ISSN: 1863-5598

ZKZ 64717
10-14

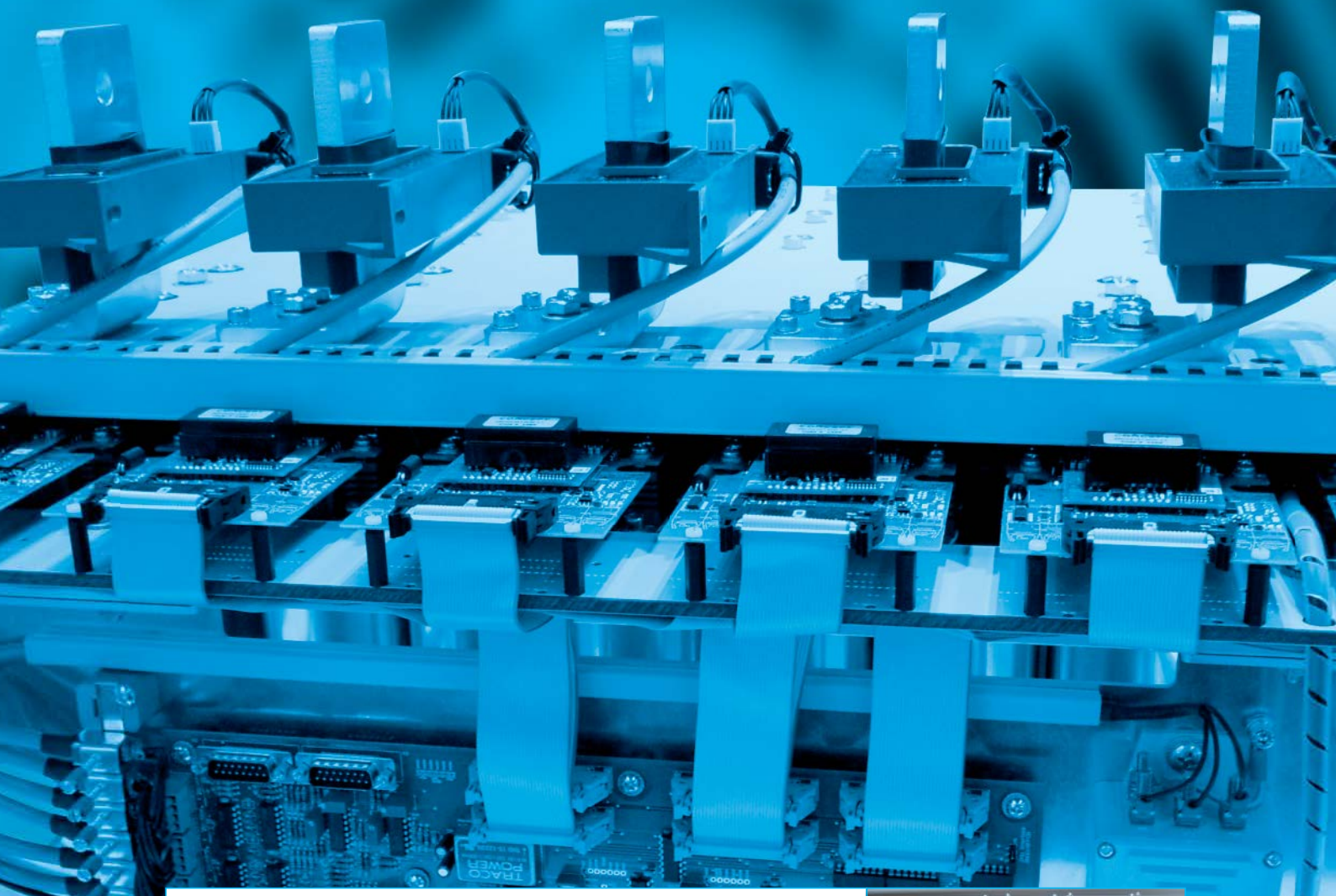
Bodo's Power Systems®

Electronics in Motion and Conversion

OCTOBER 2014

Discover Planet e (p. 54)

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



VARIS™ – the modular inverter system

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

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

engineered by

GvA Power Electronics

Welcome to the House of Competence.

GvA Leistungselektronik GmbH | Boehringer Straße 10 - 12 | D-68307 Mannheim
Phone +49 (0) 621/7 89 92-0 | www.gva-leistungselektronik.de | VARIS@gva-leistungselektronik.de

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

powerguru.org

CONTENT

The Gallery

Vincotech
The Power to Move Ahead

Speed and Flexibility

Vincotech, a 100% independent company within **Mitsubishi Electric Corporation**, is a market leader in power modules. With over 40 years of experience Vincotech develops and manufactures high-quality electronic power components for Motion Control, Renewable Energy, and Power Supply applications.

What Vincotech offers:

- Power module topologies ranging from 4 A to 800 A and from 600 V to 2400 V
- All topologies with low stray inductance (Rectifier, Sixpack, PIM (CIB), IPM, Boost, NPC, H-Bridge, Half-Bridge, PFC, etc.)
- 21 various standard housings

The Vincotech difference:

- A large variety of standard products for qualified, reliable solutions
- Multiple chip sources from twelve leading semiconductor manufacturers, e.g.: CREE™, Infineon, Fairchild, ROHM™, Vishay, etc.
- Building blocks to design your product – flexible designs to meet your specific requirements
- Ultra-low inductance designs
- Phase-change material – no more thermal grease

New SiC-MOSFET modules for solar, UPS, and battery management

***flow*3xPHASE 0 SiC** and ***flow*3xBOOST 0 SiC**

- Three-phase inverter (BUCK/BOOST) with split output topology **or**
- Three-channel boost circuit
- SiC-MOSFET 2nd generation switches (multiple sources)
- Integrated capacitors
- Temperature sensor

www.vincotech.com/flow_0_SiC

If you can imagine it – we can build it

www.vincotech.com

Industrial Drives | Solar Inverters | UPS | Embedded Drives | Welding | Power Supplies

Bodo´s Power Systems®

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

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

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

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

Creative Direction & Production
Repro Studio Peschke
Repro.Peschke@t-online.de

Free Subscription to qualified readers

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

circulation ASC audit since 06/2006 print run 24 000

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

Events

PCIM South America 2014,
Sao Paulo, Brazil, October 14-15
http://www.mesago.de/en/SAPCIM/home.htm

electronica 2014,
Munich, Germany, November 11-14
http://www.electronica.de/

sps ipc drives 2014,
Nuremberg, Germany,
November 25-27
www.mesago.de/de/SPS/home.htm

Power Electronics 2014 Moscow,
Russia, November 25-27
http://expoelectronica.primexpo.ru/en/

Working for Peace

Engineers have invented technology that has improved our lives, and military funding has always been a strong driving factor for innovation – but warfare using this technology is one of the worst things I see happening in our world. People and politicians have to be mature enough to settle conflicts without having soldiers and civilians killed. History must influence peoples' attitudes and politicians' diplomatic skills.

Health disasters in our world abound and are worth fighting for. In Africa, Ebola seems to be emerging and out of control. Can we not focus our resources on controlling that epidemic and finding a cure? Is it not shameful that people in war zones support the beheading of news reporters? To me this seems like a modern form of cannibalism – have we not progressed ?

We need to fight for excellent education everywhere in our world. Education is the fundamental path towards a better life and fulfilling work, the way for positive change in the face of centuries-old man-made disasters.

I grew up knowing that my grandfather was killed in World War I. My mother's brothers, my uncles, therefore had an exemption from participating in WW II, but sadly both died in that war. So I grew up missing a lot of my family members. Being born after the war in 1953, I am thankful that my life so far has not been directly affected by war. But the nearby border between the former East and West Germany always provided bad images, including reports of people killed crossing the border. Ending the East-West Cold War was a historical great step forward. Now I meet customers from all over the world, cooperating for a better world – so while some progress has been made, there's more than enough which remains to be done.

eCarTec 2014,
Munich, Germany
October 21-23
http://www.ecartec.de

Free day ticket using code **A8EJ2Q5**
http://www.ecartec.de/tickets/

My recent visit to the EPE ECCE conference in Lappeenranta close to the Finnish-Russian border showed me that industrial cooperation is a great way to overcome borders. I was impressed with the environmental "green" thinking process evident in many ways at the University in Lappeenranta. But this is in contrast to Finnish plans for nuclear power and building more such nuclear plants in the future. In light of the disaster in Fukushima, it is not a "green" approach in my view.

Communication is the only way to progress. We delivered nine issues this year, and October marks 117 technical articles published year to date, amongst 728 pages. They are all archived on my web-site and also retrievable at PowerGuru. Bodo's Power Systems serves readers across the globe. If you speak the language, or just want to have a look, don't miss our Chinese version: www.bodospowerchina.com.

My Green Power Tip for October:
Speak with the Finish about the ongoing building and planning of new nuclear power plants. Is this in conflict with their environmental concerns, and wouldn't investment in wind turbines be more advisable?

See you soon at eCarTec, and around the world.

Best Regards

The Perfect Fit

HLSR

The perfect fit for your design: a cost-effective current transducer that out-performs shunts in every way. The compact package of the HLSR requires only 387 mm^2, less board area than many shunt solutions. Large clearance/creepage distances ensure safety, and high performance produces accurate measurements across a wide temperature range of -40°C to +105°C. The LEM HLSR – a single compact device that eliminates complexity in your design.

The LEM HLSR series:

- High performance open-loop ASIC based current transducer
- $10A_{RMS}$, $20A_{RMS}$, $32A_{RMS}$, $40A_{RMS}$ and $50A_{RMS}$ nominal current versions
- Single +5V or +3.3V power supply
- Fast response time: 2.5 µs
- Full galvanic isolation
- 8 mm clearance/creepage + CTI 600
- Low offset and gain drifts
- Over-drivable reference voltage
- Through-hole and SMT packages

www.lem.com

At the heart of power electronics.

LEM®

Energy Efficiency Electrifies SEMICON Europa

For the first time, SEMICON Europa 2014 will offer two new power-related technical forums — Power Electronics Conference (8-9 October) and Low Power Conference (7-8 October). The exhibition and conferences in Grenoble will offer an in-depth look at the cutting-edge energy technology delivering new levels of energy efficiency in electronics. Energy efficiency is a key challenge and advances in power microelectronics, batteries, mobility, and energy harvesting systems are making power management smarter to reduce energy consumption. SEMICON Europa's two new Power Conferences focus on how innovators and their technologies are building energy-optimized applications.

The theme of the Low Power Conference is "Highly Energy Efficient Nanotechnologies and Applications." The number of connected electronics devices is growing exponentially.

The Power Electronics Conference is themed "The Ultimate Path to CO2 Reduction." Modern power semiconductors play an essential role in energy conservation and worldwide CO2 reduction. Philippe Roussel, business unit manager at Yole Developpement, will present the keynote on market and technology overview of the Power Electronics industry, including a look at the impact of Wide BandGap (WBG) Devices. He believes that the emergence of new WBG technologies such as SiC and GaN will reshape the established power electronics industry, especially on the high-voltage side. SiC and GaN offer benefits (higher frequency switching, power density, and more) that may dramatically help improve the power conversion efficiency.

www.semiconeuropa.org

Quality & Design Center now ISO/IEC 17025 Accredited

Würth Elektronik eiSos, manufacturer of electronic and electromechanical components, has successfully accredited its global Quality & Design Center in Shenzhen (China) in accordance with ISO/IEC 17025. This is an important step for the company as the investment for the accreditation ensures the highest quality standards for product durability and high process reliability. The Quality Design Center was built in 2009, close to one of the manufacturing locations of this globally active company.

This laboratory inspects the quality of the raw materials and the final goods, which are leaving the Asian production lines. To represent the high standards in the quality laboratory officially, the ISO/IEC 17025 accreditation process was initiated and completed in March of this year.

Laboratories accredited based on this standard show that their technical systems and methods are able to carry out accurate and repeatable laboratory tests. The test results are recognized among ilac-MRA accredited laboratories. Accreditation, like certification, is based on conformity with standards, but also on the requirement of being able to perform special repeatable laboratory tests. To guarantee this standard for the future, internal audits and conformity tests are conducted on a regular basis.

www.we-online.com

APEC 2015 Sponsors Announce Student US1000 Travel Support

The joint sponsors of the Applied Power Electronics Conference have announced the continuation of the popular $1,000 Student Attendance Travel Support to cover part of the travel and conference expenses for up to 40 students to attend APEC 2015 in Charlotte, NC, March 15-19, 2015. Now in its 10th year, this popular program, initiated by the Power Sources Manufacturers Association (PSMA) ,is now jointly underwritten by PSMA and the other co-sponsors of the APEC Conference – the IEEE Power Electronics Society (PELS) and the IEEE Industry Applications Society (IAS). The recipients will be chosen by the APEC 2015 Award and Grants Committee. Application forms are available at APEC Attendance Travel Support Application. The criteria for the travel support reimbursement are:

The applicant must be an undergraduate or graduate student enrolled in a power electronics program at an accredited institution.

Only students who have not received travel support in the past will be considered.

The recipients must be an author or co-author of a paper that was accepted for presentation at APEC 2015 The recipient must attend APEC 2015 and submit expense receipts to the Committee

Up to two students from a single institution may each receive Travel Support. However, they may share their reimbursement with other students from the same institution who submitted applications

Applications must be made and received by the Committee by October 17, 2014

The recipients will be notified by the Committee by November 14, 2014

As part of the application process, students must provide information about their educational institution, degree program, the name of their faculty advisor and a brief description of their career interest and reasons for planning to attend APEC. The application also requires the title and ID number of the accepted paper, as well as the name(s) of co-author(s). More information about the APEC Student Travel program may be found at the Education Forum page:

www.psma.com/technical-forums/education/news

RichardsonRFPD
An Arrow Company

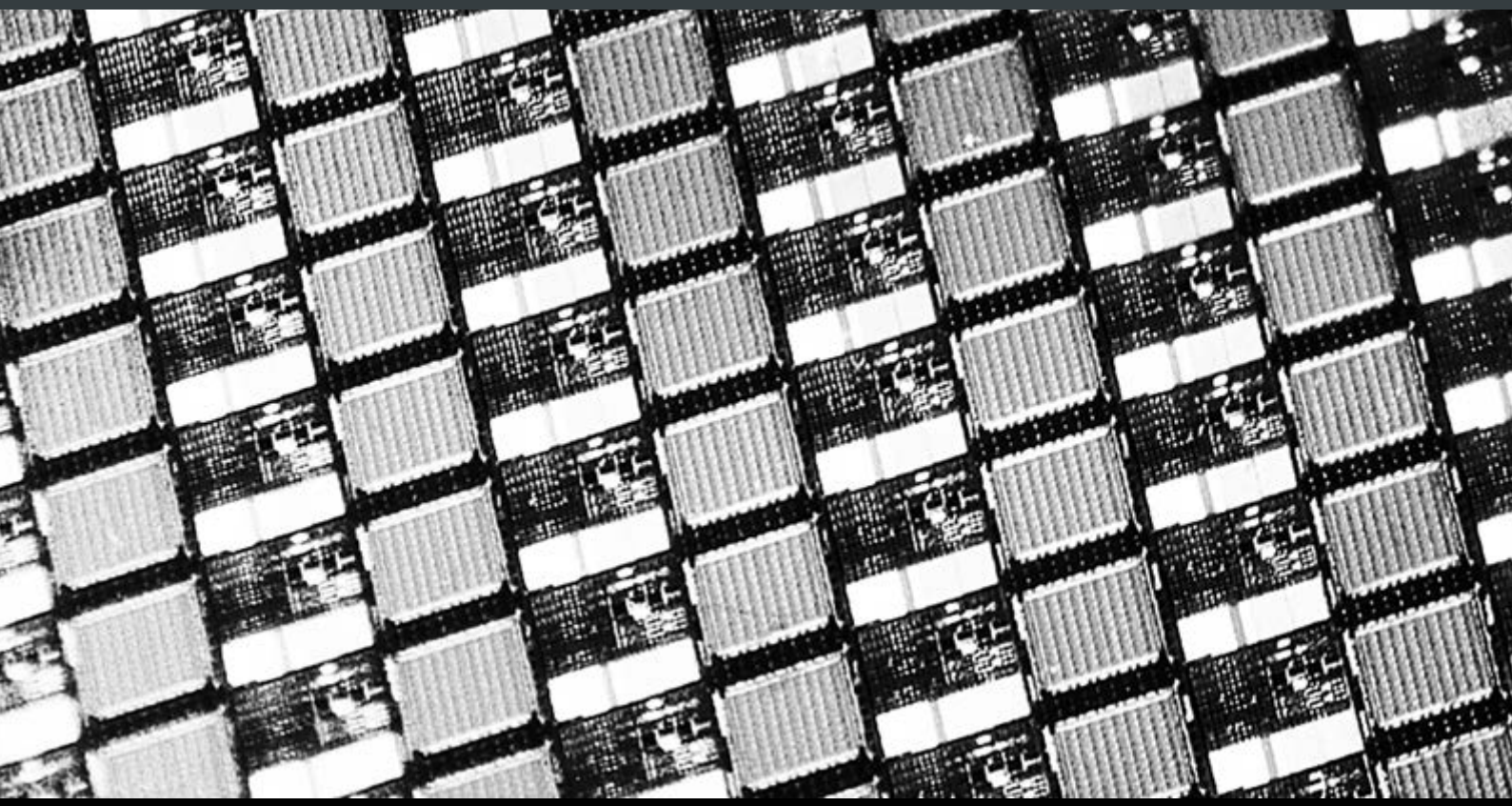
Arrow
RF & Power

Your Global Source for Silicon Carbide Technology

Realize the benefits of SiC technology with our offering of SiC MOSFETs, diodes, MOSFET modules and SiC/Si hybrid modules from industry-leading manufacturers Cree, Microsemi, Vincotech and Powerex.

Find it all on our SiC Tech Hub, along with new product announcements and the latest SiC news and market trends.

Visit richardsonrfpd.com/SiCPower to learn more.



richardsonrfpd.com | 630 208 2700

SENSOR and IRS² Call for Papers Now Online

The AMA Association for Sensors and Measurement requests the submission of papers to be presented at the AMA Conferences 2015, the SENSOR and IRS². Both conferences will be held parallel to the SENSOR+TEST 2015 from the 19th to the 21st of May in Nuremberg. The deadline for submission is 17 October 2014.

Smart cities, Industry 4.0, or resource efficiency – sensing and measuring are among the key technologies for technical advance. The AMA links innovators from research and development, from science and industry. The AMA Conferences SENSOR and IRS² are regarded as networking platforms, targeting an international community of professionals and providing insights in the latest research results from diverse disciplines.

This call for papers is aimed at all professionals who would like to present their developments at one of the two technical conferences. The presentations are requested in the form of lectures or poster sessions. They must be submitted before 17 October 2014. The SENSOR conference focuses on the development of sensors and actuators as well as measuring and testing technology in general. The IRS² deals with state-of-the-art developments in infrared sensors and systems.

The parallel SENSOR+TEST trade fair with more than 500 exhibitors is considered to be the most important European information platform for sensor, measuring, and testing technology, providing the conference participants with opportunities to participate in the innovation dialog beyond the AMA conferences.

Interested parties are requested to include an abstract of their paper before 17 October 2014 and to mail it to conference@ama-science.org.

For a document template and further information on the AMA conferences and their focal topics please go to

www.ama-science.org/direct/call-for-papers

Indium Corporation's Technology Experts to Present at SMTAi 2014

Several Indium Corporation experts will share their technical knowledge with attendees at the Surface Mount Technology Association's International Conference and Exhibition (SMTAi) from Sept. 28-Oct. 2 in Rosemont, Ill.

Dr. Ning-Cheng Lee, vice president of technology, will deliver two presentations. Low-Porosity Pressureless Sintering of Novel Nano-Ag Paste for Die-Attach reviews the use of a newly-developed nano-Ag paste, which allows for a pressureless sintering die-attach process that creates sintered joints exhibiting very low porosity, high joint shear strength, and very good electrical and thermal conductivity.

Tim Jensen, senior product manager for engineered solders, will present Advancement of Solder Preform Technology to Reduce QFN Voiding. This paper explains how the use of solder preforms can minimize the excessive wicking down the via, while producing a solder joint with adequate stand-off and very low voiding.

Dr. Ron Lasky, senior technologist, will present two papers. Risk and Mitigation for Tin Pest and Tin Whiskers outlines the reliability concerns of both of these phenomena. It also includes a review and analysis of the varying strategies to address each of them.Dr. RunSheng Mao, research chemist, will present Complicated Board Programming for Automated Printed Solder Paste Inspection without CAD Data Files. This paper describes a unique technique for evaluating solder paste printing performance objectively, using a "virtual part" approach to program test boards for SPI operation without CAD data files.

SMTA International is an annual technical conference and exhibition on electronics assembly and advanced packaging that draws industry professionals from around the world. For a full schedule of presentations, visi:

www.smta.org/smtai

www.indium.com

Rog Mobile a Free Mobile App for Apple and Android Devices

Rogers Corporation's Advanced Circuit Materials Division launched ROG Mobile, a free mobile app for Apple and Android devices. The new app allows users to access Rogers' calculators, including the popular MWI (Microwave Impedance) simulation tool, literature, technical papers and the ability to order samples, all while on the go with their smart phones and tablets. ROG Mobile includes tools and technical information to assist users with Rogers Corporation's high performance printed circuit board materials.

Several Rogers' calculators are featured that assist RF engineers with electrical, thermal and mechanical simulations for microwave PCB designs. The popular Microwave Impedance Calculator, which assists with microwave circuit design predicts the impedance of circuits made with Rogers high frequency circuit materials and also predicts transmission line losses.

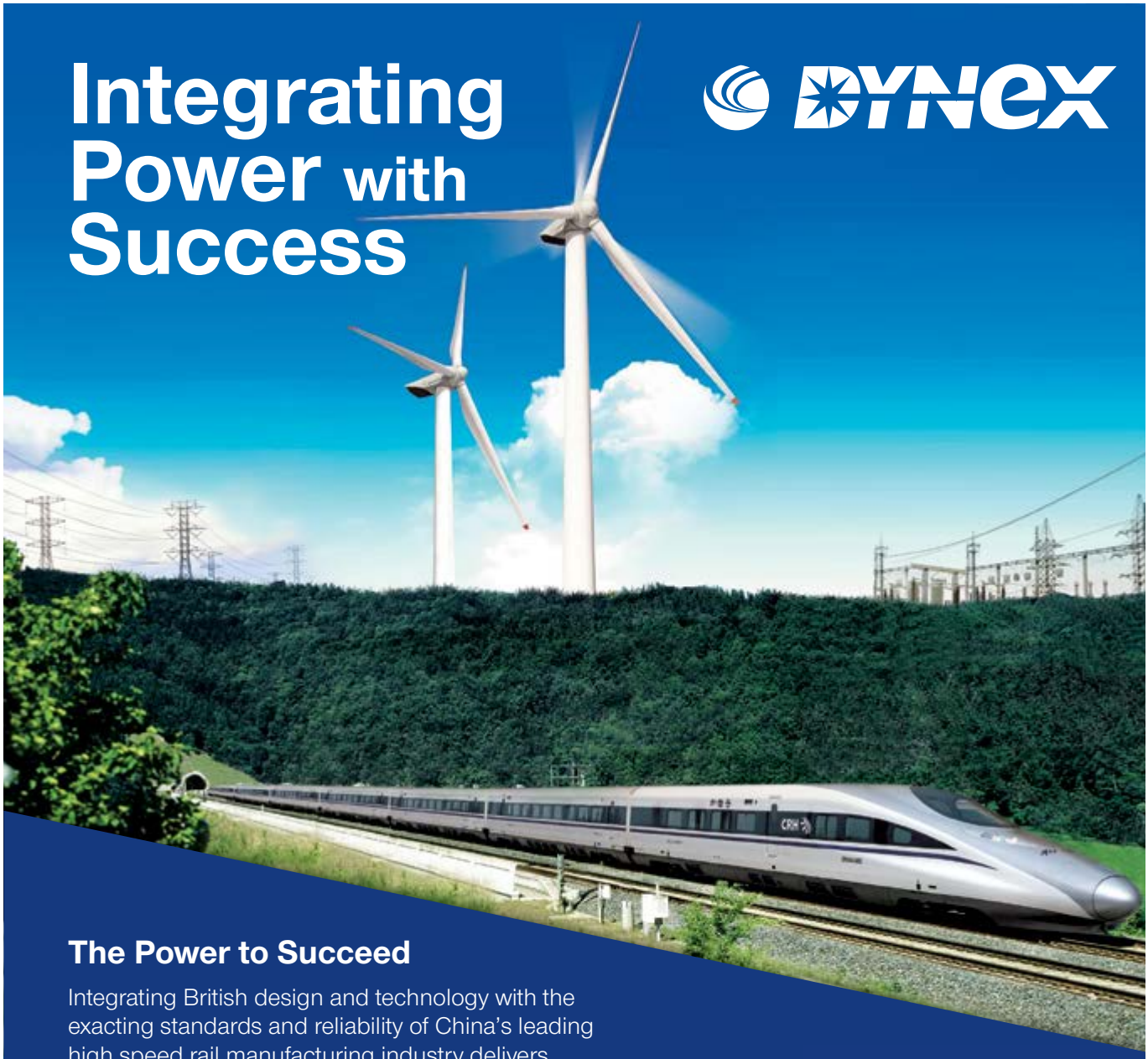
Data sheets and fabrication guides can be viewed easily for a range of Rogers' high frequency materials. Users can also stay up to date by viewing articles and tech tips written by Rogers' experts. After a user determines which Rogers' material is best for their application, samples can be ordered directly through the app for optimal convenience.

To download the new free ROG Mobile App, visit the Apple App Store or Google Play and search for ROG Mobile or visit the Rogers Corporation website at:

www.rogerscorp.com/rogmobile

W

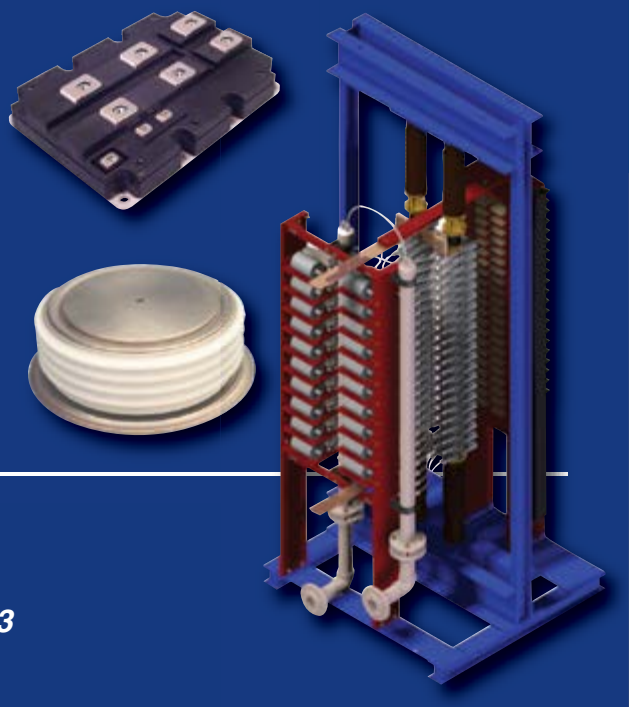
Integrating Power with Success



The Power to Succeed

Integrating British design and technology with the exacting standards and reliability of China's leading high speed rail manufacturing industry delivers the best in high power semiconductor components and assemblies.
Dynex and CSR Times Electric working together to bring our customers the power to succeed.

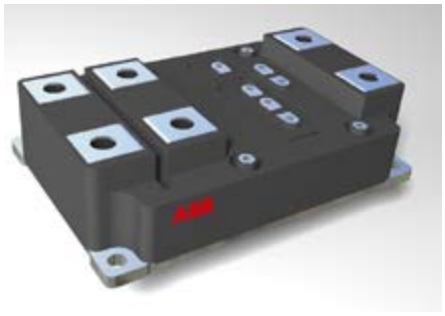
Products	Current/A	Voltage/V
High power IGBT/FRD modules	100~3600	1200~6500
Phase Control Thyristors	300~6800	1400~8500
Rectifier Diodes	400~10000	1400~8500
GTO	600~4000	1300~4500
Assemblies	As per customer's requirements	



www.dynexsemi.com
T: +44 (0)1522 502 901 +44 (0) 1522 502 753
E: power_solutions@dynexsemi.com

LinPak – IGBT Open Standard Medium Power Phase-Leg Module

ABB presents a new open standard phase-leg module outline, the LinPak. The innovative LinPak concept answers the market's request for a new package that offers exceptionally low stray inductance and, due to separated phase- and DC-connections, allows for simpler inverter designs. The very low-inductive internal module design and the massive DC-connection enables both, a very low-inductive busbar design and a high current carrying capability. Both are desperately needed for state of the art silicon chipsets and even more for future SiC solutions.



The LinPak module design results in excellent internal and external current sharing, making it ideally suited for paralleling, it thus renders possible a large range of current ratings with just one article.

Derating-free paralleling will be possible up to at least four modules. Moreover, the LinPak features an integrated temperature sensor and has a dedicated mounting area for a gate-drive adapter board. For harsh environments in traction or off-highway vehicle applications, the adapter board can be additionally fixed with four screws in the module corners.

This new open standard external module design can be freely used from all module manufacturers, as long as the outline and terminal positions are kept identical. So far at least two major suppliers are committed to this new high-power IGBT package.

Based on the shown concept, ABB will develop highly reliable traction rated modules, starting with 1700V / 2 x 900A and 3300V / 2 x 450A. Also Cu-based industrial versions at 1700V, 1200V are targeted. Soon high-voltage traction versions with the same footprint, but rearranged electrical connections in order to cope with the higher clearance and creepage requirements will be presented. Voltage ratings for the high voltage versions will be up to 6500V.

www.abb.com/semiconductor

Transphorm Partners with Tata Power Solar to Introduce India's Most Efficient Solar Inverter

Transphorm Inc. announced that it is partnering with Tata Power Solar, to introduce India's most efficient solar inverter using Transphorm's patented EZ-GaN™ technology. This collaboration enhances Tata Power Solar's position as a solar solutions and technology leader, by launching inverters based on Transphorm's unique GaN-based power switching platform.

Currently widely used in LEDs, GaN is the next generation in power electronics. The GaN transistor combines low switching and conduction losses, offering reduced energy loss of more than 50 percent compared to conventional silicon-based power conversion designs.

Transphorm has established the industry's first and only qualified 600V GaN device platform with its TPH Series portfolio of GaN products, backed by its world-leading GaN power IP portfolio.

Under the partnership, Transphorm will supply GaN transistors, while Tata Power Solar will locally manufacture and market the GaN-powered solar inverters. The first PV Inverter product is scheduled to be released in early 2015.

www.transphormusa.com

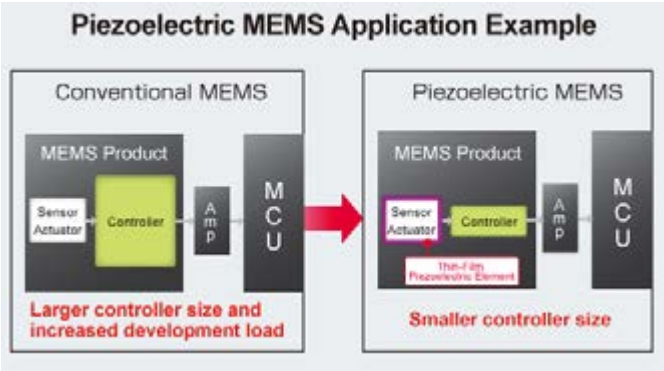
www.tatapowersolar.com

Foundry Business for MEMS Utilizing Thin-Film Piezoelectric Elements

ROHM has recently established a process for MEMS (Micro Electro Mechanical System, hereinafter 'piezoelectric MEMS') utilizing thin-film piezoelectric elements, and implemented the industry's first* foundry business that integrates product design and manufacturing processes, from wafer pulling to mounting, in order to meet a variety of customer needs.

Piezoelectric elements, which possess the inherent property of generating a voltage when pressure is applied, are incorporated into a variety of electronic devices, from conventional inkjet printheads to autofocus systems in infrared and standard cameras. Combining these elements with MEMS technology, which is commonly used in accelerometers and gyroscopes, makes it possible to simplify design and reduce the size of processing controllers, contributing to increased performance, lower costs, and greater end-product miniaturization. In addition, the energy-saving characteristics of the piezoelectric element itself, which requires very little power during standby, are garnering increased attention, particularly in the sensor market where explosive growth is expected.

ROHM has already begun conducting joint development of piezoelectric MEMS products based on customer requirements and gradually



expanding its production lines to accommodate growth markets, such as industrial inkjet printers, sensors, and wearable devices. Going forward the company will continue to integrate piezoelectric elements with MEMS technology in order to achieve greater miniaturization and energy savings.

www.rohm.com/eu

Danfoss and Vacon to Join Forces in the AC Drives Business

Danfoss announces a public tender offer for all shares of the Finnish AC drives company Vacon. Vacon shareholders are being offered a cash consideration of EUR 34 for each share in Vacon, representing an aggregate equity purchase price of approximately EUR 1038 million.

After a careful examination of Danfoss' offer, the Board of Directors of Vacon has unanimously decided to recommend that the shareholders accept it. Vacon is truly one of the great industrial success stories, even globally speaking. By joining forces, the two companies will create a Nordic-based global player – a new AC drives business with the clear ambition to build a leading position in the AC drives market," says Panu Routila, Chairman of the Board at Vacon.

The background for Danfoss' offer is the company's strategic focus on creating profitable growth. Vacon is a good match to achieve this ambition. Today, both Danfoss Power Electronics and Vacon are significant players in the AC drives business, and together they will gain an even stronger market position.

"We have a clear strategic ambition to be one of the absolute top players in the businesses where we operate. Vacon is a very strong and innovative player and by creating this new drives business we can ensure a strong long-term growth trajectory," says Niels B. Christiansen, CEO at Danfoss.

www.danfoss.com

www.vacon.com

Alpha to Attend SMTA International and Present Technical Papers

Alpha, a global leading materials supplier, will attend the SMTA International Conference and Exhibition on September 28 – October 2, 2014 at the Donald E. Stephens Convention Center in Rosemont, Illinois. In addition to exhibiting at Booth #321, Alpha will be presenting technical papers on: "The Effect of Solder Paste Reflow Conditions on Surface Insulation Resistance" and "Low Temperature Assembly of LED Packages on PET & Polyimide Flexible Substrates."

The first paper, to be presented by Karen Tellefsen, Ph.D. and Mitch Holtzer of Alpha, focuses on the effect of reflow profile on the electrical reliability of no-clean solder paste residue. This topic is of high interest within the electronics assembly community, as understanding how SIR results fluctuate based on reflow profiles can increase the long-term reliability of a solder paste and ultimately help reduce warranty claims.

The second paper to be presented is co-authored with Multek and presents a structured study covering the assembly of LED packages on thermally conductive flexible substrates. Presented by Rahul Raut from Alpha and Brent Sweitzer from Multek, this presentation will look further into Multek's Polyimide and Polyester (PET) Q-Prime® flexible substrates paired with Alpha's standard SAC and low temperature solder paste and examine the low-temperature assembly process that was developed as a result.

www.alpha.alent.com

www.smta.org

Industry's Smallest 18-V eFuse Power Protection Switch Efficiently Defends Systems

TI eFuse offers multiple levels of protection, extends battery life and reduces solution size in portable and adapter-powered devices

Texas Instruments introduced the industry's smallest bidirectional 18-V, 5-A protection switches with high power efficiency. These tiny devices reduce solution size and extend battery life in portable and adapter-powered devices, and enterprise and client solid state drives (SSDs).
For more information, visit: http://www.ti.com/tps25942-pr-eu

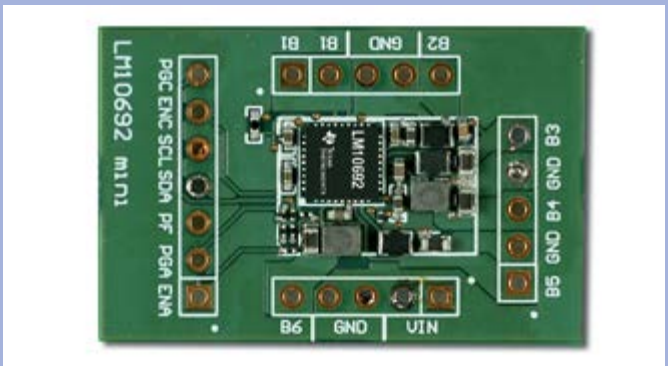
Enterprise SSDs are reading and writing more data than ever before, which is driving a requirement for increased speed and reliability in smaller form factors. TI's TPS25940 and TPS25942 integrated circuits include back-to-back FETs to provide bidirectional current control, while reducing system size by 50 percent compared to discrete solutions. These smart eFuse ICs save board space by maintaining over/under voltage threshold accuracy of 2 percent, eliminating the need for a separate supply voltage supervisor chip.

The TPS25940 eFuse power switch integrates DevSleep mode, which enables hosts and devices to completely hibernate an SSD serial ATA (SATA) interface to reduce power consumption to less than 5 mW.
The TPS25942 eFuse power multiplex (MUX) integrates an enable block function which allows the system to select between non-ideal diode mode and ideal diode mode.

Features and benefits of the TPS2594x:

- Extend battery life and reduce power loss: In addition to DevSleep mode, these smart-eFuse devices integrate an active mode to reduce power consumption by providing an internal low-resistance switch (42 mOhm typical).
- Accurate, reliable protection: Fast short-circuit response of 200 ns minimizes bus droop and supply stress during short-circuit events.

Intelligent MUX: Allows two supplies of equivalent voltage to be designated primary and secondary without turning off the overcurrent protection NFET of either, which reduces holdup capacitor requirements by up to 70 percent.



TI also introduced a new power management unit (PMU) with six integrated buck regulators designed for the SandForce® SF3700 SSD controllers for notebooks and PCs. The LM10692 provides phase-shifted operation at 2-MHz switching frequency to reduce the input-current ripple. In addition, the integrated PMU minimizes inductor and capacitor size to save valuable board space. Using TI's LM10692 and MSP430 with SandForce's SF3700 controller reduces system size to a tiny 13.5-mm by 9.3-mm footprint. As part of this collaboration, TI joined the SandForce Trusted® program today in order to provide premium support and enable faster time-to-market for customers using TI solutions with the SandForce controller.

Availability, packaging and pricing
These SSD power management devices are shipping in volume production in the following package options and prices in 1,000-unit quantities:
TPS25940 eFuse power switch: 20-pin, WQFN package at US$0.85.
TPS25942 eFuse power MUX: 20-pin, WQFN package at US$1.10.
LM10692 PMU: 36-pin, VQFN package at US$2.80.

About Texas Instruments
Texas Instruments Incorporated (TI) is a global semiconductor design and manufacturing company that develops analog ICs and embedded processors. By employing the world's brightest minds, TI creates innovations that shape the future of technology. TI is helping more than 100,000 customers transform the future, today.
Learn more at:

www.ti.com

One Source Solutions for your Power Modules

Cu-AlN & Al-AlN Substrates

Cu-AlN Substrates with superior bending strength > 650MPa
Al-AlN Substrates with excellent reliability (> 3.000 heat cycles from -40/+125 °C)

Power Sintering Paste

With high reliability (> 1.000 heat shock cycles from -55/+150 °C) for low pressure (< 8MPa) and pressureless Ag sintering

GaN HEMT Epiwafers on Si

With high breakdown voltage (1.000V) and low leakage current (1E-6A)

DOWA
DOWA HD Europe GmbH
+49 (0) 911 - 56 98 93 20
info@dowa-europe.com
www.dowa-europe.com

Internet of Things Fuels Power Electronics

By Wolfgang Patelay, freelance editor

There´s no doubt – nowadays electronic technologies have infiltrated nearly all sectors of our daily life. From the very first the electronics industry is characterized by rapid evolution concerning size, speed, performance, and power consumption – speed and performance were always increasing and size and power consumption were always shrinking. This evolution is going on up to date and enabled the development of tiny but high performance handheld devices – smartphones and tablet computers – which you can see in the hands of nearly anybody. These handheld devices nowadays allow the users to connect to the Internet any time and everywhere. Thanks to the fact that the Arpanet emerged in the mid 1990s from a network only for scientists to a general usable Internet for anybody today.

And right now we are at the dawn of a new era – the age of the Internet of Things. The Internet of Things (IoT) refers to the interconnection of uniquely identifiable embedded computing-like devices within the existing Internet infrastructure. Typically, IoT is expected to offer advanced connectivity of devices, systems, and services that goes beyond machine-to-machine communication and covers a variety of protocols, domains, and applications. The interconnection of these embedded devices (including smart objects), is expected to usher in automation in nearly all fields, while also enabling advanced applications like a smart grid. Things, in the IoT, can refer to a wide variety of devices such as heart monitoring implants, biochip transponders on farm animals, automobiles with built-in sensors, or field operation devices that assist fire-fighters in search and rescue. Current market examples include smart thermostat systems and washer/dryers that utilize Wi-Fi for remote monitoring.

And all these IoT devices need power to operate. If you bear in mind the plethora of such devices its clear that energy efficient is paramount yet nowadays but even more important in future. Therefore there is great effort in the electronic industry to reduce energy consumption by eliminating power losses. A good opportunity to learn more about the success of this effort and the state of the art of energy efficiency in electronic products is electronica 2014, held this year from November 11th to 14th at the fairgrounds of Messe München. This year electronica is celebrating its fiftieth anniversary, and will once again be the industry platform for exchange of information and expertise about all aspects of electronics including energy efficient solutions for the industry and consumers.

Electricity represents one-third of all energy consumed around the world. Growing energy prices are causing the industry and consumers to rethink things. Therefore the future belongs to intelligent solutions for low energy consumption in the sectors for mobility, industrial plants as well as household and consumer electronics. Exhibitors from around the world will present the latest trends and developments for energy-efficient electronic components, systems and applications.

A good example is the high-voltage switcher UCC28880 which is expanding Texas Instruments portfolio of high-voltage power solutions for offline AC/DC designs. This 700V-switcher with a quiescent current of less than 100 µA – half the power consumption of existing solutions integrates a 700-V power MOSFET and high-voltage current source, increasing overall energy efficiency of “always-on” non-isolated power systems with output currents up to 100mA, such as smart meters, home automation equipment and white goods. The controller reduces system cost and minimizes the overall size of the power supply, while maintaining high efficiency and system performance. Designers can use the switcher to build different converter topologies, such as buck, buck-boost and flyback, without adding extra semiconductor components.

Another example for the great effort to reduce power consumption is Infineon Technology, the company which acquired power electronics specialist International Rectifier recently. Dr. Helmut Gassel, Head of the Business Unit for Industrial Power Control at Infineon has identified various markets and regions where energy efficiency continues to increase in importance - for environmental as well as cost-related reasons. He states: “In China, entire fleets of busses for inner-city transport are switching to electric drive systems. In the United States, they are experimenting with electrified highways for trucks. And regulated drives for industrial facilities are catching on in Europe. Energy efficiency is also developing into an important sales argument for household appliances and intelligent building-control systems.”

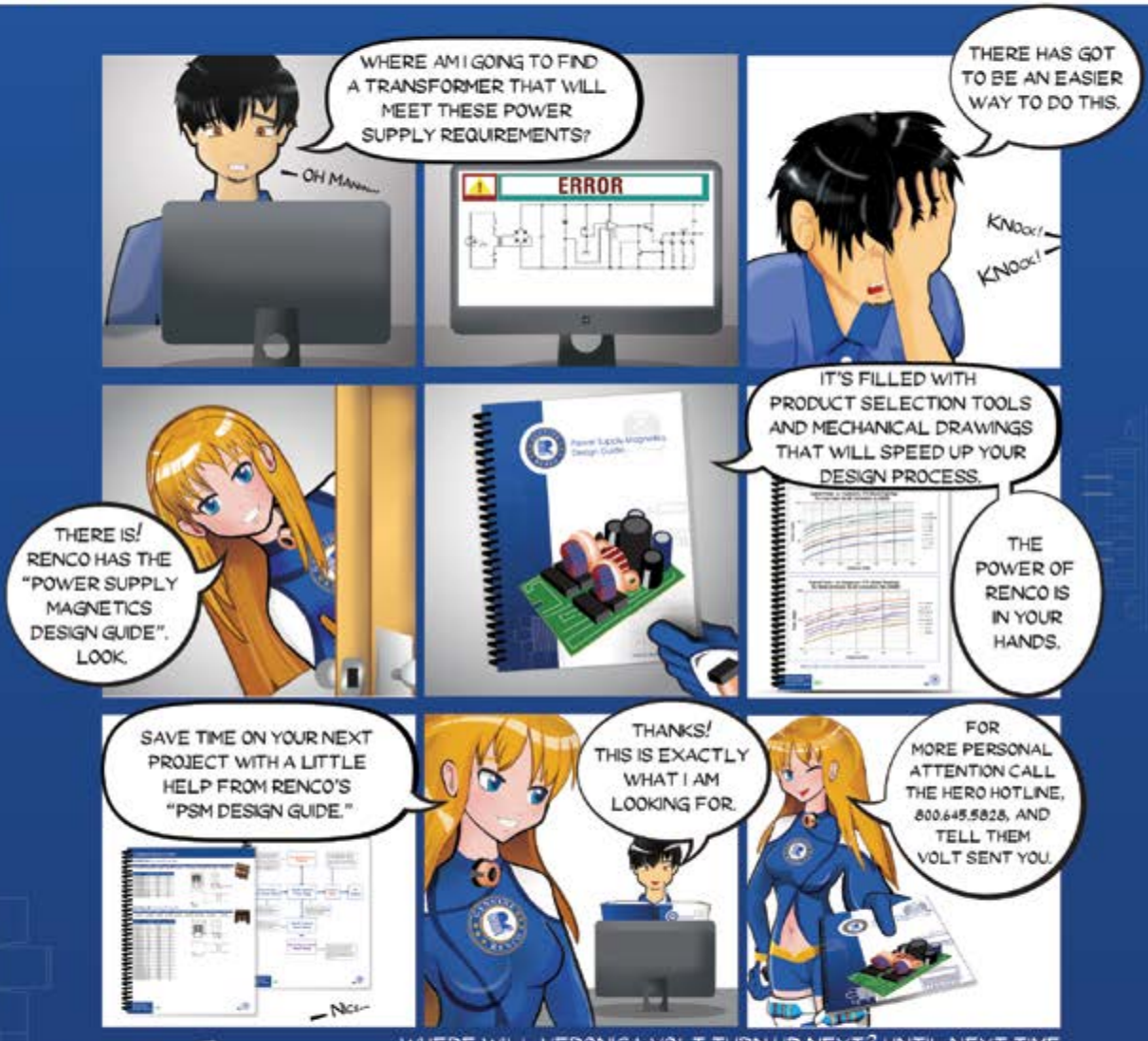
STMicroelectronics will present at electronica the LSM6DS3, its first iNEMO Ultra product - an always-on, high-performance 6-axis combination accelerometer and gyroscope that sets new standards for device and system power efficiency, signal noise, and performance in motion sensors. In concert with its ultra-low-power STM32 Microcontrollers, the LSM6DS3 combos will create - according to the company - new possibilities for the development of battery-powered smart sensor systems to be embedded in mobile and wearable devices and innovative objects for the Internet of Things (IoT). The tiny (2.5x3.0x0.8mm), iNEMO Ultra 6-axis inertial-sensor combo (3-axis accelerometer/3-axis gyroscope) delivers industry-leading noise performance while effectively managing system power with state-of-the-art technology that in testing has proven to be typically 20% more energy-efficient than the best alternative combos in low-power mode while delivering outstanding performance and protecting valuable board real estate.

These are only three examples of a multitude of new energy efficient power products which will be demonstrated at electronica 2014 in München - let´s go there and have a closer look.

Hope to see you at electronica in November.

SUPPORT FOR POWER SUPPLY MAGNETICS ENGINEERS

COMICS
ISSUE 2



WHERE WILL VERONICA VOLT TURN UP NEXT? UNTIL NEXT TIME...

Engineering Hero Hotline **1.800.645.5828**

Regardless of your stage in the design process, our design guide provides valuable insight and time savings to engineers.

www.RencoUSA.com

Parts shipped from USA or Hong Kong

Electronics Industry Digest

By Aubrey Dunford, Europartners

The European Commission launched a € 5 billion public private partnership -ECSEL -to boost Europe's electronics design and manufacturing capabilities. This initiative is the core of the Electronics Strategy for Europe to mobilise € 100 billion in private investments and create 250,000 jobs in Europe by 2020. The EU will invest some €1.18 billion in the Electronic Components & Systems for European Leadership (ECSEL) Joint Technology Initiative (JTI). ECSEL will help industry launch new pilot projects and build on the €1.79 billion already invested universities at the early stages of product and service development, bringing research closer to market. EU funding will be provided through the research and innovation programme Horizon 2020.
26 EU Member States and Associated States have lined up to put a similar amount of € 1.17 billion into ECSEL. Industrial partners will contribute more than € 2.34 billion.

SEMICONDUCTORS

Measured in Euro, European semiconductor sales for the first 5 months of 2014 are running 4.7 percent ahead of the same period in 2013 (9.6 percent in dollars), so the WSTS. European semiconductor sales were € 2.266 billion in May 2014, plus 1.9 percent versus the previous month and an increase of 3.7 percent versus the same month a year ago.

Worldwide semiconductor revenue is on pace to reach $ 336 billion in 2014, a 6.7 percent increase from 2013, and up from the previous quarter's forecast of 5.4 percent growth, so Gartner.

Infineon Technologies is expanding its Austrian site in Villach. Core emphasis is on the expansion of expertise for the manufacturing of the future as well as R&D. Infineon's expansion plans foresee investments and research costs amounting to a total of € 290 M, creating approximately 200 new jobs in the period from 2014 to 2017, primarily in R&D. At the site, important developments will be advanced and production-ready innovative technologies will be transferred by Infineon to other sites. At the same time Infineon' strategy will include expansion of its volume manufacturing on 300 millimetre thin wafers in Dresden and on 200 millimetre wafers in Kulim, Malaysia. A wide-scale research program with innovations in materials, processes, technologies and system expertise is the second pillar of the Villach site expansion. Here the program focuses on the integration of innovative substrates such as gallium nitride and silicon carbide, on MEMS and sensor technologies as well as on the continuing development of 300 millimetre thin wafer technology.

Avago Technologies, a supplier of analog semiconductor devices with a focus on III-V based products and complex digital and mixed signal CMOS based devices and PLX Technology have entered into a definitive agreement under which Avago will acquire PLX, a leader in PCI Express silicon and software connectivity solutions, in an all-cash transaction valued at approximately $ 309 M, or $ 293 M net of cash and debt acquired. The core PLX PCIe silicon business broadens Avago's portfolio serving the enterprise storage and networking end markets.

SEMI projects back-to-back years of double-digit growth in worldwide semiconductor equipment sales. The SEMI outlook calls for the total semiconductor equipment market to grow 20.8 percent in 2014 to reach $ 38.4 billion and to expand another 10.8 percent in 2015 to exceed $ 42.6 billion. Following two years of spending declines, key drivers for equipment spending are investments by foundry and logic fabs for sub 20nm technology, NAND flash makers for leading edge technology (including 3D NAND) and capacity, DRAM technology upgrades for mobile applications, and expansion of advanced packaging capacity for flip chip, wafer bumping, and wafer-level packaging.

PASSIVE COMPONENTS

LEMO, a Swiss supplier of precision custom connectors has acquired Northwire, a US-based specialty cable manufacturer of wire and multi-conductor cable and retractiles for the medical, aerospace and defense, energy and industrial markets. The acquisition of Northwire will enlarge the LEMO offering, providing a complete cable connector solution to their customers.

Astrodyne, a US-based supplier of specialized power solutions including power supplies, EMI filters, and electronic control products, has completed the acquisition of Filter Concepts, a Californian provider of EMI filter products. Through its recent acquisitions of Radius Power, LCR Electronics and now Filter Concepts, Astrodyne has created one of the largest and most capable EMI filter providers in North America.

DISTRIBUTION

RS Components has signed an agreement with Rohm Semiconductor that positions RS as an authorised global distribution partner of the electronic component vendor. RS holds a sizeable inventory of several hundred Rohm components, which includes discrete semiconductors, power management ICs, LEDs, display drivers, optical switches, video and audio processors, and sensor devices.

Avnet Technology Solutions has appointed Miriam Murphy as senior vice president, (SVP) North region, which comprises the UK and Ireland. She will be responsible for accelerating growth and profitability in these key territories for Avnet and its partners.

FBDI, Germany's component distribution association, has taken a new initiative on component traceability. It has established a Traceability work group which will work to integrate the latest requirements of the legislative authority (which includes market surveillance, new product security regulations, EN 9120 traceability standard) into the existing FBDi Traceability guideline. Monitoring of the relevant legislation will also be on the agenda, as well as the discussion on proposals for policy documents.

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

www.europartners.eu.com

Allegro Power ICs in Automotive Electronics

Power Management Solutions for Infotainment

Allegro MicroSystems offers a comprehensive portfolio of automotive-grade products which provide necessary power rails for LCD panels, bias power, LED backlights, MCUs, MPUs, GPUs, memory and interface power for infotainment systems.

Allegro's solutions are extremely robust, handling wide ambient temperature ranges and input/output operating conditions. Design focus is applied to fault mode survival and recovery. It produces industry-leading packaging for enhanced thermal performance.

Allegro's strong presence with automotive-qualified design, fabrication, assembly, and test locations adds to the high degree of reliability and performance quality.

Allegro MicroSystems' manufacturing sites are certified to ISO/TS16949:2009

Applications include:

- Audio entertainment
- GPS display
- USB power
- Heads Up Display (HUD) projector
- Instrument cluster electronics and displays
- Center stack electronics and displays
- Automotive system, memory and I/O power
- Automotive control units
- Interior smart lighting

Features/Benefits:

- AEC-Q100 qualified
- Wide VIN operation
- Alternator load dump capable
- Seamless idle-stop-start operation
- Integrated MOSFETs
- Adjustable or fixed switching frequency
- Synchronizable switching frequency
- Switching frequency outside AM band
- Strong fault mode protection
- Overtemperature protection
- Over voltage protection
- Undervoltage lock out
- Over current protection
- Pin short protection

Representatives

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

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

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

Allegro™ MicroSystems Europe Ltd

www.allegromicro.com/camp1211

Digital Power Growth Changes Trajectory

By Richard Ruiz, Research Analyst, Darnell

Digital power is no longer an emerging technology, but it is still far from maturity. It is safe to say that in the past 24 months, the digital power market has entered a new phase and is on a new growth path. It is growing faster than the power conversion or power electronics market in general and is projected to grow from $2.1 billion in 2014 to $9.3 billion in 2019, a compound annual growth rate (CAGR) of 34.7%.

Darnell Group, the pioneer in analyzing the markets for digital power, recently released its fifth-edition report on "Trends in Digital Power Electronics." The digital power conversion market will experience substantial growth over the next several years as users demand more advanced features and functions in their products. This growth will be led by a surge in 2014 and settle down into a pattern of rapid growth for the next five years.

Growth will be driven across a number of sectors including communications, computers, solid-state lighting and a growing smart grid/energy management segment. The new growth pattern for digital power can be seen in two facts. First, the market for digital power converters is growing faster than the market for digital ICs. And second, the market for digital dc-dc converters is growing more slowly than the market for digital ac-dc power supplies. Both of these facts point to important changes.

Over the past seven years, the market for digital ICs has been growing at about 12%, while over the same period the market for digital power converters has been growing by over 50%. The faster growth for digital power converters is a reflection of the fact that that market is in an earlier stage of its maturity.

It was not until the second- or third-generation of digital ICs was available that the market for digital power converters began to grow more rapidly. At that point, the digital IC market was significantly more mature, entering its fourth+ generations of products.

The relative maturity of the digital power IC market is visible in several ways. For example, the recent announcement by Texas Instruments, Inc. (TI) of an enhanced a third-party ecosystem of digital power hardware and software tools as well as development services. This ecosystem allows digital power design engineers who use TI's broad portfolio of C2000™ microcontrollers (MCUs) to develop their systems quickly and easily.

The members of the ecosystem include Altair Engineering, Inc., MathWorks and Powersim. Each company has demonstrated its digital power offerings on one or more of TI's C2000 MCU solutions, enabling applications such as inverter control, power factor correction and power conversion. This ecosystem is open to additional member companies.

In the announcement, TI noted that manufacturers need proven hardware and software to help them easily develop digital power systems and accelerate time to market. The ecosystem enables manufacturers developing on TI's C2000 MCUs to find the best digital power offering to meet their unique needs, get the most out of their TI MCU solutions and create differentiated products. Members of TI's digital power ecosystem offer services to meet the growing needs of the digital power market, including faster time to market, increased efficiency and more reliable control.

Another example of the relative maturity of digital power ICs was the recent announcement by STMicroelectronics, Inc. of market-first sub-dollar Cortex-M4 devices with FPU in volume production, the new STM32F301 access product line brings 32KBytes to 64KBytes on-chip Flash and 16KByte of SRAM, offering an easy step into ARM Cortex -M4-core-based MCU development. The STM32F302 and STM32F303 offer extended Flash density from 32KBytes to 256KBytes. Additional STM32F3 devices with up to 512KBytes of Flash will be introduced later this year.

The new sub-30ns analog comparators combined with 5Msample/s 12-bit ADC, the fastest ADC in any ARM Cortex-based MCU, offer ultra-fast reaction time for control-sensitive applications such as digital power, sonar, motor control, lighting, or wireless chargers. This ultra-fast ADC, with support of oversampling to allow 16-bit resolution at 20ksamples/s and 18-bit at 1.2ksamples/s, enhances precision, making these devices ideal for applications such as sensor data processing, healthcare, power meters, and instrumentation. In the new STM32F302/303 devices, the USB-LPM (Link Power Management) mode reduces connectivity power consumption.

Within the market for digital power converters, the digital dc-dc converter segment was the first significant adopter of the new technology, particularly for distributed power architectures in enterprise-scale systems where power management is more complex and the demand for improvements in efficiency is strong.

For example, Murata Power Solutions and Ericsson Power Modules AB announced that they have entered into a technical collaboration agreement with the goal of accelerating the adoption of digital power products. Under the terms of this agreement each company will introduce a range of standardized digital power modules. This will result in the availability of multiple product sources to manufacturers that are considering migrating designs from analog to digitally monitored and controlled units.

"We believe this joint initiative will encourage manufacturers to speed up their adoption of digitally controlled power systems. Initially, the benefits of using digitally controlled power sources were considered not to be worth the extra price. However, customers now can see the advantages digital control and monitoring can bring to their end application, so we believe that by introducing a second-source route of Ericsson's products we will speed the development of this market," commented Tatsuo Bizen, CEO and President of Murata Power Solutions.

Murata Power Solutions joins CUI, Inc. in a cooperative digital power activity with Ericsson. This activity is starting to take on the form of an "alliance" similar in some ways with the POLA and DOSA alliances. It is expected to include a common PMBus interface and may extend to both isolated and non-isolated dc-dc converters. Additional companies may be expected to join this effort in the future.

And while the maturity of the market for digital dc-dc converters is evidenced by the growth of alliances and second-sourcing, digital power is also beginning to appear in new classes of ac-output power supplies. For example, Westinghouse Electric Corp. has expanded its generator series with new digital inverter generators, which feature a simple plug-and-play system and are more compact, quiet and lightweight than traditional portable and full-frame generators.

Westinghouse's WH1000i and WH2000i Series generators utilize smart digital inverter technology to automatically regulate their power output based on the number of appliances connected to them. This enables the generators to run more quietly than other portable generators, conserve fuel and provide clean, stable power, similar to that of a utility generator, all at pricing attractive in the consumer market.

The value of digital power has always been the functions it can provide, and that functionality has become more defined and focused over the past several years as users demand a number of specific features and operations such as auto-compensation, PMBus capabilities, loop control, monitoring and reporting, parameter setting, OTP memory capability, etc.

Although these features and functions vary by industry, there are a number of common requirements identified. Among these, auto-compensation was cited as one of the of the more desired features of digital power as it eliminates a substantial burden from the power supply design and results in a more robust power supply for the life of the power supply.

Applications have already been identified that favor digital control, and products have been developed that meet those requirements or offer certain features that are critical to updated system designs. These are the so-called "legacy" applications for digital power management and control. They are large markets that will keep the traditional distributed power architectures in use for many years, with many of them incorporating digital control at some level. In contrast, new power architectures identified in this report incorporate digital power right from the beginning, and that makes them different from the legacy architectures.

These are just a few highlights of the trends that are detailed in Darnell's its fifth-edition report on "Trends in Digital Power Electronics." Over 35 tables and graphs are presented in this report covering the external ac-dc power supply market, the embedded ac-dc power supply market and the dc-dc converter module power supply market. This comprehensive analysis provides decision makers with a detailed and insightful look at the current and future opportunities available in the digital power supply market.

www.Darnell.com

The Expanding Markets for GaN Technology

By Alex Lidow Ph.D.; Efficient Power Conversation

KEY TAKE AWAYS

- GaN technology is in its infancy and will follow a "Moore's Law" path of improvement by doubling performance every two years.
- Integrating power devices on a single chip is straightforward in GaN and improves cost and performance significantly. Beyond today's $12B power transistor market is the $31.2B power management market. GaN technology is poised to attack these applications with superior cost and performance by integrating analog and power functions onto a single semiconductor chip.
- The entire $300B semiconductor industry, now dominated by silicon, is a "bull's-eye" target for GaN technology.

In the past five issues of Technology Driving Markets we traced a path from the basic properties of a gallium nitride crystal, to the electrical characteristics that result, to how this material, when transformed into an eGaN® FET, can enable some amazing new end-use applications, such as wireless power transfer, LiDAR, and envelope tracking. eGaN FETs can also replace the aging silicon-based power MOSFET in most existing applications including AC-DC and DC-DC power conversion, yielding substantial performance gains. The prize is a $12B market now occupied by an aging incumbent.

The Expanding Markets for GaN Technology

The GaN technology journey is just beginning, and we are still far from its theoretical performance limits. It is quite reasonable to expect a rate of improvement reminiscent of Moore's Law, which predicted the growth of microprocessor technology – doubling of product performance every two to four years for at least the next decade. (see figure 1)

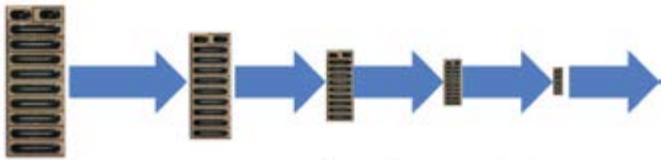


Figure 1: Moore's Law for eGaN FETs

Beyond just performance and cost improvement, the greatest opportunity for GaN technology to impact the power conversion market comes from its intrinsic ability to integrate both power-level and signal-level devices on the same substrate. GaN technology, as opposed to common silicon IC technology, allows designers to implement monolithic power systems on a single chip in a more straightforward and cost-effective way.

Today, eGaN FETs are made such that the product is a single discrete transistor. These devices work in conjunction with driver and control integrated circuits. Transistors of all types, plus their accompanying integrated circuits, form the majority of the power management market. According to IHS iSuppli Research, in 2011 this market in total was $31.2B.

Is GaN a good candidate to replace this entire $31.2B market? We believe the answer is yes, and that it will occur in stages over the next few years.

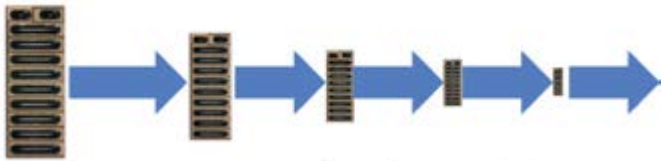


Figure 2: Today's eGaN FETs (eight blue devices) are used as discrete transistors mounted on PCBs with silicon-based driver and control ICs. Moore's Law for eGaN FETs

Figure 2 shows the way in which typical power systems designers implement circuits with eGaN FETs today. The eight blue rectangles are individual eGaN FETs mounted onto a printed circuit board (PCB), forming a type of DCDC converter commonly used in computer server and telecommunication equipment.

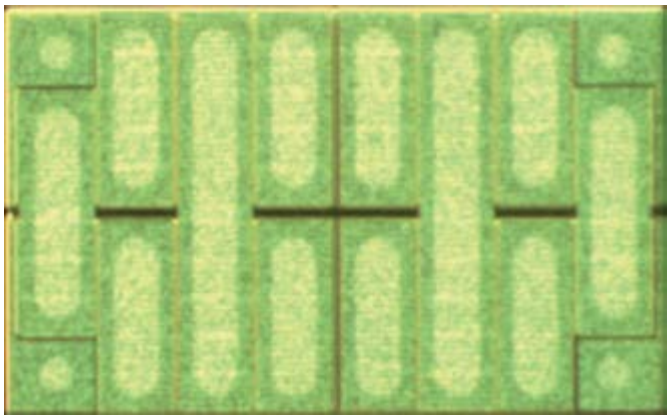


Figure 3: Four eGaN FETs integrated onto one chip.

In figure 3 is shown a product under development at EPC whereby four of those devices are integrated onto one chip. Not only does this integration save space on the PCB, but it also saves production costs and boosts the performance of the system (Look for these products in 2015). This type of innovation – the ability to integrate functions on a single chip – further increases the relative competitiveness of eGaN FETs compared with MOSFETs. Integration of discrete devices, however, does not necessarily increase the size of the market beyond

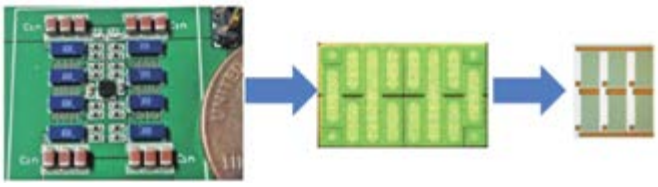


Figure 4: The evolution of eGaN technology from $12 B discrete transistors mounted on a printed circuit board, to integrated power devices, and finally to the 31.2B integrated power-plus-analog functionality Power Management Market.

the $12B occupied by discrete transistors, but allows eGaN FETS to attack that market in a more profitable fashion.

To get at the larger, $31.2B, power management market, the next step to be taken is to integrate the analog IC functions that are the exclusive territory of silicon today. That step, illustrated in figure 4, is also under development and should be ready for customers in the 2017 time frame. The integration of power and analog functions yields additional cost and space savings and, even more significantly, it brings GaN's superior performance to the analog circuitry driving the eGaN FETs. The replacement of the relatively slow silicon analog driver IC with an integrated GaN circuit enables a large boost in product performance – at a greatly reduced cost!

The $31.2B market for power management semiconductors is also just a stepping- off point on the way to addressing the entire $40B analog IC market and, potentially, the total $300B semiconductor market!

Has silicon reached the end of the road? Not yet, but a major challenge to silicon's supremacy has finally surfaced after almost 60 years of silicon's dominance.

www.epc-co.com

Analysing Thermal Performance of Intelligent Power Modules for Better PCB Design

Intelligent power modules are the designer's choice for low-power motor-drive applications, particularly where cost and size constraints are tight. A new study of module thermal performance under various operating conditions helps designers to predict operating temperature, power and PCB design accurately for optimum reliability, cost and size.

By Stefano Ruzza & Marco Palma, International Rectifier, Motion IC Group Europe

Designing with Intelligent Power Modules

Motor controllers for use in home appliances and light industrial drives are typically designed using an intelligent power module containing gate drivers built using HVIC technology, power switches configured as a half-bridge or three-phase bridge, and protection components. The module connects directly between the motor and the processor hosting the motor-control algorithm, and replaces as many as 30 or more discrete components depending on the configuration. As an integrated solution, the intelligent power module not only simplifies design, lowers bill of materials costs and saves PCB space, but also enhances reliability and helps reduce electromagnetic interference (EMI).

In most applications the module is intended to operate without a heatsink. This further reduces bill of materials costs and simplifies assembly. However, careful thermal design is needed to ensure that the module can maintain a suitable steady-state temperature under maximum load that will enable the system to satisfy minimum reliability targets.

IR's µIPM™ modules are widely used in heatsink-free inverters in HVAC equipment, fans, pumps, compressors and variable-speed drives up to 150W-250W power rating. The modules are packaged as 12mm x 12mm or 8mm x 9mm PQFN devices, which are designed to dissipate heat through large electrical contacts soldered down onto the PCB. The size and thickness of the PCB copper traces have an important influence on the heat that can be dissipated into ambient, and hence on the steady-state temperature of the module. Under-specifying these traces can compromise reliability, while over-specifying results in a larger and more expensive solution than is strictly necessary.

By devising an experiment that allows the steady-state temperature of a µIPM to be measured at various power levels with a variety of PCB designs, IR has developed a set of temperature-versus-power curves that provide an accurate reference for designers of motor-control systems. Using these curves can help optimise the thermal design, power rating and module operating temperature to meet all the cost, size and reliability constraints of any given application.

Plotting IPM Temperature versus Power

Experimental Setup

By connecting the IPM so that a known current is injected into the body diodes of two MOSFETs making up one inverter leg, and varying the current, enables the relationship between PCB metallisation, module operating temperature and power dissipation to be examined. The voltage drop across the two diodes is equivalent to the volt drop across the module. Hence measuring this voltage allows the module power dissipation to be calculated. The circuit diagram of figure 1 shows a simplified version of the test setup.

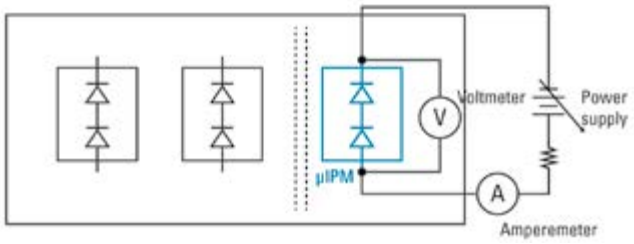


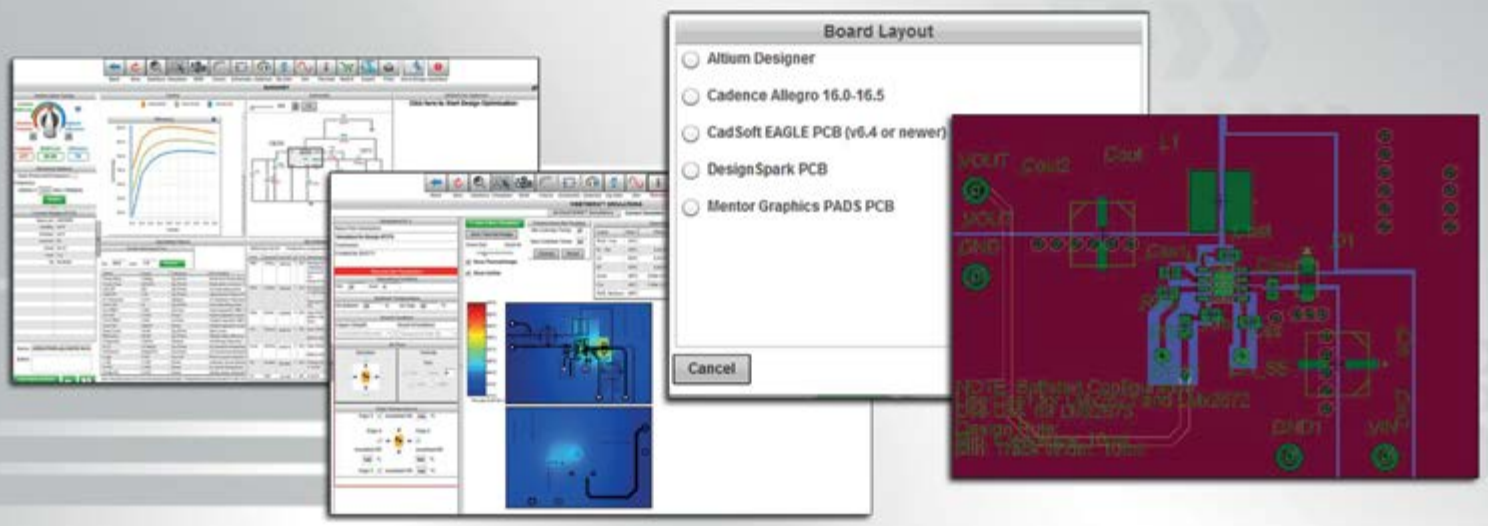
Figure 1: Simplified circuit diagram for current-injection test.

One of the advantages of using this approach, rather than analysing the inverter while driving a real load such as a motor, is its simplicity. The experiment is easy to setup and control, and effects such as parasitic inductance and capacitance, voltage and current spikes, and noise are eliminated. Since the objective of the experiment is to induce and measure temperature changes in response to changes in power dissipation, the method of DC current injection and the absence of these effects does not affect the accuracy of the results.

The thermal performance was assessed using six different sizes and thicknesses of PCB metallisation. Table 1 lists the metallisation patterns tested.

PCB trace area	PCB copper thickness
60mm x 22mm	1oz -> 35µm
	2oz -> 70µm
40mm x 22mm	1oz -> 35µm
	2oz -> 70µm
15mm x 17mm	1oz -> 35µm
	2oz -> 70µm

Table 1: Experiments were carried with PCB traces of 1oz -> 35µm or 2oz -> 70µm copper thickness, and three different sizes.



Altium · Mentor Graphics · OrCAD CADENCE PCB SOLUTIONS · DESIGNSPARK PCB · EAGLE

Texas Instruments

Create a power supply board layout with TI's WEBENCH® PCB Export

- Get proven systhesized power designs
- Includes all required footprints
- Download to popular CAD software

WEBENCH® Design Center

Start your design now!

www.ti.com/webench

Results

For each PCB design, varying the current injected into the body diodes of the inverter leg and recording the test current and voltage across the module as well as case temperature and ambient temperature allows the relationship between power dissipation, PCB design and operating temperature. The graph of figure 2 plots the temperature difference measured between the case and ambient (ΔTc-a) against power dissipation. Since the PQFN package has very low junction-to-case thermal resistance (RTHj-c) of around 2.2°C/W, it is possible to assume that the case temperature is equal to the junction temperature (Tc=Tj) in steady-state conditions.

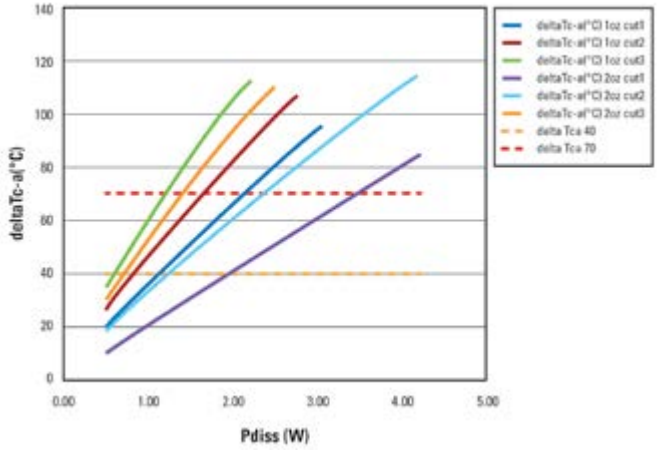


Figure 2: Case-to-ambient temperature difference versus power dissipation for test metallisation patterns.

The two horizontal lines at ΔTc-a = 40ºC and 70°C show how this graph can be used to predict the metallisation required to support a given power dissipation while maintaining a target steady-state temperature. Alternatively, the graph can be used to predict the steady-state case temperature for a given PCB design.

If the module is being used as part of a fan-control system, the rotation of the fan may provide some cooling effect on the surface of the module. This should also be taken into account during the thermal design of the system. To assess performance in this type of application, the test board was placed in a closed box and measured with airflow ranging between 0.8m/s to 1.2m/s on the module surface. The speed of the airflow was measured using an anemometer. Figure 3 compares the performance of two PCB metallisation patterns, with and without fan cooling.

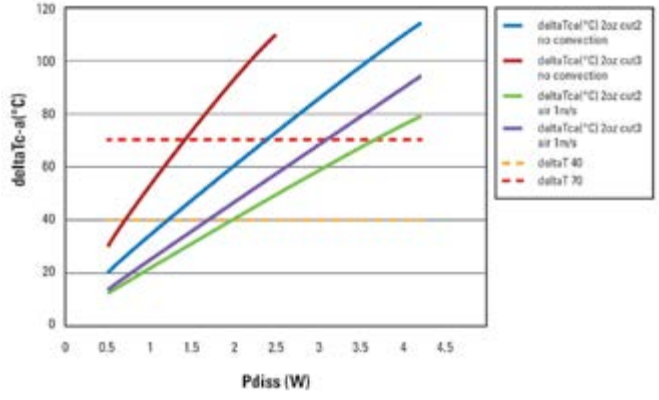


Figure 3: Effect of forced-air cooling in fan-control application.

Thermal Capacitance

It is often desirable to be able to predict the thermal performance of the system immediately after turn-on until the point at which a steady-state temperature is reached. To assess this transient thermal performance, the system can be modelled as a thermal resistance and thermal capacitance in series. The time constant of the system can then be calculated, allowing the case temperature at any time between turn-on and steady-state to be predicted.

Using the test-PCB design with the smallest area of metallisation, a step change in the injected current was applied and the module case temperature was recorded from the time the step was applied until the temperature became stable. Since the RTH values at both the initial and final temperature are known, measuring the time constant (Tau), allows the thermal capacitance Cth to be calculated. Figure 4 illustrates the thermal time constant of the complete system, from application of the current step to achieving steady state.

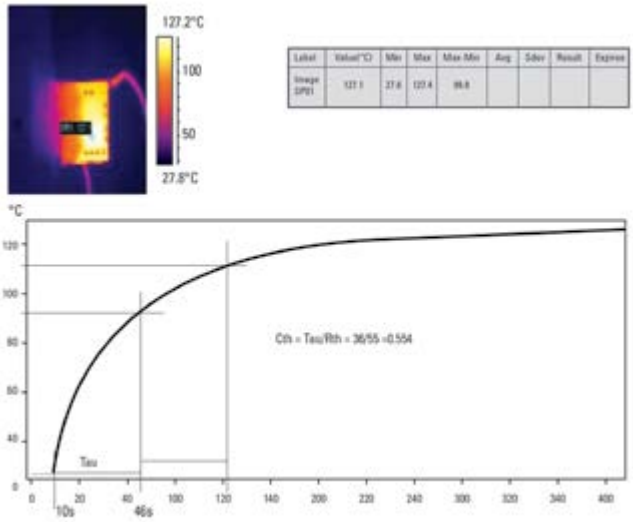


Figure 4. Thermal behaviour of the system at startup has a time constant of several minutes.

Conclusion

The intelligent power modules used in many low-power motor drives are housed in advanced packages that combine high thermal efficiency and small external dimensions. Since the modules are typically intended for use without a heatsink, the thermal dissipation provided by PCB traces has a critical influence on power rating and reliability.

Modelling the steady-state thermal performance and thermal capacitance of an experimental motor drive using various PCB designs has generated a set of graphs that can be used to predict system behaviour accurately enabling engineers to deliver even more economical and reliable solutions to market.

www.irf.com

Intelligent Design

Starts with Intelligent Analog PIC® Microcontrollers

INTELLIGENT
ANALOG

Analog design is difficult and consumes precious development time. Microchip's intelligent PIC® MCUs integrate analog functions such as high performance Analog-to-Digital Converters, Digital-to-Analog Converters and Op Amps providing simple-to-use interfaces that ease analog design. A single-chip solution enables reduced system noise and provides higher throughput, while dramatically reducing design time and cost.

Applications

- Environmental quality sensors
- Portable medical equipment
- Industrial equipment
- Power conversion
- Efficient motor control
- Lighting
- Power measurement and monitoring
- Energy harvesting equipment
- Solar inverters

microchip DIRECT
www.microchipdirect.com

MICROCHIP

microchip.com/intelligentanalog

Voltage Proof on the Highest Level

200 V Conductive Polymer Aluminum Electrolytic Capacitors

The achievements of the semiconductor industry set trends in current and future electronic devices: they are characterized by lower power consumption, lower operating voltages in the control circuits, miniaturization, and higher clock frequencies. However, these trends do also require capacitors in the power supply that can cope with higher current loads while at the same time the available volume is decreasing [1, 2].

By Dr. Arne Albertsen, Jianghai Europe Electronic Components GmbH

Under these conditions, conductive solid polymer aluminum electrolytic capacitors offer advantageous solutions, for example in power supplies, energy management, motherboards, and other applications with high current demand. A common feature of these applications is the demand for ultra-low ESR values of the capacitors.

In recent years, the rated voltage range of commercially available polymer aluminum electrolytic capacitors has been increased through improvements of the electrically conductive polymers and the optimization of the process steps in the production. Jianghai and their joint-venture partner ELNA succeeded through intensive research and development to produce a new series of polymer aluminum electrolytic capacitors with an unprecedented rated voltage range of up to 200 V. Thus, further fields of application, such as automotive electronics, industrial automation, LED ballasts, telecom infrastructure and white goods can now make use of this advanced capacitor technology.

Construction of polymer aluminum electrolytic capacitors

The construction of solid conductive polymer aluminum electrolytic capacitors is similar to wet aluminum electrolytic capacitors [1, 2].

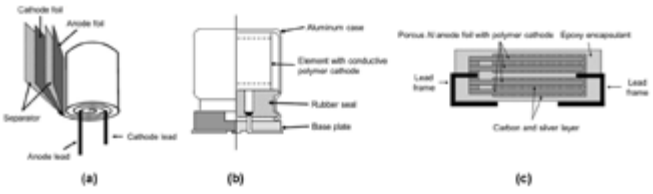


Figure 1: Construction of (a) radial leaded, (b) radial SMD, and (c) SMD stacked polymer aluminum electrolytic capacitors

The main difference between the two technologies is the electrolyte. While the “classic” aluminum electrolyte capacitors contain a liquid electrolyte as cathode connection to the roughened and formed surface of the aluminum anode, polymer electrolyte capacitors utilize a solid electrolyte, i.e. an electrically conducting plastic.

In particular, the wound cell type (both for radial leaded and surface-mount electrolytic capacitors) and the stacked design (for SMD Capacitors) are commonly found in the market (figure 1).

Electrically conducting plastics

Plastics or polymers are lightweight, durable and they can be processed easily. They are used in many applications as an alternative to traditional materials. But, as most plastics are insulators, they cannot be used like metals or semiconductors to conduct any electrical current [4].

In 1977, a team led by Hideki Shirakawa produced a shiny plastic film by the accidental overdose of a catalyst. Surprisingly, this film allowed for an electrical current flow. Together, Alan G. Mac Diarmid, Alan J. Heeger and Hideki Shirakawa explored the fundamentals of this phenomenon and were awarded the Nobel Prize for Chemistry in 2000 [9].

While metals and semiconductors have relatively close adjacent so-called energy bands, regular plastics have energy bands so far apart from each other that a current flow is impossible under normal conditions [4] (figure 2).

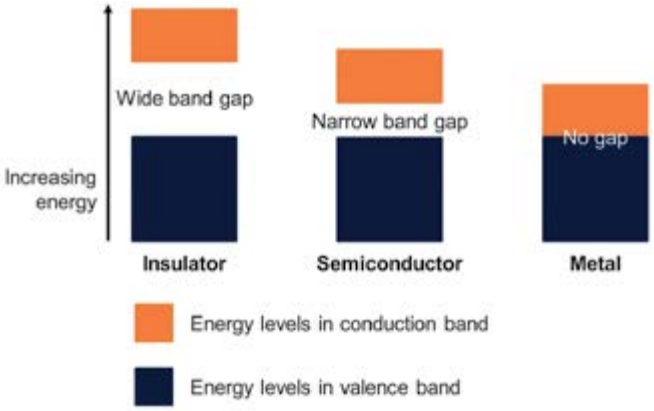


Figure 2: Simplified representation of the energy bands for different materials [9]

An exception is the group of “conjugated polymers”, which involves alternating single and double bonds such as plastics with extended π electron systems. The p-electrons are not tied to a single molecule, but they are rather characterized by a high mobility along the molecule chain. Through the conjugation of many p-electrons, a wide band of highest occupied molecular orbital (valence band) and the lowest unoccupied molecular orbital (conduction band) is formed in the plastic molecule chain.

The electrical conductivity of conjugated polymers is called intrinsic conductivity, and it is initially quite low. Through the generation of positive particles, e.g. by (electro-) chemical oxidation, the conductivity can be increased considerably (figure 3). This process is also known as doping, while this is not comparable to the doping (of few) foreign atoms in the semiconductor process.

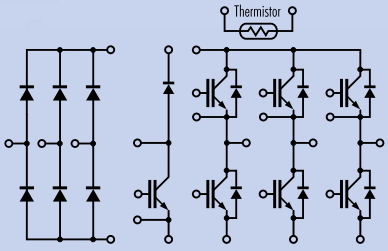
Fuji's Chip Technology

The Independent Way

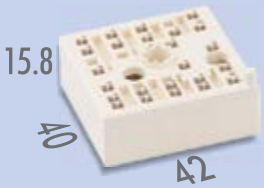
V-Series IGBTs

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

Fuji Electric's V-Series IGBTs, MiniSKiiP® compatible

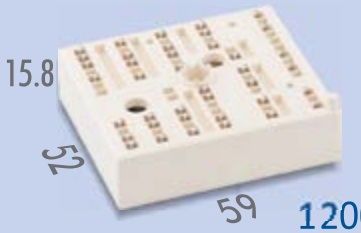


MiniSKiiP® 1



1200V
8A
15A

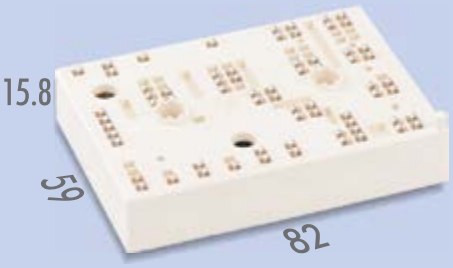
MiniSKiiP® 2



1200V
25A
35A

Also available with larger rectifier diodes

MiniSKiiP® 3



1200V
50A
75A
100A

Fuji Electric
Innovating Energy Technology

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

Initially, the electrical conductivity merely exists within the polymer chains. In order to enable the whole material to conduct an electrical current, the ends of the polymer chains need to be close enough to each other to allow the electrons to jump from one polymer chain to the next [9].

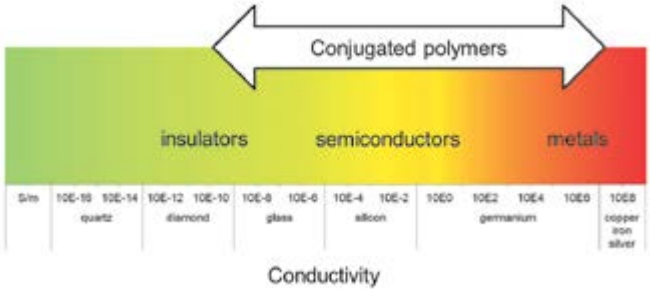


Figure 3: Conductivity of some materials as compared to conjugated polymers [9]

The sensitivity of many polymers to elevated temperatures, atmospheric oxygen and moisture is a major challenge in the development of intrinsically conductive polymers for use in electronic components [5]. Table 1 shows the typical electrical conductivity of cathode materials for aluminum electrolytic capacitors.

Electrical Conductivity of the Electrolyte in S/cm		Cathode Material	Conduction Mechanism	Heat Resistance
high	100	PEDOT	Electronic Conduction	Pyrolysis above approx. 350 °C
⇑	10	Polypyrrole	Electronic Conduction	Pyrolysis above approx. 300 °C
	1	TCNQ	Electronic Conduction	Pyrolysis above approx. 200 ~ 240 °C
	0,1	MnO_2	Electronic Conduction	Phase Transition at approx. 500 °C
low	0,01	Electrolyte Solution	Ion Conduction	Boiling Point at approx. 160 ~ 190 °C

Table 1: Electrical conductivity of some cathode materials (typical values)

More stable polymers on the basis of thiophene, pyrrole and aniline are found in various technical applications, while a combination of poly-3,4ethylenedioxythiopene and polystyrolesulfonicacid proved to be especially advantageous [4].

The short name of this substance is “PEDOT:PSS” and this material combines high conductivity, very good transparency in the visible range, thermal stability, mechanical flexibility and above all a very good solubility in water. Its characteristics allow this conductive polymer to be used as a transparent electrode material in a variety of many (opto-) electronic components, such as solar cells, light-emitting diodes, liquid crystal displays, or touch panel displays [6].

The particular challenge when using PEDOT:PSS as cathode material in an electrolytic capacitor is to ensure a complete coverage of the highly roughened (etched) surface of the anode foil (figure 4).

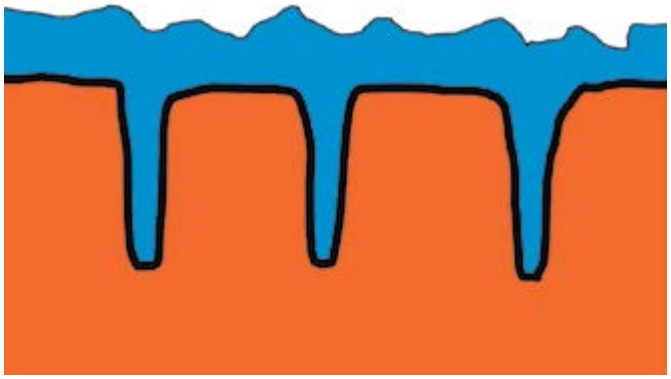


Figure 4: Cross-section of the anode of a polymer alu e-cap (simplified)

The manufacturers use two alternative methods to achieve this: (1) the in-situ polymerization and (2) the impregnation with a pre-fabricated polymer dispersion.

The older method of in-situ polymerization has some disadvantages, such as high consumption of the EDOT monomer, longer production time by necessary repetition of the polymerization process step, defect formation on the dielectric and a limitation of the dielectric breakdown voltage strength to values less than 50V (figure 5). For comparison: “wet” aluminum electrolytic capacitors can achieve dielectric breakdown voltage strengths in the range up to 750V [3].

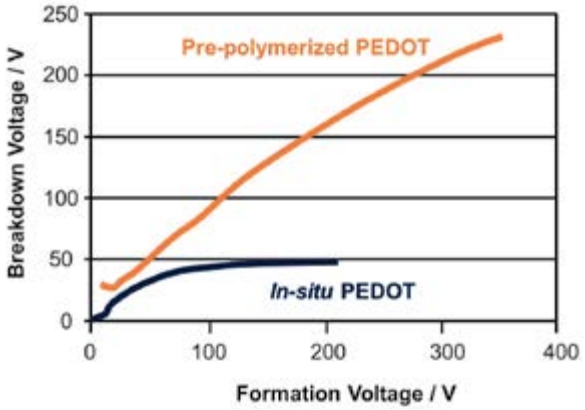


Figure 5: Process-dependency of the dielectric breakdown voltage [12]

The higher costs in connection with the limited voltage proof with the in-situ process motivated extensive research activities for the development of electrically conductive polymer dispersions. Today, PEDOT:PSS dispersions with a mean particle size of 30 nm and high electrical conductivity in the range 500 S/cm are commercially available [5]. Recent articles report that electrical conductivity values in the range from 1000 S/cm up to over 3000 S/cm can be achieved by using specific solvent mixtures and an optimized temperature control during the processing [6, 7].

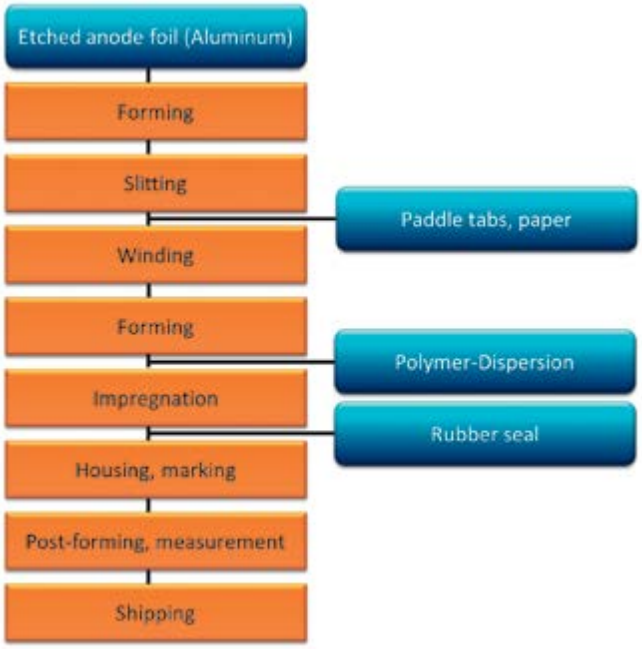


Figure 6: Manufacturing process of polymer aluminum electrolytic capacitors

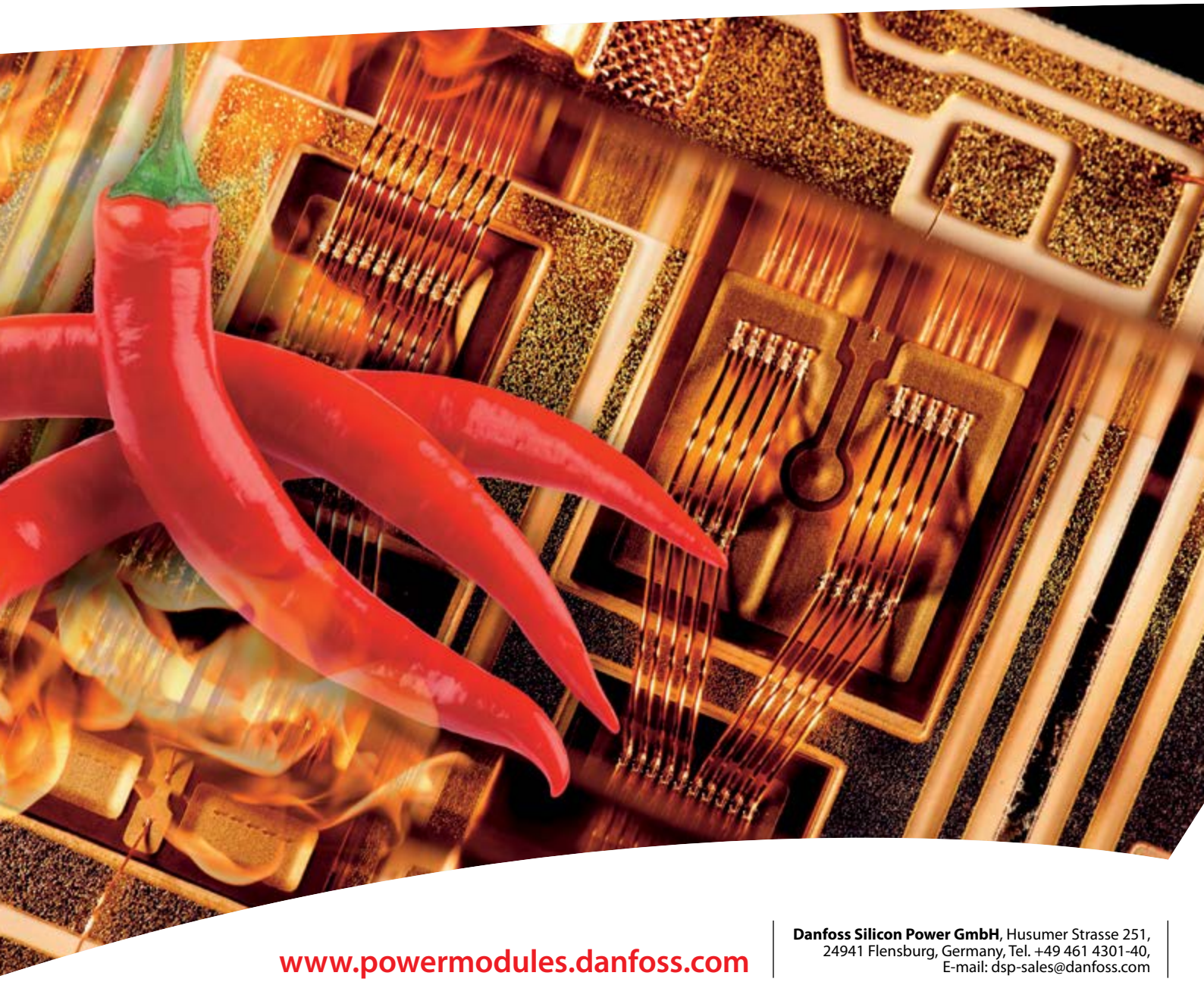
MAKING MODERN LIVING POSSIBLE

More power, less size, longer lasting!

Add value with power of customisation

At Danfoss Silicon Power we combine cutting edge technologies with the power of customisation to create unique solutions that solve your business challenges. In a dynamic market that demands increasingly compact, more powerful and longer lasting power modules – all while minimising cost. Customisation is the way to stay ahead of the competition.

Call us and discover how we can spice up your next project.



www.powermodules.danfoss.com

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

Jianghai has developed a patent-pending formulation for such nano-dispersed polymer solutions that enable rated voltages up to 200 V at high conductivity. Figure 6 shows the manufacturing process of polymer aluminum electrolytic capacitors. The formation before the impregnation is necessary because a later self-healing of defects in the dielectric layer is not possible due to the absence of liquid electrolyte. The defects in the dielectric are caused for example by slitting the mother rolls of anode material to the required width, by the riveted connections between anode foil and connecting tabs, as well as by the winding of the capacitor cell.

Properties of polymer aluminum electrolytic capacitors

Due to the high electrical conductivity of solid polymer electrolyte system aluminum electrolytic capacitors, polymer e-caps offer small capacitance changes (fig. 7a) and very low, almost constant ESR values (figure 7b) across the entire operating temperature range. The superior electron conductivity in the polymer provides a high current-carrying capability at minimal self-heating.

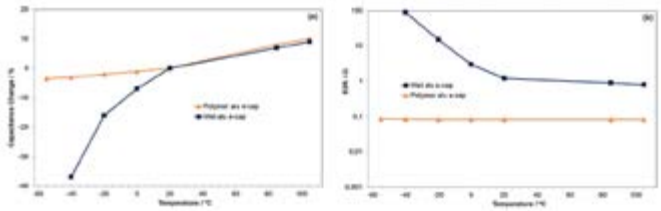


Figure 7: Temperature dependency of capacitance (a) and ESR (b)

As the solid electrolyte cannot evaporate, only temperature-induced changes in material (and thus changes of the conductivity) limit the operating life. The rated voltage may be applied without any derating over the entire temperature range.

In case of a local overheating due to a dielectric breakdown in the aluminum oxide, the polymer film reduces its conductivity as a result of the high temperature and thus electrically isolates the defect site. This effect is called “self-healing”.

Missing gas formation and “good-natured” overload behavior without significant ignition or fire tendency complement the range of benefits of this capacitor technology, and its excellent frequency response is similar to the film capacitor (figure 8).

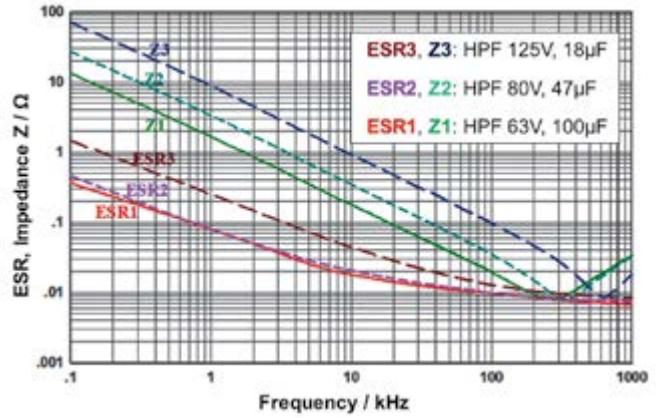


Figure 8: ESR and impedance vs. frequency of some polymer aluminum electrolytic capacitors

Lifetime of polymer aluminum electrolytic capacitors

As shown in table 1, the polymer solid electrolyte has a much higher electrical conductivity than any liquid electrolyte. Hence, the lifetime of polymer capacitors does not follow the traditional Arrhenius equation: instead of a doubling of life at 10 K temperature drop [1], we see a tenfold increase in lifetime at 20 K temperature decrease (equation 1).

$$L = L_0 \times 10^{\frac{T_{cat}-T_a}{20\,K}}$$

The main factors that influence the lifetime L of a polymer aluminum electrolytic capacitor are the ambient temperature Ta in conjunction with the upper category temperature Tcat and the lifetime L0 at Tcat. Figure 9 shows the superior lifetime performance of a polymer aluminum electrolytic capacitor at different ambient temperatures compared to a wet aluminum electrolytic capacitor.

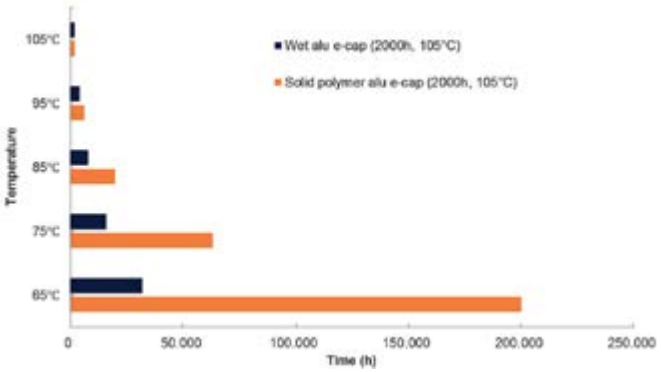


Figure 9: Lifetime as a function of the ambient temperature for aluminium electrolytic capacitors with wet electrolyte (blue) and for polymer aluminum electrolytic capacitors (orange)

The aging mechanism of electrically conductive polymers is the subject of current research. Some groups [8, 10] examined particularly thin polymer films, because these are of great commercial importance due to their use in displays and solar panels. It is believed that under the influence of higher temperatures, the ionic bonds between PEDOT and PSS break up and form conductive “grains” of oligomers of PEDOT:PSS – this decreases then the observed electrical conductivity.

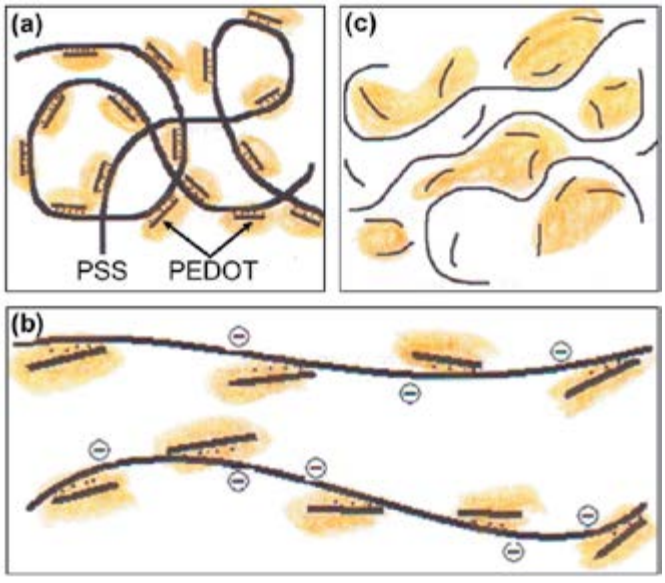


Figure 10: Illustration of a proposed aging process for conductive polymers (from [10])

Figure 10 illustrates this potential effect of increased temperature on the initially disordered PEDOT:PSS "tangle" of long polymer chains (a), that first unfolds and breaks into short chain-structures (b) until it is finally taking on a "grain" structure (c) [10].

Standardization

The conditions for the tests and measurements of the electrical parameters of electrolytic capacitors with solid conducting polymer electrolyte are laid down in the generic specification IEC 60384-1 "Fixed capacitors for use in electronic equipment" as well as in the sectional specifications IEC 60384-25 "Surface mount fixed aluminum electrolytic capacitor with conductive polymer solid electrolyte" and IEC 60384-26 "Fixed aluminum electrolytic capacitors with conductive polymer solid electrolyte".

Summary

Modern electronics design requires compact capacitors with very low ESR values and high ripple current capability in connection with long lifetime. New polymer aluminum electrolytic capacitors from Jianghai offer unprecedented rated voltages ranging up to 200 V. This facilitates solutions for a variety of applications, e.g. in automotive electronics and industrial automation, LED ballasts and telecom infrastructure, and for white goods.

The applicability of polymer aluminum electrolytic capacitors depends on the individual case and its respective application requirements. Therefore, an intensive project support for each application by the electrolytic capacitor manufacturer is strongly advised.

www.jianghai-europe.com

Literature

[1] Albertsen, A., Lebe lang und in Frieden! Hilfsmittel für eine praxisnahe Elko-Lebensdauerabschätzung, Elektronik Components 2009, 22-28 (2009)

[2] Albertsen, A., Auf eine sichere Bank setzen – Zuverlässigkeit von Elektrolytkondensatoren, Elektronik Components 2010, 14-17 (2010)

[3] Albertsen, A., Gebührenden Abstand einhalten! – Spannungsfestigkeitsbetrachtungen bei Elektrolytkondensatoren, Elektronik Power, 54-57 (2011)

[4] Bayer AG: Baytron P® – Tor zu einer neuen Polymer-Generation, Pressemitteilung (16.01.2001)

[5] Elschner, A., Kirchmeyer, St., Lövenich, W., Merker, U., Reuter, K.: PEDOT - Principles and Applications of an Intrinsically Conductive Polymer, CRC Press (2011)

[6] Park, H., Ko, S., Park, J., Kim, J.Y. & Song, H.: Redox-active charge carriers of conducting polymers as a tuner of conductivity and its potential window. Sci. Rep. 3, 2454; DOI:10.1038/srep02454 (2013)

[7] Pecher, J., Mecking, S.: Nanoparticles of Conjugated Polymers, Chemical Reviews 110, 10, 6260-6279 (2010)

[8] Stöcker, T., Köhler, A., Moos, R.: Why Does the Electrical Conductivity in PEDOT:PSS Decrease with PSS Content? A Study Combining Thermoelectric Measurements with Impedance Spectroscopy, JOURNAL OF POLYMER SCIENCE PART B: POLYMER PHYSICS 50, 976–983 (2012)

[9] The Royal Swedish Academy of Sciences: The Nobel Prize in Chemistry, 2000: Conductive Polymers, Advanced Information, Stockholm (2000)

[10] Vitoratos, E., Sakkopoulos, S., Dalas, E., Paliatsas, N., Karageorgopoulos, D., Petraki, F., Kennou, S., Choulis, S.A.: Thermal degradation mechanisms of PEDOT:PSS, Organic Electronics 10, 61–66 (2009)

[11] Yamauchi, D.: Latest Technological Trends for Conductive Polymer Aluminum Solid Electrolytic Capacitors, Engineering Dept., Nichicon (Fukui) Corp. (07.11.2012)

[12] Young, J.:High Voltage Polymer and Tantalum Capacitors, Industrial Session 1.3
"Advances in Capacitors and Ultracapacitors for Power Electronics" in: Proceedings of the 2013 Twenty-Eighth Annual IEEE Applied Power Electronics Conference and Exposition (APEC 2013) held at Long Beach, California (March 17-21, 2013)

Author

Dr. Arne Albertsen studied physics with a focus on applied physics at Kiel University. Following diploma (1992) and doctoral thesis (1994), both on stochastic time series analysis from a biophysical membrane transport system, he pursued an industrial career in plant construction of specialized waste water treatment and renewable energy generation technologies. In 2001, he started to work with leading manufacturers of electronic components like BCcomponents, Vishay, and KOA. He worked in managing positions in design-in, sales, and marketing for passive and active discrete components until he joined Jianghai Europe Electronic Components in November 2008. In his current position as manager sales and marketing, Dr. Albertsen is responsible for the support of European customers. The core of his work comprises design-in activities, application support, and sales of capacitors for professional industrial applications.
a.albertsen@jianghai-europe.com

Optimized Core and Bobbin Allow for more than 25 Percent Increase in Power Handling

DC/DC SMT transformer for PoE+, datacom, and industrial are the applications

There are a wide variety of applications, including Power over Ethernet (PoE and PoE+), datacom/telecom and industrial, operating from a 12v, 24v or 48v input, that require an isolated switch mode power supply solution to convert the available input voltage to the required regulated output voltage and current. The isolation and power conversion element in these supplies is typically a surface mount (SMT) switch mode transformer. With power levels up to 40W, the typical power supply topologies used are the continuous mode flyback or the active clamp forward.

By John Gallagher, Pulse, Staff FAE

For these power levels and topologies the best transformer platform, in terms of power efficiency, board area and cost, is the EP13. This platform has become the de facto industry standard. However, as power efficiency becomes more important and system power requirements increase, there are typically two limiting factors when using the standard EP13 platform.

The first limitation is the core cross-sectional area (Ae), which dictates the number of primary winding turns required to limit the magnetic flux density (B) in a given power supply application. A simplified description of the effect the Ae has on transformer design can be summarized by stating that the smaller cross-sectional area available in the core, the greater the number of turns required to limit the magnetic flux to the required level, which directly correlates to higher winding resistance (DCR) and proportionately higher power losses.

The second limitation is that surface mount transformers must have good coplanarity (0.127mm or less) to ensure that the leads of the platform are properly soldered to the PCB. This specification limits the number and gauge of winding wires that can be terminated without damaging the lead or causing solder bridges to adjacent leads. Limiting the wire size and number of wires causes higher resistance and additional power losses. An innovative SMT transformer solution using the industry standard EP13 footprint, but utilizing a modified core to increase the cross-sectional area and a new lead shape to increase the number of windings that can be terminated, is now available. The result is a higher power handling transformer with an industry standard footprint.

The most effective way of demonstrating the advantages of this new platform is by comparing the designs for two different topologies.

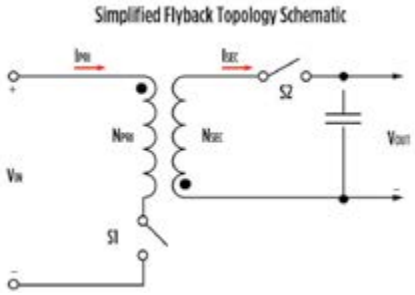


Figure 1: Simplified Flyback Topology Schematic

Continuous Mode Flyback – Design Comparison – Example 1

The continuous mode (CM) flyback is most often employed for lower power DC/DC applications (<60W) and offers the advantages of a low part count and relatively low solution cost, but the disadvantages of higher peak currents and output voltage ripple. A simplified flyback schematic is shown in Figure 1 and the transformer current waveforms are shown in

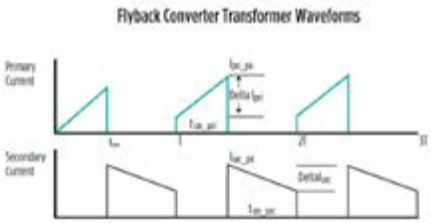


Figure 2: Appendix A reviews the basic operation of the transformer in a flyback topology and details the specific design equations required. A more detailed analysis of the flyback circuit is available. (http://www.pulseelectronics.com/library/published_articles -- G034)

For purposes of this comparison, flyback transformers were designed for a 33-57v input and 5v output at six different power levels (20W to 45W) on both the standard EP13 and EP13Plus platforms. The inductance

CM Flyback Transformers (33-57v input, 200kHz)						
	Output Power (5v/xxW)					
	20W	25W	30W	35W	40W	45W
Ind	54uH	43uH	36uH	31uH	27uH	24uH
Ipk_pri	2.3A	2.8A	3.4A	4.0A	4.5A	5.1A
I_rms_pri	1.1A	1.4A	1.6A	1.9A	2.2A	2.5A
I_rms_sec	5.6A	7.0A	8.4A	9.8A	11.2A	12.6A

Figure 3: CM Flyback Transformers (33-57v input, 200kHz)

Pre-Applied Thermal Interface Material (TIM)

The Infineon-qualified solution

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

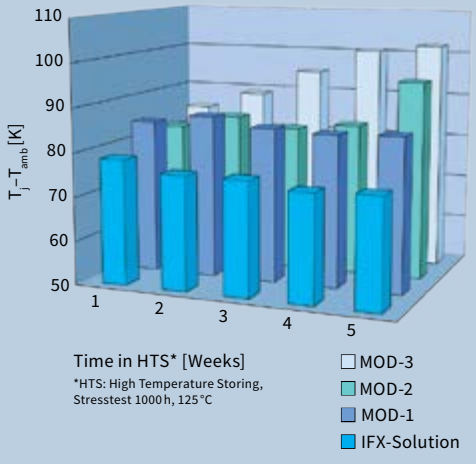
TIM does not only provide the lowest thermal resistance, it also fulfills the highest quality standards given for power modules to achieve the longest lifetime and highest system reliability.

Main Features

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

Benefits

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



www.infineon.com/tim

requirements and peak and rms currents are shown in Figure 3. The power loss within the transformers was compared and is shown in Figure 4.

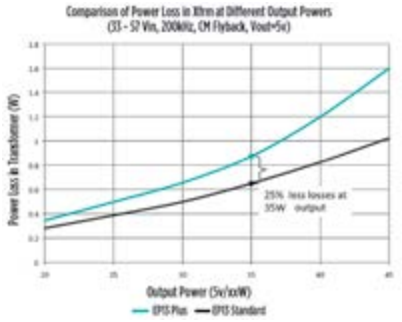


Figure 4: Comparison of Power Loss in Xfrm at Different Output Powers

Because the EP13Plus has a larger cross sectional area, fewer turns are required and this, along with the modified lead, allows for lower winding resistance. As can be seen Figure 3, as the output power increases, the power loss difference between the standard EP13 and EP13Plus widens. The output power a transformer can deliver, for a given temperature rise, is directly proportional to the power loss within the transformer. So a 25% reduction in transformer loss with the new EP13Plus represents a proportional 25% increase in output power capability. As an example, for a 45°C rise, the EP13, in flyback mode, can deliver 25W, but the EP-13Plus can deliver 32W of power.

Active Clamp Forward Transformer – Design Comparison - Example 2

The active clamp forward is often implemented in applications between 20-200W and offers the advantage of excellent efficiency

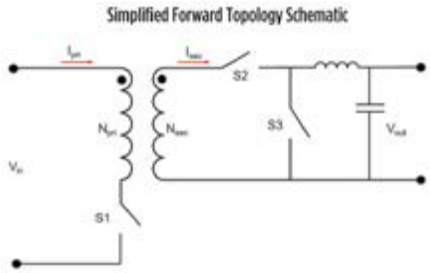


Figure 5: Simplified Forward Topology Schematic

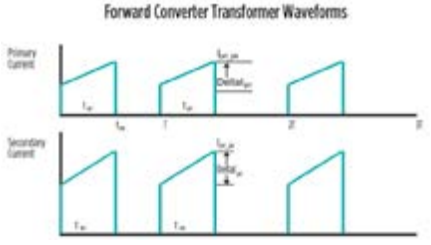


Figure 6: Forward Converter Transformer Waveform

due to facilitation of zero volt switching, lower drain voltages, and low output inductance requirements, but comes at the cost of added complexity and higher component count. A simplified active clamp forward schematic is shown in Figure 5 and the transformer current waveforms are shown in Figure 6. The basic operation of the transformer in a forward topology along with the relevant design equations are detailed in Appendix B.

For purposes of the comparison, forward transformers were designed for a 33-57v input and 5v output at six different power levels (20W to 70W) on both the standard EP13 and EP13Plus platforms. The rms currents for these designs are shown in the Figure 7. The power loss within the transformers was compared and is shown in Figure 8.

Active Clamp Forward Transformers (35-57 V input, 200kHz)						
Output Power (5v/xxW)						
Output Power	20	30	40	50	60	70
Output Current	4	6	8	10	12	14
Xfrm Sec RMS Current	3.2	4.8	6.4	8.1	9.7	11.3
Xfrm Pri RMS Current	0.90	1.3	1.8	2.2	2.7	3.1

Figure 7: Active Clamp Forward Transformers (35-57V input, 200kHz)

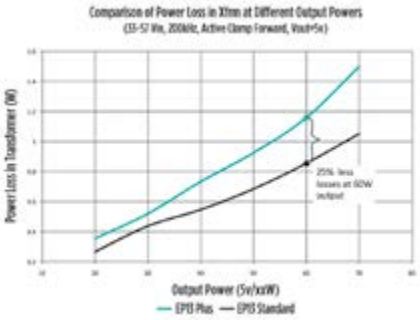


Figure 8: Comparison of Power Loss in Xfrm at Different Output Powers

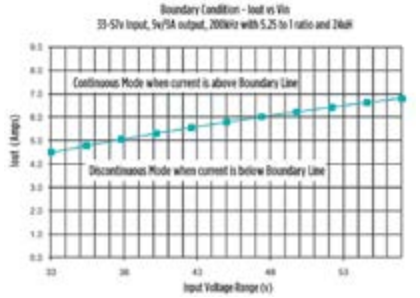


Figure 9: Boundary Condition –Iout vs Vin 35 67 v Input, 5v/9A output, 200kHz with 5.25 to 1 ratio and 24 µH

As we saw in the flyback design example, as the output power increases the difference in power loss between the standard EP13 and EP13Plus also increases. Again, the output power a transformer can deliver, for a given temperature rise, is directly proportional to the power loss within the transformer. The 25% reduction in transformer loss with the new EP13Plus represents a 25% increase in output power capability. As an example, for a 45C rise the EP13 can deliver 42W, in a forward topology, but the EP13Plus can deliver 53W.

Conclusions

The innovative design approach for the EP-13Plus platform has a demonstrated ability to provide 25% more power handling in the same footprint and mechanical size as the industry standard EP13. This offers designers the flexibility to increase power density or to lower thermal loads in existing designs. To assist power supply designers in incorporating this new platform, a catalog series of EP13Plus transformers for continuous mode flyback and active clamp forward topologies is available. These 12 designs cover both 9-57v and 33-57v input ranges and can provide six different output voltages from 3.3v to 24v.

Appendix A – Continuous Mode Flyback Transformer Operation

The basic operation of the flyback topology can be broken into two operating states, the on-time and the off-time. The on-time is when S1 (input side switch) is closed and the input voltage is applied to the transformer causing the current on the primary to ramp upward in proportion to the transformer magnetizing inductance. During this time, S2 (output side switch) remains open (either through the diode action or as a controlled switch) so the transformer must store the input energy in its magnetic field as the secondary current path is blocked. The off-time begins when switch S1 is opened and switch S2 is closed creating a current path to the output. During this time the stored energy in the transformer is transferred to the secondary winding and discharged to the output. This cycle is repeated at the operating frequency (FreqkHz) or cycle time (T). If during the off-time the secondary current reaches zero, the power supply is said to be operating in discontinuous mode. If the current remains above zero, the power supply is said to be in continuous mode.

For the purposes of the above flyback transformer comparison we set two circuit operating points. First, we targeted the maximum duty cycle (ie: on_time/cycle_time or ton/T) to be <0.45 which determines the turns ratio as follows:

N = Npri/Nsec = (Vin_min-Vs1) * Dmax/ ((Vout+Vs2)*(1-Dmax)) (1)

Second, as it is not possible to have a supply that will operate in continuous mode across

the entire range of output power, we will target a minimum output current, Ioutmin, at which the supply will transition between continuous and discontinuous mode. As can be seen in Figure 9, the transition point will vary with input voltage.
For the purposes of this comparison we selected an output current of 50% of full load at minimum input voltage. This current determines the required primary inductance as follows:

Lmin_uH = (Vout+Vs2)*(1-Dmax)2 *N2 * 1000 / (2*Ioutmin*FreqkHz) (2)

Finally, in order to complete the transformer designs, we need to know the peak primary current and heating or rms currents in the transformer which can be found using the following equations:

Iripple_sec = (Vout+Vs2)*(1-D)*N2 *1000 / ((Lpri_uH * FreqkHz) (3)

Ipk_sec = Iout_max / (1-D) + 0.5* Iripple_sec (4)

Irms_sec = [(1-D) * Ipk_sec – Iripple_sec * Ipk_sec + Iripple_sec].5 (5)

Ipk_pri = Ipk_sec/(N*nefficiency) (6)

Irms_pri = [(D) * Ipk_pri – Iripple_pri * Ipk_pri + Iripple_pri].5 (7)

With the above information, the first step in the flyback transformer design was to determine how many primary turns are required in order to prevent core saturation, represented by the equation:

Npri = Lpri_uH * Ipk_pri * 100 / (Bpk_gauss * Aecm2) (8)

A good rule of thumb for maximum flux density (Bpk_gauss) is 2800 G, but it will vary somewhat depending on the ferrite core material selected. With the turns ratio known, the number of secondary turns was found and then the strands and gauge of wires that can fit within the core window and be terminated on the pins was determined. Because the EP13Plus has a larger core area it requires less turns to allow for the same Lpri and Ipk_pri, and the lead arrangement allows for larger wires, reducing the winding resistance.

Appendix B – Active Clamp Forward Transformer Operation

The basic operation of this topology can be broken into two operating states. During the first state, on-time, switch S1 (input side switch) is closed and the input voltage is applied to the transformer. Also during this time switch S2 is closed and S3 is opened, allowing the input current to be transferred, via the magnetic field of the transformer, directly to secondary winding and through to the load. The secondary current will be a function of the primary current and the turns ratio of the transformer. During the second state, off-time, switch S1 and S2 are opened effectively disconnecting the transformer from the circuit. Switch S3 is closed, allowing current to continue to flow to the load from the stored energy in the output inductor. This cycle is repeated at the operating frequency or cycle time. The duty cycle (D) is the ratio of on-time over cycle time (ton/T).
For the purposes of this comparison we set the duty cycle (Dmax) to <0.65 which determine the turns ratio per the following equation:
N = Npri/Nsec = (Vin_min-Vs1) * Dmax / (Vout+Vs2) (10)

As there is no energy storage required in a forward transformer, the limiting design factor is power loss and temperature rise. It is therefore necessary to optimize the combination of core losses and copper losses. The core losses are caused by the volt-usec applied to the transformer primary and are minimized by increasing the number of primary turns. The copper losses are caused by rms currents and are minimized by reducing the number of turns. The general equations required for the forward transformer design are:

Irms_sec = Iout_max * D.5 (11)

Irms_pri = Irms_sec / (N * nefficiency) (12)

DeltaBgauss = Vin*D*106 / (Aecm2 * FreqkHz * Npri) (13)

CoreLossW = a * CoreVolumecm3 * DeltaBgaussb * FreqkHz(b+c) (14)

Unlike the CM flyback, the current waveforms in a forward transformer have considerable AC content. It is therefore necessary to analyze the AC copper losses as well as the DC copper losses. Although the equations and explanation of AC proximity losses are not covered in this overview, they were accounted for in the designs as presented. In general, AC copper losses are minimized by reducing the height (thickness of wire and number of layers) as much as possible and interleaving the primary and secondary windings. A good rule of thumb is to attempt to balance the overall copper losses and the core losses. Ultimately, however, one is looking to minimize the overall losses. Again, because the EP13Plus has a larger core area, the turns can be reduced without creating additional core losses. This reduction in turn allows for lower DC and AC copper losses.

Thermal Efficiency of Chipscale Packaging for eGaN® FETs

Semiconductor packaging has been saddled with four key complaints since the advent of the solid state transistor; (1) packages have too much resistance, (2) they have too much inductance, (3) they take up too much space, and (4) they have poor thermal properties that limit heat extraction.

By David Reusch, Johan Strydom, and Alex Lidow, Efficient Power Conversion Corporation

In 2010 enhancement mode gallium nitride power transistors were introduced without a surrounding plastic package. The unique characteristics of the lateral GaN-on-silicon transistors enable the active devices to be protected from the normal environmental abuses without a cumbersome molded plastic package. These chipscale packages, with a Land Grid Array (LGA) format, eliminate the parasitic inductance and resistance of the semiconductor package as well as the space occupied a conventional package. In this paper we explore the fourth key complaint, thermal performance of the chipscale package, and we compare this performance with the state-of-the-art power MOSFET packaging available today.

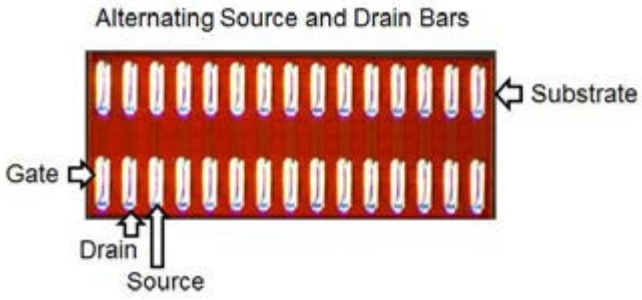


Figure 1: Enhancement mode gallium nitride power transistor (EPC2021 [1]) in a chipscale package. Shown are the solder bars that are mounted facedown on a PCB.

Thermal models:

To set the stage for the thermal analysis, let us first look at the physical construction of the chipscale package. In figure 1 is the EPC2021 eGaN FET [1]. The solder bars make connection between the PCB and the gate, source and drain of the transistor. The top row of bars is separated from the bottom row in order to make ample room for vias on the PCB that can pull heat from the center of the transistor to the back of the PCB.

The solder bars mate with traces on a printed circuit board, and the final assembly might look like the buck converter in figure 2.

In figure 3 is shown a cross sectional diagram of a device mounted on the PCB. The arrows show the various paths for heat to be removed from the active junction of the transistor and can be defined as follows:

- RΘJC (Thermal resistance from junction to case): This is the thermal resistance from the active part of the eGaN FET to the top of the silicon substrate, including the sidewalls.
- RΘCA (Thermal resistance from the case to ambient). This is the thermal resistance from the top of the silicon substrate, including the sidewalls, to ambient.
- RΘJB (Thermal Resistance from junction to board). This is the thermal resistance from the active part of the eGaN FET to the PCB. For this path the heat must transfer through the solder bars to the copper traces in the board.
- RΘBA (Thermal resistance from board to ambient). This is the thermal resistance created by the PCB itself from the solder connection to the eGaN FET to ambient.

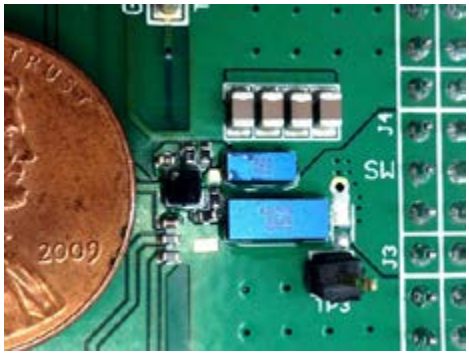


Figure 2: 48 VIN – 12 VOUT buck converter with enhancement mode gallium nitride transistors (Top device: EPC2001 [2], bottom device: EPC2021) mounted face-down on PCB.

It is straightforward to add a heatsink to this device as has been described in the literature [3]. With a heatsink attached to the silicon substrate two additional resistances that replace RΘCA, must be added to the model, RΘTIM – the thermal resistance of the thermal interface material separating the silicon substrate from the heatsink, and RΘHA – the thermal resistance of the heatsink to ambient. For the purpose of this analysis we will only consider devices without a heatsink.

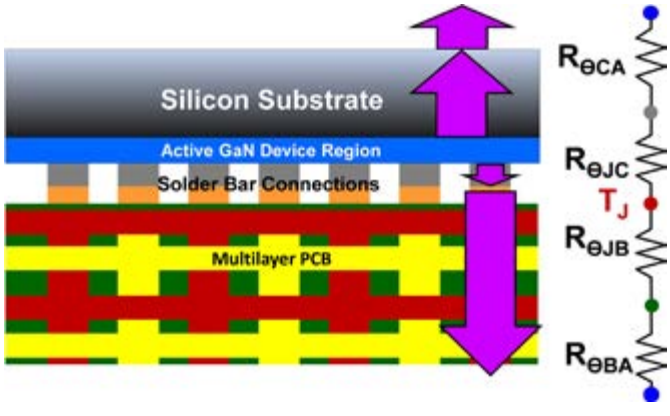


Figure 3: Components of thermal resistance for the device in figure 1.

Package comparisons:
The thermal efficiency of a package can be determined by comparing the two parameters that are uniquely determined by the package, RΘJC and RΘJB, normalized to the package area. In table 1 is a compilation of this data for several popular surface mount MOSFET packages as well as two popular eGaN FETs.

Device Package	$R_{\Theta JC}$ (°C/W)	$R_{\Theta JB}$ (°C/W)	Area (mm^2)
Blade [4]	1	1.6	10.2
CanPAK S [5]	2.9	1	18.2
CanPAK M [6]	1.4	1	30.9
S308 [7]	-	1.8	10.9
S308 Dual Cool [8]	3.5	2.7	10.9
Super SO8 [9]	20	0.9	30.0
Super SO8 Dual Cool [10]	1.2	1.1	30.0
EPC2001 [2]	1.0	2.0	6.7
EPC2021 [1]	0.5	1.4	13.9

Table 1: Comparison of package area and thermal resistance components RΘJC and RΘJB.

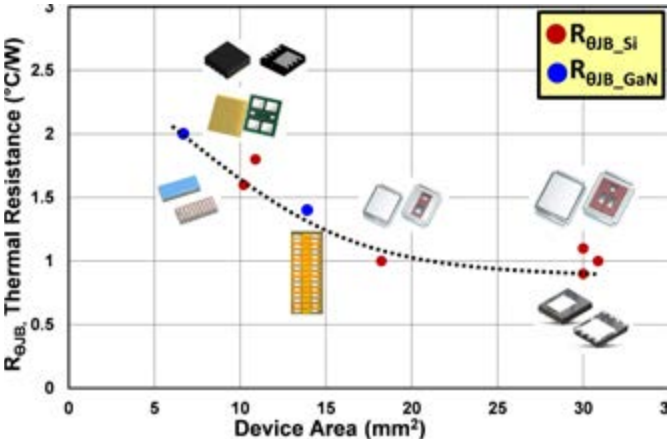


Figure 4: RΘJB (Junction to PCB Thermal Resistance) for several package styles.

In figure 4 is a plot of the junction-to-PCB resistance for each of these packages. Red dots represent the MOSFET packages, and blue dots represent the eGaN FETs. All of the packages sampled fall on a single trend line indicating that performance for this element of thermal resistance is determined primarily by package size, and not technology. In contrast, in figure 5 is plotted the thermal resistance from junction to case (RΘJC). The CanPAK and double-sided cooling SO8 packages are far less efficient at getting the heat out of the top

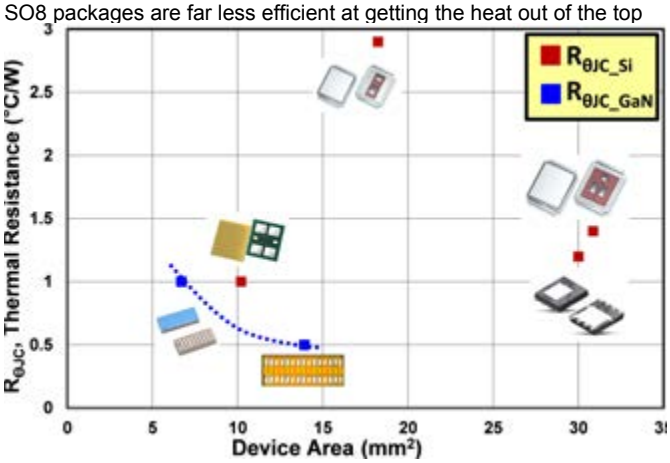


Figure 5: RΘJC (Junction to Case Thermal Resistance) for several package styles. eGaN FETs (represented by blue squares) have superior thermal resistance.

of the package than either the Blade package or the eGaN FETs. The eGaN FETs, however, are over 30% lower than the even the Blade when normalized to the same area.

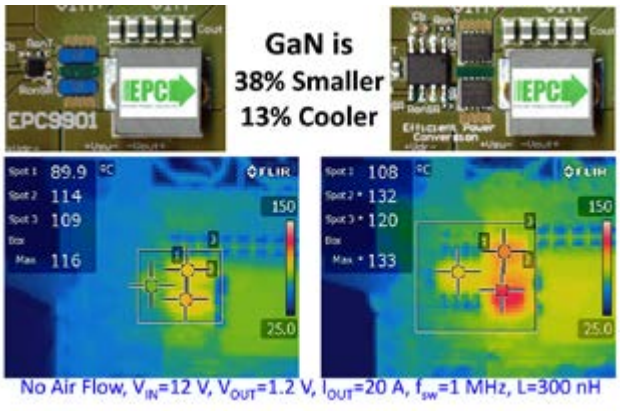


Figure 6: Comparison of thermal performance of two buck converters. On the right is an eGaN FET-based converter (Control and Synch Rect: EPC2015). On the left is a MOSFET-based converter (Control: BSZ097N04LS G S3O8, Synch Rect: BSZ040N04LS G S3O8). Spot #1 is the driver IC; Spot #2 is the bottom FET (Synchronous rectifier); Spot #3 is the top FET (Control).

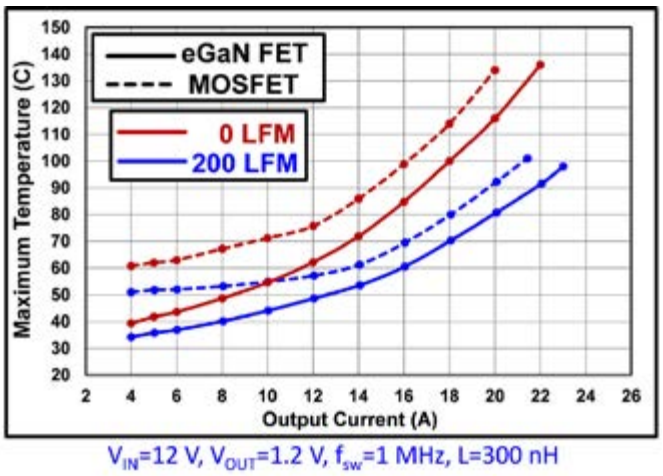


Figure 7: Maximum transistor temperature in still air (0 LFM) and with 200 LFM air flow for the buck converters in figure 6.

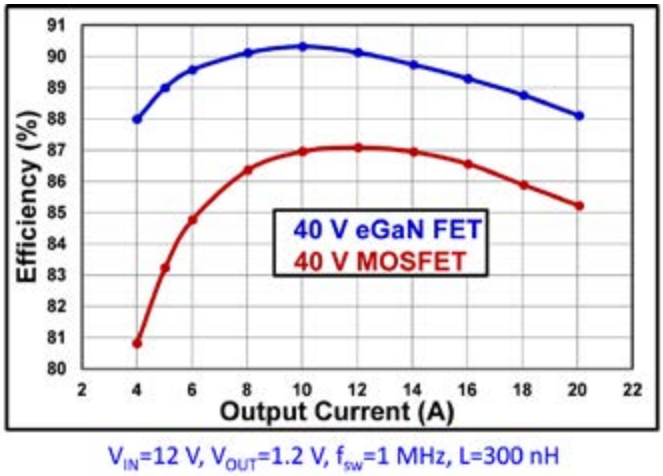


Figure 8: Efficiency comparison between the MOSFET and eGaN FET-based buck converters in figure 6 with no airflow.

The conclusion that can be drawn is eGaN FETs in chipscale packaging can achieve higher power density than any power MOSFET in a commercially available package today.

High Power Density DC-DC Conversion:
It has been previously demonstrated that the chipscale packaging of eGaN FETs have extraordinarily small parasitic inductance and virtually zero parasitic resistance [11]. Add to this the almost ten times faster switching speed and the superior thermal efficiency, and large improvements can be realized in power density.

To illustrate this performance gap two buck converters were constructed with virtually identical layout as shown in figure 6. The board on the left has eGaN FETs, and the board on the right has MOSFETs in 3mm x 3mm S3O8s with similar voltage and on-resistance ratings. Because GaN transistors require a smaller die size to achieve the same on resistance as that of a silicon power MOSFET, and because they require no additional packaging, the resulting transistor footprint on the PCB is 38% smaller in the eGaN FET-based buck converter.

With both converters powered up at 1 MHz with 12 VIN and 1.2 VOUT, the performance difference can be measured both thermally and electrically. In figure 6 the thermal image shows that the peak temperature of the eGaN FET-based buck converter is 17oC (13%) lower than the MOSFET-based converter. This temperature discrepancy is plotted in figure 7 against output current with both zero airflow and 200 LFM airflow directed across the circuit. The corresponding conversion efficiency for both converters, operating with zero airflow, is plotted in figure 8. There is an improvement of over 3 percentage points in peak efficiency (25% reduction in losses) with eGaN FETs in the circuit.

Summary
Chipscale packaging is more efficient than conventional power transistor packaging. In addition to having lower parasitic resistance and inductance, it has a smaller footprint and improved thermal efficiency. Add to these attributes the superior electrical performance of GaN-on-silicon power transistors and it is clear that the aging power MOSFET is falling further and further behind.

References
[1] Efficient Power Conversion EPC2021 datasheet, www.epc-co.com
[2] Efficient Power Conversion EPC2001 datasheet, www.epc-co.com
[3] A. Lidow, J. Strydom, M. de Rooij, D. Reusch, “GaN Transistors for Efficient Power Conversion,” Second Edition, Wiley, ISBN 978-1-118-84476-2, pages 76-83.
[4] Infineon Blade BSN012N03LS datasheet, www.infineon.com
[5] Infineon CanPAK S-size BSF134N10NJ3 G datasheet, www.infineon.com
[6] Infineon CanPAK M-size BSB012N03LX3 G datasheet, www.infineon.com
[7] Infineon S3O8 BSZ075N08NS5 datasheet, www.infineon.com
[8] Texas Instruments S308 Dual Cool SON 3.3x3.3mm CS-D16323Q3C datasheet, www.TI.com
[9] Infineon Super SO8 BSC010N04LS datasheet, www.infineon.com
[10] Texas Instruments Super SO8 Dual Cool SON 5x6mm CS-D16321Q5C datasheet, www.TI.com
[11] D. Reusch, D. Gilham, Y. Su and F.C. Lee, “Gallium nitride based multi-megahertz high density 3D point of load module,” APEC 2012. pp.38-45. Feb. 2012.

Implementing Gate Drivers for 3-Level NPC-2 Power Modules with Reverse Blocking IGBTs

Although 3 level converter topologies can lead to reduced total harmonic distortion and hence minimise the size and cost of filtering at the output stage, the best known configuration, NPC1 (Neutral Point Clamped), usually increases the number of switching devices (IGBTs and diodes) required, which adds to the complexity of the system.

By Christoph Dustert and Andreas Volke,
CT-Concept Technologie GmbH, a Power Integrations company

However, a new topology, NPC2, based on reverse-blocking IGBTs enables the power semiconductor count to be reduced.

The topologies are shown in Figure 1.

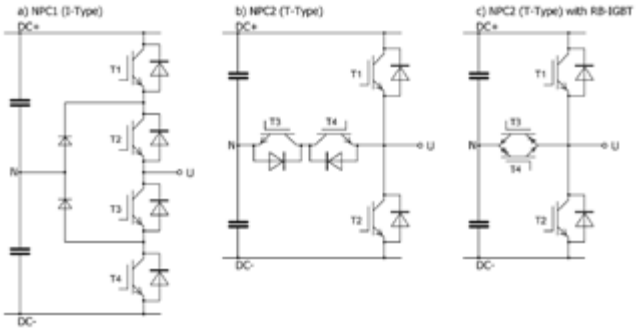


Figure 1: Overview of 3-level half-bridge topologies

Compared to the classical NPC1 setup which consists of four IGBTs and six diodes, the NPC2 design in Fig. 1b features a reduced amount of semiconductors. To decrease the amount of semiconductors in NPC2 setups, two reverse-blocking (RB) IGBTs can be used. RB-IGBTs can sustain forward and reversed biased voltages of equal levels, unlike standard IGBTs which can sustain only a fraction of the forward blocking voltage when in reverse blocking state. Therefore, RB-IGBTs enable NPC2 topology designs to be implemented using two fewer diodes (Fig. 1c), leading to several advantages including reduced conduction losses, better utilization of package area and simplified auxiliary terminal arrangement.

Gate-driver considerations

Common to all the NPC topologies shown in Figure 1 is that during normal operation, the voltage of the phase output U alternates between 1/2DC+ and 1/2DC- with respect to the neutral point N. In other words, it changes its polarity. This is of particular significance for IGBTs between junctions N and U of the NPC2 topology which form the bidirectional switch. The resulting voltages for these IGBTs are shown in Figure 2.

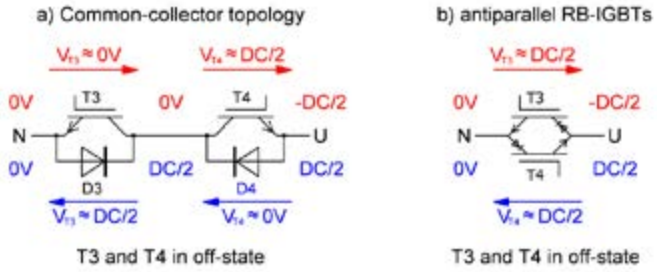


Figure 2: Idealized voltage distribution for different kinds of bidirectional switches

The collector-emitter voltage of the IGBT switches in Figure 2a is always positive or (idealized) zero; depending on the actual phase output voltage at position U. Hence, for short-circuit and overvoltage protection, no special requirements need to be considered for the gate drive unit. However, if RB-IGBTs are used, the alternating voltage at junction U will require modifications to be made to the short-circuit and overvoltage protection schemes, otherwise, the gate-driver stage and eventually the power stage will be damaged.

Overvoltage protection

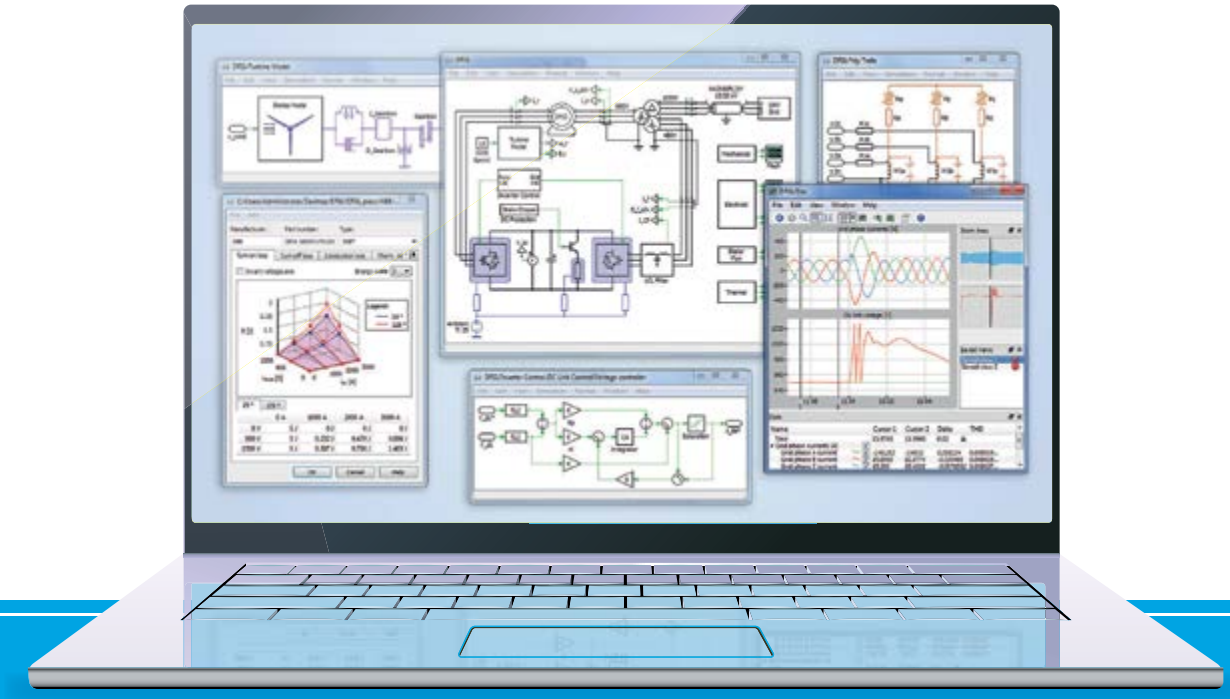
To protect IGBTs against transient over-voltages during turn-off events, an active clamping circuit is commonly used. Active clamping reliably limits overvoltage by driving the IGBT into the active region and reducing the change of commutation current (di/dt).

A standard active clamping setup is shown in Figure 4a for IGBT T1. TVS diodes (D2…Dx) are connected from the collector to the gate via a low-voltage Schottky diode or PIN diode (D1). This diode is necessary to avoid a current flow from the gate into the IGBT collector, and requires only a blocking capability of, for example, 40 V. However, if an NPC2 topology with RB-IGBTs is selected, the typical active clamping circuit with unidirectional TVS diodes and a low-voltage diode cannot be used. This is because the voltage across the RB-IGBTs will change the polarity depending on the switching states (Figure 4b). As long as the polarity of the collector of the respective IGBT is positive, the TVS diodes of the corresponding gate driver can block this voltage from the driver. However, as soon as the collector voltage reverses its polarity the TVS diodes start to conduct and the full collector potential will be applied to the anode of the low-voltage

plexim
electrical engineering software

plecs

THE SIMULATION SOFTWARE PREFERRED
BY POWER ELECTRONICS ENGINEERS



MODELING DOMAINS

- Electrical
- Control
- Thermal
- Magnetic
- Mechanical

KEY FEATURES

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

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

diode D1. This voltage is approximately equal to half of the DC-link voltage, and would lead to the destruction of the IGBT and associated driver.

Figure 3 shows measurements using an NPC2 power module 4MBI300VG-120R-50 from Fuji Electric. The load is connected between U and DC-, while the top switch, T1, is turned on and off. The waveform of channel 2 (Vce RB-IGBT T3) illustrates the alternating voltage between N-U during the turn-on and turn-off phases of IGBT T1.

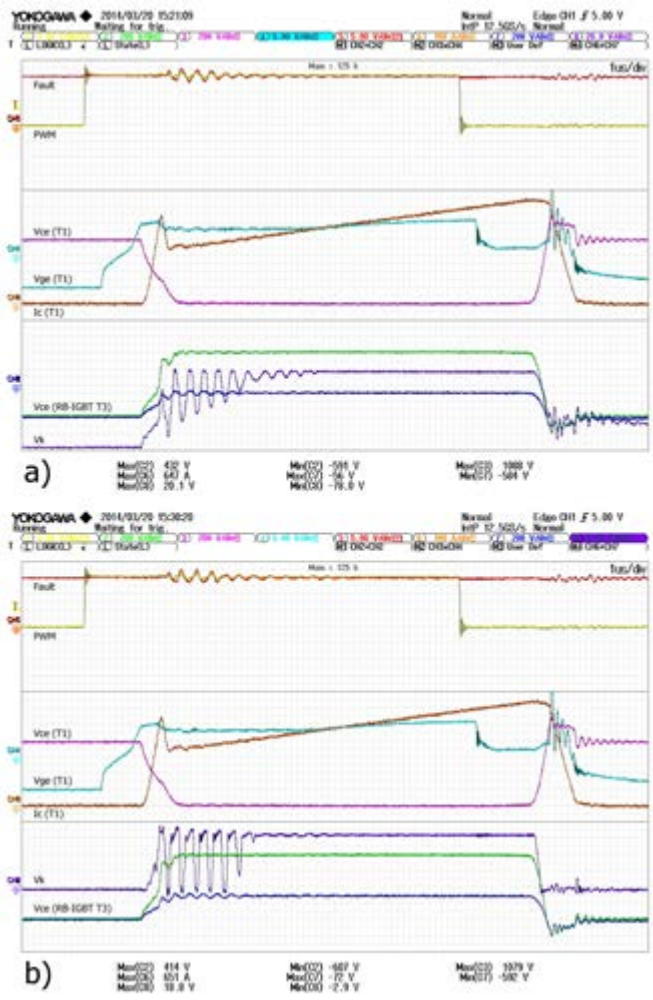


Figure 3: Switching waveforms of an NPC2 topology with RB-IGBTs (VDC = 800V, Iload = 650A) a) standard VCE monitoring b) modified VCE monitoring

There are two possible options to prevent this happening. First, bidirectional TVS diodes can be used instead of a unidirectional devices (see Figure 4c). However, as shown in Figure 3, the negative voltage 'Min (C2)' may reach levels which are equal to the break-down voltage of the bidirectional TVS diodes. If this occurs the reverse voltage of the diode D1 will exceed limits, therefore this approach is not recommended.

The preferred solution (Figure 4d) is easily realized by replacing the low-voltage diode, D1, with a high voltage diode which has a blocking capability of at least half the DC-link voltage. Creepage and clearance distances of the diode package must also be considered and it may be necessary to use more than one diode.

Short-circuit protection

To protect IGBTs of any topology during a short-circuit event, a reliable desaturation monitoring function is required. A widely-used implementation of desaturation monitoring with high-voltage diodes is shown in Figure 5a. However, if NPC2 topology with RB-IGBTs is being used, the desaturation monitoring with high-voltage diodes method will not work anymore. This approach only works as long as the corresponding collector voltage has positive potential (referenced to emitter) and the high-voltage of the corresponding gate driver can block this voltage away from the driver's low voltage sense input. Once the polarity turns negative, the diodes start to conduct and an excessive current will flow through the diodes, which will damage the driver and/or associated IGBT.

A more advanced solution is to replace the high-voltage diodes with a resistor network (Rvce in 5b). In this circuit, the VCE voltage is measured during the IGBT turn-on state which avoids inadvertent tripping of the monitoring function.

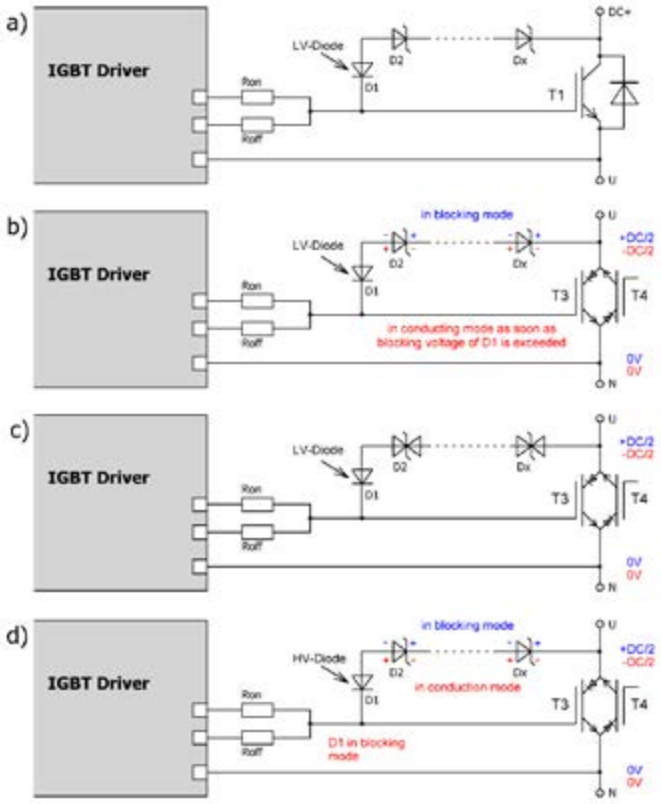


Figure 4: a: standard active clamping circuit for IGBTs; b: standard active clamping on RB-IGBTs; c: possible active clamping circuit for RB-IGBTs; d: preferred active clamping circuit for RB-IGBTs

By implementing short-circuit protection using a resistor network, the resistors Rvce scale down the collector voltage and also limit the current flowing from the collector to the gate-driver sense input.

Short-circuit protection using a resistor network

During an IGBT off-state, the driver's internal MOSFET T5 connects the sense pin to COM (negative potential of the gate driver), see figure 5b. The capacitor Cax is then pre-charged/discharged to the negative supply voltage. The function of D1 is to clamp the voltage VK to the positive supply voltage VCC to protect the sense input of the gate driver against high voltages. To limit the losses in the resistor network and diode D1 it is recommended that the current at maximum DC-link voltage be adjusted to between 0.6 and 1 mA.

At IGBT turn-on and in the on-state, the MOSFET T5 turns-off. While VCE decreases, Cax is charged from the COM potential to the IGBT saturation voltage. The voltage of Cax is continuously compared with a reference voltage determined by Rref. In the event of a short-circuit, the voltage of capacitor Cax increases as the IGBT is driven out of saturation. Once the voltage of Cax is higher than the reference voltage, the gate driver will interpret this as a fault condition. Figure 5c illustrates this scenario.

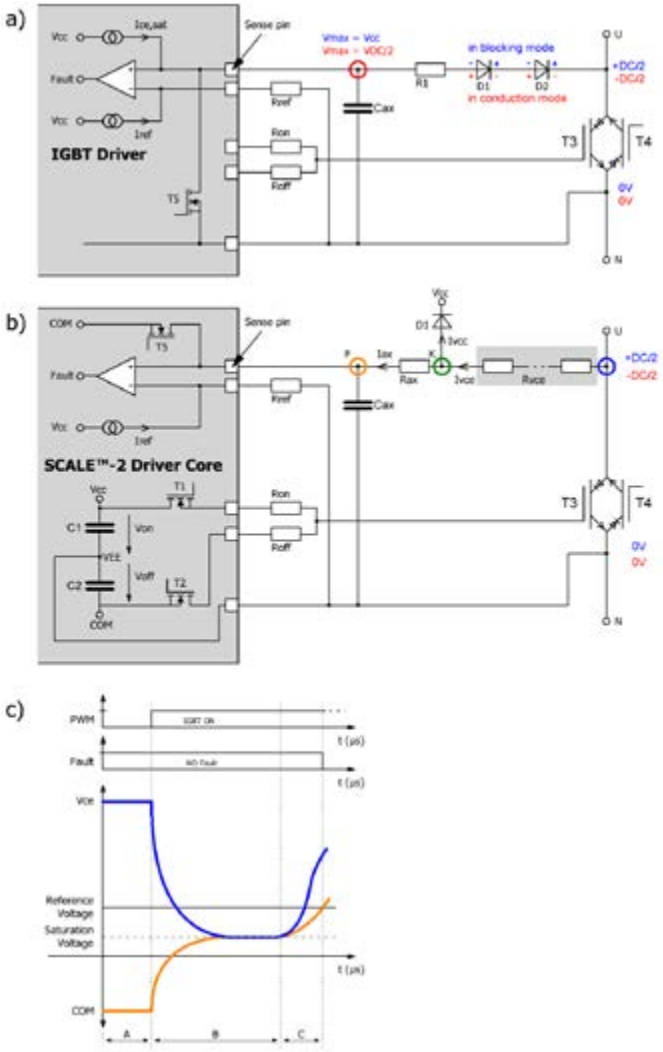


Figure 5: Schematic of desaturation monitoring using: a) high-voltage diodes on RB-IGBTs b & c) resistor network

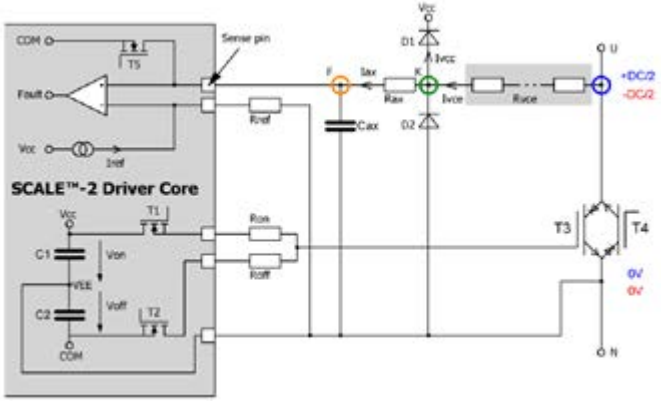


Figure 6: Modified desaturation monitoring for RB-IGBTs using a resistor network

If a negative voltage is present during the off-state, the voltage at junction K will also be negative. To prevent a current flow out of the sense pin of the gate driver, a further diode, D2, must be added (Figure 6), otherwise, substrate currents and unintended latch-up effects will occur within the gate drive circuitry (It is also possible to implement active rectification inside the ASIC to address this point).

The results of incorporating the additional diode D2 are shown in Figure 3b. Comparing channel 8 (Vk) of both measurements, one can observe that the voltage Vk is limited to a lower negative value (-2.9 V with D2 compared to -78 V without D2).

Conclusion

RB-IGBTs can be used in NPC2 topologies, bringing significant benefits to applications such as solar power and UPS systems as long as attention is paid to the design of protection circuitry. Without these modifications the gate driver and eventually the entire power stage will be damaged as the negative voltage at the phase output will overload the gate driver unit. These changes can be simply and effectively implemented using standard gate driver cores from CONCEPT www.IGBT-Driver.com/products/scale-2-driver-cores.

For more information refer to:
http://www.igbt-driver.com/news

www.IGBT-Driver.com

How Digital Isolation Technology Drives System-Level Efficiency

Power supply efficiency continues to be an area of focus in the power electronics industry. Advances in power electronics components and topologies are driving individual power supply efficiencies to higher performance levels. The improvement in the efficiency of each power supply is an important – and essential – element in addressing the rapid growth of power consumption. Another, perhaps greater, opportunity to dramatically reduce power consumption is the system-level, intelligent management of energy.

By Atefeh Mirbagheri, Faisal Ahmad and John Camagna Akros Silicon, Inc., United States

This article describes implementation of high-speed, digital isolation as an enabler for system-level power management in enterprise networks utilizing Power over Ethernet (PoE) technology. With this approach, the network switch and all of the powered devices on the network become part of an intelligently managed system that offers the potential for energy savings that go far beyond the capabilities of individual power supplies.

Network-Level Power Management

Digital power control provides the opportunity to go far beyond the full-load efficiencies of individual power supplies by actively controlling, in real time, the power consumed at each node in a system. For example, in a networked building, devices in unoccupied rooms can be placed on standby or can be turned off. Further, device power levels can be adjusted based on environmental conditions or according to real-time demands for computing power and bandwidth.

All of this control requires a system-level approach into the management power in the network. The opportunity for energy savings is growing as PoE advances are now pushing the power levels at individual nodes from 30 to 90 Watts. This changes the landscape by allowing higher powered devices to be controlled from the network switch.

Enabling intelligent power management requires real-time data. Since PoE is an isolated power system [1], gathering this data requires access to information across an isolation barrier at data rates that go beyond the capabilities of traditional isolation methods. An approach using high-speed, digital isolation is able to overcome this limitation, thereby allowing for the full realization of system-level energy management.

Network-level power management requires real-time telemetry and control of all regulators in the system. As an Ethernet network is a distributed system via CAT-5 or higher cables, galvanic isolation is mandated for ground loop suppression and safety concerns [2]. Figure 1 shows a typical PoE implementation with the connection between a PoE Powered Device (PD) and the network switch acting as the PoE Power Sourcing Equipment (PSE). The system-level power management protocols are implemented in a processor in the network switch, which commands the power system through an isolated I²C interface to the PSE controller. The PSE controller controls the power delivered to each individual PD. The PSE controller also reports voltage and current information back to the processor through the same I²C interface, so that it has the power consumption information needed to manage energy usage.

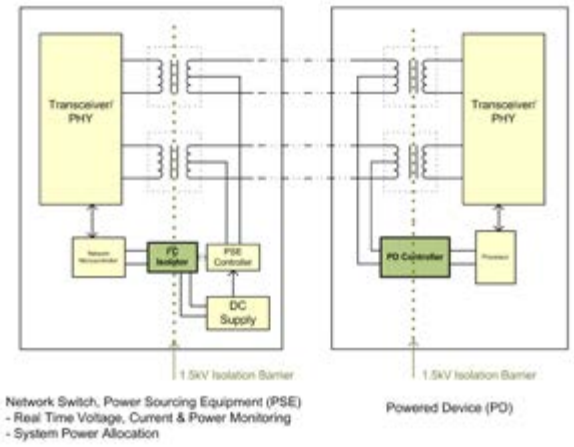


Figure 1: Network System Diagram with PSE & PD

A challenge to implement this level of energy management at the system level is transferring data across the isolation barrier at a frequency that enables optimized network power management. To enable both real-time monitoring and control of multiple Ethernet ports from a single processor, data transmission speeds as high as 3.4MHz on the I²C bus are needed. Not only does the communication from the processor to the individual PSE need to be faster, but with high-end switches available in the market having as many as 96 ports, the need for high communication bandwidth has never been greater. Compounding this system challenge, PSE controllers are also moving from 4 channels to as high as 12 channels per IC, also requiring three times as much communication between a processor and a single PSE controller. The traditional solutions, optocouplers, have long propagation delays, which limit their ability to support these higher communication speeds [3]. In contrast, high-speed digital isolators can enable these higher data rates.

Isolating a High-Speed I²C Bus

The I²C bus has been a commonly used interface for bidirectional data transfer in many applications (Figure 2). For decades, its popularity has been due to its simplicity and flexibility [4]. The bus is controlled by one device; the master, which can communicate with

Straight to the optimized design

Cooling systems

Laminated bus bars

Fuses for the protection of power semiconductors

ep.mersen.com

MERSEN

Eldre | Ferraz Shawmut | R-Theta

one or more slave devices. The clock (SCLK) and data lines (SDATA) are shared by all slaves. Each bidirectional data transfer happens during one clock cycle.

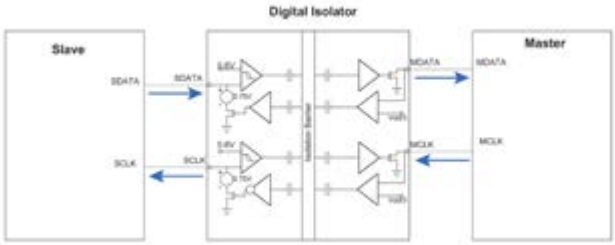


Figure 2: I2C Bus Data Transfer Diagram

The timing is very critical for accurate data transfer, especially in high speed applications. All propagation delays through transmission path need to be carefully accounted for, in order to ensure accurate data transfer. As shown in Figure 3, the falling edge of MCLK is propagated across the isolation boundary before it reaches SCLK with a delay time referred to as M-S_{CLK_DELAY}. The PSE response time to receiving the falling edge on SCLK is $S_{RESPONSE\_DELAY}$. When the PSE responds with a falling edge on SDATA, it is propagated back to the processor to reach MDATA with a time of S-M_{DATA_DELAY}. Adding these delays together results in:

$$Total_{DELAY} = M\text{-}S_{CLK\_DELAY} + S_{RESPONSE\_DELAY} + S\text{-}M_{DATA\_DELAY}$$

For correct data transmission, $Total_{DELAY}$ must be less than the time that MCLK is low for a 3.4MHz operating frequency or 150ns period with a 50% clock duty cycle.

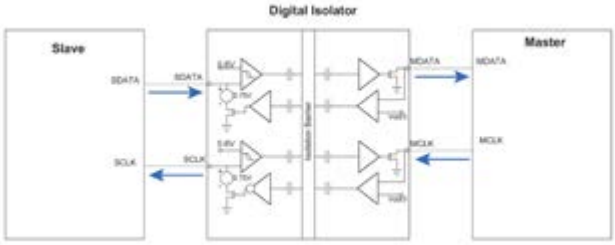


Figure 3: Propagation delay from Master to Slave

Considering the challenges, managing the propagation delay through the isolation boundary can be done very accurately using high-speed digital isolators. For instance, compared to optocouplers, the propagation delay through a digital isolator is much shorter. A typical propagation delay through optocoupler is greater than 100ns, while typically 40ns [5] for the high-speed digital isolator.

Digital Isolators Vs. Optocouplers

In order to prevent ground loops that could damage the equipment and to meet industry safety requirements, 1500Vrms galvanic isolation is required in PoE. While both optocouplers and digital isolators provide this level of isolation, digital isolators allow high-speed data transmission (Figure 4).

Digital isolators are implemented in standard CMOS technology that provides benefits of lower propagation delays, reduced power consumption and improved reliability. Optocouplers, on the other hand, use photons to cross the isolation barrier and the process of integrating the photons to create an electrical signal is slow. As the industry steadily adds higher bandwidth requirements to their systems, to either allow for control of multiple systems or for faster monitoring of individual channels, digital isolators uniquely enable the requisite communication.

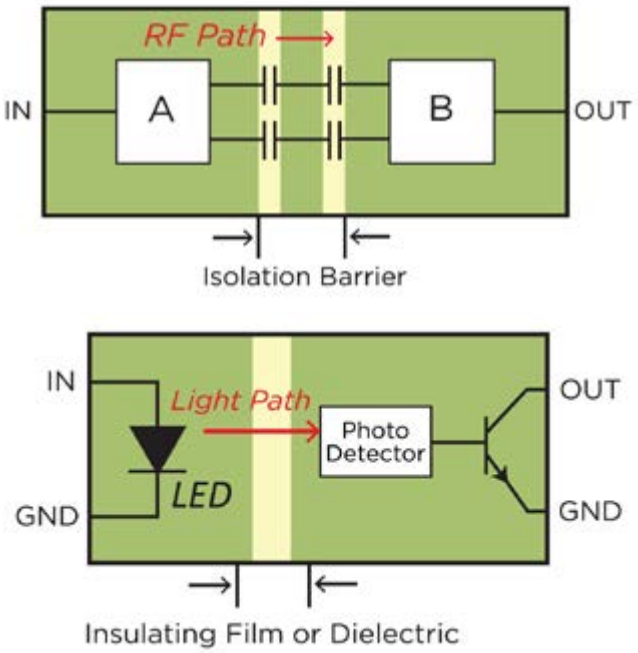


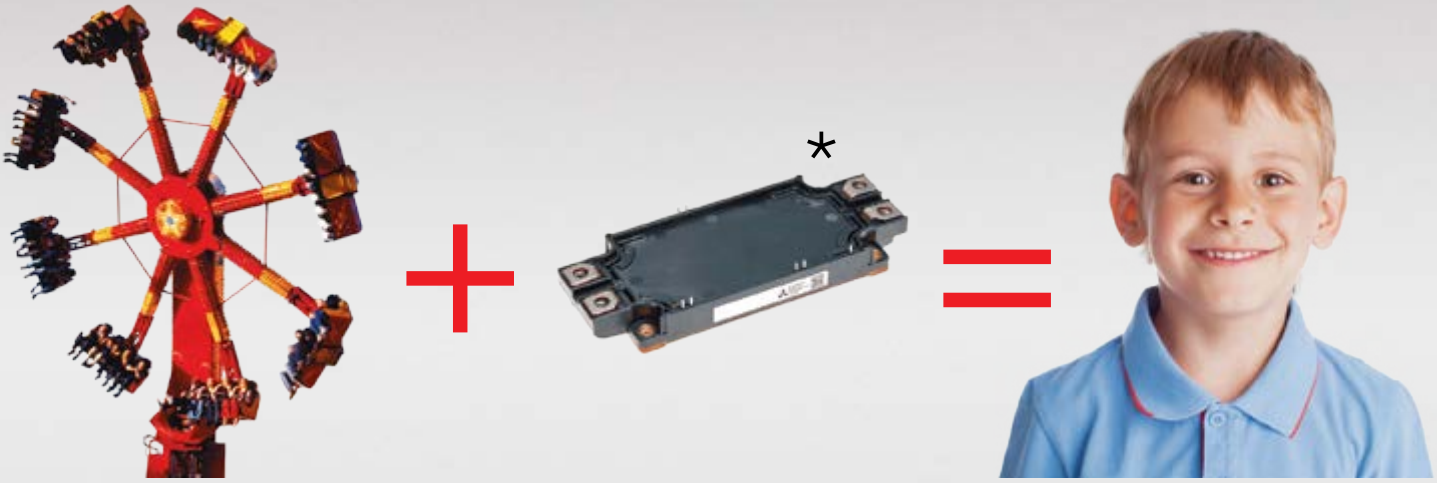
Figure 4: Comparison of Optocouplers Vs. Digital Isolators

Conclusion

With the ongoing industry trend of enabling system power management to reduce energy consumption, network-level power control is needed to achieve system-wide efficiency gains. All distributed systems mandate galvanic isolation, and implementing cost-effective, reliable data communication across this boundary is necessary to successfully implement network-level power management. Using digitally isolated power management ICs allows for system-level energy management that enables the trend of improving system-wide energy efficiency. In contrast to optocouplers, digital isolators provide a unique solution that can be built using reliable and low-power CMOS technology to accommodate high-speed data transfer up to 3.4MHz.

References

[1] IEEE Standard for Ethernet, IEEE Standard 802.3, 2012.
[2] IEEE Criteria for Class IE Electric Systems, IEEE Standard 308, 1969.
[3] Avago Technologies, “High Speed LVTTL Compatible 3.3 Volt Optocouplers.” HCPL-260L/060L/263L/063L datasheet, May. 2013.
[4] I2C-bus specification and user manual, UM10204, 2012
[5] Akros Silicon, “AS174x datasheet, High Speed I2C Bus Digital Isolator.” Datasheet, 2014.



Always first-class results:
Power Devices from Mitsubishi Electric.

Precise and efficient control of dynamic processes puts heavy demands on the components used. When it counts, power devices from Mitsubishi Electric are always first choice. Because, in addition to many innovations, they consistently provide added quality, performance and robustness – and therefore reliably ensure first-class results.

★ **6th Generation IGBT Module NX-Package**
- Excellent thermal conductivity by AlN substrate
- Superior power cycling capacity by optimized bonding
- 6th Generation IGBT with CSTBT™ Chip Technology
- Integrated NTC for T_C-sensing
- Comprehensive line-up for 1200V and 1700V

eco Changes for a greener tomorrow

More information: semis.info@meg.mee.com / www.mitsubishichips.eu

MITSUBISHI ELECTRIC
Changes for the Better

EZPower™ Smart Load Switch with Rapid Turn-Off Fault Protection and Current Monitoring

Alpha and Omega Semiconductor Limited introduced the AOZ1363, a high current smart load switch with rapid turn-off fault protection and current monitoring. The device has an operating input voltage range from 5V to 16V and is capable of supplying up to 6A of continuous current. A low on-resistance of 23mΩ in a thermally enhanced 3mm x 3mm DFN package makes the AOZ1363 optimal for space-constrained applications that require circuit protection such as the latest notebook PCs, hot swap supplies and micro servers.

The AOZ1363 integrates several smart functions to safely and effectively manage, and monitor loads. The device features an internal current limiting circuit, which protects the system from sourcing excessive load currents, in conjunction with a thermal protection function that limits excessive power dissipation. Externally programmable soft-start circuitry controls inrush current from highly capacitive loads during hot-plug events. The device can communicate load information in real time through the current monitoring pin (ISEN) with an accuracy window of 10% at a specified load current of 3A. The AOZ1363 can detect over-current fault conditions and execute a rapid power-down within a delay time of 100ns maximum. It also features an input overvoltage protection which allows the device to power-down when the power input voltage exceeds 19V.

www.aosmd.com

SEMIKRON
innovation + service

Interfaces to Meet Your Needs

SEMIKRON is a leading manufacturer of power modules and systems.

Our wide range of power modules offers a multitude of interconnection technologies for all applications and mounting processes. Our sales and application support is at your disposal around the globe. **Contact us the way you want.**

www.semikron.com/contact


Spring Contact


Press-fit Contact


Screw Contact


Solder Contact

See you at HUSUM Wind!

15 – 18 September 2015 in Husum, Germany

Book your stand now!

MESSE HUSUM & CONGRESS

in co-operation with

Hamburg Messe

HUSUM Wind

The German Wind Trade Fair and Congress

www.husumwind.com

Partners of HUSUM Wind 2015

BWE German Wind Energy Association

GWEC Global Wind Energy Council

VDMA Power Systems

DIN Rail DC-DC Converter Line up to 600 W

CUI Inc announced the expansion of their DIN rail dc-dc product line with the addition of over 90 new high wattage models ranging from 50~600 W. The VHK and VFK DIN families are high efficiency isolated dc-dc converters packaged in a rugged aluminum case that feature an ultra-wide 4:1 input. With efficiencies as high as 92% and an integrated aluminum heat sink, the units are able to operate at higher temperatures with a minimal amount of air flow. They have been designed for applications where the convenience of DIN rail mounting is required, such as industrial equipment, mobile equipment, and telecom base stations.

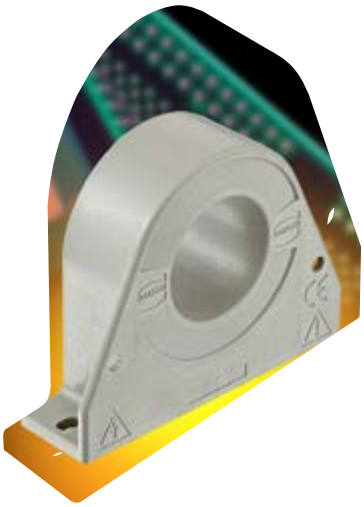
Users can select from input voltages of 9~36 Vdc or 18~75 Vdc for 50~400 W models and 18~36 Vdc or 36~75 Vdc for 600 W models. Output voltages of 3.3, 5, 12, 15, 24, 28, 32, or 48 Vdc are available depending on the series. Standard operating temperature range is -40~85°C, with the 50 W model operating up to 60°C under convection-cooled conditions.

Safety features of the VHK and VFK DIN series include over current, over temperature, input transient, and short circuit protections. Additional features include output trim, remote sense and remote on/off control. For applications that require power above 600 W, the VFK600-DIN series comes standard with load share capability.

www.cui.com

Hall-Effect Current Sensors Cover Range from 100 A to 800 A

HARTING has introduced a range of Hall-effect current sensors with a current range from 100 A to 800 A. The new HCSE (Hall-effect current sensors Eco) family consists of four models, and are based on the open-loop measurement principle which provides a direct representation of the primary current with an accuracy of up to ±1%.



The HCSE sensors can measure direct or alternating currents, including signals with complex waveforms, over a frequency range from 0 to 50 kHz. Because the devices use proven Hall-effect technology to sense the magnetic field created by the current flowing in a conductor, they provide non-contact, galvanically isolated measurements with high immunity to interference from the magnetic fields of external current-carrying conductors. The wide temperature range of -25° to +85°C allows use in thermally critical applications. The sensors come in standard sizes and their compact, unified shape across the whole product range offers a high degree of freedom for integration into individual applications.

Thanks to their high reliability and accuracy, the new sensors are ideal for application such as power supplies for welding equipment, rectifiers for direct current drives or uninterruptible power supplies.

www.HARTING.com

30th ANNIVERSARY 1985-2015

APEC® 2015

March 15 -19, 2015

Charlotte Convention Center
Charlotte, North Carolina

The Premier Global Event in Power Electronics™

Visit the APEC 2015 website
for the latest information:

www.apec-conf.org

Two IO-Link Reference Designs for Proximity Sensing and Enhanced Distributed Control

Two subsystem reference designs from Maxim Integrated Products, provide very accurate, low-power optical proximity sensing (MAXREFDES27#) and enhance distributed control with a compact digital-input hub (MAXREFDES36#).

Modern 'smart' manufacturing relies heavily on high-speed automation and superior sensing. With that comes an increased need for versatile and accurate proximity sensing—never an easy task—and more system sensor inputs. Both of these new space-saving subsystems integrate the IO-Link® standard for industrial applications. The MAXREFDES27# proximity sensor employs the IO-Link protocol to provide efficient two-way communication between a controller and a remote optical sensor. The MAXREFDES36# digital hub utilizes the IO-Link protocol to enhance distributed control, enabling 16 digital inputs to reside near bina-

ry sensors, thereby reducing expensive and bulky cabling at the PLC side and enabling higher DI density.

www.maximintegrated.com

Switching Regulators Meet Extended Temperature, and Small Layout Requirements

ROHM Semiconductor recently introduced two switching regulator series designed to archive high operating voltage, extended temperature, and small layout requirements demanded of today's high performance, space-constrained power supply applications. Delivering extremely high power efficiency over a wide current load, ROHM's new switching regulators are optimized to support a comprehensive range of industrial, consumer and battery-powered equipment power supplies. As users demand increased performance from smaller and smaller power supply applications, ROHM's expanded DC/DC switching regulator line offers significant efficiency advantages over other voltage regulators and permits designers to further shrink board sizes.

ROHM's BD9G101G DC/DC converter features a high and wide input voltage range (VCC=6V~42V), an integrated internal high-side 42V power MOSFET, and provides 0.5A of DC output. ROHM's high-efficiency 6MHz synchronous step-down switching regulator BU9000xGWZ utilizes an ultra-low current pulse-frequency modulation (PFM) mode and provides up to 1.0A of load current with an input voltage range from 4.0V to 5.5V.

www.rohm.com/eu

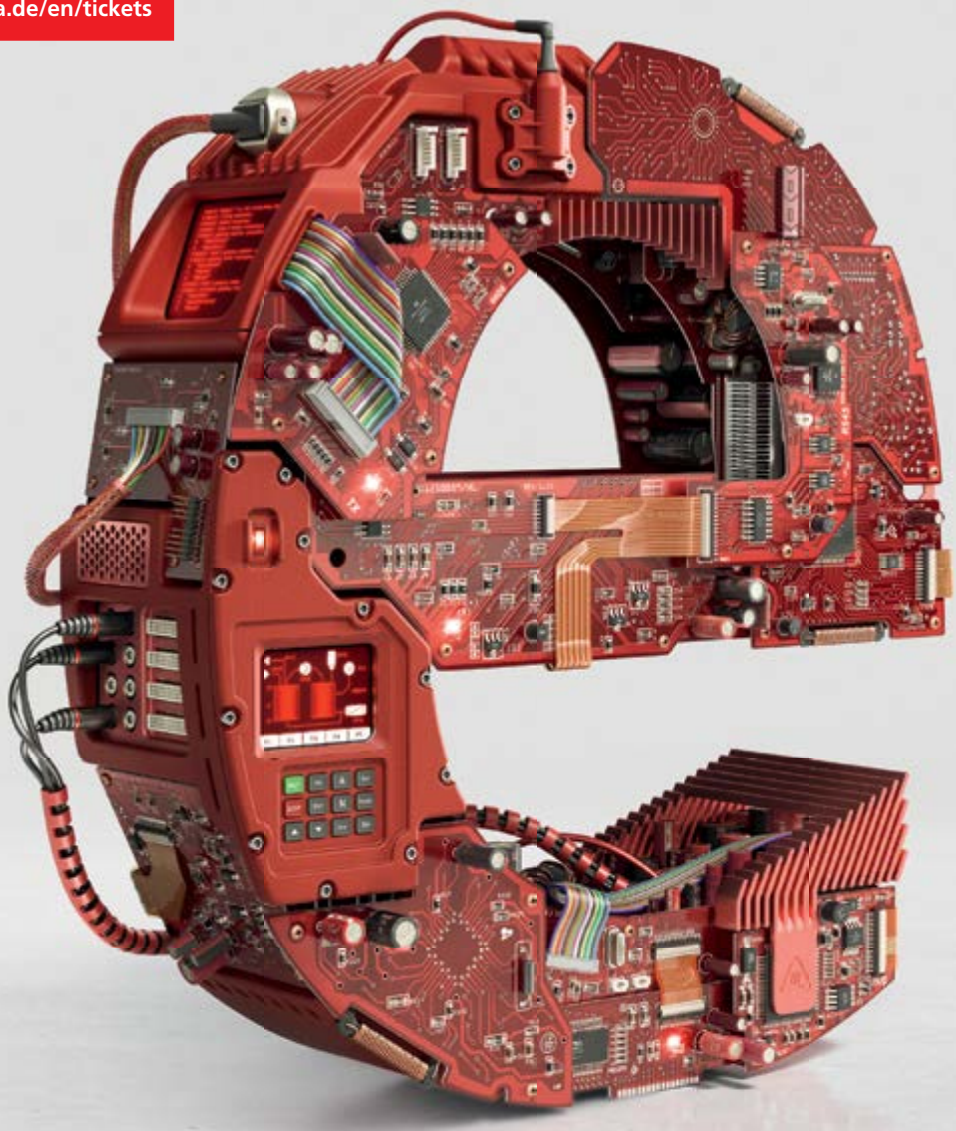
Messe München International

Connecting Global Competence

Welcome to Planet e.

The entire embedded universe at a single location!

Tickets & Registration
www.electronica.de/en/tickets



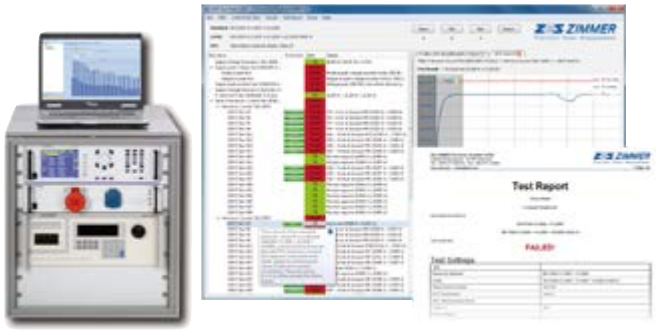
26th International Trade Fair for
Electronic Components, Systems
and Applications
Messe München
November 11–14, 2014
www.electronica.de

50 years
electronica

electronica 2014
inside tomorrow

LMG Test Suite – CE Compliance Test Software

With the LMG Test Suite ZES ZIMMER presents its latest CE compliance test solution. The LMG Test Suite tests in accordance with the currently valid version of EN 61000-3-2/-12 or EN 61000-3/-11 and also supports measurements per ECE R-10.4 Annex 11 (e.g. electromagnetic compatibility of vehicles). The software is available for download to customers as free demo version or full version.



As renowned manufacturer of precision power measurement technology, ZES ZIMMER is represented on international standards committees. As a result, changes and updates are immediately incorporated into the test systems. The measurement results and the limit values (either fixed or product-specific) defined in the standards are also visualized graphically. The analysis can be carried out either online, while directly connected to the measurement hardware, or offline, using stored data records. Each data record is furnished with the basic characteristic data of the test sample (RMS values of voltage and current, active power, reactive power and apparent power, power factor, harmonic distortion, etc.) to increase the significance of the information and to avoid incorrect allocations.

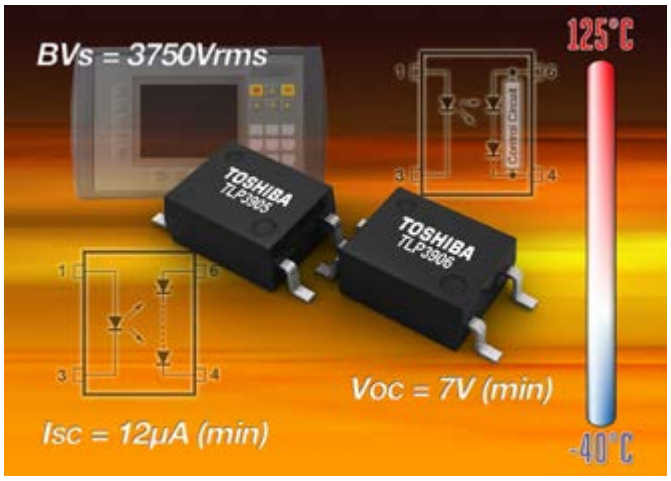
The LMG Test Suite supports all AC power sources available on the market which fulfil the requirements of the CE standards to be tested. This provides maximum flexibility for the customers. In particular, they can continue to use the sources that are already available and thus avoid additional investments. Calibration of the AC power source specifically for the CE tests is not necessary, as the test system monitors compliance with the stipulated source parameters. For example, the system analyzes the voltage harmonics and presents them graphically. This ensures freedom from distortion and voltage stability of the source. Any problems from this side of the test structure are thus excluded reliably.

www.zes.com

www.bodospower.com

Photovoltaic Couplers in Small-Size SO6 Packages

Toshiba Electronics Europe (TEE) has launched TLP3905 and TLP3906 small-size photovoltaic couplers in SO6 packages designed for use in measuring instruments, as MOSFET gate drivers or the replacement of mechanical relays.



The structure of a photovoltaic coupler is a photorelay without a MOSFET chip. Users can create an isolated relay by combining the photovoltaic coupler with an external MOSFET of their choice. This makes it possible to realize larger voltages and currents and exceed the capabilities of existing photorelay products.

While maintaining the fundamental performance of Toshiba's current products, TLP190B and TLP191B, the new products, TLP3905 and TLP3906 expand application possibilities by increasing the maximum operating temperature to 125°C (max) and increasing the isolation voltage by 50% to 3750Vrms (min).

In addition, TLP3906 integrates a control circuit for releasing the MOSFET gate charge, ensuring a turn-off speed of 0.3ms - approximately one third of TLP3905. TLP3906 also guarantees a minimum LED trigger current IFT (max) of 3mA to ensure low power dissipation of LED current. The devices also provide short circuit current I_{SC} of min12μA, the open voltage VOC is min. 7V.

www.toshiba-components.com

First High Value MLCC Capacitors

Mouser Electronics, Inc., is now shipping the Multilayer Ceramic Capacitors (MLCC) from Taiyo Yuden, including a large capacitance 330μF high end capacitor in an MLCC package, claimed to the first of its kind in the world. These small devices boast a high capacitance, low equivalent series resistance (ESR), and low impedances at high frequencies. Taiyo Yuden is known for producing high value capacitors in small packages while maintaining the highest quality standards.

The new Taiyo Yuden Multilayer Ceramic Capacitors, available from Mouser Electronics, includes a 330uF capacitor in an EIA 1210 package. Taiyo Yuden has expanded their capacitor product lines to include new capacitances in their EMK (16 VDC), AMK (4 VDC), TMK (25 VDC), and UMK (50 VDC)

multilayer ceramic capacitor families. These new capacitors are available in packages as small as 0.4mm x 0.2mm, are built on a monolithic structure for increased reliability, and also offer wide range of capacitance values in standard case sizes.

Capacitors store electricity on a temporary basis, and are also used to remove unwanted electronic noise from power supplies and communications signals. Small high quality capacitors are important when used in battery powered electronic devices such as mobile phones, tablets, laptop PCs and digital cameras. Small size high value capacitors are especially suited for Internet of Things devices where space is extremely limited. Taiyo Yuden's product focus is on higher capacitance with very low ESR, while also reducing the size of the package, making them especially useful in these applications. These small capacitors target low power portable battery powered devices such as laptop computers, mobile phones, LCD TVs and tablet PCs.

www.mouser.com

Single-Chip Display Power and LED Driver for Smartphones

Intersil Corporation announced the ISL98611 display power and LED driver for smartphones. The ISL98611 is the first power management IC that integrates the display power and backlight LED driver functions in a single chip. It significantly improves efficiency of both functions to increase smartphone battery life by an hour or more.

In addition to extending battery life, the ISL98611 also improves display brightness uniformity and color consistency. The highly integrated ISL98611 has a boost regulator, LDO and inverting charge pump for generating two output rails at +5V and -5V in a single device. It also includes a boost regulator with 3-channel current sinks for the LED backlight driver.

www.intersil.com/products/ISL98611

AC Current Sensor IC with Differential Output and Galvanic Isolation

The ACS726 from Allegro MicroSystems Europe is a current sensor IC designed to provide an economical and precise solution for AC current sensing in industrial, commercial and communications applications.

In addition to featuring galvanic isolation, it is the first current sensor IC to include a fully differential back-end amplifier that can be used to adjust gain and bandwidth via external RC networks. The back-end amplifier is fully independent and, when unused, can be powered down to reduce power consumption. The fully differential output of this device gives better immunity to output offset drift as well as common-mode noise.

The low-profile device package makes it easy to incorporate into customers' applications. Typical uses for the ACS726 include motor control, load detection and management, switched-mode power supplies, and overcurrent fault protection.

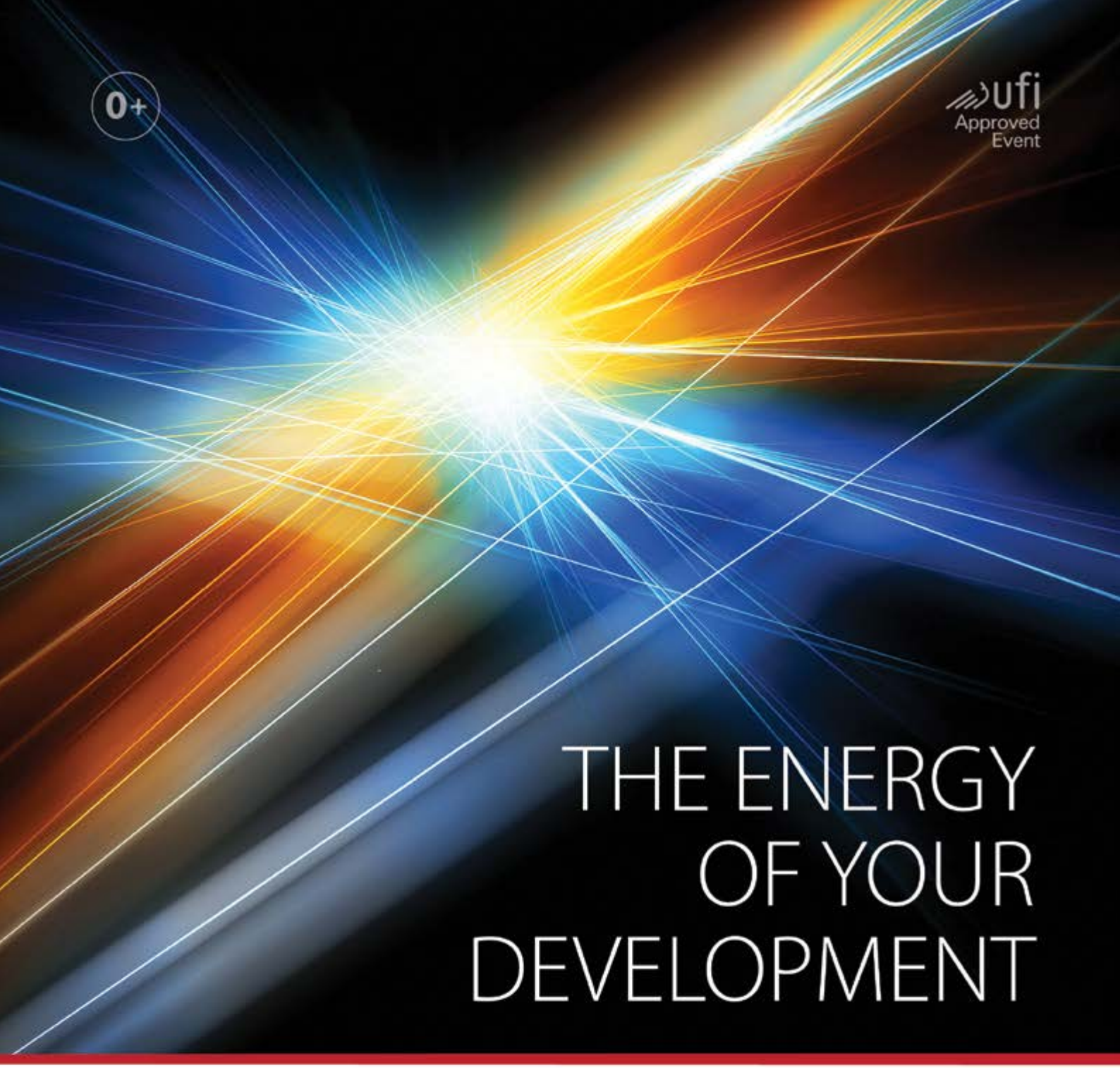
The device consists of a precise, low-offset, linear Hall sensor circuit with a copper conduction path located near the surface of the die. Applied current flowing through this copper conduction path generates a magnetic field which is sensed by the integrated Hall IC and converted into a proportional voltage.

Device accuracy is optimised through the close proximity of the magnetic field to the Hall transducer. A precise, proportional voltage is provided by the low-offset, chopper-stabilised BiCMOS Hall IC, which is programmed for accuracy after packaging.

The output of the device has a positive differential voltage when an increasing current flows through the primary copper conduction path, which is the path used for current sensing. The internal resistance of this conductive path is 1.1 mΩ typical, providing low power loss. The terminals of the conductive path are electrically isolated from the sensor IC signal leads, allowing the ACS726 current sensor IC to be used in high-side current sense applications without the use of high-side differential amplifiers or other costly isolation techniques.

The ACS726 is provided in a small, low-profile surface mount QSOP24 package (suffix LF). The leadframe is plated with 100% matt tin, which is compatible with standard lead (Pb) free printed circuit board assembly processes. Internally, the device is Pb-free, except for flip-chip high-temperature Pb-based solder balls, currently exempt from RoHS. The device, excluding the back-end amplifier, is fully calibrated prior to shipment from the factory.

www.allegromicro.com



11th International exhibition

POWER ELECTRONICS

POWER ELECTRONICS

25–27 November 2014

VENUE | CROCUS EXPO, MOSCOW, RUSSIA

Organisers:

primexpo ITE GROUP PLC

Tel.: +7 (812) 380 6003/ 07
Fax: +7 (812) 380 6001/ 00
E-mail: power@primexpo.ru

Request the conditions of participation on the website:

www.powerelectronics.ru

Ultra-Low Jitter Programmable Clock

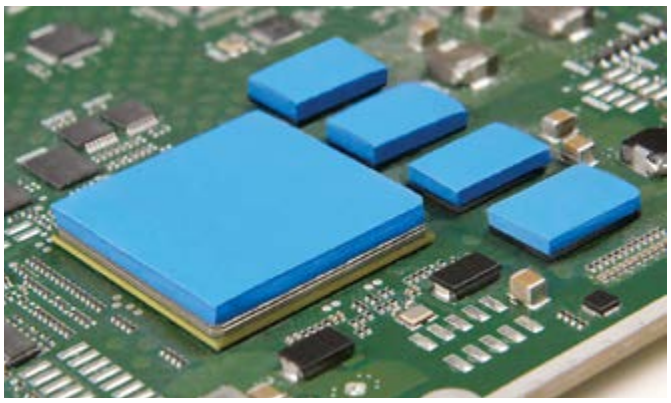
Exar Corporation announced an addition to its family of universal clock products. The XR81112 series offers output frequencies from 10MHz to 1.5GHz with ultra-low phase noise jitter of less than 200fs

that makes them ideal for demanding communications, audio/video, and industrial applications. The tiny 3x3mm QFN-12 packaged devices are the smallest on the market with this broad feature set.
The XR81112 clock synthesizer utilizes a flexible delta-sigma modulator and a very wide-ranging VCO in a PLL block that has been optimized to be extremely power efficient. With a core current consumption of just 20mA, these parts dissipate 60% less power than equivalent competitive devices, providing a compelling power efficiency benefit to system designers. The PLL can operate from either an input system clock or a crystal, and incorporates both an integer divider and a high-resolution (<1Hz) fractional divider for increased flexibility to generate any clock frequency. Additionally, up to four different frequency multiplier settings can be stored, allowing for different application configurations and providing BOM savings compared to multiple synthesizers. The XR81112 is configurable for LVCMOS, LVDS or LVPECL outputs.

http://www.exar.com

Highly Compliant Gap Filler Takes the Heat without Adding Stress

The Bergquist Company has combined high thermal conductivity with high conformability in its latest Gap Pad® HC 3.0 gap filler, creating a high-performance thermal material for applications where low assembly stress is a must.



Hard-working components such as ASICs and DSPs can now run cooler in electronic equipment such as telecom linecards and consumer products, using the new highly compliant Gap Pad HC 3.0 to eliminate insulating air gaps without placing excessive stress on the PCB or fragile component I/Os. Gap Pad HC 3.0 can also be inserted between electronic modules and heatsinks to maximise thermal dissipation. The gap filler is available in sheet form or as die-cut pads in thicknesses from 0.508mm to 3.175mm.
Gap Pad HC 3.0 achieves low thermal impedance at low pressures by combining a unique 3.0 W/m-K filler package and low-modulus resin. The material has shore hardness of 15, and thermal impedance as low as 0.57 °C-in^2/W at 10% deflection (1mm-thick sample in standard test fixture). As well as minimising assembly stress, high conformability also ensures excellent interfacing and wetting-out against a variety of surfaces including those with high roughness or topography.

www.bergquistcompany.eu

SAW Filters are Widely Used in Communication Systems

Aspen Electronics have brought Nanjing Electronic Devices Institute (NEDI) to the UK and European markets. NEDI have developed more than one thousand different types of SAW resonators and filters with excellent quality and high reliability. The ND series of Saw Filters, for example, are available in both leaded and surface mount configurations in packages such as TO39, F11 DCC6 and QCC8.

The wide range offers centre frequencies from 30MHz to 2.4GHz; Bandwidths of 0.02 to 60%; Insertion loss of between 2 and 35dB's; Amplitude ripple of 0.2 to 2.0db with corresponding Group delay ripple of 10 to 500ns.

The devices find applications in signal processing, frequency selection and control in audio-video, communication and remote control systems found in the Mobile Communication, Satellite Communication, Base Station, Security Systems and Data Transmission industries to name just a few.

In addition to a standard product portfolio NEDI are also able to accommodate custom designs to meet customers' specific needs. The company also has an aggressive programme of developing new products for existing and emerging markets. To that end Nanjing Electronic Devices Institute has excellent R&D facilities, highly skilled workers and cost-effective material sourcing and can be considered to be a leading supplier of SAW components in China. Production is carried out to the ISO 9001:2000 Quality System, for which the company has full qualification certification.

www.aspen-electronics.com

Current Sensor ICs Feature High Accuracy and Internal Isolation

The ACS722 and ACS723 current sensor ICs from Allegro MicroSystems Europe are high-accuracy devices featuring internal galvanic isolation, and are ideally suited to use in low-power applications incorporating high output voltage swings at low currents.

The devices are true bidirectional ±5 A or unidirectional 10 A sensor ICs which provide an economical and precise solution for AC or DC current sensing in non-automotive applications such as industrial, commercial, and communications systems. The compact package makes them ideal for applications where space is limited while also saving costs due to the reduced board area.

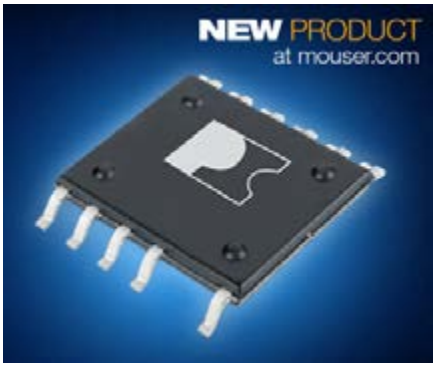
Typical applications include motor control, load detection and management, switched-mode power supplies, solar invertors and overcurrent fault protection.

Each of the new ICs consists of a precise, low-offset, linear Hall sensor circuit with a copper conduction path located near the surface of the die. Applied current flowing through the copper conduction path generates a magnetic field which is sensed by the integrated Hall device and converted into a proportional voltage. Device accuracy is optimised through the close proximity of the magnetic field to the Hall transducer.

www.allegromicro.com

LinkSwitch-HP Switcher ICs in Stock

Mouser Electronics is now stocking the LinkSwitch™-HP Family of Energy Efficient Off-Line Switchers from Power Integrations. These switching power supply ICs dramatically simplify power supply circuit designs by eliminating many common external components such as an optocoupler and secondary control circuit components. The new eSOP-12B K-package is a low profile surface mounted package for ultra-slim designs, allowing heat transfer to the PCB by the bottom pad and source pins.



The Power Integrations LinkSwitch-HP Family of Energy Efficient Off-Line Switchers, available from Mouser Electronics, offer high efficiency with fewer external components. Off-line power supplies improve circuit efficiency while reducing heat dissipation, providing better power supply performance compared to linear or switch mode power supplies.

These Power Integrations LinkSwitch™-HP Off-Line Switcher family of flyback power supply ICs incorporate a primary side regulated (PSR) controller and high-voltage power MOSFET on a single chip. This switching power supply family includes ICs optimized for constant voltage (CV) operation when operating at power ranges from 9 Watts to 90 Watts. The LinkSwitch-HP controller IC features ±5% CV accuracy, a selectable current limit, programmable latching or hysteretic over voltage protection, under voltage protection, thermal protection, improved overload power compensation over line, a fast AC reset, and a programmable shutdown delay time.

The switcher operates at 132 kHz which reduces the transformer and power supply size. An accurate programmable current limit maintains tight regulation over the output power while limiting limits overload power. Frequency jittering keeps electromagnetic interference (EMI) low, reducing EMI filter cost. A fully integrated soft-start minimizes start-up stress, which improves power supply reliability.

www.mouser.com

POWERING INDUSTRIAL

Intersil's power modules reduce design time, lower cost and save board space. These complete DC/DC solutions offer small form factor, high efficiency and advanced features such as digital control, current sharing and can cascade up to six modules for higher output power.

Analog Power Modules

Intersil's family of analog power modules provides users fully integrated DC/DC power solutions that combine the controller, power FETs, output inductor and compensation circuitry in a single rugged package. This minimizes the external component count, simplifies design and delivers best in class thermal performance.

ISL8225M / ISL8216M / ISL8240M

Digital Power Modules

Our expanding portfolio of digital power modules combines Intersil's industry-leading digital DC/DC technology with advanced IC packaging. Now you can get all the efficiency and telemetric data you expect from digital along with the design simplicity that comes with a fully integrated module.

ZL9101M / ISL8270M / ISL8271M

go.intersil.com/power-module.html

- Download Datasheet
- Read App Note
- Order Demo Board
- Watch Video

intersil™

intersil.com

See Intersil's leadership power technologies at **intersil.com/industrial**

Power Modules
Digital Power
Integrated FET Regulators
Switching Regulators
FPGA Power
Hot Plug
Voltage Monitors
Power Sequencers

New Range of Mixed-Signal PicoScopes

The PicoScope 3000D Series Mixed-Signal Oscilloscopes (MSOs) are ideal for engineers working on a diverse range of embedded systems. These compact USB-connected devices form a complete portable test system, with two or four analog channels and sixteen digital channels as well as a built-in arbitrary waveform generator.

The PicoScope 3000D Series offers a comprehensive suite of advanced features as standard, including math channels, automatic measurements with statistics, spectrum analysis and color persistence display mode. Also built in are advanced digital triggering with pulse width, window, dropout, channel logic, digital pattern and other qualifiers, mask limit testing and alarms. Serial decoding supports SPI, I2C, I2S, RS-232/UART, CAN, LIN and FlexRay protocols on up to 20 analog and digital channels, even with a mixture of protocols at the same time.

www.picotech.com

THE QUEEN'S AWARDS FOR ENTERPRISE: INTERNATIONAL TRADE 2014

The PicoScope 3000D Series MSOs are available with analog bandwidths from 60 MHz to 200 MHz. Maximum digital input frequency is 100 MHz, equivalent to a data rate of 200 Mb/s (5 ns pulse width) on each channel. All models come with a USB 3.0 interface and are fully compatible with USB 2.0, giving high performance and fast update rates with both port types. Like all PicoScopes, they display waveforms in a resizable window on your PC's screen, giving you an uncluttered space for multiple high-resolution analog and digital traces. It's easy to save, share and analyze waveforms, with all of your PC's networking, storage and processing facilities instantly available. The deep memory buffers of 128 to 512 megasamples, much larger than other scopes costing several times more, allow long captures even at fast real-time sampling rates of up to 1 gigasample per second. Hardware-accelerated data processing maintains smooth and rapid display updates even with very large capture sizes.

EMC Feed Through Capacitors

Wrexham-based, film capacitor manufacturer ICW has introduced a FT range of polypropylene capacitors developed specifically for EMC feed through filtering applications.

This range is available in four styles with rated voltages from 63Vdc to 1500Vdc; up to 660Vac and testing to Y class voltage withstand requirements.

Operating with currents from 5A to 600A and with connections from M3 to M20, ICW is also able to offer customers sub-assembly and full filter assembly at highly competitive rates.

David Thomson, managing director of ICW, said: “Our extensive EMC feed through capacitor ranges demonstrate ICW’s ability to provide solutions to the power electronics market. With capabilities extending from DC link, pulsed power, resonant circuits to EMC filtering, ICW is able to offer a complete film capacitor solution to power electronics designers.”

www.icwltd.co.uk

Advertising Index

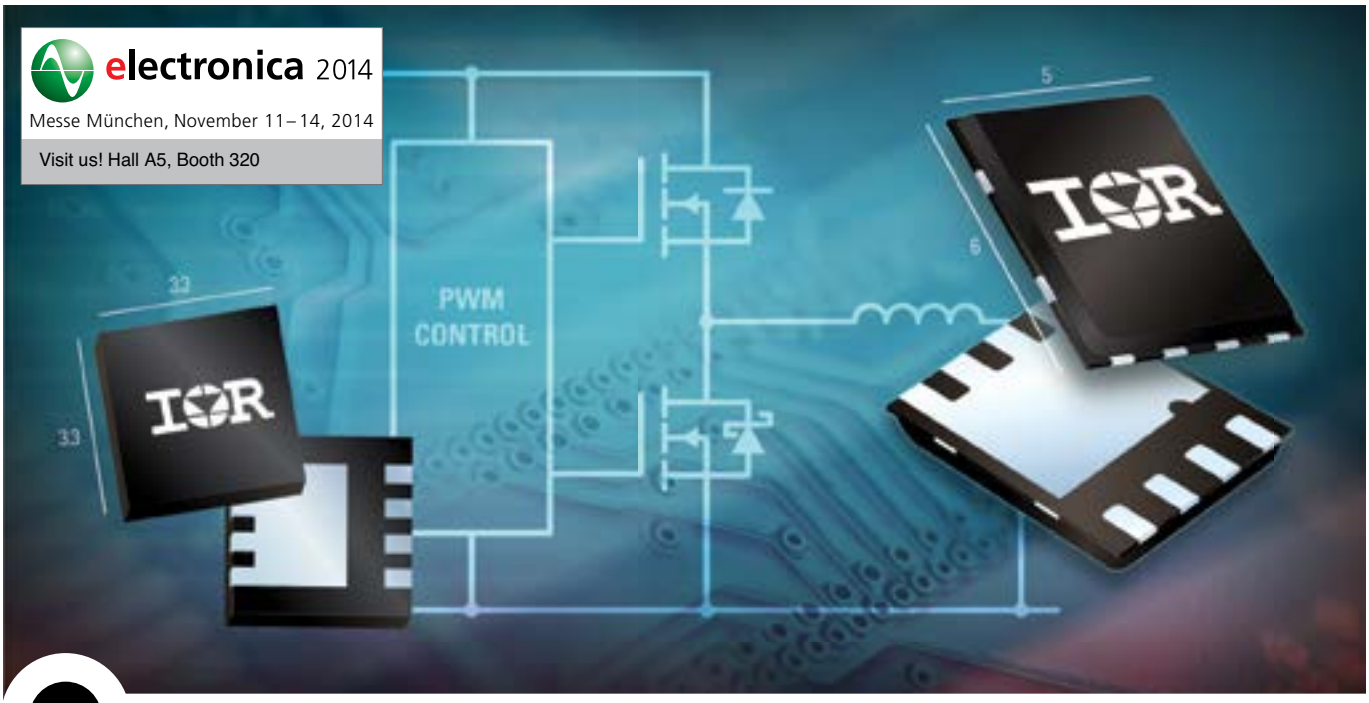
HiPak. Hot applications require innovative solutions.

Flicker from steel smelters is compensated with multi-level voltage source SVC (Static VAR compensation) taking advantage of ABB's innovative HiPak IGBT modules, eg the new 3,300 volt 500 ampere dual module.
Demanding high-power applications such as traction inverters, medium voltage drives, wind turbines, HVDC and FACTS benefit from the high reliability of ABB's HiPak modules.
ABB's family of HiPak modules are available from 1,700 to 6,500 volt as single IGBT, dual / phase-leg IGBT, chopper and dual diodes. All modules feature low losses combined with soft-switching performance and record-breaking Safe Operating Area (SOA).
For more information please contact us or visit our website:
www.abb.com/semiconductors

ABB Switzerland Ltd. / ABB s.r.o.
www.abb.com/semiconductors
abbsem@ch.abb.com
Tel.: +41 58 586 1419

Power and productivity
for a better world™

ABB



25V *FastIRFET™* Power MOSFETs

Benchmark performance with best in-class R*Q figure of merit

Specifications:

Package	Part Number	I_D	$R_{DS(on)}$ typical / max		Q_G typical @4.5V (nC)	Q_{GD} typical @4.5V (nC)
			@10V (mΩ)	@4.5V (mΩ)		
PQFN 5 x 6	IRFH4201	100A	0.70 / 0.95	.97 / 1.25	46	16
	IRFH4210D (FETKY)		0.85 / 1.10	1.10 / 1.35	36	13
	IRFH4210		0.85 / 1.10	1.10 / 1.35	37	13.2
	IRFH4213D (FETKY)		1.10 / 1.35	1.5 / 1.9	26	9.2
	IRFH4213		1.10 / 1.35	1.5 / 1.9	25	9.4
	IRFH4234		3.5 / 4.6	5.6 / 7.3	8.2	3.1
PQFN 3.3 x 3.3	IRFHM4226	40A	1.7 / 2.2	2.6 / 3.3	16	5.8
	IRFHM4231		2.7/3.4	3.7/4.6	9.7	3.6
	IRFHM4234		3.5 / 4.4	5.6 / 7.1	8.2	3.1

IR's *FastIRFET™* devices work with any controller or driver to offer design flexibility while delivering higher current, efficiency and frequency capability in an industry standard footprint.

Applications:

- Advanced telecom equipment
- Netcom equipment
- Servers
- Graphic cards
- Desktop, ultrabook and notebook computers

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

*FastIRFET™ is a trademark of International Rectifier

International
IOR Rectifier
THE POWER MANAGEMENT LEADER