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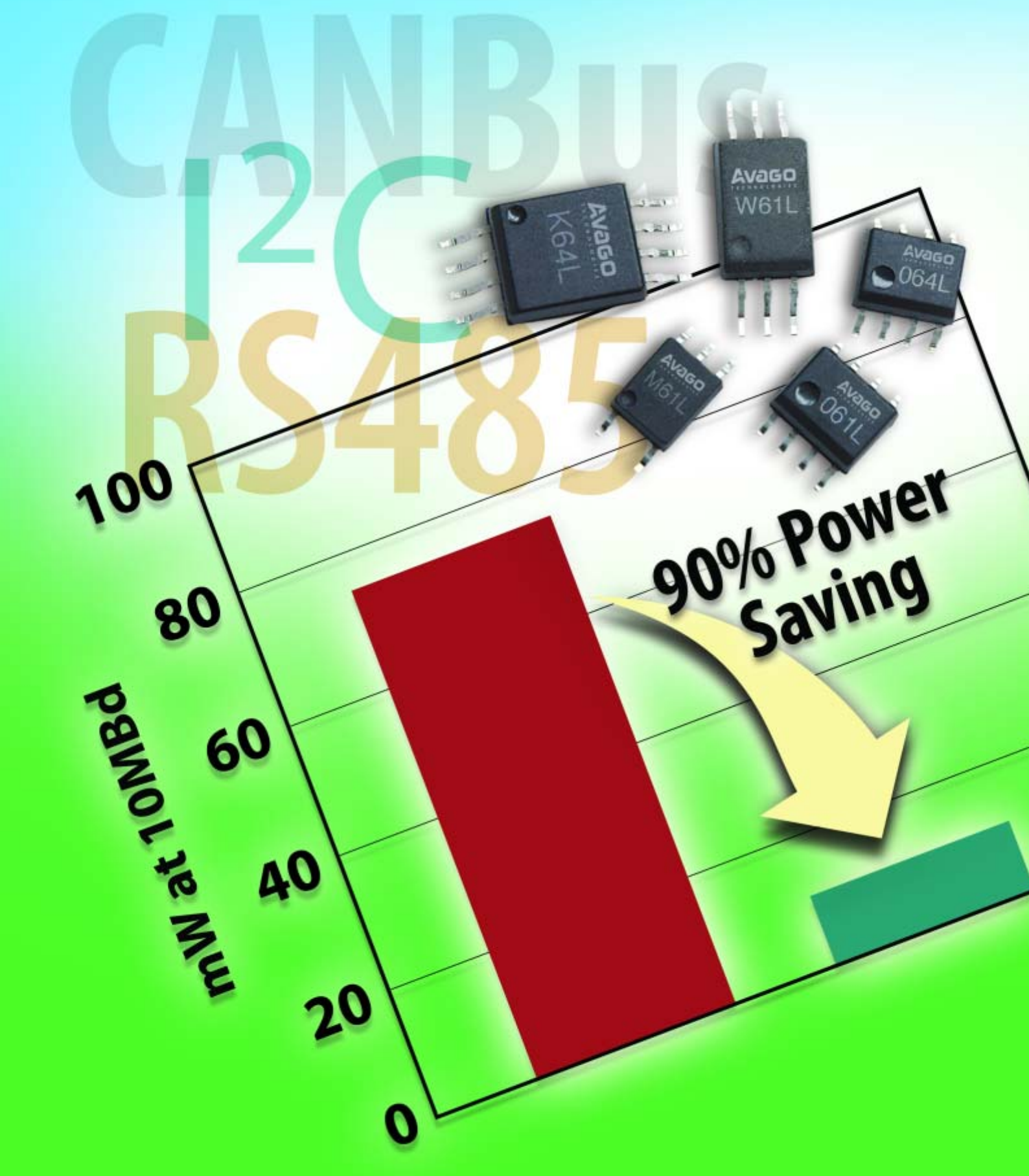
Bodo´s Power Systems®

Electronics in Motion and Conversion

November 2009



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The new SCALE-2 dual driver core 2SC0650P combines highest power density with broad applicability. The driver is designed for both high-power and high-frequency applications. It is suit-able for IGBTs with reverse voltages up to 1700V and also features a dedicated MOSFET mode. Intelligent paralleling allows all forms of parallel connection of high-power modules. Multi-level topologies are also supported. The 2SC0650P offers all SCALE-2 specific advantages such as minimal jitter and ultra-short signal delay times. CONCEPT's patented planar trans-former technology assures efficient high-voltage isolation with long-term reliability which satisfies the highest requirements.

Features

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- 2 x 6W output power
- +15V/-10V gate voltage
- Separated gate paths (on/off)
- 150kHz switching frequency
- 80ns delay time
- ±1ns jitter
- 3.3V to 15V logic compatible
- Integrated DC/DC converter
- Short-circuit protection
- Embedded paralleling capability
- Superior EMC (dv/dt > 100V/ns)

CT-Concept Technologie AG, Renferstrasse 15, CH-2504 Biel, Switzerland, Phone +41-32-344 47 47

www.IGBT-Driver.com

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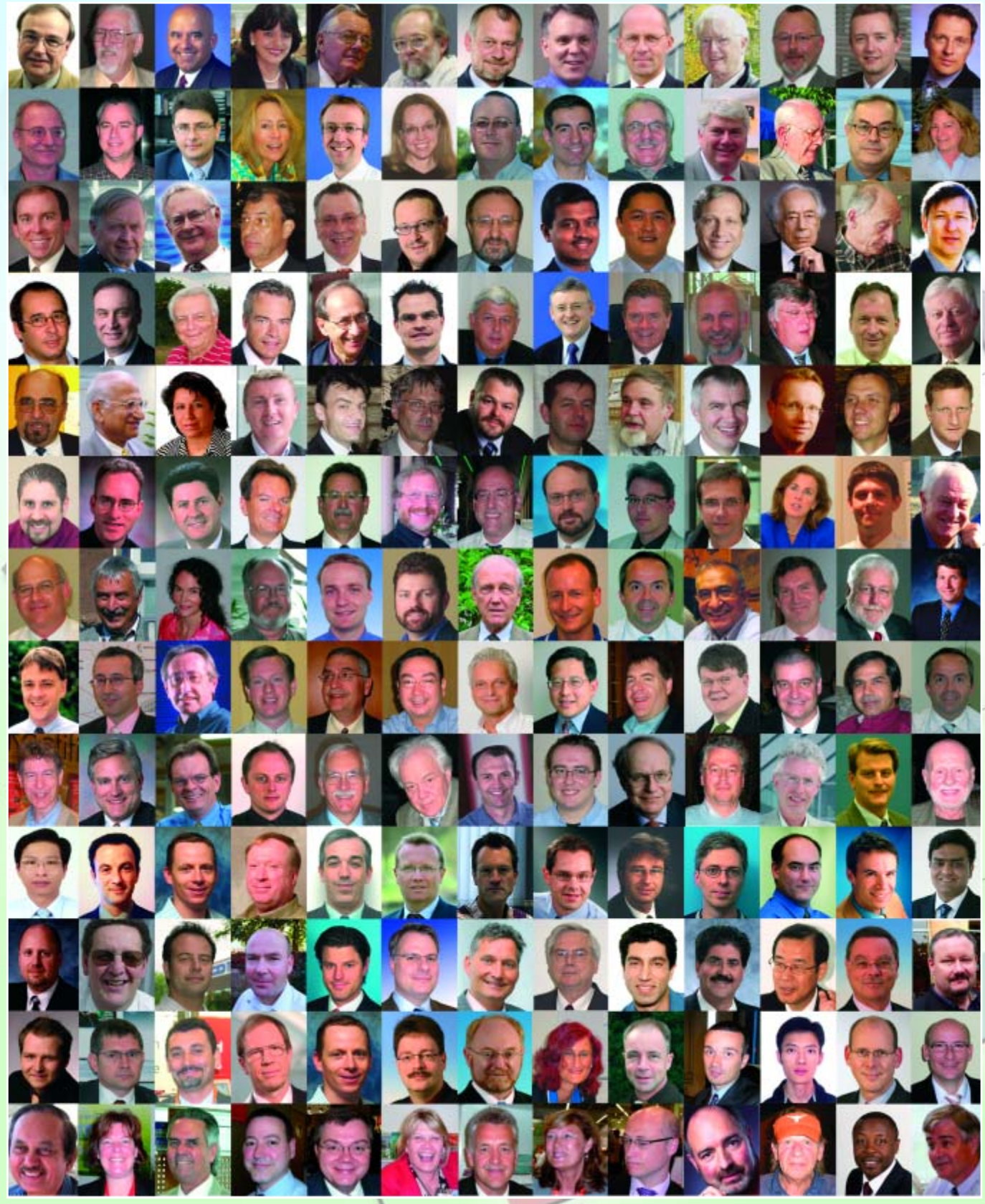
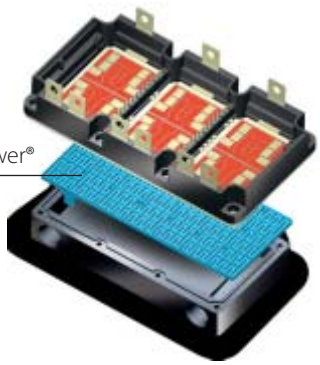


The future of cool design

Move into the fast lane with customized power modules



It cannot be stressed enough: Efficient cooling is the most important feature in power modules. Danfoss Silicon Power's cutting-edge ShowerPower® solution is designed to secure an even cooling across base plates. In addition, our modules can be customized to meet your automotive requirements in detail, offering: Low weight, compact design, extended life and very low life cycle costs. In short, when you choose Danfoss Silicon Power as your supplier you choose a thoroughly tested solution with unsurpassed power density. Day in and day out. Please go to siliconpower.danfoss.com for more information.

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Events

Productronica,
Munich, Germany,
November 10-13
http://productronica.com/

SPS/IPC/DRIVES,
Nuremberg, Germany,
November 24-26
http://mesago.de/sps

Power Electronics,
Moscow, Russia,
December 1-3
www.powerelectronics.ru

APEC 2010,
Palm Springs, CA,
February 21-25,
www.apec-conf.org

Nature is Leading Edge

Technology is a force which drives progress in our world while the economy follows up and down cycles. Making an investment is always debatable but fortunately, technology that helps the environment is consistently strong. We should take advantage of a few quite moments during Thanksgiving to assess what is really important and to prioritize.

We tend to think in the realm of given knowledge but SEMICON describes an investigation of 450mm wafers and for power semiconductors they are undergoing a material migration from Silicon to Silicon Carbide and Gallium Nitride. These new wafer materials make designs for higher current capability on a given die size possible. While moving to larger wafer sizes with established Silicon processes is exciting it is also good to see Texas Instruments equipping an existing manufacturing facility in Richardson, Texas with 300mm processes. This fast track approach shows their confidence in future market demand. On the down side we've all heard about world-class power semiconductor manufacturing sites in the US that will soon close. A different level of management skill and judgment must be involved.

The companies in our industry are carefully, but increasingly, reporting positive forecasts for the future. SEMICON Europa just took place in Dresden and the Productronica is just around the corner - both events showcase the manufacturing of semiconductor electronics solutions. Semiconductor equipment manufacturers have suffered a severe downturn but hopefully they have utilized the time to focus on and make progress in technologies for future application-oriented work flow. Demand will rise again and require renewed and updated manufacturing equipment. A good example is Finetech, the repair and micro assembly equipment manufacturer, who demonstrated at their plant in Berlin how precise PC board and hybrid circuits can be reworked to avoid waste, while meeting the highest quality levels.

Renewable power's strong market position of is built on the wind, water and solar energy industries. These segments are growing and experienced very little of the slump common to other applications over the last year. Semiconductors and their efficient usage are

the leading edge here - driven by new semiconductor materials with the support of with modern passive components and hardware. Nothing works, however, if temperature isn't managed with good analysis and mounting practises. It is good to see a full set of analytical tooling in use for optimizing results.

The SPS/IPC/DRIVES show will provide us with another opportunity this Autumn to view industry reports. Industrial control and intelligent electrical drives contribute to lowering energy consumption through efficient new designs.

For all of you not travelling as much as is necessary to pick up on all crucial information, you have my publication in print each month, and in .pdf form from my website, in addition to the e-newsletter twice monthly for instant updates.

There is no better way to communicate. We all share one world. As a publisher I serve the world: one magazine, on time, every time.

My Green Power Tip for the coming months:

November is a month to prepare for the colder weather ahead. Find something to insulate yourself! Your comfort will improve and the world's energy resource will benefit.

Hope to see you again in Munich at the Productronica or at the SPS/IPC/DRIVES in Nuremberg.

Best regards

Bodo

SPS/IPC/
Drives
Hall 1.528

Future precision.
Future performance.
Now available.

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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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- PCB mounted
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- Multi-Range configuration
- +5 V Single Supply
- Low offset and gain drift
- High Accuracy @ +85° C
- Access to Voltage Reference
- Analog Voltage output

www.lem.com

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Retirement of B. Halla as CEO, D. Macleod President & CEO

Brian Halla

Donald Macleod

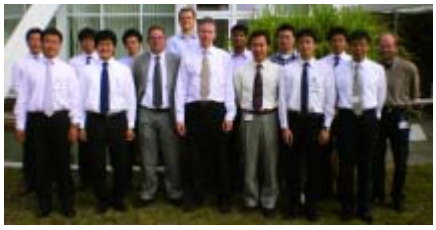
National Semiconductor Corp. announced that Brian L. Halla will retire as chief executive officer effective Nov. 30, 2009. He will remain executive chairman of the company. Halla will be succeeded by Donald (Don) Macleod, who will become the company's president and chief executive officer and be appointed to its Board of Directors effective Nov. 30, 2009. Macleod currently serves as National's president and chief operating officer (COO).

"Strongly deserved," said Brian Halla. "This is 'the house that Donnie built', and he deserves to be its chief executive. I'll stay on through the 'rainy season' to make sure there are no leaks in the roof." Halla plans to retire from the Board of Directors at the end of National's fiscal year 2010 (May 30, 2010), the fourteenth anniversary of his joining the company.

Don Macleod, 61, joined National in 1978 and has served in escalating positions throughout his tenure.

www.national.com

European Design Centre



ROHM Semiconductor announced the creation of a new European Design Centre (EUDC) which aims to provide dedicated products, project management and design-in support to customers in Europe. The EUDC is located in Wilich-Münchheide and started operations from 1st September 2009.

"The new design centre will significantly expand our scope in offering innovative integrated circuits (IC's) that meet the requirements of our European customers and – by being close to the market - define and maintain the right product roadmap for the future", said Dr. Michael Davis, Technical Director at ROHM Semiconductor.

With its proximity to customers, and backed by the expertise and resources of ROHM Japan, the EUDC will be able to deliver timely services, product design, and support to customers in all aspects of their design-in needs for ROHM products. Furthermore, it will enable them to have access to the latest technologies.

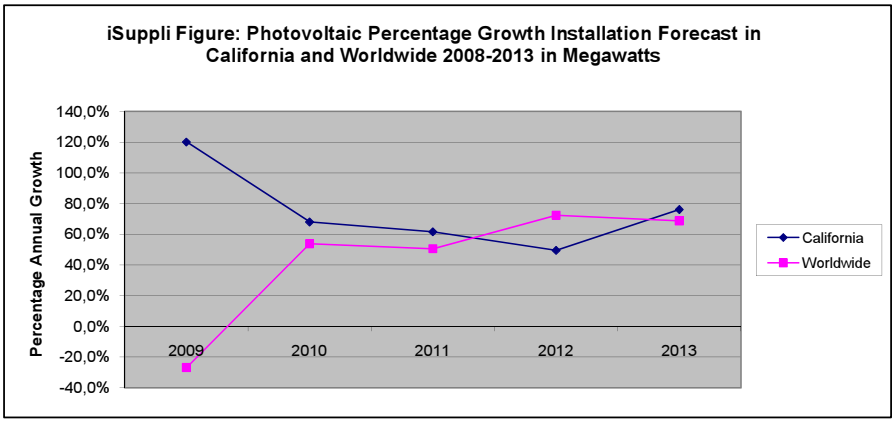
www.rohmeurope.com

The New Sunshine State

In particular, California has taken advantage of these incentives, causing installations in the state to rise even during the worst phases of the economic downturn. At the height of the credit crunch in the first quarter, California's installations increased to 77MW, up from just 38MW during the same period in 2008. Applications for rebates continued to increase, reaching 65MW in the second quarter, with only half the quarter counted in this data.

www.isuppli.com

iSuppli Figure: Photovoltaic Percentage Growth Installation Forecast in California and Worldwide 2008-2013 in Megawatts



Power Electronics eCommerce Portal

www.sindopower.com, the B2B eCommerce Portal of SindoPower GmbH, a holding company of the SEMIKRON Group, went live on 01.09.2009.

The unique feature of this portal is the comprehensive technological support service and information pool brought to users through a variety of media: technology chat room and forum, E-mail and telephone service. This provides users with personal online and telephone support in all matters relating to power electronics.

The SindoPower portal features an online shop containing a wide range of SEMIKRON products that can be delivered straight from the warehouse. Power electronic modules can be ordered directly from the online store at reasonable prices and even in small quantities. Product information such as graduated price ranges, availability, replacement time and custom duty information can be accessed directly at www.sindopower.com. In the "Knowledge Base" users can access a comprehensive information pool covering all areas related to power electronics.

"SindoPower is the first portal in the field of power electronics to link eCommerce with technological consultation," comments Dirk Heidenreich, CEO of SEMIKRON. "This portal gives development engineers online access to an extensive pool of technological information and the opportunity to communicate with others in the technology forum, or even contact experts in the TechChat or on the telephone hotline."

www.sindopower.com

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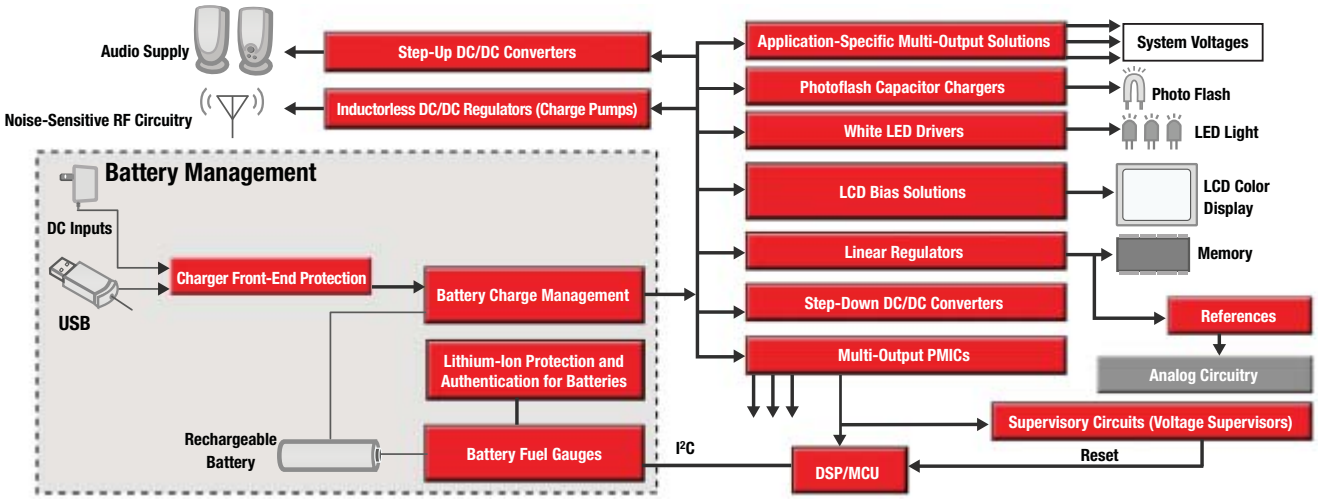
High-Performance Analog>>Your Way™



TI delivers low-power solutions to fit battery power design challenges for a variety of applications, including cell phones, notebook computers, portable medical and industrial devices and more. TI provides applications knowledge and local technical support to help maximize battery life in your portable designs.

Device	Description
TPS61220	0.7-V input DC/DC boost converter for solar cells
bq24150	1.25-A integrated switch-mode, single-cell Li-Ion and USB charger
TPS61087	3.2-A switch-current, limit-boost converter
TPS62290	1-A buck converter in 2x2 QFN package
TPS62750	Programmable input-current-limit buck converter for USB applications
TPS63030	95%-efficient buck-boost converter in 2.5x2.5 QFN package
TPS61165	High-power boost LED driver in 2x2 QFN package
TPS61500	High-brightness boost LED driver with 3-A switch
TPS65001	3-channel mini PMU with 1 buck converter and 2 LDOs
TPS781xx	1-µA quiescent-current LDO
TPS728xx	200-mA LDO with 2 output options via VSEL pin

www.ti.com/portable
For samples, evaluation modules and tools

Texas Instruments

Update of Power Electronics Conferences Supported by ECPE

ESREF 2009, 5 – 9 October 2009, Arcachon/Bordeaux, France,
20th European Symposium
"Reliability of Electron Devices, Failure Physics and Analysis"
http://www.ecpe.org/download/power_electronic
/ESREF2009_programme.pdf

ICSCRM 2009, 11 – 16 October 2009, Nuremberg, Germany,
International Conference
on Silicon Carbide and Related Materials
http://www.icscrm2009.org/

CIPS 2010, 16 – 18 March 2010, Nuremberg, Germany,
6th International Conference on
Integrated Power Electronics Systems
http://www.ecpe.org/download/power_electronic/cips2010_cfp.pdf

PCIM Europe 2010, Conference and Exhibition,
4 – 6 May 2010, Nuremberg, Germany
International Conference on Power Electronics,
Intelligent Motion, Power Quality
http://www.ecpe.org/download/power_electronic/PCIM_2010_CFP.pdf

Advanced Materials at Productronica 2009

Rogers Corporation will highlight some of its latest material advances at the upcoming Productronica in Munich, Germany (November 10-13, 2009. Rogers Advanced Circuit Materials Division will display many of its recent innovations in materials for low-cost, high-volume production lines. These materials include RO4730™/RO3730™ antenna grade laminates, RO4360™ 6.15 Dk laminates, and RT/duroid® 5880LZ advanced materials. Hall B2, stand 401.

www.rogerscorp.com

3,000 Km Solar Power Race in Australian Desert

Microsemi Corporation announced that it is a sponsor of the Umicore Belgian Solar Team in the 10th World Solar Challenge event in Australia from October 24 - October 31, 2009. Participants will compete on a 3,000-kilometer course from Darwin to Adelaide, in cars fueled only by solar energy.
A bronze-level sponsor of the Umicore Belgian team, Microsemi was selected to provide critical solar bypass diodes for power-generation panels in the team's car, an application not unlike how the company's products are used in satellite solar panels.
The bypass diodes are part of Microsemi's extensive portfolio of energy-management products for applications in alternative energy, oil and gas exploration, electric vehicles, energy saving (including intelligent lighting control), and plasma generation for semiconductor, solar cell, LCD panel, and industrial glass manufacturing. In addition to its bypass diodes for satellite solar panels, Microsemi also offers a variety of other solar products including bypass integrated circuits and power modules for solar inverters.

http://www.globalgreenchallenge.com.au/

http://www.microsemi.com

Digital Power Patent License Agreement

CUI, Inc., a subsidiary of Waytronx, Inc., has entered into a non-exclusive Field of Use Agreement with Power-One, Inc. (Nasdaq: PWER) to license Power-One's Digital Power Technology patents to CUI. The non-exclusive license agreement provides access to Power-One's portfolio of Digital Power Technology patents for incorporation into CUI's new line of digital point of load power modules.
"Power-One is pleased to license its digital power portfolio to CUI, Inc.," said Alex Levran, Chief Technology Officer of Power-One. "We feel this move continues our goal of expanding the market for Digital Power Technology and the inherent advantages it holds over standard analog solutions," explained Levran.
CUI is a PMBus member, and through its V-Infinity power division, manufactures a range of embedded and external power electronics devices for OEM manufacturers.
Waytronx's President & CEO, William Clough said, "We are excited to partner with Power-One to incorporate their digital power management technology into our line of products. With this agreement, we can now bring a product to market that is able to take full advantage of digital power's potential over a broad target market."

www.cui.com

Support of Smart-Grid Metering Engineers

Power Integrations launched a new technical microsite, www.powerint.com/smartmeters, focusing on energy-efficient power supply solutions for utility meters used in smart-grid energy networks.
Utility companies are investing in the so-called smart grid as a way of monitoring, controlling, and managing electric power consumption in homes and businesses. The smart grid requires advanced metering solutions that can communicate with both the power company and the consumer – providing real-time information on energy use and cost. Smart meters help balance energy demand by allowing the supplier to implement incentive programs, such as variable pricing based on peak network loading. Utilities are also installing innovative network-connected devices that manage end-user power consumption. Customers are given pricing concessions in exchange for granting the supplier control of certain non-critical circuits.

www.powerint.com/smartmeters

innovation

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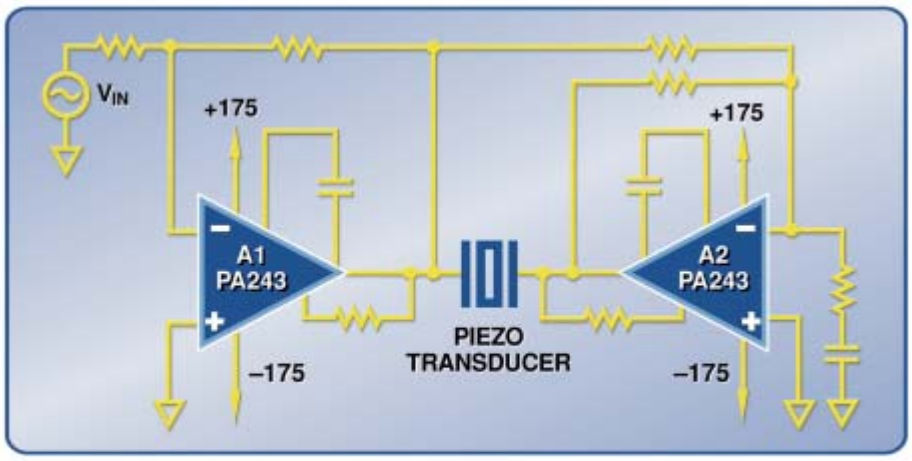

Drive Piezos. Keep It Simple.

DESIGN PIEZO TRANSDUCER BRIDGE DRIVER WITH LOW COST DUAL AMPLIFIER IC

Cirrus Logic makes driving piezos simple. With the monolithic PA240 series from the Apex Precision Power® product family, it is now possible to achieve levels of performance previously found only in hybrid designs. Offered in a variety of packaging options, the PA240, PA241 and PA243 feature inputs that are protected from excessive common mode and differential mode voltages and a safe operating area (SOA) that has no second breakdown limitations. The external compensation for these ICs provides flexibility in choosing optimum gain and bandwidth for the specific application.

APPLICATIONS

- Commercial Printing
- Medical Imaging
- Ultrasonic Cleaning
- Ultrasonic Welding
- Ultrasonic Wire Bonding

Model	Slew Rate	Supply Voltage Operation	Output Current	Quiescent Current	Package
PA240	40V/µs	±50 to ±175	60mA Continuous 120mA PEAK	2.2mA	CC – 7-pin DD pak CX – 7-pin TO-220
PA241	40V/µs	±50 to ±175	60mA	<2.2mA	CE – 8-pin TO-3 DF – 24-pin PSOP DW 10-pin SIP
PA243*	30V/µs	±50 to ±175	60mA	<2.2mA	DF – 24-pin PSOP

*Dual

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LEARN MORE AT
www.cirrus.com

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For product selection assistance or technical support with Apex Precision Power® products email apex.support@cirrus.com.

Embedded Designer's Forums come to UK and Ireland

Six detailed sessions per forum showing how to enhance embedded designs with the latest low-power, connectivity and user-interface technologies
Attendees will receive substantial discount on select Microchip development tools
Microchip announces the opening of registration for its Embedded Designer's Forum (EDF), a worldwide series of technical learning events focused on innovative technologies that will help designers stay ahead in today's competitive environment. The forums will run from October 2009 through February 2010 at 120 locations across the world, with 51 forums located in Europe and 6 forums across UK and Ireland running in November and December. All attendees will receive a substantial discount on select Microchip development tools, as well as a free, hands-on training class at any of Microchip's 37 worldwide Regional Training Centers. To register or for more information, please visit:

www.microchip.com/EDF

Michael Knappmann Regional Director

Avnet Abacus has appointed Michael Knappmann as Regional Director, Central Europe to spearhead its growth in Germany and Switzerland.
Michael Knappmann brings 30 years experience of local, national and global distribution in the electronic components industry to the role. He reports to Graham McBeth, President of Avnet Abacus, and will be based in Poing.
Michael Knappmann has held many senior roles within distribution. Previously Michael was Director for Lighting Business Development at Arrow covering the EMEA region. Prior to that he help the position of VP of Marketing responsible for active, passive, electromechanical and embedded products. He joined Arrow when it acquired Sasco Semiconductor GmbH, where he spent ten years, including seven as Managing Director. Previously, he spent five years in sales and general management positions at Future Electronics Deutschland GmbH.

www.avnet.eu

EU must Act to Tap Europe's Largest Energy Source

More than 140 company representatives in 38 countries have signed the European Offshore Wind Declaration, calling on national governments and the EU to give the necessary political and legislative support to develop a new multi-billion Euro offshore wind industry.
Offshore wind energy has the potential to power Europe seven times over, and offshore wind projects already in various stages of planning would, if realised, supply 10% of Europe's electricity demand. Offshore wind is clean, emits no greenhouse gases and would reduce Europe's dependence on imported fossil fuels.
The declaration, drawn up by the European Wind Energy Association (EWEA), commits businesses to ensuring that a sufficient supply of turbines, components, foundations, installation and cable-laying vessels are available to exploit this abundant, free, and fuel-free energy source. But crucially it also calls on the EU and member states to take action to resolve planning, grid and other obstacles to harnessing Europe's enormous offshore wind energy potential.
Signatories include companies from all over the world such as Acciona Energia, Airtricity, DONG Energy, E.ON Climate & Renewables, EnBW, GE Energy, Iberdrola renewables, Mainstream Renewable Power Ltd, NEO Energia - Grupo EDP, Renewable Energy Systems, SIEMENS Wind Power, Suzlon Wind Energy, Goldwind, Vattenfall Vindkraft and Vestas Wind Systems. Representatives of governments, universities, media and non-profit organizations have also signed.

www.ewea.org/offshore

Conference and Users´ Meeting

Simulation is the key to both innovative and optimized products, and accelerated development processes. ANSYS Workbench is the integrated CAE environment which provides first-class tools for the entire range of product development processes: structural mechanics, fluid mechanics, electromagnetics, and multiphysics.
For three days, CADFEM, ANSYS Germany and, for the very first time, Ansoft will present a diverse range of technical information for specialists and interested beginners at one of the largest specialist conferences on simulation.

www.usersmeeting.com

TI Opens World´s Most Advanced Analog Manufacturing

Texas Instruments announced the opening of its manufacturing facility in Richardson, Texas. The company expects to begin moving equipment into the facility in October. Known as RFAB,("R" for Richardson, "FAB" for fabrication), the fab will be the world´s only production facility to use 300-millimeters (12-inch) silicon wafers to manufacture analog chips, wich are essential componnts in virtually all electronics. The facility will gie TI a strategiy advantage in high-volume production because thousands of analog chips can be each of these wafers, more than double the number on the commonly used and smaler 200-millimeter wafers.
The facility will produce analog integrated circuits based on TI´s proprietary process. Customers will use these chips in electronics ranging from smatphones and netbooks, to telecom and computing systems.

www.ti.com

Fuseac® Lights the way for Unparalleled Failure Protection

Fuseac® technology electrically disconnects before catastrophic failure, with or without light indicator

Electronic Concepts, Inc. once again outshines the competition with Fuseac®, a revolutionary patented capacitor fuse technology designed to provide reliable protection against overheating of metallized dry film capacitors in AC applications. Fuseac® intuitively detects hazardous conditions and electrically disconnects, avoiding catastrophic failure. An optional light bulb indicator easily identifies the disengaged capacitor.

Designers of power management systems can now have unparalleled protection from disastrous overheating failures thanks to Fuseac® technology, now available in a wide range of Electronic Concepts products. Fuseac® can be equiped with or without optional indicator light. So call Electronic Concepts today or visit our website to learn how Fuseac® lights the way for unparalleled failure protection.

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www.fuseac.com

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SPS/IPC/DRIVES 2009 Nuremberg, 24 - 26 November

The most important meeting place for the electric automation sector, SPS/IPC/DRIVES, will take place from 24 – 26 November 2009 in Nuremberg. The exhibition covers the whole electric automation market and focuses on the specific requirements of users. This was affirmed in a recent survey of the members of the Executive Committee and the technical faculties of ZVEI (German Electrical and Electronic Manufacturers´ Association) which showed that there is neither the need nor the desire to change the concept, the structure, the modus operandi or the location of the event.

Packed with information

In this the 20th year of the event, more than 1,300 companies are expected to exhibit at SPS/IPC/DRIVES. They will fill eleven exhibition halls with the complete array of components and systems in the electric automation sector which will be on show to a trade audience. Nearly 300 exhibitors from outside Germany will be participating.

The main focus on the exhibition stands is the dialogue with users. For the exhibitors, there is the chance to persuade the high calibre trade audience (two-thirds work in design and development, production or management) of the merits of their products. And visitors can access a high volume of information and guidance in their search for the best solution to their automation problem.

Extra time for technical discussions

As a result of the high visitor numbers the SPS/IPC/DRIVES Exhibitors' Advisory Board has decided to extend the opening times this year. Thus on Tuesday, the first day of the exhibition, the halls will stay open until 19:00 hrs, which will allow more time for detailed discussions between the users and the exhibitors. This will also relieve the pressure on the Wednesday which is traditionally very busy. The event will continue to take place over three days, from Tuesday to Thursday.

Important topics in the spotlight at SPS/IPC/DRIVES 2009

The main topics at this year's SPS/IPC/DRIVES, "Safety and Security", "Energy Efficiency" and "Industrial Identification" will be addressed at the forums in the eleven exhibition halls and at the simultaneous conference. The importance of these topics for today's electric automation sector will be reflected in the products and services being offered on the exhibition stands.

Solutions are at the heart of the exhibition

SPS/IPC/DRIVES has always had a strong practical orientation and the exhibitors strive to provide the best possible advice to the visitors during the three day event. You won't find flashy or gimmicky presentations here. Once again this year, the Exhibitors' Advisory Board has set a high value on a factual, product oriented approach from the exhibitors.

SPS/IPC/DRIVES Conference – the automation sector in discussion

The objective of the simultaneously held SPS/IPC/DRIVES conference is to support debate between the researchers, product developers and users in the electric automation field. Offering 18 seminars and 56 presentations in German language, the 2009 conference will again offer the optimum stage for finding out about and discussing current technologies, new developments and practical applications.

www.mesago.com/sps

PV Industry Landscape, Drastically Modified within One Year

Yole Développement updated its markets & technological study dedicated to the photovoltaic industry: Photovoltaic Technology Equipment & Market Report 2009.

In its analysis, Yole Développement takes into account the financial crisis: the company presents an overview of the PV industry including all markets and technological impacts.

This markets & technological study offers a full description and analysis of photovoltaic's market, technologies, manufacturing processes, equipment and materials. It also includes key figures, analyses and useful tools for strategic decisions.

For several years, the Photovoltaic (PV) industry was primarily seen as an outstanding financial investment, delivering a high-performance return-on-investment (ROI) with limited risk. The objectives were simply to adapt the production capacities to answer a high market demand. In this context, Polysilicon and wafer producers, cell and module manufacturers were assured to sell their entire production.

But 2009 has been quite particular as the financial crisis has not spared the PV industry. The credit crunch, lower-than-expected market growth, and a large product offer have in fact forced companies to be more innovative than ever. As a consequence the whole PV chain, from polysilicon producers to module manufacturers, is working on new technical solutions to reach grid parity and finally make PV a competitive renewable energy source. Government incentives as well as new power grid structure (e.g. smart grid) will contribute, in the coming years, in making PV a viable alternative to conventional energy sources such as coal or nuclear. As cost reduction has become one of the top priorities for equipment and material suppliers, we are today seeing them partnering with cell manufacturers to pull production cost down.

www.yole.fr

MAGNETICS® Launches New Websites

Magnetics, a leading world supplier of precision soft magnetic components and materials, announces the launch of its new and improved website, www.mag-inc.com, along with the initial launch of the Chinese language www.mag-inc.com.cn. In addition to an improved user-friendly layout, the sites offer many new enhancements. New advanced search tools allow users to search by part number, dimensional and magnetic parameters, and keywords. Expanded product detail, a comprehensive datasheet library, updated design software, and a competitive part number cross-reference assist engineers at every step of the design process.

These websites are also the portal to MyMagnetics; Magnetics new password-secured customer website. MyMagnetics provides customer specific information such as pricing, availability, order status and account information to registered customers. In addition, users can request samples, place orders, check invoices, and track shipments, creating a comprehensive online purchasing experience.

www.mag-inc.com

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New Levels of Performance In Piezoelectric

Cirrus Logic Inc. has delivered new levels of performance for the piezoelectric driver market with the addition of the PA107DP and MP103FC high-voltage, high-speed power amplifiers to its Apex Precision Power® product family. The PA107DP is capable of slew rates up to 3000 V/µs, which raises the bar for single-package hybrids. The MP103FCFC is a new dual-channel designed hybrid that can deliver a very high 15 A X 2 of output current. Both devices are operational with voltage supplies of up to 200 V.

The PA107DP is an attractive option for driving piezos used in medical imaging and ultrasound applications, as well as programmable power supplies for the ATE market, because the high slew rate increases voltage response time. The end result is greater accuracy and rapid delivery of voltage throughout the end system, enabling imaging scans that take less time to complete and power supplies that cycle with greater efficiency, for example. Customers needing higher speed will select the PA107DP because it extends the available slew rate performance within the Apex Precision Power product family by 3X that of the PA85, which features a 1000 V slew rate. The PA107DP also improves output current performance with 1.5 A/5 A PEAK, and a high-gain bandwidth of 180 MHz. The device is housed in a 12-pin Power SIP package that requires less than two square inches of board space.

"Through the Apex Precision Power brand of products, Cirrus Logic has a long history of innovation in the piezo drive market for high-voltage, high-speed products," said Greg Brennan, vice president and general manager, Cirrus Logic Apex Precision Power business unit. "We continue to see rapid acceptance of off-the-shelf piezo drive technology in new market segments, such as medical imaging, where larger discrete solutions have been more typical. With the introduction of the PA107DP and MP103FC, we continue to expand the performance parameters of single-packaged IC and hybrid piezo drivers that can be easily retrofitted into existing systems or prototyped for next generation designs."

The MP103FC is a dual-channel device that allows designers to save significant board space in multichannel systems. The device features up to 15 A of output current per channel, operating voltages ranging from 30 V up to 200 V and a slew rate of 180 V per microsecond. The targeted application for the MP103FC is driving piezo print heads in large format industrial ink jet printers typically used to produce wide format banners and billboards.

The MP103FC uses the industrial temperature range "open frame" packaging form factor developed for a number of Apex Precision Power products to offer a lower per unit cost, in comparison with a hermetically sealed hybrid, while still providing very high levels of performance.

Model	Slew Rate	Output Current	Supply Voltage Operation	Production Volume Pricing 1K Pieces USD*
PA107DP	3000 V/µs	1.5 A continuous 5 A PEAK	40 V to 200 V	$165.55
MP103FC	180 V/µs	Up to 15 A PEAK x 2	30 V to 200 V	$85.04

Key Product Specifications

*Per unit pricing for production estimating only; actual per unit cost through distribution may vary. Visit "Contacts" at www.cirrus.com for a complete list of Cirrus Logic sales representatives and distributors.

Availability, Demo Boards

The PA107DP and MP103FC are available in sample quantities for evaluation and prototyping, as well as volume production. Evaluation kits are available. Complete product information is online at www.cirrus.com. For technical support, contact Apex Precision Power product support toll-free at 800-546-2739, or apex.support@cirrus.com.

Cirrus Logic Inc.

Celebrating its 25th year as a leading fabless semiconductor company in 2009, Cirrus Logic develops high-precision, analog and mixed-signal integrated circuits for a broad range of innovative customers. Building on its diverse analog and signal-processing patent portfolio, Cirrus Logic delivers highly optimized products for a variety of audio and energy-related applications. The company operates from headquarters in Austin, Texas, with offices in Tucson, Ariz., Europe, Japan and Asia. More information about Cirrus Logic is available at:

www.cirrus.com

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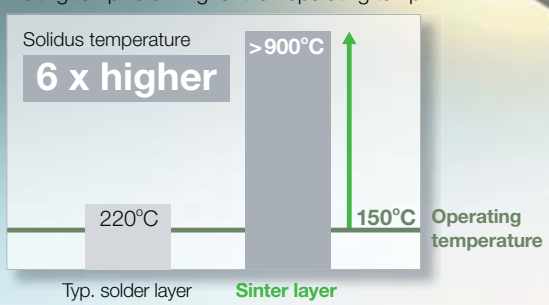

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High-Brightness LED Driver with Temperature Management Control

WEBENCH design tool displays effects of temperature foldback, simplifies design of LED systems

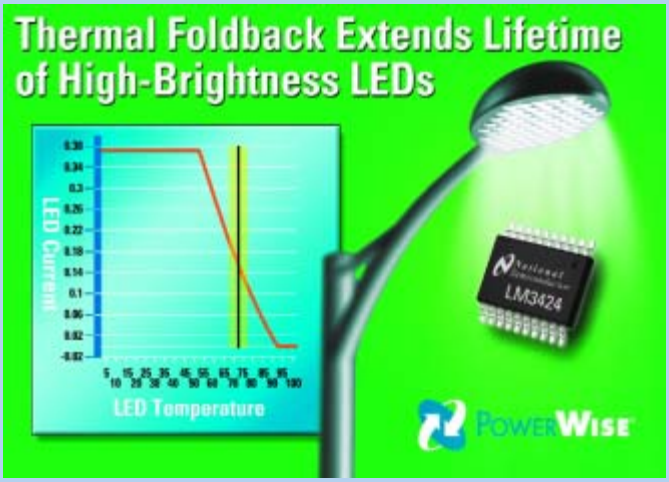
National Semiconductor Corp. has announced a new LED driver with temperature management control and the addition of an online design environment to support it. The LM3424, a member of National's PowerWise® energy-efficient product family, drives high-brightness LEDs in a variety of indoor, outdoor and automotive applications. Supported in National's WEBENCH® LED Designer, its temperature management control, thermal foldback, enables lighting designers to quickly and easily design a reliable thermal system using the LM3424.

Thermal foldback combats high temperatures LEDs can reach as a result of environmental conditions. When LED temperatures rise above a safe threshold, the lifetime and efficacy of the LED decreases. With the LM3424, lighting designers can program temperature and slope breakpoints within which the LEDs operate safely. When an over-temperature condition occurs, the LM3424's thermal foldback circuitry reduces the regulated current through the LEDs. The reduced current dims the LED to a range programmed by the designer and the LED remains within the range until it returns to a safe operating temperature.

This method of thermal foldback maintains the lifetime and efficacy of the LED and ensures the warranty period of fixtures in applications such as automotive headlights, high bay warehouse lighting and street lighting.

National's WEBENCH LED Designer helps lighting designers identify the ideal temperature threshold or foldback breakpoint of the LEDs. Traditionally, resistor values are calculated by hand to identify temperature foldback breakpoints. The WEBENCH online design environment allows the designer to easily enter the temperature foldback and slope points and then visualize the behavior of the design at different LED temperatures. This requires no hand calculations. An interactive temperature slider shows the results graphically. The LED driver design automatically updates with entry of temperature breakpoint requirements.

Technical Features of National's LM3424 LED Driver
Offered in a 20-pin thermally enhanced TSSOP package, the LM3424 drives up to 18 high-brightness LEDs in series with output current above 2A in a typical application. It contains all of the features to regulate currents based on buck, boost, SEPIC, flyback and buck-boost topologies.



The LM3424 operates over a wide input range of 4.5V to 75V. The pulse-width modulation (PWM) controller is designed for high-speed capability including an oscillator frequency range that can be synchronized up to 2.0 MHz. Additional features include PWM and analog dimming, programmable softstart and protection features such as low-power and thermal shutdown, and cycle-by-cycle current limit.

For more information or to order samples and an evaluation board, visit:

http://www.national.com/pf/LM/LM3424.html

Available now, National's LM3424 and is priced at $1.75 in 1,000-unit quantities. More information about National's LED drivers is available at:

http://www.national.com/analog/led

National Semiconductor is a leader in analog power management technology. Its products include easy-to-use integrated circuits, PowerWise products that enable more energy-efficient systems, and SolarMagic™ products which improve the energy output of solar arrays. The company celebrates its 50th anniversary this year. Headquartered in Santa Clara, California. National reported sales of $1.46 billion for fiscal 2009. Additional information is available at:

www.national.com

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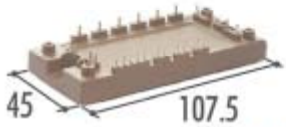
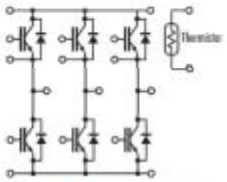
6-Pack IGBT

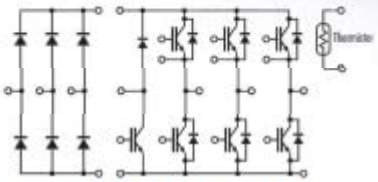


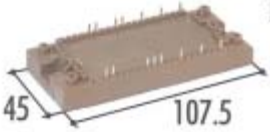


600V: 50A , 75A , 100A
1200V: 35A , 50A , 75A , 100A

600V: 100A , 150A
1200V: 75A , 100A , 150A , 180A

PIM IGBT



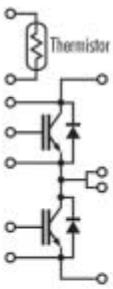


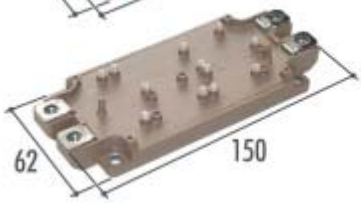
600V: 50A , 75A , 100A
1200V: 25A , 35A , 50A

600V: 100A , 150A
1200V: 50A , 75A , 100A , 150A

2-Pack IGBT

1200V: 225A , 300A , 450A , 600A





6-Pack & PIM with PressFit Contacts

		25A	35A	50A	75A	100A	150A	180A
6-Pack	600V			●	●	●	●	
	1200V			●	●	●	●	●
PIM	600V			●	●	●	●	
	1200V	●	●	●	●	●	●	

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SiC – Diodes Excel in Most SMPS Applications

Total costs of complete designs must be compared

Most astonishingly, even the manufacturers of state-of-the-art SiC diodes limit their recommended applications mainly to just PFCs and motor drives, neglecting the far larger realm of applications in which they equally excel over PN diodes.

By Dr.– Ing. Arthur Seibt, Vienna

In fact, since their advent some years ago, SiC diodes are the superior choice in the majority of SMPS applications as there is no basic difference between their function in PFC circuits and most other SMPS circuits. Any price comparisons to PN diodes just based on component prices rather than on the total costs of complete SMPS designs will be misleading. SMPS designers should seriously consider and evaluate SiC diodes at least in all hard-switching applications. Many will be in for hefty surprises.

Basic differences of PN and SiC diodes

The differences are extensively treated in other publications. SiC diodes are Schottky diodes, free from recovery effects and extremely fast, only their capacitance has to be charged and discharged. Their switching performance is independent of temperature and thus will not severely deteriorate as is the case with PN diodes. They may be operated at elevated temperatures where PN diodes are close to failure.

The free-wheeling diode in PFC circuits

In the familiar PFC boost circuit the diode plays a central role which may be more obvious here than in other circuits. When the switching transistor turns on, the diode should turn off immediately because otherwise the transistor will switch on into a full short circuit to the boosted output voltage close to or above 400 V causing extreme overcurrent and high dissipation. All PN diodes display a reverse recovery time during which they remain on. With PN diodes, the transistor as well as the diode have to be oversized. Even if the cost penalty is accepted, the high dissipation remains. Ultrafast or hyperfast PN diodes exhibit a much higher forward voltage of up to 4 V.

If the PN diode is replaced by a SiC diode, the transistor has to discharge only the capacitance, its peak current will be dramatically reduced, thus a much less expensive type will suffice saving cost, also the diode does not have to withstand a high peak current. This has been covered in many articles. Professionally designed PFC's with SiC diodes and Coolmos fet's achieve 97 to 98 % efficiency.

´Where is the difference to most other SMPS circuits: there is none!

This article is to show that there is no substantial difference to the role of the diodes in most other hard-switched SMPS circuits, hence it should be evident that SiC diodes excel also in these applications and should replace old-fashioned PN.

The most important SMPS circuit, at least up to 250 W output, a limit fast moving upward with even better semiconductors and passives, is the flyback converter, a misnomer, a more appropriate term would be storage converter. Of its two operating modes: DCM and CM, the latter is more important in practice. In this mode, the switching transistor also turns on while the secondary diode is still conducting, there is no basic difference to the PFC, the transformer (also a misnomer as it is none, but a storage choke with – mostly – independent input and output) is in between but it should be a good one with close coupling. Consequently, also here the SiC diode far outperforms any PN diode. One might suspect at first sight, that the higher forward voltage of SiC, slightly increasing with temperature, will lead to higher losses, but which counts are the total losses, apart from the fact that hyperfast PN diodes exhibit even higher forward voltages. The almost total absence of switching losses with the SiC diode outweighs by far any higher forward loss. And also here the transistor and the diode can be replaced by smaller ones, the losses are considerably reduced. This advantage becomes the more pronounced as the temperature rises. With a PN diode, the fast increasing switching losses cause a rise in power dissipation with the danger of thermal runaway while, with a SiC diode, the total losses remain almost constant, the input power will not budge.

All modern SMPS tend to be as compact as possible, hence efficiency is the catchword and it will determine eventually how small the circuit may become. SiC also allows higher switching frequencies. It is too often overlooked that a higher switching frequency is no benefit or advantage as such, because all losses will rise. Some passive components can be reduced in size, but the higher losses require a larger heatsink or a fan.

The author has performed extensive comparisons between the best PN diodes available and SiC especially in high power flyback converters: the SiC diode beats any other one hands down! Of course, it is not applicable to low output voltages, the advantages become the more striking the higher the output voltage, but the tests showed that they can be used to advantage down to 25 V. This applies to the standard 600 V types.

Beware of misleading cost comparisons

Too often, components are compared without taking their effect on the whole circuit into account.

At present, SiC diodes are still „more expensive", or are they really? The first grave mistake or trap is any comparison by comparing data sheet specs. One must not compare PN and SiC diodes volt by volt and ampere by ampere. PN diodes mostly have to be oversized in order to achieve an acceptable switching behaviour, life and reliability, that is a low enough working temperature. In typical circuits a 2 A SiC beat a 15 A PN diode by far. Only the total costs of complete SMPS designs must be compared, i.e. one designed with PN diodes and one with SiC diodes. SiC's limitations regarding peak currents have to observed. There are types on the market which are a combination of Schottky and PN diode.

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Interview on High Voltage Driver Technology with Wolfgang Ademmer CEO CONCEPT

By Bodo Arlt, Editor BPS

Bodo Arlt: How did CONCEPT start and what was the vision?
Wolfgang Ademmer:
CT-Concept Technologie AG started as an engineering company back in 1986. At that time Heinz Rüedi, the founder, identified a lack of gate drive design know how in the power electronics market and the resulting market need for gate drive solutions. Consequently he designed the first ready-to-use gate drive unit for power MOSFETs called IPD505. Understanding the challenges of high power gate drive design with regard to performance and reliability, Mr. Rüedi was convinced that having a highly integrated gate drive circuit would be key to success. So CONCEPT moved along with the design of the 1st generation of an ASIC chipset called SCALE, which has become the standard for high power gate drive units.

Bodo Arlt: What future end markets will drive CONCEPT for technology development?
Wolfgang Ademmer:
CONCEPT products are dedicated to all inverter applications in a power range of 50kW to several Megawatts. Main stimulus for new technology development are coming from windmill, solar, traction and automotive applications. Topics of relevance in this context are paralleling of modules, high temperature capability, compactness and reliability.

Bodo Arlt: What is the position CONCEPT has for the wide range of IGBT Modul manufactures?
Wolfgang Ademmer:
For the IGBT Module manufacturer CONCEPT is the perfect complementary fit. With the complete product portfolio of high power IGBT drivers and our technical support we enable short design-in cycles as well as state-of-the-art inverter designs. Therefore CONCEPT offers two main product families. Driver cores which flexibly work with nearly all IGBT and MOSFET technologies and Plug-and-play driver which are tailored to the specific module types and used silicon technologies..

Bodo Arlt: What are the technologies that CONCEPT can offer for innovation leadership?
Wolfgang Ademmer:
CONCEPT offers the most compact high power gate drivers available in the market due to the highly integrated SCALE-2 ASIC chipset. This goes along with a minimum component count leading to highest MTBF. A comprehensive feature set including AAC (Advanced Active Clamping), regulated gate voltage, delay times less than 80ns and direct paralleling describe the current benchmark in gate drivers. Beside the chipset innovations, CONCEPT has introduced planar transformers for high voltage isolation based on a patented layer structure. This technology enables higher operating temperatures, highest switching frequencies and an ultra-flat design.

Bodo Arlt: What makes CONCEPT different from other driver suppliers?
Wolfgang Ademmer:
CONCEPT is a privately owned, fully independent company which is dealing with all IGBT module manufacturers. That makes us a competent and neutral partner for the end-customer regardless of the used IGBT module/ technology. Our products are dedicated to solve the customer problem in a cost effective and performance optimized way. Furthermore we are open to to collaborate with customers to create custom specific solutions. And do not forget that CONCEPT is established since more than 20 years in the market with a proven track record of products in the field. A comprehensive product portfolio, sound experience in gate drive design, high volume production capacity and last but not least a long term supply guarantee makes us a stable and reliable business partner for all well known companies around the globe.

Bodo Arlt: Can you tell us about the range of your technology and some of its features?
Wolfgang Ademmer:
CONCEPTs product range is covering all high power applications and topologies. We provide solutions for paralleling IGBT modules in all voltage classes, 2- and 3-level applications as well as ultra fast switching applications. The new SCALE-2 ASIC chipset comprises all the necessary functionality.

Bodo Arlt: How much is CONCEPT involved in the end customer's applications?
Wolfgang Ademmer:
More and more we deal with end customers in the concept phase of their new inverter design as an accepted partner for gate drive design. This helps us to better understand the requirements of the overall system and the allows the end customer to design an optimized inverter system including a highly customized driver.

Bodo Arlt: How much is CONCEPT involved in commodity applications using the advantage of your expertise and technology to support low cost volume products?
Wolfgang Ademmer:
CONCEPT is focussing to the high power gate drive market. We classify our selves into the market of 50kW inverter power rating and upwards with a focus to high performance, high-power and high-voltage systems. With our new SCALE-2 low cost core at a price of 10USD per channel, we are touching the borderline of other gate drive solutions based on opto-couplers or coreless transformer IC. Yet we have no intention to address the market for even lower power ratings.

Bodo Arlt: What do you see as your core competencies?

Wolfgang Ademmer:
Mixed signal ASIC design combined with extensive know how in power semiconductors and in designing transformer solutions describe the core competence of CONCEPT. Crucial for our success is not only the innovative power within the company, but also the capability to translate customer needs into new products. This is why we will continue to intensify our technical customer support.

Bodo Arlt: Who are your competitors you believe will stimulate the race for leadership?
Wolfgang Ademmer:
Only few competitors have shown up in the market up to now. Among those we have identified players who try to copy first generation CONCEPT products in a simple way. Others are more innovative and realize digital drivers for the high-voltage segment. Though there are interesting aspects in this technology, it is still in its infancy, carrying too much overhead due to missing integration. We're watching these technology trends carefully and will continue to integrate those who provide value add to our customers. The main competitors for CONCEPT are still the in-house design activities at customer side. Typically we compete with existing driver stage solutions where we have to compare ourselves with the custom specific requirements and cost, which is defined only by components. This is driving our efforts to achieve a competitive cost position while creating a functionality which is more than the customer expects. With our new SCALE-2 drivers we have made a big step towards this goal.

Bodo Arlt: How was the name CONCEPT selected?
Wolfgang Ademmer:
CONCEPT stands for the "conceptual" approach which was taken to solve technical problems not only with the narrow view of the current topic itself, but with foresightedness of the broader technical challenge and its intelligent solution.

Bodo Arlt: Thank you Mr. Ademmer for the time. We look forward to a successful future for the technology innovations at CONCEPT.

www.IGBT-Driver.com

Wolfgang Ademmer:

Wolfgang Ademmer, 41, started his career in the power electronics market in 1993.
Holding several positions in sales and marketing since than, he became Vice President Sales & Marketing at eupec GmbH (a 100% Infineon Technologies AG company) in 2003, where he implemented a new solution oriented strategy. With the merger of eupec and Infineon in 2005, Ademmer - who holds a degree in electrical engineering and business administration - moved to Munich to head the new business segment for hybrid vehicles and white goods. Major milestones during this time were the development of CiPoSTM and HybridPACKTM. In 2008 he worked as consultant for small and medium size companies in the high-tech environment with a focus to establishing and conducting business plans for growth. Since May 2009 he acts as CEO of CT-Concept Technologie AG.

CiPoS™ and HybridPACK™ are trademarks of Infineon Technologies AG

Electronics Industry Digest

By Aubrey Dunford, Europartners

GENERAL

With revenues forecast to decline by over 13% in 2009, the European EMS industry is facing a period of uncertainty and rapid change, so ReportLinker. In Western Europe, the leading Tier 1 EMS providers have already relocated volume manufacturing to lower cost locations. They have, however, retained a manufacturing presence and are looking to compete in the growth markets of aerospace and defence, medical, control and instrumentation and automotive and industrial as they recover in the 2010/2011 time frame. It is here that the real battle for the vast majority of the around 700 EMS companies in Europe will take place. A key trend in recent years has been the migration in EMS production from Western Europe to Central and Eastern Europe (CEE) resulting in the CEE accounting for just under 55% of European EMS revenues in 2008. EMS revenues in the CEE forecast to decline by 17% during the year.

SEMICONDUCTORS

Worldwide sales of semiconductors in July were $ 18.2 billion, an increase of 5.3 percent from June 2009, so the SIA. “The fifth-consecutive month of sequential increases reflects improving demand in the consumer sector,” said SIA President George Scalise. The first six months of 2009 saw an average monthly year-on-year decline of 25 percent, while July 2009 sales were 18.2 percent lower than July 2008. Europe is still hit worse than other regions. Measured in Euro, European semiconductor sales of € 1.665 billion in July 2009 rebounded slightly, up 3.1 percent on the previous month and down 23.3 percent versus the same month a year ago, so the WSTS. On a YTD basis semiconductor sales declined by 23.6 percent in 2009 versus the same period in 2008.

The acquisition of Singapore-based Chartered Semiconductor by Globalfoundries via ATIC of Abu Dhabi has catapulted the company into the No.-2 position among pure-play foundries in terms of revenue for the first half of 2009 (with sales of $ 1159 M), so iSuppli. Specifically, Globalfoundries, a joint venture with AMD which prior to the acquisition had just one 300mm facility, will now have two operational 300mm facilities and five 200mm factories

Dialog Semiconductor, a German mixed-signal integrated circuits supplier, and TridonicAtco, a member of the Zumtobel Group, have established a joint development centre for next generation energy efficient lighting technology in two locations in Austria: Graz and Dornbirn.

Microsemi, a manufacturer of analog mixed-signal integrated circuits and high reliability semiconductors, has sold the assets of Semicoa to a third party. In connection with this sale, the United States Department of Justice has settled its civil action against Microsemi.

SEMI predicts 64 percent growth in fab spending for 2010 to reach $ 24 billion, after a 51.7 percent decline this year. A large portion (about $ 14 billion) is expected to come from six companies (TSMC, GlobalFoundries, Toshiba, Samsung, Intel, and Inotera). Worldwide installed capacity is expected to decline by 2 to 3 percent in 2009 mainly due to the closure of 31 fabs. This overall capacity is expected to have a slow growth rate of only 4 to 5 percent in 2010, to about 21.5 million wafers per month in 200 mm equivalents. Worldwide semiconductor manufacturing equipment billings reached $ 2.69 billion in the second quarter of 2009. The billings figure is 13 percent lower than in Q1 2009 and 66 percent less than the same quarter a year ago. SEMI also reported worldwide semiconductor equipment bookings of $ 2.95 billion in the second quarter of 2009. The figure is 58 percent less than the same quarter a year ago but 83 percent greater than in Q1 2009.

Soitec, a French supplier of silicon-on-insulator, has entered into collaboration with IBM to pioneer 22-nm node and beyond silicon wafer substrate and bonding techniques that will enable wafer-level, 3D integration technology for next-generation ICs. Soitec will also work with Corning on the development of silicon-on-glass (SiOG) substrates for the flat panel mobile display market.

OPTOELECTRONICS

Leading TFT-LCD panel makers including LG Display, Sharp and Samsung Electronics are actively seeking advancement into China, so Displaybank which explains that the trend can be analyzed as a strategic move by these makers in order to aggressively target Chinese LCD TV market.

PASSIVE COMPONENTS

Supply bottlenecks are emerging in passive components including resistors, capacitors, inductors, quartz crystals, resonators and SAW components, warns German electronics industry association ZVEI. That’s because passive component manufacturers have reduced production capacities during the economic crisis. To ensure a reliable supply of passive components, customers need to place early orders to give manufacturers sufficient lead time, says the ZVEI.

OTHER COMPONENTS

Apache Design Solutions, a suppler in power and noise integrity for Chip-Package-Systems (CPS) convergence, has acquired Sequence Design, an EDA supplier in RTL Design for Power solution. Terms of the transaction were not disclosed. .

DISTRIBUTION

TDK-Lambda has selected PPM as its UK distributor of the year for the second time in succession. Founded in 1994, Pulse Power & Measurement provides a sales and distribution channel to its partners for a wide range of specialist RF and power conversion equipment and components.

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

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Europe Breaking Through Digital Barriers

By Linnea Brush, Senior Research Analyst, Darnell Group

Recent developments are putting Europe at the forefront of "breakthroughs" in digital power management and control technologies. European companies have always had a strong presence at Darnell Group's Digital Power Forum (DPF), and the continued commercial deployment of digital power is opening up new opportunities. Companies like Ericsson and STMicroelectronics have long been active in the digital market, but new entrants are capitalizing on digital's move into emerging application segments. These trends will be highlighted at the Digital Power Europe (DPE) conference that Darnell will be hosting in Nuremberg, Germany, in March, 2010.

For example, regulators in the US and EC have been proposing minimum efficiency requirements for offline power supplies. The new 30-mW no-load target representing the new five-star rating system agreed upon by LG Electronics, Motorola, Nokia, Samsung and Sony Ericsson is expected to help drive digital control in ac adapters, according to Cambridge Semiconductor. One effect of minimizing no-load power consumption can be the creation of large voltage drops and lengthy recovery times when transitioning from no-load mode to full output power. Designers must ensure that a circuit capable of meeting the 30-mW challenge can also start up quickly and recover well from zero- to full-load conditions.

CamSemi offers a novel power conversion topology that enables low-cost, high-efficiency switch-mode power supplies, called RDFC (Resonant Discontinuous Forward Converter). The approach is considered "ideal" for single-rail, high-volume consumer applications. The main control loop is digital, although the bipolar transistor/power switch is controlled via analog feedback. This loop ensures the transistor is always run with the optimum amount of charge in the base so that it goes off quickly at turn-off.

The consumer market has not been the traditional focus of digital power solutions, due to the higher cost of such implementations. But costs have come down to the point that they are becoming more competitive with analog solutions. At the Digital Power Forum '09, the delegates were mixed about whether digital control would find significant commercial penetration in the portable consumer device market. Wolfson Microelectronics would disagree.

Wolfson is a mixed signal company whose expertise is in audio products. They have recently come out with a new range of power management ICs that enable smaller, more cost-effective designs. In particular, Wolfson has announced the WM8320 "processor companion IC," which supports all ARM processors. The WM83xx family is targeted at portable consumer devices with batteries, and the hardware can be configured to accommodate different processor models and applications. Limitless configurations are possible using OTP memory. Importantly for digital, the I2C bus can be used, as well. Wolfson said they are "definitely seeing a market for digital in portable consumer devices that require a lot of configurability and function."

Other breakthroughs are occurring, as well. In July, 2009, Power-One Inc. and Powervation Ltd. announced that they had entered into a non-exclusive Field of Use license for Powervation under Power-One's digital power technology patents. Powervation said, "We believe that our differentiated digital energy control semiconductor and system solutions provide substantial benefits to our customers for management of the power delivery and energy efficiency of information processing systems. Our collaboration with Power-One on the intellectual property for systems-level communication and digital power control means that our customers can easily move to the next level of power architecture implementation."

Powervation then announced that it had secured $10 million in additional financing, which will be used to broaden its global sales, marketing and operations infrastructure, and further advance its research and development initiatives. The funding followed the launch of Powervation's first digital power conversion IC, the PV3002. Central to the IC is Auto-control™, a unique algorithm that monitors output voltage on a cycle-by-cycle basis and automatically compensates for variations in line, load, capacitance and inductance.

CUI Inc.'s power division V-Infinity then announced that it is developing a line of digital point-of-load (POL) modules that will utilize Powervation's digital power conversion ICs. The new Novum series modules will combine high power density in a compact footprint and offer a wide array of digital control and power management functions. It will utilize Powervation's Auto-control technology, which will allow the new modules to work in real time, ensuring stability and improved transient responsiveness.

The Novum modules will operate off a 12V nominal input and come in 12 and 25A configurations. Output voltages will be programmable and will utilize standard PMBus commands for configuring and monitoring. A wide array of digital power control functions will be supported, including current monitoring, temperature sensing, margining and voltage sequencing. The Novum series is being developed for a board design engineer to realize better energy efficiencies and improved time to market compared to the traditional analog approach through design flexibility and system optimization.

Optimizing energy management in advanced electronics systems has become a "corporate imperative for manufacturers of these products," according to Powervation, not just to meet their aggressive eco-priorities, but also to deliver the most economically efficient products to their customers. Ericsson Power Modules is following this philosophy, as well. Their recent introduction of the BMR454 dc-dc converter is designed to offer customers "a broad range of products to improve energy management and contribute to reducing CO2 emissions."

The BMR454 eighth-brick family delivers up to 240W with an efficiency rating up to 95% at full load; and, in what the company is calling

an industry first, a PMBus interface is included. The parameters of the BMR454 can be monitored via PMBus, and they can also be adjusted into an endless number of combinations, including an intermediate bus converter in front of a range of regulators, or as a traditional dc-dc module powering applications such as hard drives, fans, radio base stations, servers, routers, and 48Vdc systems.

The adoption of digital control opens new possibilities for advanced control loop techniques. At DPF '09, STMicroelectronics discussed a new non-linear transient response technique that is aimed to enhance dynamic performance of digital converters. The technique takes advantage of digital control architecture by avoiding user configuration while ensuring a stable operation. Case studies were presented to demonstrate the performance and the advantages of the technique, both in terms of total bill of materials and final user flexibility.

With respect to classical non-linear techniques, this algorithm automatically configures response parameters while ensuring loop stability and transient performance. The measurements on application boards show that transient voltage drop is consistently reduced, while stability and response quality is maintained. The non-linear algorithm calculates the response parameters based on linear loop configuration, thus requiring no special tuning from the user.

Even though major developments are still occurring in digital power management and control, the technology is becoming firmly entrenched in many system designs. Many DPF '09 delegates believe it is already "a given" in certain high-performance applications. Breakthroughs are still the domain of European and North American companies, however, and mainstream deployments are likely to remain in higher-end products (including portable consumer devices), at least over the next few years.

Digital Power Europe '10 will draw an international audience and focus on the latest commercial developments in digital control, including system maker evaluations and requirements. The conference will feature the various standards, regulations and other market drivers that are particular to Europe, as well. Ultimately, digital power management is a global trend, however, with cooperation across continents. DPE '10 will represent all the major opportunities available to the power supply industry today.

Digital Power Europe (DPE)

http://dpfeurope.darnell.com/

Digital Power Reports

http://www.darnell.com/digital/

www.powerpulse.net

Future Trends in PV Inverters & PV Installation Design

Impact on PV market, players and industry

A new market & technology study dedicated to the photovoltaic inverters has been released: PV Inverter Trends. This analysis presents the existing PV inverter solutions and their main parameters evolution (size, efficiency, cost, reliability ...). PV Inverter Trends report allows to understand better the main technical challenges, current solutions and future trends regarding those parameters.

By Brice Le Gouic, Market & Technology Analyst,
Power Electronics & Compound Semiconductors at Yole Développement

This market & technological study also includes an important topic, which has recently appeared as a key point for PV inverter business: the evolution of its environment. Photovoltaic plants can have highly diversified structures due to plenty of characteristics: local configuration, presence of sources of shadow, distance between buildings, available area, and size of the installation… thus, one of the objectives of this report is to apprehend the evolution tendency for those architectures, and see the consequence on PV inverter systems and on players' strategy. Inverter market forecasts according to our segmentation – residential, industrial and buildings, solar farms – are shown and analyzed taking into account the 2009 crisis and impact on PV industry.

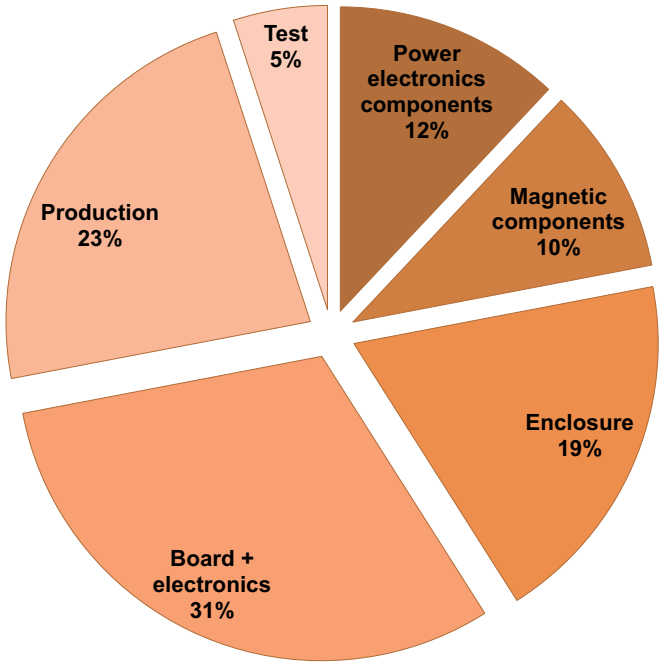

Figure 1: Cost breakdown
Source:Yole Développement, Sep. 2009

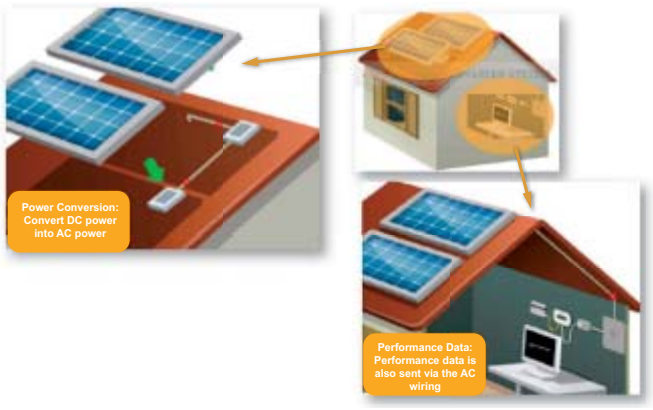

Figure 2: Micro Inverter Architecture
Source:Yole Développement, Sep. 2009

Market trends

PV inverter business is following general PV market trends: the latter being driven by financial supports provided by governments and development of well-established companies.

Yole Développement has estimated the 2008 PV inverter market a bit more than €2.5 billion, mainly driven by Spanish solar farm segment and German market. And Yole Développement does not expect 2009 PV inverter business to overcome this amount.

Effectively, 2009 has faced the crisis and seen Spain cut out of its economical
advantages. On the other hand, 2009 has also seen the birth of new countries ready
to implement PV as a new source of energy, meaning very interesting feed-in tariffs and loans. And PV inverter for residential segment is now entering in a
standardization era."

Newest PV inverter developments have shown interesting results at different levels: evolution of key characteristics, efficiency, cost, reliability, use of new materials (SiC, GaN), and adoption of disruptive

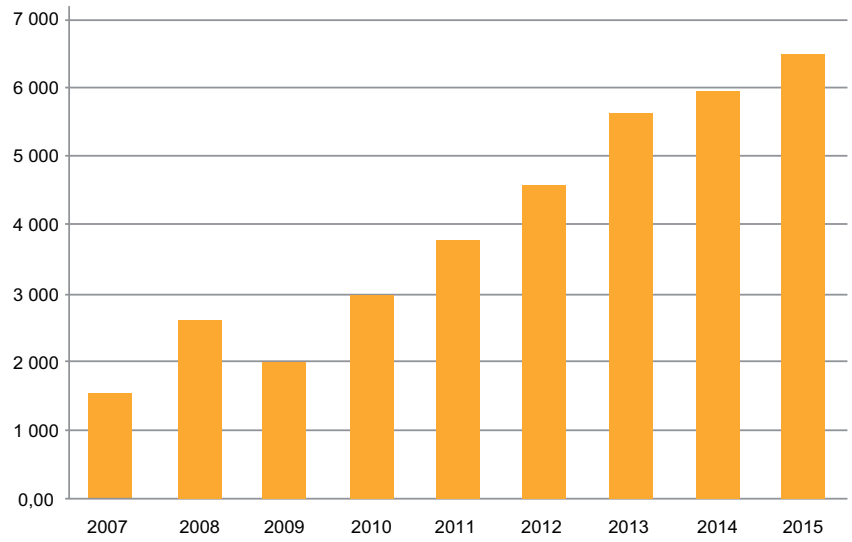

Figure 3: Worldwide PV Inverter Market
Source:Yole Développement, Sep. 2009

technologies like micro-inverters… all those parameters imply an important variety of players strategy. Those latest advancements are having and will have consequent impacts on PV inverters themselves and on the environment into which they evolve: high-sized installation demand induces an increase of inverter size and centralization, and new inverter solutions provide atypical plant architectures. Indeed, besides centralization trend and the objective to provide bigger inverters, micro-inverters appear as an alternative solution, challenging every well-established characteristics of classical inverter industry.

Moreover, the recent acquisition of OKE by SMA is a revealing fact of micro-inverters introduction on the market. As a consequence, those recent items have a significant impact on classical PV inverter business, industry and players. Nevertheless, the early stage of production adoption of those technological products justifies Yole Développement's estimation. Micro-inverters technology will stay below 1% of 2009 market.

Those technological breakthrough and the high opportunity that PV inverter market represents have a serious impact on players' behaviors: most of them who used to consider the inverter as a final product, now sees an interest in integrating new functionalities for a quick return on investment of the global installation:

- Monitoring
- Electrical protection
- Services like on-site maintenance, warranty, free software…

Thus, vertical integration of the PV supply chain keeps on evolving and companies are working closer on common objectives for an accurate and complete offer.

Yole Développement is a market research and strategy consulting company, specialised in the MEMS fields as well as compound semiconductors and photovoltaic. Yole Développement offers various kinds of services:

- Custom market research and technology/strategy analysis
- Marketing and communication services through Micronews, I-Micronews.com
- Market reports

Every single day, Yole Développement's team of 18 consultants is in contact with the world's key players, industrial companies, R&D institutes and investors, in order to help them understand the markets and technology trends. In our analyses, Yole Développement takes into account the whole value chain including materials and equipment suppliers as well as device and system manufacturers.

Other publications dedicated to the photovoltaic industry:

- Photovoltaic Incentive Programs & Country Profiles: understand the details and impact of PV installation incentive programs in 25 countries.
- PV Fab Database 2009: unique database describing a close to 800 photovoltaic fabs on a worldwide basis from materials to solar modules
- Photovoltaic Technologies Equipment and Materials 2008: Complete kit to evaluate your own opportunity in the photovoltaic market

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Power Efficiency within Solid Isolation and Insulation Barrier

Reduction in power requirements without compromising on noise isolation and high voltage insulation

Optocouplers are needed to provide high voltage insulation against transient voltage surges and to reject common mode transient noise from interfering with the input signals. Avago's next-generation optocouplers, ACPL-1L/061L/064L/W61L/K64L(ACPL-x6xL) offer a significant reduction in power requirements without compromising on noise isolation and high voltage insulation performance. These new optocouplers provide up to 90% power saving compared to the standard optocouplers available today and 40% power saving compared to alternative isolators.

By Yeo Siok Been, Digital Optocoupler Product Manager, Avago Technologies

Power efficiency is one of the key design parameters that equipment designers are constantly striving to improve. There are four important reasons why the designers are continuously hunting for low power optocouplers:

a) Low LED forward current is needed so that it can be directly driven by most microcontrollers or ASICs (as shown in Figure 1), without needing external buffers.
b) To reduce power requirement especially in multi-channels parallel communication lines. An optocoupler consists of a LED at the primary side of the isolation barrier and a detector IC on the secondary side of the isolation barrier. By having both a power efficient LED and detector IC, the current consumption in each communication channel can be reduced. This reduction will be multiplied by the number of communication channels and this value will be significant as the number of channels increases. With lower power consumption, the heat generated will be reduced and thus the thermal management of the design can be simplified.
c) The efficiency of the isolated DC-DC converter often determines the available power in the isolated module. To meet this limited power budget, low power optocouplers are needed.
d) By driving at a lower forward current, the operating life of the LED in the optocoupler improves.

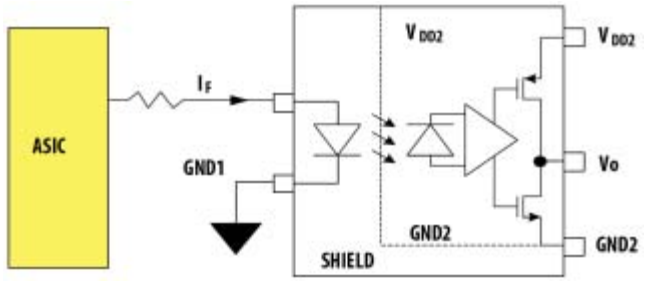

Figure 1: shows that ACPL-M61L can be directly driven by the ASIC without needing external buffer

Avago's new-generation optocouplers, ACPL-M61L/061L/064L/W61L/K64L(ACPL-x6xL) offers significant improvement in power efficiency, along with excellent noise isolation and high voltage insulation performance. These new optocouplers consume 90% lesser power compared to the standard optocouplers available today and 40% lower power as compare to alternative isolators.

Functions of an Optocoupler:

The two primary reasons for using optocouplers are to provide high voltage insulation and to provide noise signal isolation. Electrical equipment, especially for industrial applications, need to operate for many decades. Hence, a high quality insulation barrier in the optocoupler is needed to be able to provide outstanding reliability of high voltage insulation. In addition, optocouplers serve to reject high common mode transient noise which appears simultaneously or common to either set of floating points, which otherwise may result in abnormal voltage transitions or excessive noise on the output signal. This is known as noise isolation capability.

Existing Isolation Solutions:

There are alternative isolation solutions that improve power consumption by trading off the thickness of the insulation barrier to improve the signal transfer efficiency. In addition, edge-triggered coding technique (as compare to level-triggered coding technique in optocouplers) is adopted to meet power efficiency requirements. Figure 2 illustrates these coding techniques. In the edge-triggered coding technique, the internal signal is transmitted with short pulse during the input transition time. This coding technique improves the power efficiency at low data rate signal but the power consumption will increase with frequency. Conversely, in the level-triggered coding technique, the LED detects the level of forward current set by the input signal and pulses the light output to the detector. As the total energy (defined as the total area under the curve) of the coded signal is higher for the level-triggered coding technique, any common mode leakage current is less likely to be corrupted by this signal. It is thus more robust against common mode noise.

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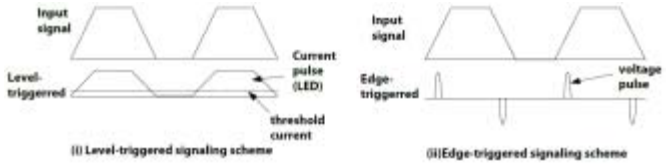


Figure 2 Different decoding signaling techniques

Avago's New-Generation Low Power Optocouplers (ACPL-x6xL): To ensure the optocouplers are built with a high level of insulation voltage and noise isolation performance, the composition and thickness of the insulation layer are preserved. The new ACPL-x6xL provides as high as 1140Vpeak working voltage and 5000Vrms isolation voltage. The same level-triggered coding technique is employed to ensure good common noise rejection during static (without signal transmission) and dynamic (with signal transmission) environment. ACPL-x6xL is also built with a Faraday shield to channel the common mode transient noise to ground. In addition, connecting a limiting resistor in series to the input of the LED itself provides a good RC noise filter for noisy environments (as illustrated in Figure 3). All these enable ACPL-x6xL to have the best in class application level common mode noise immunity (35kV/μs).

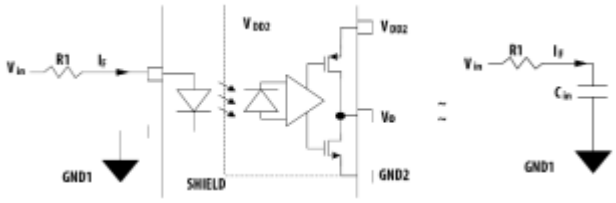


Figure 3 Current limiting resistor (R1) and the LED parasitic input parasitic capacitance act as a low pass filter to high frequency noise.

To ensure the optocoupler can be driven by a low forward current, while maintaining consistent speed performance across a wide range of temperature, the new optocouplers are individually trimmed for precision control of its switching threshold. As a result, the forward current driving requirement has been reduced to as low as 1.6mA. With this trimming technology, ACPL-x6xL optocouplers are able to transmit 10MBd signal with a maximum propagation delay of 80ns across wide temperature range of -40°C to 105°C.

Having low LED driving current (>1.6mA) not only allows ACPL-x6xL to be directly driven by most microprocessors (shown in Figure 1) but helps to increase the operating life of LED. In general, the operating life of the LED has an inverse relationship to the LED driving current. As shown in Figure 4, with the advanced LED technology developed by Avago, the LED of the ACPL-x6xL optocoupler degrades at only 1% after 22 years when operating at 3mA at 85°C temperature on a 50% duty cycle signal!

The operation of an optocoupler consists of an input current signal that drives a LED to generate light signal. This light signal is then converted to a small electrical current signal through a detector chip. This small current signal is then amplified and processed through a transimpedence amplifier (TIA). To allow the TIA to work across a wider supply voltage range of 2.7 to 5.5 volts, an internal regulator is used. To reduce power consumption on the detector chip, Avago has developed a proprietary circuit. In this patented design, the current used for the internal regulator is also re-used for signal amplification resulting in very efficient utilization of the supply current. A maximum of 1.3mA is needed to allow 10MBd operation of the optocoupler detector.

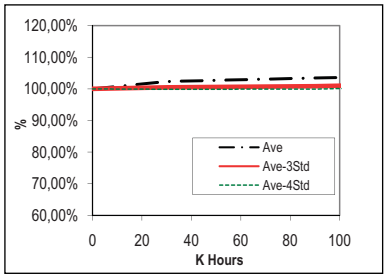


Figure 4: LED's LOP degradation graph driving at 3mA at 85°C, with the LED being turned on 100% of the time. This graph is extracted from the equivalent field hours calculated using Black's Model (Operating Life Stress Test conditions at 125°C, LED driving current = 20mA).

ACPL-x6xL's Intelligent Features

Two additional features have been designed into this new generation of optocouplers. First of all, a feature similar to "under-voltage-lock-out" is designed in. In many cases, due to the power up and down sequence, some components within an electrical module do not receive a sufficient level of supply voltage to ensure proper operation of the device. At times, glitches occurring at the output may accidentally trigger the next stage. This feature is designed-in to ensure the output of the optocoupler can be set to a deterministic state during power up and power loss.

On the other hand, designers often face issues where the rise and fall time of different communication line varies due to the variation of the load. Output nodes that have higher load capacitance will have higher rise and fall time (as depicted in Figure 5). This results in a large variation of propagation delay, pulse width distortion and propagation delay skew performance. ACPL-x6xL is designed with a slew-rate controlled output feature. This feature allows the rise and fall time of the output signal to be well controlled across a wide load capacitance range. This is important in parallel communication where different communication lines (for example clock and signal lines) may have different fan-out. This unique feature can only be found in ACPL-x6xL and not in other standard optocouplers/isolators available today.

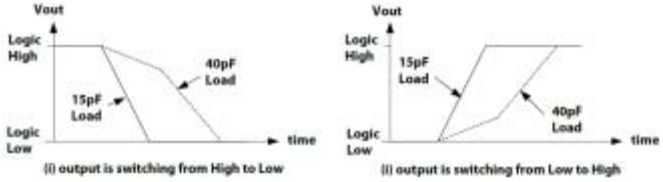
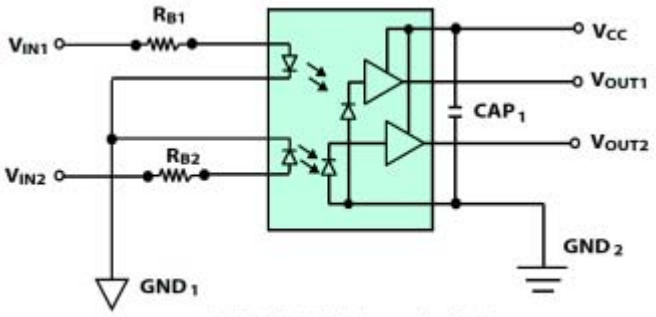


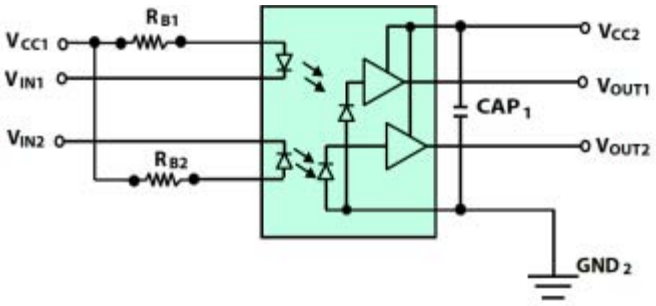
Figure 5 shows the rise and fall of the output varies with load capacitance.

Ease of Use

ACPL-x6xL has LED input configuration, not only help to provide noise filtration, but also to provide great flexibility for designer. By changing the input polarity, one is able to change the output from inverting to non-inverting output without adding an additional inverter. For users who wish to fine tune speed, performance, etc, a peaking capacitor can be added in parallel to the limiting resistor. In addition, these new optocouplers (ACPL-x6xL) are characterized with voltage driving mode. In the past, the designers will take the lead to calculate the value of the limiting resistor to set the LED driving current. The new ACPL-x6xL can now be easily driven in voltage driving mode by following the recommended resistors value stated in the datasheet. However, for designers who wish to have better speed performance, but are able to compromise on power, the optocoupler can be driven by a higher LED current within the recommended driving condition.



(i) ACPL-064L in inverting logic



(i) ACPL-064L in non-inverting logic

Figure 6 shows that by inversing the input polarity of optocoupler, the output logic can be programmed to inverting or non-inverting logic.

Summary:
In summary, the new generation optocouplers provide the power efficiency that is required while providing excellent high voltage insulation and noise isolation (in both a static and dynamic environment) performance. These new optocouplers are built in with additional features (slew-rate controlled and glitch-free output during power up and down). They are extremely easy to use and now available in voltage driving mode. In addition, ACPL-x6xL (ACPL-M61L/061L/064L/W61L/K64L) is a flexible optocoupler that allows special customization to suit each application's need. These customizations include inversion of logic polarity and tuning of speed parameter.These new 10MBd digital optocouplers (ACPL-x6xL) are suitable for communication interfaces (RS485, CANBus, and I²C), microprocessor system interfaces, and digital isolation for A/D, D/A conversion applications.

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Class D Audio Amplifier Matches Class AB With Higher Efficiency

Class D audio amplifiers are now geared up to replace class AB

An integrated high voltage audio driver facilitates the design and construction of a high power class D audio amplifier on a single layer printed circuit board (PCB) that outperforms the traditional linear class AB solution. Additionally, the high voltage class D driver implements a self-oscillating PWM topology that offers adequate power supply rejection ratio to achieve high performance with unregulated power supply.

Although, many high performance medium and high power audio applications prefer to use class AB designs for linearity, advances in semiconductor process technologies and circuit techniques are making class D solutions attractive for a variety of high power low noise audio applications. As a result, class D audio amplifiers are proliferating in the world of high fidelity sound equipments with the ability to handle hundreds of Watts of power with higher efficiency and linearity. And simultaneously attaining total harmonic distortion (THD) that is far below 0.05 percent.

By Jun Honda, Manuel Rodriguez and Wenduo Liu,
International Rectifier, El Segundo, Calif.

However, designing and building a high power class D audio amplifier that matches the performance of a traditional linear class AB amplifier with fewer components and a single sided printed circuit board (PCB) design is not a simple task. Especially, when using traditional through-hole components that contribute to switching noise due to increased stray inductances and resistances.

To address these challenges and assist the designer in the design and development of a high power class D audio amplifier using through-hole components on a single sided PCB board, International Rectifier has developed an integrated high voltage class D audio driver circuit with features and functions tailored for achieving higher noise immunity. In addition, power MOSFETs have been specifically tailored for this application. Called digital audio MOSFETs, its die size and parameters have been optimized to obtain the best performance from a class D audio amplifier, while concurrently reducing the size and the cost of the solution1.

Structurally, to achieve low on-state resistance per silicon area, each digital audio MOSFET consists of two power MOSFET switches connected in half-bridge configuration. In addition, its gate charge Qg, body diode reverse recovery Qrr and internal gate resistance RG(int), as well as packaging, are all optimized to enhance class D audio amplifier performance in areas like efficiency, THD and EMI. Because the parameters will vary with die size, the designer must select the most appropriate MOSFET for the desired output power. To simplify the MOSFET selection process, a table has been created that identifies four different digital audio MOSFETs with different set of combinations of these parameters along with drain-source breakdown voltage (BVDSS) for different output power levels. These include IRFI4024H-117P, IRFI4212H-117P, IRFI4019H-117P and IRFI4020H-117P as shown in Table 1.

Hence, when the integrated high voltage driver is combined with the most favorable power MOSFETs, the class D audio amplifier design is capable of delivering up to 500 W audio power on a single layer PCB with performance that is comparable to class AB solution but with higher efficiency.

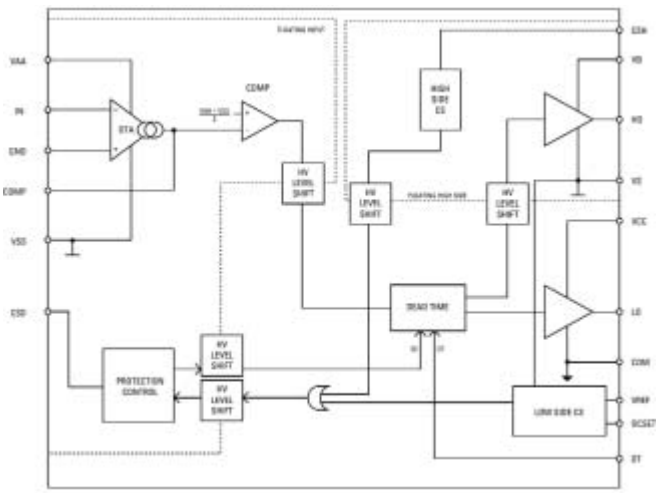

Figure 1. Error amplifier, PWM comparator, gate driver and protection circuitry are key functions integrated on this class D audio driver chip.

Integrated Audio Driver

Designed to handle both half- and full-bridge topologies, the new audio driver IRS2092 integrates on-chip four key functions required for high performance class D audio amplifier design2. These include error amplifier, PWM comparator, gate driver and robust protection circuitry, as shown in Figure 1. The built-in protection circuitry simplifies the complex task of overload protection with self-reset control and under-voltage lockout protection (UVLO). In addition, the chip delivers programmable preset dead-time for improved THD.

While the error amplifier minimizes the noise generated by the switching amplifier and the fluctuations of the power supply, the gate driver also plays an important role in achieving high audio performance. Besides maintaining a close match between high- and low-side gate driver stages, it also controls the dead-time to prevent simultaneous "on" states in high- and low-side MOSFETs. By allowing designers to program and preset dead-time as per the MOSFETs selected, the integrated driver IC prevents any shoot-through and ensures safe operation of the amplifier. Since the dead-time is set based on the voltage applied to the DT pin of the IC, the audio driver circuit makes this selection easy and reliable by employing only two external resistors connected to pin DT, as shown in Figure 2.

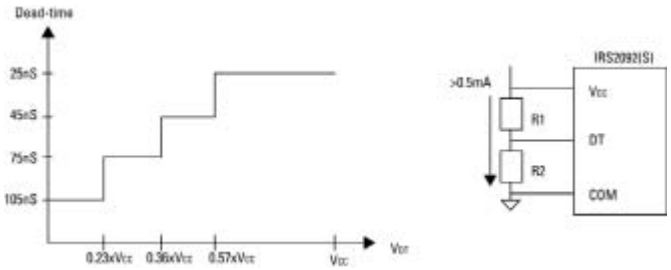

Figure 2. For improved total harmonic distortion (THD), the dead-time is preset with resistors R1 and R2.

In reality, the error amplifier compares the output audio signal with the input, and then filters the output using an external LC lowpass filter. Also, to ensure that the output does not contribute any noise to the input due to close proximity of the two stages on-chip, the input and output circuits are isolated using proprietary high voltage state-of-the-art junction isolation technology.

Capable of handling switching frequencies up to 800 kHz, the driver's analog PWM modulator allows self oscillating PWM modulation for better performance and robust design. In essence, a self oscillating PWM modulator is an analog version of a second order sigma-delta modulation having a class D switching stage inside the loop. The benefit is that all the error in the audible frequency range is shifted to the inaudible upper frequency range by the nature of its operation.

Regarding protection, both low- and high-side MOSFETs are protected from overload condition via current sensing across the on-resistance of the MOSFETs. For that, the voltage across drain-to-source during the on-state of the MOSFET is measured. When this voltage gets higher than the threshold, IRS2092 turns off the MOSFET. While the voltage setting on the OCSET pin programs the threshold for low-side current sensing, the high-side setting is accomplished by CSH and VS pins. However, the threshold for CSH is internally set at 1.2 V. An external resistive divider is used to program this threshold. In addition, an external reverse blocking diode is employed to block the high voltage feeding the CSH pin. Consequently, the forward voltage drop of 0.6 V across the blocking diode is the minimum threshold for the high-side MOSFET.

To further take full advantage of the high noise immunity of the driver chip for attaining optimum audio performance, the class D circuit board is designed to minimize trace impedances and curb noise coupling between analog and switching sections. Accordingly, the PCB design ensures that the analog signal ground is separated from the switching stage, as well as the power ground.

Comparing The Performance

Combining the integrated audio driver IRS2092 with the appropriate optimized digital audio power MOSFETs, a class D audio amplifier reference design has been developed using the half-bridge system shown in Figure 3. Because this design is scalable, the output power can be scaled from 25 W per channel to 250 W per channel by simply changing the output MOSFETs with appropriate voltage ratings. To further assist the user in picking the right MOSFET for the desired output and load impedance, Table 2 has been produced that identifies the optimized MOSFETs for a specific output power level.

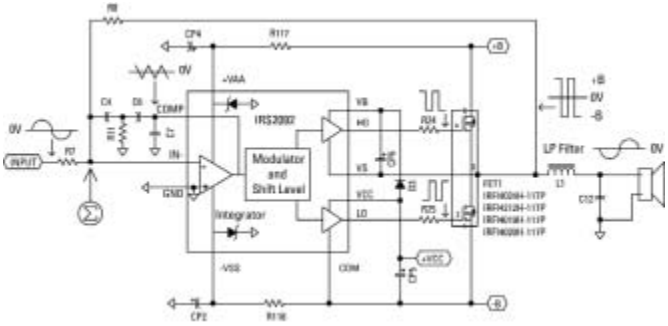

Figure 3. Simplified half-bridge system level class D audio amplifier circuit with scalable output power to 500 W.

To demonstrate its capability, the THD plus noise (THD+N) and efficiency performance of the scalable class D reference design is compared with that of a class AB design using similar test conditions. Thus, measurements conducted with sinusoidal signal frequency of 1 kHz at 1 V rms and 4 Ohms load impedance shows that the THD+N for class D remains far below 0.03% over a wide range of output power. The switching frequency used here is 400 kHz and the supply voltage is ±35 V. Utilizing the same test parameters, the class D performance is then compared with class AB, which in this case is a brand name amplifier. The test results are displayed in Figure 4. From this comparative figure, it is seen that for output power levels between 50 and 100 W, the THD+N performance for class D is comparable with class AB. Below 50 W, class D outperforms class AB, while above about 150 W the performance for both the amplifiers drops rapidly due to clipping.

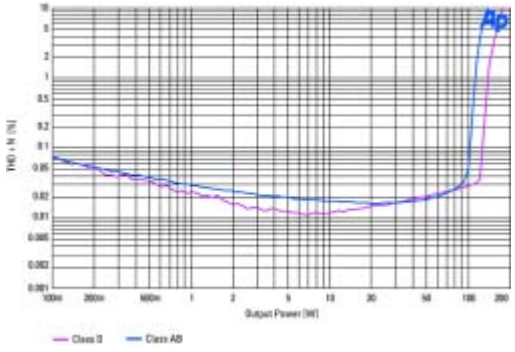

Figure 4. Comparing THD+N performance of class D amplifier with class AB for a wide output power range.

Although, the above measurements were conducted at 1 kHz, it was observed that the distortion performance of the class D audio amplifier design is equally good over the entire audio band. As demonstrated in Figure 5, THD+N versus frequency test indicates that the distortion is low (<0.03%) and remains consistent over the entire audio range of 20 Hz to 20 kHz, even as the output power is increased from 10 W per channel to 50 W per channel with 4 ohms load impedance.

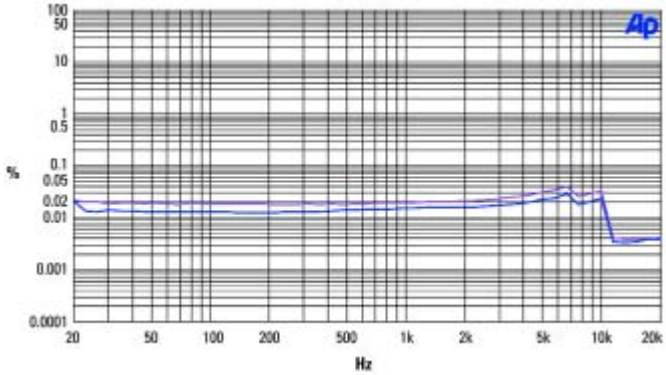

Figure 5. This test indicates that the THD+N performance for the class D remains low (<0.03%) over the entire audio range of 20 Hz to 20 kHz.

Similar test conducted for noise indicates that the noise floor for class D remains below -80 dBv over the entire audio range (Figure 6).

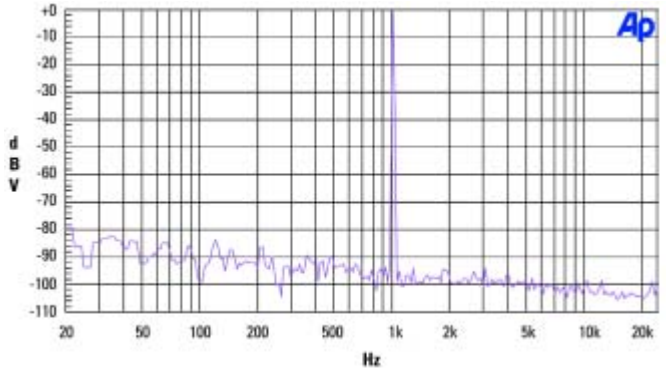

Figure 6. The noise floor for class D amplifier remains below -80 dBv over the entire audio range.

Part Number	BV_{dss} (V)	R_{ds}(on) @10V m(Ω)	Q_g (nC)	Q_{sw} (nC)	R_g(int) (Ω)	Package
IFRI4024H-117P	55	48	8.9	11	2.3	TO-220FP
IFRI4212H-117P	100	58	12	56	3.4	TO-220FP
IFRI4019H-117P	150	80	13	140	2.5	TO-220FP
IFRI4020H-117P	200	80	19	230	3.0	TO-220FP

Table 1:
Optimized digital audio MOSFETs with typical key paremeters

Regarding efficiency, the performance for class D audio amplifier is high because the combined power (conduction + switching) losses have been minimized using the optimized digital MOSFETs and the driver circuit. Hence, the measured performance for the reference design in figure 3 tailored for a 50 W per channel stereo amplifier driving 4 Ohm load is about 90%. This performance is consistent even as the output power is scaled to 250 W per channel as illustrated in Figure 7.

MOSFET RATING		55V	100V	150V	200V
IR Power MOSFET	FET1A FET1B	IRFI4024H-117P	IRFI4212H-117P	IRFI4019H-117P	IRFI4020H-117P
Half Bridge	8 Ω	25W X 2	60W X 2	125W X 2	250W X 2
	4 Ω	50W X 2	120W X 2	250W X 2	Not Supported
Full Bridge	8 Ω	100W X 1	240W X 1	500W X 1	Not Supported
Nominal Supply Voltage	+B, -B	±25V	±35V	±50V	±70V
Min/Max Supply Voltage	+B, -B	±20V – ±28V	±28V – ±45V	±45V – ±60V	±60V – ±80V
Voltage Gain	Gv	20	30	36	40

Table 2: Scalling the output from 25W to 500W using a variety of optimized digital audio MOSFETs

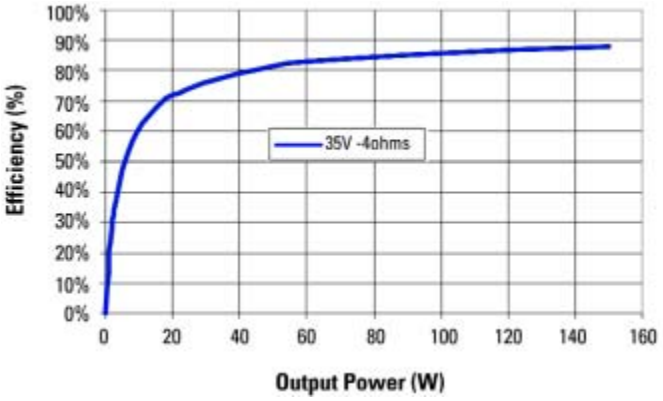

Figure 7. As illustrated, the class D amplifier's efficiency consistently remains near 90% even as the output power is scaled to 250 W per channel.

Similarly, employing the brand name amplifier, class AB performance was measured under similar test conditions and presented in Figure 8.

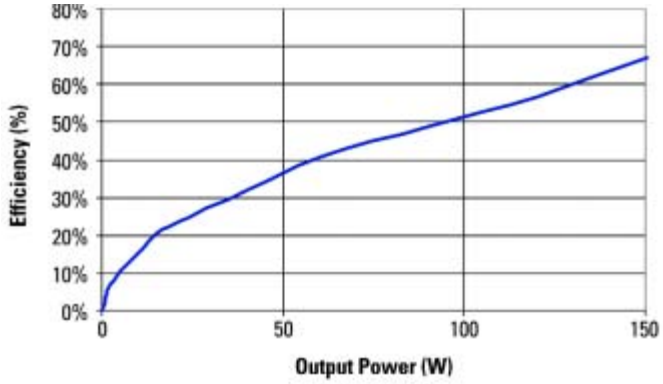

Figure 8. From this figure, it is observed that class AB efficiency is high (about 65%) around 150 W output power, but much lower than class D efficiency. Plus, unlike class D, the class AB efficiency drops significantly as the output power goes down.

From figure 8, it is observed that class AB efficiency is high (about 65%) around 150 W output power, but much lower than class D efficiency. Plus, unlike class D, the class AB efficiency drops significantly as the output power drops. As can been seen from figure 8 that class AB efficiency at 100 W is slightly over 50% and further drops to around 35% at 50 W. And this downward trend continues almost linearly, declining to 20% efficiency around 20 W output. By compari-

son, class D accomplishes dramatic improvements in efficiency performance, especially at lower power levels. For instance, it maintains efficiency over 80% all the way down to 40 W as illustrated in figure 7. The same figure shows that between 20 W and 40 W output, class D design offers >70% efficiency. In other words, class D's efficiency performance is far superior to class AB, especially at power levels that are practically used.

Also, the power supply rejection ratio (PSRR) measured for the class D amplifier was -65 dB at 1 kHz signal. This high PSRR is attributed to the self-oscillating frequency of the driver. And it enables the class D amplifier to offer high performance even with unregulated power supplies.

Conclusion

Combining the attributes of a dedicated high voltage audio driver circuit with optimized digital audio power MOSFETs, a high power class D stereo amplifier is built whose output is scalable. And its performance is comparable to a class AB amplifier, but with improved efficiency. In addition, it can deliver high performance with unregulated power supplies. That means, high power class D audio amplifiers are now geared up to replace class AB amplifiers in high performance audio equipments.

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About The Authors

Jun Honda is a senior staff engineer in International Rectifier's Consumer-IC design center in El Segundo, Calif. Jun has more than 15 years of experience in designing consumer, as well as professional audio circuits, including class D audio amplifiers.

Manuel Rodriguez is a senior systems engineer for Class D Audio at International Rectifier's headquarters in El Segundo, Calif. Manuel has over 20 years of experience in designing audio power amplifiers and switching mode power supplies for major audio manufacturers, where he designed car and home audio amplifier products for leading brands. Manuel began consulting for IR in June 2005 before joining the company as an employee in 2007.

Wenduo Liu is a systems applications engineer in International Rectifier's Emerging Technology Group in El Segundo, Calif. Wenduo has more than 10 years of experience in power electronics. His research focuses on integrated high density power modules, including class D audio amplifiers, iPOWIR and GaN based power devices.

Intelligent Development Platform Makes Power Management Easier

COM-based Mobile Applications Mobilizes Computer-on-Module Applications

With continuing miniaturization of processor technology, high-tech applications — whether ticket systems, diagnostic computers, or portable test devices — are becoming increasingly mobile. They all need an efficient power supply if this mobility is not to be hindered by power restrictions.

By Andrea Mayer, Product Marketing Manager, Kontron

The time-consuming development of such power supplies can considerably delay the market launch of new products. However, this is where vendors working in the embedded field can provide valuable support. One such product is Kontron MARS, a reference kit for a smart battery system created by embedded computer specialist Kontron. MARS is an acronym that stands for "Mobile Application platform for Rechargeable Systems."

Last year, Intel's® Atom™ platform — a compact and power efficient chipset and processor — gave a real boost to the embedded industry. Computing power was concentrated in a 13 x 14 mm² chip that is particularly suitable for use in the embedded computer systems of embedded mobile applications such as mobile ultrasound scanners, game controllers, portable checkout or information systems.

The compact yet powerful processor consumes much less energy than its x86 predecessors, but developers of new mobile applications are regularly confronted with the time-consuming task of equipping their mobile ticket system or portable test device with a mobile power supply. That means drafting specifications, sketching circuits, designing layouts, requesting hardware, consulting manuals, testing the system, and so on. Only after racking their brains to create a fully functional system can the developers get to their core business of writing their application-specific software. This is where vendors of embedded computer technology can provide valuable support.

Releasing the Brake on Innovation

Kontron's Mobile Application platform for Rechargeable Systems, or MARS for short, provides exactly this type of support. By making use of ready-made components of proven caliber instead of starting from scratch to completely develop new battery solutions themselves developers can shorten the time to market and improve reliability. But Kontron MARS is not only a hardware module, as one might expect. Rather, it is a reference design package consisting of hardware, software, and associated circuit diagrams that can be used universally for all carrierboards designs.

In principle, Kontron MARS allows developers to add the ready-made layout plans and circuit diagrams for smart battery functionality to their own carrierboard layout using a simple copy and paste procedure. That decreases the time needed for evaluating the hardware, drafting circuit diagrams, and incorporating the various components needed. The components that are utilized have already been tested and have proven their reliability, so developers can count on the mobile power supply operating perfectly.

In addition, there's no need for the application developers to finalize the entire application specific hardware before programming the software that goes with it. With the MARS reference board they can start software development and evaluate it on the development platform. With this development "in-the-loop" they know which components are going to be employed and can improve the appropriate programming while the specific hardware is still being configured. The combination of Computer-on-Modules and reference platform for rechargeable systems MARS enables developers to concentrate on their core competencies and save valuable development time.

A System Providing Guidance to Developers

Kontron's MARS consists of three elements: the MARS reference board, various cables to supply power and enable data communication, and the circuit diagrams plus development data that are provided to registered customers. The MARS reference platform supports up to two smart batteries through a smart battery manager. In principle, the developer can build up a test system based upon an evaluation platform which has the same functionality as his application will have in the end.

The purpose of the evaluation board is to provide all possible interfaces to the COM Express™ module. Therefore the evaluation board is always larger than the customer-specific carrier board with only the necessary interfaces. Kontron's intention with MARS is to provide as wide a range of functionality as possible. The modular structure of the reference platform acts as a guide for developers, as it were, enabling them to obtain exactly the solution required for the application as simply as possible.

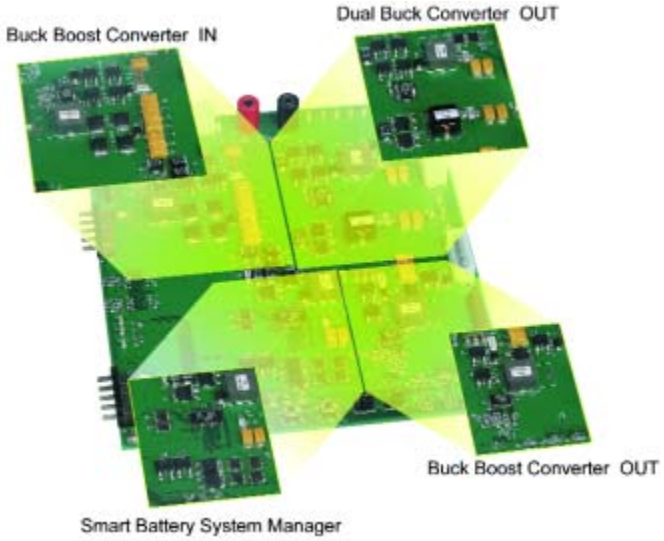

Figure 1: Kontron MARS has a modular structure and comes with various function units that developers can implement in their applications as needed.

Kontron MARS features four function units that can be used whenever required:

The buck boost converter IN extends the input voltage range to 5 - 28 VDC, ensuring a sufficiently high charging voltage and producing an output voltage of up to 19 V. This makes it possible to charge any smart battery currently available. If the target system's supply voltage is larger than the required battery's charging voltage, the developer can dispense with this converter or bypass it.

The buck-boost converter OUT increases the battery output voltage if a backup battery with Vmin < 12 V is used. If the developer will employ a smart battery with a voltage range always over 12 V, he can manage without. The same applies if he uses the wide-range input of the Kontron ETXexpress® modules in order to simplify the system design.

The smart battery system manages the charging and discharging processes of up to 2 smart batteries in parallel or serial operation. Furthermore, it is responsible to provide the smart battery state data via System Management Bus to the carrier board.

The dual buck converter provides an ATX-compliant power supply. It supplies all necessary voltages for the carrierboard and Computer-on-Module as well as connection options for - 5 V and - 12 V or + 3.3 V via a DC/DC switching controller.

From these function units the developer picks just the ones needed and can leave out the elements not required.

Using Power Intelligently

Kontron MARS supports operation of two smart batteries. Smart batteries feature an integrated microcontroller which provides data such as battery characteristics, current charge/discharge rate and extrapolated remaining capacity via the system management bus. The COM-based system can use this data in programming the target application. This enables helpful functions to be implemented in the mobile application, such as displaying the battery charge status signalling when the battery needs to be replaced or the device should be docked on the charger.

MARS provides developers a great deal of flexibility with respect to the batteries used by the application. It supports various types of smart batteries for example, different chemistries like lithium-ion and NiMH. Developers can even incorporate different types of batteries in parallel. The advantage of doing this is that developers are able to leverage the specific properties the batteries have, such as the robustness and cost advantages of nickel-metal hydride batteries or the high energy density and long storage life of lithium-based batteries (lithium-ion and lithium-polymer).

For instance, an application can draw its main power from a large Li-ion battery and a smaller, low-cost NiMH fall back battery provides the required energy while the Li-ion battery is being replaced. This serial mode means the application could continue to run without having to shut it down first to replace a flat battery. Also MARS can automatically switch from one voltage source to another within just a few microseconds, making it well suited as an uninterruptible power supply. Utilized this way, the smart batteries could easily bridge the period during when an application's main source of power is changed. An example of this is when the line voltage fails or a device is transported to another location without being able to terminate the application (such as in the case of medical apparatus).

Figure 2: With the help of Kontron MARS, mobile applications — such as the diagnostic system for automobiles shown here — can be supplied with uninterrupted energy: A fall back battery allows to replace the discharged battery without intermission.

Optimized for Mobile Use

If two smart batteries with the same cell configuration are employed in parallel mode, developers can increase battery efficiency by up to 10 % compared to serial mode: Since both batteries discharge in parallel at the same time, only half the amount of current is drawn from each battery, as opposed to the discharge that takes place when the batteries are utilized individually in turn. This is defined by the current flowing and the resistance presented by the battery and power cables. A further positive side effect is that the batteries do not heat up as much, which further increases efficiency and furthermore their operating life. Also, if the same types of batteries are used, then the charging cycles are considerably shorter. Of course the parallel mode makes it possible to replace the batteries sequentially during operation.

The rules how Kontron MARS manages the Smart Battery System are programmed via an easy to use API. By this a developer additionally can define how MARS provides power to the application in

any operating system that supports ACPI (advanced configuration and power interface), for MARS is stored in the ACPI registries provided for the purpose using BIOS in Kontron ETX®, ETXexpress®, microETXexpress® and nanoETXexpress modules.

Figure 3: MARS Installation ATX

Back on the Innovative Track

In a nutshell, the Kontron MARS platform helps vendors of embedded technology saving time and effort that they can invest more effectively in the application development for power management in mobile systems. The choice of ways in which the mobile power system can be used gives them more scope to enrich their applications with additional innovative features.

What the developers say:

IES GmbH & Co. KG, a highly qualified company that has made a name for itself in the field of intelligent embedded system solutions, is one business that makes successful use of the functionality Kontron MARS offers. The company largely serves customers in the manufacturing sector, specifically those in the machine and plant construction market sub-segment. Kontron's smart battery system is utilized for the development of mobile, portable customer service computers which run on two rechargeable lithium-ion batteries.

"The MARS solution package provided by Kontron consists of software and hardware components that are perfectly tuned to each other, which makes MARS ideal for requirements regarding customers' applications," says Martin Steger, Managing Director of IES. "Given the technical requirements made in such sophisticated applications, it's a major advantage to be able to draw on proven packages of solutions tailored to the computer platform," he adds.

Developing a battery management system that meets the high demands of modern PC hardware and users would be relatively time-consuming and, above all, associated with development risks that are difficult to estimate. "Being such a small software and hardware vendor as we are, we probably wouldn't be able to create applications like these at all if it weren't for Kontron's preliminary work on MARS," says Steger. "And even if we could, overall costs would be so high that the majority of potential customers would be put off from employing these technologies." IES can also reduce the development risk involved by using MARS. Aside from this, the company employs the MARS starter kit to obtain proofs of concept that are essential for certain fields of use.

Shorter Time to Develop

Kontron's smart battery system is also used by b-plus GmbH, a specialist in automation, embedded system solutions, and automotive applications. Engineers at the Deggendorf firm use MARS when evaluating nanoETXexpress modules with a view to their integration in mobile applications. "The standardized hardware and software interfaces save us time-consuming steps in product development, such as the time we'd otherwise need to get the battery and controller to communicate with each other," says Bernd Eggl, leader of the Embedded System Solutions team at b-plus. "Besides that, integration in commonly used operating systems such as Windows already exists, so there's no need for us to program any drivers or test software," he explains. "Another point is that MARS also allows us to check the results in the development phase more easily." All in all, this means that less effort is required for development and that new products have a shorter time to market.

Figure 4: MARS-develop-platform

Kontron MARS - key features at a glance

- Ready to use, easy to integrate Smart Battery System management
- Less development effort and faster time to market
- Modular structure allows individual configuration for any application
- Copy and Paste layouts and routings
- Application development in the loop
- Supports up to two Smart Batteries in parallel or serial mode
- Supports different types of smart batteries for cost efficient designs
- Wide input voltage range from 5 to 28 V for charging and power supply
- Parallel mode with enhanced battery efficiency and faster recharging cycles

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Progress in Using Normally-off SiC JFET Power Transistors – The First Year

Since the initial release of the normally-off SiC JFET in September 2008, much has been learned

The 1200 V normally-off SiC JFET released in 2008 has generated market interest in applications including solar or photovoltaic (PV) inverters, server/telecom power supplies, industrial welding inverters, future electric drive automotive inverters, and even audio amplifiers. The normally-off SiC 1200 V JFET was released in a TO-247, in the form of a 100 m-Ohm (SJEP120R100) and a 63 m-Ohm (SJEP120R063) variety. Some of common market drivers behind adopting these JFETs are better efficiency, higher power density, and potentially less system cost.

By Jeff Casady, SemiSouth

For these competing drivers, it is important to move to higher switching voltages, higher frequencies, and higher efficiencies simultaneously. These three requirements are conflicting, and are limited by the conventional power transistors and diodes in silicon, which in turn is driving advanced designs to use SiC power transistors and diodes. The relatively new, normally-off SiC JFET has proven to be cost-effective compared to previous SiC transistor developments. To use the high-speed, efficient, SJEP120R063, it is important to keep parasitic capacitance and inductance in the circuit to a minimum. For example, to effectively measure the switching energy in these devices, very close spacing is used to minimize the parasitic inductance between the JFET and the driver chip. An example of a standard test fixture used to measure switching energy losses in the normally-off JFET, shown in Figure 1, a standard half bridge circuit is shown with a SJEP120R063 from SemiSouth, an IXYS 509 driver chip, and a 1200 V, 20 A SiC diode (SDP20S120 from SemiSouth).

Aside from close spacing in the circuit to minimize parasitic inductance because of the high-speed (high di/dt) nature of the device, it's important to understand the gate drive philosophy of the normally-off SiC JFET. This device enjoys many similarities to a MOSFET, with a standard output family of curves for gate voltages ranging from 1.0 to 3.0 V. A nominal threshold of +1 V is typical for the normally-off SiC JFET, but because of the PN junction diode between gate and source, and gate and drain, there are differences between the SiC JFET and the MOSFET. The gate – drain/source diodes both have variable capacitance, and when VGS increases enough the SiC gate-source PN junction diode will conduct. The diode current is a function of VGS, chip size (area), external gate resistance, and temperature. For the conduction mode of SJEP120R063, the diode (IGS) will conduct 150-200 mA at a minimum RDSON. When switching, IGS will be increased for a very short time period to charge and discharge the variable capacitances between the gate and D/S terminals [R. Kelley, et al.].

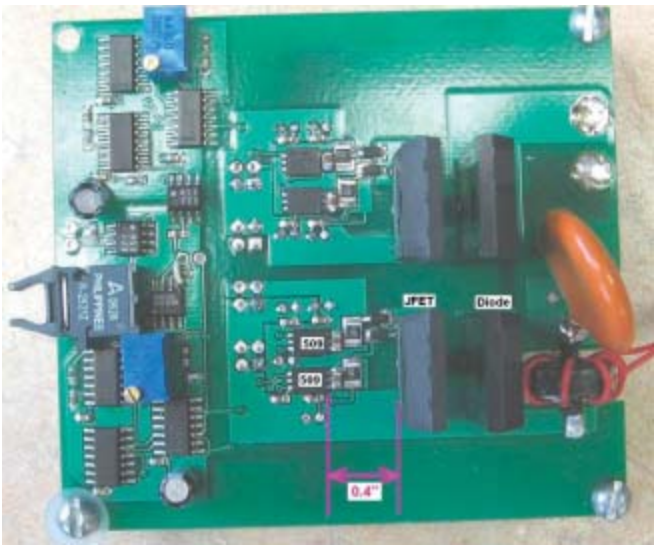

Figure 1: Example of a standard test fixture in a half-bridge configuration used to measure switching energies in a normally-off SiC JFET. All drive components are standard, low-cost, available components. SiC JFET's are SJEP120R063 from SemiSouth (normally-off, 1200 V, 63 m-Ohm), and SiC diodes are SemiSouth SDP20S120 (1200 V, 20 A). The dual gate driver chips are 509 driver chips from IXYS.

In Figure 2 an example driver schematic is shown in more detail with the corresponding gate pulses (turn-on and turn-off), and a small (~ 100-200 mA) gate current when the device is in the conduction mode.

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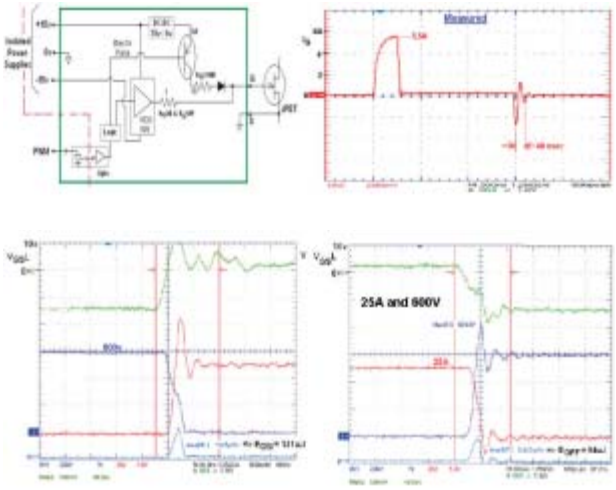

Figure 2: Example of SJEP120R063 SiC JFET drive circuit topology illustrating dual pulse (100 ns turn-on & 40 ns turn-off through IXDD 509 driver and RG) and conduction through pnp. All drive components are standard, low-cost, available components [R. Kelley, et al.].

In the topology of Figure 2, the turn-on and turn-off is handled through a dual-stage gate driver chip (IXDD 509) with a bipolar supply of +/- 15 V. The turn-on, as shown in the upper right graph of Figure 2, is a 5.5 A, 100 ns IGS pulse used to turn the SJEP120R063 JFET on with minimal losses (EON of 131 µJ as shown in the lower left graph of Figure 2). Once the device is turned on, the logic chip turns on a simple, low-cost pnp bipolar transistor to provide a low level of IGS (200 mA) with a 6 V supply (stepped down from + 15 V through a simple DC-DC converter). The IXDD 509 then supplies the short (less than 40 ns) negative IGS pulse of a few amps to discharge the internal device capacitances and turn off the JFET. The turn-off energy, as shown in the waveforms from 25 A, and 600 V in the SJEP120R063 is only 94 µJ, which results in a total EON + EOFF of 225 µJ.

How do the SJEP120R063 results compare to Si IGBT technology at 1200 V?

Examining the previous measured results above discussed in Figure 2 for the SJEP120R063, one can compare its performance with a popular Fairchild Non-Punch-Through (NPT) IGBT, the FGL40N. In the table below, the key device characteristics are compared, with particular differences seen in improved conduction losses at light load or low-frequency (obviously no collector-emitter saturation voltage in the unipolar SJEP120R063), and improved switching losses for higher-frequencies (measured total energy losses compared in the SJEP120R063 with datasheet numbers from the FGL40N result in 7-10 times improvement).

Parameter		*NPT IGBT FGL40N*	*JFET SJEP120R063*	*Performance Difference*
Technology		Si – IGBT	SiC – JFET	
Breakdown Voltage	V_{DS}	1200V	1400V	Higher breakdown margin
On Voltage (conduction)	Von	2.5V	Unipolar	Reduced losses at low current
Input Capacitance	C_{iss}	1700 pF.	1220pF	Reduced Gate Power Loss
Effective Output Cap Energy Related	$C_{O(ER)}$	260 pF	100 pF	2.5X Lower Switching Losses
Operating Temperature	T_j	-55°C to 150°C	-55°C to 175°C	Safe Operation at higher Temp
Thermal Impedance	$R_{thj\text{-}c}$	0.25K/W	0.6K/W	X2 worse but offset by overall lower dissipation losses
Turn-On Losses Turn-Off Losses Total Losses	E_{ON} E_{OFF} E_{TOTAL}	550 uJ 1000 uJ 1550 uJ	131 uJ 94 uJ 225 uJ	7-10X Lower Switching Energy

Table 1: Comparison Between silicon N Type IGBT and SiC JFET

The silicon IGBT therefore has limited ability to allow the inverter designer to improve its performance. The designer can over-size the device to improve conduction efficiency, which in turn will decrease the switching efficiency. To aggressively push the voltage, frequency, and efficiency of the inverter up, the SJEP120R063 offers substantial new options.

The applications impact of the available SiC power transistors

In 2009, Fraunhofer Institute for Solar Energy Systems examined the impact of dropping in SiC power transistors on state-of-the-art solar inverter systems. In their work with the SJEP120R063 SiC JFET, they were able to achieve a world record solar inverter efficiency of > 99% in a Heric® single phase solar inverter module by replacing an Infineon silicon generation four IGBT [B Burger et al.]. From Figure 3, in a full three phase full bridge topology (right), an efficiency increase of ~ 1.2% using the same JFET in place of the IGBT was achieved, even though the JFET operated at three times higher frequency (48 kHz). This shows the ability to increase inverter efficiency while also cutting the cost, size, and weight of the unit through reduction in magnetics at the higher frequencies.

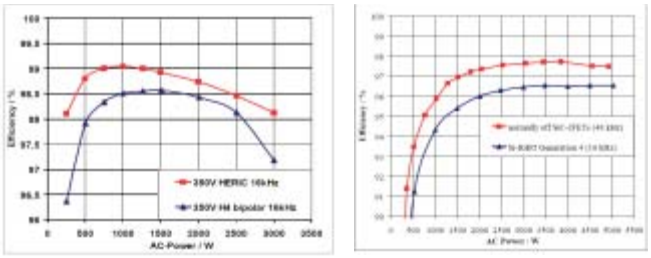

Figure 3: Left is a comparison of the SJEP120R063 SiC JFET from SemiSouth (> 99% peak efficiency) to a generation four Si IGBT in a single phase solar inverter circuit (Heric® topology) up to 3 kW. Right is a comparison of the SJEP120R063in a three phase full-bridge inverter up to 5 kW, at 48 kHz, with ~ 1.2% improvement in efficiency compared to the generation four Si IGBT at only 16 kHz. [B Burger, et al.]

The next generation SiC power transistors

Additionally, there are newer, higher power normally-off SiC JFET's in development. A 1200 V, 25 m-Ohm SiC JFET, normally-off, has been recently reported. The DC family of curves, shown in Figure 4 (left graph), has a saturation current approaching 120 A at room temperature [A. Ritenour, et al.]. Although it will be offered in bare die form for modules as well as TO-247 packages, a 15 mm2, 25 m-Ohm JFET packaged in a low-parasitic Kyocera package for characterization is shown in Figure 4 and the switching performance is shown in Figure 5.

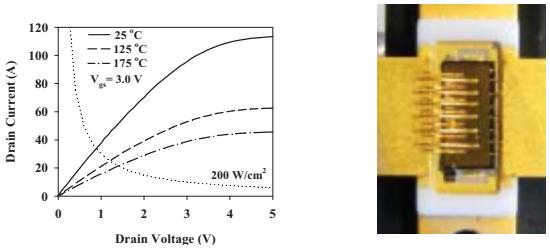

Figure 4: At left are the pulsed output characteristics at Vgs= 3 V for 1200 V normally-off SiC JFET showing a room-temperature saturation current over 100 A. At right is a picture of the 15 mm2 normally-off SiC JFET assembled in Kyocera A0883 LDMOS package. Package was selected strictly for the purpose of device characterization and is not representative of the product packaging [A. Ritenour et al.].

The switching performance of the 15 mm2 die in a single-switch clamped inductive load test circuit was characterized using a dual-stage, bipolar gate drive (± 15 V) similar to that described above. Four 10 A SiC Schottky diodes were paralleled at the clamping diode position in the test circuit. Figure 5 shows switching energies at half rated voltage (Vds= 600 V) and 25 °C as a function of drain current. At 20 and 40 A, the total losses are 0.31 and 0.74 mJ respectively. This device was benchmarked against a similarly rated Si trench IGBT (Infineon IGW40T120). The IGBT switching losses were taken from the datasheet at Vcc= 600 V, Ic= 40 A, and Tj= 25 °C. The use of a SiC Schottky diode in the IGBT inductive load test circuit would reduce the IGBT losses so the turn-on and turn-off losses were scaled to 40% and 70% of their respective datasheet values in order to provide a more fair comparison with the results for the SiC JFET. Figure 5 (right graph) compares the switching losses at V= 600 V, I= 40 A, and Tj= 25 °C. The total switching losses for the Si IGBT are 4.8x higher than for the SiC JFET (3.56 mJ compared to 0.74 mJ).

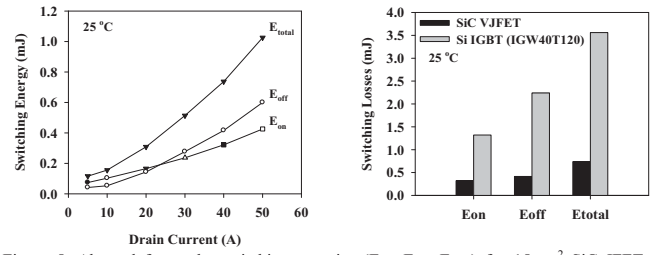

Figure 5: Above left are the switching energies (Eon, Eoff, Etotal) for 15mm2 SiC JFET as a function of drain current (Vds= 600 V and T= 25 °C). On the right is a comparison of switching energies (Eon, Eoff, Etotal) for SiC JFET and Si IGBT at V= 600 V, I= 40 A, and Tj= 25 °C.

The significance of the SiC power transistor availability in the power electronics market

What has limited silicon carbide in the past has been the technology – making the technology affordable, reliable, and available in volume to take advantage of SiC's performance advantages. With the release of the SiC normally-off JFET from SemiSouth, an important missing piece of the SiC power component business is now available, and we will see new market penetration by SiC power transistors in solar inverter, power supply, and eventually automotive electric drive markets. The SemiSouth JFET has demonstrated lower conduction losses and up to 7-10 times lower switching energies than comparable rated Si IGBT technology. Other vendors such as Cree, Infineon, Rohm, and others are also beginning to offer various versions of SiC power transistors at 1200 V.

Acknowledgements

The author gratefully acknowledges the engineering technical staff at SemiSouth which contributed significantly to this work, including, but not limited to, Dr. D.C. Sheridan, Dr. A. Ritenour, R. Kelley, F. Rees, T. Francis, W. King, A. Mulkana, B. Robinson, D. NullI E. Bowman, I.R.B. Casady and S. Sunkari.

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Flyback Converter and Snubber Design

Every application has its special needs

The Flyback topology is very common for DC/DC converters. Their advantages are the simple design and the low component cost. The function principle is simple. Only a few components are needed. The following article gives some practical ideas to design a Flyback converter.

By Ralf Negele, Negal Engineering GmbH Switzerland

Flyback Transformer Design

The Flyback topology is very common for DC/DC converters. Their advantages are the simple design and the low component cost. The function principle is simple. Only a few components are needed. The problems are often in the detail. During the design phase several questions arise: Which conduction mode is needed, continuous or discontinuous mode? Which snubber networks are needed? What is important to reduce conducted and radiated emissions?

Nowadays there are a lot of full integrated circuits for flyback converters available, but only a few of standard Flyback transformers. Every application has its special needs. It is not easy to buy “standard” Flyback transformers. So the power supply designer must calculate its own Flyback transformer to get the best performance in cost, size and efficiency.

At the beginning one has to decide, continuous or discontinuous mode. If the operating mode is continuous, one has to consider the recovery time of the secondary diode. As long as the flux of the transformer is not zero, the secondary diode is conducting. It looks nearly like a short for the primary switch if it turns on during the secondary diode is conducting. This results in higher switching losses and higher radiated and conducted emission due to the high current spikes. The problem is reduced if the secondary diode is replaced by a Schottky diode. If the flux of the transformer is zero when the primary switch is turning on, the turn on current spike is much lower. Thus discontinuous operating mode is more practical. The disadvantage of the discontinuous mode is: To transfer the same power to the secondary side a bigger core is needed. This would increase the cost of the power supply.

Discontinuous Mode

During the turn on time of the primary switch, energy is stored in the primary winding of the Flyback transformer. During the turn of time of the primary switch, this energy is transferred to the secondary output capacitor and load.

Figure 1: Primary current waveform

Figure 1 shows the typical primary current waveform when operating in the discontinuous mode. The input line current is rising linear with a starting point at zero current. The average current needed for further calculation is simply the current IP divided by 2. The starting point for our calculation is the amount of energy needed by our application. With the knowledge of the primary current waveform, we can write the following two equations to calculate the stored energy in the transformers primary inductance.

$$W_{IN} = V_{\mathrm{Pr}i} * T * \tau * \frac{I_P}{2} = \frac{1}{2} * {I_P}^2 * L_P$$

Equation 1: Stored energy

The needed power for our power supply is calculated as follows:

$$P_{IN} = W_{IN} * T * \tau$$

Equation 2: Input Power

P_{IN} : Input Power
T : Period of one cycle
$_T$: Duty cycle
V_{PRI} : DC-Input Voltage
f_S : switching frequency
L_P : Primary transformer inductance

With Equation 1 and Equation 2 the maximum primary inductance needed to store the energy in the discontinuous mode can be calculated. For this calculation one should consider the efficiency of the power supply.

Core selection and number of turns

If an appropriate core is selected, the number of turns to store the energy in the core can be calculated with the knowledge of the AL value (core constant). This value is found in the datasheet. Trickier is the selection of the core. For example, E-Cores are very cheap, but they have a higher leakage inductance which in turn can lead to higher emissions. ETD cores have a lower leakage inductance, but they need more space. If we need a high switching frequency of the Flyback converter, we can use ferrite as core material. Maximum core losses and saturation must be considered. If the switching frequency is low, it is likely that saturation will limit the maximum core flux. If we use a ferrite core, an air gap can solve this problem. The

air cap should be in the middle of the core. Otherwise we may have problems with radiated EMI. To select the right core some experience is needed.

Secondary inductance

The secondary inductance is calculated in the same way as the primary inductance, except we use the output voltage and power. In order to meet international safety regulations, the transformer in an off-line power supply must have adequate insulation between the primary and secondary windings. We have to know which isolation voltage and the safety creepage distance is required by the applicable safety regulation.

Snubber Design

Flyback converters are using a fast primary switch. The fast turn on and turn off behaviour of the primary switch produces a high du/dt. This fast voltage transition produces an overshoot and lead to ringing waveforms when the switch turns off. That must be properly suppressed. Without this, semiconductors can fail and conducted and radiated noise levels will be higher than necessary. This can lead to higher cost and time when designing the input EMI filter. The high frequency ringing must be damped using RC or RCD snubber networks. On the primary side a possible location for the RC network is between the drain and source of the primary switch. The more effective the RC network is, the more power is dissipated in the resistor. This can lead to lower standby efficiency which could be a problem in green mode power supplies. The best way is if the ringing and overshoot can be minimized or avoided. The source of the problem is the leakage inductance and stray capacitance that leads to ringing wave forms. Leakage inductance and stray capacitance of the transformer are minimized by splitting the primary winding. Further the PCB must be optimized.

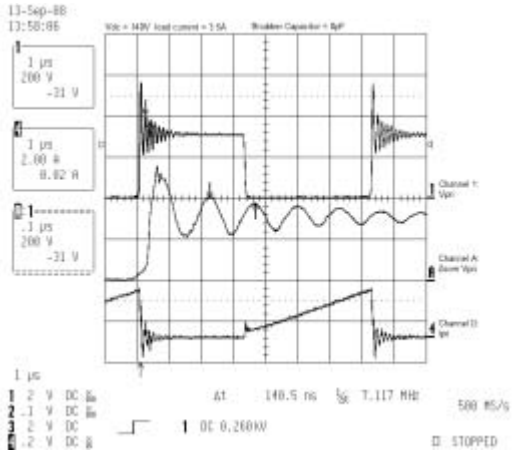

Figure 2: Ringing waveform without snubber network

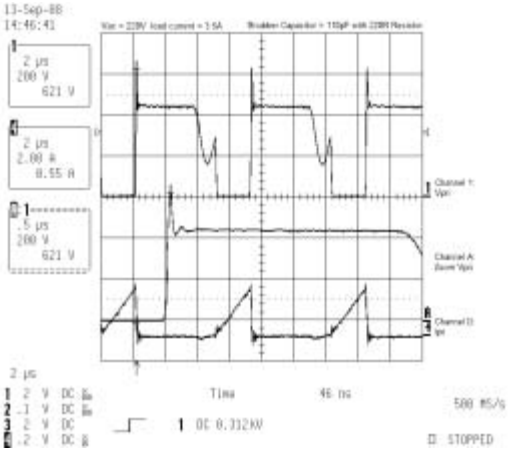

Figure 3: Ringing waveform with snubber network

In many cases we can not avoid a RC snubber network. Therefore, it is important to optimize the network to reduce the power dissipation in the resistor.

Designing the RC Snubber network

First measure the ringing frequency. As we can see in Figure 2 the ringing frequency is approximately 7.2MHz with a peak of 550V. Now we can add a capacitor parallel to the drain-source of the primary switch. The value of the parallel capacitance should be adjusted until the ringing frequency is 30% less than when we started, in our case 5MHz. We get a capacitance of 100pF. Now we need a series resistor to damp the ringing waveform. The ringing will be well damped if we use a resistor equal to the impedance of the resonance circuit. A good starting point is to use a resistor equal to the impedance of the capacitor. Finally one should consider the maximum power dissipation in the damping resistor. Figure 3 shows the effectiveness of the snubber circuit.

Conclusion

During the design phase of the Flyback power supply many aspects must be considered. A good understanding of magnetic core materials is necessary to design an optimized and well working transformer. Also the Layout process and the construction of the transformer are very important. If one could build a Flyback transformer with low leakage inductance and parasitic capacitance, a lot of money and time can be saved to controlling conducted and radiated emissions.

A New breakthrough in More Efficient Power Conversion

Major design challenges of the deep trench epi filling technology

Since making a high efficiency power supply means saving energy bills in the places like the data centers, it is not surprising that power supply manufacturers are focusing on designing a high efficiency power supply. In computing area desktop PCs and laptop computers take huge portions of energy consumption. Therefore energy efficiency organizations have been very active in establishing guidelines for higher efficiency levels for power supplies. There is 80 PLUS program (http://www.80plus.org), which unites electric utilities, the computer industry and consumers in an effort to bring energy-efficient technology solutions to the marketplace.

By Won-Suk Choi, Sung-Mo Young, and Denny Kim, Fairchild

One well-known organization is Climate Savers Computing Initiatives (CSCI, http://www.climatesaverscomputing.org) which was established in June, 2007 by Intel, Google, and others. It drives to improve energy efficiency and save power consumption of PC and server like IT equipments. Its goal is to reduce CO2 emission by 54 million tons per year for world wide IT equipments by 2010. Its focus activity is to develop how IT equipments to save power and educate how we can reduce power consumption. Specifically, it recommends two ways: one is to change power supply with a higher efficiency and one is for IT equipments and users that have a need to activate power saving settings like sleep or hibernate mode for PCs. It also sets technical specifications for high efficiency power supply as listed in its webpage. Under the rapidly changing circumstances that are encouraging energy-savings, most industry experts agree that new power technologies can play a critical role in the power conversion area. In this respect new products with state-of-the-art technology are always essential for better efficiency. A good example in high voltage devices is charge-compensated Super-Junction MOSFETs. Newly developed deep-trench filling MOSFETs utilizing charge-compensation theory have ultra low on-resistance and extremely fast switching speed, and can provide improved efficiency in switch mode power supplies.

Technological Considerations

The power losses of the switching device can be broken up into four parts: conduction losses, switching losses, turn-off state losses due to leakage current, and driving losses. In most switching power applications utilizing high voltage switching devices, the last two parts take a relatively small portion in total power losses. Between the two major power losses, the conduction losses can be reduced through realizing lowest possible on-resistance. The switching losses are determined by duration of switching transient, a period that current and voltage present simultaneously across the channel of the device. Obviously, faster switching transients reduce switching power losses. The switching device should have very low parasitic capacitances to be switched quickly. Therefore, considerable work has been done for improvements in on-resistance and parasitic capacitances. Among them, most remarkable achievement for on-resistance reduction was charge balance technology. The super-junction device utilizing charge balance theory is introduced to semiconductor industry ten years back, and it set a new benchmark in high voltage power MOSFET market. This technology has deep P-type pillar-like structure in the body in contrast to well-like structure of conventional planar technology. The effect of the pillars is to confine the electric field in the lightly doped epi region. Due to this p-type pillar, the resistance of n-type epi can be reduced dramatically compared to the conventional planar technology while maintaining same level of breakdown voltage. Therefore, this new technology has broken new ground in terms of the silicon limit regarding of on-resistance and achieved only one third specific on-resistance per unit area compared to planar processes. It is well-known that this technology also achieved unique non-linear parasitic capacitance characteristics, and therefore enabled reduced switching power losses.

Most commercially available super-junction devices adopted multiple epi layers to build the deep p-type pillar structure. In this structure, key design parameters for lower on-resistance are aspect ratio of p-type pillar and distance between unit cells. The common way for higher aspect ratio is adding more layers. However, the more layers means more complex process steps, and the increased process steps results in more expensive manufacturing cost. This structure is also hard to scale down for narrower cell pitch. As higher cell density is critical to bring about lower on-resistance it is another disadvantage of multiple epi layers technology. In order to realize better performance with lower cost comparing with existing technologies, it would be better to change rule of the game. By changing super-junction technology from multiple epi to deep trench filling it is possible to eliminate the existing drawbacks. This new technology firstly forms deep trench on n-type epi, and then fills it with p-type epi. In this way, the new technology has achieved much higher active cell density and simpler processes. For an example, new technology achieved number of epi process reduction by 67% compared to previous multi epi technology. Major design challenges of the deep trench epi filling

technology are uniformity at both building the deep trench and filling it. If there are crystal defects or voids, they cause shift in electrical characteristics. Therefore, precise control in the processes is important to manufacturability. By overcoming all these challenges through device and process engineers' endless efforts, the world first super-junction device utilizing deep trench epi-filling technology, the SupreMOSTM came into the real world. Together with its fewer process steps, the on-resistance per specific area of SupreMOS is less than one fourth of standard power MOSFETs, and 40% smaller compared to previous generation charge-compensated Super-Junction MOSFET, SuperFETTM. The reduced on-resistance of the new technology is directly related to conduction losses in the systems. In addition, it opens a way to more compact system design since device with similar on-resistance can be packaged into smaller package.

Efficiency Considerations

As a result of the reduction in the on-resistance per specific area, required chip area for same on-resistance becomes smaller with the new deep trench epi filling technology. This leads to very low gate charge and input capacitance. At 190mOhm, 600V rating, total gate charge of new device is only half of previous generation's. Even though power losses in gate driver are relatively small in comparison with conduction or switching losses, reduced gate charge can contribute to efficiency improvement. It also has reduced Miller capacitance, capacitance between gate and drain. The smaller Miller capacitance gives even more reduced switching power losses in hard switching applications as voltage and current transitions mostly take place while the Miller capacitance is being charged or discharged. As a result, the new super-junction device can be operated with higher switching frequencies. Another important measure for the use at high

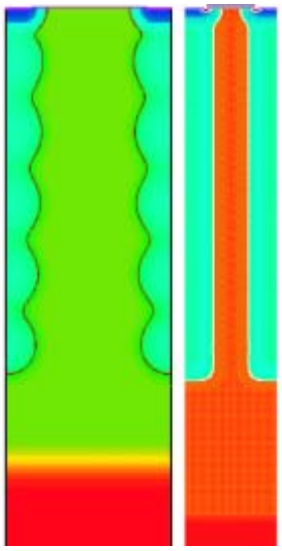

Figure 1 Vertical structure of SuperFETTM (left) and SupreMOSTM (right), not in same dimensions

frequency switching is a stored energy in the output capacitance. The energy is dissipated at every turn-on and causes power losses. When compared stored energy in the output capacitance, new device has approximately 30% less energy stored than in the case of previous generation at typical bulk capacitor voltages for switching power supplies. The benefits to switching losses are also verified in 600W continuous current mode power factor correction evaluation board. The system operating frequency is set to 120kHz, and STEALTH™ 2

fast recovery diode is applied as boost diode. As shown in figure 2, new device achieved about 30% reduction in switching losses and 0.7% higher power conversion efficiency. This represents a total power loss savings of more than 4.5W by simply replacing a single device.

Another test has done with 70mOhm SuperFET in TO-3P and 85mOhm SupreMOS in TO-220. The 70mOhm is nearly lowest on-resistance with multiple epi technology in big TO-3P package. There-

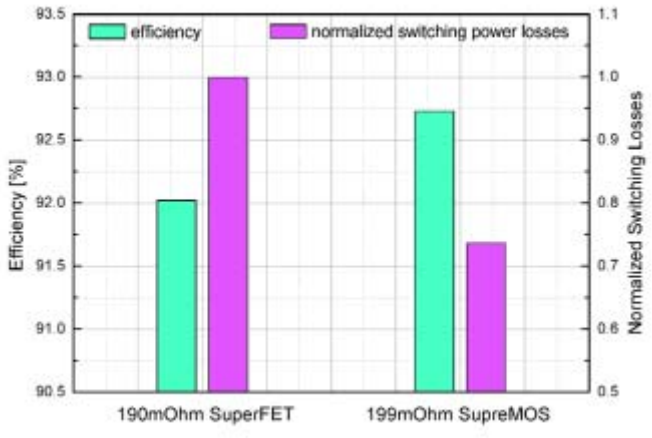

Figure 2 Efficiencies and switching power losses in 600W CCM PFC

fore, parasitic capacitances are huge, and switching performance is far inferior to 85mOhm new device. The external gate resistances have reduced for the 70mOhm SuperFET from 30Ohm and 10Ohm for turn-on and off respectively to 10Ohm and 4.7Ohm considering its slower switching characteristics. However, 85mOhm SupreMOS still showed smaller switching losses and higher power conversion efficiency over all load ranges in 800W rated continuous current mode power factor correction block.

The reduced switching losses due to faster switching are very beneficial to power conversion efficiency during hard switching conditions.

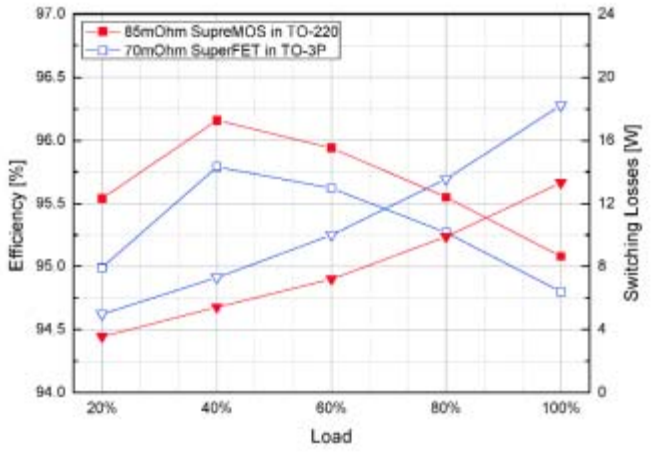

Figure 3 Efficiencies and switching power losses in 800W CCM PFC

In soft switching converters, however, switching losses are minimized through zero voltage or zero current switching techniques. Therefore, most important parameter for soft switching converters is on-resistance. As stated above, new deep trench filling technology offers ultra low on-resistance and is the best candidate for soft switching converters. In addition to the on-resistance, there are other important electrical characteristics for soft switching converters. One is the stored energy in output capacitance. It influences switching losses at turn-on in case of hard switching, but also determines how much resonant energy is required in soft switching converters. As shown in figure 4, SupreMOS has the lowest stored energy in output capacitance at typical DC link voltage of switching power supplies.

Another important parameter is body diode reverse recovery charac-

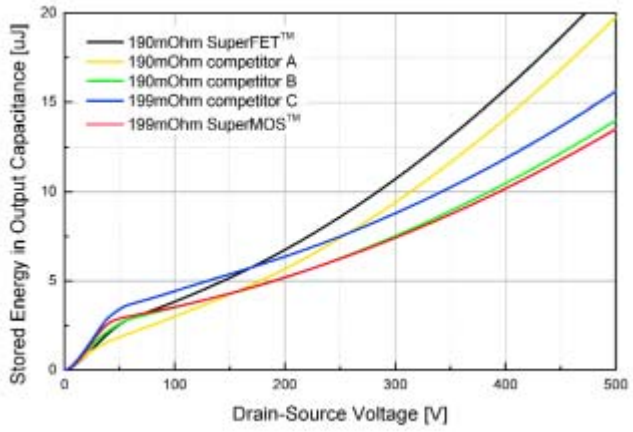

Figure 4 Energy stored in output capacitance

teristics. Since many soft switching converters utilize the body diode to achieve zero voltage switching condition, hard commutation of body diode takes place during system operation. In that case reverse recovery characteristics of the body diode affect both efficiency and system reliability. The SupreMOS shows less reverse recovery charge than major competitors at same di/dt and forward current level. Also, it offers better reverse recovery dv/dt capability and smaller peak reverse recovery current. A competitive analysis between the SupreMOS and one of major competitors is shown in figure 5. The competitor part just failed but the SupreMOS withstands the stress at same conditions. Therefore, the SupreMOS can provide higher reliability especially under severe load transient or shorted output conditions.

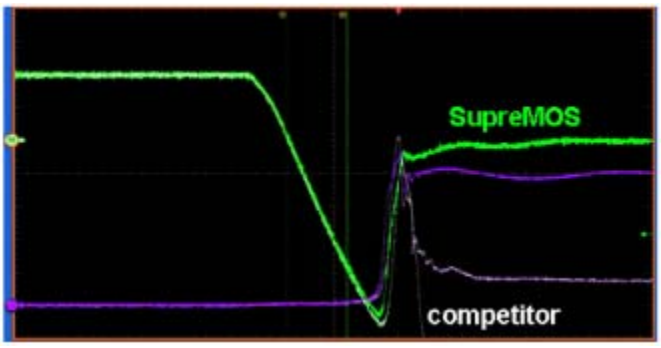

Figure 5 Body diode reverse recovery characteristics

Summary

This article explored a new technology that has set a new benchmark not only in conduction losses but also in switching losses through low parasitic capacitances. This is nearly an ideal switch, and greatly improves the efficiency of power supplies. This is another leap forward in more efficient design and ultimately, in global sustainability.

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Sensorless Control for Electrical and Hybrid Electric Vehicles

An Overview and Simulation

For Electrical Vehicles (EV) and Hybrid Electrical Vehicles (HEV) sensorless control of electric machines is a particular relevant topic. There are two main reasons why. Firstly mechanical position sensors are difficult to integrate and to implement into the driveline of the vehicle. Secondly the mechanical sensors are fragile and susceptible to Electro Magnetic Interference (EMI) and signal distortion.

By Peter van Duijsen,Simulation Research, The Netherlands, and

Pavol Bauer, TU Delft, The Netherlands

If mechanical position sensors could be minimized or eliminated entirely and replaced by software algorithms, the costs of the driveline would reduce while reliability would increase. The sensorless control would not only be important for a smooth control of the driveline, it would also be independent from signal distortion. Signal distortion would impact on the control of the drive and thereby introduce unbalance on the driving voltage vector causing noise and vibration. The Ideal Rotating TransFormer (IRTF) is introduced for modeling the electrical machines. The advantage of the IRTF based machine models is, that they give better insight in the machine modeling required for observer design.

General model of the AC machine

To study the sensorless control and to design a sensorless control for either the Induction Machine (IM) or the Permanent Magnet Synchronous Machine (PMSM), a machine model is required from which the stator and rotor flux can be identified. Recently the Ideal Rotating TransFormer (IRTF) was proposed to give a better insight into the operation of sinusoidal distributed AC machines [1].

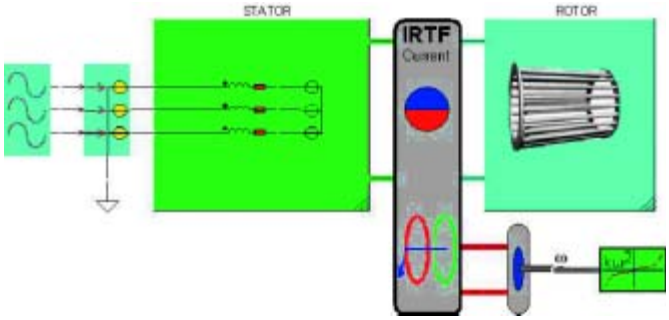

Figure 1: Basic IRTF AC machine model for modeling the Induction, Synchronous and Permanent Magnet Synchronous Machines

The basic IRTF AC machine model is build around the ideal transformer. In this Caspoc model [3] in Figure 1 the airgap is modeled in the IRTF model. Here the flux and current produce the electromagnetic torque where the IRTF models the position dependent coupling between stator and rotor. On the left side the model of the stator (green) has to be added, on the right side the model of the rotor (blue) has to be added. The electromagnetic torque is exported from this model on the bottom connection. The position of the rotor is fed into the model. An interface block is used to connect the signal oriented IRTF model to a mechanical model. A quadratic load in the figure above represents the mechanical model. Any type of mechanical model can be connected to this interface.

Depending on the machine type, IM, Synchronous Machine (SM), Synchronous Reluctance (SynRel) or PMSM, the stator and rotor models have to be connected to the IRTF model. Since all sinusoidal distributed AC machines have a sinusoidal distributed stator winding the model for the stator is for almost all machine types equal. The rotor is depending on the type of machine. A PMSM has a constant rotor flux and is simply modeled by a constant rotor flux connected on the right side of the IRTF. The IM with squirrel cage has no constant rotor flux but an equivalent winding that has to be modeled. For the IM the rotor circuit with the rotor time constant Tr=Lr/Rr has to be modeled.

The Caspoc models in Figure 2 [3], give insight in the functioning of the machines and can easily be interchanged. Not only is it visually better understandable how the machine model is build, it also gives insight in how the stator and rotor flux can be constructed from measured voltage and current signals from the machine. The IRTF models allow us to have better insight in creating an observer required for sensorless control. Numerous schemes to build machine and observer models are given in [1] and [2]

All the stator flux estimators described in this article use the stator winding resistance and inductance. These two parameters have to be known in advance. However during the operational time of the drive, due to the losses in the stator yoke and the winding resistance losses, the stator winding resistance increases. This thermal dependency also has to be modeled in the observer.

Because of saturation, the stator and rotor flux are not ideal, but follow the magnetization curve of the lamination. As a result, Ld and Lq vary upon load of the machine.

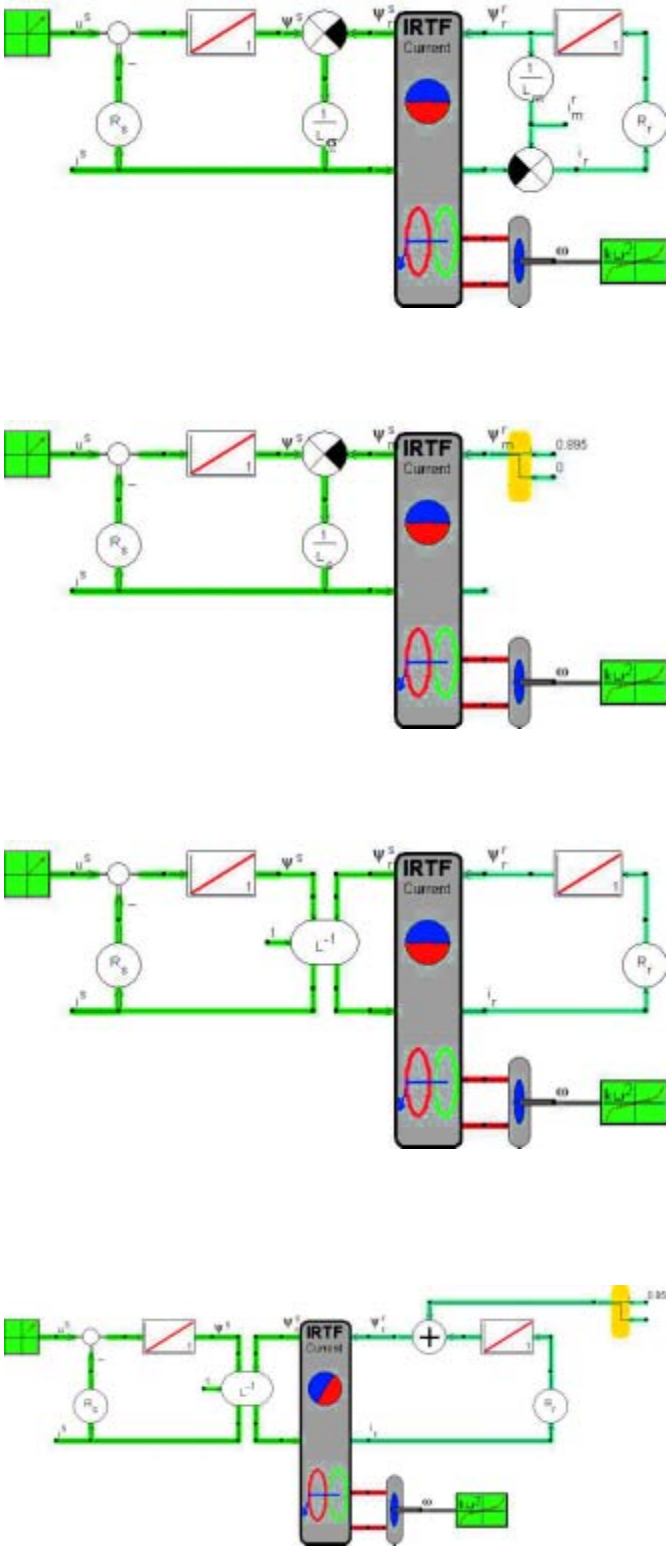

Figure 2: IRTF based AC machine models, a) IM with magnetizing inductance modeled on the rotor side and equal stator and rotor leakage inductance, b) PMSM with constant rotor direct axis flux, c) IM with different leakage inductance modeled on the stator side, d) PMSM with damper winding and constant rotor field

Sensorless control

The sensorless control can be applied to Field Oriented Control (FOC) and Direct Torque Control (DTC). DTC is actually already a sensorless control method if the control scheme from figure 3 is used. DTC is the most simple to implement sensorless control method [2]. Its disadvantage is however the undetermined switching

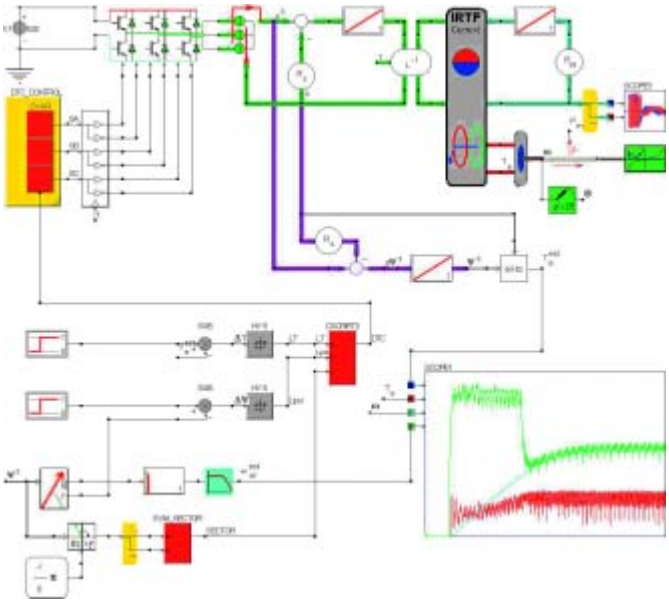

Figure 3: Direct Torque Control with stator speed estimation

behavior and its resulting torque ripple.

For FOC the sensorless control can be implemented by replacing the position and or speed sensors with an observer. The main problem to be solved is in designing a good observer that replaces the position and speed sensor. The rest of the FOC remains equal to the FOC with mechanical position and speed sensor. Various control structures are given in literature and the reader is suggested to have an overview in [4],[6],[7],[2].

Requirements on speed and position estimation for vehicles

Eliminating the position sensor basically leaves us with the question, how accurate the position estimation should be. The accuracy of position estimation is dependent on the type of machine. For a PMSM, accurate position estimation is required, in order to keep the stator current in an optimal angle with regard to the rotor flux angle. The rotor flux angle is fixed and given by the position of the magnets in or on the rotor. For nominal speed control the stator current has to be in quadrature with the rotor flux. For field weakening the stator current has to be positioned more in advance of the rotor flux in order to have the optimum torque within the current and speed limiting cycles [2]. This requires an absolute position sensor that resolves the rotor flux position to approximately less than 0.2 degrees mechanical [8]. Machines with higher pole count would even require a higher resolution. To resolve angles less than 0.176 degrees mechanical also requires an 11bit encoder. In case of high angular speed, these position measurements have to be transferred to the control system at a fairly high speed, requiring a high bandwidth resolver with high bandwidth data transfer. Sensorless control would eliminate the transfer of these measurements, since the actual measurement is taking place in the inverter itself. However the accurate position estimation remains even in sensorless control.

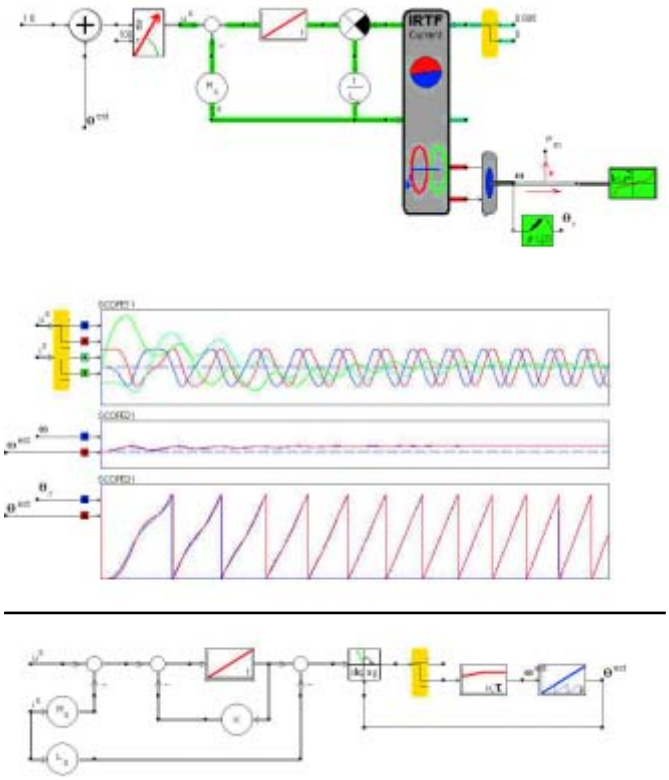

Figure 4: PMSM start up showing the agreement between simulated and estimated rotor angular-speed and position. Scope 11 shows us and is in the stationary reference frame. Scope 21 shows the simulated ?r and estimated ?est angular rotor speed, scope 31 shows the simulated ?r and estimated ?est rotor position.

For induction machine drives the position estimation is less stringent in Field Oriented Control (FOC). The observer has to estimate the rotor flux and the slip of the induction machine. Especially estimating the slip in the induction machine is prone to errors because most observers are based on machine parameters that vary due to temperature and non-linearity. The task of the observer is to predict the speed and position of the rotor without any mechanical sensor [5]. The only inputs to the observer are the stator voltages and stator currents. There are two types of observers that are commonly employed; the first type is based on the basic harmonic model of the machine and the second model is based on the anisotropy of the machine. Both methods are discussed in [5].

Practical application of the basic harmonic model

Figure 3 already showed the DTC application. In figure 4 the PMSM modeled in Caspoc [3] using the IRTF is shown. The driving voltage vector us feeding the PMSM model, which is the output from the inverter leads the rotor flux by 90 degrees electrical. The rotor is modeled by a constant flux of 0.995wb, as shown by the yellow block on the right side of the model.

The observer tracks the rotor position based on the voltage and current of the PMSM and is represented by the block diagram in figure 4. Instead of using the measured rotor position ?r in for controlling the supply voltage, the estimated rotor position ?est is used. As shown in the last scope of figure 4, the estimated rotor position ?est agrees very well with the actual rotor position ?r.

V Conclusion

Choosing the right simulation method allows the user to study effectively various sensorless drives used in hybrid and electrical vehicles. Using the new IRTF model as described in [1] inside Caspoc [3], the machine can be modeled in detail and it also gives insight in how to create an observer model suitable for sensorless operation. In reference [1] numerous Caspoc simulations are given, describing AC machine modeling. In reference [2] FOC and observer models in Caspoc are explained in detail.

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Efficiency Improvement with Silicon Carbide-Based Power Modules

SiC to become the next generation of power semiconductors

In recent years, discrete Silicon Carbide-based (SiC) devices have been introduced to the market. This article describes the utilization of SiC-based diodes and switches in power modules, and compares them to Silicon-based (Si) power modules. Whereas SiC switches have lower overall dynamic losses, they show higher static losses due to their lack of conductivity modulation and to limitations in chip size due to their high base material price.

By Zhang Xi, Daniel Domes, Roland Rupp, Infineon Technologies

The demand for devices with low switching loss, low conduction loss, and high temperature tolerance is a major driving force of technology development in power semiconductors. In recent years, SiC-based Schottky diodes have been introduced into the market as discrete devices in standard TO-packages [1]. These new diodes have superior performance compared to Si-based devices, mainly with respect to switching losses and thermal performance, and are well-established in hard switching applications up to 600 V in high-end power supplies [2]. In addition to this market entry point for SiC power devices, this emerging technology is also being considered
[1] by industry and research institutes as an ideal candidate for high-power module applications.

The main goal of this article is to offer insights regarding the trade-off between static and dynamic losses when moving from highly cost-effective Si-based solutions to high-performance but costly SiC-based solutions. In this article, the following switch configurations are compared:

a) Si IGBT (Infineon IGBT4) vs. Si free-wheeling diode (Emitter Control4)
b) Fast Si IGBT (Infineon IGBT2) vs. SiC free-wheeling diode (Infineon 1200-V SiC Schottky diodes)
c) SiC JFET cascode switches (1200 V normally on SiC JFET vs. 40-V OptiMOS™2 Si MOSFET)

The SiC JFET is used due to the superior maturity and reliability of this switch compared to the SiC MOSFET [3].

IGBT power modules with SiC free-wheeling diodes

SiC Schottky diodes in discrete packages were introduced to the market in 2001. The main advantages of these diodes are well-described in [4].

The first commercially available high-power module containing SiC Schottky diodes as free-wheeling diodes is a 600-A, 1200-V PrimePACK™2 IGBT power module with a type designation FF600R12IS4F from Infineon Technologies.

The 1200-V SiC diodes used are bare Schottky diodes with a p+/p-JTE edge termination structure and a Ti-Schottky barrier providing a barrier height of 1.27 eV, and allowing nearly the same threshold voltage as Si-based PIN diodes. Each individual chip has a current rating of up to 15 A. The required current rating of the free-wheeling diode is achieved by paralleling of multiple chips, which can be done easily due to the positive temperature coefficient of these devices. The total current rating of the diodes used per IGBT chip is 60% of the nominal IGBT current rating, thanks to the superior switching and thermal performance of these diodes.

Figure 1 shows the typical switching behavior of SiC Schottky diodes in combination with Infineon's fastest IGBT chip, the S4 chip based on IGBT2 technology.

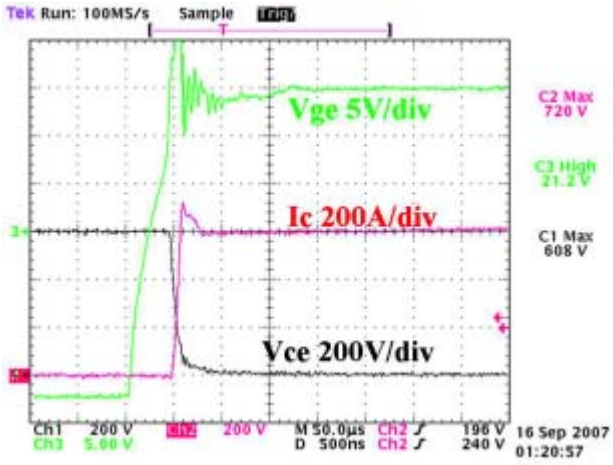

Figure 1: Typical turn-on behavior of 1200-V, 600-A IGBT S4 Chip with 360-A SiC Schottky diodes (Tj = 25°C, Rg_on = 0.5 Ω)

Due to the absence of a reverse-recovery charge of SiC Schottky diodes, the turn-on gate resistor of the IGBT can be reduced dramatically to reduce turn-on losses (in the example, 0.5 Ω is used). The reverse-recovery current, as seen in Figure 1, is reduced dramatically in comparison to a Si-based freewheeling diode. Figure 2 shows the typical switching loss of the module:

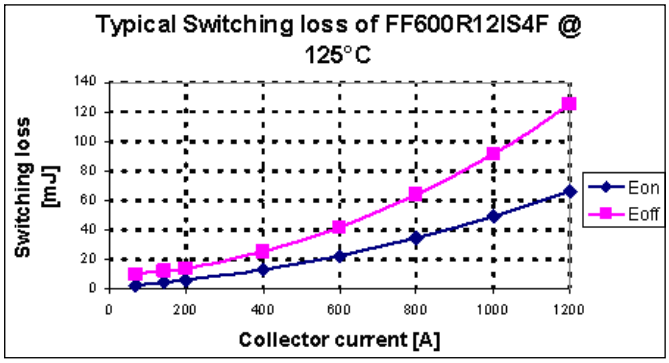

Figure 2: Typical switching loss of PrimePACK™ 2 module FF600R12IS4F with SiC Schottky diodes

SiC JFET power modules

The conductivity of Si-based MOSFETs drops sharply when the blocking voltage of the switch is higher than 1000 V. IGBTs are appropriate choices for switches with blocking voltages > 1000 V. However, due to the tail current while switching off, switching losses have certain physical limits. The need for a faster switch with low conduction loss has driven the development of a new switch based on SiC material, the SiC-based Junction Field-Effect Transistor (JFET, see e.g. [7]).

Infineon's SiC JFET is normally on with a pinch-off voltage of ~ -15 V. For compatibility with standard applications, it is optional to provide switches that are normally off (cascode configuration). These are formed by a 40-V low-voltage Si-MOSFET (OptiMOS™) in series with a 1200-V SiC JFET.

The first prototype of a power module containing SiC JFET switches is an EasyPACK 2B module with H-bridge configuration. Each switch in the module contains 6 SiC JFETs in parallel to achieve an Rds_on of approximately 70 mΩ at room temperature.

Figure 3 shows the static behavior of SiC JFET in combination with a low-voltage OptiMOS™2 in cascode configuration as described before.

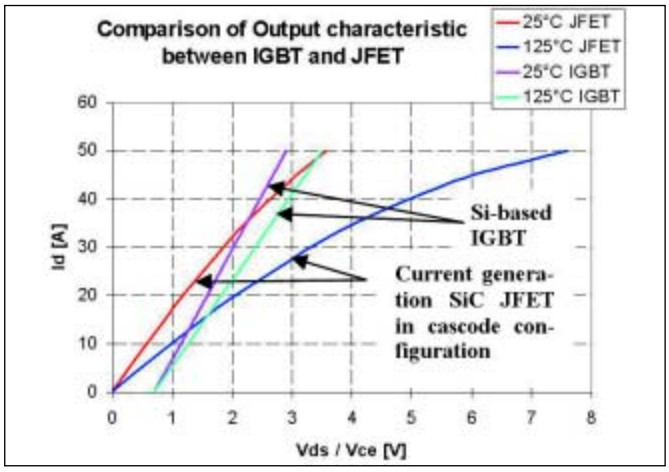

Figure 3: Static characteristic of SiC JFET in cascode configuration at 25°C, 125°C

Dynamic tests have been done with different gate resistor values (39 Ω …82 Ω). The results are shown in Figures 4 and 5. The test conditions were: Tj = 125°C, Id = 40 A, Vdc = 600 V, inductive load.

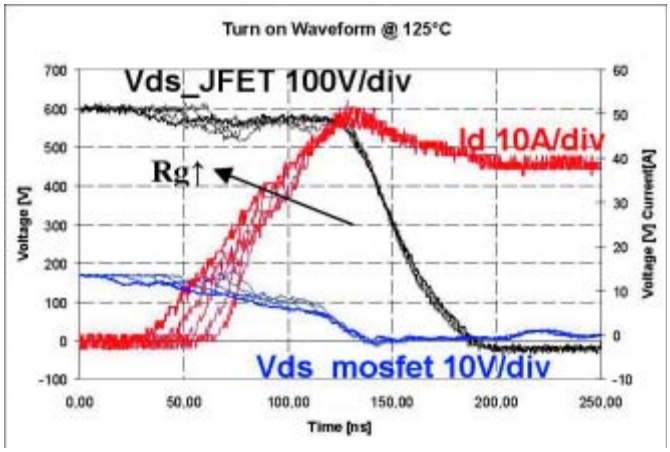

Figure 4: Dynamic test waveforms of SiC JFET module: turn-on at 125°C

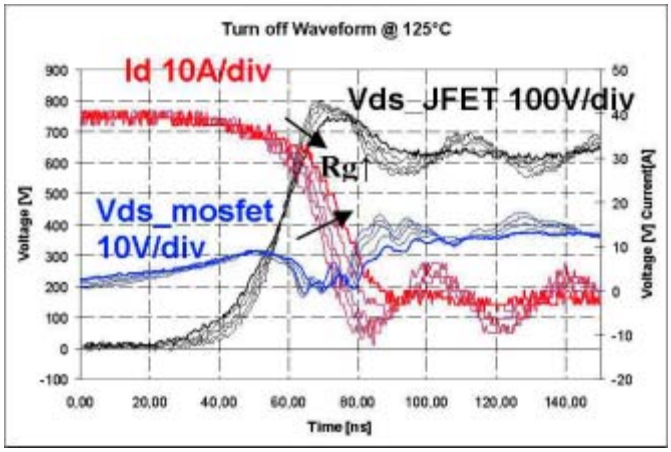

Figure 5: Dynamic test waveforms of SiC JFET module: turn-off at 125°C

A comparison of dynamic losses to standard IGBT module is shown in Figure 6:

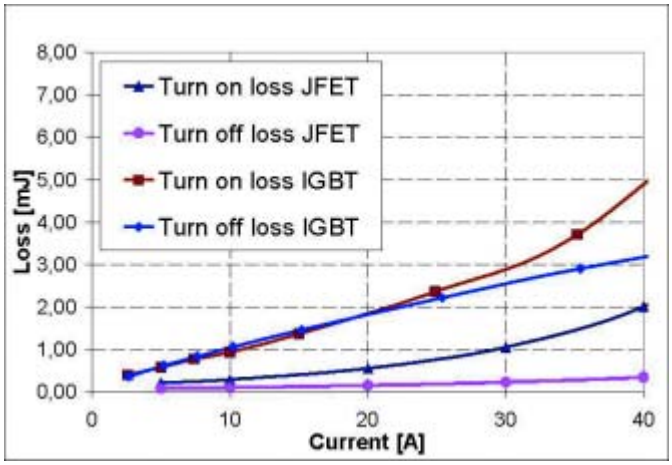

Figure 6: Comparison of switching losses of the JFET module vs. a 25-A, 1200-V standard module with IGBT4 (Tj = 125°C, Vdc= 600 V, Rg = 39 Ω)

The results indicate that the turn-on losses are quite low due to the low reverse-recovery charge of the body diode. The turn-off losses are very low due the absence of minority carriers in JFETs, similar to MOSFETs. Another advantage is that the di/dt slope during turn-off can be fully controlled simply by varying the gate resistor.

Comparison between Si-based power modules and power modules utilizing SiC devices

The two possibilities described above for utilization of SiC-based devices in power modules will now be compared to pure Si-based configurations by calculating inverter losses based on [5]. The data for pure Si-based modules was taken from the datasheet for a 25-A, 1200-V IGBT4 module [6]. The measurements with IGBT and SiC Schottky diodes were performed on a 25-A, 1200-V IGBT4 module together with the 15-A, 1200-V SiC Schottky diodes previously described. The measurement of SiC JFET in cascode configuration was performed with the SiC JFET EasyPACK 2B module. The conditions for calculation were: Tj = 125°C, Vdc = 600 V, Irms = 21.2 A, cosφ = 0.8. The gate resistor value for each configuration was chosen to have the lowest possible switching losses. The results are shown in Figure 7.

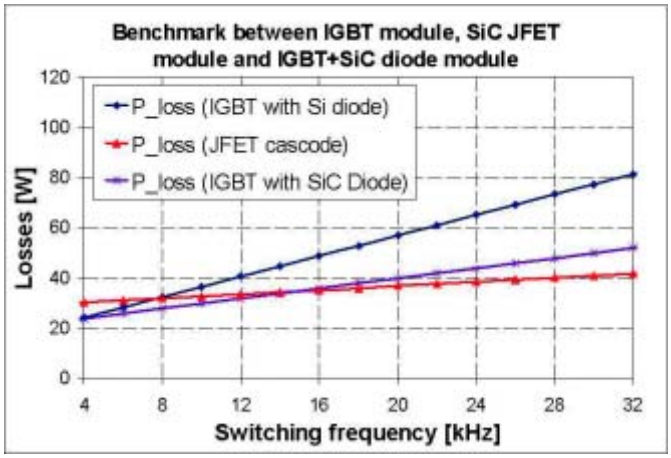

Figure 7: Benchmark of total losses between IGBT module, SiC JFET module, and IGBT+SiC diode module (Tj = 125°C, Vdc = 600 V, Irms = 21.2 A, cosφ = 0.8)

The calculated results in this example clearly demonstrate the advantages of SiC-based devices:

- For applications, whose first priority is efficiency, the efficiency of the converter at fsw = 20 kHz can be increased by 1.1% by utilizing an SiC diode with an IGBT if the same output power is maintained. Utilizing a SiC JFET can increase the efficiency by up to 1.3%.
- For applications whose first priority is power density, the output power of the converter at fsw = 20 kHz can be increased by 31% by utilizing a SiC diode if the same semiconductor losses are maintained. Utilizing an SiC JFET can increase the output power by 28%. Under these conditions, the IGBT/SiC diode combination outperforms the JFET due to lower conduction losses of the IGBT compared to the unipolar JFET device.
- Utilizing a SiC diode with an IGBT can increase the switching frequency of the converter from 20 kHz to 38 kHz if the same semiconductor losses are maintained. With a SiC JFET, the switching frequency can be even increased to 70 kHz with the same losses. The increase of switching frequency can then decrease the size and cost of the output filter. However, the exact degree of size or cost reduction depends on several other factors.

The utilization of SiC Schottky diodes or SiC JFETs can decrease the switching losses dramatically. The configuration of IGBTs together with SiC diodes as free-wheeling diodes combines the superior conduction performance of IGBT chips with the ultra-low reverse-recovery losses of SiC Schottky diodes. Even lower switching losses can be achieved with SiC JFETs. Due to the missing conductivity modulation in the unipolar component, the conduction losses of the SiC JFET, however, are slightly higher than with IGBTs due to a trade-off between chip area and cost. Depending on the switching frequency or the application requirements, one can choose among these different configurations.

Conclusions

This article describes modules utilizing SiC devices (Schottky diodes, JFETs). The performance of these modules is compared to Si-based power modules. The results clearly show the benefits of utilizing SiC devices:

- With the same converter design, the efficiency of the whole system can be increased. Smaller heat sinks or passive cooling systems can be used.
- With the same thermal design, the output power of the converter can be increased. The power density of the system can also be increased.
- Increasing the switching frequency makes it possible to reduce the size of the output filter and thus reduce the system cost.

The first applications that can benefit from these advantages are those that need high efficiency (for example, solar converters) or contain an output filter (for example, medical equipment or UPS). In the long run, depending on the cost and diameter development of silicon carbide base material, silicon carbide-based power semiconductors are thought likely to become the next generation of power semiconductors and bring a new wave of innovation into this field.

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Chip Temperature Measurement without Additional Sensors

The temperature-dependent forward voltage drop of an IGBT for a small sense current is a particularly suitable method

Stress induced by thermal cycles causes power electronic systems to have a finite service life. To estimate this service lifetime, accurate information on the thermal profile in the chips under the given operating conditions is required. This paper discusses how the temperature profile can be determined without the need for specially modified modules.

By Dr. Uwe Scheuermann, Manager Product Reliability, SEMIKRON

When designing power electronic systems, development engineers do not only have the functional aspects in mind, but also factor in the expected service life. To estimate the service life of a system, however, accurate data is needed on the thermal cycles the system has to withstand during operation over the expected operating time.

One-dimensional thermal networks can be used to simulate the thermal behaviour of a power electronics system with a sufficient degree of accuracy. By supplying a characteristic power loss profile into this network, a temperature profile or "mission profile" can then be calculated. Extracting the number of thermal cycles from the mission profile allows for the evaluation of the expected service lifetime on the basis of an appropriate lifetime model.

While the power losses generated at each operating point can be derived with relative ease from data sheet values, the determination of the correct thermal equivalent circuit proves more difficult. Although many manufacturers of power modules give thermal circuit parameters for their modules in the form of Foster equivalent circuits, this equivalent network apparently cannot account for the user-specific cooling conditions. A Foster network is a series circuit of parallel resistor/capacitor pairs, which results from system theory as a transfer function for stepwise constant power pulses. Since a one-dimensional network of this kind can be calculated analytically, the temperature profile for an arbitrary sequence of power pulses can be easily derived. Nevertheless, it must be emphasized that such transfer functions must not be connected in series.

Therefore, to ensure an appropriate thermal design, the transmission behaviour of the system as a whole (incl. module, thermal interface, coolers and fans) has to be emulated by an accurate thermal equivalent model. To do so, the chip temperature has to be determined by way of time-resolved measurements of the complete system.

The use of external temperature sensors is problematic due to the fact that the surface of the power electronic chip in the module is normally not accessible. Therefore, it is advantageous to use a temperature-dependent chip parameter and thus to use the chip itself as a sensor. For an IGBT, the temperature-dependent forward voltage drop for a small sense current is a particularly suitable method, since components commonly used today have an almost linear negative temperature coefficient. For a constant sense current of 100mA, this results in a typical temperature dependence of ~-2mV/K. Every component has to be calibrated before the measurement is taken, as, for technology reasons, the temperature coefficient is subject to a certain production spread.

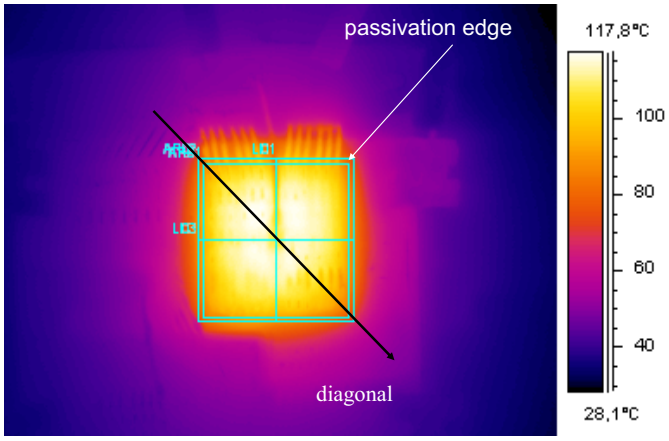
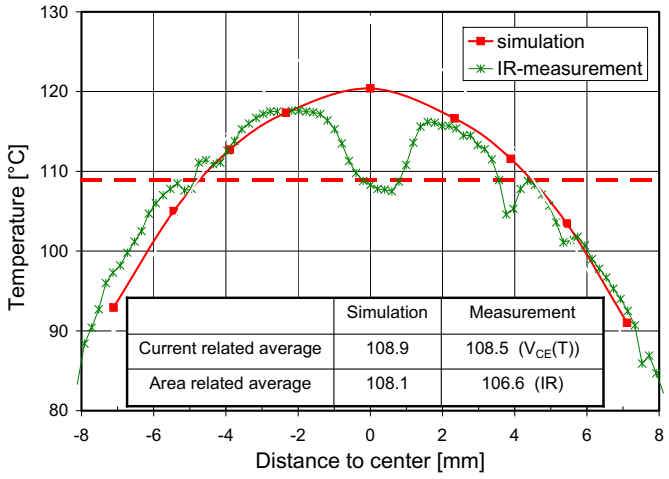


Figure 1: IR camera image of a Trench IGBT for 150A in a SEMiX® module on a water-cooled heat sink at 9°C.

Once this calibration curve has been established, the chip temperature after load current turn-off can be determined by supplying the sense current through the component and measuring the voltage drop; this simple procedure is normally referred to as the VCE(T) method. What should be noted, however, is the fact that the component first has to reach a state of electrical equilibrium before the temperature measurement can be performed. This is known as the recombination time and amounts to approx. 50µs in state-of-the-art IGBTs. Thus, temperature measurements are possible below 0.1ms after turn-off. This time resolution is virtually impossible to achieve using external sensors. If, before the load pulse is turned off, the IGBT is in a state of thermal equilibrium, the cooling curve may be measured between 100µs and several seconds and a correct Foster network can then be derived.

Calibration is done using homogenous heating of the device in a furnace or on a hotplate. During active operation, however, the power chip is not heated homogenously, but displays a lateral temperature gradient (Figure 1). For effective cooling and large chip dimensions, this can give rise to temperature differences of 40°C and more. The question is what geometrical significance the temperature determined using the VCE(T) method actually has.



	Simulation	Measurement
Current related average	108.9	108.5 (V_{CE}(T))
Area related average	108.1	106.6 (IR)

Figure 2: Comparison of the IR camera reading along the chip diagonal with the corresponding temperature profile from the simulation. An overview of all results is also shown here.

A study was conducted to investigate this question more closely [1]. For the case described in Figure 1, which refers to an IGBT loaded with a constant power loss of 273W, a VCE(T) measurement was carried out and resulted in a virtual junction temperature of 108.5°C. To illustrate the significance of this temperature reading in geometric terms, a three-dimensional model of the module set-up including heat sink was generated. By adapting the effective thickness of the thermal paste layer and the heat transfer coefficient between heat sink and cooling water, a good approximation of the thermal behaviour of the real system was achieved. Figure 2 shows a comparison of the measured and simulated chip temperature along a diagonal section through the chip center. The gate region which was not biased with power loss and the shading of the chip temperature by the wire bonds, which can be observed in the measurement, were not taken into account in the simulation.

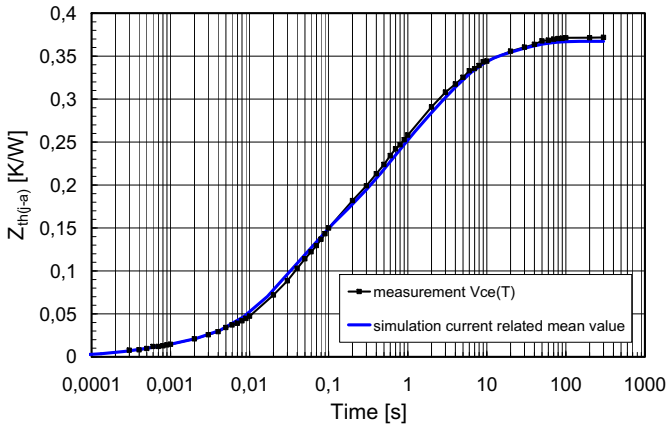


Figure 3: The impedance characteristic calculated from the simulation by current-related averaging is almost identical to the impedance curve measured using the VCE(T) method.

What was taken into account in the simulation, however, was the measuring current distribution. Owing to the negative temperature coefficient of the measuring current, a higher current density is established in the warmer chip regions. The current-related average temperature reading was 108.9°C. An area-related average of the temperature distribution obtained from the simulation resulted in a temperature of 108.1°C. At 106.6°C, the area-related reading taken by the IR camera was slightly lower due to the shading caused by the wire bonds.

These results show that the VCE(T) method delivers a virtual junction temperature which corresponds with a current-related average of the temperature distribution in the chip. As shown in Fig. 3, a correct depiction of the transient thermal impedance is also delivered. The fact that these values are very much concurrent with the temperature value obtained by area-related averaging shows that the VCE(T) method is an ideal procedure for comparing measurement and simulation results.

Sources:

[1] U.Scheuermann, R.Schmidt: Investigations on the VCE(T)-Method to Determine the Junction Temperature by Using the Chip Itself as Sensor, Proc. PCIM09, CD-ROM, Nuremberg, 2009.

Potential of SiC and other Wide Bandgap Semiconductors in Power Electronic Applications

ECPE Seminar in cooperation with EPE Association

The third User Forum for the first time also considered other wide bandgap devices, in particular Gallium Nitride (GaN) as its subtitle expresses. The user Forum 2009 took place right after EPE conference in Barcelona. Prof. Andreas Lindemann (Otto-von-Guericke-Universität Magdeburg, Germany) took the chair together with Prof. José Millán (Centro Nacional de Microelectrónica --- CNM Barcelona, Spain) and Mr. Thomas Harder (ECPE).

By Prof. Andreas Lindemann, Otto-von-Guericke-Universität Magdeburg, Chair for Power Electronics

State of the Art

Starting in the beginning of the supply chain, the SiC material situation is not a concern anymore: While cost has decreased in the course of time, wafer quality has increased, permitting to produce devices with an area of some 25mm² with appropriate yield. This is suitable for a nominal power in the Kilowatt range and can be extended by parallel connection of devices.

Schottky diodes with voltage ratings of typically 600V and 1200 V are commercially available and used in different kinds of converters, often together with Silicon transistors; this combination permits to significantly reduce switching losses, thus to downsize the transistors or to increase efficiency. SiC transistors are currently sampled as JFETs, MOSFETs or BJTs, typically with voltage ratings of 1200V or above: JFETs are quite mature unipolar devices; normally-on JFETs however require some measure --- like a cascode circuit --- to avoid short-circuit during power-up in voltage source converters. Alternatively, MOSFETs can be used as unipolar SiC switches, also providing a significantly lower on-state resistance RDS,on than comparable high-voltage Silicon devices; conduction of bipolar body diode can be deactivated connecting a SiC Schottky diode antiparallel. Although channel mobility and oxide stability still lead to some concern, SiC MOSFETs have already proven to pass at least most reliability tests. Bipolar junction transistors can serve as an alternative, requiring current-source instead of voltage-source drivers.

Devices for higher voltage ratings --- including bipolar pin-diodes for blocking voltages above 4500V --- have been built and tested in special applications, proving their feasability. However obviously the high-power segment suffers from a kind of chicken and egg problem: System manufacturers would require to calculate the bill of materials of a novel system with SiC converter; however extrapolation of high-voltage device cost today will still end up in quite inaccurate numbers. It is obviously easier to take evolutionary steps, gradually increasing device voltage and current capability.

GaN devices will always be of lateral type which facilitates integration. Conventional and cost-effective processing is e. g. possible on Silicon wafers. First power devices --- such as 600V diodes --- have been reported. It will be interesting to see on the occasion of one of the next User Forums, how promising GaN diodes, transistors and possibly integrated circuits will penetrate power electronic applications.

The aforementioned components and samples are still packaged in a conventional way, i. e., as modules, transfer moulded discretes or in some cases with hermetic packages. Research aims at progress regarding parasitics --- of particular importance with respect to fast switching of unipolar devices --- and reliability also when elevated temperature is applied.

Outlook and Conclusion

Generally speaking, the availability of wide bandgap devices has not set an end to the art of circuit design --- still, the philosophy of circuit designers may be to follow different approaches: The most simple solution can be preferred, but also a technically more complex circuit eventually reducing cost. The former in many cases happens when SiC Schottky diodes replace bipolar Silicon diodes such as in power supplies with high switching frequency; however --- as an example for the latter --- some snubber circuit together with a reduced switching frequency may be a workaround, too. Obviously, well-established Silicon- competes with emerging SiC- and in future GaN-technology. In the case that the functions of active and passive switch can be decoupled, often a coexistence will be the optimum, combining a Silicon transistor --- such as a charge-compensated MOSFET --- with a wide bandgap --- i. e., SiC --- diode. While this is already cost-effective for many applications, special requirements enable more comprehensive use of wide bandgap devices: SiC devices permit to achieve an up to now unrivalled efficiency of some 99% for photovoltaic inverters; increased device cost will pay back rather soon through the compensation for electricity fed into the grid. For this reason, converters for renewable energy can be expected to contribute to the continuous introduction of wide bandgap devices in power electronics. Other application areas --- possibly also related to high voltage or high temperature --- may follow in future. This exciting development might be reported on the occasion of a similar User Forum planned for every two years in the future.

www.uni-magdeburg.de/llge

ECPE

EPE EUROPEAN POWER ELECTRONICS AND DRIVES

OTTO VON GUERICKE UNIVERSITÄT MAGDEBURG
FAKULTÄT FÜR ELEKTROTECHNIK UND INFORMATIONSTECHNIK

150V High-Side Driver IC with Internal Vs Charge

International Rectifier has introduced the AUIRS2016S for automotive gate drive applications including common injection rails, diesel and gasoline direct injection applications and solenoid drivers.
The AUIRS2016S is a high-voltage power MOSFET high-side driver featuring an internal Vs-to-GND recharge NMOS. The device's output driver features a 250mA high pulse current buffer stage. The channel can be used to drive an N-channel power MOSFET in the high-side configuration, operating up to 150V above ground. The AUIRS2016S also provides negative voltage spike immunity (-Vs) to protect against catastrophic events during high-current switching and short circuit conditions.
The AUIRS2016S is a robust, highly reliable IC designed to meet the rugged performance needs of automotive under-the-hood motor control units, targeting energy-efficient applications such as diesel and gasoline direct fuel injection systems.
Qualified to AEC-Q100 standards, the AUIRS2016S also offers 5V compatible logic level inputs, one high-side output and internal low side Vs recharge, CMOS Schmitt trigger inverted input with pull up resistor and CMOS Schmitt trigger inverted reset with pull down resistor.
The new device utilizes IR's advanced high-voltage IC process which incorporates next-generation high-voltage level-shifting and termination technology to deliver superior electrical over-stress protection and higher field reliability.

www.irf.com

ESD Protection Portfolio with Industry's Smallest 0201 Package

Tyco Electronics announced the addition of three new devices to its line of electrostatic discharge (ESD) protection devices. The 0201-sized Silicon ESD (SESD) devices are approximately 70 percent smaller than prior generation 0402-sized devices and help provide protection and improve reliability of portable electronics such as mobile phones, MP3 players, PDAs and digital cameras.
The SESD device's miniature footprint -

measuring a mere 0.6mm x 0.3mm x 0.3mm - offers designers flexibility in space-constrained applications. Bi-directional operation allows placement on the PCB without orientation constraint and won't clip signals that swing below ground. Designed to withstand IEC61000-4-2 ESD test pulses, the SESD device helps protect sensitive integrated circuits (ICs).

www.circuitprotection.com

Multiphase PWM for Intel Mobile CPUs

Intersil Corporation introduced new compact multiphase PWM regulators that comply with the Intel Mobile Voltage Positioning (IMVP-6.5TM) specification. Intersil's new ISL62882 and ISL62883 reduce total component cost and implementation footprint for a wide range of Intel-based mobile handsets, notebooks, network systems and embedded designs, including the new Capella® platform based on the Ibex Peak-M® chipset. Each new regulator supports various CPUs using programmable 3-phase, 2-phase or 1-phase operation. Configurable overshoot reduction capabilities provide minimal Vout overshoot, which pre-empts voltage misreadings and the potential for product underperformance or failure. Both devices feature phase dropping, diode emulation, adaptive body diode conduction time reduction to optimize light load efficiency and FB2 (full buffering) to optimize transient response and Z(f) in 1-phase mode. In addition, the

ISL62882 provides a split LGATE function that further improves efficiency.

www.intersil.com

Digital 10A Synchronous DC/DC Controller

Summit Microelectronics has expanded its family of Programmable Power Manager (PPM) integrated circuits (ICs) with the SMB211 single-channel, synchronous DC/DC controller. The SMB211 continues Summit's innovative approach to power supply design by combining flexibility, features and performance with ease-of-use. With a serial digital interface, the SMB211 can be easily configured during development (on-board, non-volatile memory) and re-programmed in system by host software. The result is a high-performance digitally controlled power supply design that is easily customizable without tedious hardware design cycles or complex microcontroller-style software coding.

Summit's unique programmable, non-volatile mixed-signal IC technology combined with a convenient GUI development environment allows for unparalleled functional and parametric flexibility in power supply design. This flexibility applied to common problems such as dynamic voltage/current control and intelligent battery charging, allows for significant system performance improvement while realizing drastic reductions in design effort. Digital programmability enables high integration and system flexibility in a single chip — impossible with conventional "hard-wired" analog power ICs. Additionally, this integration reduces the bill-of-materials yielding the lowest total system cost and size. Summit solutions address the biggest challenges facing OEM developers today: increasing system functionality, performance and complexity accompanied by shrinking development-time cycles.

www.summitmicro.com

Sixteenth-Brick Provides 12V @ 7A Output

Power-One, Inc. introduces the SSQE48T07120 DC-DC Converter, an ideal DPA or IBA power source for communications, data server/storage, and workstation applications with efficiencies up to 93%. This DOSA-compliant sixteenth-brick provides 12 VDC @ 7 amps with 100% of full-rated power available at 55°C, and 7 amps @ 70°C, using only 200 LFM airflow.
The SSQE48T07120 product also features the capability to withstand a 100V input transient for 100ms, meets EN 60950 Basic Insulation requirements, and is UL94 V-0 flammability rated. Additional features include: a wide-range 36 to 75 VDC input, the capability to start up into pre-biased loads, and no minimum-load operation.

www.power-one.com

Low-Power High-Precision Op Amps

Microchip Technology, Inc. presents three new families of low-power, high-precision operational amplifiers (op amps). Thus, the Company now offers a broad portfolio of high precision Op Amps with Gain Bandwidth Product (GBWP) from 10kHz to 50MHz.
The MCP6051/2/4 (MCP605X), MCP6061/2/4 (MCP606X) and MCP6071/2/4 (MCP607X) op amps feature offset voltages of just 150 microvolts and are well suited for applications requiring low power consumption, low-voltage operation and high precision, such as portable instrumentation devices used in industrial (i.e. portable gas detectors, pressure-monitoring devices, toll booth tags, digital multimeters, RFID readers, bar-code scanners). Medical applications include blood glucose meters, wearable heart-rate monitors and body temperature measurement sensors.

www.microchip.com

3,400V Phase-Leg Rectifier Module for Higher Efficiency

IXYS Corporation announced its extension of its diode rectifier module range to 3,400 volts repetitive reverse voltage.
The dual rectifier diode module with a part number MDD175-34N1 features two diodes in an industry standard module. Each diode is rated at 175 Amps average current at a case temperature of 100 degrees centigrade and rated to 3,400V operation up to 125 degrees centigrade.
“This extension of the usable voltage range of existing products to 3400V represents a significant technological breakthrough for efficient power rectification above 2500V,” commented Bradley Green Vice President of International Sales of IXYS. “Most of our competitors struggle for reliability in product manufacture with operating voltages above 2,000V and this latest development further highlights our long standing tradition for market leading development in the bi-polar high voltage, high power arena.”
The MDD175-34N1 module benefits from IXYS’ own direct copper bond (DCB) isolated substrates which have been extended to offer a 3,600 volt terminal to base isolation rating. Product features also include the standard set of IXYS’ design parameters; ruggedness; world leading reliability and highest efficiency and is designed to fulfil all relevant industrial standards for most applications.
The new High Voltage Rectifier family is a new generation that covers the global trend for many applications to increase the supply voltage and is typically utilized in any front end rectification stage in applications such as motor drives, wind power conversion systems and DC power supplies.
The new technology fulfils the need of the engineer who needs to raise the voltage of a rectification system without the need for operating devices in series and in many cases can therefore reduce the system component count.

www.ixys.com

Flexible Mechanical Encoder Series

CUI Inc announces the release of a line of flexible mechanical encoders that can be configured into over 1,000 different versions. The 2-bit quadrature ACZ series is available in three sizes: 11 mm (ACZ11), 12 mm (ACZ12), and 16 mm (ACZ16). The encoders have a rotational life of up to 100,000 cycles and are rugged, utilizing metal material where similar models would use plastic. This series is ideal in applications for audio, aircraft, medical, and test equipment.

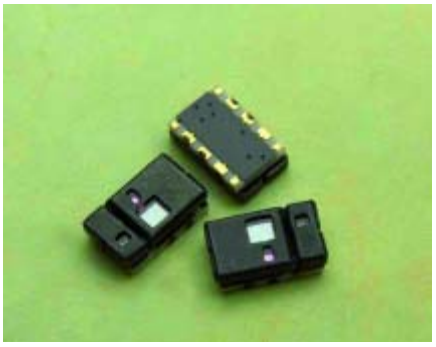
Options for the ACZ series include detent, a push button, vertical or right angle mounting, and numerous shaft configurations. Resolutions available include 12, 15, 20, and 24 PPR. CUI is also able to customize rotational torque in order to meet a customer’s exact tactile feel requirements. The ACZ series is available now through Digi-Key and starts at under $2.10 per unit. For OEM quantities please contact CUI directly.

www.cui.com

Ultra-Thin Integrated Ambient Light and Proximity Sensor Module

Avago Technologies announced a new ambient light and proximity sensor that has been integrated into an ultra-thin module for use in mobile phones. Avago's compact APDS-9800 integrated sensor module is designed to help conserve power and extend battery life in mobile phones and is easy to install. This new sensor module can also be used in other mobile electronic applications such as PDAs, handheld games and personal computers.

Built in a surface mountable package that is 1.45 mm thick by 4.95 mm in length by 3.0 mm wide, the APDS-9800 offers many technical features that are required by mobile phone manufacturers such as an extended detection range, and signal conditioning cir-



cuitry which offers superior performance in bright sunlight conditions. The APDS-9800 is composed of four chips: an ambient light sensor IC; proximity sensor and signal conditioning IC; LED emitter; and detector. The ambient light sensor, which has a spectral response that is close to that of the human eye, is used to control display backlighting brightness. The proximity sensor signal conditioning IC consists of an LED driver and receiver circuit with excellent ambient light cancellation capability. The built-in LED and detector allow the sensor to detect the proximity of an object to the device.

Avago's APDS-9800 includes a shutdown mode to conserve power consumption and extend battery life. Additionally, the pulse width, burst rate, duty cycle and frequency can be controlled to further minimize power consumption.

www.avagotech.com/sensors

New Generation, FINEPLACER® matrix

Finetech has extended their product range with the FINEPLACER® matrix.

This is a major step into the future for the entire product family. The modular approach got more perfect. Depending on the customer's demand the configuration can be a high end re-work system or a high precision mounting and bonding station. Optional there are 10µm or 3µm accuracy available. The flexible architecture can be easily adapt any of the tooling options.

The re-work configuration covers the full tool set of necessary steps. Using the high precision for placement the strength is shown for handling multi chip modules.

Up to 12 inch wafers have been included in the handling capability. The system is first choice for constant stable results in medical, automotive, air and space applications.

www.finetech.de

RO4360 Laminates for High-Frequency Amplifiers

The Advanced Circuit Materials Division of Rogers Corporation has introduced RO4360™ laminates, developed for the special requirements of high-frequency amplifier designers. RO4360 laminates feature a dielectric constant of 6.15 and loss of 0.003 @ 2.5GHz. The laminates are based on a ceramic-filled, thermoset resin system reinforced by glass fiber for excellent mechanical stability compared to PTFE woven glass.

RO4360 laminates provide the performance and reliability designers need in a lower total PCB cost solution. Building on the successful legacy of the company's RO4350B™ laminate materials, the new product features low dissipation factor, generous power-handling capability, and improved thermal conductivity. Environmentally friendly RO4360 laminate materials are RoHS compliant and compatible with standard printed circuit board processing methods. The copper-clad laminates exhibit a high glass transition temperature (Tg) of greater than 280ºC and a low coefficient of thermal expansion (CTE) in the z-axis (30 PPM/ºC) needed for reliable plated through holes (PTHs) in multilayer circuits.

www.rogerscorp.com

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Benchmark Power MOSFETs for High Performance Applications

Benchmark Point of Load: VRM, Buck Regulation

Part Number	V_{DS} (V)	I_D (A)	$R_{DS(on)}$ Max V_{GS}=10V (mΩ)	Qg (nC)	Package
IRFH7921PBF	30	14	8.5	8.3	PQFN (5x6)
IRFH7932PBF	30	25	3.3	34	PQFN
IRFH3702TRPBF	30	16	7.1	9.6	PQFN (3x3)
IRFH3707TRPBF	30	12	12.4	5.4	PQFN (3x3)
IRF8721PBF	30	14	8.5	8.3	SO-8
IRF8788PBF	30	24	2.8	44	SO-8

Benchmark Power Supply: Synchronous Rectification

Part Number	V_{DS} (V)	I_D (A)	$R_{DS(on)}$ Max V_{GS}=10V (mΩ)	Qg (nC)	Package
IRFB(S)3004PBF	40	330	1.75	160	TO-220(D^2-PAK)
IRFB(S)3006PBF	60	270	2.5	200	TO-220(D^2-PAK)
IRFB3077PBF	75	210	3.3	160	TO-220
IRFB4110PBF	100	180	4.5	150	TO-220
IRF7853PBF	100	8.3	18	28	SO-8

Benchmark Industrial: Industrial Battery, UPS

Part Number	V_{DS} (V)	I_D (A)	$R_{DS(on)}$ Max V_{GS}=10V (mΩ)	Qg (nC)	Package
IRF3205Z(S)PBF	55	110	6.5	76	TO-220(D^2-PAK)
IRFB(S)3806PBF	60	43	15.8	22	TO-220(D^2-PAK)
IRF1018E(S)PBF	60	79	8.4	46	TO-220(D^2-PAK)
IRFB(S)3607PBF	75	80	9.0	56	TO-220(D^2-PAK)
IRFB(S)3307ZPBF	75	120	5.8	79	TO-220(D^2-PAK)

IR's latest MOSFETs offer benchmark performance and are tailored for DC/DC conversion, AC/DC synchronous rectification, and Industrial Battery applications such as E-Bike and UPS systems.

IR's latest Trench technology in a wide range of packages up to 250V enables low $R_{DS(on)}$, low gate charge, and high switching capability for today's demanding designs.

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