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Electronics in Motion and Conversion

March 2013

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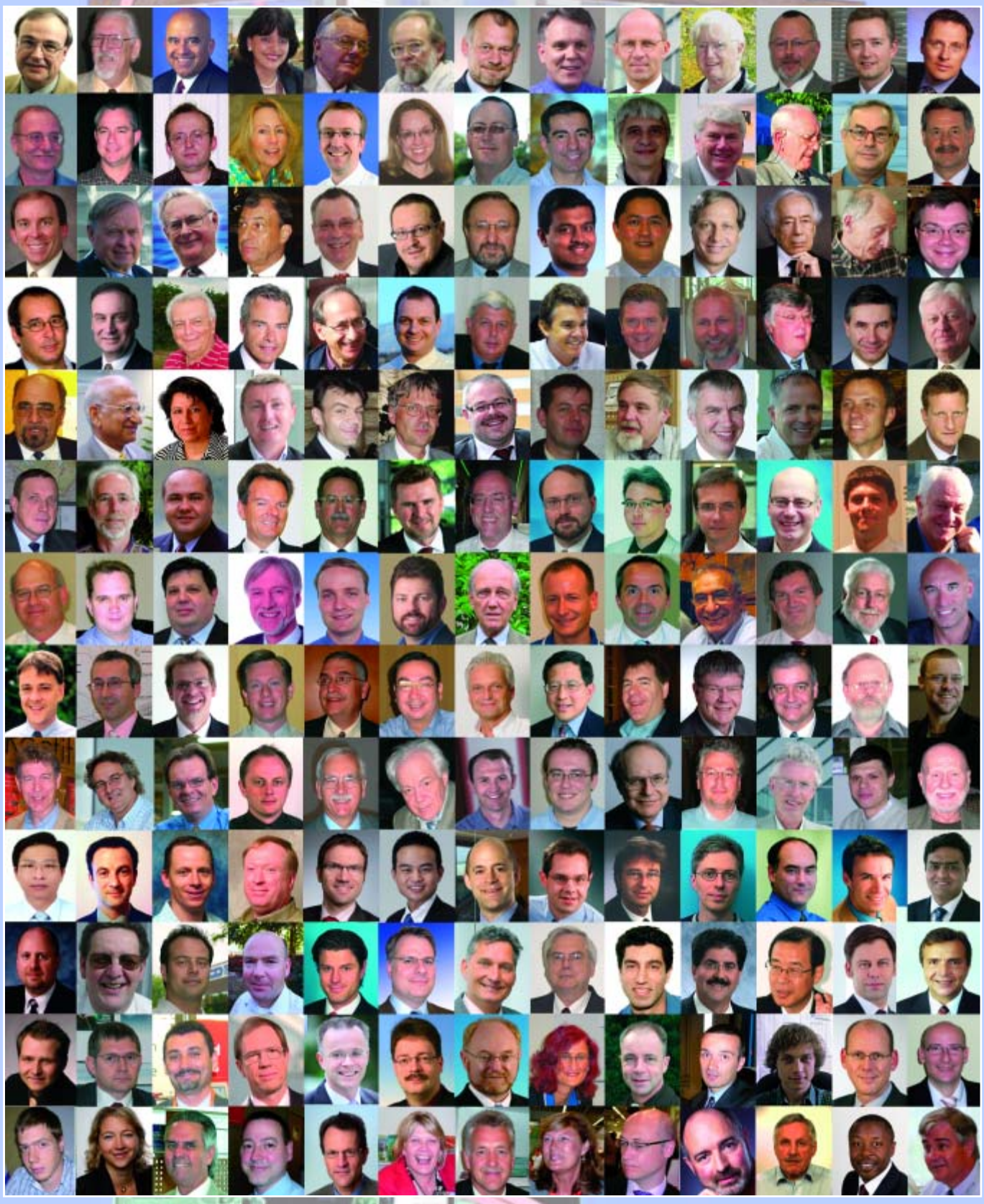

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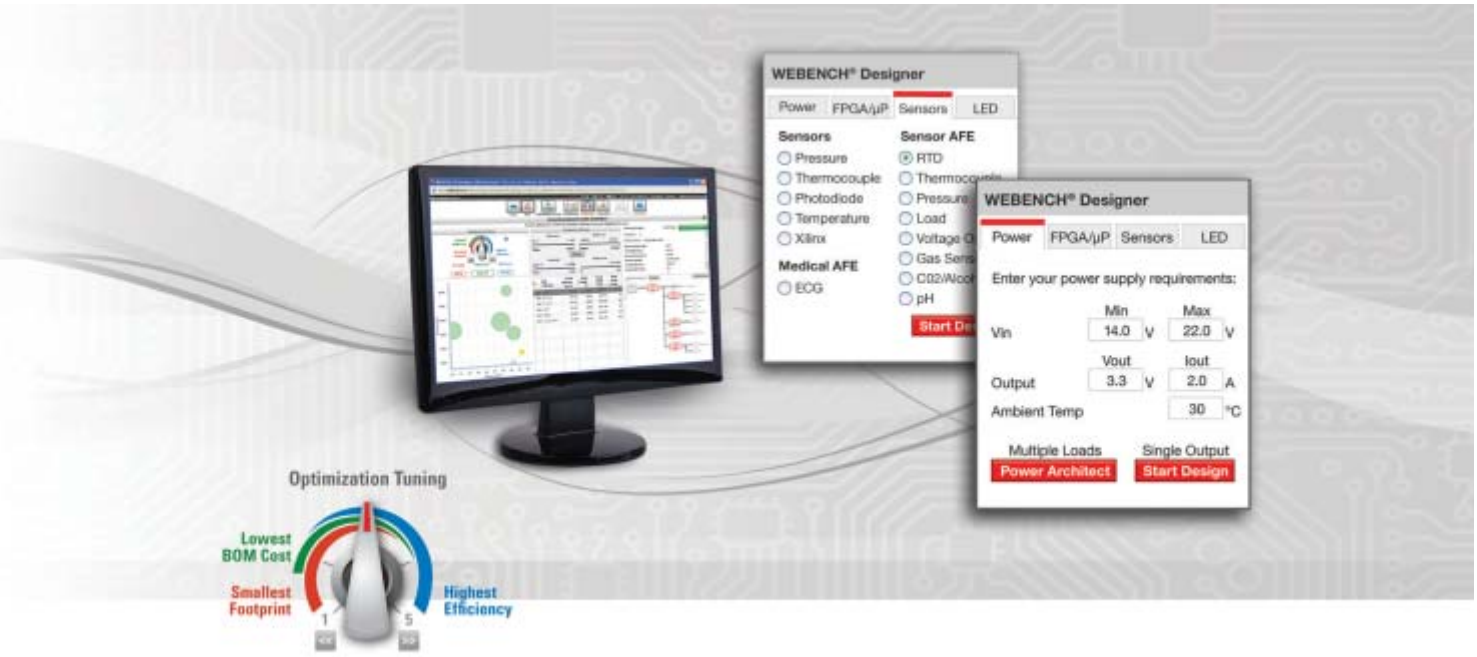

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Events

Embedded World 2013,
Nuremberg, Germany, February 26th - 28th
www.embedded-world.eu

New Energy 2013, Husum, Germany,
March 21st-24th www.new-energy.de

EMC 2013, Stuttgart, Germany
March.5th – 7th www.mesago.de/de/EMV

APEC 2013 Long Beach CA,
USA, March 17th - 21st www.apec-conf.org

SMT/Hybrid 2013, Nuremberg, Germany,
April 16th-18th www.mesago.de/de/SMT

PCIM Europe 2013,
Nuremberg, Germany, May 14th -16th
www.mesago.de/de/PCIM/home.htm

Sensor + Test 2013, Nuremberg, Germany,
May 14th -16th www.sensor-test.de

Start the Year in Long Beach!

The first international conference for power electronics that we attend each year is in Long Beach. A few days of hard work in nice weather is always a pleasure. California is a great place for sunny warm days. For about 10 years now the APEC has been in Long Beach, while advanced technology pushes on: the digital control of power is now represented in standard products, and new semiconductor materials are now available for efficient designs.

Time moves faster as we get older, and design requirements are more demanding. But now we have so many channels available for instant communication. So many, in fact, that it is necessary to carefully differentiate subjects and train ourselves to focus on those of value. As a young boy, and later starting my career as an engineer, I learned to store up ideas and thoughts until I could have a good discussion with colleagues to work out a solution together. Today, everybody's thoughts are published instantly. Does this speed things up or actually demand more time? It's hard to say.

Listening to design engineers, I hear that the cycle still takes time, and turn-around is still measured in man-years of effort. Modern simulation helps to reduce this and we are all more productive. Engineers strive to get information as they need it, and search engines on the internet have become a great tool - we now "google" a subject to get focused information. But many websites are sales vehicles and an endless number of e-newsletters are forwarded too frequently. Does this help with innovation and design? Do engineers have time to read and watch all those videos? Does the design progress stop while we're watching educational videos created by marketing departments? Creatively designed web pages may not always deliver much content of importance.

An engineer reading a book or magazine has a much higher speed of comprehension. Skimming known aspects while reading is fast, and the interesting diagram stays on his desk. This kind of learning was popular during my time as a student and when I speak with young people today, it seems that hasn't changed much except that now books and magazines are available electronically.

Today, it is necessary to select the right platforms, ones that can be searched for information supplied for engineering. PowerGuru is one of these web sites; an indexed, searchable database of new technology and helpful educational articles for engineers and students. Like the print-copies of my magazine, you will find all articles published in my magazine as HTML documents and searchable with keywords. Try it at www.powerguru.com.

Communication is the way to progress. We delivered twelve issues last year and will continue this year, each month, on time, every time. Last year approached 900 pages and 132 technical articles, a continuous improvement since I started my publication. This year, with my March issue, we have 23 technical articles amongst 164 pages, to date. As a media partner, Bodo's Power Systems is internationally positioned. If you speak the language, or just want to take to look, don't miss our Chinese version: www.bodospowerchina.com.

My Green Power Tip for March:
Visit warm places when it's winter where you live. You can turn down your furnace and save on heating. Long Beach is such a place as California has mostly warm weather.

See you at APEC in Long Beach

Best Regards,

Future precision.
Future performance.
Now available.

CAS-CASR-CKSR

The transducers of tomorrow. LEM creates them today. Unbeatable in size, they are also adaptable and adjustable. Not to mention extremely precise. After all, they have been created to achieve great performance not only today – but as far into the future as you can imagine.

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www.lem.com

At the heart of power electronics.

LEM®

New Top Management Structure at SEMIKRON Group

Company gets ready for the future

Semikron Group is being restructured to become more responsive to global developments. These developments refer to market flexibility requirements as well as to corporate organisation structures.

Photo: from left: Harald Jäger, Peter Frey and Thomas Dippold

In the course of these restructuring activities, Harald Jäger has been appointed a new member of the board. He joins the top management team consisting of the present directors of many years, Peter Frey (Sales) and Thomas Dippold (Corporate Finance). Harald Jäger has held various management positions throughout the company for almost 20 years. He will be responsible for production and engineering.

Dirk Heidenreich will retire from operational management, but will continue to take on other responsibilities for the company. He will remain the Managing Director of the Semikron owner families' non-operative holding company, Semikron International Dr. Fritz Martin GmbH & Co KG. "After 25 years of being responsible for operative business, the time has come for me to lay operational leadership in new hands. I will focus on the company's strategic alignment in the future, and will work as a consultant to the new management team", says Dirk Heidenreich.

Dr. Thomas Stockmeier, CTO at SEMIKRON, will leave the company on February 15, 2013, and has opted to take on new challenges outside the power electronics industry.

www.semikron.com

International Rectifier Mourns the Passing of Its Founder and Former Chairman and CEO, Eric Lidow

International Rectifier announced with deep regret that Eric Lidow passed away on January 18, 2013. Mr. Lidow co-founded IR in 1947 and served as Chairman of the company's board of directors until his retirement in May 2008.

Over the course of more than six decades, Mr. Lidow transformed International Rectifier from a start-up company that developed selenium photoelectric cells and selenium rectifiers into a world leader in power management technology that today produces thousands of innovative analog, digital, and mixed signal integrated circuits and other advanced power management technologies

and products. Mr. Lidow served as the Company's Chairman and Chief Executive Officer until 1995, after which time he assumed the position of Executive Chairman.

"Eric was a highly respected pioneer in the power semiconductor industry", stated President and Chief Executive Officer, Oleg Khaykin. "The development and growth of International Rectifier was a great source of pride to him and as we continue to grow as a Company, the legacy of Eric's leadership during his 60 years at IR will remain. Everyone at International Rectifier wishes to send their heartfelt condolences to Eric's family at this time of great sorrow."

www.irf.com

Agreement Covers Global Distribution of Cree's Silicon Carbide Power Products

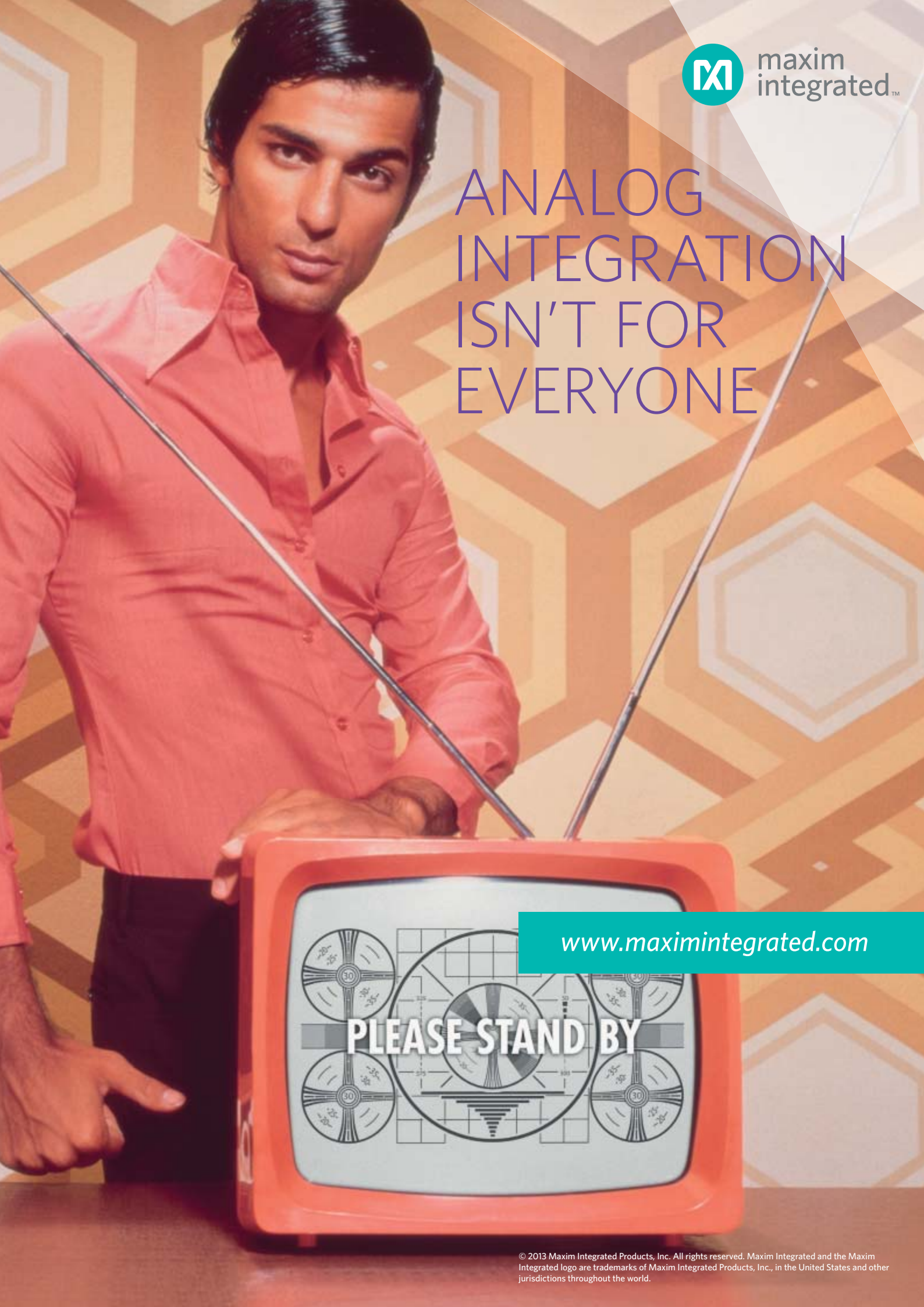
Richardson RFPD, Inc. announced it has completed an agreement to distribute Silicon Carbide power products from Cree, Inc. ("Cree"), a U.S.-based manufacturer that specializes in semiconductor products for power and radio-frequency (RF) applications, lighting-class LEDs and LED lighting solutions. Under the agreement, Richardson RFPD will only distribute Cree's SiC Schotty diodes, MOSFETs and power modules worldwide.

"Cree is recognized globally as a leader in silicon carbide technology," stated Chris Marshall, vice president, Richardson RFPD. "Adding their capabilities to our energy and power products portfolio further solidifies our focus to support our customers who are seeking the most efficient solutions for their high power applications."

"Cree Power is pleased to welcome Richardson as a worldwide distribution partner," stated Paul Kierstead, director of marketing, Cree. "Combining Cree Power's revolutionary Silicon Carbide power MOSFETs and diodes with Richardson RFPD's proven power design-in capability helps assure our customers of the most energy efficient, smallest, lightest and least costly power system solutions."

For technical information or to purchase Cree products, please visit the Cree storefront on the Richardson RFPD website. For information on Richardson RFPD's entire portfolio of Silicon Carbide (SiC) products, please visit the Silicon Carbide (SiC) Technology page on the Richardson RFPD website.

www.richardsonrfpd.com



Industry Session on Nanotechnology at APEC 2013

The Power Sources Manufacturers Association Nanotechnology Committee is sponsoring an Industry Session at APEC 2013 titled “Nanotechnology Applications in Power Electronics.” Taking place on Thursday morning, March 21, 2013, from 8:30 AM to 11:30 AM at the Long Beach Convention Center in Long Beach, CA, the session will provide a broad overview of current nanotechnology applications, materials and opportunities, with particular emphasis on power electronics.

Nanotechnology is already being applied in semiconductors, components, packaging and power storage designs. PSMA’s Industry Session is geared to attendees who need to anticipate and identify potential opportunities for this emerging technology. The six speakers to be featured at the session are experts from industry, research and government whose expertise enables them to provide an overview of the current applications for nanotechnology and to provide insights on market opportunities.

Co-chairs of the session are Chuck Mullett and Dr. Anthony Laviano of NANOWorld®.

www.psma.com

Another Step Toward the Smart Community

Toshiba Corporation announced that it has acquired privately-held Consert Inc., an intelligent energy management company that converts electric consumption in homes and small businesses into cost-effective clean sources of capacity and energy reserves for utilities. The purchase makes Consert a Toshiba subsidiary that will enhance Toshiba Group's smart community business in the United States. Operations in North America will be integrated with Landis+Gyr, the leading global provider of integrated energy management products and a Toshiba Group company.

Consert, through its Virtual Peak Plant™ (VPP) offering, is able to deliver a fully-integrated, intelligent load management solution for utilities. VPP provides improved forecasting and capacity management, real-time outage management information, remote service connections and significantly improves customer service as well as end-consumer communications and energy efficiency.

www.toshiba.co.jp/index.htm

www.landisgyr.com

www.consert.com

Announcement of Representative for Russia

UltraVolt announced its representative for Russia, Betronik Ltd. Betronik will now offer UltraVolt standard products and services including high-voltage modules, high-voltage systems, and HV test fixtures in Russia, Kazakhstan, and Belarus.

Betronik Ltd. is a supplier and distributor of electronic components including diodes, capacitors, and resistors. With considerable experience in both the electronics field and with UltraVolt’s power supplies, Betronik offers expert technical assistance to meet customers’ individual high-voltage requirements. Many of UltraVolt’s customers in the Russian marketplace work with applications including test equipment, x-ray, photo multiplier tubes, and lasers. UltraVolt and Betronik will work collaboratively in order to meet customers’ specific application requirements.

www.ultravolt.com

Global Distribution Agreement

CUI Inc, announced that it has signed a global distribution agreement with Future Electronics, a world class leader and innovator in the distribution and marketing of electronic components. This agreement allows Future Electronics to leverage their experience and resources to launch CUI's product portfolio to a global market and a diverse customer base. In selecting Future Electronics as a global distribution partner, CUI noted the strength of Future Electronics' demand creation programs and its robust field support resources which will add greater reach for its Novum® Advanced Power product line as well as its broad portfolio of standard power supplies and board level components.

Under the terms of the agreement, Future Electronics will now begin a phased rollout of products from CUI's Power and Components groups with stock available immediately for many items.

"We are very pleased to be launching the CUI franchise," said Jodie Metsos, Vice President of Corporate Product Marketing for Future Electronics. "Their line of power supplies and board level components has had a tremendous amount of interest from our sales and engineering teams and most importantly, our customers. We see a very positive outlook for the Future/CUI partnership."

"As a worldwide leader in the distribution industry Future has long distinguished itself as a first class organization in this space," said Matt McKenzie, President of CUI. "We believe the core strengths of our companies align very well, and we look forward to greatly expanding our market reach through this partnership."

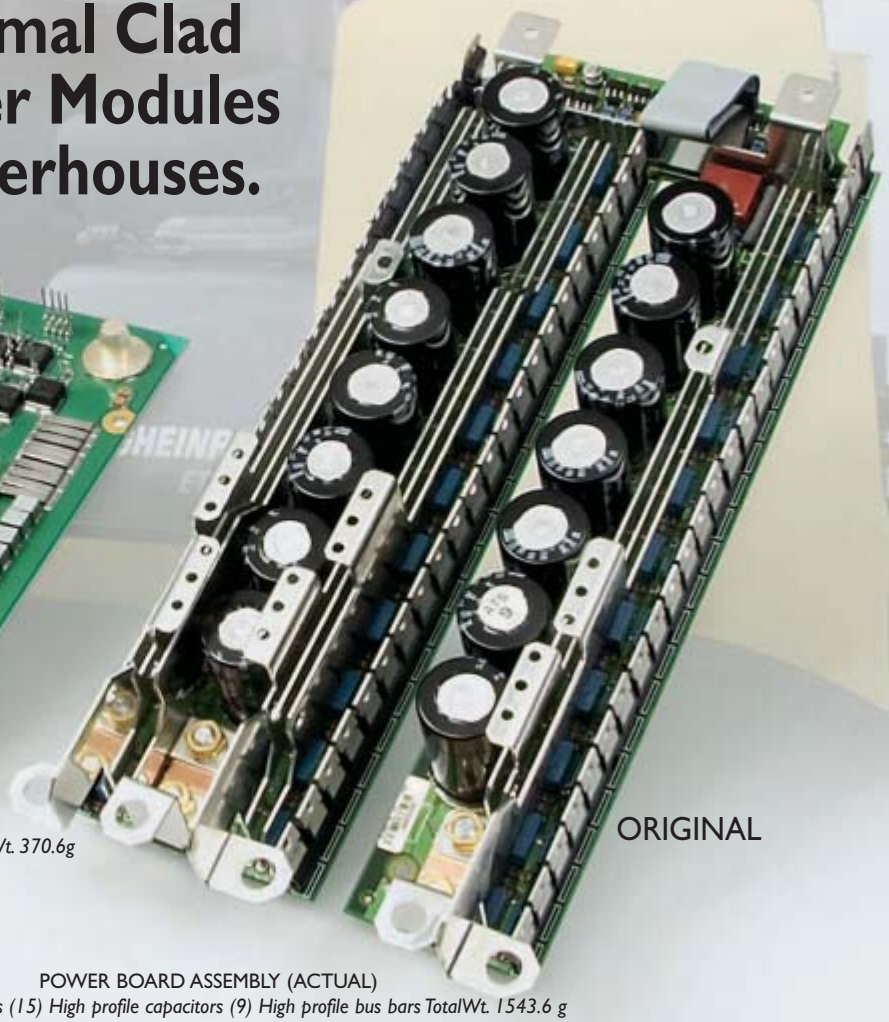
www.cui.com

www.FutureElectronics.com

Bergquist Thermal Clad Turns Big Power Modules Into Small Powerhouses.

NEW

POWER BOARD ASSEMBLY (ACTUAL)
(48) FETs (9) Low profile capacitors (5) Low profile bus bars TotalWt. 370.6g



ORIGINAL

POWER BOARD ASSEMBLY (ACTUAL)
(66) Thru-hole FETs (15) High profile capacitors (9) High profile bus bars TotalWt. 1543.6 g

With Thermal Clad,® Jungheinrich Forklift Converted All The Power Into Half The Space.

Bergquist Thermal Solutions let you increase power capacity without adding size.

Jungheinrich, a leading European forklift manufacturer, needed to reduce their motor control size and cost while maintaining power output levels. Thermal Clad insulated metal substrates (IMS®) allowed their engineers to replace high profile thru-hole FETs, capacitors, and bus bars with fewer low profile, surface mount components.
This sleek design reduced package size by over 50%, all without sacrificing a single watt of power. Thermal Clad's unique dielectric coating dissipates heat more efficiently than FR-4 or other PCBs – ideal for high watt-density applications such as motor control.

"We needed to reduce our processing cost, it was too labor intensive. With Thermal Clad we were able to automate, dissipate the heat better, and reduce our size by at least 50%."
Stephan Taube
Electronic Development Engineer of Jungheinrich Forklifts

Automated assembly lowers manufacturing costs.

Cooling with Thermal Clad IMS eliminates the need for heat sinks, clips, fans and other discrete components that increase package size and require costly manual assembly. Now, using surface mount technology, Jungheinrich was able to automate much of the assembly process thus reducing cycle times and long-term manufacturing costs.

Get your FREE Sample.

To qualify for a FREE Thermal Clad Select Sample, please visit our web site or call today.

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Semikron Acquire all Shares in Electric and Hybrid Car Developer Compact Dynamics

After acquiring the majority of Compact Dynamics, the development specialist for electric and hybrid cars, in May 2010, Semikron International GmbH now have acquired the remaining 30 percent of shares that were so far held by the three Managing Directors, Maximilian Eck, Bernhard Hoffmann and Dr. Andreas Gründl. All three of them will leave Compact Dynamics GmbH on February 28, 2013, as scheduled, and will remain active consultants to the company.

At the same time, Semikron International GmbH have appointed, with immediate effect, Oliver Blamberger the new General Manager of Compact Dynamics. As of March 01, 2013, Mr. Blamberger will be the solely responsible business manager for Compact Dynamic, while closey cooperating with the mother company.

"I am proud to be holding a key position within such a highly innovative and exciting field of technology", says Blamberger. "We are delighted to have found in Mr. Blamberger an experienced business leader to lead our innovative team into the future", said former business owners, Maximilian Eck, Bernhard Hoffmann and Dr. Andreas Gründl.

www.semikron.com

World Summit for Small Wind WSSW2013 Program

For the fourth time, WWEA, in cooperation with New Energy Husum, will hold the World Summit for Small Wind WSSW2013, from 21-22 March 2013. The WSSW2013 takes place on the occasion of the New Energy Fair Husum, the international trade fair for small wind and decentralized renewable energy.

An International Advisory Committee comprising experts from Australia, China, Ethiopia, Germany, and Mexico put together a high-quality programme with leading small wind experts from around the world: Speakers from Austria, Bangladesh, China, Denmark, Ethiopia, Germany, India, Korea, Poland, Sweden, Turkey, and USA will present latest achievements and challenges of the small wind sector. Also the International Renewable Energy Agency IRENA will present its activities in the field of small wind turbines.

The first day of the WSSW2013 will be dedicated to standards and certification, one of the most challenging topics for the small wind industry. The presentations will cover the current status of small wind certification and will be followed by an interactive panel discussion. The first day will also deal with technology and industrial strategies as well as hybrid systems.

On the second day, speakers will present the most important markets for small wind and discuss the related policies and regulations which enable the rapid growth of the small wind sector. Presentations will cover markets in industrialized as well as in developing and emerging countries, for grid-connected as well as for off grid applications. The second day will also conclude with a panel discussion which will involve the audience.

www.new-energy.de/en/small_wind_turbines.html

What is Europe's Industry Strategic Direction?

Top semiconductor executives from leading device, equipment and materials manufacturer as well as representatives from the European Union will debate the strategic direction of Europe's semiconductor landscape at the Industry Strategy Symposium Europe which took place from February 24-26 near Milano. ISS 2013 has focused on three key European challenges:

Will Europe's semiconductor industry find a common strategy to keep pace with other regions with regard to "More Moore" and "More than Moore" manufacturing?

What are the critical technologies, new materials and productivity gains needed to keep the industry viable?

What are the market drivers in 2013 (and beyond) and what will the semiconductor landscape look like?

www.semi.org/europe

www.intersil.com

Award Ceremony Held again at PCIM 2013 in Nuremberg

For the second time, the Semikron foundation and the ECPE European Center for Power Electronics e.V. will issue the “Semikron Innovation Award” and the “Semikron Young Professional Award“ at this year‘s PCIM Europe in Nuremberg. Applications must be submitted by March 31. The award ceremonies will be held at this year’s power electronics show, PCIM, in Nuremberg (May 14-16, 2013). Venue and time will be announced soon.

The awards are presented once a year during the “PCIM Europe” power electronics show in Nuremberg, Germany. The winners are selected in cooperation with the ECPE European Centre for Power Electronics. The top award is endowed with 10,000 Euro. There is also the “Young Professional Award” for power electronics, endowed with 3,000 Euro, which is awarded to young professionals less than 30 years of age. Apart from the prize money, the criteria for the Young Professional Award are the same as for the innovation award. Both self-submitted applications and suggestions by third parties are welcome.

The winners are selected by an independent jury of at least five people consisting of renowned representatives from research and industry. Applications can be submitted by individuals and engineering teams. In their applications, applicants need to outline the innovation they created and its expected social benefit.

www.semikron.com

Würth Elektronik Partnering with RS Components

The electronics company RS Components has created a printed circuit board design tool - the new version of DesignSpark PCS 4.0 - that offers developers comprehensive support from the development phase to the ordering the printed circuit boards. Würth Elektronik's online shop WEdirekt is also linked-up with the new version of the software.

The software version from RS Components includes many practical functions, such as a component library (ModelSource) and a PCB assembly service. RS Components chose to work with Würth Elecrtnonik's online shop WEdirekt as one of its partners for the integrated offer feature (PCB Quote).

PCB Quote generates a cost overview based on standard PCBs and the specifications used. The designer can then immediately select a supplier - such as WEdirekt - and continue working based on this direct offer. Once the design for the PCB is finished, the order goes straight to the supplier and enters production.

"We are pleased with this partnership", emphasises Markus Osterberger of Würth Elektronik. "We are convinced that our price-performance package at WEdirekt will attract many DesignSpark users and that we will be able to attract new customers with our know-how and abilities."

www.we-online.com

EMV 2013 – focus on e-mobility

The EMV 2013, the most important exhibition on electromagnetic compatibility in Europe, focuses on e-mobility from 5 to 7 March 2013 in Stuttgart.

The „e-mobility special 2013“, organized by EMC Test NRW, is a highlight of the EMV. The special exhibition area offers an information and discussion platform, which attracts visitors by impulse speeches and exhibits.

The accompanying workshops with topics like “EMV und Sicherheit in der Elektromobiliät – aktuelle Anforderungen und Trends” (in German) or “EMV-Anforderungen an Hochvoltsysteme in Elektro- und Hybridfahrzeugen” (in German) focus on e-mobility.

Prof. Dr. Gernot Spiegelberg, head of e-mobility Siemens Corporate Technology, will give a lecture on Wednesday 06 March from 12.30 am to 2:30 pm about “Zukunft der Mobilität – Smart eCars mit Smart Traffic in Smart Grids” (in German). The plenary lecture is free of charge.

In addition to the focus on e-mobility, the EMV 2013 informs about the latest technologies and trends in all areas of electromagnetic compatibility. The accompanying 39 workshops provide further qualification at the highest level.

www.e-emc.com

Test to Save

The WT310 and WT300 allows high accuracy power measurement

With the growing awareness of the need to save energy, protect the environment, prevent power shortages, and the like, products must be designed to save energy. To quickly release products with excellent power performance, product development and manufacturing divisions must improve their operational efficiency. Toward this end, they need power meters with high measurement efficiency.

By Marisa Robles Consée, Corresponding Editor; Bodo's Power Systems

In recent years, the demand for energy-efficient machinery and equipment designed to address global environmental problems and to effectively utilize energy resources has been increasing. Yokogawa Meters&Instruments claims to meet the demands of the high-accuracy power measurement market with the recently developed WT310 and WT300 series of digital power meters.

"These meters are useful in reducing the power consumed by electrical and electronic instruments, and are suitable for use in applications ranging from R&D to production", states Terry Marrinan, Vice President of Yokogawa, referring to an IEA study (International Energy Agency). Between 5 and 15 percent of residential electricity used in the OECD countries is attributed to standby power consumption.

According to the IEA this is the equivalent of about 240 million tonnes of CO_2 every year. By 2020 it is expected that approximately 4.6 billion products will feature a standby option, contributing around 50 TWh of electricity consumption per year. "This amount is equivalent to the total electricity consumption of a country like Greece or Portugal", he says. That may be the reason why IEA has launched a 1 W standby initiative and is expected to decrease this threshold to 0.5 W by 2013. In fact, if the power consumption is between 0.5 W and 1.0 W then it is estimated that electricity consumption in standby/off mode in 2020 will be about 15 TWh. "Estimated to save around 35TWh of electricity consumption, this means a total electricity consumption of Denmark.

The WT310 and WT330 series digital power meters are the successors to the established WT210 and WT230 series, of which about 50,000 units have been sold since their launch in 2002. By offering the WT310 and WT330 series, enhanced with various new functions that are supposed to satisfy the latest market needs, Yokogawa aims to capture a larger share of this market. "With the WT300 series digital power meters we have developed the 5th generation of Yokogawa's recognized high performance low cost products which are easy to use, cost effective and accurate for a wide range of applications in production, testing, evaluation and R&D", Mr. Marrinan explains. They are suited for standby-power measurements, Energy Star, and IEC62301 testing, Battery Charger and other low level power measurements.

Product highlights

The two product series will have a total off mode: The WT310 with one input element and a maximum input current of 20 A, the WT310HC (1 input element / max. input current of 40 A), the WT332 with two input elements and a maximum input current of 20A and the WT333 with three input elements and a maximum input current of 20A.

The WT 300 series features a measurement accuracy of 0.1 % of reading and a DC measurement of 0.5 Hz to 100 kHz frequency range. It measures all AC and DC parameters. Ordinary power meters need to switch measurement modes depending on what is being measured, from voltage, current, and power to items such as integral power consumption and harmonics analysis that require calculation. The WT310 and WT330 series can measure all these in just a single measurement mode. Moreover, the short measurement interval of just 100 ms improves measurement efficiency. The WT300 series allows for low current measurements down to 50 mA (WT310 only) and high current measurements up to 40 A RMS (WT310HC only).

Figure 1: The WT300 series digital power meters are Yokogawa's fifth generation of power meters

A nice feature is the automatic range switching during integral power consumption measurement: Usually on two power meters are required for that kind of measurement, one for higher loads and the other for lower loads. The automatic function enables a single meter to continuously measure both load ranges. An additional feature of this function is range skipping. Rather than changing one step at a time, the device can change directly to the target range. The WT310 and WT330 series thus reduce switching time, improving both operational efficiency and measurement accuracy.

At last, the auto ranging function is available in selected ranges. It is used to select or change the range automatically in specific ranges. This results in shorter range changing times, allowing more quick and efficient testing. Typically, when power meters operate in an integra-

tion mode to measure power consumption and standby power, the measuring ranges need to be fixed. However, if the input level exceeds the maximum of the selected range, the test will need to be repeated. The WT300 Series has a high speed automatic ranging capability in integration mode, which removes the need to repeat any test.

Bundled together with the WT310 and WT330 series is WT Viewer Free Plus, a PC utility program that can be used to configure the instrument and to display and record measurement data. This includes a communication function that automatically searches for instruments that are connected to the PC.

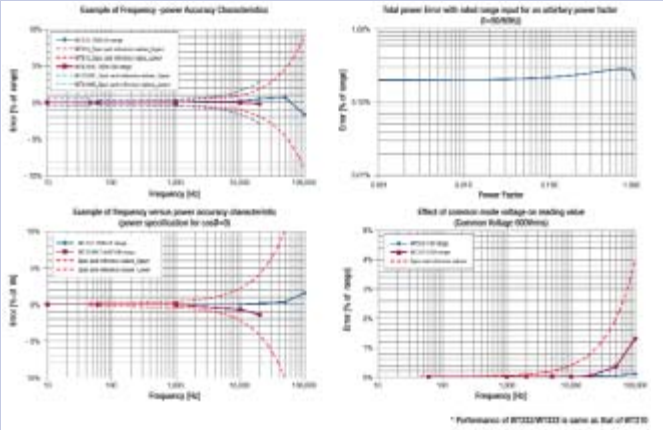


Figure 2: Example of basic characteristics

Major Target Markets

Digital power meters are used in the electronics and mechatronics fields to measure the power consumption of home appliances, office equipment, industrial machines, hybrid/electric vehicles and other battery-driven equipment, solar power/wind power generation related devices, and so on. They are useful in product development, performance testing, and quality control.

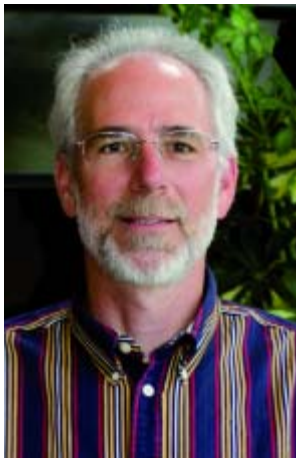
With the WT300 series Yokogawa addresses manufacturers of lights and home appliances such as TVs, HDD recorders, air conditioners, and refrigerators as well as f of office equipment such as PCs, printers, and multi-use machines, of devices, batteries, and chargers used by hybrid, plug-in hybrid, and electric vehicles as well as manufacturers of motors and other types of industrial equipment. The digital power meters are also suitable for manufacturers of equipment used in photovoltaic, wind, and other types of renewable power generation systems.

www.tmi.yokogawa.com

Easing the Conversion to Digital Power

The benefits of digital power are well documented, with countless technical articles and analyst reports filling an array of engineering publications. The problems it solves are recognized by both large and small OEMs from the medical, industrial, automotive and almost every other market sector. But, there are barriers to the wide-scale acceptance of digital power and here we look at recent developments that will lead to its greater adoption.

By Bruce Rose, Technical Marketing Manager, CUI Inc.



We live in an increasingly digital world, but there are some functions that resist moving out of the analog domain. In some cases analog may still be the best alternative – such as handling some real-world sensor inputs, or driving certain outputs to physical devices. But for the majority of functions, a digital solution does exist, and offers many benefits, but has yet to be adopted by a majority of engineers. And digital power is definitely in this latter class, perceived as a step too far for many engineers and project teams.

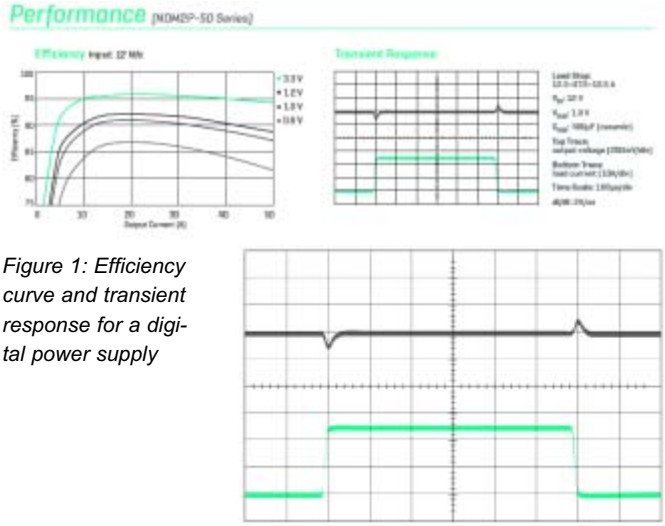


Figure 1: Efficiency curve and transient response for a digital power supply

Power supply design has traditionally been the province of analog experts, with recent technologies and circuit trends placing increased demands on their skills. One of the most challenging functions is point-of-load regulation, for delivering supply current to advanced microprocessors and FPGAs. These parts, with their internal clock frequencies of hundreds of MHz or several GHz; and their power dissipation requirements, means the supply must react properly in the face of step-changes in load of tens of amps, on a nanosecond timescale, while maintaining, for example, 1V output to a fine tolerance. This demands a very wide bandwidth in the regulator's control loop; the function can equally well be thought of as a wide-band amplifier that is set to a fixed-DC-level output.

To achieve this, an analog designer would contrive high gain at DC, and apply standard control-loop techniques to place poles and zeros in the loop's response so that it responds to step-changes in load rapidly, but without "ringing", and remains stable under all load conditions. They might analyze their circuit from first principles to determine its gain/phase response profile; or they might measure it with a network analyzer; or in less demanding cases they might reach a solution empirically. All are classic analog-design territory. All of these analog approaches are based upon a fixed, linear control loop topology.

The digital approach

Conversely, the digital approach uses analog-to-digital converters, which digitize the output voltage, and a microcontroller core that runs software algorithms to implement adaptable digital control loop schemes. The digital control loop then generates signals to drive pulse-width-modulated (PWM) outputs to control the power switches, typically MOSFETs.

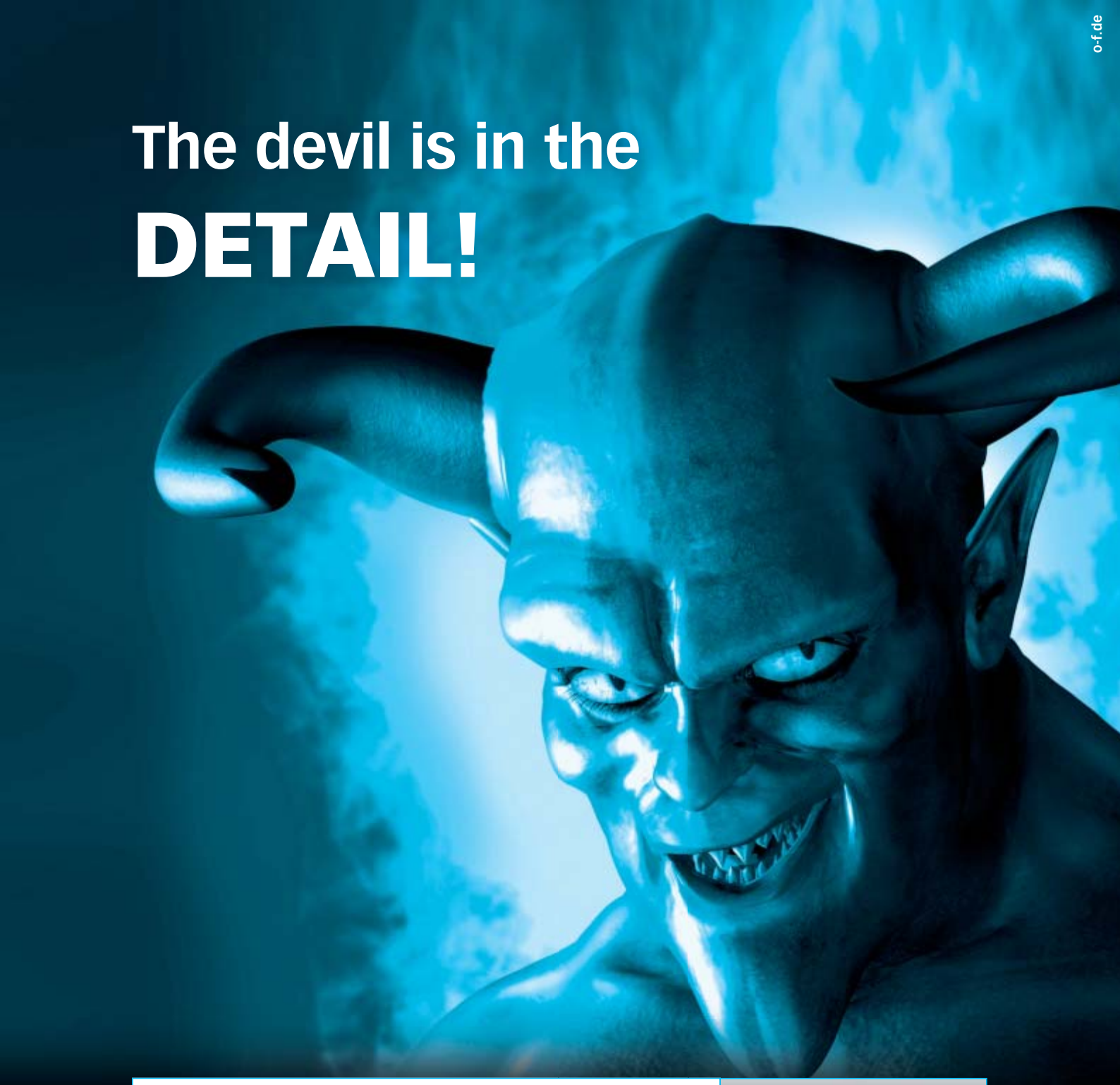
With the digital control loop comes the ability to adapt the control algorithms to optimally react to the immediate input voltage and output voltage and current conditions. All of the "secondary" PSU (power supply unit) functions such as sequencing, ramping, margining, fault response and reporting of voltage, current and status, and external control, become exercises in software - taking delivery of stable voltage to be the primary role.

The power management bus (PMBus) is therefore the default medium to communicate with the digital power component and this gives engineers significant flexibility. Indeed, this level of flexibility can be shown by looking at the specification sheet of a digital control IC made by Zilker Labs (Intersil), for example. The list of PMBus output commands (Vout mode/command/trim – and so on) comprises 15 entries: just for time-related commands (delay, rise time, fall time) there are five commands; overall there are well over 100 commands in the set.

A problem of increasing complexity

Ask any power systems designer if they would like a greater ability to control, configure and monitor their circuits and the answer will undoubtedly be "yes". But that enthusiasm has typically only been put to use in large, connected systems such as telecoms or network infrastructure racks, industries that need to see everything from the performance of individual regulators to whole cabinets. Controlling and monitoring system boot-up and shut down, energy management, maintenance and even predictive maintenance identifying incipient failures are all benefits of digital power delivery, in addition to excellent circuit-level behavior.

The devil is in the DETAIL!



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Because these industries are the primary ones to truly adopt digital power delivery thus far - and because the new technologies are often designed for them - digital power is sometimes perceived as applicable to only a niche market, closed to all but the largest organizations with the necessary resources.

Analog designers with the skills to configure a stable control loop by the judicious use of resistors, capacitors and gain settings often believe that they will need corresponding expertise in writing software or code for DSPs; they may well be intimidated by the perceived need to add such logic design skills. Similarly, for most microcontroller software coders, they believe that they will need to become experts in control theory and Nyqist criteria, topics last visited (or skipped) in a college course. Management may incorrectly believe they're faced with allocating extra training, or deploying engineers from other departments to the PSU design project, and such skilled coders are likely to be fully employed elsewhere. It is not to belittle the power-supply design discipline – more a reflection of reality – to say that engineers with both high-frequency analog abilities and the skills handle logic/software design have not traditionally migrated to PSU design.

Removing this perception of complexity

For both individuals and companies, therefore, the barrier to adoption of digital power has been perceived as relatively high. This is particularly true when the context is not that of a large IT infrastructure rack, or a telecoms routing center, but rather in smaller projects, or when only a proportion of the task demands advanced capabilities. Both engineers and management have often concluded that while the benefits of digital power would be "nice to have", the cost, and the risk of adopting a new technology is too high. Much of the literature and design support material that has been published on digital power has assumed a large-scale conversion to the digital philosophy. What has been lacking is an approach that would allow exploitation – selectively at first – of the benefits and performance of digital power without going through a steep learning curve, and without putting a project schedule at risk by moving a complete power supply system design over to an unknown (to that design team) technology.

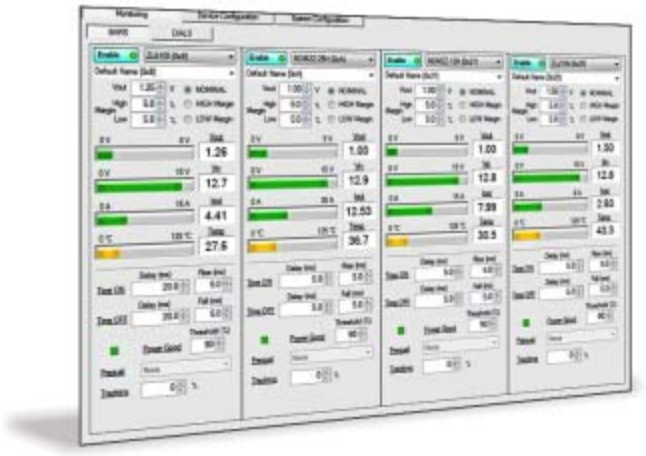

Figure 2: CUI's GUI enables the simple implementation of a digital power supply

To bridge this gap in skills and confidence, a "toe in the water" approach to digital power adoption is essential in order to allow power engineers, system architects, product marketers and program managers to assess if the move to digital power suits a project.

We've addressed this in our NSM2P series of Novum Advanced Power modules using a No-Bus approach, which lets OEMs benefit from efficiency gains, auto-compensation advantages and ease of design inherent in digital power systems without incorporating a digital bus into their system

But prioritizing ease of use doesn't mean sacrificing performance. The NSM2P delivers industry-leading performance in a package that is easier to implement than an analog point of load module. Users do not have to write any code, but instead use an intuitive GUI to configure the required input and output conditions, plus functions such as voltage sequencing, voltage margining, and voltage tracking. During the product development cycle the engineers have the opportunity to configure, control and monitor the power delivery circuits using the GUI over a 3-wire digital bus connection. Once the module has been configured, any further connection to the bus is no longer required: the module exceeds the performance of an analog regulator while occupying a smaller footprint.

Other benefits follow; one physical part, and one part number, can occupy many sockets with only the difference of internally contained configuration files to distinguish them. And the confidence to deal with, and to fully exploit, the promise of digital power can be gained without risk to reputation or product development schedules.

For engineers, architects, marketers and managers that seek to to implement a full digital power system, CUI has developed the NDM2P and NDM2Z series, which opens the entire suite of digital features to the user. In doing so, organizations with a 'digital vision' can benefit from the telemetry and power management advantages of digital power while leveraging the "plug and play" aspect of a power module design.

No matter the iteration however, perhaps the greatest benefit, and the one that addresses one of the most difficult issues in the analog/digital skills gap, is automatic compensation. Available in all CUI Novum Advanced Power modules, auto compensation enables the module to dynamically set optimum stability in real time as conditions change and is one of the key benefits of the digital power control loop. It eliminates the need for manual loop compensation, one of the most labor intensive, time-consuming aspects of analog power design, and the need to build in margins for component ageing, manufacturing variations, temperature and other factors. The realized benefits for the design engineer include improved performance, faster time to market and lower overall cost.

Summary

Thanks to recently released module developments such as auto compensation and the No-Bus platform, digital power continues to address misperceptions that have limited the technology's adoption to a select group of corporations. Now, a greater number of OEMs will see the opportunity to migrate to digital and benefit from improved system efficiency and auto-compensation algorithms. This industry shift towards simple to use power modules can only be a good thing.

CUI will present in more depth about this topic at the Applied Power Electronics Conference (APEC), held March 17-21 in Long Beach, California. For more information on this topic visit the CUI show booth, 725.

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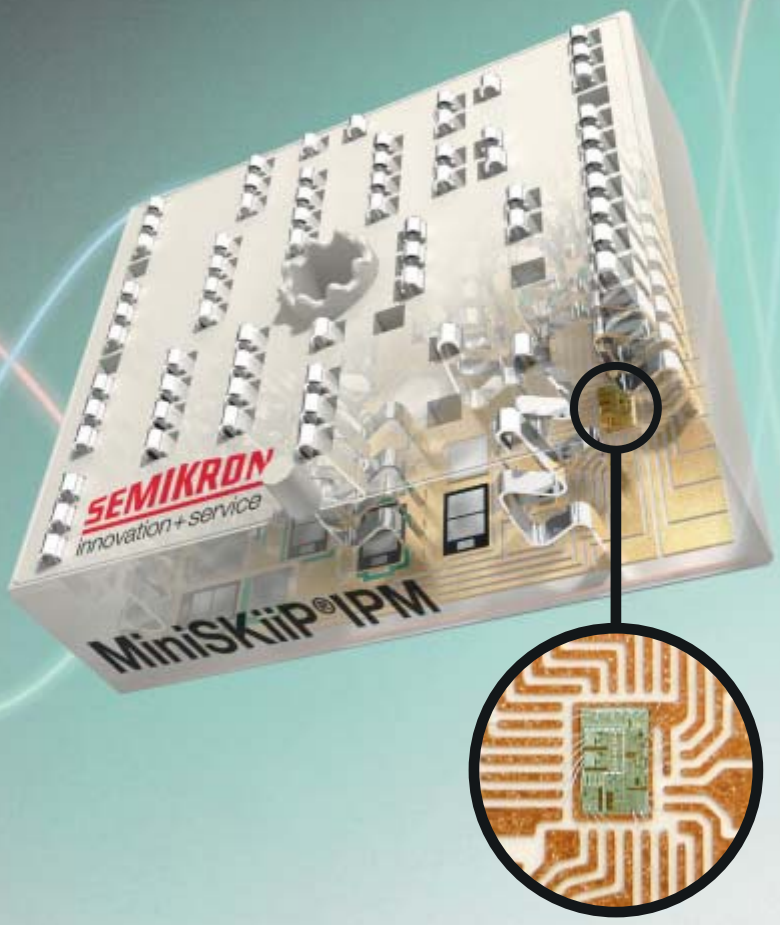

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Electronics Industry Digest

By Aubrey Dunford, Europartners

In 2013, PC shipments were 352.7 million units, a 3.5 percent decline from 2011 so Gartner. Tablets have dramatically changed the device landscape for PCs, not so much by 'cannibalizing' PC sales, but by causing PC users to shift consumption to tablets rather than replacing older PCs, said Gartner. Tablet PC shipments are expected to reach more than 240 million units worldwide in 2013, easily exceeding the 207 million notebook PCs that are projected to ship, so NPD DisplaySearch. In a market that has been dominated by one major player, Apple, shifting market dynamics are creating the opportunity for a greater variety of choices, which will drive shipment growth in 2013 to 64 percent Y/Y.

SEMICONDUCTORS

The fabless IC suppliers grew by 6 percent in 2012, 10 points better than the 4 percent decline registered by the IDMs (i.e., companies with IC fabrication facilities) and eight points better than the 2 percent decline shown by the total IC market last year, so IC Insights. Fabless IC company sales increased over 7x from 1999 to 2012 whereas total IDM IC sales were up less than 50 percent over this same time period. In 1999, fabless IC company sales accounted for just over 7 percent of the total IC market. However, in 2012, fabless IC suppliers represented 27.1 percent of worldwide IC sales

Renesas Electronics plans to cut more than 3,000 additional jobs as it prepares to raise at least 150 billion yen ($ 1.8 billion) from The Innovation Network Corporation of Japan (INCJ), a government-backed fund and a consortium of 8 customers (Toyota Motor, Nissan Motor, Keihin, Denso, Canon, Nikon, Panasonic and Yaskawa Electric).

Globalfoundries announced plans to build a global R&D facility at its Fab 8 campus in Saratoga County, N.Y. The new Technology Development Center (TDC) is expected to play a key role in the company's strategy to develop innovative semiconductor solutions allowing customers to compete at the leading edge of technology.

Hans Rijns and Dave French will jointly take responsibility for the NXP Semiconductors R&D function. Hans Rijns is appointed Chief Technology Officer.

Dialog Semiconductor, a German provider of highly integrated power management, audio and short range wireless technologies, announced a strategic equity investment into Arctic Sand Technologies, an MIT spinoff commercialising an innovative new approach to power conversion for multiple markets, including smartphones, tablets, ultrabooks and data centres. The terms of Dialog's investment are not disclosed. Arctic Sand's patented TIPS (Transformative Integrated Power Solutions) technology uses a unique approach for conversion, based on switch capacitive techniques. The technology facilitates the use of smaller inductive components, resulting in increased efficiency and an overall higher power density factor over and above today's competing technologies.

Hemlock Semiconductor will lay off approximately 400 employees in Michigan and Tennessee in the coming weeks in response to significant oversupply in the polysilicon industry and the threat of potential tariffs on its products sold into China. Hemlock Semiconductor Group consists of several joint venture companies owned by Dow Corning, Shin-Etsu Handotai and Mitsubishi Materials. Hemlock Semiconductor is a provider of polycrystalline silicon and other silicon-based products used in the manufacturing of semiconductor devices and solar cells and modules.

OPTOELECTRONICS

OLEDs and organic solar cells can now be developed at Fraunhofer Institute for Applied Polymer Research IAP in Potsdam-Golm in a near-industrial scale. The new pilot line was designed and implemented by Fraunhofer IAP in cooperation with the plant manufacturer Mbraun.

PASSIVE COMPONENTS

Teknoflex was placed into administration on Monday 14th January 2013. With over 50 years' experience in PCB manufacture, Teknoflex is the UK's largest supplier of flexible and flex-rigid multilayer circuits and assemblies. Simon Robert Thomas and Shelley Anne Bullman of

Moorfields Corporate Recovery were appointed Joint Administrators. They now manage the affairs, business and property of the company and are looking the sell the business as a going concern.

Huber+Suhner acquired the assets of Astrolab, based in Warren, New Jersey at a non-disclosed price. The deal will be financed from own resources. With its patented minibend and microbend cable assemblies Astrolab is mainly active in high tech niche markets like space & defence and offers high end radio frequency solutions for industrial markets.

OTHER COMPONENTS

Saft, a French supplier of batteries for industry, has bought from Johnson Controls the Nersac Li-ion battery facility near Angoulême in France. This transaction is in line with the agreement concluded with Johnson Controls in 2011 relating to the sale of Saft's shares in the Johnson Controls-Saft joint venture, for $ 145 M.

TDK announces the opening of TDK-Lambda's EMEA Advanced Technology Centre in Bristol, UK.

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
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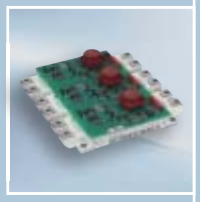

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Li-ion Batteries Dominate Portable Applications, Lag in Large-Format Applications

By Richard Ruiz, Research Analyst, Darnell Group

For the foreseeable future, lithium battery chemistry will remain the preferred choice for consumer electronic products such as laptops, mobile phones, GPS, ebooks and other portable devices. In fact, additional applications including power tools, medical, and military equipment are increasingly transitioning to Lithium-ion (Li-ion) technology. Larger-format Li-ion batteries are beginning to experience some "push-back" particularly in aircraft applications such as the Boeing 787 and Airbus A350 XWB passenger aircraft.

Particularly for portable applications, other technologies such as ultra-capacitors, fuel cells and thin-film battery technology are considered to be potential long-term alternatives to standard Li-ion battery packs. Ultra capacitors can deliver high power and have a long cycle and calendar life. Fuel cell systems currently offer similar energy density to advanced Li-ion batteries, and may eventually be capable of greater energy density. Thin-film battery technology is still new and expensive, but has the potential to significantly affect the Li-ion battery pack market in the longer term.

Ultracapacitors (ultracaps) are one of the best devices for delivering a quick surge of power and they are expected to have an impact on the portable lithium-ion battery packs market. Since ultracapacitors store energy in an electric field, rather than in a chemical reaction, it can survive hundreds of thousands more charge and discharge cycles than a battery can. Despite the advantage in cycles, ultracapacitors still lag behind batteries when it comes to energy storage capacity, which is extremely important in portable power devices. Currently, they can only store about 5% of the energy of comparable Li-ion batteries and they are also more expensive per energy unit.

Technically, it would be possible to use ultracaps in place of Li-ion batteries in a cell phone or a camcorder, or some other consumer device with some serious benefits. A consumer would never have to replace the ultracapacitor and the device would recharge very quickly. But it wouldn't stay charged for very long with today's ultracapacitors—perhaps as little as 90 minutes, not long enough for current consumer demands. However, the advantage of ultracaps is that they can capture and release energy in seconds, providing a much faster recharge time compared to Li-ion batteries. In addition, ultracaps are very effective at accepting or delivering a sudden surge of energy, and that makes them a good partner for Li-ion batteries in specific devices such as power tools.

Although micro fuel cells for portable devices have been expected to emerge for a long time in the consumer industry, their development has remained stalled as they typically have lower power and shorter calendar life. However, once they emerge, the use of portable fuel cells has a number of advantages. They maintain a high energy density, they use liquefied fuel as an energy supply, they are environmentally friendly and they have a fast charge with a long runtime.

Unlike other markets, batteries and fuels cells do not have much synergy in the portable market. This is more an either/or sector. Several companies are now offering products that they claim can compete with battery technology. For example, Horizon Fuel Cell Technologies offers in-store availability and retail sales of its micro-fuel cell product, the MINIPAK, which uses a refillable metal hydride fuel cartridge.

In fact, in 2012 Horizons MINIPAK was named "Gadget of the Year" in Germany. The device is a universal portable power charger and power extender compatible with a variety of portable electronic devices including cellphones, GPS handheld devices, MP3 players and others. Since external battery chargers are a key area of market opportunity for portable fuel cells, the successful implementation of this technology could provide the growing lithium-ion battery charger market with direct competition.

In addition, new specific markets such as environmental remote monitoring have also been recognized as promising areas for fuel cells. Military man-portable applications such as remote monitoring/sensing and mobile soldier power also remain a strong area of focus for fuel cell developers, and are expected to a be potentially large revenue category for portable fuel cells given the expected high average cost per unit.

The adoption of small thin-film batteries are also expected to have a long-term effect on the Li-ion power packs market. If successful, they have the potential to drastically change the landscape of the Li-ion battery pack market. The development of small thin-film battery represents entirely new class of electronic component. They are designed to be ultra-thin and flexible-providing nearly lossless energy storage capability along with much improved re-chargeability, cycle life, and power performance. Building on technologies initially developed at the Oak Ridge National Laboratory, a number of vendors have begun to commercialize thin film battery technology.

These batteries are not only thin, but flexible, and can be so small as to enable many new (or better applications) not just in a mobile environment but also in the growing world of embedded sensors. Recent advancements in each of these technologies is expected to impact the battery packs industry over the next several years.

While various types, shapes and sizes of Li-ion batteries are expected to continue dominating portable electronics applications, the near-term future of large-format Li-ion batteries is less clear. While Boeing is still struggling to get the Yuasa Li-ion battery pack used in the 787 Dreamliner recertified, Airbus has chosen to replace the already-qualified Li-ion battery from Saft with a NiCd pack from the same supplier.

According to a statement released by Airbus, "the root causes of the two recent industry lithium-ion (Li-ion) main batteries incidents (on

the Boeing 787) remain unexplained to the best of our knowledge. In this context, and with a view to ensuring the highest level of program certainty, Airbus has decided to activate its “Plan B” and therefore to revert back to the proven and mastered nickel-cadmium (NiCd) main batteries for its A350 XWB program at Entry into Service (EIS).” Airbus considers this to be the most appropriate way forward in the interest of program execution and A350 XWB reliability.

Airbus stated in a written release that it is confident that the Li-ion main battery architecture it has been developing with Saft Batteries and qualifying for the A350 XWB aircraft is robust and safe. The A350 XWB flight test program will continue as planned with the qualified Li-ion main batteries. In parallel, Airbus has also launched additional maturity studies on Li-ion main batteries behavior in aerospace operations and will naturally take on board the findings of the ongoing official investigation.

As announced on Darnell’s www.PowerPulse.net two days prior to the change by Airbus: After an exhaustive examination of the JAL Li-ion battery involved in the recent fire on a Boeing 787, investigators from the U.S. National Transportation Safety Board (NTSB) determined that the majority of evidence from the flight data recorder and both thermal and mechanical damage pointed to an initiating event in a single cell (the battery in question is composed of 8 cells). That cell showed multiple signs of short circuiting possibly from dendrite formation, leading to a thermal runaway condition, which then cascaded to other cells. Charred battery components indicated that the temperature inside the battery case exceeded 500 degrees Fahrenheit. The Li-ion batteries used by Boeing are supplied by Yuasa, not Saft which supplies Li-ion batteries to Airbus.

As investigators work to find the cause of the initiating short circuit, they ruled out both mechanical impact damage to the battery and external short circuiting. It was determined that signs of deformation and electrical arcing on the battery case occurred as a result of the battery malfunction and were not related to its cause.

During the 787 certification process, Boeing studied possible failures that could occur within the battery. Those assessments included the likelihood of particular types of failures occurring, as well as the effects they could have on the battery. In tests to validate these assessments, Boeing found no evidence of cell-to-cell propagation or fire, both of which occurred in the JAL event.

The NTSB learned that as part of the risk assessment Boeing conducted during the certification process, it determined that the likelihood of a smoke emission event from a 787 battery would occur less than once in every 10 million flight hours. Noting that there have been two critical battery events on the 787 fleet with fewer than 100,000 flight hours, the NTSB Chairman stated that „the failure rate was higher than predicted as part of the certification process and the possibility that a short circuit in a single cell could propagate to adjacent cells and result in smoke and fire must be reconsidered.“

As the investigation continues, which will include testing on some of the batteries that had been replaced after being in service in the 787 fleet, the NTSB will continue to share its findings in real time with the FAA, Boeing, the Japan Transport Safety Board, and the French investigative agency, the Bureau d’Enquêtes et d’Analyses.

Power Electronics for Medium-Voltage Applications

While the development and production of power electronics systems in the industrial voltage range between 400Veff and 660Veff are regarded as state of the art, at voltage levels above problems occur which are not expected in this form. They begin with a voltage level of 1000Veff and aggravate of course when voltage levels between 3000Veff and several 10,000V are intended to be reached.

By Werner Bresch, GvA

In this context it is rather strange that it is less the power semiconductors used which presents the problems, but rather the lack of knowledge and understanding of the general behaviour of power semiconductors in medium-voltage applications. It is also the lack of availability of suitable auxiliary materials such as clamping devices, coolers, insulation materials, auxiliaries such as triggers, auxiliary voltage supplies for drivers or controllers as well as sensors and the lack of understanding and knowledge of how to transfer them to a suitable and sensible mechanical set-up. The worst thing is that the abovementioned materials and auxiliaries are not simply available to purchase at the nearest specialist electronics store. They simply do not exist!

Insulation coordination in medium-voltage applications

Irrespective of the circuit topology used, for example 3-level, multi-level, cascaded systems or direct series connection, special demands must be placed on the insulation in medium-voltage applications. Air gaps and creepage paths with the corresponding levels of contamination as well as air humidity and perhaps condensation have to be prevented. As the voltage values rise, the creepage resistance of the insulating materials used becomes of ever greater importance. Frequently, additional requirements are placed on these insulating materials with regard to compressive creep strength, tensile strength, shear strength, for example for clamping devices, and resistance to oil when they are used under oil etc. The difficulty often resides in combining the required properties.

Another aspect is the dielectric strength, which is determined essentially through the choice of creepage paths and air gaps, the insulating materials used (CTI value) and not least by the geometric shape of the current carrying metallic parts. Before the disruptive discharge over an air gap to the chassis on earth potential occurs, there is a partial discharge. This takes place on sharp-edged live parts such as heat sinks or clamping devices on account of a local field rise. This external partial discharge forms on the surface of the mechanical structure of the power electronics and spreads out into the surrounding air space. In darkened rooms, this is easy to identify by way of a weak bluish glow. Another indication that a partial discharge is taking place is an ozone odour which is typical of it. Although the bluish glow may look visually beautiful, it causes lasting and irreversible damage to the insulation of the system. Another typical characteristic of a partial discharge is that there is a voltage value where the partial discharge begins (inception voltage). If the voltage is reduced significantly below this value, the partial discharge will stop or expire (extinction voltage). If the voltage rises significantly above the value of the inception voltage, a disruptive discharge of the voltage to earth will occur.

The insulation voltage specified in the data sheet as test verification and as an aid in deciding whether the power electronics component or power electronics module may be used for the specified operating voltage is not very helpful. The specified insulation voltage value merely tells us that the component has been checked for this voltage and there was no disconnection failure shut down of the test equipment. It does not state that there was no partial discharge during the insulation voltage measurement and therefore no pre-damage to the insulation path occurred. The following insulation voltage measurements may therefore be repeated only with a reduced test voltage. It makes much more sense to specify a partial discharge voltage and at this point to specify the partial discharge extinction voltage. The partial discharge voltage, i.e. the voltage level at which the partial discharge begins, is higher and will not be reached if the test voltage is not increased above the level of the partial discharge extinction voltage. The ageing of the insulation path is therefore avoided.
What has been described above applies very generally and relates essentially to auxiliary materials and auxiliaries such as heat sinks, clamping devices, mechanical fixtures, trigger modules, auxiliary voltage supplies, wiring networks, sensors, coolants (air, water, oil) etc.

Power semiconductors in medium-voltage applications

Generally, all known types of power semiconductors can be used in medium-voltage applications. These are predominantly components such as IGBTs in 3-level or multi-level circuit topologies, cascaded systems, but also in direct series connection. However, in many cases IGCTs, GTOs (transparent emitters), thyristors and also diodes (avalanche diodes) are used in the circuit topologies mentioned above.
However, power semiconductors of whatever type used in a medium-voltage application - that is a whole different world!

IGBTs in medium-voltage applications

Appreciated and well-known properties of IGBTs can no longer be utilised, but other properties of bipolar power semiconductors which have almost been forgotten suddenly become very interesting. For example, the short-circuit recording through desaturation, which is easy to implement, and independent switch-off by the IGBT driver can no longer be utilised in medium-voltage applications. The short circuit would have to be recorded externally and reported to the CPU, and the IGBTs would have to be switched off selectively in the correct sequence within 10us. A real challenge. What is possible, however,

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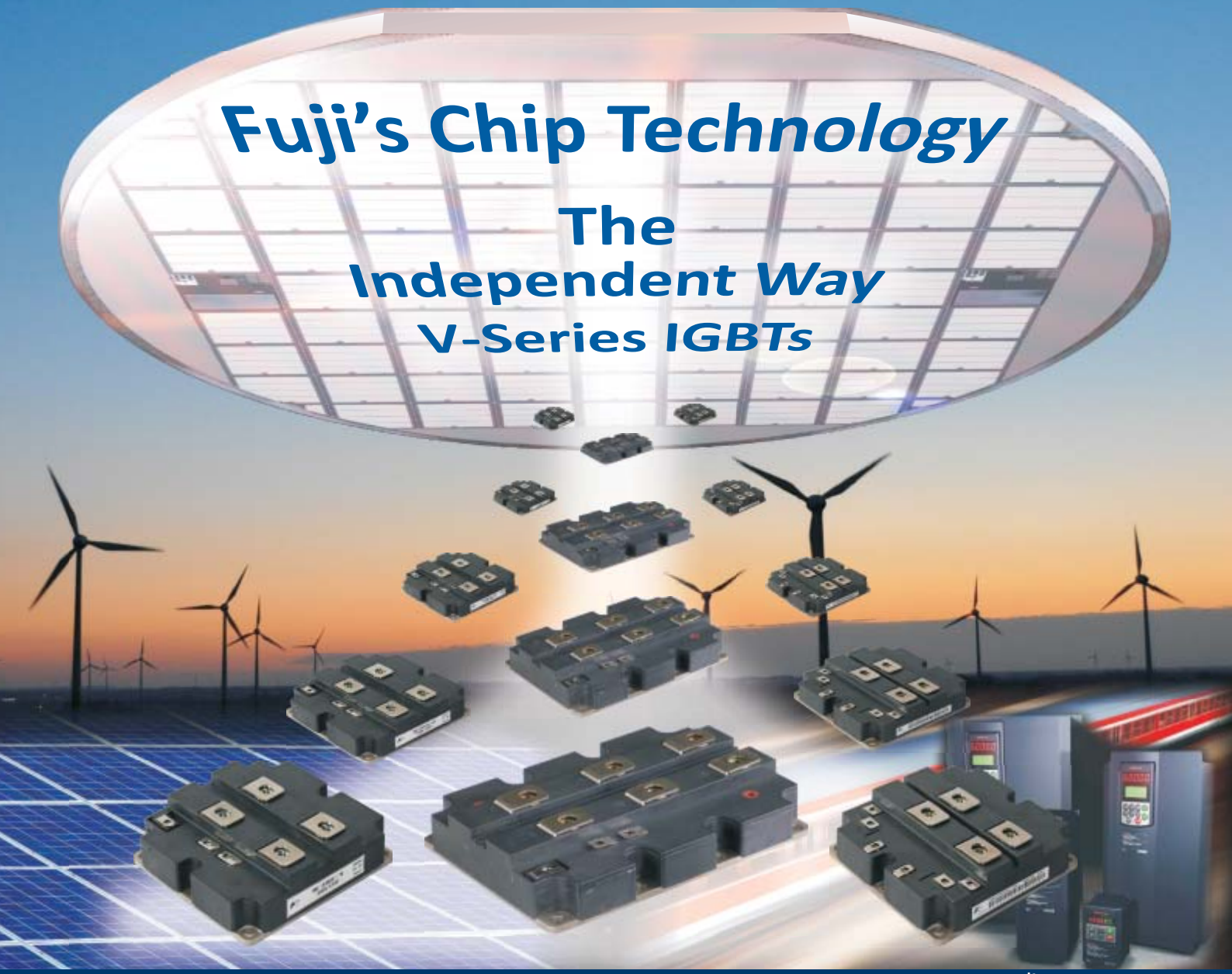
The Independent Way

V-Series IGBTs



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

High Power IGBTs

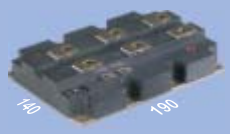
1200V & 1700V

- Low thermal impedance
- Low internal inductance
- $T_{j,max}$ = 175°C
- $T_{j,op}$ = -40 ~ 150°C
- $T_{stg,min}$ = -40°C
- V_{iso} = 4.0kV
- CTI > 600

1700V also available with AlSiC-Baseplate

1 in 1

1200A
1600A
2400A



2400A
3600A

2 in 1

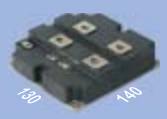
600A
800A
1200A

3300V

- Low thermal impedance
- Low internal inductance
- $T_{j,max}$ = 150°C
- $T_{j,op}$ = -40 ~ 150°C
- $T_{stg,min}$ = -40°C
- V_{iso} = 6.0kV
- CTI > 600
- VPD = 2.6kV

AlSiC Baseplate

1 in 1



800A
1000A

1200A
1500A

Fuji Electric
Innovating Energy Technology

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Products Overview ▸www.fujielectric-europe.de/info/overview.pdf

is crowbar protection, as is usually implemented when using bipolar power semiconductors. If IGBT modules are used, the insulation voltage may no longer be sufficient. The coolers then need to be insulated. In the event of a fault, IGBT modules present problems because plasma discharge may be expected. Plasma discharge in medium-voltage applications is an unpleasant thing. The approach to solving this problem is the use of pressure-contact IGBT housing technologies. In conjunction with the wider air gaps and longer creepage paths required for medium voltage, this leads to longer commutation paths affected by leakage inductance, which entails a reduction in the switching speed and thus a reduction in the clock frequencies on account of increased switching losses. We are then no longer talking about a clock frequency of a few kHz, we are talking at best about a few hundred Hz. The short-circuit protection philosophy needs to be completely reconsidered, as does the safety concept in relation to redundancy in the event that a component fails (is a component short-circuited or is it no longer conductive). Increased effort is also required in respect of the triggering, monitoring, status feedback, particularly if a direct series circuit is implemented with IGBTs. In this case, it is also sensible to make dedicated selections.

IGCTs, GTOs, thyristors, diodes in medium-voltage applications

The use of bipolar components is often equated to using an obsolete technology. However, in medium-voltage applications these components have a charm all of their own. The switching behaviour of these components is controlled by di/dt reactors and therefore defined very precisely. If at all, leakage inductances play only a secondary role. Air gaps and creepage paths are therefore easier to set. The achievable clock frequencies (IGCT, GTO) are roughly identical to those of the IGBTs (of the same voltage class). The coolers must be constructed so as to be isolated as they are directly loaded with potential. Usually, components are used in hermetically sealed, pressure-contact housings (disc cells). Plasma discharge is unlikely because in the event of a fault the component goes into a short circuit (conductive). This means that safe further operation in the event of a fault is exclusively an issue of redundancy (single, dual, multiple redundancy). The components have a very high surge current capacity in comparison with IGBTs over a relatively long period of time of 10ms (factor of 1000 in comparison with IGBTs). In the case of turn-off bipolar power semiconductors, this leaves plenty of time to safely record an overcurrent externally and to turn it off within the turn-off limit current. There remains the option of an additional crowbar triggering in order to prompt upstream overcurrent protective devices to turn off the system. Although this method is primitive, it is effective. Here too, increased effort is required in respect of triggering, monitoring, status feedback, particularly if a direct series circuit is implemented with IGCTs, GTOs, thyristors and diodes. In this case, it is also sensible to make dedicated selections.

Wiring

If power semiconductors are connected directly in series, particular attention must be paid to ensuring an even static and dynamic voltage sharing. A static voltage sharing is forced by a voltage divider resistor in parallel with each component which is connected in series. The dynamic voltage sharing can be achieved by means of an RC element in parallel with each component. In the case of IGBTs increased effort in relation to triggering, monitoring, status feedback and communication within the series circuit is necessary. In addition, overvoltage limiters may also be employed. It is definitely sensible to select and pair the components in view of those parameters which are relevant to series circuits. This may reduce the costs for protective circuits significantly. From a voltage level of 20kV and up, parasitic leakage capacitances to ground may cause blocking voltage unbalance. The size of the parasitic leakage capacitance and therefore of the voltage unbalance depends on the zero voltage capacitance of the power semiconductor, the distance between the live parts and the chassis earth as well as the dielectric between them (air, oil). An additional suppressor capacitor in close proximity parallel with the power semiconductor solves this problem.

Mechanical configuration

Gradually a multistage complex mechanical structure develops consisting of a heat sink, power semiconductor, clamping units if necessary, protective circuit, driver circuits, sensors, communication and feedback electronics and feeder units for each of these stages. As has already been outlined, the procurement of parts for a single stage operating on the industrial network 400Veff/660Veff would not be difficult. The individual components are designed for this. If they are connected in series in order to move on to the medium-voltage range, it is apparent that the stages constructed in this way are not suitable and cannot simply be upscaled to use at a higher voltage level. Neither the insulation strength nor the form of the individual components within the stage are suitable for this purpose. Attention must therefore be given beforehand to assessing the suitability of the materials employed for use at a higher voltage level. For example, sharp edges should be avoided on live metallic parts and, if necessary, a homogeneous distribution of the electric field should be ensured through the use of field shielding rings around each stage of the series circuit.

Components for medium-voltage applications

For medium-voltage applications, GvA Leistungselektronik GmbH has developed a series of „ready-to-use“ components which can be used in a scaleable fashion in the form of a modular system.

Inductive power supply system (IPSS)

The inductive power supply system (IPSS) is particularly suitable for supplying power to trigger modules such as thyristors or IGBTs in medium-voltage applications, regardless of whether they are in 3-level or multi-level configuration, in cascaded systems or direct series connection. The supply system can also be used, for example, to supply power to measurement and sensor systems, auxiliary electronics etc. at a high voltage level. The IPSS consists of 3 individual function blocks, the basic unit (BU), the current loop (CL) and the decoupling unit (DCU).

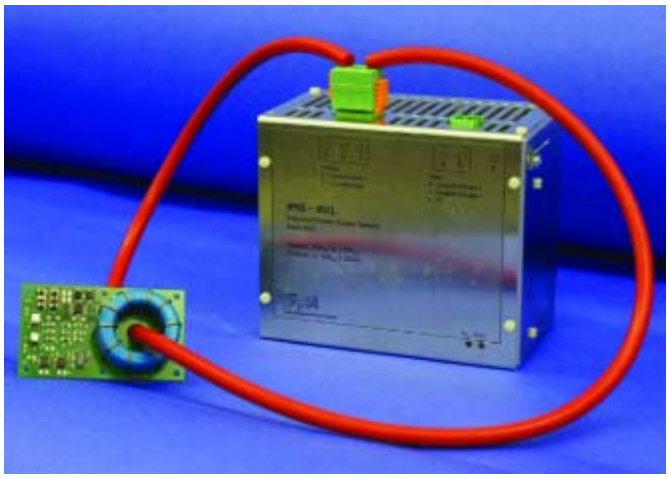
The basic unit (BU)

The BU is the primary-side part related to the chassis earth of the IPSS and is supplied with a DC voltage between 24Vdc and 110Vdc. The large input voltage range of the BU enables supply both from a PLC and by means of other standardised DC voltage sources (48Vdc, 60Vdc, 108Vdc). The required voltage level depends directly on the number of decoupling units that need to be supplied. The BU generates an impressed trapezoidal alternating current with a frequency of 21kHz at the output. The amplitude of the alternating current on the output side and its frequency is independent of the level of the input voltage.

The current loop (CL)

The BU supplies a secondary alternating current of 10Aeff as standard. The wire cross-section must be dimensioned in accordance with this. Since in medium-voltage applications the decoupling units are at high potential, particular attention must be paid to the insulation strength of the current loop CL. The insulation strength and the partial discharge strength are determined mainly by the quality of the current loop insulation. The maximum length of the current loop is 6m

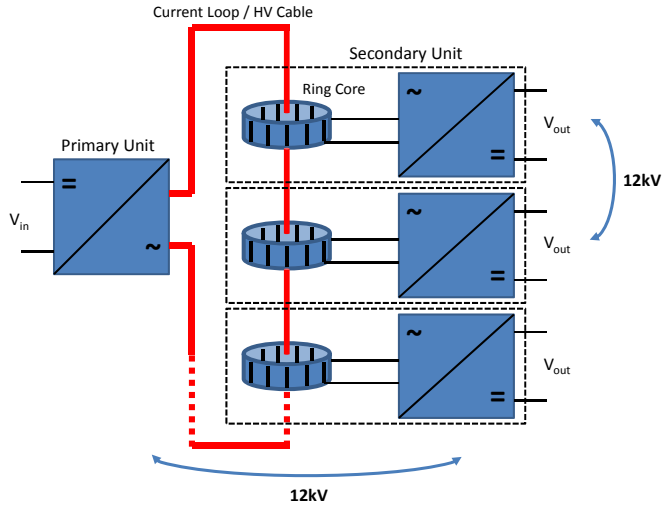
as standard and is therefore sufficient for most applications. Larger current loop lengths are possible on request.



Picture 1: Inductive Power Supply System (IPSS) with BU, CL and DCU

The decoupling unit (DCU)

The decoupling unit uses a toroidal transformer through which the conductor of the current loop is guided. There are various versions of the toroidal transformer with a different number of windings for different secondary output voltages. As standard, the decoupling unit is available with 12Vdc, 15Vdc and 24Vdc. The output voltage is controlled and is independent of the level of the output current or loading. The maximum output current of a decoupling unit is 1000mA in the standard version.



Picture 2: Block Diagram of IPSS

System properties of the IPSS

The IPSS inception voltage between the input of a BU and the output of a decoupling unit may be up to 12kVeff. The same applies to the voltage difference between the outputs of two decoupling units. The insulation voltage is up to 17kVeff (partial discharge inception voltage) or 13kVeff (partial discharge extinction voltage). The insulation test voltage is 24kVeff for 1 minute. Higher insulation voltage values are available on request.

Thyristor trigger unit (TTU) for the electrically isolated triggering and monitoring of high-power thyristors

The trigger unit has been developed specifically to cater for the needs of high-power thyristors used in medium-voltage applications and allows the safe electrically isolated triggering and monitoring of these elements. The IPSS, which has already been outlined, may be used as the power supply unit. Its insulation coordinates will then be relevant for the thyristor series circuit to be created. The trigger module generates a gate trigger current at the thyristor with a gate trigger current rise of up to 2.5A with a subsequent back porch trigger current of 500mA. Therefore the trigger unit is suitable both for the reliable triggering of thyristors with high di/dt loads, as occur for example in pulser or crowbar switches, and for applications with a large inductive load. Furthermore, the trigger unit has an integrated emergency trigger function and protects the thyristor from overhead ignition when the permitted operating voltage is exceeded. In addition, the trigger unit permits the recording of the anode voltage and the cooler temperature. This offers lots of different options for monitoring, detecting a faulty power semiconductor element and voltage zero-crossings and, last but not least, fault states in cooling or unpermitted overload situations. The fault signals are transmitted via fibre-optic cables in a potential-free way.

Complete power stages for medium-voltage applications

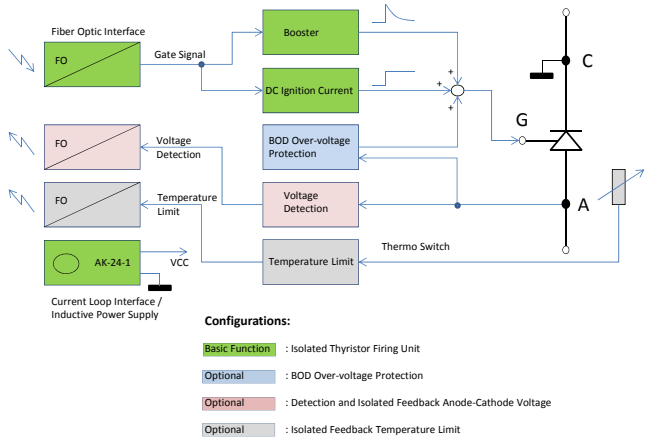
The power stages for vast variety of circuit topologies listed below are „ready-to-use“ power electronics units. However, they are not finished devices in the sense of a device with a controller and the corresponding software. This is the responsibility of our customers and in many cases it is their core area of expertise. Therefore, GvA Leistungselektronik GmbH does not appear as a competitor in the sense of finished devices in any case. We manufacture and supply power electronics modules.

Medium-voltage thyristor pulser bidirectional; W1C 12kV / 32kA

This pulser switch consists of a discrete mechanical unit consisting of 8 thyristors connected anti-parallel in series. It is equipped with the trigger module and the IPSS auxiliary voltage supply as well as a

protective network for static and dynamic voltage sharing. The highest permitted connection voltage is 12kVeff, and the highest permitted pulse current is up to 32kA with a pulse duration of up to 100ms. The switch is air-cooled (self-ventilated) and therefore one of the weakest versions in terms of continuous current-carrying capacity. The mechanical design is such that much higher current carrying capacities can be achieved by using forced ventilation or liquid cooling and by using larger disc-type thyristors. The status monitoring and error feedback signals are transmitted via fibre-optic cables in a potential-free way, as described above under trigger module.

Picture 3: Thyristor trigger unit (TTU)



Picture 4: Block diagram of TTU

Medium-voltage thyristor switch W1C 24 kV / 600A

This single-phase alternating current switch consists of a discrete unit comprising 18 double thyristor modules connected in series. It is equipped with the trigger module and the IPSS auxiliary voltage supply, as well as a protective network for static and dynamic voltage sharing. The highest permitted connection voltage is 24kVeff, the highest permitted current is up to 600Aeff. The switch is liquid-cooled. The mechanical design is such that larger thyristor modules may be used and thus much higher current carrying capacities can be achieved. The status monitoring and error feedback signals are transmitted via fibre-optic cables in a potential-free way, as described above under trigger module.

Medium-voltage IGBT DC switch E1C 16kV /10A

This 16kVdc IGBT switch was already described in detail in Bodos Power Systems edition ZKZ 64717 12-12 issue December 2012. In order to avoid any unnecessary repetition, we refer interested readers to this edition of Bodos Power Systems.

Universal 3-level IGBT inverter stack IO6 C 8060 W 073

This IGBT 3-level inverter power unit is used universally, for example as a drive inverter or as a medium-voltage active filter. It is fitted with 1200A / 3300V IGBTs, IGBT drivers with status sensors, DC filter, current and voltage sensors and is equipped for liquid cooling. The maximum output voltage is 2kVeff, the maximum output power is 2MVA.

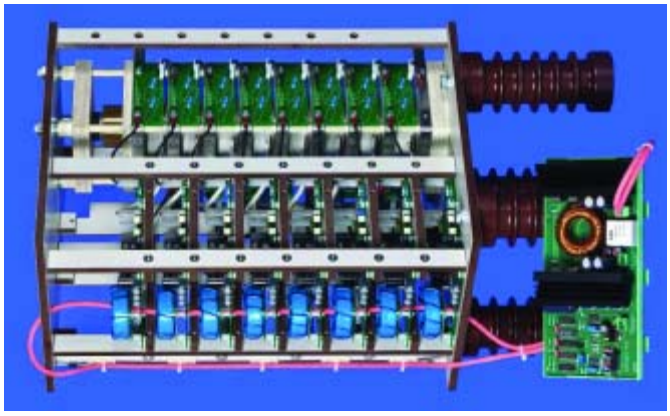


Bild 5: Thyristor Pulser Bidirectional W1C 12kV / 32kA

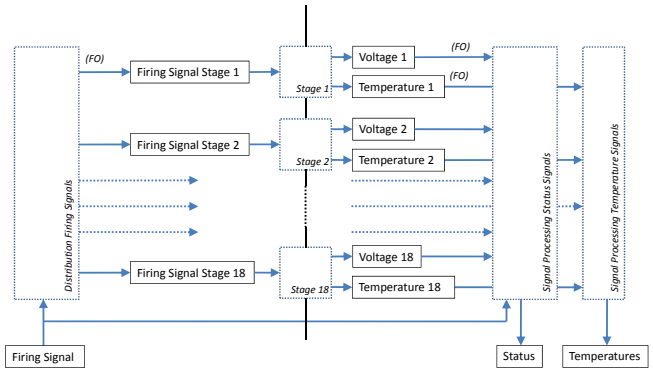


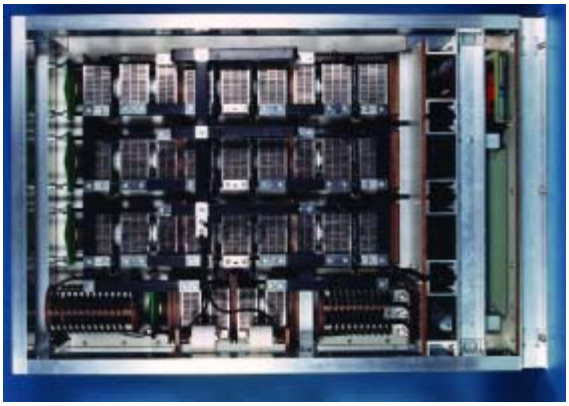
Bild 6: Block diagram of medium voltage switch W1C 24kV / 600A

……..and other solutions for medium-voltage applications

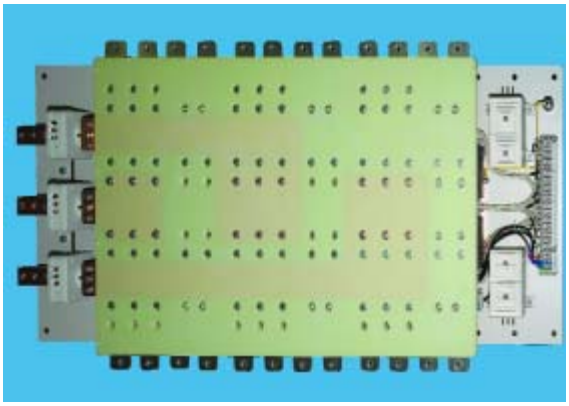
Over the past 20 years during which GvA Leistungselektronik GmbH has existed, many power electronics units for medium-voltage applications have been developed and commissioned for in some cases very exotic applications. In order to keep the scope of this publication to a sensible level, they are only outlined in brief below:

- Uncontrolled rectifiers 20kVdc / 40kVdc to 100kVdc, 40Adc.

Picture 7: IGBT DC Switch, E1C 16kV /10A with IPSS, IGBT driver, senses, diagnostic, communication interface and potential free feedback.



Picture 9: …….e.g. IGCT 3-Level-Inverter-Stack



Picture 8: Universal IGBT 3-Level Inverter Stack

- Three-phase contactless IGCT medium-voltage switch, 12kveff, 1600Aeff, water-cooled.
- Various IGCT 3-level inverters with different power semiconductor equipment up to 4.2kVeff output voltage, 3MVA output power, air- and water-cooled.
- IGCT traction chopper 4kVdc, 600Adc, 1000Hz, oil-cooled, two IGCTs connected directly in series.
- IGCT 3-level inverter phase branches output voltage 12kVeff, output current 600Aeff, four IGCTs connected directly in series per switching function (16 x IGCTs per 3-level inverter phase branch)
- Thyristor, IGCT, GCT pulser switch in various voltage and current classes.

Don't be afraid of power electronics in the medium-voltage ranges

In the context of the applications outlined above and the diversity in the use of a wide range of different power semiconductors and circuit topologies, GvA Leistungselektronik GmbH boasts a broad wealth of experience of using power semiconductors and power electronics output stages in the medium-voltage range. Over the years, the IPSS, trigger modules and IGBT controllers described above have emerged as core components, which are now offered as individual components or in combination with power semiconductors as power electronic stacks within the field of power electronics. Our customers receive system components, which have been tried and tested many times, and they can benefit from this product`s because the time to market for a new development in power electronics in the medium-voltage range is shortened significantly.

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Providing Unparalleled IGBT Efficiency

TRENCHSTOP™ 5 – Bringing the IGBT into a new realm of efficiency

The IGBT is coming of age with the TRENCHSTOP™ 5 capable of providing benchmark efficiency levels for high speed switching topologies such are boost PFC (AC/DC) stages and high voltage DC/DC topologies commonly found in applications such as Photovoltaic Inverters, Uninterruptible Power Supplies (UPS) and Inverterized Welding Machines.

By Mark Thomas, Discrete IGBT Product Marketing, Infineon Technologies Austria

The TRENCHSTOP™ 5 technology, shown on the right hand side of figure 1, uses the key principles of Infineon's TRENCHSTOP™ concept by combining trench-gate and fieldstop structures and further extends the performance with a new enhanced cell design and reduction of wafer thickness.

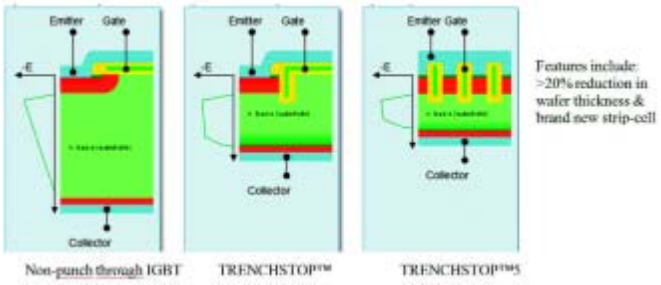

Figure 1: Infineon's IGBT technology evolution

In order to minimize total power losses and produce an IGBT with the lowest combination of conduction losses ($V_{CE(sat)}$) and total switching losses (E_{ts}) ever seen, the TRENCHSTOP™ 5 incorporates two new distinctive features.

1) The chip thickness been reduced from 70µm, which was already rated as the thinnest IGBTs commercially available at 600V, to 50µm. This represents >20% wafer thickness reduction whilst providing 650V-rated blocking voltage. This creates an optimization of the carrier profile, which results in a major reduction of minority carriers within the drift zone, which has thus relieved the IGBT of the preverbal Achilles' heel of long tail currents.
2) Meanwhile a new transistor stripe cell structure means a significant increase current density whilst the gate charge (Qg) is reduced.

Static Behavior Comparison

When looking at a trade-off diagram at 25°C, as shown in figure 2, which compares on-state losses [$V_{ce(sat)}$] versus turn-off switching losses [E_{off}] of the TRENCHSTOP™ technology versus the new TRENCHSTOP™ 5, one can clearly see the significant improvement in efficiency the new IGBT brings.

Compared to the 40A H3 product (IGP40N60H3), which is a high speed optimized IGBT using the TRENCHSTOP™ technology, the TRENCHSTOP™ 5 shows >60% lower switching losses and 10% lower on-state losses, thus representing significant improvement in total switching losses compared to the previous IGBT generation.

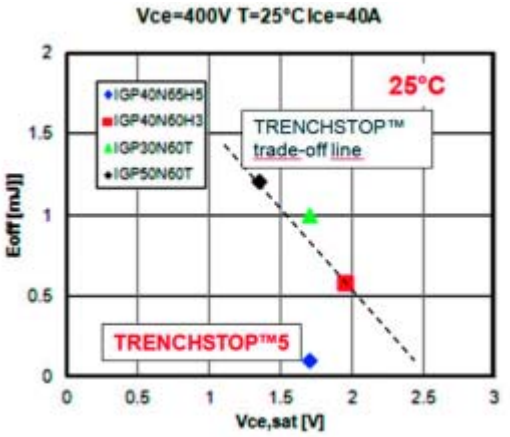

Figure 2: Trade-off plot showing $V_{ce(sat)}$ versus E_{off} at 25°C

At high junction temperature operation meanwhile, a mild positive temperature coefficient of $V_{ce(sat)}$ and Eoff losses ensures easy paralleling without risk of thermal runaway. Additionally, designers who design their IGBTs into their applications to operate at high junction temperatures or at different junction temperatures throughout the operating range will not be penalized by having a significant degradation of efficiency as is case with currently available IGBTs on the market that have a positive temperature coefficient.

As figure 3 shows, the $V_{ce(sat)}$ and E_{off} trade off point marginally increases in a positive direction at high junction temperature and the $V_{ce(sat)}$ is now >75% lower than the 40A H3 device.

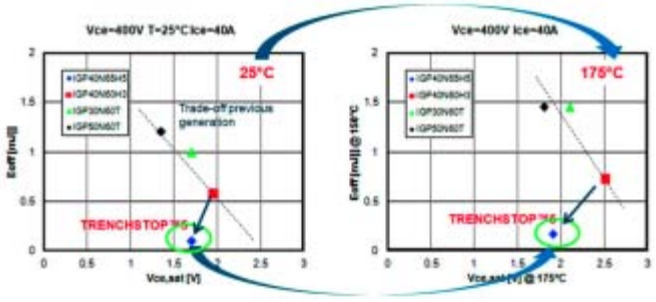

Figure 3: Trade-off plot showing Vce(sat) versus Eoff at high junction temperature

Dynamic Behavior Comparison

The distinctive long tail current of the IGBT during switching was identified as being a limitation of the IGBT due to minority carriers needing time to traverse the drift region or to recombine, thus limited the IGBT penetration into high speed applications.

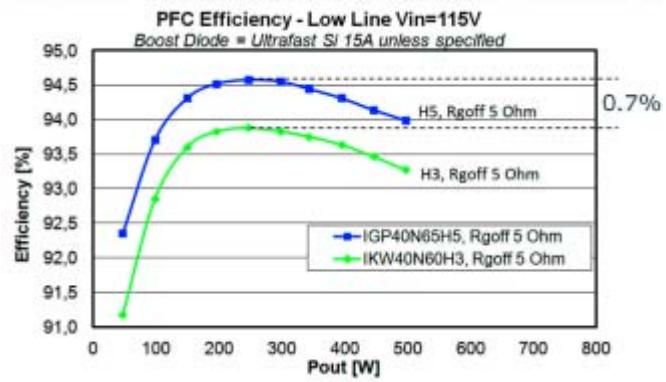

Figure 4: turn off switching comparison between H3 and H5[2]

In 2008, when Infineon successfully launched the 600V HighSpeed 3 (H3) family, the MOS-like turn off behavior was the key value designers appreciated and as result the H3 has been successfully designed into designs switching up to 80 kHz, thus showing the IGBTs presence expanding into higher switching frequency domains. Feedback from customers regarding electromagnetic compatibility (EMC) behavior of the H3 has been very positive and as a result, the TRENCHSTOP™ 5 was designed to have the same level of di/dt, voltage overshoot and settling time behavior during turn off as the H3.

The significant improvement in the performance of the new H5 version of the TRENCHSTOP™ 5 meanwhile comes from the losses occurring during the turn-off phase. This can be seen clearly in figure 4 where the area of voltage versus current is significantly lower for the H5, whilst the same level of di/dt and voltage overshoot are maintained.

Full Comparison with Infineon's HighSpeed 3 Technology

Compared to the HighSpeed 3 (H3) family, the TRENCHSTOP™ 5 shows a significant improvement in all static and dynamic parameters. It provides

- 50V higher blocking voltage to allow for bus voltage increases without compromising reliability. Also for solar applications, cosmic radiation robustness in increased
- 250mV lower conduction losses ($V_{ce(sat)}$) and a factor of 2 lower turn-on/-off switching losses (E_{on} and E_{off}), resulting in the highest efficiency high speed IGBT ever released.
- drastic reduction of C_{oss}, C_{re}s ensures benchmark light load efficiency
- 50% reduction in gate charge (Q_g) allows for lower power driver ICs to be used without sacrificing performance and enables a system cost reduction
- Mild positive temperature coefficient of the conduction and switching losses mean efficiency is not sacrificed when devices are driven with higher junction temperatures and thermal run away during paralleling is not a problem.
- The TRENCHSTOP™ 5 uses the brand new Rapid silicon diode as the free-wheeling diode (FWD), which offers 50ns reverse recovery time (t_{rr}) and temperature stable forward voltage (VF). This ensures turn-on losses are minimized and overall efficiency is optimized.

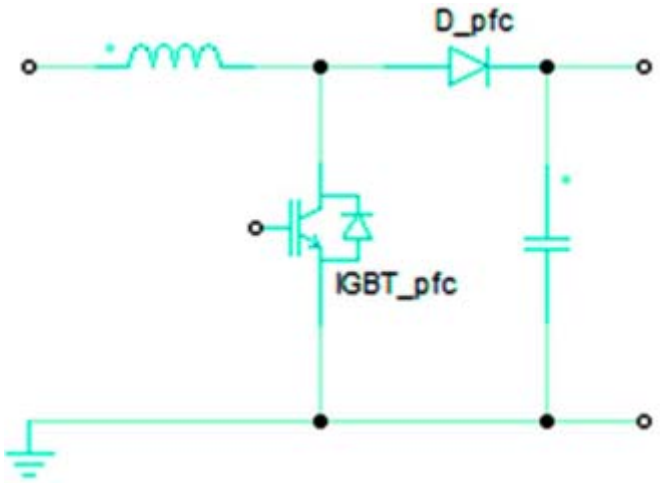

Figure 5: Standard PFC configuration used for comparison analysis

Application Measurements Proving the Benefits of the TRENCHSTOP™ 5

To highlight the performance the new TRENCHSTOP™ 5, application measurements have been carried on a standard power factor correction (PFC) circuit comparing a 40A H3 device against a 40A TRENCHSTOP™ 5 H5 device.

The 500W PFC efficiency is measured at 70 kHz under low line conditions. The IGBT is being used in the boost position as denoted by IGBT_pfc, whilst Infineon's new 650V ultrafast recovery Rapid diode is being used as the boost diode denoted by D_pfc.

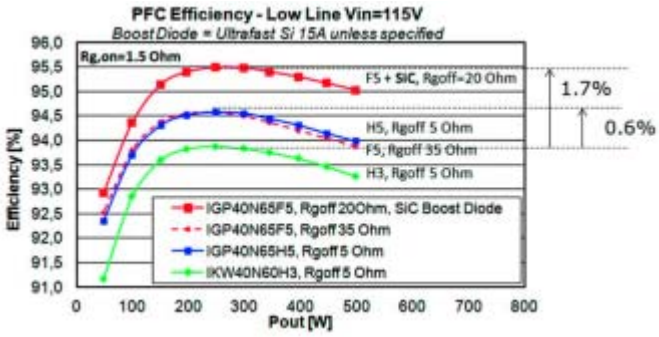

Figure 6: 70 kHz PFC measurement comparison

The gate driver circuit is kept the same throughout the investigation with the turn-on/-off gate resistor value kept at 5Ω.

From the measurements, as shown in figure 6 below, the PFC efficiency has been improved by 0.7% when the TRENCHSTOP™ 5 H5 version has replaced the H3.

This indicates that with the same gate driver circuit configuration and EMC levels, just by performing a straightforward "old IGBT out – new IGBT in" test, a considerable efficiency improvement has been achieved. This low design effort, to get almost instant efficiency improvement on existing designs adds value to end customer products.

Conclusion

Through application measurements it has been proven that the TRENCHTOP™ 5 sets a new benchmark for IGBTs switching greater than 50 kHz. As a result of the best optimization of carrier profile in combination with Infineon's further advancement of thin wafer technology, a dramatic reduction in both turn-off and turn-on losses in hard switching applications, along with a low $V_{ce(sat)}$ value provide an IGBT that can achieve a considerable improvement in the highlighted PFC topology above. Furthermore, the overshoot and EMC behavior is on the same level as the well-known HighSpeed 3 series. The H5 with the Rapid diode as the free-wheeling diode offers an ease-of-use solution for high performance hard switching industrial applications like photovoltaic inverters, UPS and welding. The TRENCHSTOP™ 5 extends the performance range of the IGBT, it is now up to designers to harness the full capability. Further information can be attained via www.infineon.com/trenchstop5

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Developing Custom Power Module Solutions

What has to be considered

In the last few years, the power module market demand quickly changed due to the stringent power design constraints of cost saving and efficiency increase in the final application. R&D engineers are working for innovative solutions where high integration level and latest chip technologies are the driving factors in the design phase. Power modules suppliers are compelled to fulfil these requirements and to deliver solutions that are optimized to meet customers' wishes. Semikron did also put into the focus custom solutions, tailored to customer's needs in order to offer the best assembly solution. This article outlines all the aspects to consider when offering a custom solution in order to fulfil the continuous change in market demand of power modules design and performances.

By Eng. Marco Di Lella - Product Manager Semikron Italy

The today R&D power engineers are working to develop electrical topologies which are able to ensure the best efficiency performances, power consumption and space reduction.

There are some markets that are very sensitive to these topics. UPS and solar market are the best examples: the layout complexity can be very different from customer to customer and there is a continuous research to find out the best electrical solution and the minimum number of power modules to be used to achieve high performance level. Electrical vehicle application is a new emerging market where the above topics will become the challenging point when offering a power module solution.

Some other markets, like welding or motor drive, are not affected by these constraints and quite standard electrical configurations are required; just slight changes in the existing configurations and possible redesign based on the latest chip technologies are required. For such kind of market, the most cost effective product is the winning factor for the power suppliers. Figure 1 show how customer needs and power suppliers strategies are interconnected.

	Customer requirements		Power suppliers strategy	
	High integration level due to complex layout	High efficiency	Compact solution offer	Cost
UPS	o	o	++	+
Solar market	o	o	++	+
Motor drive	x	x	-	++
Welding	x	x	-	++
Power supply	x	o	-	+
EV applications	o	o	++	+

o required
x not required
++ Very important
+ Important
- Not so important

Figure 1: Customer demand and power supplier offer matrix interconnection

Depending on the market there are different strategies implemented:

a) Non cost driven markets: the winning factor is the capability to offer solutions that meet customers specific needs. Differentiation is the key word in this case, so that customer can perceive the uniqueness of the solution that other competitors are not able to offer.

b) Cost driven markets: it will be needed to offer quite standard solutions. This market is normally based on high quantities per year.

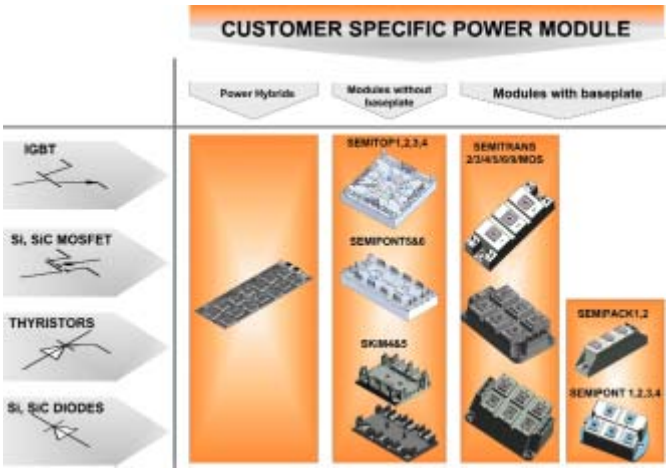

Figure 2: Available platforms and chip to offer custom solutions

Semikron offers power module solutions to meet both market demands and recognizes that custom solution is an important market. Semikron´s target with its subsidiary Italy is to serve customers with special type products.

There are three important key points:

- focus to the application
- fast time to market
- customer differentiation

Focus to the application
Semikron offers the right chip technology in the right power modules in order to meet customers' requests. This leads to the advantage of a high power integration level and space saving.

Semikron offers power modules with or without baseplate, featuring different power contact interface such as soldering terminals or screws terminals. The platforms can integrate the latest chip technologies like SiC diodes, Mosfet even for high voltage applications and IGBT for high switching frequencies (Figure 2).

The application support team suggests the best combination between chipset and power module. The experience in different application markets such UPS, PV, electrical drives, welding and railway help together with thermal and electrical simulations support to choose the right housing and the right number of modules to build up the required electrical configuration and thus ensuring the best thermal performances of the application.

The newest chip technologies are all qualified from reliability and dynamic perspective. Chip technologies that have passed more than 17 different reliability tests for more than 10.000hours of tests are considered for a custom project.

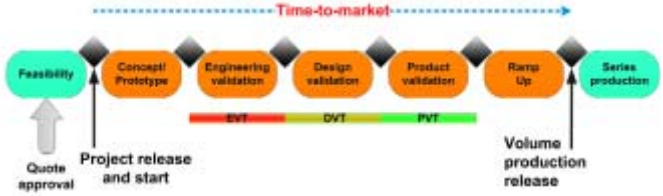

Figure 3: Product life cycle process

Fast time to market
Power electronics is a dynamic market and product development and introduction are particularly critical. How fast the first prototypes can be ready and how fast the mass production can be released are essential market success factors for a customer: to be first in the market means to capture market share respect to the competitors.

Any new project starts with the customer and ends to the customer passing through the power supplier project evaluation, defining the product life cycle process.

Time-to-market is measured as the time between project release and volume release.

Each validation phase consists of a series of steps to be fulfilled; at the end of each validation phase some prototypes are produced and delivered to customer for final approval in order to proceed to the next step.

Semikron Italy supports his customers every day to achieve fast time to market when developing a new project. This means collaboration in all project phases: the customer is involved during the project definition to ensure a quick definition of engineering specifications. This helps to eliminate changes late in the design process when they are very expensive so to get the right request the first time.

Software support is used to minimize the engineering workload so to ensure that every product performs according to customer requirements. This allows to manufacture a custom module quickly and according to customer request.

Semikron has built up a flexible production: similar products are grouped into families that can be processed in one of the same equipment in the same sequence. This allows to shorten changeover time between products. The production lead time is therefore reduced, resulting in high quality manufacturing products, with lower manufacturing costs and on time delivery.

Customer advantages
The power module market is often based on standard electrical configurations. In most cases a custom solution is not available in the market and customer has to put in place a lot of efforts to achieve the desired configuration. More than one power module could be necessary to assembly the final configuration; the number of modules even increases with configuration complexity level. The required space for the application becomes relevant and PCB routing becomes more difficult, especially if the pin-out is not optimized for this purpose. Customer is going therefore to face a huge bill of material management and a lot of efforts in the logistic. PCB routing issues enlarge the development time and the final application cost will increase. Nevertheless customer will need more time to enter the market.
A custom-made solution becomes therefore the right solution to overcome the above issues. By using custom electrical configurations, the number of modules can be reduced and each power module will feature only the needed electrical requirements. PCB design efforts are reduced saving development time thanks to a perfect match between module pin-out and PCB routing needs. There is a significant reduction of bill of material and easier logistic and assembly process is achieved. Assembly error occurrence is reduced and manufacturing reliability is increased.

As matter of fact a custom solution reduces the form factor of the final application with space saving and cost reduction respect to the use of standard modules.

A case study has been carried out by considering the development of a three-phase PWM rectifier buck converter featuring IGBTs and diodes rated for 40A/1200V as per picture 4.

Comparison between a standard solution based on TO devices and a custom solution based on SEMIPONT™6 platform by SEMIKRON has been performed.

- Due to reduced parts to manage, the assembly time is reduced. Just one module against 27pcs to handle, with an estimated assembly time reduction up to 85%.
- Reduced parts to handle reduce the risk of assembly error occurrence. Manufacturing errors can be reduced up to 80%. Less parts to handle ensure higher manufacturing reliability and higher first-pass yield.

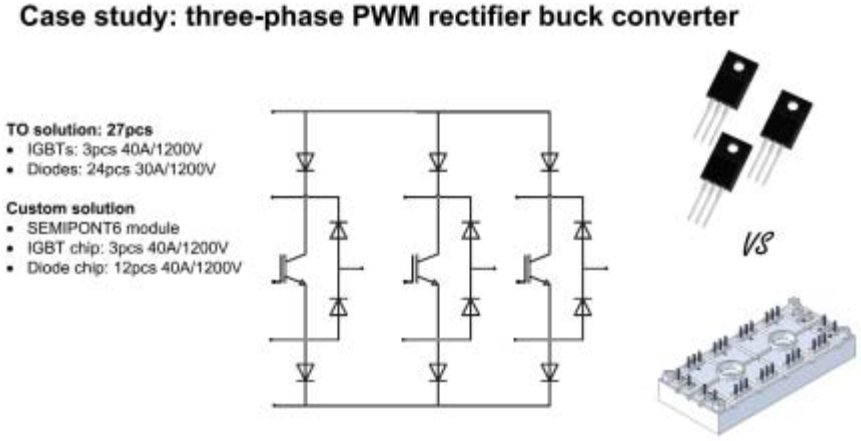

Figure 4: Three-phase PWM rectifier buck converter design

Due to the very complex layout, 27pieces of TO devices are needed against one SEMIPONT™6 module integrating the whole three-phase configuration. One screw per TO device is needed for heat-sink assembly, while the power module needs one assembly step with only two mounting screws. There is a clear benefit in the PCB routing, since the power module pinout has been designed according to customer requirements while TO devices do not feature flexible power pins position.

Conclusions

Besides volume driven standard configurations in power modules Semikron offers also customer specific topologies in various housings addressing the market need for differentiation in dedicated applications. Semikron has established in its subsidiary Italy a support and production structure to handle specific customer demands in a short and effective way with dedicated application support team, experienced R&D team and a flexible module production.

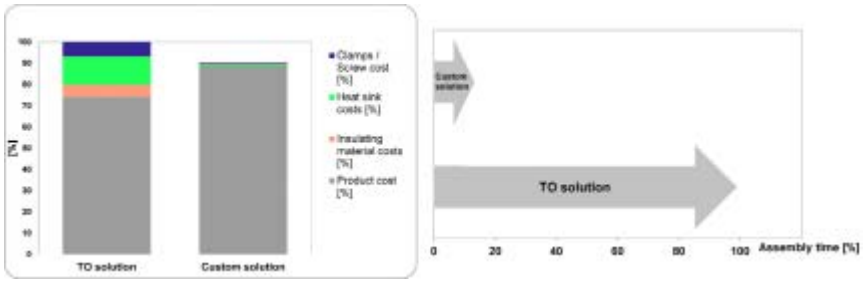

Figure 5: Material cost split and assembly time comparison

The investigations confirmed therefore the benefits in using a custom solution especially about material costs, assembly time and manufacturing process:

- A significant bill of material reduction leads to a 10% lower material costs for the custom solution. The cost breakdown is shown in picture 5.

Customer realize the benefits of a custom solution in terms of easy assembly process due to reduced material handling, form factor reduction due to high integration level and higher production reliability.

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Trench XPT IGBT for Maximum Energy Delivery

With the introduction of the 650V Trench XPT IGBT technology IXYS sets a milestone in energy efficiency providing a best in class solution for IGBTs, by combining an innovative and unique trench gate architecture with well-established XPT (eXtreme light Punch Through) thin wafer technology. With its transparent emitter design and a newly applied technology of precisely controlling the injection efficiency IXYS has successfully developed this new IGBT technology resulting in measurable advantages to latest trench devices available on the market.

By Iain Imrie, Elmar Wisotzki, Jeroen van Zeeland – IXYS Semiconductor GmbH

In 2008 IXYS successfully introduced the 1200V XPT planar portfolio followed by the expansion to a broad 650V XPT planar product line in 2010. Continuous improvements of the device performance are targeted to follow the high efficiency demands in hard switching applications. The 650V range, rated to a maximum junction temperature of 175°C is selected as a carrier product portfolio for this new trench gated XPT IGBT because of the increased demand in the 650V market. This increased popularity is mainly caused by the popularity growth of the Neutral Point Clamped (NPC) configurations. In general customers are interested in the efficiency benefit of the NPC inverter topology.

For optimal usage the NPC configuration requires different switches which are optimized for different frequencies. Therefore the new Trench XPT IGBTs are available in medium and fast speed versions. XPT IGBTs are performing best when using a SONIC Free Wheeling Diode (FWD). The SONIC portfolio is also optimized to serve these different speed classes. A new edge termination design for the 650V SONIC, medium (low Vf) and fast (high speed), diodes has been introduced ensuring high thermal stability and reliability at 175°C. For extremely demanding applications an extra step in efficiency can be made using a Silicon Carbide (SiC) Free Wheeling Diode. The product Trench XPT IGBT portfolio will thus be offering both Silicon and SiC FWD options as standard products.

The new Trench XPT IGBTs offered by IXYS show a milestone improvement in trade off performance compared to the latest competitor trench IGBT devices available on the market. This is proven in comparative trade off measurements of the normalized turn off losses (Eoff) versus static losses (VCE(sat))as shown in figure 1. The Trench XPT devices with comparable Vcesat values to competitor parts show a significant reduction in turn off losses of approximately -25% leading to best in class devices. The medium speed class of Trench XPT devices show an even more drastic turn off loss reduction of almost -40% with only a marginal (4%) higher value in VCE(sat).

XPT Characteristics

IXYS' XPT IGBT was designed to provide low switching losses while retaining low on-state voltage. This was achieved with improved SOA and short circuit ruggedness ratings. The output characteristics at different temperatures are shown in Figure 2.

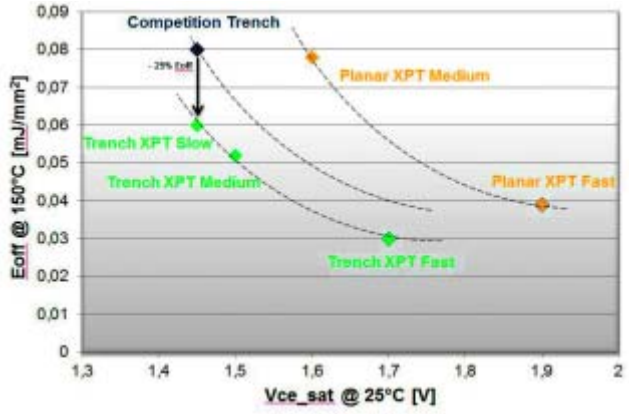

Figure 1: Trade off comparison, 650V IGBTs

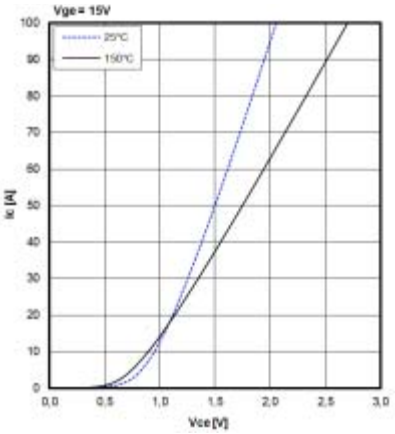

Figure 2: Trench XPT output characteristic

The Trench XPT has a low VCE(sat) (1.5V @Inom,25°C & 1.75V @Inom, 150°C). The positive temperature coefficient of the Trench XPT provides a negative feedback, making the XPT suitable for paralleling in modules or circuits. In addition to the low VCE(sat) the Trench XPT also has a low off-state leakage current at 150°C (<100µA @650V). The switching characteristics of the 50A, 650V Trench XPT are shown in figures 3 & 4.

As can be seen in figure 3 the current waveform has a smooth switching behaviour reducing EMI and resulting in small over voltage transients. The linear voltage rise and short tail current during turn-

off, leads to reduced losses (Eoff = 1.2mJ). The Trench XPT has a low gate charge (Qg = 95nC @15V), requiring lower gate drive power when compared to other standard trench IGBTs.

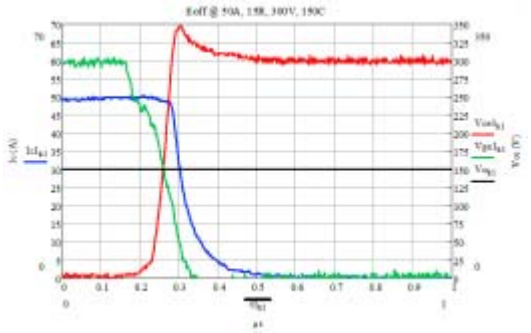

Figure 3: Trench XPT turn-off characteristic

XPT and SONIC – the perfect match

The latest 650V Trench XPT generation has a higher maximum junction temperature of Tjmax=175°C. Consequently an improved complimentary fast recovery diode design was developed utilizing p-doped guard rings, with new metal field plates and an optimized passivation layer termination structure; allowing for a higher junction temperature up to 175°C. The optimal match for reduced turn-on losses is achieved when the 650V Trench XPT with its higher current density is used alongside the metal field plate IXYS Sonic diode which also has a low on-state voltage with excellent temperature behaviour. The Sonic diode has soft recovery characteristics, which allows the Trench XPT to be turned on at very high di/dt's even at low current and temperature conditions where usually diode snappiness can occur. The Sonic diode retains soft switching behaviour during turn-off of freewheeling currents nullifying EMI problems.

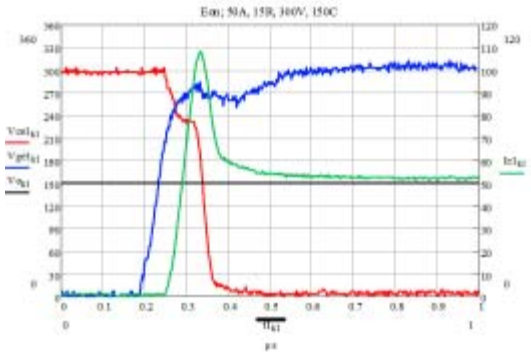

Figure 4: Trench IGBT turn-on characteristic

Sonic diodes combine a low reverse recovery current along with a short reverse recovery time, as shown in figure 4 to minimise the turn-on energy of the Trench XPT (Eon = 1.3mJ). The Sonic diode Vf is less sensitive to temperature resulting in better suitability for parallel operation of diodes and minimizing switching losses.

Rugged XPT Characteristics

The IGBT behaviour under short circuit conditions is a very important issue relating to motor drives applications and the IXYS XPT IGBT has shown extremely rugged performance during short circuit testing. The chip design was optimised with a low forward transconductance, therefore providing an approximate short circuit current of 4x nominal current to ensure robust short circuit performance.

Figure 5 shows the 50A, 650V Trench XPT during short circuit with a gate voltage of +/-15V at 150°C for 10µs. Characterisation of the Trench XPT technology showed extreme ruggedness during short circuit of the device at elevated voltages and temperatures for 10µs without any detriment to the IGBT characteristics. The Trench XPT has a square RBSOA at 650V up to two times nominal current at very high temperatures (150°C).

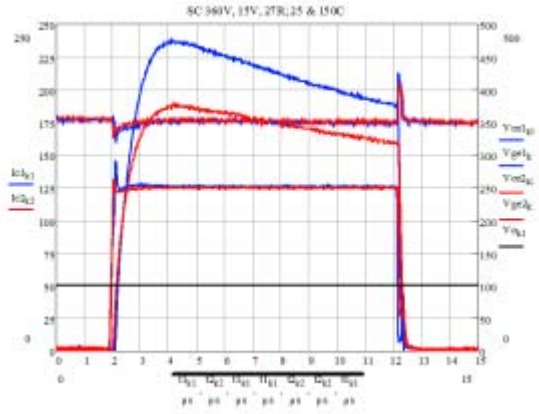

Figure 5: Trench XPT IGBT short circuit characteristic

Trench XPT & SONIC Reliability Assurance

Due to the increase in the maximum junction temperature (Tj max) of the 650V Trench XPT the following quality tests were accordingly verified; High Temperature Gate Bias (HTGB), High Temperature Reverse Bias (HTRB) and Humidity. Correspondingly the new improved metal field plate SONIC diode design was also verified according to increased HTRB and Humidity tests. Both of the new chip designs demonstrated outstanding stability and ruggedness with regard to elevated junction temperature and tough environmental conditions.

Product availability

More detailed information about the Trench IGBTs is displayed in the datasheet of the available devices. These are accessible under www.ixys.com. See figure 6 for an overview of a few selected Trench IGBT discrete and module products; please notes that the package and current specification influences the VCE(sat) value.

Part Number	V_{CES} [V]	$I_{C110/90°C}$ [A]	$V_{CE(sat)}$ [V]	E_{off} [mJ]	R_{thJC} [K/W]	Conf.	Speed class	Package
IXXH30N65B4	650	30	1,66	0,60	0,65	Single	Medium	TO-247
IXXH60N65C4	650	60	1,80	0,93	0,33	Single	Fast	TO-247
IXXH60N65B4H1	650	60	1,70	1,34	0,33	Copack	Medium	TO-247
MIXD80PM650TMI	650	82	1,50	1,8	0,55	Multi Level	Medium	MiniPack2B
IXXN110N65B4H1	650	110	1,75	1,40	0,17	Copack	Medium	SOT-227B
IXXX160N65B4	650	160	1,54	2,36	0,16	Single	Medium	PLUS247
IXXK200N65B4	650	200	1,40	2,54	0,13	Single	Medium	TO-264

Figure 6: Selected overview of the Trench XPT Portfolio

Herewith the measurable advantage of the Trench XPT IGBT is shown compared to existing Trench and Planar technologies. Directly compared with the competitor Trench devices the Trench XPT IGBT gives a ~ 25% Eoff benefit. Therefore IXYS with its Trench XPT IGBT technology combined with the SONIC diode sets a new milestone in energy efficiency.

www.ixys.com

Advances in Power Devices Driving Class-D Amplifier Progress

The success of class-D audio amplifiers in important home, in-car and portable markets has brought new opportunities for engineers to explore new design avenues and so differentiate their products from those of competitors. Class-AB amplifier design, on the other hand, now offers few such opportunities and brings size, weight and power penalties that are unwanted especially in portable or mobile applications.

By Jun Honda, International Rectifier Corp

As class-D design continues to progress, further improvements in audio output, physical size, energy efficiency and sound quality are closely linked to improvements in component performance.

Critical IC Improvements

The key components of a class-D amplifier are the PWM-control IC and the audio MOSFETs. The improvements in control ICs are mainly concerned with increasing noise immunity, to deliver a better listening experience for the end user. Chip makers such as IR are able to draw on experience gained in kilowatt-class switching motor drives to achieve this.

As far as MOSFET performance is concerned, device designers are optimising devices at the silicon level for better on-resistance x gate-charge Figure of Merit (FoM) and tighter control over the gate charge and input/output capacitances to enhance switching speed and accuracy and so minimise audio distortion. In addition, multi-die integration in advanced packages such as DirectFET® is allowing devices dimensions to be reduced. The package technology is helping improve switching performance, power rating and efficiency by lowering stray inductance and promoting dual-sided cooling for increased power dissipation. The reference designs mentioned earlier are able to operate at high power outputs without the use of a separate heatsink.

Current practice for controller ICs can be seen by examining a device such as IR's IRS2092, a single-channel audio driver in 16-pin PDIP or SOIC package. Integrated on-chip are an error amplifier, PWM comparator, switching stage with deadtime insertion, shutdown and over-current protection, and click-noise reduction. Its 1.2/1.0A MOSFET gate-drive capability allows use with various digital audio MOSFETs covering applications from 50-500W audio output-power.
The IRS2052, IRS2053 IRS2093, capable of driving two, three or four audio channels respectively with 0.5/0.6A MOSFET gate-drive capability, are closely related controllers in the MLPQ48 package. These devices provide a selection of additional features such as clip detection, temperature-sensor input, thermal shutdown, DC-offset protection and on-chip oscillator.

MOSFET Selection and Audio Power

To complete the amplifier design the controller is teamed with a pair of optimised digital audio MOSFETs capable of satisfying the audio output power requirements of the target application. Figure 1 shows how the output MOSFETs can be selected based on voltage rating and the target audio output power.

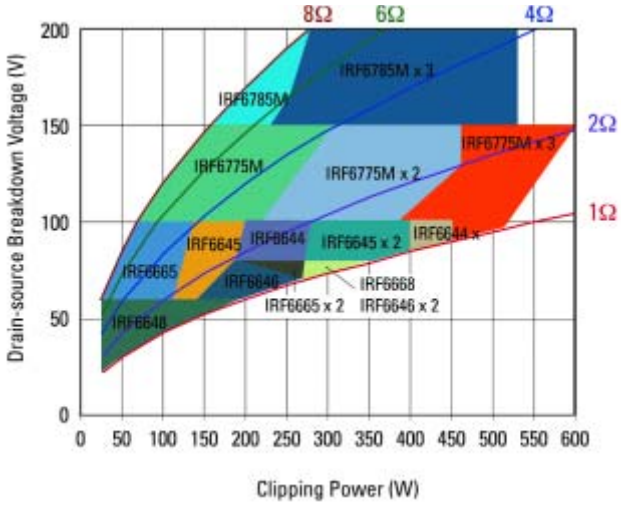

Figure 1: MOSFET selection based on voltage rating and audio output power

This approach, using highly integrated controller/driver ICs and discrete audio power MOSFETs, allows designers to use relatively straightforward component-selection processes not only to optimise audio performance but also to scale their amplifiers to achieve the desired number of audio channels and output power. Single- and multi-channel controller/driver ICs sharing a common package style and compatible pin-outs, and a growing choice of optimised digital audio MOSFETs offering various ratings in DirectFET® or other industry-standard packages such as the TO-220, permit re-use of a single topology, component layout and PCB to create a family comprising several differentiated amplifier products.

Reference design	Output power (4Ω)	Controller/driver IC	Audio output MOSFETs
IRAUDAMP5	2x120W	IRS2092	IRF6645
IRAUDAMP8	4x120W	IRS2093	IRF6665
IRAUDAMP10	2x300W	IRS2052	IRF6775
IRAUDAMP11	3x120W	IRS2053	IRF6665

Table 1: Scaling amplifier designs by driver and MOSFET selection

IR has completed a number of reference designs that speed up development and illustrate how designs can be scaled. The IRAUDAMP5 2x120W (into a 4Ω load) reference design combines the IRS2092 with two IRF6645 devices. this, and similar reference designs based on the multi-channel drivers are summarised in table 1.

Innovation in Integration

Another evolutionary direction is towards greater silicon integration, as seen in families such as IR's PowIRaudio™ IR43x1 and IR43x2 series, which have supply-voltages ranges of 40V, 60V or 80V. This approach has now reached the point where the output power MOSFETs are integrated in the same package with the amplifier control functions, resulting in considerable reduction of component count, circuit complexity and board dimensions. Figure 2 compares the functions of these fully integrated devices with those implemented in the discrete controller/driver ICs. The internal design of the integrated devices draws on the PWM switching and noise handling proved in discrete controllers, and the advances in digital audio MOSFETs, to deliver high audio performance within a significantly smaller overall pc-board area.

The controller IC of these single-package amplifiers includes the circuitry for protection features such as over-current protection, thermal shutdown and support for an internal or externally triggered shutdown

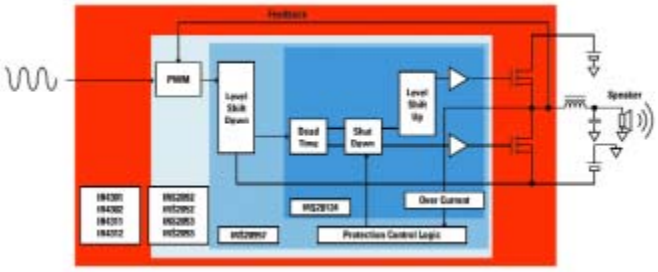

Figure 2: The latest class-D amplifier ICs integrate output MOSFETs in the same package

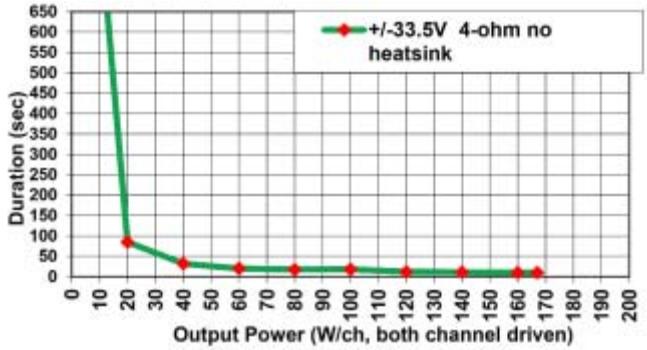

Figure 3a: Power duration for heatsink-free design using a single amplifier IC

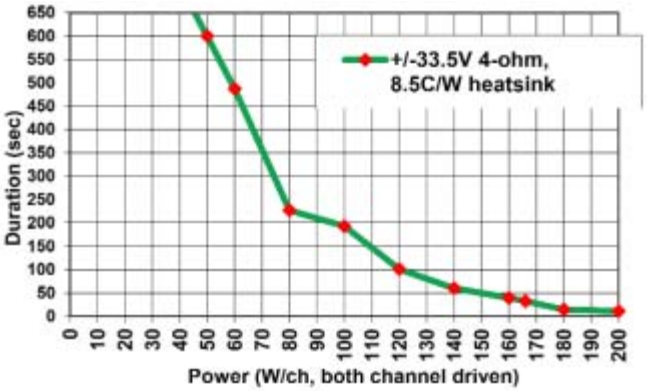

Figure 3b: Extending power duration by adding small heatsink

mechanism. Clip detection is also featured on selected models. All devices can be operated from a single power supply or from a split-rail configuration.

Taking advantage of established experience with class-D amplifiers, these devices also prioritise efficient cooling for optimum MOSFET performance with smooth efficient switching for low distortion and high reliability. The latest devices use IR's 5mm x 6mm (for single-channel devices) or 7mm x 7mm PQFN low-profile power package, which features terminals connected to large exposed thermal pads for efficient heat dissipation.

Architecture and Peak-Power Duration

A major incentive for designers adopting class-D amplifiers is the opportunity to create compact designs, taking advantage of the inherently high efficiency of the switching amplifier principle to minimise the size and bulk of any heatsinks required. The single-package devices are able to operate with no heatsink for defined periods up to the maximum power, as figure 3a illustrates. This is for a 2x70W design using a 2-channel IC. Figure 3b shows how the maximum permissible operating time at high power outputs is extended by fitting a heatsink rated for 8.5°C/W.

Figure 4: Amplifier architecture selection by power duration

An alternative approach for extending the power duration is to use a different amplifier design combining two or more single-channel devices. For example, an amplifier built using two single-channel IR4301 devices can drive 2x70W for longer than the design of figure 3a/b built with a single IR4302. Figure 4 shows how the power duration can be adjusted by using single-channel or two-channel ICs in heatsink-free designs or with a heatsink fitted. It is worth noting that a discrete solution using external digital audio MOSFETs is recommended for applications requiring the best power duration.

Fully integrated class-D amplifiers allow designers to build products combining compact dimensions and very high audio performance, with THD+N as low as 0.02%. The resulting designs contrast starkly with traditional class-AB products, which typically require large, finned heatsinks even at relatively low audio power ratings. IR has compiled six PowIRaudio reference designs based on these devices, for applications ranging from 35W to 130W per channel.

Conclusion

The design and performance of class-D audio amplifiers continues to improve, closely linked to advances in optimised semiconductors. As efficiency and distortion move closer toward ideal values, and heatsink-free designs become feasible for some applications, engineers also have the choice of fully integrated amplifier ICs or a controller/driver with discrete digital audio MOSFETs to deliver competitively priced new products offering higher audio power, higher energy efficiency, smaller size and lower weight.

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Pushing the PoE Envelope

New requirements will demand triple the power of the current standard

Advances in Powered Device (PD) energy management ICs are enabling implementation of Power-over-Ethernet (PoE) devices requiring up to 90W.

By James Ashe, VP of Marketing, Akros Silicon Inc.

Power-over-Ethernet (PoE), like many design innovations, was developed to solve a problem: Voice-over-Internet-Protocol (VoIP) phones needed a reliable power source, and powering the phones over the Ethernet cable would eliminate the need for wall adaptors. In response, Cisco Systems pioneered PoE technology in 2000, and in June, 2003, the IEEE 802.3af standard was published. This first PoE standard allowed for PoE operation of Powered Devices (PD) up to 13 Watts and opened up a new market for PoE devices including Ethernet phones, wireless access points and security cameras. In 2009, the new IEEE 802.3at standard, sometimes referred to as PoE+, expanded the power delivery to 25.5 Watts. Both of these standards utilize one differential pair of wires in a standard Ethernet cable and RJ-45 connector.

In January 2012, Cisco published a whitepaper promoting a further advance to PoE that supports up to 60 Watts. This new configuration utilizes two differential pairs in a Cat 5 or Cat 6 cable and RJ-45 to deliver power to the PD. At this increased power level, PoE is now practical for a whole range of devices including thin clients, monitors, IPTV, building management systems, industrial networking and a host of other higher power applications. And just as the "af" standard evolved to "at," there are already many applications that require up to 90W, making a range of new candidates for deploying higher-power PoE.

Implementation of 60W/90W PoE

Implementation of advanced PoE systems will require the availability of Power Sourcing Equipment (PSE) that is capable of delivering 60W or even 90W of power, as well as an effective technology solution for PD product manufacturers to incorporate into their new designs.

60W/90W PoE implementation at the PD needs to take into consideration a number of important factors:

- Multi-rail power conversion configurable to voltages required for device sub-systems including LED backlighting.
- Real-time energy monitoring – such as input power measurements, power system health monitoring on a continuous basis.
- High-efficiency conversion – including light load management, ultra-low standby power and sleep-mode power.
- Fast system dynamic response and sequencing control – including the ability to rapidly change operating mode of the device from continuous to discontinuous modes and to rapidly go in and out of standby and sleep modes; flexible sequencing control to optimize multiple-rail output power start-up.
- Digital power control – such as voltage margining to manage power consumption under differing performance requirements, managing standby and sleep requirements.
- High-efficiency EMI control and mitigation – minimizing radiative and conductive emission noise from the power supplies.

Total Energy Management

The system designers' challenge is to achieve all necessary design requirements by providing an implementation that has the highest system efficiency, is adaptable, occupies the smallest possible PCB real estate, and is cost effective.

Akros Silicon recently introduced the AS1860 (Figure 1), the latest member of the company's family of system-on-a-chip (SoC) energy management ICs that offer PD designers an integrated solution to 60W/90W PoE implementation. The device utilizes Akros' GreenEdge™ technology that provides 2KV of digital isolation without the use of optocouplers and their associated compensation networks.

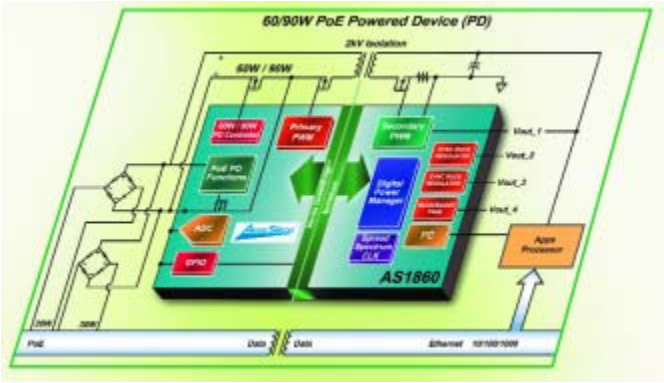


Figure 1:
Akros' AS1860 SoC IC enables 60W/90W PoE implementation.

In order to achieve the requirements listed above for PoE implementation in Power Devices at these higher power levels, a total energy management approach is needed that not only provides high-efficiency power conversion ICs, but also focuses on total system efficiency. The objective is to dynamically control the power by monitoring the environment resulting in truly efficient system designs – not just of power sub-conversion. Additionally, a total energy management approach minimizes emissions, systematically, at the source.

Alternative approaches to higher power (60W and above) PoE deployments require multiple components, such as two or three power management ICs, several optocouplers and custom transformers. In addition to adding component cost, consuming board space and increasing design complexity, these approaches are vulnerable to shoot-through issues and losses due to rectifier diode and reverse recovery. In contrast, Akros' approach can accommodate 60W and

above PoE applications using just two components: one AS1860 SoC and one external FET. Moreover, by integrating GreenEdge digital isolation, the AS1860 enables the implementation of many advanced diagnostic and high-voltage telemetry features that allow operators to remotely manage power, which in turn enhances reliability and energy efficiency.

PSE – PD Interoperability

The IEEE has instituted a working group to establish a new PoE standard for the rapidly approaching higher-wattage implementation. In the meantime, it will be important for designers to be assured of interoperability between PSE and PD implementation. Recognizing this, Akros has entered into an interoperability collaboration with Broadcom, leading producer of PoE PSE power controllers. Broadcom's model BCM59111 and Akros Silicon's AS1860 (Figure 2) interoperability was demonstrated at electronica 2012 in November, 2012.

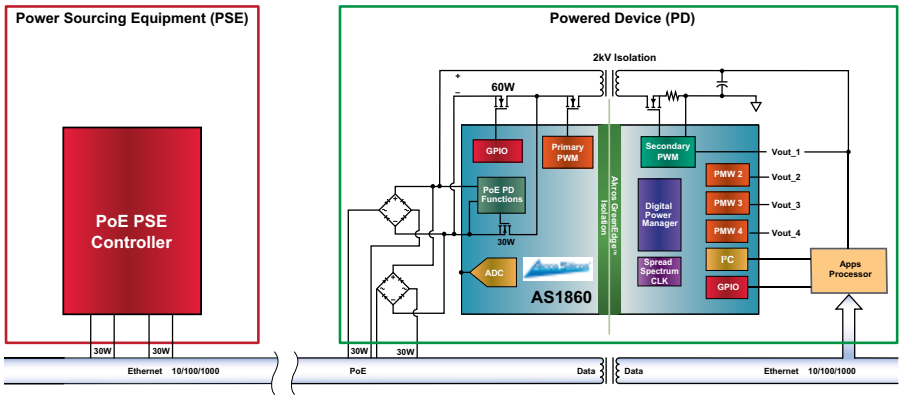


Figure 2: Interoperability of Broadcom's PoE PSE controller (BCM59111) and Akros' SoC IC (AS860)

Conclusion

As Ethernet bandwidths continue to increase, the nature of the devices that will require PoE will also increase. With bandwidths supporting IPTV, Point-of-Sale Terminals and other such devices, the need to manage system power will become even more important. Power Sourcing Equipment power requirements will be managed by having the ability to adjust the power delivered to the Powered Devices under widely varying operating conditions. The PDs will be required to provide this information in real time and respond to PSE control inputs. The total energy management approach presented in this article provides a proven and cost-effective means of responding to the evolving – and increasing – demands of PoE systems.

www.akrossilicon.com

New Approach to Thermal Management via Advanced Heat Transfer Solutions

Much of modern life relies on the transporting, processing and storing of huge quantities of data through highly integrated semiconductor technology.

By Neill Ricketts, CEO, Versarien

Electronic products are being packed with a greater number of features and enhanced functionality, but their physical dimensions are being squeezed further and further, to fulfil consumers' desires for sleeker form factors. Bandwidths are continuing to rise, yet the space into which complex digital systems must be housed is simultaneously decreasing. The removal of heat from the area around the central processing unit (CPU) at the heart of these systems is, as a result of this, becoming an ever more pressing challenge.

As each generation of microprocessor chips make use of smaller package formats while containing a larger numbers of transistors (in line with Moore's Law), the higher levels of heat being generated potentially put system reliability at risk if this heat cannot subsequently be dissipated.

Industry now faces the issue of finding more effective ways to deal with the heat present within electronic designs so that operational longevity is not compromised. Conventional heat sink solutions are no longer proving to be adequate, as they do not offer the high levels of thermal performance necessary, plus they are in many cases too bulky to be implemented within space constrained system designs. New thermal management products which are now being called for will need to maximise heat transfer performance, while still offering a cost effective, robust implementation. In order to tackle this increasingly serious problem, for most of the last decade researchers have looked at how micro-porous metallic materials, which emulate the high surface area structures found in nature, might enable more effective transfer of heat to be realised.

Taking Inspiration from Nature

In both plant and animal physiology there is an overriding need to maximise all available surface area. This means that the various biochemical processes taking place can be carried out with the highest levels of efficiency. Sponges and corals, for example make use of their porous physical form to ensure that they can absorb enough nutrients from the external environment. Bone also has a porous nature so that it is lightweight while still having a high degree of mechanical strength.

Figure 1: Mixing of Copper & Non-Metallic Particles

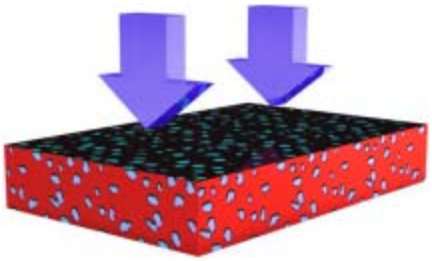


Figure 2: Compacting of Mixture

Figure 3: Application of Heat to the Mixture

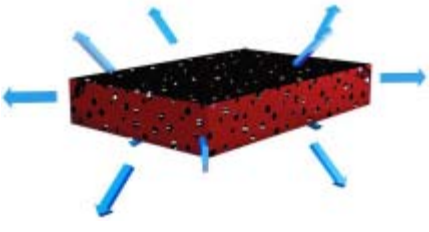


Figure 4: Removal of Non-Metallic Particles from the Mixture

The main obstacle holding back the use of micro-porous metallic structures in thermal management has been making the fabrication process simple and cost effective enough to be commercial viable. Several years ago, members of the University of Liverpool's Department of Engineering started to investigate how this problem might be resolved. The Lost Carbonate Sintering (LCS) process that was subsequently developed there allows the production of a copper base material with a homogeneous distribution of micro-fine open cell pores throughout. The porous metal structure that this process is capable of creating has, as we will see, several key benefits.

LCS Process

The LCS process developed at the University of Liverpool consists of 4 main stages (Figures 1 to 4 illustrate these):

1) Firstly the copper particles are mixed together with non-metal particles. The ratio of copper to non-metal particles

Figure 5: VersarienCu

and the particle size will affect the pore diameter and pore density of the material that is finally produced.

2) Next the mixture is compacted into net or near net shape forms.
3) Heat is then applied to the compacted mixture by placing it in a high temperature industrial oven. The copper particles within the mixture adhere to one another other without melting. Temperatures of around 1000 °C (within a vacuum) are needed for completion of this stage. The heat also causes the non-metal particles to be eliminated (or this can be done via dissolution after the material is cooled).
4) Quality assurance and customisation activities (such as finishing) are then carried out.

The optimised morphology and designed surface area of the resulting open cell porous metal material allows far more efficient heat transfer than previous porous metal solutions. This means that larger quantities of thermal energy can be dissipated.

Commercialising LCS

Having partnered with the University of Liverpool and C-Tech Innovation Ltd, Gloucestershire-based start-up Versarien has taken the innovative IP developed there and been able to transform it into a fully marketable product. Employing the LCS process, the company can deliver an economically viable permeable metallic foam material in high unit volumes. Its VersarienCu advanced thermal interface material has the capacity to radically change how heat dissipation is executed in modern electronic designs. Highly versatile, it can be applied to a broad spectrum of different industry scenarios – with the cooling mechanisms in servers, workstations, automotive systems and power conditioning equipment all benefiting from its use.

The VersarienCu offering is made from 99.7% pure, gas-atomised copper powder with a nominal 50 ìm particle size. It exhibits up to 10 times more effective transference of heat energy than conventional micro-channel heat sinks of equivalent size. A major reduction in heat sink weight and physical dimensions compared to competing products for a given level of heat transfer is thus possible, resulting in considerably smaller form factors. A heat transfer coefficient of approximately 150-200 kW/m^{2}K can be achieved (with 64% porosity, 425 µm pore size and a flow rate of 2 l/min using de-ionised water).

Porosity Characteristics

The pore morphology used in VersarienCu can be set to fit specific application requirements. Diameters from 20 µm to 1.5 mm can be specified. Overall porosity levels can also be altered as necessary, with 50% right up to 80% possible. Smaller pore sizes will improve heat transfer, but will at the same time demand higher pumping power so that the fluid can pass through the material. For this reason, engineers will have to decide on whether their design needs the extra heat dissipation made possible by such pore sizes or whether trade-offs can be made so that bill of materials costs can be kept in check.

As semiconductor devices become ever more complex and their form factors shrink still further, the heat they generate will continue to rise, thereby putting system reliability at risk. By applying the biophysical principles that govern nature to electronic design it is now possible to implement advanced thermal management solutions based on micro-porous metallic materials. This has led to implementation of less cumbersome and more effective methods for getting rid of unwanted heat.

www.versarien.com

Highly Integrated 8-Bit RGB Laser Driver for Automotive Projectors

Maxim Integrated Products, Inc. announced that it is now sampling the MAX3601, a highly integrated, 8-bit RGB laser driver for pico laser projectors in automobiles. It is a smaller size, brighter light, and lower cost solution than traditional technology, and it enables sharper, pixel-perfect heads-up displays (HUD) in automobiles.

This IC drives three RGB lasers to provide a brighter light without compromising the low power. The high intensity of the lasers project brighter, more vivid images onto the HUD to easily alert the driver while enhancing safety. In addition, its high integration means longer battery life, less heat build-up, and a smaller module size.

Key Advantages: Low cost: minimized PCB area with functional integration; three current-output laser drivers combined into one IC; Low power: with only 80 mW bias current, the device achieves maximum light output with excellent power efficiency; Small size and easier design/manufacturing: three integrated lasers eliminate the need for additional optics; High efficiency: less than 1W total module power provides long battery life, low heat dissipation, and minimal thermal sinking

www.maximintegrated.com

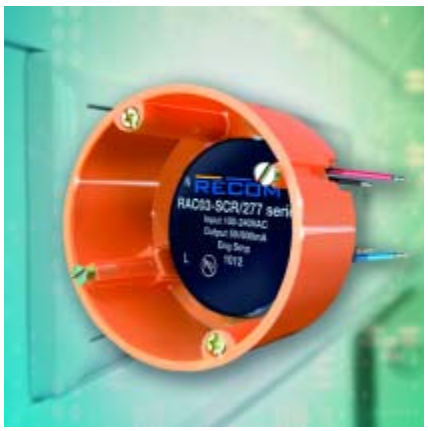
Lowest Phase Noise Frequency Synthesizer

Texas Instruments Incorporated introduced a wideband frequency synthesizer with integrated voltage-controlled oscillator (VCO) that delivers the industry's lowest phase noise. Its combination of ultra-low noise phase-locked loop (PLL) and industry's highest phase detector frequency outperforms the competition in both phase noise and spurs. The LMX2581 combines the capability to drive highest system performance along with the flexibility of a wideband frequency synthesizer that outputs 50 to 3760 MHz. It allows designers to use one frequency synthesizer to support a variety of demanding applications in wireless infrastructure, radar, medical imaging, defense and aerospace, and test and measurement. For more information and to order samples, visit www.ti.com/lmx2581-pr-eu.

In addition, the LMX2581 improves total link power efficiency and communication channel capacity when combined with the following high-speed analog signal chain devices from TI: LMK04828 or LMK04800 clock jitter cleaner; AD42JB69 dual-channel, 16-bit, 250-MSPS analog-to-digital converter (ADC) with JESD204B serial interface or ADC16DV160 dual-channel, 16-bit, 160-MSPS ADC; DAC34SH84 quad-channel, 16-bit, 1.5-GSPS digital-to-analog converter (DAC), and the TRF3705 300-MHz to 4-GHz quadrature modulator.

www.ti.com

3 Watt AC/DC Mini Power Supplies for Smart Home Applications



With the RAC03-SCR/277 series, Recom brings regulated mini power supplies onto the market that are designed to fit behind standard wall outlets. Due to their round and flat shape, it is possible to implement simple and quick Smart Home solutions without extensive renovation works. The only 11mm thick disks can be easily mounted behind switch-plates or within wall boxes. Thus, DC voltage can be also available from the wall socket which is very useful for many home automation applications.

The 3W mini power supplies achieve an excellent efficiency of up to 78%. With the wide input voltage range of 85 to 305VAC, they can be used worldwide. Output voltages of 3.3, 5, 12 or 24VDC with currents from 900mA to 125mA are available. With a stand-by power consumption of only 40mW, the mini power supplies are particularly energy-saving and consume less than a twelfth of the requirements of the EuP directive. The modules have a 3kVAC isolated output and operate reliably in ambient temperatures up to +85°C. They are ideal for use in home and office as well as for a variety of applications in building automation, security systems and communication systems. The warranty period is 3 years. The RAC03-SCR series are CE marked and UL certified.

www.recom-electronic.com

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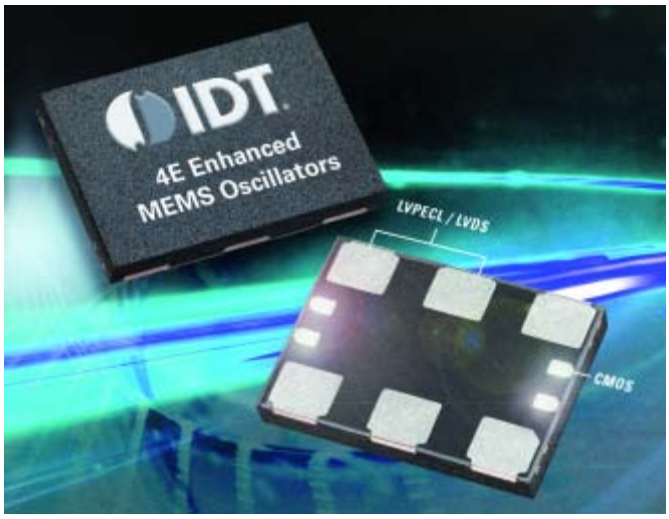
High-Performance Quad Frequency MEMS Oscillators with Multiple Synchronous Outputs

Integrated Device Technology, Inc. the Analog and Digital Company™ delivering essential mixed-signal semiconductor solutions, announced the industry's first high-performance quad frequency MEMS oscillators with multiple synchronous outputs. IDT's latest oscillators offer configurable outputs in an industry-standard compatible package footprint, saving board area and bill-of-materials (BOM) cost in communication, networking, storage, industrial, and FPGA applications.



The IDT 4E series ±50 ppm enhanced MEMS oscillators integrate an LVDS or LVPECL output with a synchronous CMOS output into a single package, eliminating the need for an external crystal or secondary oscillator. Available in frequencies up to 600 MHz, the new oscillators save board area, simplify the application circuit, and reduce BOM cost in any high-performance application requiring an LVDS or LVPECL frequency source. Additionally, the oscillators feature two control pins to select between four factory-programmable output frequencies, allowing for the replacement of four components with a single device. This enables the customer to reduce their BOM count, consolidate their inventory, and realize cost benefits.

The IDT 4E series oscillators are designed with the physical dimensions and pinout of an industry-standard six-pin CMOS, LVDS or LVPECL oscillator, but with four additional pins (10 pins total) strategically placed to maintain backward compatibility with existing six-pin sockets. This allows designers to use the oscillators in existing sockets while offering additional functionality for new designs.

www.idt.com/go/MEMS

Wide Terminal Low Ohmic Chip Resistors for Current Detection

Rohm has recently expanded its lineup of high power wide terminal low ohmic chip resistors designed for current detection in automotive systems, motors, power supply applications, and more. The latest addition, the LTR18 series, offers 1W of rated power in the 3216 size (3.2x1.6mm, t=0.58mm) - 4 times greater than conventional products. Typically, resistors used for current detection in automotive, power supply, and motor circuits require low resistance, low TCR (Temperature Coefficient of Resistance), and high rated power. What's more, the growing interest in electronic products with ever increasing functionality will require even higher currents, heightening demand for products that

support higher power in a compact form factor, particularly 1W in the 3216 size.

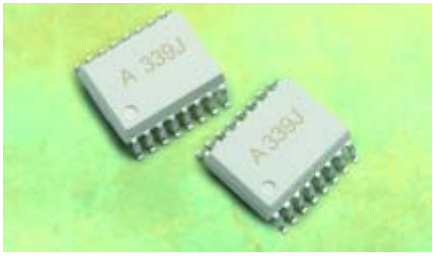
In response, an original heat dissipation design was used to provide 4x the power rating vs. conventional products in the 3216 size, along with improved materials and a revamped resistor element structure for superior TCR characteristics even at low resistances. And the novel wide terminal configuration minimizes mechanical stress at the joints and improves joint reliability against temperature fluctuations. In addition, higher power handling capability and improved temperature characteristics make them ideal for sets with stringent temperature compensation requirements, such as automotive applications, while reducing design load significantly.

www.rohm.com/eu

New Generation of Smart Gate Drive Optocoupler

Avago Technologies announced a highly-integrated smart gate drive optocoupler device, the ACPL-339J. The device is a 1A output current gate drive optocoupler with dual outputs optimized for driving both high-side and low-side gates of the MOSFET buffer stage. The ACPL-339J features an internal active timing control circuitry preventing cross conduction and minimizing switching losses in the MOSFET buffer stage.

Expanding upon previous generations of market-proven smart gate drive optocoupler



devices, the ACPL-339J is designed to further maximize gate drive design scalability for motor control and power conversion applications ranging from low to high power ratings. Uniquely designed to support MOSFET buffer of various current ratings, the ACPL-339J makes it easier for system engineers to support different system power ratings using one hardware platform by interchanging the MOSFET buffers and power IGBT/MOSFET switches. More importantly, these changes can be made without redesigning the critical circuit isolation and short circuit protection.

www.avagotech.com

SMPD Portfolio with Fast Rectifier Bridges for Higher Frequency

IXYS Corporation announced that it is extending the Surface Mount Power Device (SMPD) range to include fast rectifier products which are essential in many topologies and are used in power semiconductor solutions for switch mode power supplies (SMPS), converters/inverters and uninterruptible power supplies (UPS).

The DHG60U1200V is an example of a fast rectifier bridge with an output current of 62A and a repetitive reverse blocking voltage of 1200V. This three phase rectifier is using SONICTM Diodes, specified with a reverse recovery time of only 0.2 micro seconds. The Sonic diode has a soft recovery behavior while maintaining a low reverse recovery current. The low reverse recovery current and faster turn off reduces switching losses and noise that is usually generated by standard rectifier diodes. This product performs optimally in circuits dealing with higher frequency alternating current applications.

The IXYS SMPD, which has been in volume production since its introduction in 2010, is an innovative power module which can be easily surface mounted on a printed circuit board (PCB) using standard pick and place and reflow soldering process. It is a preferable automated PCB assembly process for the industry without costly screws, cables, bus-bars or hand soldered contacts that have been used for standard power modules in the past. Additionally, these products are much lighter in weight than comparable standard power modules.

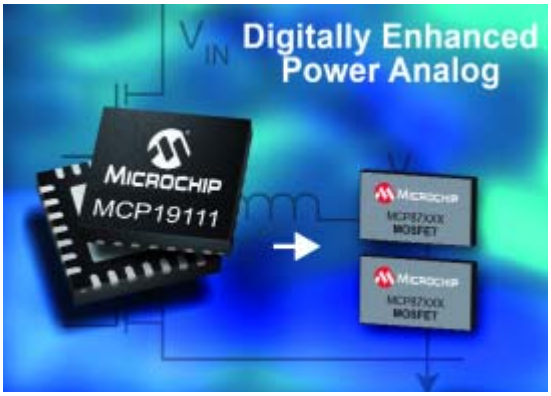
"Expanding the SMPD portfolio with the fast rectifier products enables customers to build more power inverters completely with surface mounted solutions since the SMPD with standard rectifier, IGBT and MOSFET die technologies are already available. In many applications the frequency of the generated AC by inverters is higher than the typical 50-60 Hz line frequencies. Furthermore there are other power system applications where rectification of higher AC frequency is needed. IXYS is targeting to further expand the SMPD portfolio with other configurations so more topologies can be designed. The SMPDs are then used as simple 'building blocks'; thereby creating a heat-spreading advance which enables a reduction of the heat sink dimension," commented Mr. Jeroen van Zeeland, head of marketing at IXYS GmbH.

For more information of the DHG60U1200LB please refer to the IXYS website http://ixapps.ixys.com/DataSheet/DHG60U1200LB.pdf

www.ixys.com

Analogue-based power management controller with integrated MCU

With the MCP19111 Microchip claims to deliver the world's first digitally enhanced family of power analogue controller. The family operates across a wide voltage range of 4.5 to 32V and offers a significant increase in flexibility over conventional analogue solutions. The hybrid mixed-signal power-management controller integrates an analogue-based PWM controller with a fully functional Flash-based microcontroller. This integration offers the flexibility of a digital solution, with the speed, performance and resolution of an analogue controller. Also, the MCP19111 has integrated MOSFET drivers configured for synchronous, step-down applications. When combined with Microchip's expanded family of high-speed MOSFETs, the MCP19111 drives customisable, high-efficiency power conversion. The MCP19111 controller is offered in a 5x5 mm, 28-pin QFN package.
Additionally, Microchip has expanded its high-speed MOSFET family, with the MCP87018, MCP87030, MCP87090 and MCP87130. Rated at 25V, these 1.8 mΩ, 3 mΩ, 9 mΩ and 13 mΩ logic-level MOSFETs are suitable for Switched-Mode-Power-Supply (SMPS) applications.



www.microchip.com/MCP19111

Development Board Demonstrates Ease of Designing with 200 V eGaN® FETs

Efficient Power Conversion Corporation (EPC) announced the availability of the EPC9004 development board, featuring EPC's enhancement-mode gallium nitride (eGaN) field effect transistors (FETs). This board demonstrates how recently introduced IC gate drivers, optimized for GaN FETs, make the task of transitioning from silicon power transistors to higher performance eGaN FETs simple and cost effective.
The 200 V EPC2012 eGaN FET is ideal for use in applications such as wireless charging, magnetic resonance imaging (MRI), and low RF frequency applications such as smart meter communications.

www.epc-co.com

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300V Power MOSFETs Offer Benchmark Rds(on) to Improve System Efficiency

The portfolio of power MOSFETs offers ultra-low Rds(on) to improve system efficiency and may allow designers to reduce part count where multiple MOSFETs are used in parallel.
The devices are qualified to industrial grade and moisture sensitivity level 1 (MSL1), are offered lead free and are RoHS compliant.
Specifications:

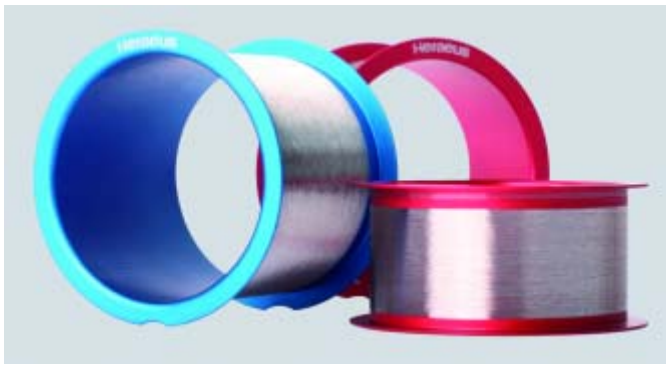
Part #	Rdson Max @ 10Vgs (mOhm)	Qg Typ (nC)	Id	Package
IRFB4137PBF	69	83	40	TO-220
IRFP4137PBF	69	83	40	TO-247
IRFP4868PBF	32	180	70	TO-247

Datasheets and a MOSFET product selection tool are available on the International Rectifier website at:

www.irf.com

Palladium Coated Copper Wire (PdPRo) for IC Applications

This product is another contribution to the current Heraeus portfolio of non-gold bonding wires that includes a wide range of bare copper products, as well as Ag based products.
The main benefits of PdPRo are the higher stitch pull values and the wider 2nd bond process window compared to conventional copper wires. It has a consistent Free Air Ball (FAB) roundness in the N2 environment which contributes to a robust quality at a wide range of the gas flow rate. PdPRo is easy to optimize and able to plug and play with other CuPd wires.



This bonding wire can especially be used in Stand-off Stitch Bond (SSB) / Reverse Stand-off Stitch Bond (RSSB) and is available in diameters ranging from 0.6 to 2.0 mil.
Roman Perez, Product Manager of copper bonding wire products of the Bonding Wire Business Unit of Heraeus, states: “The advantages of PdPRo are evident. PdPRo has an excellent workability and reliability performance. It is definitely an economical alternative to gold wire while keeping outstanding quality.”
This product provides customers the possibility to choose the most suitable technology for wire materials other than gold. Thus the PdPRo has an overall broader position in the wide range of bonding wires.

www.heraeus-contactmaterials.com

High-Accuracy 130A and 150A Current Transducers to PCB-Mount Range

LEM has introduced the LA 130-150 series of current transducers for use in motor drives, inverters, power supplies and general industrial applications. These printed-circuit board (PCB) mounted devices share a common, compact case outline, and are available to measure nominal full-scale currents of 130 and 150 ARMS. Thanks to the application of LEM's established expertise in Closed-Loop Hall Effect transducer technology, the LA 130-150 series offers high-accuracy, extremely linear measurements at a very competitive price.

The LA 130-150 series measures DC, AC, and pulsed currents, providing an output in the form of a current signal proportional to the measured (primary) current. Two conversion ranges – a factor of 1000 or 2000 – are offered, with two mounting styles; the transducers can be supplied with an open aperture through which the current carrying the primary current is routed: or they can be supplied ready-fitted with a primary conductor that will connect direct to the host PCB. Within the 33.5(H) x 37(W) x 16(D)mm outline, the conductor aperture is a generous 13.5 x 10 mm. In form, footprint and function the LA 130-150 series is backward-compatible with LEM's prior-generation devices.

www.lem.com

1.5 kW to 4 kW 1U Programmable DC Power Supply

Magna-Power Electronics released to production its SL Series 1U (1.75") high programmable DC power supply. The SL Series continues the company's commitment to market-leading power density, offering models ranging from 1.5 kW to 4 kW, all in a 1U rack-mount package. The new SL Series is released with 54 different models, with voltage ratings ranging from 5 Vdc to 1000 Vdc and current ratings ranging from 1.5 Adc to 250 Adc. With extensive interfaces and controls, the new series satisfies the requirements for a wide range of applications, including: automated test equipment (ATE), automotive and hybrid/electric development, semi-conductor burn-in, battery charging, among a wide variety of research and development activities.

All SL Series models come standard with front panel control, external 37-pin isolated analog and digital I/O, and a RS232 computer programming interface. For computer communications, Remote Interface Software is provided, along with Magna-Power Electronics IVI Driver, enabling programming from a variety of environments, including LabVIEW and Visual Studio. Load-dependent variable speed fans are also standard on all models. Available options include: LXI TCP/IP Ethernet Interface (+LXI), IEEE-488 GPIB Interface (+GPIB), USB Edgeport (+USB), and High Slew Rate Output (+HS) for fast output transitions. Master/slave operation will be available with the UID47 device, enabling multiple units to be tied in series or parallel.

All SL Series models are available with three-phase input, including 208/240 Vac, 380/415 Vac, or 440/480 Vac. 1.5 kW models are also available with a new single-phase Universal Input (UI), allowing for an input voltage range spanning 85 Vac to 265 Vac. The Universal Input for the 1.5 kW models implements active power factor correction (PFC) for a 0.99 power factor at maximum load, keeping input current draw to a minimum.

The new SL Series product line is Magna-Power Electronics first 1U product, building upon the immense success of the company's 2U rack-mount XR Series, which now spans from 2 kW to 8 kW. All of the company's product lines, including the new SL Series, use the company's signature current-fed power processing topology to deliver superior control and enhanced system protection, with a greater tolerance to abusive loads.

The new product series was designed and is manufactured at the company's vertically integrated headquarters in Flemington, NJ USA. In early-2012, the company completed an expansion, which more than doubled its Flemington, NJ USA manufacturing facility and added a new research and development center. The company's first international sales office, Magna-Power Electronics GmbH, was also opened in 2012 in Germany. The company continued construction at its headquarters with the third phase of its manufacturing facility expansion, set for completion in early 2013.

www.magna-power.com

Silence is golden in power design

Even electronic devices work better when they have peace and quiet – that may be the reason why Micrel has added four more high-current devices to its ripple blocker family of LDO linear regulators and load switches. The MIC94305 and the MIC94325/45/55 families support more than twice the output current load offered by previously released 200mA Ripple Blocker products. The MIC94310 Ripple Blocker is a monolithic integrated circuit that provides high-frequency ripple attenuation (switching noise rejection) to a regulated output voltage. This is vital for applications where a DC/DC switching converter is required to lower or raise a battery voltage but where switching noise cannot be tolerated by sensitive downstream circuits such as in RF applications.

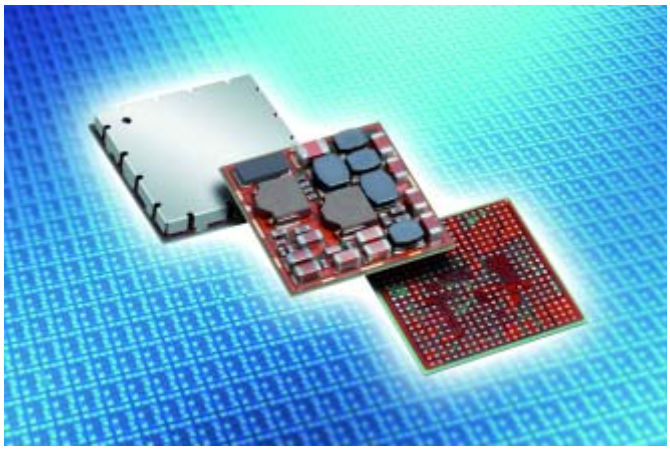
In addition, this new series offers an operating input range of 1.8V to 3.6V with exceptional transient performance, ultra-low dropout and very high PSRR (80db @ 1KHz). The devices deliver up to 500mA output current and active noise rejection over a wide frequency band: >50dB from 10Hz to 5MHz at a 500mA load. The MIC943x5 options include a 500mA load switch MIC94305, two fixed output LDOs (MIC94345/55) or adjustable output voltage (MIC94325). The MIC94355 version offers an auto-discharge for the output capacitor when the part is disabled. All versions offer current-limit and thermal-limit protection. The devices also feature a -40ºC to +125ºC junction temperature range. Package options include 0.84mm x 1.32mm, 6-bump CSP and the 1.6mm x 1.6mm Thin DFN package.

www.micrel.com/rippleblocker

IC Embedded Power Management Module for Smartphones and Tablets

TDK Corporation presents a series of highly integrated, multi-channel power management modules for smartphones and tablets. Based on TDK's SESUB technology (semiconductor embedded in substrate), the new module is the world's first IC embedded power management module for smartphones and tablets. Aimed at reducing lead times and development costs for manufacturers of smartphones and tablets, the new product features a power supply management IC chip that is embedded directly into the substrate. In combination with newly developed surface-mounted capacitors and power inductors, this results in a space-saving footprint that is up to 60 percent smaller than discrete solutions. The highly integrated module offers advanced multi-channel power management capabilities in a single miniature package with dimensions of only 11.0mm x 11.0 mm x 1.6 mm.

The major features of the new power management module are its high-efficiency step-down converter power supply in a 5-channel configuration with a maximum output of 2.6 A, and its low-noise, low-loss voltage regulator power supply for up to 23 channels. A highly efficient lithium-ion secondary battery charging circuit is also included. Thanks to the fact that the IC completely embedded in the miniature three-dimensional SESUB structure, the power management module features superior thermal attributes compared with solutions with discrete packaged ICs. The module also offers greatly improved EMC performance due to the self-shielding effect of its design.



The series meets the emerging needs for miniaturized multifunctional power management modules able to provide all of the functions in a smartphone with exactly the right amount of power, thus contributing to longer battery life.

www.epcos.com

ADVERTISING INDEX

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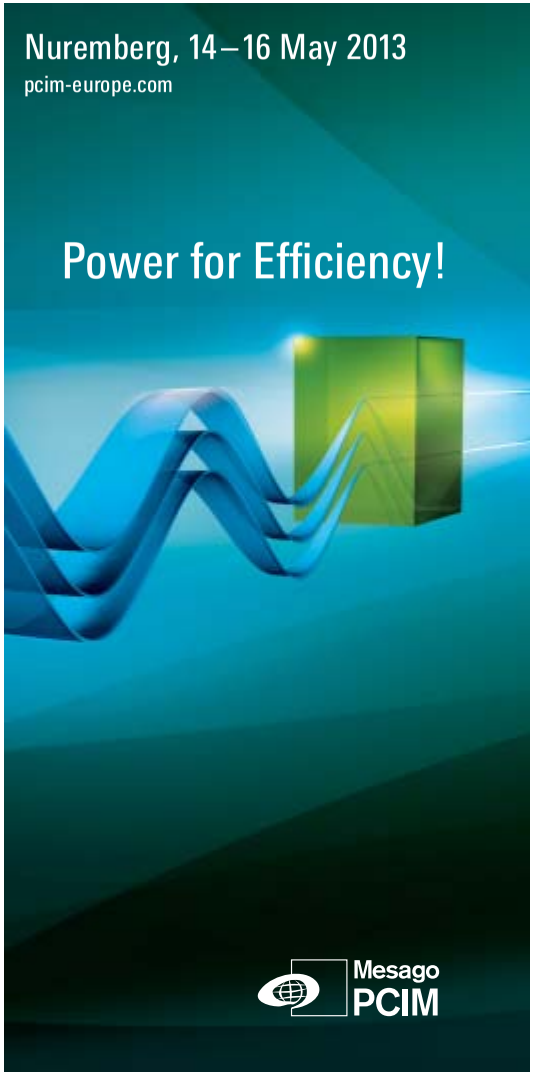
International Exhibition and Conference
for Power Electronics, Intelligent Motion,
Renewable Energy and Energy Management

Conference, Seminar and Tutorial Program



Why you should attend

The Conference

- experience the most application orientated conference for power electronics
- hear the leading experts presenting their latest technologies
- choose from more than 200 outstanding technical presentations
- benefit of plenty of networking opportunities and establish new contacts

The Exhibition

- get an overview on new technologies, innovations and applications
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- attend free panel-discussions and presentations at the exhibition forum

PCIM Europe offers the unique opportunity to attend high-quality conference presentations and to experience the applications at the show floor within one event.

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is held in parallel to PCIM Europe.
www.sensor-test.com

What attendees say

»Excellent conference with wide variety of topics and supporting exhibition to experience practical, state of the art solutions in your relevant field.«
Tirthajyoti Sarkar, Senior Device Engineer, Fairchild Semiconductor, India

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»PCIM is the most important European event in the Power Electronics field. If you attend it, your company will be paid back in visibility, increased number of contacts and relationships and great chance to promote its products.«
Bettina Rubino, Application Development Senior Engineer, STMicroelectronics, Italy

»PCIM is a place where knowledge is smoothly exchanged. In PCIM, students, researchers and companies share and discuss up to date technologies.«
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Seminars

Sunday, 12 May 2013 from 14.00 – 17.30 hrs

Loop Compensation of Voltage Mode and Current Mode DC/DC Converters
Stefan Klein, Würth Elektronik eiSos GmbH & Co. KG, Germany

Basics of Electromagnetic Compatibility (EMC) of Power Systems
Jacques Laeuffer, Dtalents, France

SMPS Topology Selection
Bruce Carsten, Bruce Carsten Associates, USA

Current Mode Control
Ray Ridley, Ridley Engineering Europe, France

New Developments in Power-Factor Correction
Richard Redl, ELFI S.A., Switzerland

Wireless Power Technologies
Dan Jitaru, Delta Energy Systems, USA

Tutorials

Monday, 13 May 2013 from 9.00 – 17.00 hrs

The Latest Trends in Soft Switching Topologies
Dan Jitaru, Delta Energy Systems, USA

Controlling DC-DC Converters for Fast Dynamic Response
Richard Redl, ELFI S.A., Switzerland

Electromagnetic Design of High Frequency Converters and Drives
Jacques Laeuffer, Dtalents, France

High Performance Control of Three Phase Inverters
Jens Onno Krah, Cologne University of Applied Sciences, Germany

High Frequency Magnetics Design
Ray Ridley, Ridley Engineering Europe, France

Understanding Batteries for Optimized Power Electronics Development – Battery Designs, Charging Requirements, State-of-charge Monitoring, Lifetime
Dirk Uwe Sauer, RWTH Aachen, Germany

Power Electronics for Renewable Energy Systems
Mike Meinhardt, SMA Solar Technology, Germany
Siegfried Heier, Peter Zacharias, University of Kassel, Germany

IGBT Gate Drive Technologies
Reinhard Herzer, Arendt Wintrich, Semikron Elektronik, Germany

Design Approaches to SMPS Control
Bruce Carsten, Bruce Carsten Associates, USA

Reliability of IGBT Power Modules
Josef Lutz, Chemnitz University of Technology, Germany

Conference

Registration information and full program with all lectures, posters and speakers on **www.pcim-europe.com/program**

Tuesday, 14 May 2013

Conference Opening and Award Ceremony

KEYNOTE »HVDC – State of the art and future trends«

Wide Bandgap Devices I	Advanced Power Substrate Materials	Thermal Management – Heat Sink	**Special Session** Solar Power I	Motors and Actuators
Passive Components and New Materials	Power Module Design I	Control Techniques in Intelligent Motion Systems	Energy Storage Systems	Power Quality Solutions
Poster/Dialogue Session				

Wednesday, 15 May 2013

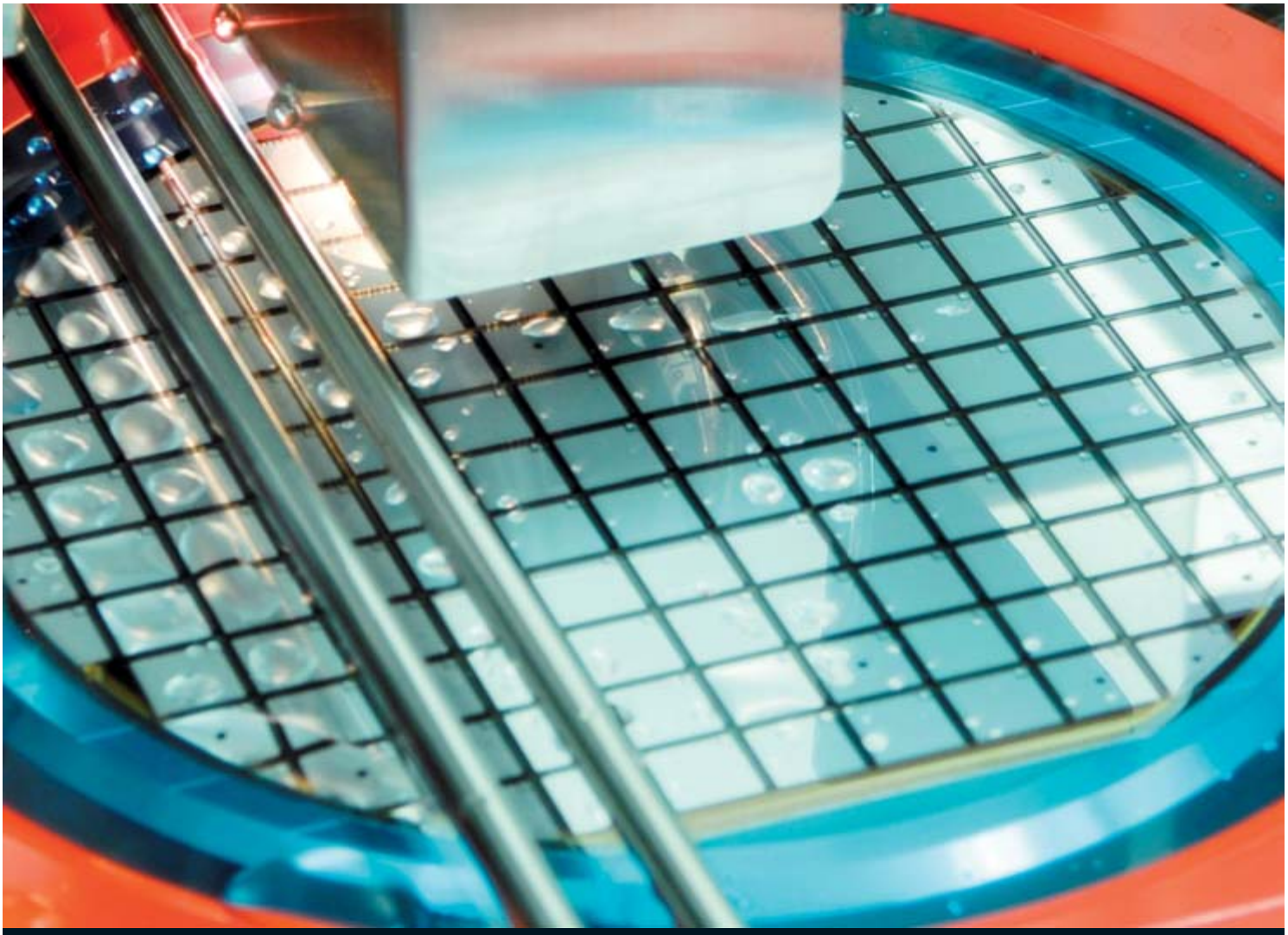
KEYNOTE »Traction Drives, from IGBT Modules to Silicon Carbide Components«

Wide Bandgap Devices II	Power Semiconductor Switches I	**Special Session** E-Mobility Charging Systems	**Special Session** Wind Energy Technology	Power Electronics in Automotive, Traction and Aerospace
Multi-Level Converter and Gate Drive	New Power Electronic Building Block	**Special Session** E-Mobility Power Train	System Reliability	Power Electronics in Transmission Systems
Poster/Dialogue Session				

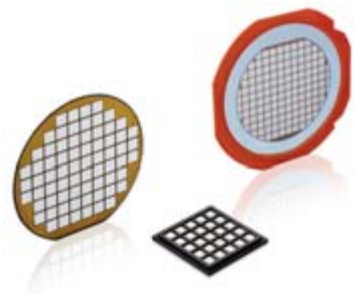
Thursday, 16 May 2013

KEYNOTE »High-Density Fast-transient Voltage Regulator Module«

Chip Interfacing Technologies	Power Semiconductor Switches II	DC/AC Converter	DC/DC Converter	
Special Session Power GaN for Highly Efficient Converters	**Special Session** Solar Power II	Power Cycling Improvements	Advanced EMC/PFC System Design	



5760000000000. Number of times an IGBT switches during an industrial application lifetime.



ABB's High Power Semiconductor SPT™ 1200 V and 1700 V chipsets (IGBTs and Diodes) are best-in-class in terms of switching performance, ruggedness and reliability. Typical applications for 1200 V are household equipment, solar energy, battery backup systems (UPS) and electrical vehicles. Applications for 1700 V include industry, wind energy and traction.
The chipsets are available for manufacturers of semiconductor power device packages and target demanding applications in the field of high power electronics. For more information please visit our website: **www.abb.com/semiconductors**

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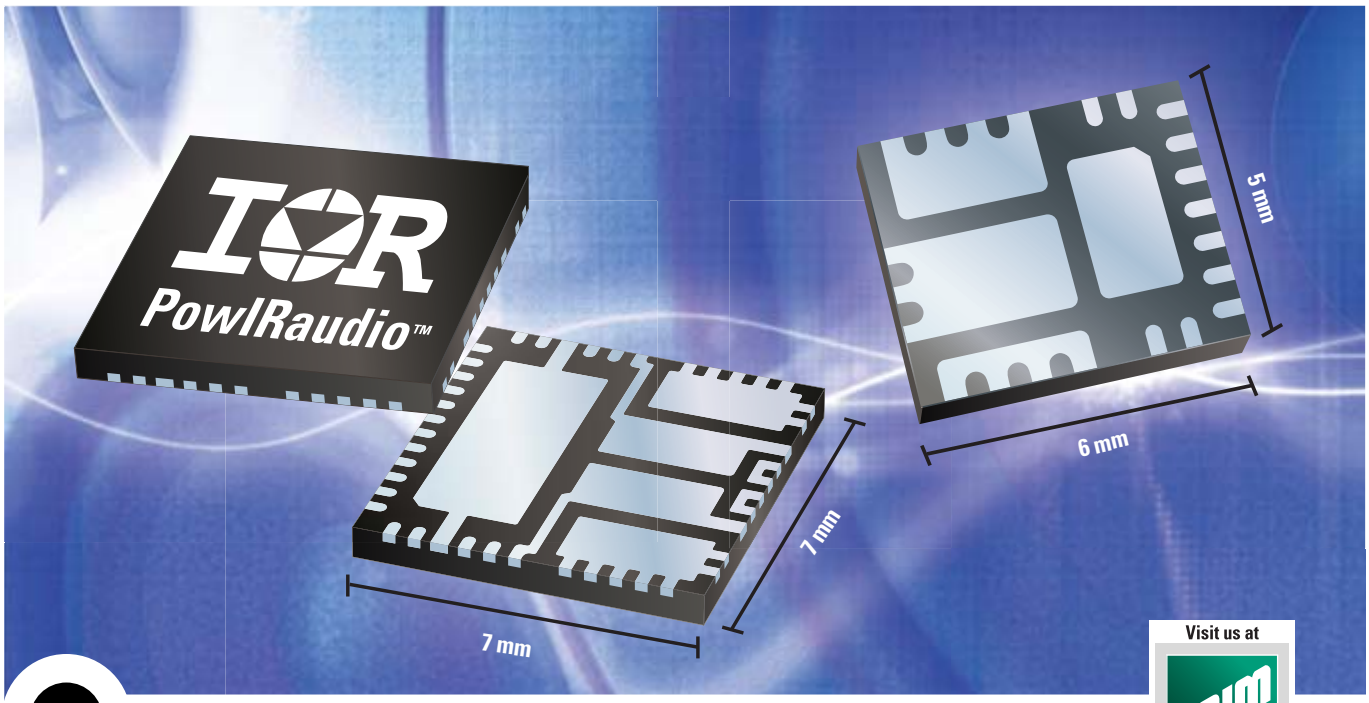

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Compact, Efficient, Class D Audio Solutions

IR's Integrated PowIRaudio™ Class D Amplifier

PowIRaudio™ Integrated Class D Amplifier

IR4301*	4Ω	130W/ch
	3Ω	100W/ch
	2Ω	70W/ch
IR4311	4Ω	35W/ch
	3Ω	45W/ch
	2Ω	60W/ch

PowIRaudio™ Integrated Two-Channel Class D Amplifier

IR4302*	4Ω	70W + 70W
	3Ω	50W + 50W
	2Ω	40W + 40W
IR4312	4Ω	35W + 35W
	3Ω	40W + 40W
	2Ω	30W + 30W

*Higher power capable if heatsink is used

PowIRaudio™ Advantage:

- No heatsink required
- Best-in-class power efficiency and audio performance
- Reduce component count, simplify design
- Compatible with single supply or split rail configuration

Reference Designs Available:

- 20W to 130W per channel
- Single supply or dual supply
- Single channel or dual channel modules

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