of IT applications and equipment designs. Like its connector version, HPCE® cables also have both one-piece (mating to gold finger) and two-piece solution (mating to right angle or vertical header).

Figure 3: HPCE® Cable Assemblies

The wide and versatile HPCE® Family solutions offer engineers with unparalleled electrical performance as well as capabilities to improve airflow and energy efficiency that is previously unseen in the PCE market. This next generation of power connectors also holds the potential to improve the existing electronic designs and will act as the catalyst to empower the new innovations across different sectors.

Figure 4: HPCE® Board-To-Board Connectors

FCI- A Leading Power Solutions Provider for Leading Technologies

With almost 30 years of experience in designing and manufacturing power solutions, including bus bar and HPCE® Family, FCI understands the evolving market requirements for power interconnections, and continues to provide innovative and cost-effective power product solutions to address the challenges of increasing power density and facilitating airflow for thermal management.

FCI provides design engineer with a comprehensive suite of bus bar and HPCE® development capability from design, simulation, testing, to manufacturing. This end-to-end suite allows FCI to cater to the unique design requirements and provide the right power solution for different equipment and applications

If there's interest in learning more about FCI's Power Solutions, please visit: www.fci.com/powersolutions

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Hardware-in-the-Loop Solution for Test and Verification of Micro-Grid Converters

Micro-grid converter control development, and testing made simple with ultra-high fidelity embedded Hardware-in-the-Loop system

By Andreas Dittrich —Enerdrive GmbH and Vlado Porobic — Typhoon HIL, Inc.

Micro-grid technology introduction

The power generation market is rapidly changing. With proliferation of micro-grid solutions and distributed energy generation (DER) evermore attention is being focused on utilizing smaller generators augmented with renewable energy sources and energy storage in order to provide high quality of service where grid is not available or to supplement grid operation. Consider that roughly 2 billion people do not have access to a reliable electricity supply and 300 000 houses in Europe have no access to the grid [1]. Hence, ensuring electricity supply to remote locations is particularly important and the use of renewable energy sources enhanced with energy storage solutions is increasingly attractive.

The main challenge in micro-grid converter and control design is achieving tight voltage and frequency control with constantly fluctuating generation/loading. One approach is to use energy storage and/or load control (match load to generation, define low priority loads), which usually requires cooperation of the local controllers. Another important challenge is to achieve the power sharing among different sources that feed a group of loads through a micro-grid. One approach is to use the so-called 'droop control'. The basic idea is to reproduce the characteristic of the synchronous generators connected to a steam/water turbine regulated through a speed governor, which are controlled such that the frequency decreases as the fed active power increases and the voltage amplitude decreases as the fed reactive power increases. The droop control can be implemented by measuring frequency and voltage and imposing the active/reactive power set-point to each of the distributed units, figure 1. Furthermore, protection and fault detection and isolation is an important aspect of micro-grid control.

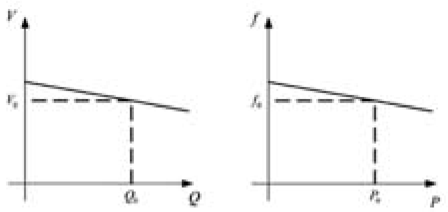


Figure 1: Micro-grid: voltage and frequency regulation by imposing appropriate level of active and reactive power

HIL solution for micro-grid control system development and comprehensive testing

HIL emulators provide a comprehensive environment for the design and testing of control systems for micro-grid power electronics converters. For real-time emulation of micro-grid systems it is critical to emulate power stage with ultra-high fidelity in order to capture all the system dynamics and interactions that span time-constants ranging from microseconds to seconds. These system interactions, if system control is not properly designed and tested, can give rise to unwanted oscillations, large-signal system instabilities, and even catastrophic failures. Typhoon's ultra-high fidelity HIL systems provides needed flexibility—while behaving as close to the real system as it gets—to realistically explore and verify all the micro-grid operating conditions and scenarios including system faults (in control system, communication system, and power sections).

In addition, TyphoonLink-Gigabit per second serial link-enables seamless connection of multiple HIL602 units into one unified HIL system that can simulate 16 or more converters, as shown in figure 2. Whether you are testing a single converter control or multiple converter control (centralized or decentralized), HIL602 in the cluster configuration provides a unified environment that is as easy to use as if you were working with a single HIL unit. Furthermore, the real-time emulation process can be controlled in a fully automated way with Python scripts via Typhoon HIL API.

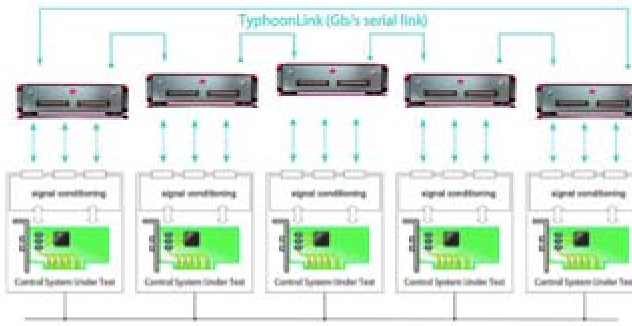


Figure 2: Complete solution of complex Micro-grid with networked HIL units

Features and Benefits of TyphoonLink-Gigabit connection are:

- Connect 4 or more HIL602 units in HILCluster configuration.
- Deploy 24 real-time computational cores as one unified HIL real-time emulation fabric.
- Test one or multiple controllers in micro-grid environment for both centralized and decentralized micro-grid control configurations.
- Test both low-level and application/micro-grid level control functionality.
- Interface seamlessly your industrial controllers to multiple HIL units via HILConnect unit.
- Automate test processes with Python scripts via Typhoon API.

Develop Micro-Grid Energy storage converter

An example of micro-grid system is given in figure 3. In this system, micro-grid model comprises diesel powered synchronous generator,

intermittent photovoltaic power source, permanent magnet synchronous machine wind turbine generator, resistive load, nonlinear current load, energy storage grid-tie inverter, utility grid and main contactor that emulates both grid-connected and off-grid operational regimes.

The focus here is on the development and testing of grid-tie energy storage inverter and its controller operating in micro-grid environment. Synchronous diesel generator's role is to supply the average power to the loads while energy storage converter can both take in and deliver peak power when load and supply are not matched (due to renewable intermittency and synchronous generator lag) thus helping support both voltage and frequency regulation in the micro-grid. Flexible and easy to use ultra-high fidelity real-time simulation environment enables fast and robust development and testing of control software for the battery energy storage inverter system.

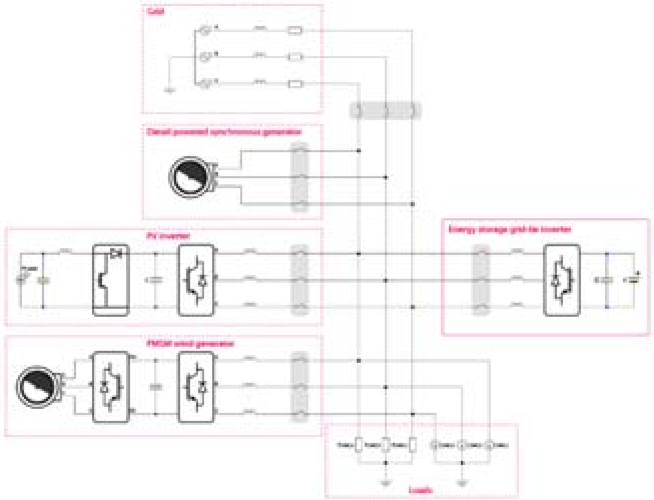


Figure 3: An example micro-grid comprising: utility grid with islanding contactor, diesel synchronous generator, grid-tied inverter with energy storage, wind and PV intermittent source and load

Test, optimize, pre-certify.

Control loops design and optimization for the energy storage inverter is done on an industrial controller platform directly interfaced with the HIL602 Cluster. All controller functions —i.e. PWM modulator, PLL (figure 4), current and voltage control loops (figure 5) etc.—as well as protection and high-level control functions (i.e. dynamic grid support) are tested for different operating conditions, such as imposed voltage harmonics (figure 6). Indeed, HILCluster is ideal for comprehensive and automated testing of micro-grid converter controllers. Automated test scripts can cover a spectrum of test cases (including fault conditions and system unbalance) that provide a cost effective solution for compete test and verification of control system performance. In addition, HILCluster provides easy to use development and test environment for system level micro-grid controller.

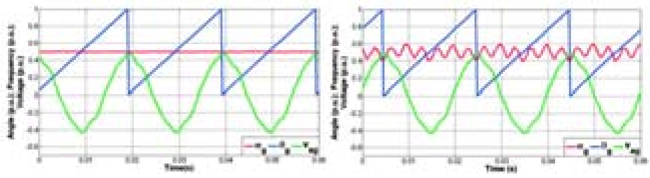


Figure 4: PLL steady-state response in distorted grid voltage conditions for different designed bandwidth

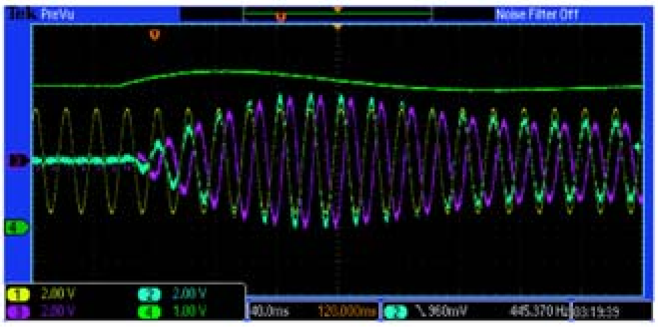


Figure 5: DC-link voltage loop, disturbance rejection test (DC-link voltage, phase voltage and phase currents)

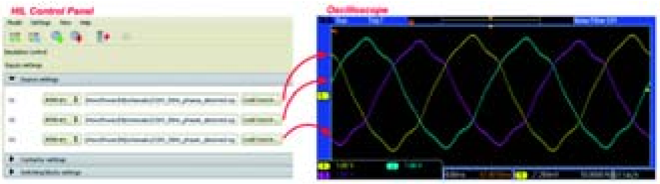


Figure 6: Grid voltage sources configured to arbitrary waveforms in distorted grid voltage conditions

Summary

To support growing micro-grid market, efficient, reliable and compact power inverters, with unique set of functions and features that differ from standard grid connected converters, need to be developed. The HIL602 system is a compact and easy to use real-time emulator that provides ultra-high fidelity environment to simulate a number of converters, electrical machines, pv panels, that are controlled with real controllers. Controller performance can be tested both in grid-tie or in off-grid configuration. Even more importantly, HIL solution is distinguished by an unmatched ease of use and flexibility to choose the circuit topology and circuit parameters, and specify disturbances and fault conditions that are often difficult and expensive if not outright impractical to do in a power laboratory.

References

[1] Remus Teodorescu, Marco Liserreand and Pedro Rodríguez, Grid Converters for Photovoltaic and Wind Power Systems, © 2011 John Wiley & Sons, Ltd. ISBN: 978-0-470-05751-3

www.typhoon-hil.com

Solid State Batteries Power

Medical Sensors and Instruments

By Steve Grady, Cymbet

New Solutions for Powering Medical Devices

Small medical sensors and surgical instruments are rapidly becoming intelligent and therefore they must be powered - often using miniature rechargeable batteries. Integrated batteries must have several key properties in order to insure safe operation and protect patient health. New solid state batteries have been introduced that are uniquely fabricated using standard semiconductor manufacturing processes and packaging techniques.

In order to meet the requirements of new medical sensors and smart instruments, several factors must be considered:

- Innovative battery packaging and connectivity options must be available
- Integrated batteries must be completely non-cytotoxic
- Batteries must be unaffected by heat-sterilization processes
- Various battery charging methods, including Energy Harvesting may be used
- Size: medical sensing technologies are becoming millimeter-scale

Innovative Battery Packaging and Connectivity

Solid state batteries have the same handling and die attach mechanisms as the integrated circuits found in medical electronic devices. This makes solid state batteries ideal for co-packaging with other ICs to create advanced Systems-in-Package (SIP) devices. An example of the use of a solid state battery wire bond attachment in an IC stack is shown in Figure 1:

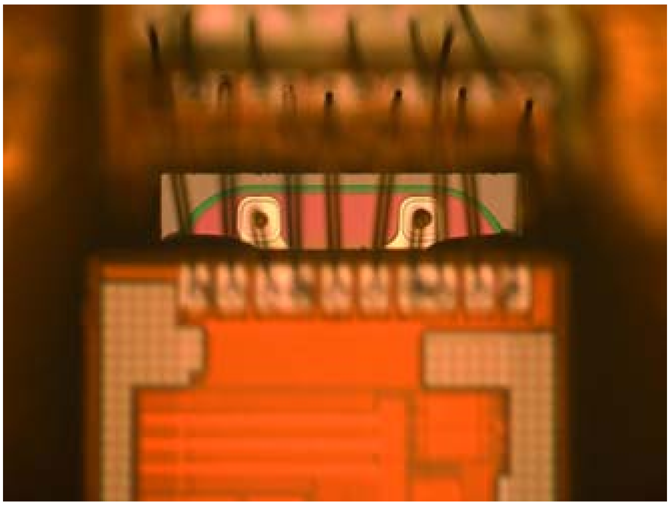


Figure 1: Solid State Battery wire bond attachment in IC stack

The rechargeable solid state battery is the second layer and wire bonds to the Vout and GND pads are shown. This device stack is the real implementation used in the Intraocular Pressure Sensor described later in this article. Solid state batteries are also available packaged in standard plastic DFN semiconductor packages that ship on tape and reel for simple, conventional surface mounting and reflow solder on a printed circuit board.

Using Solid State Batteries that are 100% Non-cytotoxic

Insuring medical product safety is absolutely critical and integrating traditional batteries into products in the past has been a problem. There are many medical applications where solid state batteries will be used either in vitro or in vivo applications. Recently, rechargeable solid state batteries have successfully-passed biological safety tests in both in vitro and in vivo biocompatibility feasibility studies. During these procedures, bare die batteries were crushed and combined into a saline solution and tested in various test conditions.

In-Vitro Battery Biocompatibility Testing

The biocompatibility of the solid state batteries was evaluated using the following in vitro test methods:

- Cytotoxicity: Medium Eluate Method (MEM) - 1x CMEM Cell Growth Medium Extract
- Cytotoxicity: Agar Diffusion - Solid Sample

In these tests, a gamma sterilized Cymbet CBC005-BDC 5ìA-hr EnerChip™ was found to be non-cytotoxic (0% cell lysis) using both the Medium Eluate Method Elution Test and Agar Diffusion Test feasibility screening procedures. The lack of any adverse biological responses in these very sensitive in vitro cell culture assays is indicative (although not a guarantee) of biocompatible test results in the other in vitro and in vivo aspects of biocompatibility as suggested by both the EN ISO 10993-1:2009 Biological Evaluation of Medical Devices - Part 1: Evaluation and testing within a risk management process and the U.S. Food and Drug Administration (FDA) Blue Book Memorandum No. G95-1 (1995) guidelines, and is therefore another excellent reason for performing these specific and very sensitive tests.

In-Body 0% Toxicity Test Results

One of the most rigorous ways to test the intrinsic biological safety of a solid state battery is to inject crushed bare die into in vivo test settings. Crushing the battery replicates the catastrophic destruction of an EnerChip-powered implanted medical device. In this traumatic scenario, the solid state battery materials would be exposed directly to the in vivo setting. The results showed no harmful histological effects on the exposed tissues.

Meeting Additional Battery Standards and Regulations

There are also many global environmental and safety standards and directives that cover batteries. Solid state batteries are the ideal solution as they address: RoHS, China RoHS, REACH, CE Mark, UL-Underwriters Laboratory, JEDEC IC Packaging Standards, IEC, NEMA/ANSI, UN Air Safety Regulations, WEEE Directive, Battery Directive, MSDS and OSHA Information, End-of-Life Disposal Instructions and Biocompatibility Standards.

Applications in Medical Device and Food Sterilization

Process temperatures such as those reached in autoclaves used in medical device and food sterilization are generally not suitable for devices containing batteries. Temperatures reaching 137 °C are com-

mon in sterilization equipment depicted in Figure 2, and can be catastrophic to conventional batteries containing volatile solvents and other additives. Yet, there are many smart medical devices and instruments that must be processed through sterilization equipment and processes that utilize integrated batteries. Such devices include surgical tools with embedded RFID tags; implantable sensors; and temperature sensors in the equipment for enabling more precise temperature control of the equipment and contents being sterilized. Moreover, it is often essential that such sensors and RFID tags be hermetically isolated from the environment to prevent moisture ingress to the device or to prevent outgassing from the device to the environment, such as an autoclave or, in the case of implantable sensors, the human body. To insure a device a device is hermetic, it is very beneficial to use a hermetically sealed battery such as the Cymbet EnerChip solid state battery.

Figure 2: Smart Medical Instrument Sterilization Equipment

Space-restrained medical devices require a small power source that occupies little volume and needs no external components (holder or socket) in order to maintain a rugged connection that will not break, separate, or corrode in harsh medical environments. Practically, apart from solid state batteries, such storage devices do not exist. Solid state batteries can be used in bare die form with solder bumps or wire bonds, or in low profile surface mount packages with or without integrated battery management, and can be recharged easily using, for example, inductive near field charging. Just as importantly, solid state batteries can tolerate the high temperatures found in autoclaves and similar equipment.

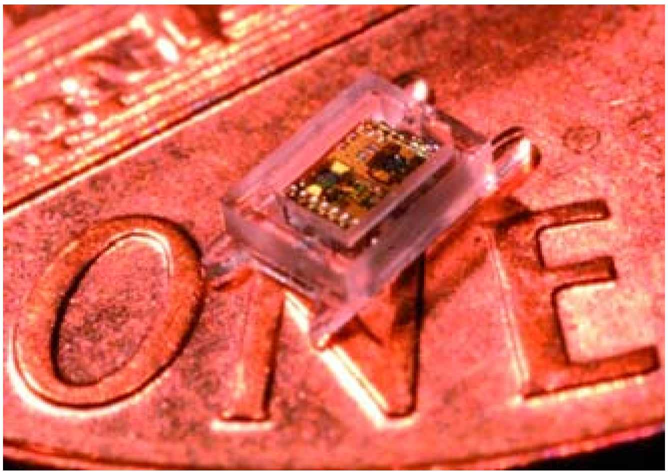


Figure 3: Intra Ocular Pressure Sensor (courtesy of University of Michigan)

Millimeter-scale Intraocular Pressure Sensor
An example of a small millimeter scale Intra Ocular Pressure Sensor created to monitor the eye health of Glaucoma patients is shown in Figure 3. Several new concepts were combined to realize a tiny, intelligent sensor powered autonomously for the device life using ambient energy harvesting.

Energy harvesting techniques are used in large scale applications like solar panel installations and wind farms, but can also be used in extremely small scale devices. In this millimeter-scale example, light is converted to electricity, stored in the rechargeable solid state battery and delivered to the sensor system. There are no traditional batteries to maintain and replace, and devices can be placed anywhere.

A University of Michigan paper that describes the background of this device can be found here: http://www.cymbet.com/content/products-embedded-energy.asp

Using Energy Harvesting to Power the Intra Ocular Pressure Sensor
The IOP sensor shown in the Figure 3 photo is depicted diagrammatically in Figure 4. The device is a four layer stack encapsulated in a bio-compatible glass enclosure. The first layer is the MEMS pressure sensor, the second layer is a 1µAh rechargeable Cymbet EnerChip solid state battery. A processor, with memory, power management and sensor A/D converter, sits on the EnerChip as the third layer. The top layer is the solar cell and wireless transceiver. All the layers are wire-bonded together to provide electrical connectivity.

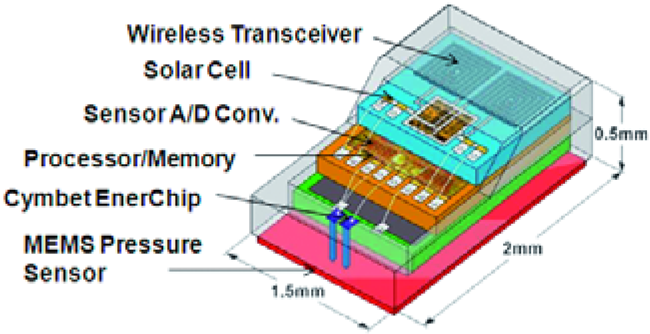
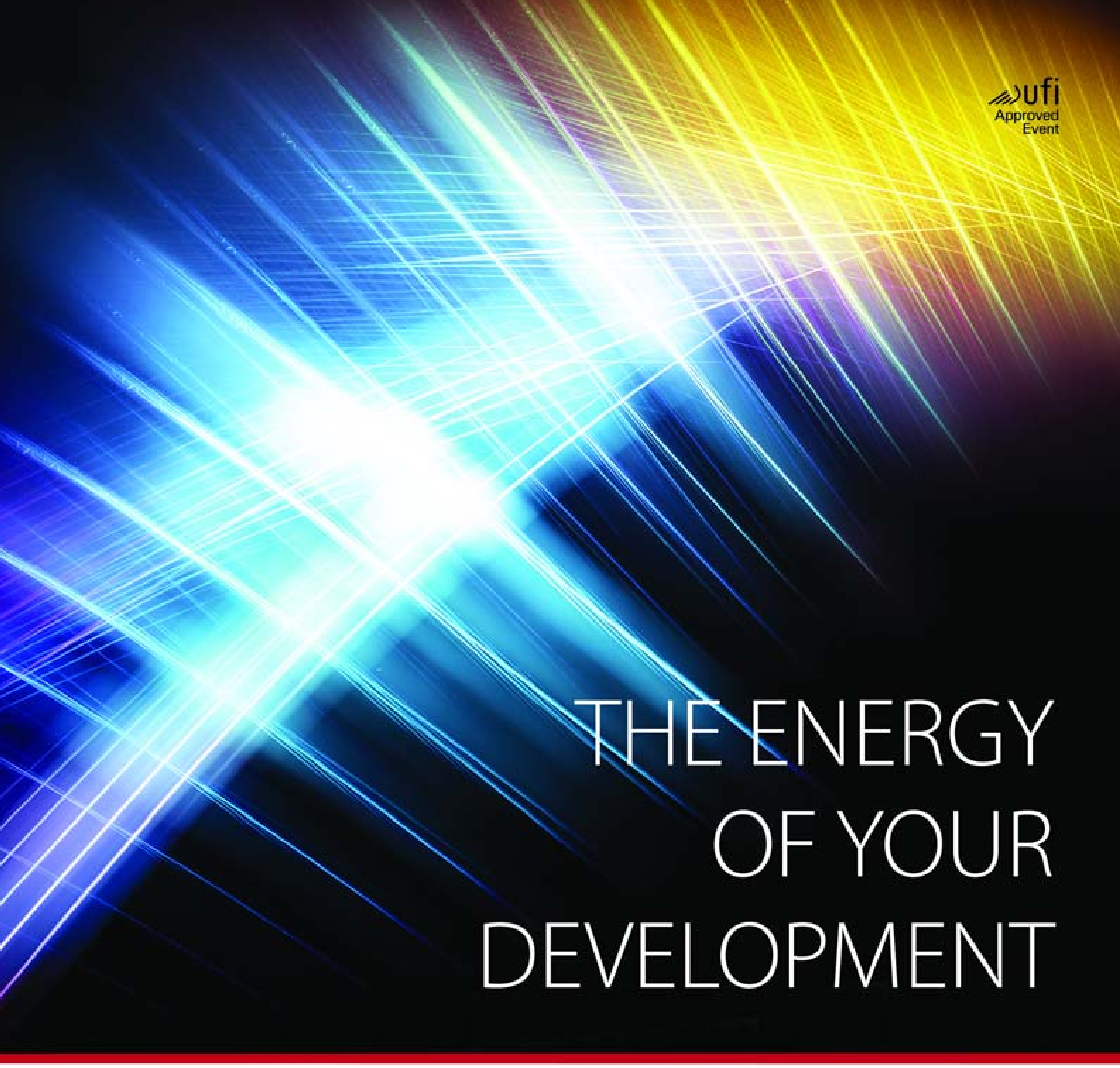


Figure 4: IOPM Layers Block Diagram

Innovating New Medical Devices Using Solid State Batteries
In order to power the next generation of miniature intelligent medical sensors and instruments, solid state batteries are the correct choice. These rechargeable batteries provide the safety, size, integration, and connectivity functions required to bring successful new products to market. Moreover, all the attributes that make them ideal for medical devices can be leveraged in many other types of miniature electronic products, such as small Internet of Things environmental sensors. For more information, and to register to win a solid state battery evaluation kit please, go to:

www.cymbet.com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R8 RAD-Hard MOSFETs Increase Efficiency

International Rectifier has launched two high performance R8 radiation hardened (RAD-Hard) power MOSFETs optimized for space grade point-of-load (POL) voltage regulator applications.

The new R8 logic level power MOSFETs utilize Trench technology to offer extremely low on-state resistance (RDS(on)) of 12 milliohms (typical) and total gate charge (QG) of 18nC (typical), increasing efficiency performance by up to 6% compared to existing solutions. The IRHLNM87Y20SCS device has a BVDSS rating of 20V and a maximum drain current (ID) rating of 17A. The new devices are available in IR's new SMD 0.2 surface-mount style package, achieving a 50% space saving compared to the existing SMD 0.5 package solution. The devices are also offered in a TO-39 package or in die form for microcircuit design solutions.

The products are fully characterized for radiation performance to 300Krads of TID and SEE with LET of 81 MeV-cm2/mg with VGS rating of 12V. Depending on the intended design orbit and anticipated radiation environment, R8 RAD-Hard MOSFETs may be well suited for applications requiring a mission life of 15 years or more.

www.irf.com

InstaSPIN™-FOC Sensorless Motor Control Technology for Low-Cost

Highly efficient, three-phase motor control expertise, once only obtainable to a niche market of motor designers, is now available to a wider audience of developers. Texas Instruments brings its revolutionary InstaSPIN-FOC™ (field-oriented-control) sensorless motor control technology to its most affordable, real-time-control C2000™ Piccolo™ F2802x microcontrollers (MCUs) series, offering a smaller package size and much lower cost. Engineers can use TI InstaSPIN-FOC technology, embedded in the read-only-memory (ROM) on the C2000 Piccolo F2802x MCU to accelerate motor control development while improving efficiency for cost-sensitive BLDC (brushless DC), PMSM (permanent magnet), and AC Induction motor based applications.

With the ability to identify, tune and control any type of three-phase, synchronous or asynchronous motor in just minutes, TI's low-cost Piccolo F2802x MCUs with InstaSPIN-FOC are ideal for a variety of applications, such as washing machines, compressors, pumps, fans, electric bicycles, tools, treadmills, compact drives, sewing and textile machines, lifts and hobby motors.

Prior to the initial Feb. 2013 launch of TI's InstaSPIN-FOC technology, sensorless field-oriented-control was out of reach for most developers because existing sensorless algorithms were not robust enough over real application conditions and were challenging to implement into a complex control system, adding months of development time.

InstaSPIN-FOC technology addresses those concerns by reducing system complexity for designers of all levels while improving motor efficiency, reliability and performance at an affordable price point – which just got even lower.

www.ti.com

Advanced Stepper Control Technology Enables Quiet Drive

Texas Instruments expanded its motor driver portfolio to include the company's first integrated stepper motor pre-driver. The DRV8711 is highly configurable with a best-in-class on-chip micro-stepping indexer, as well as stall detection, and advanced current regulation that easily and efficiently tunes any motor. External MOSFETs control the stepper motor to provide minimum heat dissipation and 20 percent more scalable output current than the nearest competitor allowing designers to customize their design.

The stepper motor pre-driver is designed for industrial applications, including textile machinery, video surveillance, ATM machines, robotics, office automation equipment and stage lighting.

Customizable driver stage: Gate drive supports up to 200 mA of source current per 400 mA of sink current with adjustable slew rate, dead-time and on-time to accommodate application requirements. The device drives external N-channel MOSFETs with a built-in charge pump to provide more design options and a cost-effective solution.

Smooth motion profile for higher performance: Spins a stepper motor with an integrated micro-stepping indexer capable of up to 1/256 micro-stepping. Adaptive blanking time and various current decay modes, including slow, fast, mixed and auto-mixed decay, achieve a smooth profile to optimize motor performance.

www.ti.com

SiC MOSFETs Enable High Efficiency and High Reliability Power Supplies

Cree, Inc. announces that its expanded portfolio of 1200 V SiC MOSFETs are being incorporated into the latest advanced power supplies from Delta Elektronika BV. Delta Elektronika demonstrated a 21 percent decrease in overall power supply losses and a reduction in component count by up to 45 percent when compared to power supply products using traditional silicon technology. "We are delighted to use Cree's new SiC transistor in our product series, as it improves both the efficiency and power density of our products," said Job Koopmann, director of Delta Elektronika BV. "The switching behavior is outstanding and controlling the MOSFET is simple and straightforward. This device is helping us to continue developing more reliable products, which our customers expect from us."

Since 1959, Netherlands-based Delta Elektronika BV has been a leader in producing highly reliable, high-quality power supplies for a range of industrial applications, such as specialized equipment used in factories, automation and industrial power conversion. Its power supplies typically provide high efficiency with low noise levels and are well known for their long operating lifespan. By implementing Cree's advanced second-generation SiC MOSFETs in its latest power supply series, Delta Elektronika BV is leading the industry in the deployment and delivery of highly reliable advanced technology.

www.cree.com

Circuit Simulation Tool for Power and Analog IC Designers

Intersil Corporation introduced the latest version of its popular iSIM™ personal edition (iSIM:PE) circuit simulation design tool, adding time saving features and further simplifying part selection for power and analog IC designers.

Intersil's iSim:PE v7.0 speeds the design cycle and reduces risk early in any project, identifying parts that can be used in current as well as next-generation designs. The easy to use tool quickly and reliably selects devices to support increasing power densities, wide input-voltage and temperature ranges, maximum efficiency, fast transient response and other vital specifications. Simulated designs are displayed in an online schematic and can be verified immediately. After verification, iSim generates a Bill of Materials and a comprehensive design report.

The new iSim:PEv7.0 is available free-of-charge from Intersil at:

www.intersil.com/iSim

Full Synchronous Buck Regulator Features Wide 3V to 36V Input Range

Intersil Corporation introduced the ISL85415, a versatile 500mA synchronous buck regulator featuring a wide input voltage range, integrated synchronous FETs and internal compensation.

New generations of communication, industrial and consumer systems require switching regulators to accommodate a wide range of input voltages and the ISL85415 meets that need supporting from 3V to 36V capability. An extended output voltage range of 0.6V to 95% of Vin also provides an excellent solution when enabling pulse-frequency modulation (PFM), a mode widely used in portable applications to improve efficiency at light loads.

The ISL85415 integrates both high-side and low-side NMOS FETs, eliminating the need for external FETs and diodes. This high level of integration reduces component count in standard buck configurations, simplifies the design process and saves time. Designers can also select external compensation if required. The wide Vin and Vout ranges, combined with integrated synchronous FETs and internal compensation, enable efficient, robust designs with a minimum number of external components.

www.intersil.com


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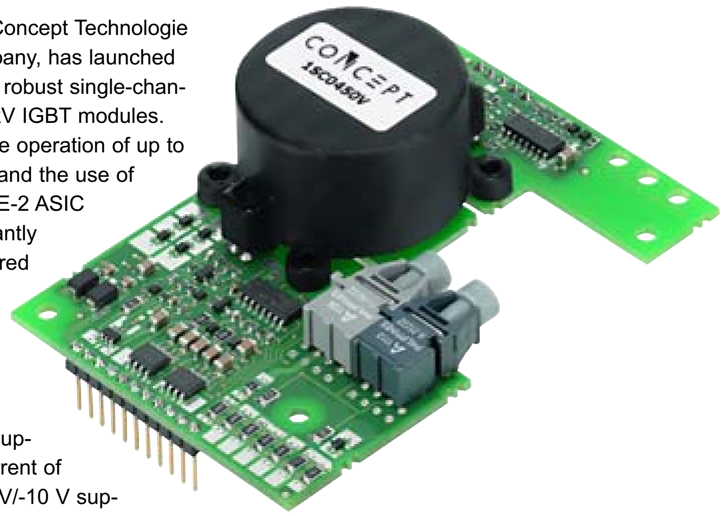
Compact 6.5 kV IGBT-Driver Cores for High Reliability



IGBT-driver manufacturer CT-Concept Technologie AG, a Power Integrations company, has launched the 1SC0450V, a compact and robust single-channel gate-drive solution for 6.5 kV IGBT modules. The driver is able to support the operation of up to four IGBT modules in parallel, and the use of CONCEPT's proprietary SCALE-2 ASIC technology results in a significantly lower component count compared to a discrete solution. This approach increases reliability, enabling a service life guarantee of over 15 years.

Featuring an on-board power supply, the drivers have a gate current of ±50 A and operate from a +15 V/-10 V supply. Power capability is 4 W at 85°C. Devices can be configured for parallel operation of IGBT modules using one central driver. Isolation is in accordance with IEC 61800-5-1 and IEC 60664-1, and the UL-compliant devices also feature Advanced Active Clamping, short-circuit protection and under-voltage lockout.

Applications include traction, HVDC, STATCOM, wind-power converters and other medium-voltage converters/drives.

www.IGBT-Driver.com

1kW Power Supply and Charger in one Unit for 400V UltraCaps

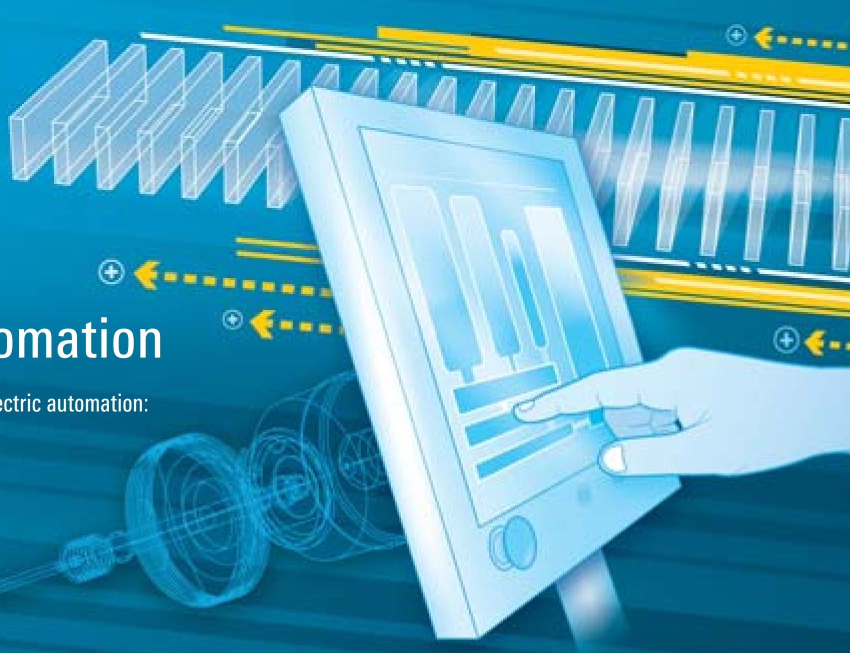
The PAS395 from PULS can be used as a regular power supply with an adjustable output voltage between 360V and 460V or as a charger for EDLC-capacitors (Electrical Double Layer Capacitors commonly known as Ultracaps, Supercaps or Greencaps).

The charging method is a constant current – constant voltage followed by a float charging mode. The output is protected with a serial diode to avoid return currents from the capacitors. To ensure that the capacitors never become overcharged, a redundant control circuit monitors the end-of-charge voltage and switches the output off in case of high voltage.

The internal fan which starts running when necessary, allows the unit to be used in any mounting orientation at altitudes as high as 6000m. The unit operates from AC 230V mains, includes an electronic inrush current limitation and an active power factor correction circuit. The unparalleled high efficiency of 94.4% reduces the heat in the cabinet and achieves the true MTBF figures resulting in the long service life of the unit.

One main application is in wind turbines. Using super-capacitors rather than batteries to control turbine pitch is a major step forward for the wind power industry and the PSA395 will play an important role in improving efficiency and reliability.

www.pulspower.com



Long-Term Operation with Compact Low-Capacity Batteries

LAPIS Semiconductor, part of the ROHM group, has recently announced the development of ultra-low power microcontrollers designed for devices such as watches or security tokens1 that require long-term operation using just coin or dry-cell batteries. The ML610Q474 family features industry-low current consumption (0.25uA in Halt mode*2) – 50% lower than conventional products – along with high noise immunity.
Security tokens used to generate one-time passwords for the rapidly expanding internet banking market or battery-driven applications such as watches and clocks demand stable operation for years powered with just a single button battery. LAPIS Semiconductor meets this need through an original design that provides the industry's lowest current consumption.
The ML610Q470 series integrates a recently developed internal regulator and oscillator circuit and adopts proprietary low-leakage current processes for the lowest power consumption on the market - ½ that of conventional products. In addition, high noise immunity is ensured through novel internal circuitry and layout (clearing ±30KV* during IEC61000-4-2 noise immunity testing).
A total support system including an ML610Q474 reference board and software development environment are provided to facilitate evaluation. Additional support tools such as user manuals and tools are offered online (registration required).

www.rohm.com/eu

Industry's Highest Voltage Power MOSFETs

Mouser Electronics, Inc. is now stocking IXYS's 4500V Power MOSFETs, the highest voltage MOSFETs in the industry with maximum voltage of 4500V and current rating from 200mA to 2A.
The IXYS 4500V High Voltage Power MOSFETs are the highest voltage Power MOSFET product line in the industry - 4500V N-Channel Power MOSFETs in international standard size packages.
The current ratings range from 200mA to 2A. They are specifically designed to address demanding, fast-switching power conversion applications requiring very high blocking voltages up to 4.5kV. Thanks to the positive temperature coefficient of their on-state resistance, these very high voltage MOSFETs are ideally suited for parallel device operation, which provides cost-effective solutions compared to series-connected, lower-voltage MOSFETs.
A ceramic isolation of up to 4.5kV is achieved with the Direct Copper Bond (DCB) substrate technology and an electrically isolated tab is provided for heat sinking. The DCB provides low thermal impedance and best-in-class power and temperature cycling capabilities. The molding epoxies meet the UL 94 V-0 flammability classification.

www.mouser.com/new/ixys/ixys-4500vmosfet-mosfet/

Efficient LED Driver Suits Backlighting Applications

Advanced Power Electronics Corp. has launched a new step-up converter capable of efficiently driving up to eight white LEDs in series

for backlighting applications. The APE1612-3 uses current mode, 1.2MHz fixed frequency architecture to regulate the LED current, which is set using an external current sense resistor.

The APE1612-3 features a low 300mV feedback voltage that reduces power loss and improves efficiency. The OV pin monitors the output voltage and turns off the converter if an over-voltage condition is present due to an open circuit condition. The APE1612-3 includes under-voltage lockout, current limiting and thermal shutdown protection preventing damage from an output overload.

Comments Ralph Waggitt, President/CEO, Advanced Power Electronics Corp. (USA): "Small size and high efficiency make the APE1612-3 ideally suited for backlighting applications. A wide 200Hz to 200kHz range enables the device to be used in PWM dimming."

The APE1612TY-HF-3 is shipped in a small RoHS/REACH-compliant TSOT-26 package.

http://www.a-powerusa.com/docs/APE1612-3.pdf

Single LNB Regulator IC Offers Higher Switching Frequency and Lower Supply Current

The A8304 from Allegro MicroSystems Europe is the latest member of a family of single low-noise block regulator (LNBR) ICs for satellite receiver applications.

The new device is a monolithic linear and switching voltage regulator which is specifically designed to provide the power and interface signals to an LNB down-converter via coaxial cable.

The A8304 requires few external components, with the boost switch and compensation circuitry integrated into the device. The 704 kHz switching frequency and user-controlled output current limit minimise the size of the passive filtering components.

An I2C™-compatible interface provides control capabilities for complex system requirements, as well as diagnostic information for system fault reporting. A "sleep" pin is also available to maximise power savings and to quickly shut down the device if required, without using I2C™ control. New control features for output source and sink current are also incorporated.

The A8304SESTR-T is provided in a very small 3 × 3 mm QFN package (suffix ES) with exposed pad for thermal dissipation. It is lead (Pb) free, with 100% matt tin leadframe plating.

www.allegromicro.com

ADVERTISING INDEX

Ultra-Low $R_{DS(ON)}$ Automotive COOLiRFET®

Package	$R_{DS(on)}$ Max@ 10Vgs (mΩ)	Q_G Typ (nc)	I_D Max (A)	RthjC Max	Part Number
D²PAK-7P	0.75	305	240	0.40˚C/W	AUIRFS8409-7P
	1.0	210	240	0.51˚C/W	AUIRFS8408-7P
	1.3	150	240	0.65˚C/W	AUIRFS8407-7P
D²PAK	1.2	300	195	0.40˚C/W	AUIRFS8409
	1.6	216	195	0.51˚C/W	AUIRFS8408
	1.8	150	195	0.65˚C/W	AUIRFS8407
	2.3	107	120	0.92˚C/W	AUIRFS8405
	3.3	62	120	1.52˚C/W	AUIRFS8403
TO-262	1.2	300	195	0.40˚C/W	AUIRFSL8409
	1.6	216	195	0.51˚C/W	AUIRFSL8408
	1.8	150	195	0.65˚C/W	AUIRFSL8407
	2.3	107	120	0.92˚C/W	AUIRFSL8405
	3.3	62	120	1.52˚C/W	AUIRFSL8403
TO-220	1.3	300	195	0.40 ˚C/W	AUIRFB8409
	2.0	150	195	0.65 ˚C/W	AUIRFB8407
	2.5	107	120	0.92 ˚C/W	AUIRFB8405
DPAK	1.98	103	100	0.92 ˚C/W	AUIRFR8405
	3.1	66	100	1.52 ˚C/W	AUIRFR8403
	4.25	42	100	1.90 ˚C/W	AUIRFR8401
IPAK	1.98	103	100	0.92 ˚C/W	AUIRFU8405
	3.1	66	100	1.52 ˚C/W	AUIRFU8403
	4.25	42	100	1.90 ˚C/W	AUIRFU8401

The new International Rectifier AEC-Q101 qualified COOLiRFET® technology sets a new benchmark with its ultra-low $R_{DS(on)}$. The advanced silicon trench technology has been developed specifically for the needs of automotive heavy load applications offering system level benefits as a result of superior $R_{DS(on)}$, robust avalanche performance and a wide range of packaging options.

The COOLiRFET® Advantage:

- Benchmark $R_{DS(on)}$
- AEC Q101 qualified
- High current capability
- Robust avalanche capability

Key Applications:

- Electric power steering
- Battery switch
- Pumps
- Actuators
- Fans
- Heavy load applications

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