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Electronics in Motion and Conversion

January 2010

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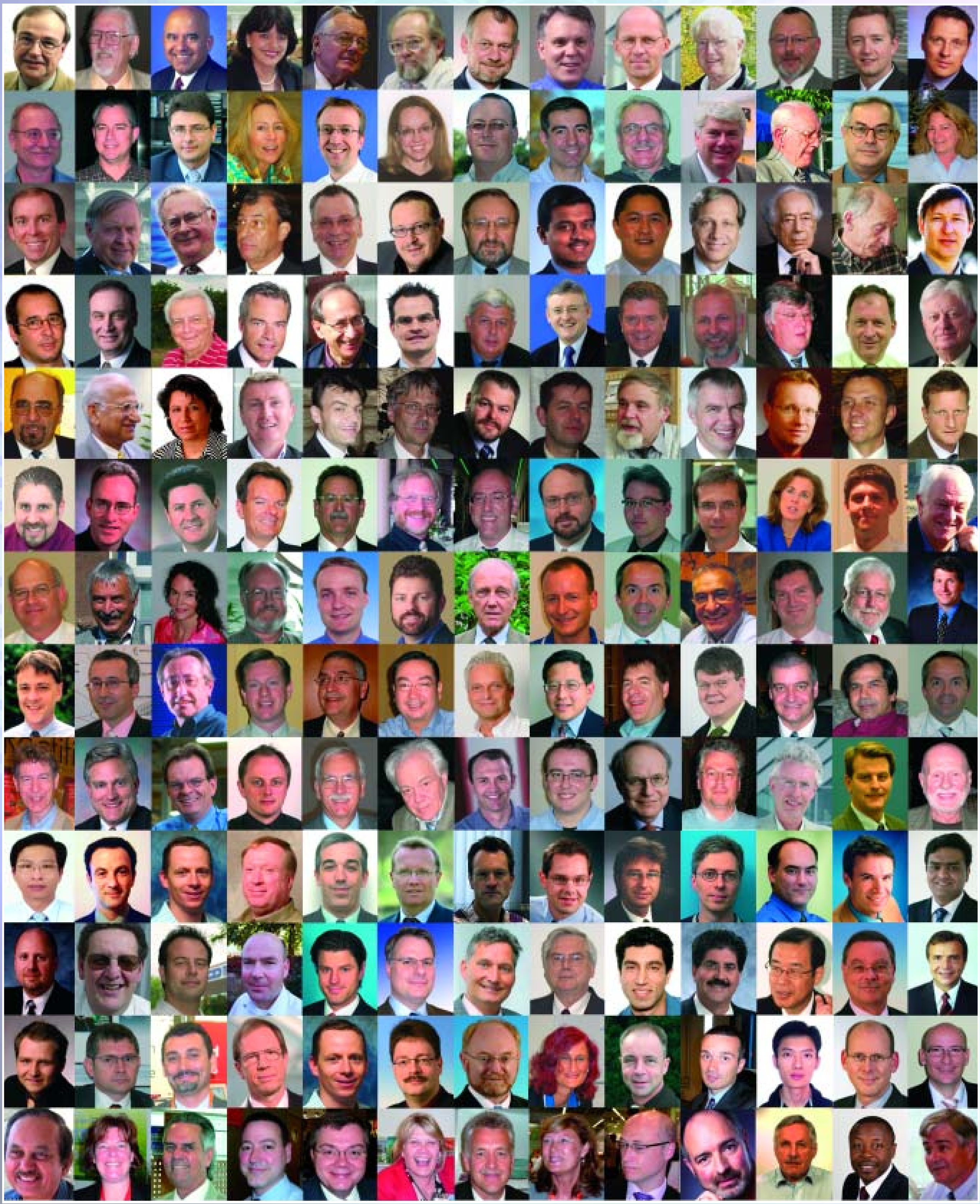

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Palm Springs, CA, February 21-25
www.apec-conf.org

Digital Power Supply Design,
Reading UK, February 23
www.biricha.com

Embedded World,
Nuremberg/Ger March 3 -5
www.embedded-world.de

EMC,
Düsseldorf/Ger, March.9–11
www.mesago.de

CIPS 2010,
Nuremberg, Ger, March 16-18
www.cips-conference.de

New Energy Husum,
Ger, March 18-21
www.new-energy.com

Smart Alternative Energy Pushes Economy

We are looking towards 2010 with high expectations for a more stabile economy. The SPS/IPC/DRIVES show in Nuremberg with its many busy exhibitors and visitors was a good sign that innovation in technology is on the move. A number of exhibitors I spoke with there had very positive feedback about their expectations of the future with energy efficient solutions in all areas being a major priority.

Alternative energy is of the utmost importance and thankfully, currently on the tip of everyone's tongue. Water, solar and wind are the topics feeding the grid. In their new product strategies, measurement and conversion play an essential role for the companies I met with in Nuremberg. Programs initiated by governments all over the world will help to achieve the goals for climate recovery and it's not only the mega projects like offshore wind parks we should be looking at. Increasingly, small turbines and solar power roof-top installations on residential buildings will, little by little, harvest alternative energy for practical use and as a whole make a significant impact on our environment.

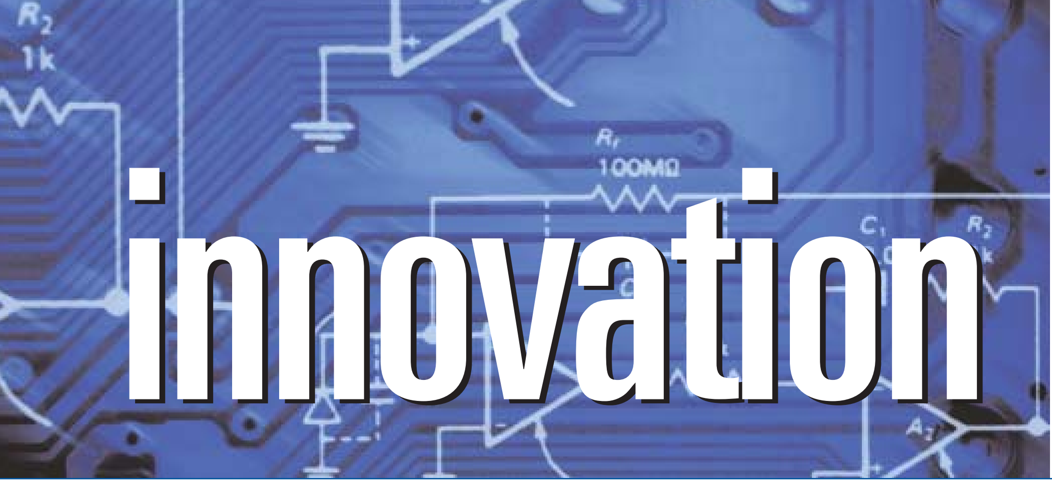
Decentralized solutions for smart grid operation will embody a full scenario of efficient power usage through flexible controlled timing for sink and source of power. These concepts will be open to include any smart power generator, storage system as well as an individual user of the grid. The IMEC article in my actually issue offers a fantastic view of tomorrow's smart grid and the components that will make it efficient. Semiconductor materials such as SiC and GaN have the potential to be the future core resources for power switches. The best-of-breed switch for higher voltage is still the IGBT invented by Wheatley and Becke because it makes solutions practical. Nevertheless, some experts still see more potential in silicon that can be utilized for higher efficiency. Control ICs and their information structures are now following what the telecommunications industry went through quite a few years ago.

All areas of research are developing ideas that will help us use energy more efficiently.

Co-generation, which combines the generation of heat and electricity using a combustion motor design suited for residential use, is just one example. In the past, the concept of co-generation was limited to massive systems for centralized heating in urban areas where the heat was distributed to local households and the electricity was fed into the grid. Now the private household is waiting for access to power blocks to substitute conventional heating and only the smart grid will be able to handle these complex tasks in the future. Power semiconductors are key elements for making this reality.

My Green Power Tip for January:
Rather than leaving your kids to their computer games, inspire them to take their trains out of their boxes and start a layout for the wintertime. This kind of creativity will help make some of them our engineers of the future and all it might take to make it happen is a little freedom and space in your home. Their future must be important to all of us.

Happy New Year



APEX PRECISION POWER

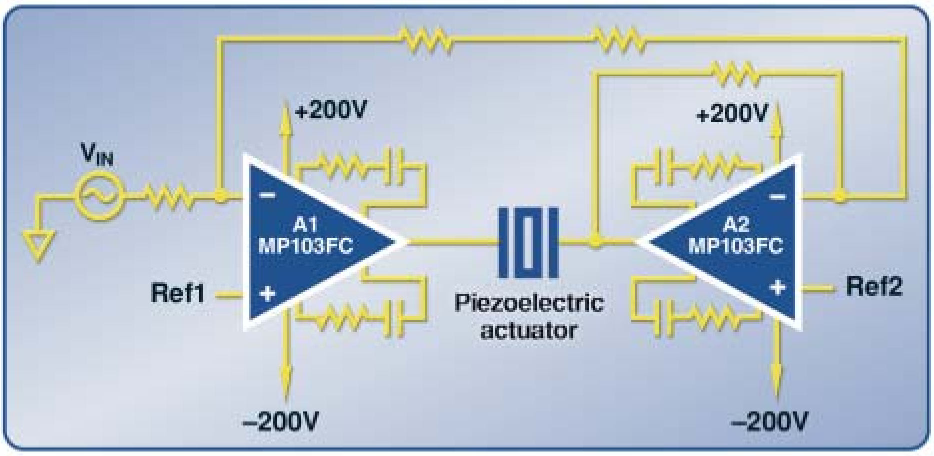
Product Innovation from Cirrus Logic

DP 12-PIN POWER SIP

(actual footprint 30.99mm X 20.17mm)

FC MODULAR 42-PIN DIP

Open Frame Product Technology
(actual footprint 65.1mm X 42.5mm)



Dual Channel Amplifier is a Space Saver For Piezoelectric Actuator Drives

The MP103FC is a dual channel power amplifier that sets new standards for combining high current, high speed and high voltage for the Apex Precision Power® family of linear amplifiers from Cirrus Logic. The MP103FC has a power bandwidth rated at 230 kHz, and a 180 V/µs slew rate, for driving piezo electric applications that require lower speeds but multiple drivers. The device also features up to 15 A of output current per channel and an operating voltage ranging from 30 V up to 200 V. The MP103FC uses "open frame" modular packaging that is ideal for high speed assembly and provides a low per unit cost in comparison with many in-house discrete designs.

Model	Slew Rate	Output Current	Supply Voltage Operation
MP103FC	180 V/µs	Up To 15 A PEAK	30 V to 200 V Dual Supply
PA107DP	3000 V/µs	1.5 A continuous 5 A Peak	40 V to 200 V Dual Supply

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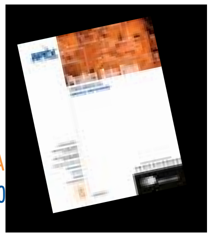


LEARN MORE AT
www.cirrus.com

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

Isabellenhütte has appointed Jürgen Brust as Managing Director

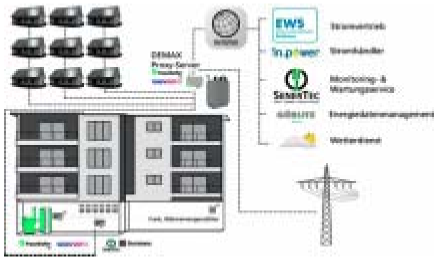
Isabellenhütte Heusler GmbH & Co. KG, one of the world's leading manufacturers of Alloys for Thermocouples and Resistance Alloys as well as Alloys for Low-Impedance Precision and Power Resistors, has appointed Jürgen Brust as new Managing Director. On July 1, 2009, the 52-year old joined Managing Director Peter Müller on the management board as head of Research and Development and Production for the aforementioned business areas including the new field of Measurement. Jürgen Brust wants to continue to develop current and precision measurement systems for hybrid and electric vehicles as well as for other applications specifically in this sector. "I can put the experience I have gained working for renowned automotive suppliers to good use in my new position", says Brust, looking forward to his new professional challenge.

Before joining Isabellenhütte, the electrical engineer and business management graduate worked at Beru AG in Ludwigsburg, a company specializing in electronics and sensor technology among other things. Brust became Managing Director at BERU Electronics GmbH in 2003 and has also worked at other subsidiaries both in Germany and abroad. In addition, he was head of the product segment Electronics and Sensor Technology.

www.isabellenhuette.de

Intelligent Energy Management in Smart Grids

Fraunhofer ISE coordinates project for an integrated communication concept.
The increasing amount of renewable energies being integrated into our electricity grid requires new management and ICT concepts. In addition to the chances of active participation in the energy markets and reducing electricity costs, a decrease in peak loads is also made possible through the intelligent use of renewable energies. The requirements of a grid management and the necessary communication technology are high. Under the coordination of Fraunhofer ISE, it will now be demonstrated for the first time how all of the features of a so-called Smart Grid can be realized by using an integrated Smart Metering concept.
An innovative energy management and com-



munication system was developed as part of the InnoNet Joint Project "DEMAX" (Decentralized Energy and Grid Management with flexible Electricity Rates) which is sponsored by the German Federal Ministry of the Economy. Based on the system developed, decentralized energy suppliers and loads from the commercial and private sector can participate in the energy market. The main component of the system includes an "Embedded System" of the newest generation that allows an internet based communication. "In order to be able to use the generated energy locally, the supply and demand must be optimally matched. For instance, the energy generated by a photovoltaic system can be used directly for charging the electric vehicle. During peak load in the evening, the cogeneration can supply a part of the electricity demand," explains Dr. Christof Wittwer, Head of the Group Operation and System Controls at Fraunhofer ISE.

www.ise.fraunhofer.de

PCIM Europe 2010 Gains Momentum

The power electronics sector is further growing. Additionally, the overall economic climate brightens up. This positive trend can be recognized at PCIM Europe 2010 as well. 75% bookings of last year's space show the positive atmosphere around the event. Nearly every exhibitor which downsized its booth is returning to its old size.
For each of our customers in this segment, a visit to this show is essential. Each year we get new contacts and valuable approaches

to enhance our company and products", says Christoph Blum form Trafomodern and shows the importance of the exchange between experts. PCIM is predestined for this exchange by the renowned conference. Besides academic findings, approved everyday solutions are presented on the conference.

www.mesago.com

Worldwide Semiconductor Equipment Sales to Grow 53 Percent in 2010

SEMI projects worldwide sales of new semiconductor equipment to total US$16.0 billion according to the year-end edition of the SEMI Capital Equipment Forecast, released here today by SEMI at the annual SEMICON Japan exposition. The figure represents the largest annual decline in equipment sales since the global industry association began its data collection program in 1991.
The forecast indicates that, following a 31 percent decline in 2008, the equipment sector will post another significant decline of approximately 46 percent in 2009. SEMI expects the market to grow approximately 53 percent in 2010 to US$24.5 billion and to further increase about 28 percent in 2011 to US$31.2 billion.
"Worldwide semiconductor manufacturing equipment sales have declined to the lowest annual levels since 1994 as the global economic crisis and industry downturn caused the world's chip makers to significantly curtail spending and expansion," said Stanley T. Myers, president and CEO of SEMI. "There has been recent improvement in equipment bookings and we anticipate a significant growth off the bottom with expectations of double-digit growth in the next two years."

www.semi.org

Everlight Electronics Announce Distribution Agreement for EMEA

EBV Elektronik, an Avnet company and Everlight Electronics announced a partnership to distribute the Everlight portfolio to illumination customers in Europe, the Middle East and Africa.
"With EBV we significantly strengthen our sales channel network and further enhance the support to our customers in EMEA. Following our strategy, this partnership will help us to further intensify our design-in focus and is an important step to expand our business into new regions and emerging market segments," said Stephan Greiner, vice president Global Sales of Everlight Electronics. "Combining Everlight's and EBV's offerings we expect to increase customer value."
Everlight Electronics Co. Ltd is a leader in the design of LEDs, Displays, Infrared and Optocoupler components serving various applications in the consumer, computing, automotive, telecommunication and industrial market segments. Everlight's exponential growth is the combined result of its well-engineered products, highly efficient inhouse manufacturing facilities and extensive global supply chain. Founded in 1983, Everlight is headquartered in Taipei, Taiwan, with operations in Asia, America and Europe.

www.everlight.com

X-FAB and Plus Semi Agree on Sale of X-FAB UK

X-FAB Silicon Foundries Group, the leading analog/mixed-signal foundry and expert in "More than Moore" technologies, and Swindon-based Plus Semi have agreed on the sale of X-FAB's wafer fabrication plant in Plymouth, UK, to Plus Semi. The agreement to transfer ownership of X-FAB UK to Plus Semi has been signed by both parties, closing is expected by the end of 2009. A technology license agreement ensures the continuation of the existing operation. Financial details of the deal were not disclosed.

Hans-Jürgen Straub, CEO of X-FAB Group, said: "We are glad to have reached a solution to continue operation and to maintain jobs at the site in Plymouth outside the X-FAB organization. The sale is an important milestone for optimizing the X-FAB group's capacities."

Michael LeGoff, Plus Semi Managing Director commented: "This has been the culmination of an enormous effort from all concerned to bring these two former Plessey businesses, Plymouth and Swindon, together again. We have retained our key engineering competence within a design and technology centre in Swindon with approximately 20 employees. Together with the 150 people we will employ at the Plymouth facility we have an exciting opportunity to find significant growth in semiconductor design and manufacture in the lucrative analog/mixed-signal semiconductor markets."

www.plussemi.com

Co-operation between Isabellenhütte and Sensor-Technik Wiedemann

W. Wiedemann and F. Heusler

The companies Sensor-Technik Wiedemann (STW), based in Kaufbeuren, and Isabellenhütte Heusler from Dillenburg have joined forces to develop a battery management solution for utility vehicles featuring hybrid drive technology. The two firms have now signed a co-operation agreement that will pave the way for further joint efforts in development and production of key components for electric drives.

The current trend in hybrid drive technology is the focus on efficient electrical energy storage systems. An increasingly important energy storage system in this context is the lithium-ion battery, which boasts high energy density coupled with high power density.

"For a lithium-ion battery to work efficiently, a well functioning battery management system (BMS) with precision voltage and current sensors is needed. By joining forces with Isabellenhütte, we are now working with one of the key leaders in the field of automotive current measurement. The joint development work will open up new possibilities for us", comments Wolfgang Wiedemann, CEO of Sensor-Technik Wiedemann GmbH who also took over as Chair of the AMA Association for Sensor Technology in mid 2009.

Sensor-Technik Wiedemann looks back on many years of experience in the development of battery management systems for automobiles. As part of its many projects, a host of utility vehicles such as compact delivery vans, small-sized lorries and buses have been fitted with hybrid drives and lithium-ion batteries.

"We are very happy about our partnership with STW, one of the key players in hybrid drive technology, and are hoping that the co-operation will help us gain further market shares in this sector," states Dr. Felix Heusler, Sales Director for Precision Measurement and Alloys, as well as member of the management board at Isabellenhütte Heusler.

Isabellenhütte was the first company in the world to achieve the ultra-precise measurement of current, voltage and temperature in automobiles using its ISA-ASIC sensor. The BMS is based on a sensor module ("IVT") made by Isabellenhütte that is able to measure a minimum voltage drop across a measuring shunt in the busbar of the traction network with a high degree of precision. "Our sensor modules are 100% configurable to the user's individual needs. Thanks to co-operation with STW in the early product development phases, we were able to fully exploit this advantage," adds Dr. Heusler.

www.isabellenhuette.de

CIPS 2010 Programme Finalised

CIPS stands for the 6th International Conference on Power Electronics Systems Integration. It will be held from March 16 to 18, 2010, at Nuremberg's Maritim Hotel which is located close to the main railway station. It will be co-organized by VDE ETG and ECPE and technically co-sponsored by IEEE PELS as well as by ZVEI.

The three main topics of CIPS are: Power electronics systems, high-power modules, and reliability of power electronics systems. For all three topics system integration will help to increase power density (and reduce costs), to increase performance (and reduce EMI), and improve reliability by a more efficient thermal management (and better cooling).

CIPS 2010 Program Overview

Tuesday, March 16, 2010

Time	Room A
10:30	Opening
10:50	Session 1: Power Electronics Systems
12:00	Lunch Break
13:20	Session 2: System Integration
15:10	Coffee Break
15:40	Session 3: Reliability
17:50	Break
18:00	Session 4: Driver
19:00	Break
19:15	Dialog Session & Frankonian Snacks and Beverages

Wednesday, March 17, 2010

Time	Room A	Room B
8:30	Session 5: Power Electronics Applications	
10:00	Coffee Break	
10:30	Session 6: Power Modules	
12:30	Lunch Break	
13:50	Session 7: Power Electronics	Session 9: Packaging
15:30	Coffee Break	
16:00	Session 8: DC/DC Converters	Session 10: Materials
17:20	Break	
17:30	Panel CAD Tools	
18:50	End	
20:00	Conference Dinner	

Thursday, March 18, 2010

Time	Room A
8:30	Session 11: Prognostics - Thermal Management
10:20	Coffee Break
10:40	Session 12: EMI & Cooling
12:20	Lunch Break
13:40	Session 13: Future Perspectives
15:20	Closing
15:40	End of the Conference

One of the basic ideas of CIPS is to bring together industry and academia such, that industry is describing new concepts and needs and academia is providing solutions for it. The scientific/technical quality of presentations and written papers, however, is ensured by an international Technical Programme Committee, which is headed by Dieter Silber, University of Bremen and Eckhard Wolfgang, ECPE e.V.

The programme structure can be seen from the overview chart. Two keynotes, 11 invited and 41 oral papers, 18 posters and one Panel Discussion will be presented. 26 come from industry, 26 from academia, 7 are authored by industry and academia and 13 come from applied research institutes, like Fraunhofer.

- Johann Kolar/ ETH Zurich will open the CIPS 2010 with the Keynote on “Performance, Trends and Limitations of Power Electronics”.
- The status of “Integrated Driver Circuits” will be described by Reinhard Herzer/ Semikron.
- Dushan Boroyevich/ CPES will give an overview on “Status of Power Electronics Systems Integration”, followed by 4 papers on this topic.
- Michel Mermet-Guyennet starts the reliability session with a contribution to “Railway Traction Reliability” followed by five regular papers. Three contributions to driver circuits finish the oral presentations of day 1.

The Dialog Session starts at 19:15 during that Franconian snacks and beverages will be served.

The second day starts with five invited papers:

- “Power Electronics System Integration for Electric and Hybrid Vehicles”, Martin März, Fraunhofer IISB,
- “Solar Power Converters”, Regine Mallwitz, SMA,
- “Fault Tolerant Designs”, Glynn Atkinson, Univ. Nottingham,
- “Paralleling of High-power Modules”, Ulrich Schlapbach, ABB Semiconductors,
- “Nondestructive SOA Testing of Power Modules”, Giovanni Busatto, Univ. Cassino.

In the afternoon there are two parallel sessions on: Power Electronics and DC/DC Converters, and in parallel Packaging and Materials.

The final session on day 2 is a Panel Discussion on “Virtual Prototyping - CAD Tools for Power Electronics: What is available and what is missing”, moderated by Thomas Harder/ ECPE e.V., and Dushan Boroyevich/ CPES.

The Conference Dinner takes place at the famous medieval Nuremberg Old City Hall.

The third day starts with an invited lecture on “Prognostics and Health Management” by Chris Bailey, Univ. Greenwich. He will explain how the “rest-of-life” of a system under operation can be estimated. The following five papers will deal with thermal management, two with EMI and two with advanced cooling technologies.

Finally, in the afternoon session “Future Perspectives” there will be two invited papers:

- “New Semiconductor Technologies Challenge Package and System Setup”, Gerhard Miller, Infineon Technologies,
- “Future Power Device Possibility” Ichiro Omura, Univ. Kyushu.

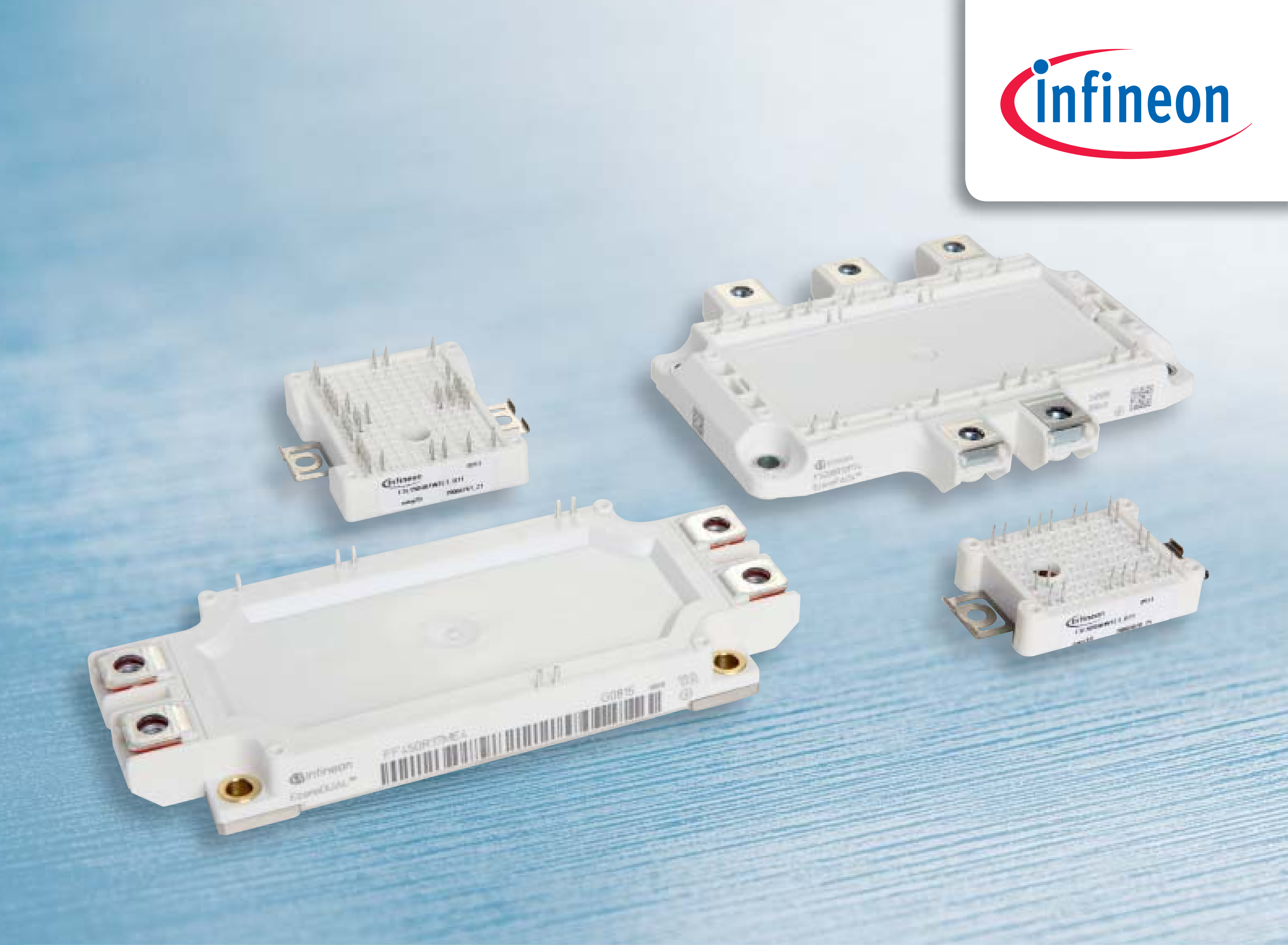
Finally, Alex Lidow (EPC) will present the second keynote on “Is it the End of the Road for Silicon in Power Management?” where he will discuss the perspective of GaN devices and systems.

In the closing session the best regular oral paper will receive the “ECPE Best Paper Award” as well as the best poster the “VDE ETG Best Poster Award”.

For companies and institutes there will be an opportunity to display results and demonstrators from current research in a tabletop exhibition.

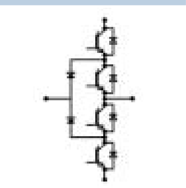
For further information please visit

www.cips-conference.de



High efficiency by 3-Level Topology

650V 3-Level-Modules with PressFIT-Technology



INFINEON'S NEW FAMILY of 3-Level Inverter modules offers significant advantages for designing highly efficient UPS and solar inverters.

THE THREE LEVEL INVERTER proves to be an attractive candidate for low and medium power low voltage applications which require high switching frequencies, complex filtering and high efficiency like double conversion UPS and solar inverters. Integrating all elements of a phase leg into one module optimises stray inductance and handling efforts.

- 30A - 450A / 650V modules
- Low inductive design
- High reliability due to PressFIT
- Optimized thermal performance
- RoHS compliant

‘Megawatt’ Press-pack IGBT Product

Westcode Semiconductors Limited (An IXYS company) announced the expansion of its groundbreaking family of press-pack IGBTs. The new device has a voltage rating of 2.5kV and a current rating of 2250A. The compact package design gives the new device unrivalled ‘Megawatt’ power density, with the advantages of high reliability and efficiency. The unique hermetic ceramic package and internal construction provides double side cooling for the IGBTs, resulting insuperior thermal, power cycling and power ratings, when compared to alternative technologies.

The compact fully hermetic package design is mechanically compatible with cooling systems (including total immersion systems such as oil) currently employed for 3000A/4000A GTO thyristors; this feature allowing for either retrofitting or design continuation of existing systems. The high current rating allows the conversion of old bi-polar drives to state-of-the-art IGBT technology, without the need to replace the basic mechanical structure. Adopting a refurbishment approach to component obsolescence is both lower cost and environmentally friendly; as it reduces consumption of both materials and energy, when compared to replacement of the equipment.

The high power density of the device, and its unique mechanical construction, also make this device ideal for new designs; in green power applications such as converters for wind & wave power generation in the high ‘megawatt’ range. The high reliability and exceptional thermal ruggedness, are also well suited to the demands of high power converters in traction applications, both for light rail and main line applications such as high-speed emu (electrical multiple unit).

Part number T2250AB25E identifies the new device. Westcode also offers a full range of complementary products, such as fast diodes, coolers and clamps to allow for the successful implementation of new designs. As, in addition to the new device and complementary products, a full design and build power sub-assemblies service is also available.

For a data sheets please go to the Westcode website at:

www.westcode.com

Announcement & Call for Papers

Darnell's

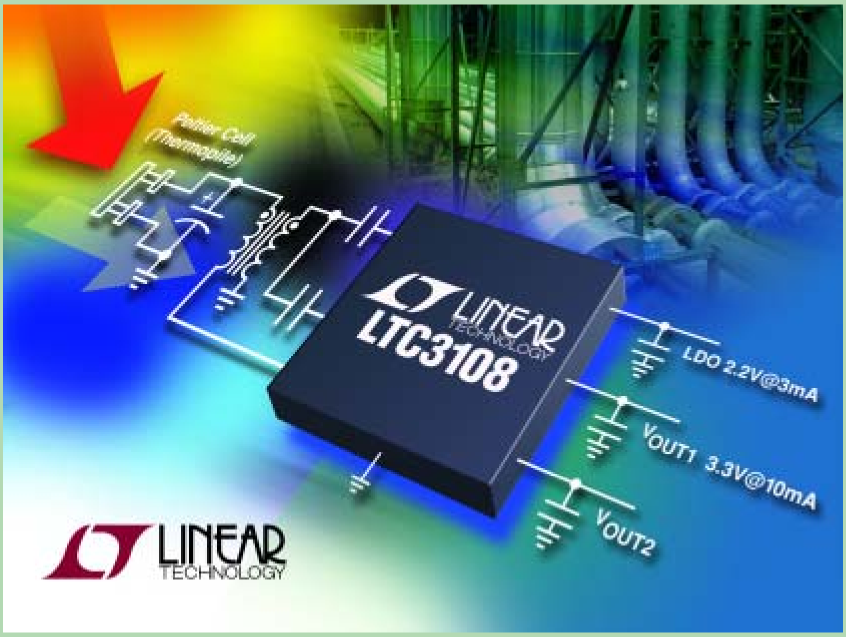
Digital Power Europe

April, 2010

dpfeurope.darnell.com

Ultralow Voltage 20mV Step-Up Converter & Power Manager for Energy Harvesting Applications

Linear Technology announces the LTC3108, a highly integrated step-up DC/DC converter designed to start-up and run from extremely low input voltage sources such as thermoelectric generators (TEGs), thermopiles and small solar cells. Its self-resonant topology steps up from input voltages as low as 20mV. Small temperature differences can be harvested and used to generate system power instead of traditional battery power. Energy harvesters are designed for applications requiring very low average power, but require periodic pulses of higher load current. For example, in many wireless sensor applications the circuitry is only powered to take measurements and transmit data periodically at low duty cycle.



The LTC3108 uses a small standard step-up transformer to provide a complete power management solution. Its 2.2V LDO can power an external microcontroller, while its main output is pin selectable to one of four (2.35V, 3.3V, 4.1V or 5V) fixed voltages to power a wireless transmitter or sensors. A second switched output can be enabled by the host in order to power devices that do not have a micropower shutdown capability. The addition of a storage capacitor provides continuous power even when the input energy source is unavailable. The LTC3108's extremely low quiescent current (<6µA) and high efficiency design ensure the fastest possible charge times for the output reservoir capacitor. The combination of the LTC3108's 3mm x 4mm DFN package (or SSOP-16) and very small external components ensure a highly compact solution for energy harvesting applications.

The LTC3108EDE's in a 3mm x 4mm DFN package and the LTC3108EGN is available in a SSOP-16 package. Industrial temperature grade versions, the LTC3108IDE and LTC3108IGN, are also available. All versions are available from stock.

Summary of Features: LTC3108

- Operates from a 20mV Input
- Complete Energy Harvesting Power Management System
- Selectable VOUT of 2.35V, 3.3V, 4.1V or 5V
- LDO: 2.2V at 3mA
- Logic Controlled Switched Output
- Reserve Energy Output
- Power Good Indicator
- Ultralow IQ: 6µA
- Uses Standard Compact Step-Up Transformer
- Small 12-Lead (3mm × 4mm) DFN or 16-Lead SSOP Packages

About Linear Technology

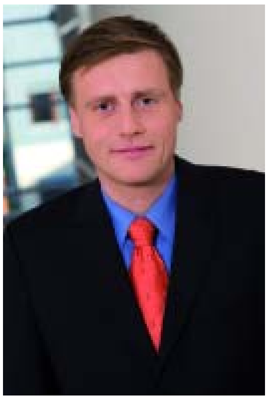
Linear Technology Corporation, a manufacturer of high performance linear integrated circuits, was founded in 1981, became a public company in 1986 and joined the S&P 500 index of major public companies in 2000. Linear Technology products include high performance amplifiers, comparators, voltage references, monolithic filters, linear regulators, DC-DC converters, battery chargers, data converters, communications interface circuits, RF signal conditioning circuits, µModule® products, and many other analog functions. Applications for Linear Technology's high performance circuits include telecommunications, cellular telephones, networking products such as optical switches, notebook and desktop computers, computer peripherals, video/multimedia, industrial instrumentation, security monitoring devices, high-end consumer products such as digital cameras and MP3 players, complex medical devices, automotive electronics, factory automation, process control, and military and space systems.

For more information, visit

www.linear.com

Efficient Energy Utilization Will Represent the Greatest Energy Resource in the Future; Strategy for the Electrification of Drivetrains from a Semiconductor Perspective

By Jochen Hanebeck, President of the Automotive division at Infineon Technologies



The manifold activities around the globe show that e-mobility is not just another hype. The question is not, if the electric vehicle (EV) will come, but rather when the "tipping point" will be reached. The challenges to be addressed for making the EV ready for mass market adoption include costs, mileage, availability of charging infrastructure and suitable business concepts.

What is the contribution of the semiconductor industry?

Costs and mileage are among the biggest hurdles to mass acceptance. The battery is always mentioned as the "weakest" part. Today you have to pay several hundred Euros per kWh power storage capacity. The costs of a battery of about 25 kWh alone are in the range of the price of a compact car. In addition, it makes a big difference in the car's total cost of ownership if you have to replace the battery after a couple of years or if the battery lasts for the whole life time of the car. A Lithium Ion battery consists of about 50 to 150 cells in order to get a battery of 200V to 450V. The mismatch in the behavior of the different cells leads to a reduced amount of charging or discharging of the battery and this effect is increasing over life time.

By introducing a so-called cell supervising circuit for active balancing of the cells for charging and discharging Infineon is able to improve this behavior. The advantage is expected to be in a range of 10% to 15% of battery capacity. We also address two other important aspects of the battery: temperature and safety. The temperature profile is controlled by a smart battery management system, consisting of sensors, microcontroller and power semiconductors, to prevent the battery from increased aging. And we are working on safety concepts for the battery e.g. the main switch.

Another cost contributor is the effort for cooling the power electronics. In contrast to the control unit of the combustion engine, the one of the electric motor – the inverter – needs water cooling, which makes it more expensive. The effort for cooling can be trimmed down when we manage to reduce the losses of the power semiconductors. In addition, a smart integration of the control unit reduces conjunction and packaging effort.

Infineon offers appropriate semiconductors for the inverter, based on our wide product range of IGBTs for industrial and automotive applications. For electrified vehicles, we are currently using IGBTs with a power rating of up to 650V and 800A. In cases a greater power rating is required – this is a trend we observe – we revert to our experience in industrial drives where we offer products up to 6,500V and 3,600A. Depending on customer requirements, we offer the IGBTs as bare die or we are integrating 3 half bridges to a power module. It contains all power semiconductors needed to drive electric motors of up to 80kW. With dimensions of about 20cm x 10cm, the module allows a very compact design of the motor control. The module easily fits to the required water cooling.

We are also developing ICs with an appropriate feature set to drive and to control the IGBTs. E.g. the required galvanic isolation of the power and the control part is already on the chip. Our TriCore microcontrollers and the appropriate sensor ICs complete the offering to drive the motor.

With regards to infrastructure, there is a need for enough charging spots, a standardized plug and a communications interface between the car and the charging spot. For the charger (on-board or external) Infineon offers the appropriate chips: Power-MOSFETs, SiC diodes, microcontrollers and sensors.

Apart from the traditional business model, where you simply own a car, one option is similar to the mobile phone business where you buy mobility in form of mileage while the car is subsidized. Such a concept needs a car being online. This not only requires communications between the car and the infrastructure but also needs secure billing and GPS navigation. Infineon's semiconductors contribute to the hardware for such a business model: for example to localize the car, to communicate between car and the operator and to support secure billing.

No electric vehicle without semiconductors

The age of the electric vehicle definitely has started and will re-define the way we have been used to mobility – once the remaining challenges have been solved the way for mass market adoption has been further paved. Infineon combines the know-how of the worldwide number one in advanced power electronics and the second largest automotive semiconductor company worldwide, delivering innovative solutions for e-mobility. We serve our customers with technologically leading products in many areas: electric drive and control, battery management, on-board charging and communications.

With energy efficiency being one of Infineon's major focus areas, together with communications and security, we are an ideal partner for the electric vehicle value chain to enable sustainable e-mobility.

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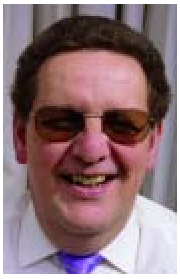
Electronics Industry Digest

By Aubrey Dunford, Europartners



GENERAL

The worst seems to be over, so the ZVEI. The German electronic components industry is forecast to grow by 6 percent to approximately € 13 billion in 2010. However, the industry will be suffering a 22 percent decline this year to € 12.3 billion, due to the global economic recession.

SEMICONDUCTORS

Worldwide sales of semiconductors in Q3 were $ 61.9 billion, an increase of 19.7 percent from the prior quarter, so the SIA. Third-quarter sales were 10.1 percent lower than the $ 68.9 billion reported for the like period of 2008. September 2009 sales were $ 20.1 billion, an increase of 8.2 percent from August 2009. Measured in Euro, European semiconductor sales of € 1,829 billion in September 2009 were up 7.2 percent on the previous month and down 21.3 percent versus the same month a year ago. The SIA also forecasts worldwide sales of $ 219.7 billion for 2009, a decline of 11.6 percent from 2008. The forecast projects that sales will grow by 10.2 percent to $ 242.1 billion in 2010.

The top 20 semiconductor companies, in total, registered a Q309/Q209 sales increase of 19 percent, so IC Insights.

Prices for most major categories of electronic parts tracked by iSuppli rose in the third quarter compared to the second. Lead times in the third quarter also increased for analog parts, capacitors, standard logic ICs, discretes, filters, crystals, oscillators, connectors, resistors, magnetics and most memory devices. Global semiconductor revenue is set to rise by 13.8 percent in 2010, following a 16.5 percent contraction in 2009, so iSuppli.

To strengthen cost competitiveness in semiconductor production, NEC Electronics announced plans to realign its assembly and test facilities and to consolidate its 5-inch wafer lines in Japan. NEC Electronics, Renesas Technology, NEC, Hitachi and Mitsubishi Electric have also announced changes concerning the capital injection plan to integrate business operations at NEC Electronics and Renesas. After the capital injection, NEC will be the top shareholder in the merged firm with a 33.97 percent stake, followed by Hitachi with 30.62 percent and Mitsubishi Electric with 25.05 percent.

Atreg, the semiconductor division of Colliers International, announced their formal appointment as advisor to Freescale Semiconductor, in the sale of two of Freescale's operational 150mm semiconductor manufacturing facilities. The automotive qualified analog fab offerings are located in Toulouse, France and Sendai, Japan. Production capacities range from 40,000 to 50,000 wafers per month.

Microsemi, a manufacturer of analog mixed signal and high reliability semiconductors, announced consolidation plans that will result in the closure of its manufacturing facility in Scottsdale, Arizona by April 2011. Microsemi expects that after the consolidation activities are completed in 18 months, annual savings benefiting operating income will range from$ 20 M to$ 25 M.

Applied Materials opened an advanced solar research and demonstration facility in Xi'an, China. Applied Materials' Solar Technology Center is the largest non-government solar energy research facility in the world. Applied first broke ground in Xi'an in 2006 and the total investment in the multi-phase project is more than $ 250 M..

OPTOELECTRONICS

September 2009 shipments of large-area TFT LCD panels reached 52 million units, up 2 percent M/M and 25 percent Y/Y, so DisplaySearch. Large-area TFT LCD revenues reached $ 6.8 billion, up 6 percent M/M and 15 percent Y/Y. For the second consecutive quarter, Q3'09 improved significantly by all metrics. Specifically, average industry utilization rose to 88 percent. In Q3'09 most TFT LCD makers were profitable, with some reaching profit margins as high as 15 percent.

PASSIVE COMPONENTS

The components business of TDK and EPCOS will now be handled by a new company under the new corporate identity mark TDK-EPC. The established product brands, EPCOS and TDK will continue to be used.

AVX and Cabot announced the resolution of all outstanding litigation between the parties relating to the supply of tantalum by Cabot to AVX. The terms of the settlement are confidential. .

OTHER COMPONENTS

EnerSys will acquire the industrial battery businesses of the Swiss company Accu Holding, which operate under the name Oerlikon Battery, has revenues in excess of $ 50 M per year.

DISTRIBUTION

European distribution billings in Q309 improved by 3 percent, when compared to the previous quarter but declined by 20 percent compared to Q308, so the International Distribution of Electronics Association (IDEA).

Avnet reported revenue of $ 4.36 billion for the first quarter fiscal 2010 ended October 3, 2009, representing a decrease of 3.1 percent over the first quarter fiscal 2009.

RS Components also announced a further round of price reductions on electronics products in its October catalogue launches. Reductions have been made on over 50,000 electronics components to coincide with the publication of the new RS catalogue in the UK, France, Germany, Austria, Spain and Italy. Reduction levels are as high as 70 percent. The distributor has also added a further 2,300 products from Molex to its connectors portfolio. The new introductions expand the number of Molex products available from RS to over 3,500 parts. RS Components also announced the addition of over 900 new devices into its range from Fairchild Semiconductor.

Rutronik and Osram Opto Semiconductors are extending their partnership to include the United Kingdom, Ireland, Denmark, Finland, Norway and Sweden.

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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Disruptive Power Architectures and Photovoltiac Installations

By Richard Ruiz, Analyst, Darnell Group

The emergence of disruptive power architectures including microinverters and dc-dc converters will be one of the most important trends in the photovoltaic (PV) market in the near-term. The accelerating worldwide growth in grid-tied PV will be driven by a number of factors including: improved technology, cost reductions, strong deployment incentives, growing consumer interests, renewable portfolio standards, climate change concerns, and a host of other policy mandates.

The number of relatively large PV projects feeding power directly to the grid will increase, but most systems will be deployed in behind-the-meter applications, where the technology competes with the retail rate of delivered electricity rather than the wholesale cost of energy supplied by central-station generating plants. In fact, worldwide PV sales have surpassed $10 billion annually and total installed PV capacity is projected to exceed 25 GW by 2011.

As a result of the growing demand for PV, the outlook for inverters used in PV systems is expected to remain strong. There are a large number of PV system configurations available and a wide range of inverters on the market. Some models use transformers and some are transformerless, and many come with sophisticated communications and monitoring systems.

Regardless of the type of inverter used, the system is usually configured in traditional central inverter architecture. Since the PV industry is constantly evolving, inverter manufacturers must continually design new products.

Despite the ubiquitous nature of the central inverter system, it has a number of limitations. It relies on one device (the inverter) that when faulty, brings down the entire system, and its inherent design means the weakest panel in each string eliminates the benefits of the better performing PV panels. (The “weakest link” module determines the string current and has a disproportionate impact on overall PV system performance.)

This latter point is especially important because PV systems are constantly exposed to the elements and that means one or more panels over the lifetime of the system will be covered by debris, dust or another form of shading. In fact, some panels may fail or weaken as a result of age or simply lose power due to panel mismatch.

The shortcomings inherent in the central inverter architecture are expected to provide a host of opportunities for several new technologies. In fact, there are a growing number of companies developing products and technology specifically designed to generate more power from the PV panels already on the market. A distributed inverter architecture using either of two specific disruptive technologies, microinverters or dc-dc solutions, are expected to present a significant challenge to the conventional central inverter architecture over the coming years.

A significant advantage both of these disruptive technologies have over traditional central inverter technology is the ability to perform maximum power point tracking (MPPT) at the panel level. The goal of the MPPT algorithm is to extract the greatest power available from the solar array. (The better the MPPT algorithm, the greater the power output.) Due to variation in shading, dirt, and aging of solar panels, individual panel voltages will vary, causing the output voltages of strings of panels to vary.

In addition to improvements in efficiency, the ability to reconfigure PV arrays without additional complex string calculations and improved operational flexibility, another opportunity for both microinverter and dc-dc solutions is the further development and availability of communications systems for both commercial and residential PV systems. Manufacturers of disruptive technologies such as microinverters and dc-dc solutions have picked up on this trend and are incorporating them into their respective systems.

Challenges and opportunities relating to distributed PV integration will be strongly influenced by the current and future attributes of PV and balance-of-system technologies. Among the more promising is the development of the building-integrated PV (BIPV) systems.

A building-integrated PV system involves integrating photovoltaic modules into the building envelope material and power generators. Evidence of this opportunity can be seen in the number of successful BIPV projects worldwide, ranging from individual residential units to large commercial developments.

The demand for technology to address the problem of PV shading is another area of opportunity for both microinverters and dc-dc solutions. Due to the nature of solar array configuration, small amounts of shade (for example, shading of less than 10 % of the surface area of a PV system) can lead to disproportionate power losses of more than 50%.

One completely shaded cell can reduce a solar panel’s output by as much as 75%, and three shaded cells can decrease 93% of the panel’s output. Common causes of shade include structural objects such as trees, chimneys and dormers, and intermittent debris including falling leaves, bird droppings, dust and clouds passing overhead, which is an unavoidable challenge that cannot be engineered out of an installation.

In an effort to promote the use of disruptive technologies such s microinverters and dc-dc solutions, a number of microinverter and dc-dc solutions manufacturers have adopted a strategy of partnerships and alliances within the industry. In fact, a number of solar suppliers and utilities have made either alliances or acquisitions of distributed electronics vendors in what is clearly a validation of the potential for both of these new disruptive technologies.

The Darnell Group expects that the trend towards business partnerships and alliances between manufacturers of disruptive technology and established PV distributors, manufacturers and distributors will continue to grow as the technology becomes more established.

An inverter is the most critical electronic component in any PV photovoltaic system. Among the challenges facing inverter manufacturers are maintenance issues, since in a PV system, the inverter is the component with moving parts.

In order to compete with the traditional inverter architecture, end users of both microinverters and dc-dc solutions must be assured that the products they use will come with warranties comparable to traditional solutions. Manufacturers of products considered to be disruptive technology, such as microinverters and dc-dc solutions, realize this and offer a range of warranty options.

The market forces affecting the traditional PV inverter industry also apply to the disruptive technologies presented in this report. Especially important are interconnection and regulatory standards.

Despite the efforts of a number of government and regulatory bodies worldwide, the goal of achieving agreement in both is still a work in progress. However, there are a number of groups working on electrical interconnection standards with the objective of reducing or removing barriers between distributed generation technology and the utility grid.

A survey done found that most projects, including PV, meet some sort of resistance from the utility companies when they try to interconnect with the grid. The expensive and sometimes difficult interconnection requirements currently in place worldwide comprise a key barrier to the increased use of alternative systems.

One of the more interesting technologies being developed to drive interconnection is the development of a “smart grid.” However, removing current interconnection requirements is not as simple as changing policies, and a method of resolving these barriers is ongoing.

Among the areas covered in our latest analysis are the technology, architecture and packaging trends affecting the industry, as well as a thorough discussion of new and emerging technologies and materials, applications, potential threats and the latest regulatory developments and standards.

Over 25 illustrations are presented depicting a variety of inverter system architectures, schematics and comparisons, technologies, product introductions, packaging solutions, efficiency standards and other relevant information. The focus of this comprehensive analysis provides decision makers with a detailed and insightful look into the current and future opportunities and threats available in the disruptive technology area of microinverters and dc-dc solutions.

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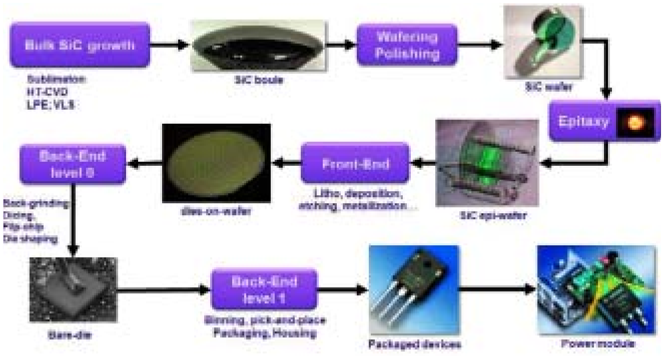
How SiC will Impact Electronics: A 10 Years Projection

Power electronic industry is still waiting for a SiC transistor: Yole Développement expects its release in 2010.

Yole Développement updated its new markets & technological study dedicated to silicon carbide industry. Yole's report details major market metrics of the current and projected SiC device and substrate business, describing the targeted applications, the key players, the supply-chain, the volumes and related market size of each segment. It gives the possible total accessible market for SiC electronics, highlighting the strengths and weaknesses of this technology over the current established silicon technologies. It describes the recent progress of device technologies as well as the new challenges offered by 4" and 6" substrates.

This $2.6B total accessible market is part of the overall $12B Si-based power discrete busi-ness (2008). Today the largest applications in potential revenue remain Power Supply PFC, UPS and Motor AC drives. Tomorrow, EV/HEV and inverters for PV installations will take the lead exhibiting higher CAGR (>15%/year).



SiC challenges a $2.6B silicon device market

However, cost issues slow-down SiC penetration and Yole Développement only forecasts approximately 4% of the overall Silicon-based power discrete market to be displaced by SiC in 2019.

"Low-Voltage applications (< 1.2kV) are representing over 99% of today SiC device sales but Yole Développement anticipates a huge increase of Medium-Voltage applications (1.2kV-1.7kV) in the next 2 years" says Dr Philippe Roussel, Project Manager at Yole Développement. High-Voltage apps will slowly appear from 2013-2014 along with technology improvement and cost reduction.

The entrance of SiC in the promising EV/HEV field has been postponed to 2014 as no switch has reached large volume production yet and car makers are still improving silicon IGBT technology. Moreover, most of the current or new entrant EV/HEV manufacturers are working on both GaN and SiC for their next-gen inverters and no choice has been validated yet.

In the 600-1200 V range, promising GaN technologies might threaten SiC. However, SiC industry maturity should protect it from frontal competition at least for the 2 next years.

4" is in full-production and 6" is in the starting blocks

The total SiC substrate merchant market, including both n-type and S.I. has reached roughly $48M in 2008. According to Yole Développement's analysis, it is expected to exceed $300M in a decade.

CREE stays ahead of the competition, but its relative market share on the open market is shrinking as II-VI, SiCrystal and several new entrants are gaining momentum in the sub-strate battle.

Yole Développement saw the emergence of a new entrant in SiC substrates in 2008: N-Crystals (Russia) who is manufacturing and marketing 2" and 3" SiC substrates 4H & 6H in both S.I. or n-type doping.

Early 2009, another Chinese company, TankeBlue, announced impressive progress on scale-up production of 3" SiC wafers, exhibiting micropipe density < 10/cm². "This let us think that Chinese companies are becoming more and more present on the market place proposing products with state-of-the-art specs and competitive pricing", explained Dr Rous-sel.

Yole Développement assesses that the technical gap between yesterday's leaders and today's challengers is decreasing day by day.

4" wafers are now at full-production at CREE and in final qualification phase at II-VI, Dow Corning and Nippon Steel. 6" is already announced by 2010. 150 mm wafers will definitely accelerate the cost reduction of SiC device manufacturing.

If no transistor, no bright future for SiC business

Transistor availability is the key condition to envision significant market growth. According to recent announcements from CREE, Semi-South, TranSiC, Rohm or Mitsubishi, Yole Développement remains confident that 2010 will see first commercial volume offers in MOSFET, J-FET or BJT.

Once this condition is met, the SiC device industry will have to cut the cost to fit with client expectations. 2 parameters will have to be improved:

SiC substrate $/mm² cost

SiC device manufacturing cost and yield, with a particular emphasis on epitaxy process.

The adoption of the SiC technology will also have to go through the severe qualification process of the industry (especially in the automotive sector). There, progress on reliability and robustness must fit the current silicon standards.

If all conditions are passed, then Yole Développement can forecast $800M market size for SiC devices in a decade from now.

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

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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.

Author

Dr Philippe Roussel holds a Ph-D in Integrated Electronics Systems from the National Insti-tute of Applied Sciences (INSA) in LYON. He joined Yole Développement in 1998 and is leading the Compound Semiconductors and Power Electronics techno-economical market analysis department.

SiC 2010 Report

Catalogue price: Euros 3,990
Publication date: October 2009
For special offers and price in dollars, please contact David Jourdan (jourdan@yole.fr or +33 472 83 01 90).
Other publications dedicated to the Compound Semiconductors Industry

Bulk GaN Market: detailed major market metrics of the current and projected bulk / free-standing GaN substrate business, describing the targeted applications, the key players, the volumes and related market size of each segment.
UV LED Market: detailed major market metrics of the current traditional UV lamp business. It gives the possible total accessible market for UV LED, highlighting the strengths and weaknesses of this technology over the current established products. It describes the recent progress in AlN single-crystal substrates as well as the UV LED performance roadmap.

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Power Conversion Enters a New Era

Knowledge is power. (Sir Francis Bacon)

Although Sir Francis might not have envisioned modern electrical power conversion in its current form, his famous 1597 quote comes very close to describing the new era of power conversion: intelligent power. While William Gilbert was playing around with static electricity in the same locale and period of time that Bacon was articulating his scientific method, I suspect that neither could have imagined the self optimizing power conversion systems that we have today.

By Chris Young, Intersil Zilker Labs

Surely early man observed electricity, whether in the benign form of simple static electricity or in the destructive form of lightning, and wished he could somehow harness that power and control it. Today, we not only know how to generate electricity but how to convert it to useful forms. But, generation and conversion are not enough. We are learning that we do not have an unlimited supply of electricity nor do we have an unlimited supply of other resources such as power supply engineers' time. We need more than just power, we need "intelligent power."

Intelligent Power Defined

In the generalized sense, intelligence can be considered to be the ability to adapt to one's environment. Interesting (non-trivial) environments tend to be dynamic, that is, non-static. As the environment changes, intelligent systems adapt to the changes. In this adaptation, there is typically some notion of a "cost" function that is observed and optimized as a means for steering the adaptation. Adaptation can cease when the environment stops changing and the cost function is optimized to an acceptable point.

When the weather turns cold, an intelligent person will turn up the temperature on their heating appliance or put on more clothes (adapt) until their level of discomfort (cost function) is minimized. A non-intelligent person will simply sit and get cold.

Thus, intelligence has three key elements: environment, cost function, and adaptation.

In terms of power conversion, the environment includes things like temperature, component values, input voltage and quality, and output loading. Cost functions include things like loss or efficiency, ripple, stability, noise, component temperature, pole or zero location. Adaptation includes things like changing the relative timing of switching, adjusting voltage or current levels, changing compensation, changing the switching frequency.

When the load increases, an intelligent power controller will adjust (adapt) the deadtime between switching actions to minimize losses (cost function). A non-intelligent power supply will simply sit and get hot.

Levels of Intelligence

As we know, intelligence is a rather relative measure. The standardized IQ test measures intelligence relative to the average of the population and sets the average value (by definition) to be 100. Since animals have a hard time taking standardized IQ tests, it is difficult to judge their IQ relative to the average human population. It is an even harder job to judge the intelligence of a machine relative to the average of the human population. (Most simply sit there doing nothing while the test is administered.)

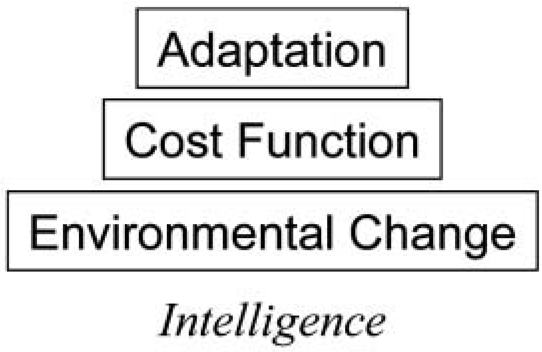

Figure 0: Key Elements

Given our definition above, we can determine, at least on a qualitative level, the relative intelligence of power controllers within their own species by how they adapt to environmental changes.

Unregulated controllers are the least intelligent of the controllers. Any adaptations to environmental changes are incidental. As an example, if the load impedance drops, the current changes only as according to Ohm's law and is defined by the impedance of the conversion system. This is something akin to the intelligence of a rock. When you drop a rock, it does not float off into space or fall when it decides to, it drops according to the law of gravity.

Feedback was introduced to power supplies to increase their intelligence, that is, to improve their ability to respond to changes in the environment. If the load impedance drops, the feedback network senses a change in the output voltage and adjusts the operation of the conversion circuitry to adapt to this environmental change. This level of intelligence, though greater than that of a rock, is still limited. For example, the feedback is designed for a point or narrow range of operating conditions assuming given values of components. The feedback design is single valued. That is, the feedback parameters do not change. The parameters must be selected to give acceptable results over the entire operating range. Because of this constraint, a power supply designer may spend a considerable amount of time adjusting parameters to satisfy the operational specification over the entire range of operation.

As the years have progressed, so has the intelligence of power controllers. Small improvements to the intelligence evolved with the addition of feedforward control, current feedback, and temperature correction. For many of these, a cost function can readily be identified and so categorized as true adaptation.

In this new era of power supplies, embedded microcontrollers are providing an entirely new level of intelligence. No longer are controllers limited to fixed or narrowly constrained parameters. The parameters can be easily changed from design to design, during operation, and even changed intelligently by the controller. Numerous cost functions can be tracked (like loss, temperature, noise, etc.) and the operation adapted based on these cost functions as the environmental conditions change.

As an example of the intelligence in the best of today's controllers, the relative loss during the power conversion process is monitored as a cost function. As environmental conditions change and losses are no longer minimal, the power controller adjusts to minimize the loss.

In the case of lesser intelligent power controllers, as environmental conditions change that impact the efficiency, for example, they simply sit there and run inefficiently, relatively speaking.

Facilitating Intelligence

Rivaling the computing power and memory of many of the early personal computers, today's newest power controllers are really systems on a chip (SOC). Figure 1 illustrates such a system from Intersil Zilker Labs.

Sensor processors collect information on input voltage, output voltage, output current, internal and external temperatures, switching frequency and phase of other power supplies, fault status, and even losses. This information is used by sophisticated algorithms running in the microcontroller which construct cost functions which are then used to adapt the behavior of the power supply as the environment changes.

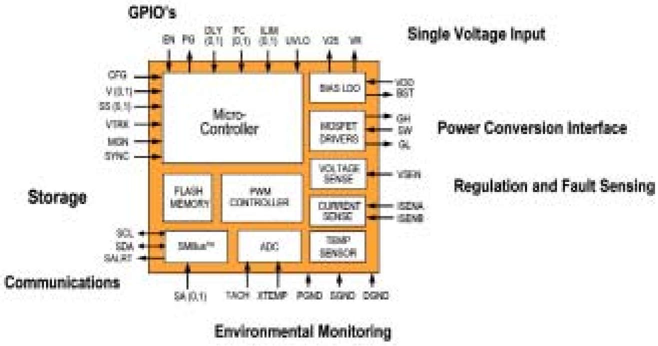

Figure 1: System on a Chip (SOC) Power Controller

Early attempts at these more intelligent power controllers tried to use expensive digital signal processors or DSP's to do the power conversion operations but manufacturers and customers soon learned that this was overkill. This was like putting the brain of whale in the head of a chicken…simply way more than what is needed. Instead, the best designs today use dedicated function state machines to handle the mundane operations of power conversion and use the microcontroller to adapt the power conversion as the environment changes.

Nonvolatile memory is used in the most intelligent of the controllers to store various categories of information including algorithms, parameters, and telemetry. Without nonvolatile memory the controller soon forgets this important information when power is removed. An additional requirement for the memory storage is error checking. The information stored and retrieved must be free from error or distortion.

The brain of the intelligent power controller, as mentioned above, is a microcontroller. In the ZL6105, auto-compensating, adaptive dc power controller from Intersil Zilker Labs, an 8 bit, 8Mhz, RISC based microcontroller is used. Coupled with 32 kilobytes of nonvolatile memory, this microcontroller adapts the power conversion process according to both deterministic and adaptive algorithms to deliver performance that greatly exceeds conventional power controllers and many other "digital" power controllers as well.

Finally, a communication interface rounds out the facilities of an intelligent controller. The ability to communicate with its peers and with the systems further enhances its ability to sense environmental changes, construct cost functions, and adapt to the changes. One of the most popular communication interfaces for these intelligent power controllers is based on SMBus hardware and uses PMBus as the protocol/language.

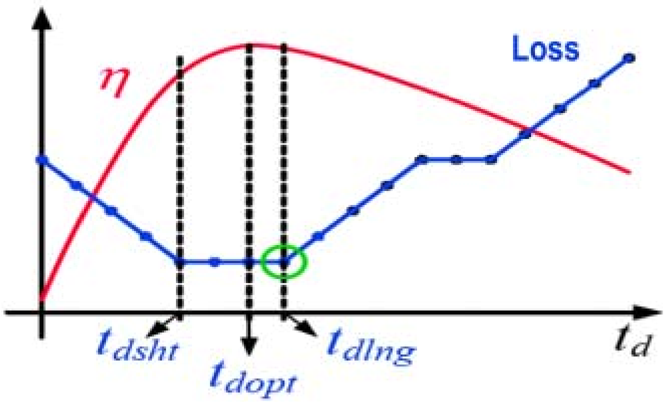

Figure 3: Efficiency Optimization by Deadtime Control

As Sr Francis Bacon said, knowledge is power. The more knowledge that a controller can collect and process about its environment, the better it is in processing quality electrical power. The architecture described above optimizes, in economic terms, knowledge gathering, processing, and adaptation.

Intelligence in Action

Let's examine a couple of examples of intelligent control in power conversion. In the first example, we have an efficiency optimizing algorithm and in the second, we have a means for automatically compensating a power supply.

There are a number of parameters that can be "tuned" to optimize the performance of a power supply including: switching frequency, ripple current, on-time of the synchronous rectifier, and relative timing between the two otherwise complimentary timed switches. In the later case, the relative timing is characterized by what is called deadtime. In a synchronous buck regulator, the deadtime is the time between, for example, the turning off of the high side switch and the

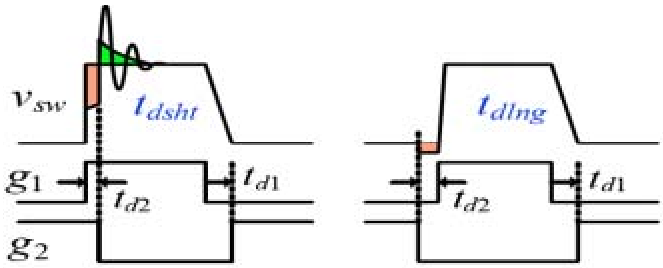

Figure 2: Deadtime Control. Short deadtime (left) and long deadtime (right)

turning on of the low side switch. More accurately, it is the time from the command for the high side switch to turn off and the command for the low side switch to turn on.

Deadtime is illustrated in Figure 2 which illustrates the relative timing of the high side gate drive, g1, and the low side gate drive g2. If the deadtime is too short, the conduction times of the two switches overlap and cross conduction occurs. If the deadtime is too long, body diode conduction occurs. Both conditions result in higher than optimal losses.

There are actually two requirements regarding deadtime control. The first requirement is to prevent cross conduction which, besides being less efficient, leads to high noise, high currents, and in many cases a shortened switch life. The second requirement is to optimize the deadtime to minimize the losses.

In the earliest of controllers, the deadtime was a fixed value. It was soon discovered that this was less than ideal for many reasons. The value of the optimal deadtime depends on the characteristics of the switches themselves (which can vary considerably from switch to switch), the junction temperature, and the current passing through the switches during commutation. A fixed value for deadtime can only be made safe, that is set long enough so that cross conduction never occurs but cannot be made optimal in the sense of loss reduction, in general. In terms of intelligent behavior, if the environmental conditions changed, requiring different values of deadtime setting, these controllers would simply sit there and be unresponsive.

Next, controllers were designed to observe the switch node voltage and not allow the low side switch to turn on until the voltage had fallen to a sufficient value. Although this protected against cross conduction by ensuring that the high side switch had turned off, it did little to optimize the body diode conduction period. For example, if the low side switch has a significant turn-on delay, then, optimally, the low side switch would need to be commanded to be turned on before the collapse of the switch node voltage. Again, such techniques can ensure that cross conduction does not occur but they are not intelligent enough to ensure optimal efficiency.

Over the last several years, new intelligent power controllers have been introduced which actually measure losses and based upon the measured loss, optimizes the deadtime settings. This optimization is illustrated in Figure 3.

Here, the horizontal axis represents deadtime. If the deadtime is initially too long (relative to optimal) and a small increase in deadtime is commanded, the losses will be observed to increase. An algorithm, running in the microcontroller, can detect this increase in loss and command a reduction in deadtime.

As the deadtime is reduced, the body conduction is reduced thereby reducing the losses. The algorithm will continue to reduce the deadtime with a subsequent reduction in loss until a reduction in deadtime actually results in an increase in loss due to an approach to cross conduction. Although full cross conduction does not occur, full commutation of the switch has not been achieved before current conducts through the complementary switch. In this case, the algorithm will increase the deadtime to move to a state with less loss. The algorithm will continue to “hover” in the area of optimal deadtime indicated by lowest losses and, therefore highest efficiency.

This algorithm, as implemented in Intersil Zilker Labs’ ZL6105, adjusts as the load changes, as the temperature changes, and even as parts age. It also optimizes in light of component to component variations associated with manufacturing processes.

By observing loss in this manner, other optimization schemes can be implemented. For example, optimal switching frequency can be determined by adaptively adjusting the switching frequency and balancing between switching losses and conduction losses.

These intelligent controllers provide optimal performance from the given components under all environmental conditions and actually outperform other controllers that lack this level of intelligence. If you were to take two switches, an inductor, and several capacitors arranged as a switching power supply and measured the efficiency using a conventional power controller and then took the same measurements with an intelligent controller, the intelligent controller is likely to give a higher efficiency as the environmental conditions are changed.

Another example of intelligent control is in the area of compensation. Compensating a power supply to be stable over all conditions has long been the bane of power supply designers. Even if a designer could compensate a supply in the lab, component variations during manufacturing would often lead to greatly reduced stability in practice. As such, wide stability margins have been the rule of thumb for years.

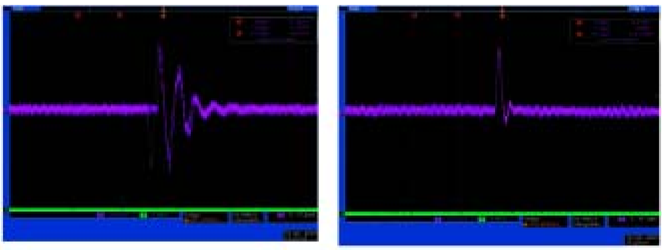

Figure 4: Automatic Compensation (right) and Manual Compensation (left)

Intersil Zilker Labs ZL6105 comes to the rescue with automatic compensation. This intelligent controller contains an algorithm which monitors small variations (cost function) in the output and adjusts the compensation based on these observations. It has two modes of operation: optimize on command and periodic optimization. In the former mode, the user can command the part to compensate and it will automatically compensate for a given plant (switches, inductor, capacitors, etc.) and environmental conditions. In the latter mode, the part automatically compensates and updates the compensation periodically to account for environmental changes.

Figure 4 shows the before and after transient waveforms for a power supply that was, first, manually compensated and then automatically compensated. The manual compensation took thousands of times longer to complete than the automatic compensation. The automatic compensation can be done as an in-circuit-test at the time the power supply is manufactured without the intervention of a power supply designer.

In the periodic compensation mode, as the environment changes, the compensation is automatically adjusted to maintain stability. Contrast this to less intelligent power controllers which once they are compensated, simply sit there seemingly unaware that the environment is changing and may eventually go unstable.

Conclusion

Power conversion is enjoying a new era in terms of intelligent power supplies. This new era comes along at the perfect time. The environment is changing for power supply designers: there are fewer designers, more challenging designs requiring higher densities and faster time-to-market, greater cost pressures, and higher performance targets. These new intelligent power controllers optimize performance so that the designer needs less time to optimize the design over all environmental conditions. With their high levels of integration they provide higher densities and higher performance with equivalent or even lower total cost of ownership.

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How Compact Fluorescent Lamps Work and How to Dim Them

Dimming function opens up a completely new family of CFL applications

Compact fluorescent lamps (CFLs) are replacing incandescent light bulbs at a rapid rate due to their tremendous energy savings and longer lifetime. Additional energy savings can be achieved by dimming but the electronic ballast required to control the lamp has a higher cost and is difficult to design. This article explains how a CFL works, how to dim them, and describes a solution for 3-way dimming applications.

By T. Ribarich, International Rectifier

Fluorescence vs. Incandescence
Incandescence is the conversion of heat to light which requires the filament inside an incandescent lamp to burn at a high temperature (350F). This conversion is very simple but the disadvantages are that only 5% of the total energy consumed by the lamp is used to generate light (95% is wasted as heat!) and the lifetime is limited to about 2,000 hours. Fluorescence is the conversion of UV light to visible light. Electrons flow through the fluorescent lamp and collide with mercury atoms causing photons of UV light to be released. The UV light is then converted into visible light as it passes through the phosphor coating on the inside of the glass tube. This two-stage conversion process is much more efficient than incandescent lamps resulting in 25% of the total energy consumed used to generate light, lower lamp temperatures (40C) and longer lifetime (10,000 hours). The lamp load itself is resistive, but the electronic ballast that is connected between the AC line voltage and the lamp for controlling the lamp current is a capacitive load. The complete CFL includes (Figure 1) the Edison screwbase and plastic housing, the electronic ballast, and the fluorescent lamp formed into a compact spiral shape.

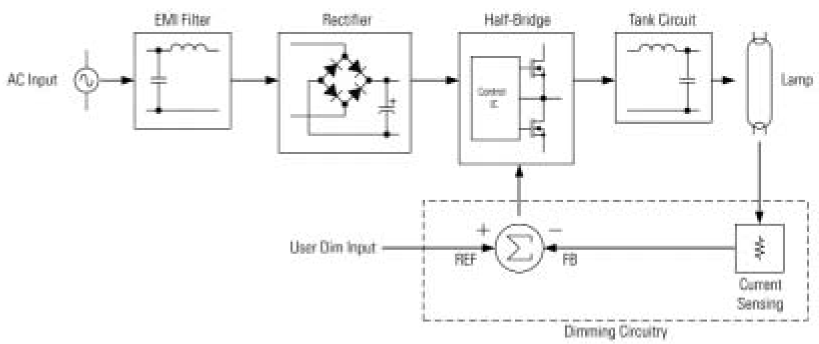


Figure 2: CFL electronic ballast block diagram

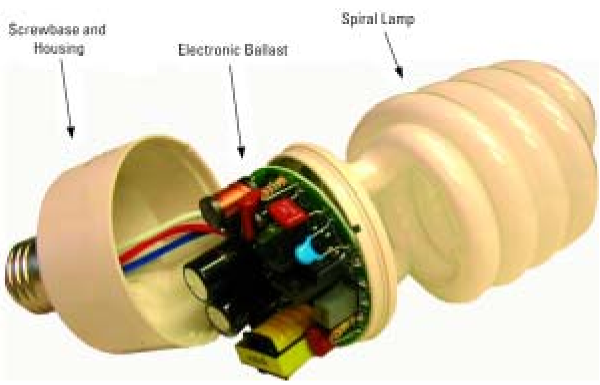


Figure 1: CFL components and assembly

CFL Operation
The electronic ballast circuit block diagram includes (Figure 2) the AC line input voltage (typically 120VAC/60Hz), an EMI filter to block circuit generated switching noise, a rectifier and smoothing capacitor, a control IC and half-bridge inverter for DC to AC conversion, and the resonant tank circuit to ignite and run the lamp. The additional circuit block required for dimming is also shown that includes a feedback circuit for controlling the lamp current.

The lamp requires a current to preheat the filaments, a high-voltage for ignition, and a high-frequency AC current during running. To fulfill these requirements, the electronic ballast circuit first performs a low-frequency AC-to-DC conversion at the input, followed by a high-frequency DC-to-AC conversion at the output. The AC mains voltage is full-wave rectified and then peak-charges a capacitor to produce a smooth DC bus voltage. The DC bus voltage is then converted into a high-frequency, 50% duty-cycle, AC square-wave voltage using a standard half-bridge switching circuit. The high-frequency AC square-wave voltage then drives the resonant tank circuit and becomes filtered to produce a sinusoidal current and voltage at the lamp.

During pre-ignition the resonant tank is a series-LC circuit with a high Q-factor. After ignition and during running the tank is a series-L, parallel-RC circuit, with a Q-factor somewhere between a high and low value depending on the lamp dimming level. When the CFL is first turned on, the control IC sweeps the half-bridge frequency from the maximum frequency down towards the resonance frequency of the high-Q ballast output stage. The lamp filaments are preheated as the frequency decreases and the lamp voltage and load current increase (Figure 3).

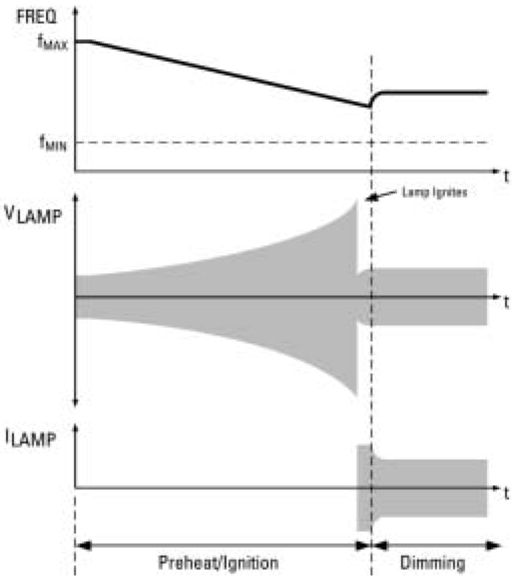


Figure 3: CFL operation timing diagram

The frequency keeps decreasing until the lamp voltage exceeds the lamp ignition voltage threshold and the lamp ignites. Once the lamp ignites, the lamp current is controlled such that the lamp runs at the desired power and brightness level.

To dim the fluorescent lamp, the frequency of the half-bridge is increased causing the gain of the resonant tank circuit to decrease

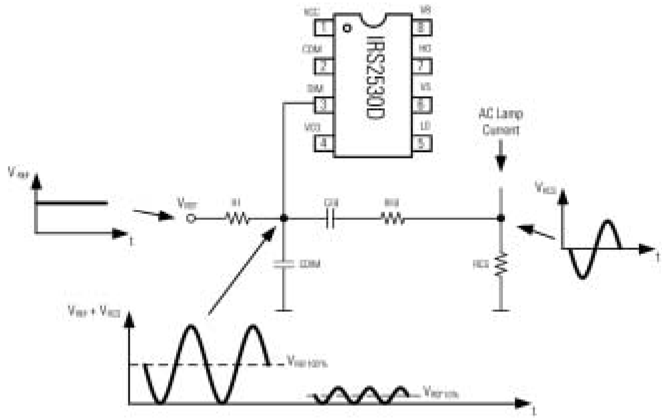


Figure 4: IRS2530D AC+DC dimming control method

and therefore lamp current to decrease. A closed-loop feedback circuit is then used to measure the lamp current and regulate the current to the dimming reference level by continuously adjusting the half-bridge operating frequency. The IRS2530D Dimming Control IC from International Rectifier includes such a feedback control circuit, as well as all of the necessary functions to preheat and ignite the lamp and to protect against fault conditions such as open filament failures, lamp non-strike and mains brown-out. The dimming function is realized by combining the AC lamp current measurement (Figure 4) with the DC reference voltage at a single node. The AC lamp current measurement across the sensing resistor RCS is coupled onto the DC dimming reference through a feedback capacitor CFB and resistor RFB.

The feedback circuit regulates the valley of the AC+DC signal to COM as the DC dimming level is increased or decreased by continuously adjusting the half-bridge frequency. This causes the amplitude of the lamp current to then increase or decrease for dimming. If the DC reference is increased, the valley of the AC+DC signal will increase above COM and the feedback circuit will decrease the frequency to increase the gain of the resonant tank. This will increase the lamp current, as well as the amplitude of the AC+DC signal at the DIM pin, until the valley reaches COM again. If the DC reference is decreased, the valley will decrease below COM. The feedback circuit will then increase the frequency to decrease the gain of the resonant tank until the valley reaches COM again.

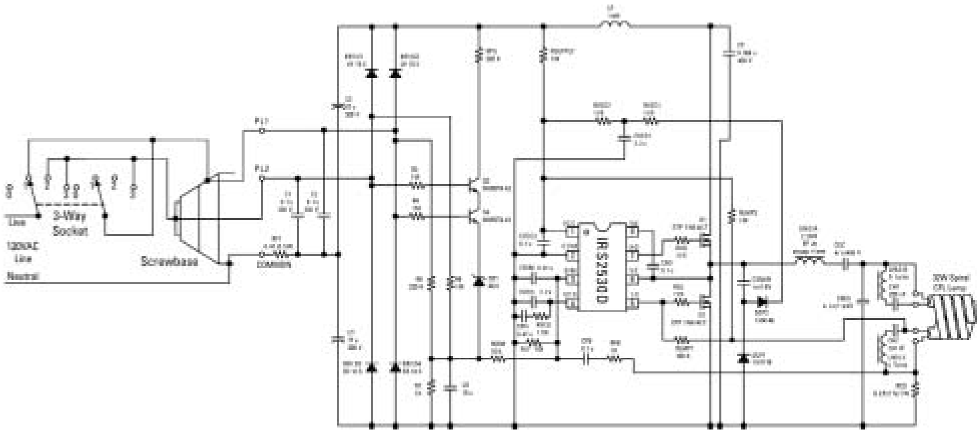


Figure 5: 3-way dimming CFL circuit schematic

3-Way Dimming

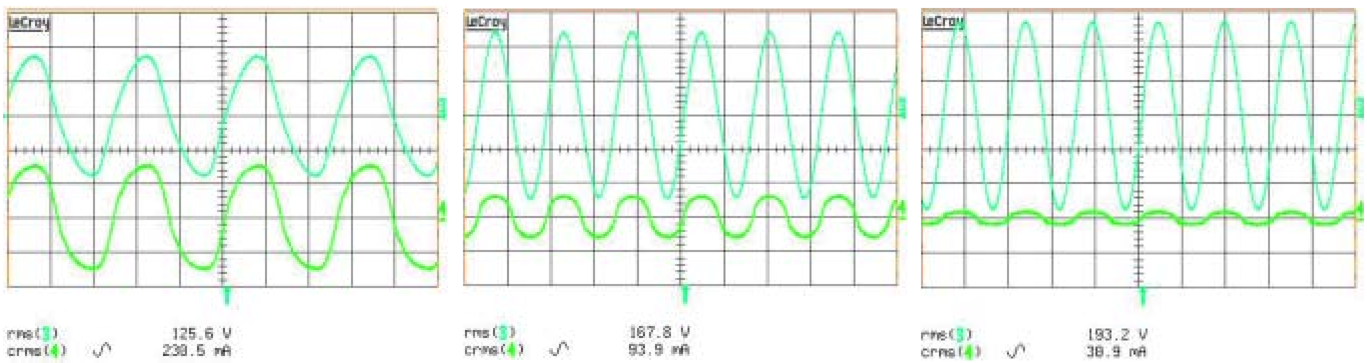
One popular dimming application is for 3-way lamp sockets. 3-way dimming incandescent lamps include two filaments and two connections on the lamp screw base. A 4-position socket is then used to switch between different filament connections to step through three dimming levels (Figure 5). The first socket switch position is the off setting where no filaments are connected, the second position connects the first filament across the AC line for the lowest brightness setting, the third position connects the second filament for the medium brightness setting, and the fourth position connects both filaments in parallel for the highest brightness setting. To achieve the equivalent functionality for a CFL, a dimming electronic ballast circuit is used to control the lamp current for each brightness level (Figure 5).

The circuit includes a rectifier and voltage doubler circuit at each input (D1, D2, D3, D4, C3 and C4), the half-bridge control circuit and MOSFETs (IRS2530D, Q1 and Q2), the resonant tank (LRES and CRES), the lamp current sensing and feedback circuit (RCS, RFB and CFB), and the 3-way interface circuit (R3, R4, R5, R6, R7, RPU, Q3, Q4, DZ1 and C5). As the switch position is changed for each dim setting, the circuit detects the change in voltage at the two screw-base input connections (PL1 and PL2) with the voltage divider formed by resistors R5, R6 and R7. Resistors R5 and R6 pull up the DC dimming reference across resistor R7 and capacitor C5 to the appropriate level to set the minimum and medium brightness levels. To set the maximum brightness level, transistors Q1 and Q2 are both turned on and the DC dimming reference is then pulled up high enough to ensure the circuit will reach the maximum brightness level. The IRS2530D controls the preheat and ignition timing with capacitor CPH, and controls the dimming loop speed with capacitor CVCO. If the lamp does not ignite, or one or both of the filaments open up, then the IRS2530D will disable the complete circuit safely to prevent excessive voltages or currents from damaging components.

The waveforms from the circuit (Figure 6A-C) show the lamp current and voltage at each brightness setting. For the 32W lamp load, the measured lamp current is approximately 240mA at the maximum brightness level, 94mA at the medium level and 31mA at the minimum level. The operating frequencies at each level are 43kHz at maximum, 62kHz at medium, and 67kHz at minimum.

Conclusion

The dimming function opens up a completely new family of CFL applications. Each dimming application presents a different set of challenges, especially with the interface circuit required. The dimming control loop required to regulate the lamp current is basically the same for each application. The challenge is to design each different interface circuit that converts the user dimming method to the necessary DC dimming reference. The IRS2530D greatly simplifies dimming designs and helps close the gap between dimming and non-dimming designs. This will enable CFL products to compete with incandescent while maintaining a small form factor and a low cost. Additional dimming circuits to consider to further enhance the performance of CFLs include triac dimming, power line communication and wireless applications.



(A) Maximum (B) Medium (C) Minimum

Figure 6A-C: Lamp voltage (upper, 100V/div) and current (lower, 200mA/div) at each 3-way dim setting (time=10usec/div)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Transfer Mold PFC Series with Compact Package

Its application is expected to cover home appliance and motor drives

This article presents a new version of Mini Dual In-line Package Power Factor Correction (DIPPFC™) developed by Mitsubishi Electric Corporation for high power air conditioners and general inverter use. In the new DIPPFC series, low thermal resistance was realized by using an insulation sheet structure with high heat dissipation. Because of the low thermal resistance, package size of the Mini DIPPFC is reduced compared to the conventional large DIPPFC and input current rating is expanded up to AC 30A$_{rms}$.

By Masahiro Kato, Teruaki Nagahara, Hisashi Kawafuji, Toshiya Nakano, Marco Honsberg
Power Device Works, Mitsubishi Electric Corporation, Japan

Inverters are increasingly used in motor control systems in order to improve efficiency and controllability of the system. For this inverter market, Mitsubishi Electric developed the Intelligent Power Module DIPIPM™ with a transfer mold structure. DIPIPM's are used for white goods such as air-conditioners and industrial motors. The inverter system involves higher harmonic current. So in the inverter system, a function to reduce the higher harmonic current is needed. Mitsubishi Electric developed the DIPPFC as a power module to reduce the higher harmonic current.

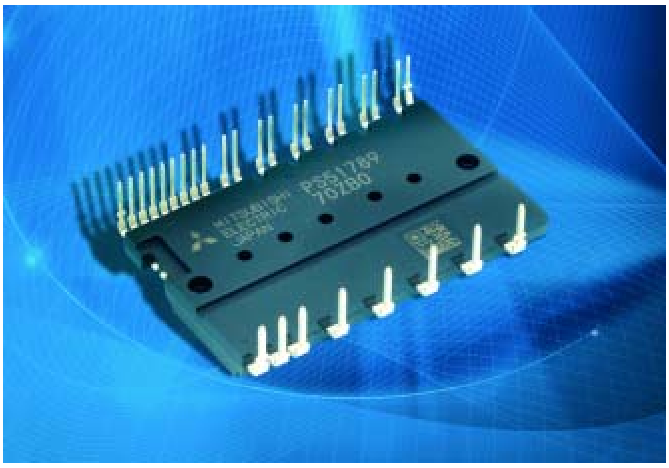


Figure 1: Outline view of Mini DIPPFC™

"Large DIPPFC series (AC 264V$_{rms}$/up to 20A$_{rms}$)" have been on sale since 2002, and it is used for package air-conditioners. This article describes a new version of DIPPFC "Mini DIPPFC series" to expand the current rating up to 30A$_{rms}$ with a more compact size compared with conventional Large DIPPFC. This new version DIPPFC series contributes to the miniaturization of the inverter PCB. Figure 1 shows an outline view of the Mini DIPPFC.

Configuration of DIPPFC™

In recent years, high harmonic currents generated in electric power systems are restricted in all electronic equipment. Especially in the EU where IEC61000-3-2 is applied, the high harmonic current regula-

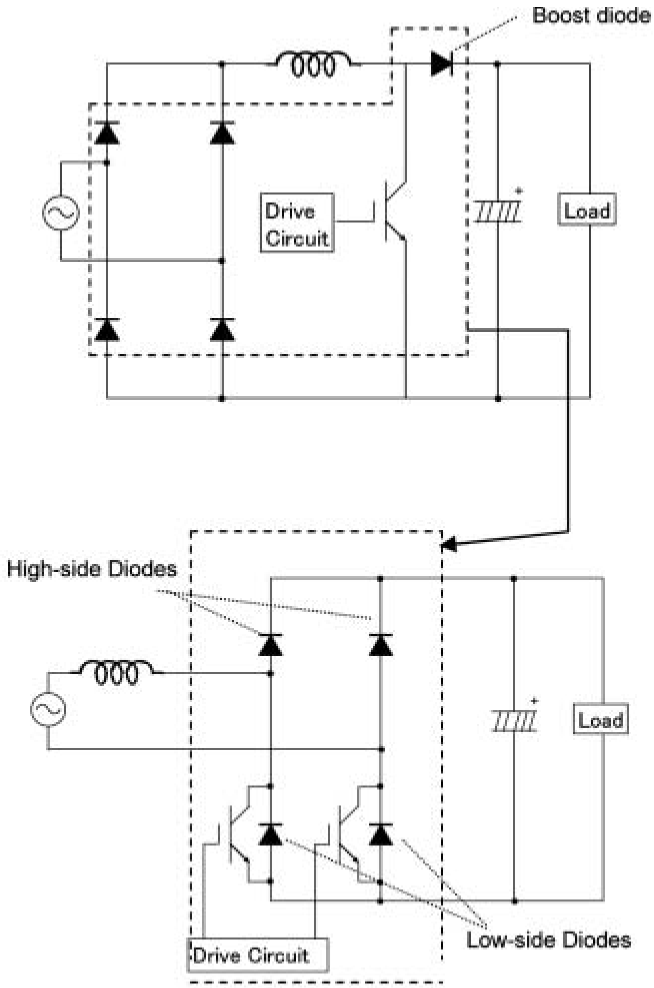


Figure 2: Power Factor Correction circuit (1 chip type)
Figure 3: Power Factor Correction circuit (DIPPFC™ type)

tion are severe, and the application of PFC (Power Factor Correction) is advanced. The power factor correction circuit shown in Figure 2 is now widely used. This circuit is composed of the diode bridge, the switching device and the boost diode. In the DIPPFC, the high-side diode of the diode bridge has the function of boost diode, and an IGBT is added in parallel with the low-side diode of the diode bridge, as shown in Figure 3.

Therefore, DIPPFC has the functions of rectification and power factor correction. DIPPFC includes a driver IC for the IGBTs as shown in Figure 2.

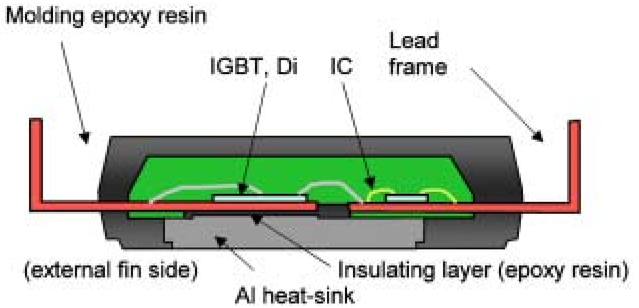


Figure 4: Structure of Large DIPPFC™

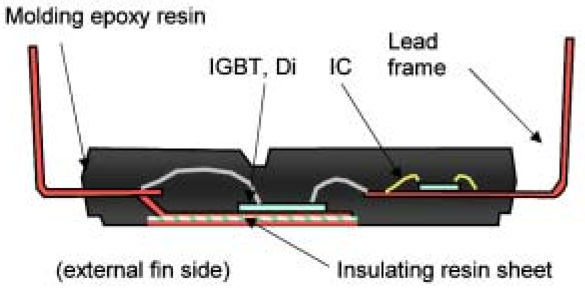


Figure 5: Structure of Mini DIPPFC™

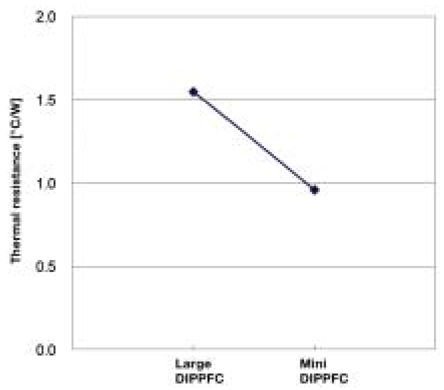


Figure 6: Comparison of thermal resistance
Mini DIPPFC™; PS51757 (AC246V_{rms}/20A_{rms})
Large DIPPFC™; PS51259-AP (AC246V_{rms}/20A_{rms})

New package structure
Figures 4 and 5 show cross-sectional drawings of a Mini DIPPFC compared with a Large DIPPFC. DIPPFC (including DIPIPM) series are simply made up of power chips (IGBTs, diodes), drive ICs and assembly components (lead frame, Al/Au wire, resin, etc.). Bare power chips and ICs are assembled directly on a lead frame and connected by Al wire or Au wire, and then they are transfer molded.

Heat dissipation structure
In Large DIPPFC, the insulating layer between lead frame and built-

in heat-sink is formed by epoxy resin. In order to reduce the thermal resistance, a ceramic-powder filler with high thermal conductivity was incorporated in the epoxy resin However this technology has reached its limits of insulation strength and heat dissipation through the epoxy resin because of the fluidity properties of the filler.

To solve the problem, the new heat dissipation structure with insulating resin sheet has been adopted in the Mini DIPPFC as shown in Figure 5. The insulating resin sheet does not need very much fluidity, in contrast to the epoxy resin, thus it is possible to increase the amount of filler in the resin sheet. By using this resin sheet, the thickness of the insulating layer can be thinner compared with that of the epoxy resin isolation in the Large DIPPFC. Therefore, the thermal dissipation can be improved considerably. As a result, the thermal resistance was improved 35% compared to the Large DIPPFC (as shown in Figure 6).

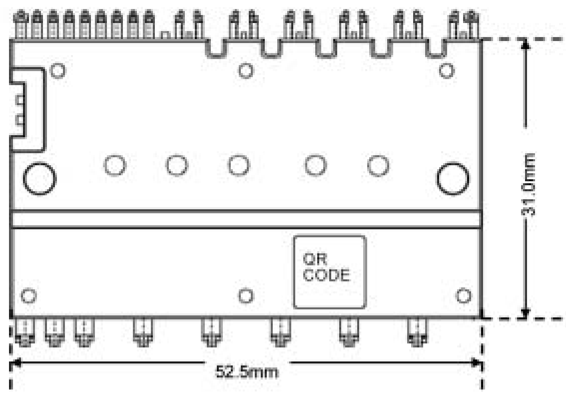


Figure 7: Package size of Mini DIPPFC™

Compact Package size
Effective heat dissipation of the power chips is achieved by applying the new heat dissipation structure with an insulating resin sheet, thereby the power chip size could be shrunk appropriately. Through

the optimization of chip size, the package size of Mini DIPPFC is considerably reduced to about 70% of the Large DIPPFC, though the current rating is up to $30A_{rms}$. Mini DIPPFC package size is shown in Figure 7.

Electrical circuit configuration and components

The internal circuitry of Mini DIPPFC comprises two IGBT chips, four diode chips and LVIC driver, which is the same as the Large DIPPFC. The LVIC is designed with necessary functions such as IGBT drive, control power supply, under voltage (UV) lockout circuit. Figure 8 shows the internal circuit of Mini DIPPFC.

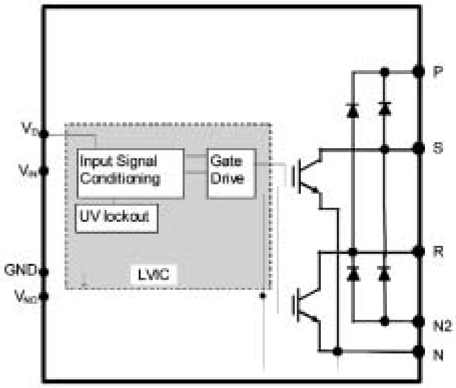


Figure 8: Internal block diagram of DIPPFC™

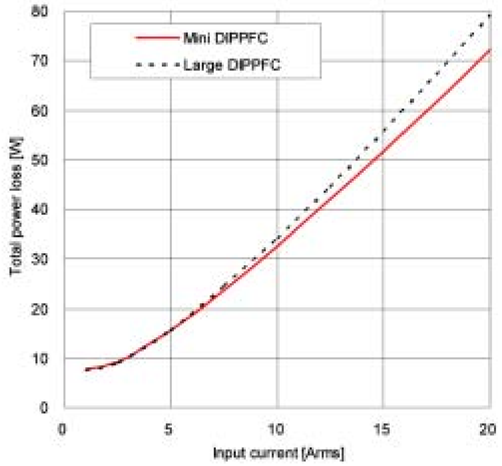


Figure 9: Comparison of module total loss
Condition: V_{in}=220V_{rms}, V_{out}=390V, ACL=0.6mH, f_c=20kHz, T_j=125°C
Mini DIPPFC™; PS51787 (AC246V_{rms}/20_{rms})
Large DIPPFC™; PS51259-AP (AC246V_{rms}/20A_{rms})

Input current Maximum Ratings

Type name	Symbol	Condition	Rating	Unit
PS51787	I_i	T_C≤100°C, V_i=220Vrms, V_o=390V, f_{PWM}=20kHz	20	A_{rms}
PS51789	I_i	T_C≤100°C, V_i=220Vrms, V_o=390V, f_{PWM}=20kHz	30	A_{rms}

Main part (PS51787)

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
Collector-emitter saturation voltage	$V_{CE(sat)}$	V_D=15V, V_{IN}=5V, I_C=30A	–	1.8	2.5	V
H-Di forward voltage	V_{FH}	I_F=30A, Applied between R-P, S-P	–	1.8	2.5	V
L-Di forward voltage	V_{FL}	I_F=30A, Applied between N2-R, N2-S	–	1.0	1.3	V
Switching time	t_{on}	V_{CC}=300V, V_D=15V, I_C=30A, T_j=125°C, Inductive load, V_{IN}=5 ↔ 0V	–	0.25	0.35	μs
	$t_{C(on)}$		–	0.14	0.23	
	t_{off}		–	0.40	0.65	
	$t_{C(off)}$		–	0.18	0.35	
	t_{rr}		–	0.11	–	
Diode recovery current	I_{rr}	V_{CC}=300V, V_D=15V, I_C=30A	–	11	–	A

Table 1

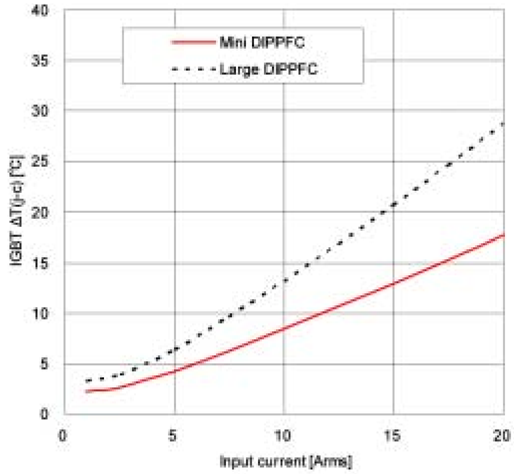


Figure 10: Comparison of IGBT $\Delta T_{(j-c)}$
Condition: V_{in}=220V_{rms}, V_{out}=390V, ACL=0.6mH, f_c=20kHz, T_j=125°C
Mini DIPPFC™; PS51787 (AC246V_{rms}/20A_{rms})
Large DIPPFC™; PS51259-AP (AC246V_{rms}/20A_{rms})

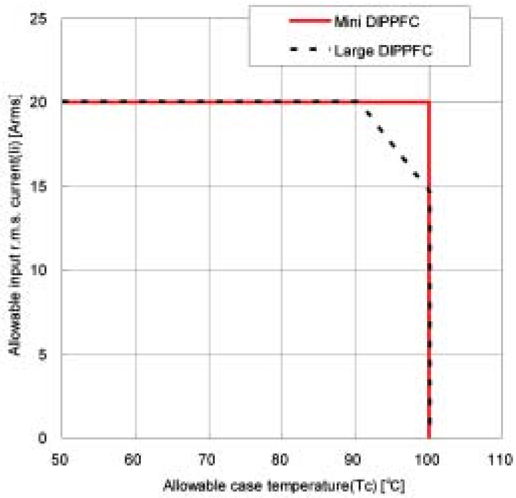


Figure 11: Allowable case temperature area
Condition: V_{in}=220V_{rms}, V_{out}=390V, ACL=0.6mH, f_c=20kHz, T_j=125°C
Mini DIPPFC™; PS51787 (AC246V_{rms}/20A_{rms})
Large DIPPFC™; PS51259-AP (AC246V_{rms}/20A_{rms})

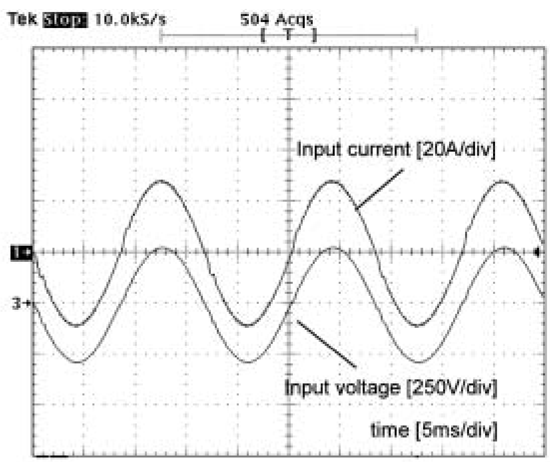


Figure 12: Input voltage/current waveform of PS51787. (With M63914FP)
Condition: Vin=200V_{rms}, V_{out}=370V, ACL=0.6mH, f_c=20kHz, I_{in}=20A_{rms}

Characteristics

Optimization of power chips

In the PFC operation it is necessary to operate the switching device with a high frequency to avoid the audible tone from the reactor. The IGBT chips are designed for high speed switching with a trench gate structure. Diode chip performance can be optimized - high speed characteristics are suitable for the high-side diode (as shown in Fig. 2) and low forward voltage characteristics are suitable for the low-side diode to reduce the total power loss. So the high-side diodes are designed as fast recovery type and the low-side diodes are designed as low forward voltage type respectively. For the large DIPPFC all diode characteristics are the same. The result of the optimization is that the total power loss of Mini DIPPFC was improved 8% compared to Large DIPPFC as shown in Fig. 9. (In the condition of V_{in}=220Vrms, V_{out}=390V, ACL=0.6mH, f_c=20kHz, T_j=125°C).

Expansion of allowable case temperature area

Because thermal resistance was improved as described above, the temperature rise between IGBT junction and module case ($\Delta T_{(j\text{-}c)}$) was able to be decreased by about 40% compared with Large DIPPFC. Fig. 10 shows the temperature rise between IGBT junction and module case ($LT_{(j\text{-}c)}$) of Mini DIPPFC (PS51787) and Large DIPPFC (PS51259-AP).

As a result, the allowable case temperature has been increased compared with Large DIPPFC (as shown in Fig. 11). This increase of allowable case temperature and the improvement of the module total power loss as described above can contribute to the cost of the cooling system.

Electrical performance

The main electrical characteristics (main part and control part) of Mini DIPPFC™ are indicated in Table 1.

Control of DIPPFC™

PFC control IC M63914FP is recommended for control of the DIPPFC. M63914FP has several functions as: PWM control of DIPPFC, soft start function, over voltage protection, over current protection, control power supply undervoltage lockout circuit and over temperature. About 99% power factor can be achieved by using Mini DIPPFC with M63914FP. The input current and input voltage wave form which was operated by PS51787 and M63914FP are indicated in Figure 12.

View in the future

In order to improve the current rating to more than $30A_{rms}$ it is necessary to develop further heat dissipation. Development of a larger current rating capacity is the next target by further improvement of thermal resistance and power device loss.

Conclusions

A new Mini DIPPFC has been developed by optimised power chips together with a high heat dissipating insulation sheet. This development contributes to the extension of the applications and miniaturization of the inverter system. Its application is expected to cover both home appliance use and general motor drives. Mitsubishi are continuously making efforts to develop devices of excellence to realize power loss reduction and save natural resources.

www.mitsubishichips.com

Negative versus Positive SMPS for Home Appliance

There are benefits with a negative supply topology

Home appliances are increasingly using SMPS supplies. Connection of the supply to the mains for non-insulated topologies, as these are widely used in this field, thus needs to be checked to ensure correct AC switch control according to the device's technology.

By Laurent Gonthier, Application & System Group Manager, Appliance Industrial and Lighting Segments, ASD & IPAD Division, STMicroelectronics

SMPS for home appliances

Home appliances such as washing machines, refrigerators or food processors employ a lot of AC loads such as valves, motors, or heating resistors. Since these loads are powered by the mains in on/off mode, they are usually controlled by Triacs or ACS. These devices are in fact the least expensive power switches to operate directly from the 110/240 V mains, due to their smaller silicon area for a given alternating current level. In addition, these devices only require a low driving current and so can be directly triggered by the appliance microcontroller unit (MCU), which considerably simplifies the driving circuit and reduces its cost.

In home appliances, capacitive power supplies have been traditionally used. However, designers are now increasingly implementing switched-mode power supplies (SMPS) to reach higher output current levels and especially lower standby power consumption. This new requirement is more and more stringent as the 2005/32/EC Energy for Using Products directive (EuP) reduces the maximum standby mode consumption for each product to be sold on the European market. The objectives are to bring this consumption to between 1 or 2 W by 2010, and below 0.5 or 1 W by 2013.

This article deals with power supply polarity. This point has to be particularly checked when Triacs or ACSs control circuits are powered with this SMPS.

Triggering quadrants for Triacs and ACS

To switch on a Triac, an ACS or an ACST, a gate current must be applied to its gate pin (G).

For Triacs and ACSTs, the gate current could be positive or negative. Figure 1 illustrates the simplified schematic of a Triac or an ACST and its associated silicon structure. As shown in these figures, a Triac or an ACST could be switched on by a positive or a negative gate current as a result of the two diodes embedded in back-to-back between G and A1.

The silicon structure of an ACS is different from a Triac. Here the gate is the emitter of an NPN bipolar transistor. So the gate current can only be sunk from the gate, and not sourced to it.

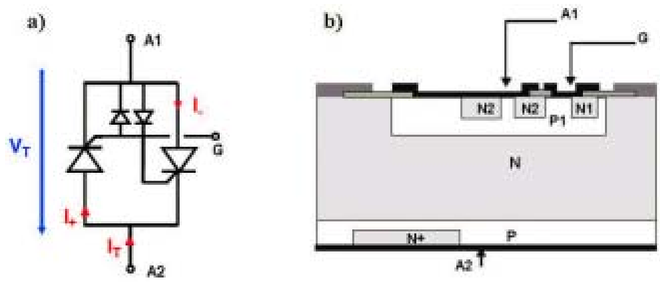


Figure 1: Simplified equivalent schematic (a) and silicon structure of Triac/ACST (b)

Four triggering quadrants are then defined as follows:
Quadrant 1 (Q1): $V_T > 0$ and $I_G > 0$
Quadrant 2 (Q2): $V_T > 0$ and $I_G < 0$.
Quadrant 3 (Q3): $V_T < 0$ and $I_G < 0$.
Quadrant 4 (Q4): $V_T < 0$ and $I_G < 0$.

Quadrants Q2 and Q3 are common to all Triacs and ACS/ACST devices. Control in Q2 and Q3 is then recommended.

Moreover, triggering in Q4 is not recommended because the triggering gate current is the highest. Also the dI/dt capability of Triacs is lower in Q4. Working in Q2/Q3 quadrants is then advisable, even for standard Triacs, to decrease the board consumption and increase the system reliability.

Two types of power supply bias

As the Triac, ACST or ACS drive reference is connected to the line, the supply of the control circuit has to be related to A1 or COM. There are two ways to connect this drive reference:

Solution 1: connect the control circuit ground (V_{SS}) to A1
Solution 2: connect the control circuit voltage supply (V_{DD}) to A1 or COM

Solution 1 is called a *positive power supply*. The voltage supply V_{DD} is above the drive reference (V_{SS}) which is connected to the mains terminal (line or neutral) as shown in Figure 2. If the supply is a 5 V power supply, then V_{DD} is 5 V above the mains reference.

Solution 2 is called a *negative power supply*. The voltage supply reference (V_{SS}) is below A1 or COM, which is connected to the mains reference (line or neutral) as shown in Figure 2. If the supply is a 5 V power supply, then V_{ss} is 5 V below the line reference.

This topology can be used with all Triacs, ACSs and ACSTs.

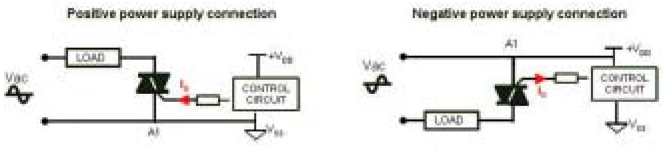


Figure 2: Triac control with positive or negative power supply

Buck or buck-boost converter?

Only a positive power supply can be implemented with the most used step-down converter - the buck converter. Indeed, for buck converters, the chopping MOSFET drive reference is connected both to the output capacitor low end (so supply GND) and the line. Indeed, to be able to control the N-MOSFET, the supply voltage has to be above the source reference. This leads to the fact that only positive supplies can be implemented with a buck converter.

The simplest negative supply that can be implemented comes from buck topology, it is the buck-boost converter. In this converter, the MOSFET stores inductive energy (in inductance L2, see Figure 3) when it is on. When the MOSFET is switched off, the energy is supplied to the output capacitor. As the freewheeling diode anode is connected to the supply reference (GND or VSS), a negative voltage is achieved.

Figure 3 shows the diagram of a negative buck-boost power supply using a VIPer16 device.

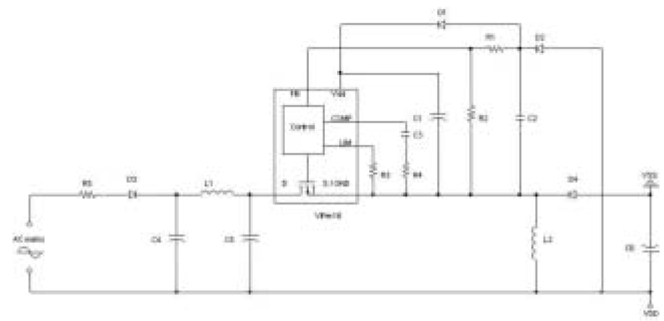


Figure 3: Buck-boost power supply with VIPer16 device

The advantage of a buck-boost converter compared to a buck converter is that there is no need for an added load resistance or an output Zener diode. Indeed, the feedback and output capacitors are not discharged symmetrically. This dissymmetry is amplified by the buck topology as the output capacitor is charged during each MOSFET on time, whereas the feedback capacitor is not. So output voltage can increase to too high a value and has to be clamped.

An additional resistance or clamping diode for no load or very light load is then required at the buck output, but not with a buck-boost converter.

Theoretically, the efficiency of a buck-boost converter should be lower than for a buck converter, as the whole inductor current is used to charge the output capacitor for the buck supply. But for 230 V AC/15 V DC, the duty cycle is very low, so there is no great difference between buck and buck-boost performances. Similar efficiency is reached for both topologies, with the same reactive components.

Flyback power supply

The second SMPS topology widely used today by designers is the flyback topology. This converter uses a transformer to store the energy instead of an inductance. The benefit of this solution, compared to a buck-boost converter, is the possibility to insulate the output voltage and also to generate several output voltages by using several secondary windings. A flyback converter can also deliver a higher power with the same monolithic device compared to a buck or buck-boost converter. Also a flyback converter can work with a higher duty cycle than a buck-boost converter. The input peak current is then lower and so are its switching losses. The flyback converter efficiency can then be slightly better.

It is easy to implement a negative supply with a flyback converter as the output voltage is insulated from the mains. So the V_{DD} terminal can either be connected to the neutral or the line. For sure, the V_{DD} voltage is then no longer insulated from the mains. This means that the insulation has to be implemented elsewhere to protect the appliance user from electrical shocks (for example, with an insulated keyboard and display).

Figure 4 gives the diagram of a flyback power supply using a VIPer16 device.

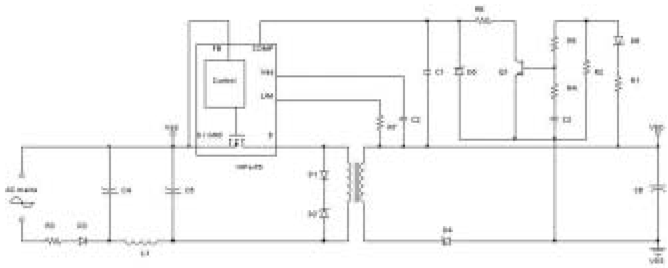


Figure 4: Flyback power supply with VIPer16 device

As the V_{DD} level has to be connected to the mains, there is no interest in implementing an insulated power supply. So only the advantage of implementing a 2nd low-voltage supply (insulated or not from the mains) or having a higher output current will push designers to use such a topology.

Conclusion

It has been shown that a negative power supply is the best topology as it can be used for almost all AC switches.

Even if the first reflex of a designer is to implement a positive power supply, negative power supplies are as easy as implementing positive ones. There are also some benefits with a negative supply topology such as, for example, the removal of output overvoltage protection for non-insulated SMPS (buck-boost topology compared to buck topology), or the opto-transistor (for flyback converters).

www.st.com

Varistors Satisfy the Extended UL 1449 Standard

The current used for the test is six times greater in the 3rd Edition than in the 2nd Edition

In recent years, the European electrical and electronics industry has reworked the safety standards for surge protective devices (SPDs) several times – in some cases with significant changes: thus the first edition of EN 60950-1 specified the mandatory use of surge suppressors. They additionally had to satisfy the then applicable UL 1449 standard on transient voltage surge suppressors (TVSS).

The second edition of EN 60950-1 stipulates that a varistor used in a primary circuit must satisfy either IEC 61051-2 or the new UL 1449 3rd Edition.

By Wolfgang Dreipelcher, Epcos

A broad range of Epcos varistors satisfies the extended requirements of the reissued UL® 1449. The third edition of this overvoltage protection standard went into effect on September 29, 2009.

Surge suppressors of non-VDR (voltage dependent resistor) type must still satisfy the requirements of the new UL 1449 when used in other applications approved by UL and classified as safety-critical components.

Changes stipulated by UL 1449 3rd Edition

As the latest standard, Underwriter Laboratories (UL) published UL 1449 3rd Edition for protective components of the SPD type in September 2009, completely superseding the preceding edition. From this time, all equipment brought onto the market must satisfy these new requirements in order to qualify for the UL label. Among other things, this results in three important changes for buyers and developers:

In the first place, some terminology has been changed. Henceforth the term TVSS (transient voltage surge suppressors) has been superseded by the term SPD (surge protective devices). In addition, UL 1449 3rd Edition is now an American National Standard (ANSI).

Second, the nominal discharge current was included in the specification. The voltage limitation is now measured at 6 kV and 3 kA.

Third, SPDs have been subdivided into type classes 1, 2, 3 and 4. The test current as well as the voltage test procedures have also been revised, with the duty cycle now being run at the nominal discharge current.

Effects on currently used designs

The new requirements on SPDs have significant effects, because for the first time IEC 60950-1 also concerns the general use of components designed to suppress surges in IT equipment. These requirements must be considered by manufacturers of power supplies for

the IT sector and other IT equipment that are designed to be connected to the power supply and incorporate a corresponding power supply with SPDs in the primary circuit.

Because primary circuits must make exclusive use of varistors for surge suppression, this standard will have significant consequences. Thus, other protective components such as gas discharge tubes or semiconductor components with nonlinear voltage-current characteristics are not classified as VDRs. Thus, their use in the primary circuit is now subject to restrictions.

UL 1449 3rd Edition applies to equipment that must repeatedly limit transient voltages in 50/60-Hz circuits to 1000 V. Depending on whether the equipment is located inside the electrical system, UL 1449 3rd Edition now makes a distinction between four types of SPD.

Type 1 specifies equipment with a permanent connection to the power line installed before or behind the main fuse. It refers to SPDs that are as a rule used without external surge-current protection. This means that they are located between the secondary side of the transformer and the power side of the fuse. This type of SPD is closest to those components that were designated as secondary surge arrestors before the introduction of the UL 1449 3rd Edition and were used primarily in the USA.

Figure 1: Type 1 Block and strap varistors

Block and strap varistors of Type 1

Block varistors
B40 with voltages from 130 V_{rms} to 750 V_{rms}
B60 with voltages from 75 V_{rms} to 1100 V_{rms}
B80 with voltages from 130 V_{rms} to 1100 V_{rms}
These varistors are listed for type 1 applications with an IN of 20 kA.

B32 with voltages from 75V to 750 V_{rms}
B40 with a voltage from 75 V_{rms}
These varistors are listed for type 1 applications with an I_N of 10 kA.

EPCOS block and strap varistors are designed for rated voltages of up to 1100 V rated currents of up to 20 kA.

Strap varistors
L*40/41/42 and L*50 with voltages from 130 V_{rms} to 750 V_{rms}
These varistors are listed for type 1 applications with an I_N of 20 kA.

L*40/41/42 with a voltage of 75 V_{rms}
L*3422 with voltages from 75 V_{rms} to 750 V_{rms}
L*32 with voltages from 75 V_{rms} to 750 V_{rms}
These varistors are listed for type 1 applications with an I_N of 10 kA.

Type 2 designates equipment connected permanently to the power line and mounted after the main fuse. These elements are also designed for the load side of the fuse inclusive of the junction boxes. Type 2 thus replaces hardwired TVSS. External circuit breakers and fuses in combination with type 2 elements can then be used. This SPD type most closely corresponds to the protective components previously designated as TVSS before the introduction of UL 1449 3rd Edition. Devices belonging to type 2 include automatic circuit breakers, hand dryers, motors as well as power supplies.

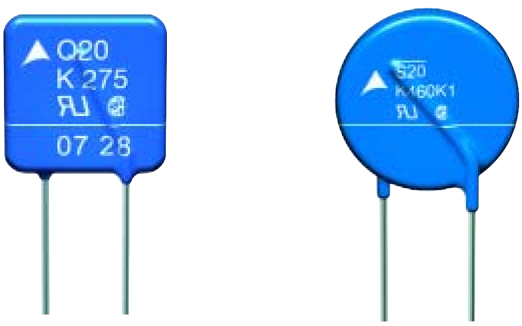


FIGURE 2: Type 2 Disk varistors

Disk varistors of Type 2
S25: B72225S* with voltages from 115 V_{rms} to 750 V_{rms}
These varistors are listed for type 2 applications with an I_N of 5 kA.

Q20: B72220Q* with voltages from 150 V_{rms} to 680 V_{rms}
These varistors are listed for type 2 applications with an I_N of 5 kA.

Q14: B72214Q* with voltages from 130 V_{rms} to 680 V_{rms}
These varistors are listed for type 2 applications with an I_N of 3 kA.

UL status: approval granted with the exception of types K175 to K440, for which approval has been applied.

Typical disk varistors for type 2 applications. The varistor on the right offers improved derating and multipulse capability. This is indicated by the marking K1 on the varistor.

EPCOS multipulse varistors with improved derating
S14 MP: B72214P2*K101
Disk diameter: 14 mm
Voltages from 130 V_{rms} to 680 V_{rms}
These varistors are listed for type 2 applications with an IN of 3 kA.
As identification, they bear the marking K1.

S20 MP: B72220P3*K101
Disk diameter: 20 mm
Voltages from 130 V_{rms} to 680 V_{rms}
These varistors are listed for type 2 applications with an IN of 5 kA.
As identification, they bear the marking K1.

Ordering code	UL classification	V_{RMS} [V]	I_{max} [A]	Number of pulses (8/20 µs)	
			8/20 µs	3 kA	750 A
B72214P2* K101	S14K to E2K1	130 to 460	6000	40	800
B72214P2* K101	S14K to E2K1	510 to 680	6000	15	500

The varistors of the S14 MP and S20 MP series offer the following benefits:
Repeated pulse impacts with a stable terminal voltage possible
Suitable for applications with frequently recurring overvoltage pulses of low amplitude
Suitable for type 2 applications to UL 1449 3rd Edition
They correspond to IEC 60950-1 Rev 2 Annex Q and IEC 60065:2002 section 14.12

Ordering code	UL classification	V_{RMS} [V]	I_{max} [A]	Number of pulses (8/20 µs)	
			8/20 µs	3 kA	750 A
B72220P3* K101	S20K to E3K1	130 to 460	12000	100	1600
B72220P3* K101	S20K to E3K1	510 to 680	10000	40	1600

Type 3 specifies SPDs used directly on the power line and connected to the service panel via a conductor at least 10 m long (to IEEE C62.41-199 Category A). This 10 m of conductor length does not include conductors used to attach the SPD. Type 3 includes SPDs that are cord-connected, plugged directly into the socket or integrated in the outlet. Type 3 elements are not subject to a nominal current discharge test as long as they are not tested as type 2 elements. Other examples are multiple sockets with integrated SPDs or power supplies for electronic equipment. It should also be noted that these measurements are conducted with the short-circuit current IK and not with the rated current IN.

Disk varistors of Type 3
S10 MP: B72210P2xxxK101
Disk diameter: 10 mm
Voltages from 130 V_{rms} to 680 V_{rms}
These varistors are listed for type 3 applications with an Ik of 3 kA. As identification, they bear the marking K1.

UL Status: Approval has been granted for types S10K275E2K1 to S10K680E2K1. Approval for types S10K130E2K1 to S10K250E2K1 has been applied for.

S20: B72220

Voltages from 115 V_{rms} to 1000 V_{rms}
These varistors are listed for type 3 applications with an IK of 3 kA.

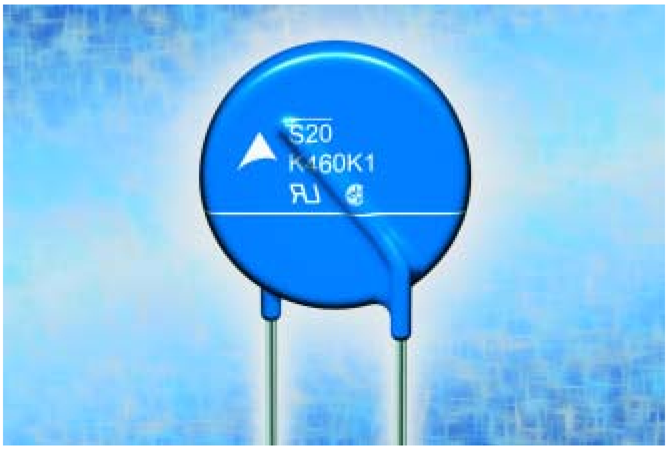
These varistors are offered for rated voltages of between 115 Vrms and 1000 Vrms and designed for short-circuit currents of up to 3 kA.

Figure 3: Type 3 disk varistors

Type 4 designates SPDs in the form of discrete components or component assemblies. A type 4 element can thus be a EPCOS single discrete metal oxide varistor, or it can also be a module or subsystem consisting of several SPD components. These components include EPCOS metal oxide varistors, capacitors and surge protective components. Type 4 is thus an SPD at component level or an SPD subsystem comprising several components that is tested in accordance with its application environment (Types 1, 2 or 3). See also: www.epcos.com/varistors.

Nominal discharge current
Further innovations included within the scope of UL 1449 3rd Edition are the nominal discharge current test and the subsequent duty cycle test. The nominal discharge current is selected by the manufacturer and can have a value of either 10 kA or 20 kA for a type 1 SPD, whereas a type 2 SPD may have values of 3 kA, 5 kA, 10 kA or 20 kA. The component is subjected to 15 pulses corresponding to the nominal discharge current selected by the manufacturer.

In order to pass this test, the component must not constitute any risk of electric shock or fire during the test. In addition, no gaps may occur in the overvoltage path. This includes all supplementary internal or external surge protective elements such as fuses or circuit breakers.



The test with a nominal discharge current includes all internal or external surge-current elements. Many developers specify and use external surge-current elements in order to protect the overvoltage component during overvoltages of longer duration. In order to pass the new tests, the external or internal surge-current element must be exposed to the same 15 pulses at the nominal discharge currents selected by the manufacturer. The nominal discharge current is noted on the type plate of the SPD.

Limitation voltage test
The measured limiting voltage test in UL 1449 3rd Edition uses a 6 kV/3 kA combination wave surge to determine the voltage protection rating (VPR) of the SPD. This test is similar to the one determining the suppressed voltage rating (SVR) in UL 1449 2nd Edition. The key difference between the tests of the 2nd and 3rd Editions is that the specified magnitude of the current used for the test is six times greater in the 3rd Edition than in the 2nd Edition. This much higher current level means that the measured limiting voltage is also significantly greater. Higher currents lead to higher limiting voltages. This means that an element tested to UL 1449 3rd Edition with a VPR of 700 V does not show a higher limiting voltage than one tested to UL 1449 2nd Edition with an SVR of 400 V.

Summary
Manufacturers of drives and large compressors that previously used varistors with small diameters, or sometimes no varistors at all, may require an upgrade to type 2 varistors. SPD (TVSS) manufacturers who use 5-mm, 7-mm, 10-mm or 14-mm varistors, or even Cu-encapsulated SMT varistors, may consider upgrading to varistors suitable for type 3 applications.

Apart from customers who work directly to UL 1449 3rd Edition, the UL 508C, UL 840, UL/EN 60950 and UL/EN 60065 terminal standards may be affected. A wide selection of Epcos components offered for overvoltage protection are suitable for almost all applications.

In order to ensure the correct type classification for an application or equipment, it is recommended that developers contact their local UL partners.

A continuously updated overview of all UL-approved varistors from EPCOS may be found under:

www.epcos.com/varistors

Real Time Parameter Determination in Saturated Inductors Submitted to Non-Sinusoidal Excitations.

The method allows the determination of parameters in saturated systems, and the algorithm is adapted to saturation level.

Parameter's determination on saturated systems is a complex task. Sometimes you can determine these parameters by calculation but building errors must be checked to verify the final values of them. You can use accurate off-line models but the time of process could be excessive for a factory process. In this article we describe a recursive algorithm to calculate the parameters in real time and buried in a generic measurement system made to test three phase inductors.

By Ramon Bargalló Perpiñà, Electrical Engineering Department, Manuel Roman Lumbreras, Guillermo Velasco Quesada and Alfonso Conesa Roca, Electronic Engineering Department. Polytechnic University of Catalonia and Jaime González Salmerón, Grupo Premo

In order to have a fast measurement of the parameters the flux linkage must be known. It is, however, expensive and difficult to measure the flux. Instead, the flux can be estimated based on measurements of voltage and current. After discussion we present a Luenberger's observer for the flux and a recursive algorithm to calculate the parameters of the considered model. Also the measurement systems calculate the total losses on the inductor and using our model we can separate it on joule and magnetic losses.

Flux estimation and observation

There are some possibilities to estimate the flux. The following table summarizes the most commons.

Model	Governing equation
voltage	$\Psi = \int (u - r \cdot i)dt$
current	$\Psi = L \cdot i$

TABLE I: Flux Estimators

These estimators have some problems:

a) If the resistance (r) is not correctly determined the estimated flux is different to the correct one.

b) If the inductance (L) is not correctly determined the estimated flux differs to the correct one.

For these reasons it is better to use a closed loop observed. The proposed Luenberger's observer is:

$$\frac{d\hat{\Psi}}{dt} = u - r \cdot i + \gamma \cdot \left(i - \hat{i}\right)$$

$$\hat{i} = I_N \cdot \left[a \cdot \frac{\hat{\Psi}}{\Psi_N} + b \cdot \left(\frac{\hat{\Psi}}{\Psi_N}\right)^n \right]$$

For values of $\gamma > 1$ is absolutely stable and the convergence of the observed values (^) to the real ones is guaranteed.

In the above expression, I_N is the current that produces the flux Ψ_N; it isn't the nominal current of the tested coil or transformer.

The unknown parameters are: r, a, and b. Using the above expression it is possible to determine the inductance:

$$L = \frac{\Psi}{I} = \frac{\Psi}{I_N \cdot \left(a \cdot \frac{\Psi}{\Psi_N} + b \cdot \left(\frac{\Psi}{\Psi_N}\right)^n \right)}$$

Or

$$L = \frac{1}{\frac{dI}{d\Psi}} = \frac{1}{I_N \cdot \left(a \cdot + n \cdot b \cdot \left(\frac{\Psi^{n-1}}{\Psi^n{}_N}\right) \right)}$$

We use the above observer in addition to a recursive estimator to obtain the unknown parameters. The figure 1 shows the structure of that.

Discrete System

By discretization the equation 1 becomes:

$$\hat{\Psi}(k+1) = \hat{\Psi}(k) + T\cdot\left[u(k) + r\cdot i(k) + \gamma\cdot\left(i(k) - \hat{i}(k)\right)\right]$$

$$\hat{i}(k) = \hat{a}(k)\cdot\hat{\Psi}(k) + \hat{b}(k)\cdot\hat{\Psi}(k)^n$$

With T in the sampling period and k represents the k sampling interval (actual time could be calculate by t = k*T) To obtain the unknown parameters we solve recursively the above equation.

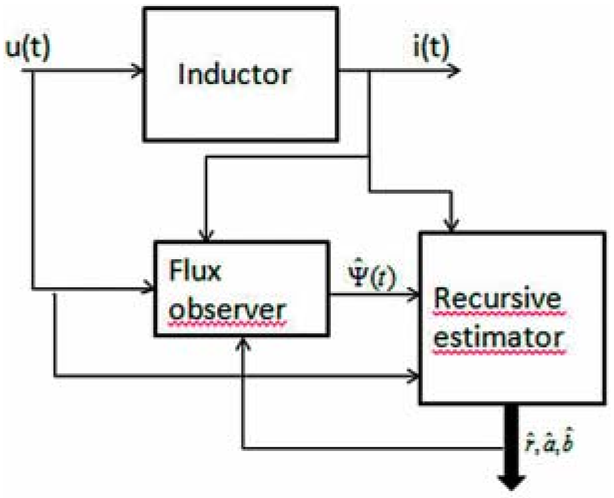


Figure 1: Flux observer + Recursive parameter estimator

Least Squares Recursive Method

The recursive least squares method (RLS) tries to determine the unknown parameters of the following matrix equation:

$$y(k) = \varphi^T(k)\cdot\theta + e(k)$$

y(k) are the measured set on instant k, $\varphi^T(k)$ are known functions, e(k) are the measurement errors (unknown) and θ are the unknown parameters. The RLS method calculates estimation for the actual time (k) based on the measurements until k and the estimation for the earlier time (k-1). The whole algorithm is:

$$\theta(k) = \theta(k-1) + K(k)\cdot\left(y(k) - \varphi^t(k)\cdot\theta(k-1)\right)$$

$$K(k) = P(k)\cdot\varphi(k)$$

$$P(k) = \frac{1}{\lambda}\cdot\left(\begin{array}{l} P(k-1) - \\ -\dfrac{P(k-1)\cdot\varphi(k)\cdot\varphi^T(k)\cdot P(k-1)}{\lambda + \varphi^T(k)\cdot P(k-1)\cdot\varphi(k)}\end{array}\right)$$

For the penalizing factor λ the suitable values are from 0.95 to 0.995 and the losses function to be minimized will be:

$$V(\theta,k) = \frac{1}{2}\cdot\sum_{i=1}^{k}\lambda^{k-i}\cdot\left(y(i) - \varphi^T(i)\cdot\theta\right)^2$$

The expression

$$\lambda^{k-i} = e^{(k-i)\cdot\ln\lambda} \approx$$

$$\approx e^{-(k-i)\cdot(1-\lambda)} = e^{-(k-i)/T}$$

As a result of approximation of (10) at the surround of λ = 1. T is a pseudo-time constant

$$T = \frac{1}{1-\lambda}$$

Suggested values for λ are 0.95 to 0.995 and these values indicates values for T for 20 to 200. It is accepted that values older that 2*T aren't any influence for the final result.

The only limitation of this method is that the parameters must be expressed as coefficient of known functions. In our case this is true because the exponent (n) for the current-flux function can be considered known (they can be determined by early test and usually it is 5, 7 or 9 depending to the saturation level of the material.

There is another limitation of this method but this is due to the characteristics of the applied signal: It must be a called persistent excitation of order N, and the following conditions must be guaranteed:

These limits exists

$$r_u(\tau) = \lim_{L\to\infty}\frac{1}{L}\cdot\sum_{t=1}^{L}u(t+\tau)\cdot u^T(t)$$

These matrix be positive definite

$$r_u(\tau) = \lim_{L\to\infty}\frac{1}{L}\cdot\sum_{t=1}^{L}u(t+\tau)\cdot u^T(t) \quad (13)$$

These expressions are true if the harmonic component of the applied signal contains at least N/2 harmonics.

Experimental Test

Figure 2 shows the experimental setup. The whole system is made with the following parts:

Current controlled PWM three phase converter.
Current and voltage sensors connected to a data acquisition card.
Data acquisition card: 16 differential channels; 1.2Msamples.
PC with labview v8.2 to show and calculate the interested values (current, voltage, power losses, parameters, etc.) The user could select what data is shown.

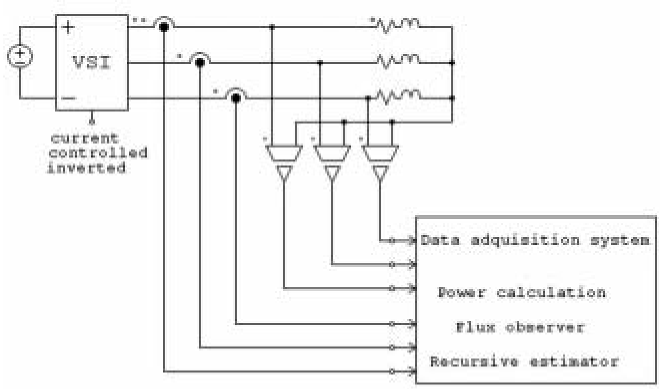


Figure 2: Experimental setup

The following pictures show the results for a one-phase transformer (1.3 kVA, 220/380 V, 5.9/3.5 A, PJ = 40 W, Po = 18 W, R1 = 0.942 W, R2 = 1.202 W, YN = 0.99 Wb, IN = 1.41 A) with PWM alimentation.

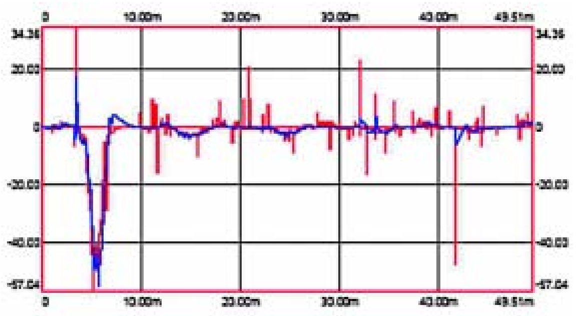


Figure 3: Measured and calculated current on a transformer

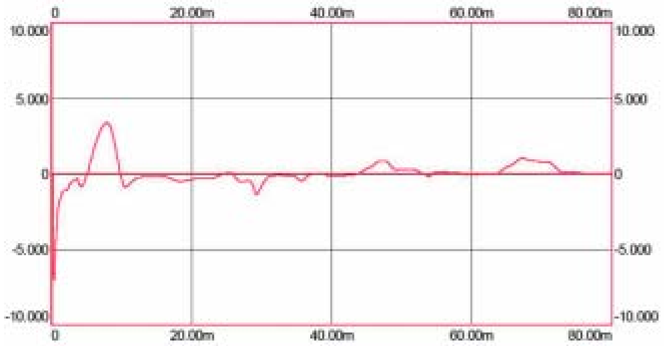


Figure 4: a(k) parameter

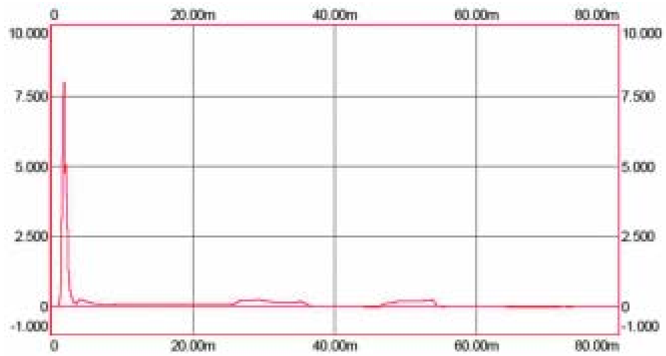


Figure 5: b(k) parameter

The magnetic material of this transformer has an exponent n = 7 (these value was calculated earlier) Final values for a and b are 0.48 and 0.52 respectively; they are agree with the values calculated by off-line methods. The following picture shows the comparison between the experimental saturation characteristic and fitted equation using the above values for a, b, and n.

The figure 7 shows the comparison between calculated inductance using experimental measurements, calculated inductance using expressions (2) and (3) and by using 2D FE calculation.

Conclussion

The explained method allows the determination of parameters in saturated systems, and the algorithm is adapted to saturation level.

For sinusoidal applied voltage the results are bad: the final values for the parameters a and b have offset. These are due the limited harmonic component of these signal (1 harmonic only allows to determine only 2 parameters under theorist assumptions: no measuring errors, etc.) As a conclusion it is necessary to apply a signal with some harmonics to avoid or minimize measuring errors)

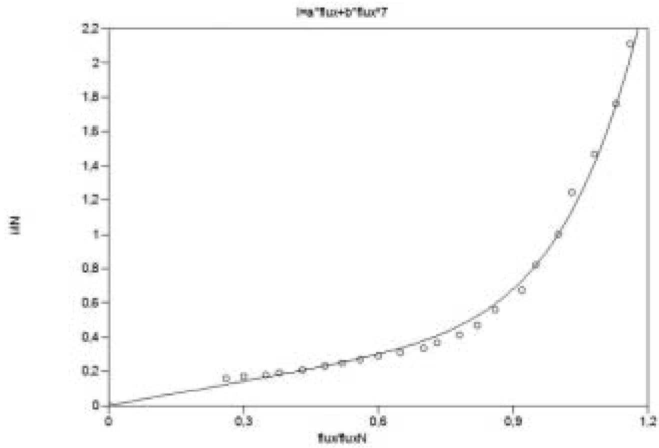


Figure 6: Experimental and fitted saturation characteristic

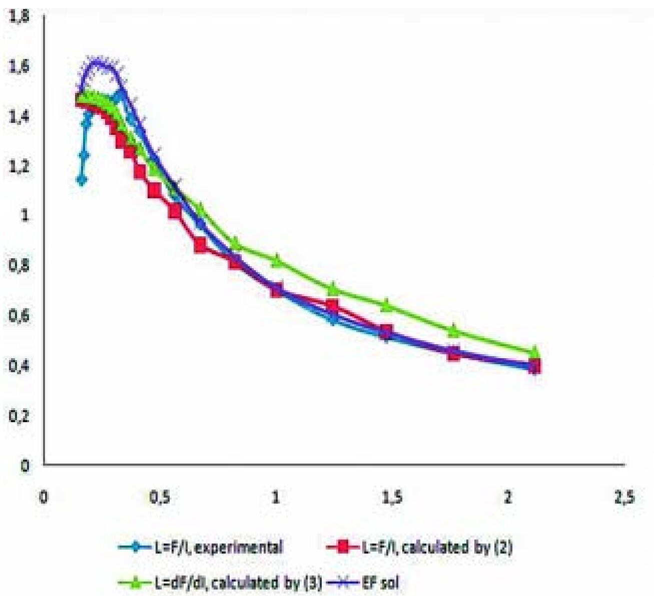


Figure 7: Calculated and estimated inductances

Acknowledgment

This work was partially granted by FIT-030000-2007-79 (MITYC) and Grupo PREMO S.A.

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www.grupopremo.com

The Smart Grid Revolution

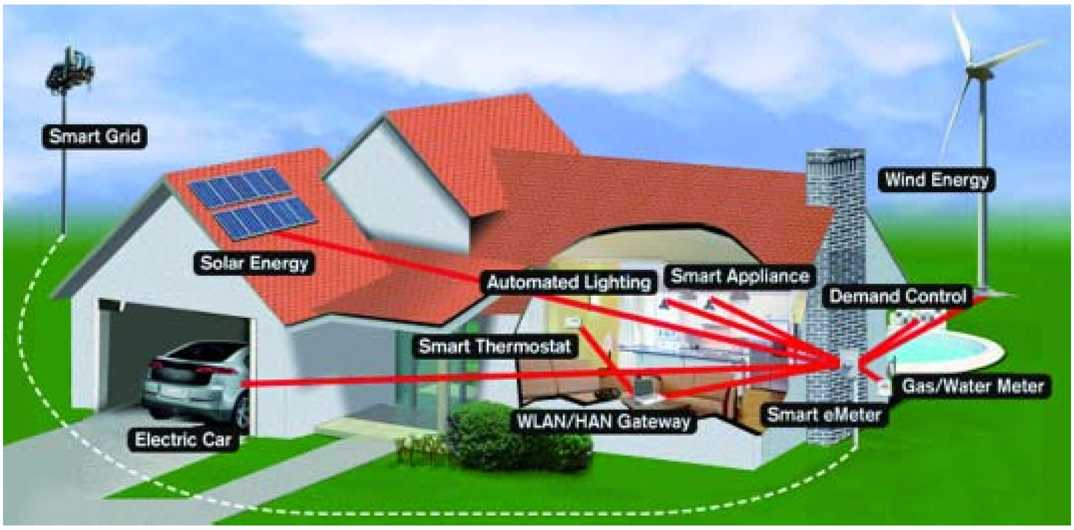
GaN-based devices can overcome limitations

In December, at the climate conference in Copenhagen, the world again committed itself to producing a sizeable part of its energy from renewable sources. And to meet those quotas, the renewable electricity generation will have to grow sharply in the coming years.

By Jan Provoost, imec Science Editor and Johan Van Helleputte – imec Director Technology Office Energy

This, however, will put a lot of pressure on the electricity infrastructure, which is not yet ready to cope with the tidal wave of renewable energy that is in the making. It will require a radical rethinking, much innovation and new technology, and a major investment to get it up to par with the expected growth in renewables. It will require a revolution, leading to what is generally called the "Smart Grid".

Imec, through its research on a.o. photovoltaics, low-power sensors, and power electronics is helping the Smart Grid revolution to become reality. On the one hand, this research has shorterterm goals – think of further improving the energy-efficiency of photovoltaic systems, to reach grid parity even faster. But there are other areas were more fundamental breakthroughs are needed – for example exploring new materials and processes to for the next generation of power devices. These should be capable of coping with high voltages and high temperatures, and they should be cost-effective. The Smart Grid will rely on such innovative power devices for network stability and quality, load balancing and management, and for energy storage.



Energy: the telecom of tomorrow
Once we reach the targets set by the EC's SET-plan, for example 20% of all energy generated by renewables in 2020, the landscape of energy generation will have changed completely. Next to the classic electricity plants, there will be millions of solar panels on rooftops, or private windmills and heat pumps that deliver electricity to the grid.

Compare this change to what has happened in telecommunications in the past 20 years. Like with energy now, there used to be only a few large telecom companies. They ran fairly homogeneous services, on networks and technology that changed only slowly. There was the phone, and you used it for voice communication, over a copper wire. Today, there are thousands of companies that offer telecom services through a mix of heterogeneous infrastructure and services, with very fast evolving underlying technologies. In this process, telecom has gone almost completely digital. This has blurred the boundaries with computing networks – the Internet – and has given both telecom and computing a sizeable boost. It has also fundamentally changed the telecom business models.

The same revolution is about to come to the energy market. With millions of heterogeneous energy generators – prosumers instead of consumers. And with a need for distributed and mobile storage points. With long- and short-distance delivery of energy, with real-time pricing, and a host of new services. And with a new grid that, while incorporating the old infrastructure, will function radically different: with much more intelligence and digital technology. With semiconductors that process electricity instead of information.

It will be a tremendous challenge to transform the electricity system worldwide into one of the most complex systems ever made by mankind. And to do this while assuring a continuity of services. This is not a green field technology deployment!

The Internet of electricity: global, super-distributed, real-time balanced
The ideal place to produce renewable electricity is not always where it is consumed. Southern Europe, for example, or the vast sun-bathed spaces of Northern Africa are the ideal place to generate solar energy. But then you need a grid that can transport this energy to where it is needed, all the way up to the Polar circle, if needed. And this of course without losing too much energy on the way.

Another challenge is assure the quality of service, at any time and at any place, in a context where increasing amounts of electricity are generated intermittently and unpredictable. On a sunny summer's day, more energy may be delivered to the net, at a moment when there may be less demand. Conversely, on a winter's night, there may be a peak demand, but less supply. So the future grid will have to cope with peaks of supply and peaks of demand that are not necessary coinciding and that are much more volatile than today. This will require a sophisticated, fast and robust load balancing with new load management systems and storage approaches. A lot of intelligent transport, innovative storage and smart pricing will be needed to achieve this.

Third, there will no longer be a sharp distinction between producers and consumers of electricity. At any one time, a net consumer may become a small producer of electricity. And this can be implemented on the level of buildings, but even on the level of appliances – think of cars, for example. So all metering and balancing equipment should function both ways. In this context, utility providers will need, at any moment, fast and detailed information about the consumption and production profiles of all its customers.

For better balancing and peak-shaving, we will need real-time pricing – varying the price of electricity at any moment and place depending on demand and supply. Again, this calls for smart metering and fast feedback at the level of every appliance. Appliances, for example, that adapt their electricity use to the price of electricity at any moment, in some cases charging a battery when the price is low, and delivering energy from that same battery when the price is high.

In summary, electricity will be transported and balanced through a interlinked network of smart grids. And there will be potentially billions of consumers and producers. This calls for an infrastructure much like we have the Internet today for computing and telecommunication.

Power electronics at the heart – imec's GaN-on-Si IIAP

The Smart Grid revolution will rely on billions of cheap smart meters, switches, sensors, actuators, convertors, invertors and batteries. Today, many of these devices are still too slow, too bulky, too expensive, and not fit for high-voltage or high-temperature use in tomorrow's grid.

The high-voltage power devices that are already used are mostly based on Si MOSFET structures. However, for an increasing number of applications, their use is limited. GaN-based devices, for example, can overcome these limits. They show a unique combination of excellent transport properties and high electrical field operation capability. Not only from an operational point of view but also in terms of energy saving opportunities, such new generation of devices will become extremely important.

The issue, of course, is if such devices can be produced cost-effectively, on large wafers that is. Last year, imec in collaboration with AIXTRON has already shown that it is possible to grow a crack-free GaN layer (1.5µm thick) on 200mm wafers. This opens excellent perspectives for GaN-on-Si devices, especially from the perspective of cost versus performance.

To leverage its experience with GaN, and to allow partners to participate, imec has recently started a research program for GaN-on-Si device research. The goal is to develop high-voltage, low-loss, high-power switching devices based on large-diameter GaN-on-Si technology. Devices that, in the years to come, will be used as building blocks for the Smart Grid.

www.imec.be

World’s Lowest Sleep Current 16-bit MCUs with USB and Touch Sensing

Microchip announces two new families of 16-bit PIC24F microcontrollers (MCUs) - one with USB functionality and one for general-purpose applications - both of which feature nanoWatt XLP extreme low power technology, small packages and mTouch™ capacitive touch sensing. The USB family provides for Peripheral, Embedded Host and On-the-Go (OTG) implementations. Microchip’s nanoWatt XLP technology provides the world’s lowest sleep currents, with current consumption down to 20nA in Deep Sleep mode, resulting in the lowest power consumption of any MCU with USB OTG -10 times lower than USB MCUs from other

ultra-low-power manufacturers.
The PIC24FJ64GA104 general-purpose family features nanoWatt XLP technology, 16 MIPS performance, 32 or 64 Kbytes of Flash, 8 Kbytes of RAM, a capacitive touch sensing peripheral, Real Time Clock and Calendar (RTCC), a 10-bit A/D, and the ability to reconfigure digital I/O pins via Peripheral Pin Select. The PIC24FJ64GB004 family builds on these features with the world’s easiest-to-use and most complete Full-Speed USB 2.0 Peripheral, Embedded Host and OTG solution. Both families are available in 28-pin QFN, SOIC and PDIP packages, and 44-pin QFN and TQFP packages

www.microchip.com

Low-Cost Driver Family for Half Watt LEDs

Infineon Technologies AG is extending its portfolio of energy efficient lighting ICs with a new family of low cost linear LED drivers. The new BCR320 and BCR420 product families address the burgeoning market for energy-saving and environmentally friendly light-emitting diode (LED) lighting solutions.
Specifically designed for driving 0.5W LEDs with a typical current of 150mA to 200mA, these LED drivers feature a negative thermal coefficient contributing to a long lifetime of LEDs and a digital interface for a pulse width modulation (PWM) signal for dimming.
With the recent introduction of higher efficiency 0.5W LEDs this class of products is expected to be adopted in a wider range of applications. However, currently available resistor solutions for biasing LED current have significant disadvantages such as inhomogeneous light output and reduced lifetime of LEDs. Alternatively, switch mode drivers do not meet the required price point for 0.5W LED applications, and drive up the number of parts and the complexity of driver circuit.

www.infineon.com/leddriver

Half-Brick Provides Ultra-Wide Output Voltage Range for Cellular Infrastructure

Power-One, Inc. introduces the HBA48T12280, a highly efficient 350-watt half-brick DC-DC converter for use in cellular infrastructure applications and more specifically to RF amplifier applications. The HBA48T12280 has a smooth efficiency curve that equals or exceeds 90% for loading conditions ranging from 40 to 100%. Its ultra-wide trim range allows it to be configured to operate within a 21 to 33 VDC output, allowing it to be used across a multitude of RF amplifier technologies.
Additional features include: 36–75 VDC input range, -40 to 100 °C operating temperature range, capability to withstand a 100V input transient for 100ms, ability to start-up into

pre-biased loads, and an on-board input differential LC-filter. The HBA48T12280 has an industry-standard half-brick footprint (2.4 x 2.28 inch, 61 x 57.9mm), a low profile 0.5 inch (12.7mm) height, and is RoHS compliant for all six substances.
Protections include: output overvoltage and overcurrent, input undervoltage lockout, and overtemperature shutdown. Interface and trim capabilities include: remote sense, remote ON/OFF (positive or negative logic option), and +18%/?25% output voltage trim ranges with industry-standard trim equations. Safety approvals include: UL60950-1/CSA 22.2 No. 60950-1, EN60950-1 and IEC60950-1.

www.power-one.com

Off-Line Green Mode Pulse Width Modulation Controller

Texas Instruments Incorporated introduced an off-line green mode pulse width modulation (PWM) controller that minimizes space and system cost while providing high efficiency in power supply applications. The UCC28610’s frequency and peak current modulation creates efficiency levels of 85 percent at full load and high efficiency over the entire load range. The UCC28610 uses 30 percent fewer external components than standard flyback controllers and is designed for applications with an output power range of 15W to 65W. Examples include AC/DC adapters, gaming, notebook and printer adaptors, LCD TVs and monitors, set top boxes, appliance power supplies, bias supplies or other supplies that need to meet ENERGY STAR efficiency standards or requirements under the Energy using Products (EuP) directive of the EU across the entire load range.

www.ti.com

Expansion of Semi-Regulated Bus Converters Portfolio

SynQor announces the release of several new entries in its SQ60 series, expanding its BusQor family of isolated semi-regulated dc-dc converters for intermediate bus architecture applications. The SQ60 series accepts the full Telco input range of 36-75V and provides a semi-regulated 12V for point-of-load converters. These converters incorporate next-generation, board-mountable, fixed switching frequency technology, and use

synchronous rectification to achieve full load power conversion efficiencies approaching 96%.

The SQ60120ETA17 provides 204W in an open-frame, eighth brick package with power dissipation so low that it does not require a heatsink.

http://www.synqor.com

UL60950-1 Recognized Surface Mount Transformer

Engineers in search of a small surface mount transformer supporting telecom device data and speech applications will find the SM501-1 Telecom Transformer from Datatronic Distribution, Inc., delivers performance, quality and reliability while meeting stringent electrical industry standards.

The surface mount SM501-1 Transformer is suitable for a wide range of BS6305 Impedance Class A non-speech data and Class B voice applications in telecom equipment, laptops, modems, instrumentation and more.

Its dielectric strength is tested to 4600 Vrms and meets various international safety standards including UL60950-1.

The SM501-1 Transformer provides space-efficient isolation between sensitive electronics and telephone lines. Its high dielectric strength helps safeguard equipment users by protecting them from electrical shock.

The SM501-1 Transformer's symmetrical design means that there is no real primary or secondary winding. Key specifications include: impedance at 600 ohms (both primary/secondary), turns ratio is 1:1, 3.8 H shunt inductance and 6 to 7 mH leakage inductance at 1 kHz.

www.datatronics.com

Insulated Water Cooler for very Large Power Semiconductors

Westcode Semiconductors Limited (An IXYS company) announces a addition to its range of power semiconductor water coolers. The insulated Aluminium Nitride cooler has a 133mm diameter contact plate, making it suitable for press-pack devices with electrode contacts up to 125mm diameter.

The new coolers incorporate geometric water channels design to ensure low values of thermal resistance, even at moderate coolant flows, while retaining a robust structure compatible with the high clamping force required by large area power semiconductors. The geometric design used for the

water channels also ensures highly uniform cooling over the entire surface area. Typical cooler to input water thermal resistance for flow rate of 10 litres per minute, are 5.2 deg. K/kW (two coolers + 1 semiconductor) and 6.1 deg. K/kW (three coolers + 2 semiconductors). Isolation voltage between water and the device is 10kV (RMS for 1 minute).

These isolated coolers allow the implementation of very high power density high voltage solutions, without the need for expensive and complex de-ionised water systems. In applications such as traction drives, marine drives and wind turbines, the existing liquid coolant systems may be extended to the power electronics resulting in lower system cost, weight, noise levels and increased energy efficiency.

www.westcode.com

SPT+ Generation of 4.5kV IGBT Modules in Mass Production

ABB Switzerland Ltd, Semiconductors starts mass production of 4.5kV SPT+ IGBT modules after successful qualification and proven ramp-up phase in the traction market.

4.5kV HV-HiPak2 IGBT modules employ the well established SPT+ IGBT and diode technologies. These modules have significantly lower conduction and switching losses while exhibiting higher SOA capability when compared to the previous generation.

The SPT+ platform exploits an enhanced carrier profile through planar cell optimization, which is compatible with ABB's

advanced and extremely rugged cell design. The on-state losses of the new 4.5kV IGBT exhibit approximately a 30% reduction as compared to the standard SPT device while keeping the same Eoff value. For the 1200A rated Hipak2 module the typical on-state voltage drop (VCE,on) at nominal current and Tj=125 °C is 3.55V. For the same module the typical turn-off switching energy (Eoff) at 2800 Vcc and Tj=125 °C is 6J. The new 4.5kV HV-HiPak2 modules will provide high voltage system designers with enhanced current ratings and simplified cooling while further enhancing the recently acquired robustness of the SPT IGBTs.

ABB's 4.5kV modules are available in current ratings ranging from 650A – 1200A in single IGBT as well as Diode configurations.

www.abb.com/semiconductors

30-100W DC-DC Converters Address Railway Applications

Global power supply manufacturer TDK-Lambda has expanded its DC-DC converter line-up with the introduction of the new CN-A Series that have a wide range 60 -160VDC input, which is widely used in railway applications. Available with nominal output voltages from 5V to 24V (adjustable ±10%) and power ratings up to 100W, these wide input range, fully-regulated and isolated power supplies deliver exceptional performance in the industry standard quarter brick footprint. The CN-A DC-DC modules are suitable for

both rolling stock and fixed installations, enabling customers to design cost-effective EN50155 compliant systems without the risks associated with custom product designs and in a much shorter timescale. TDK-Lambda also offers a design and manufacture service for customers preferring to buy in complete systems meeting their exact electrical and mechanical requirements.

www.emea.tdk-lambda.com

300mA Voltage Regulators with Inrush Current Protection

Available in the tiny USPQ-4 package (1.0 x 1.0 x 0.4mm), as well as in standard SSOT-24, SOT-25 and SOT-89-5 versions, the XC6223 Series of voltage regulators from Torex Semiconductor offer ultra fast load transient response performance, PSRR is 80dB at 1kHz, as well as protection against inrush current. These fast, low dropout voltage regulators provide a highly stable, low noise supply that meets the demands of most battery-driven circuits.

A LDO doesn't normally use a soft-start circuit so at start up, the output voltage rises very quickly after the input voltage is applied. This can cause high peaks of inrush current.
With a standard LDO, there is no inrush current protection. So the inrush current will only be limited by the current limit of the LDO (assuming that the LDO has a current limit) and if that limit is already quite high then the potential inrush current can also be high.
With a built-in protection circuit, inrush current is kept to a relatively low value without compromising on the output current capability of the LDO.

http://www.torex-europe.com/products/range/306

Broadest Portfolio of Semiconductors Specified for Operation up to 150°C Ambient

Microchip announces it has the industry's broadest portfolio of semiconductors specified for operation up to 150°C ambient - including 8- and 16-bit PIC® microcontrollers (MCUs) and dsPIC® Digital Signal Controllers (DSCs); serial EEPROM devices, and analogue products. Qualified and tested in accordance with AEC-Q100 Grade 0 requirements, the devices are optimum for under-the-hood automotive applications; extreme-environment industrial applications, such as down-hole oil drilling and lighting;

and for medical applications such as devices that are sterilised in autoclaves. Engineers can now add intelligence directly into high-temperature applications, where the silicon can be mounted directly onto high-temperature assemblies. This enables new applications for electronics that were not possible before. More information is available at Microchip's new online High-Temperature Design Center.

www.microchip.com

Fully-Sealed Interconnect System

Molex Incorporated introduces its innovative, OEM-proven MX123™, a fully sealed, high-performance interconnect system optimised for transportation power-train applications. The MX123 system maintains low and stable contact resistance under severe temperatures and vibrations making it ideal for on-engine automotive applications, off-road construction and industrial equipment.
The MX123 system uses interfacial and matte-seal technologies to optimise sealing performance and reduce package size and harness-assembly complexity. Matte seal technology allows closer-to-centre terminal spacing and eliminates the need for crimping individual cable seals. The interfacial seal is interior to the connector shroud, protecting it from damage during harness handling. Plus, the header pins are protected from scooping by a centre wall that extends longer than the terminal length.

www.molex.com

ECPE Calendar of Events 2010: Topics & Dates

Date	Location	Event	Topic
25 – 26 February 2010	Nuremberg, Germany	ECPE Tutorial	**Power Electronics Packaging** Course Instruct.: Dr. J. Popovic (TU Delft/ECPE) Dr. U. Scheuermann (Semikron)
16 - 18 March 2010	Nuremberg, Germany	ECPE Annual Event in conjunction with CIPS 2010	**6th International Conference on Integrated Power Electronics Systems (CIPS 2010)** (with ECPE Member Meeting and PCC)
March 2010	TBD	ECPE Workshop	**Power Electronics for Smart Grids - Intelligent Buildings, Lighting and Appliances**
4 - 6 May 2010	Nuremberg, Germany	Conference	**PCIM Europe 2010** with ECPE Round Table “Power Electronics for Energy Efficiency and Sustainability” (Conference), with ECPE Joint Stand (Exhibition)
6 (evening) / 7 May 2010	Nuremberg, Germany	ECPE Workshop	**Thermal Interface Materials** Techn. Chairman: Prof. E. Wolfgang (ECPE)
8 - 9 June 2010	Torino, Italy	ECPE Tutorial	**Reliability of Power Electronic Systems – Robustness Validation in Automotive (Power) Electronics (with ATA Congress)** Course Instructor: Prof. E. Wolfgang (ECPE)
June/July 2010	TBD	ECPE Tutorial	**Power Semiconductor Devices & Technologies** Course Instructor: Prof. D. Silber (Univ. Bremen)
27 - 28 July 2010	Erlangen, Germany	ECPE Tutorial	**Thermal Engineer I** (thermal design and verification) Course instructor: Dr. M. Maerz (Fraunhofer IISB)
Sept. 2010	Bordeaux, France	ECPE Tutorial	**Reliability of Power Electronic Systems** Course Instructor: Prof. E. Wolfgang (ECPE)
11 - 15 Oct. 2010	Gaeta, Italy	Symposium	**ESREF 2010** with ECPE Workshop Session ‘Reliability´
12 - 13 Oct. 2010	Nuremberg, Germany	ECPE Tutorial	**Thermal Engineer II** (thermal management and reliability) Course Instructor: Prof. E. Wolfgang (ECPE)
Nov./Dec. 2010	TBD	ECPE Tutorial	**EMC in Power Electronics** Course Instructor: Dr. E. Hoene (Fraunhofer IZM) Prof. J.L. Schanen (G2ELab)
TBD	TBD	ECPE Workshop	**MW Drives and Generators**
TBD	TBD	ECPE Workshop	**Parasitic Effects in Power Electronics**
TBD	TBD	ECPE Tutorial	**Power, Control and Sensors (IGBT drivers)**

Powerful and Highly Reliable IGBT Modules

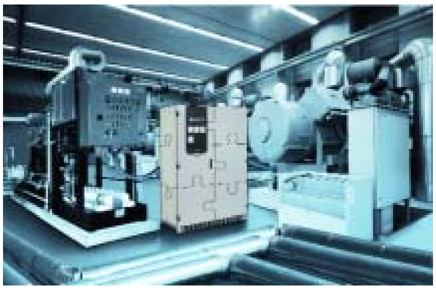
Infineon Technologies introduced EconoPACK™4 as the new member of the well known Econo module product range. Combining separated DC and AC links, screw power terminals providing excellent electric connection, and PressFIT control pins for solderless inverter assembly, the new EconoPACK™4 IGBT modules are the ideal choice for industrial applications. Available in current ratings from 100 A through 200 A and blocking voltage ratings of 650 V, 1200 V and 1700 V, EconoPACK™4 3-phase full bridge IGBT modules support powerful and compact inverter designs. eupec™ EconoBRIDGE™4 1600 V half-controlled input rectifier bridges up to 360 A nominal current complete the

line-up to be used for leading-edge power converters. Robust design, superb reliability, efficiency, low stray inductance and the new ultra-sonic welding of all power terminals and control pins are further advantages of EconoPACK™4. The modules rely on the latest IGBT4 chip technology with higher operation junction temperatures Tvjop = 150°C as well as up to 20% higher IRMS current and higher power cycling capability compared to previous chip generations. EconoPACK™4 modules in 3-level configuration are announced for 2010 and are particularly suited for power supply and renewable energy applications. Highest levels of efficiency and optimised filter cost can be realised using these 3-level one phase 650V IGBT modules from 200 A to 300 A nominal current.

www.infineon.com

Modular Design Helps Next Generation UPS Family Boost Reliability

Designed and built using a modular, building block architecture, Protect 8. UPS systems offer the most reliable performance available on the market. The building block approach marks Protect 8 as the world's first 'customer-ized' UPS each UPS is tailored to each customer's specific requirements.
The initial version launched by AEG Power Solutions is the Protect 8. 31, an industrial double-conversion model. All Protect 8 UPS are designed, assembled and tested in the

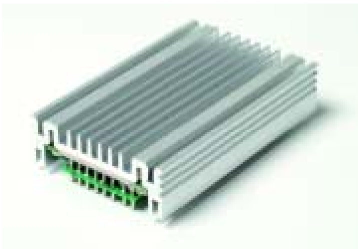


finest tradition of quality and reliability by AEG PS in Germany. Protect 8 employs VFI (Voltage Frequency Independent) technology and is a true online, double conversion UPS which guarantees a filtered, stabilised and reliable output voltage free from frequency variations, over-voltage and voltage dips.
The AEG Protect 8 has a 3 phase 400VAC input and single phase 230VAC output rated at 10/20/30/40/60/80/100/120 kVA, with customer specific ratings available on request.
The new Protect 8 UPS has an excellent dynamic response and demonstrates its "green credentials" by maintaining optimum efficiency even when not running at full load. Standard features include, extended load power-factor range, global efficiency ? 88% for UPS at 220 VDC, MTBF ? 150000 hours, variable speed low noise fans, output voltage and frequency adjustable via DOU (+/-3%), low THD on the AC output, UL compliant, parallel operation and UPS environmental protection to IP43. The Protect 8 has an Integrated Static-Bypass-Switch (Intelligent transfer zero switching time) and is fitted with an isolating transformer. Is short circuit resistant, proof against overload, can be operated with a central battery and has an ergonomic display and control unit.
Each Protect 8 UPS is built by assembling and configuring the particular rectifier, inverter and bypass modules exactly suited to each customer's specific requirements.
Thanks to this modular approach, Protect 8 systems offer exceptionally easy and rapid maintenance as any module can be quickly replaced if necessary. The building block design also reduces delivery times. AEG can assemble, configure, test and deliver Protect 8 systems in weeks rather than months.

www.aegps.com

DC/DC Modules for Railway Applications

A series of 120W DC/DC modules designed specifically for worldwide railway applications is announced by Martek Power. The CMS120 Series will interest designers of railway power supplies since they feature a very wide input voltage range, meet all relevant railway standards including EN50 155 and work across a broad operating temperature range without derating.
Designed to be PCB mounted, CMS Series modules are compact, measuring 92 x 45mm and just 20mm high - including an integral extruded aluminium heatsink. PCB connection is by 1.5mm diameter pins.
According to Martek Power, the new modules can be easily integrated into a customer's own power supply design using a minimum of external components. However, users can also use Martek Power to develop a custom power solution based around the CMS120 modules as "building blocks". Since the modules are available and already qualified to railway standards, this can provide a faster and more reliable route to market.



www.martekpower.com

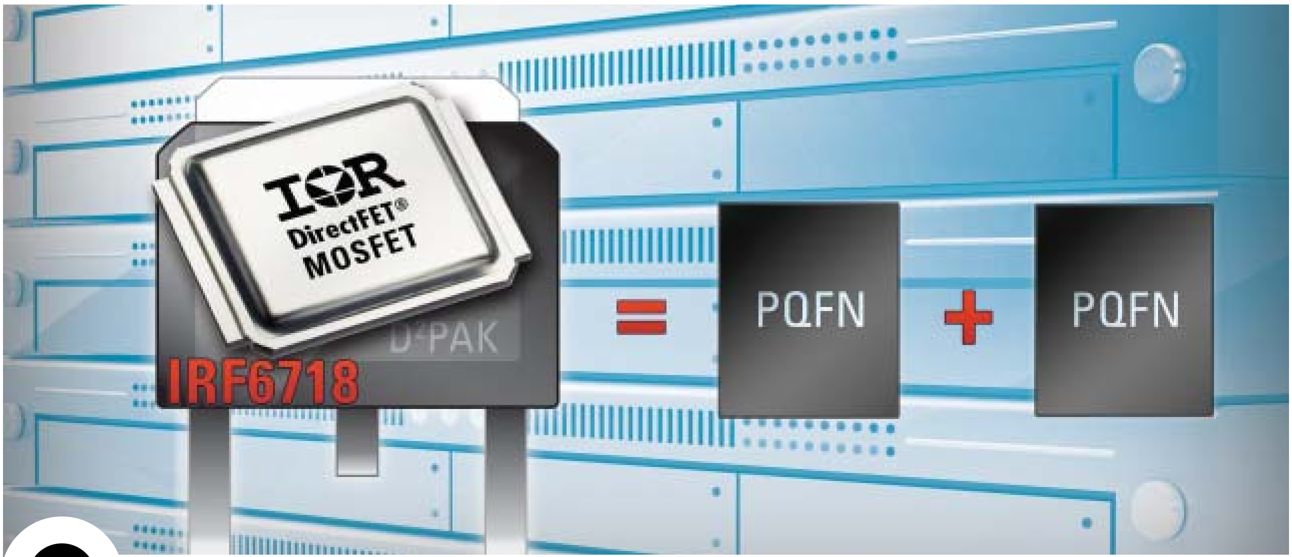
MIPAQ™ serve - IGBT Module with integrated Driver Electronics

Infineon Technologies introduces the MIPAQ™ serve. MIPAQ™ serve is a highly reliable IGBT module integrating an 3-phase full bridge configuration, a full set of driver ICs as well as digital temperature measurement. These functionalities enable MIPAQ™ serve to be a full plug-and-play solution for high-current drive applications up to 75 kW. Inside the module, there are galvanically isolated drivers based on Infineon's Coreless Transformer Technology. With the elimination of optical couplers, it will further enhance the modules' long-term stability.

The MIPAQ™ serve modules, based on the newly designed EconoPACK™ 4 utilizing 1200 V IGBT4, and manage currents of 100 A, 150 A and 200 A. High power connections are done using screws. Standardized connectors are provided for supply voltage and logic signals for plug-and-play.

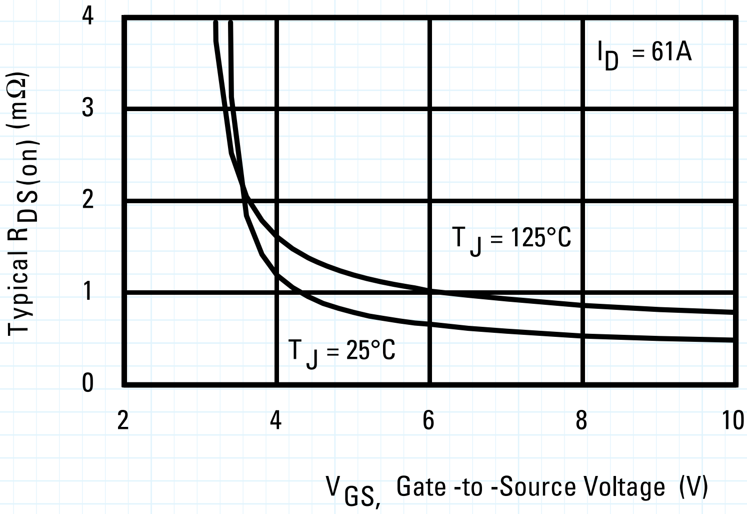
www.infineon.com

ADVERTISING INDEX



IR's IRF6718 Large Can DirectFET® MOSFET Delivers Industry's Lowest $R_{DS(ON)}$*

Optimized for Active ORing and Hot Swap Applications



Part Number	Package Size (mm x mm)	$R_{DS(on)}$ @10V typ. (mΩ)	I_D @ TA = 25°C (A)
IRF6718	7.1 x 9.1	0.5	270
Competitor 1	10.7 x 15.9	0.7	180
Competitor 2	5.1 x 6.1	0.95	60
Competitor 3	5.1 x 6.1	1.5	65

* Based on data compiled September 2009

The IRF6718L2 features IR's latest generation silicon technology in a new large can DirectFET® package delivering extremely low $R_{DS(on)}$ of only 0.5mOhm (typical) at 10V VGS in a 60% smaller footprint and 85% lower profile than a D²PAK. The IRF6718L2 significantly reduces conduction losses associated with the pass element in ORing or hot swap applications to dramatically improve the efficiency of the entire system.

FEATURES

- Industry Lowest $R_{DS(on)}$ for Reduced Conduction Losses
- Superior electrical and thermal performance in smaller footprint than D²Pak
- Dual-sided Cooling Compatible
- Reduces component count and board space compared to competing solutions
- Compatible with existing Surface Mount Techniques
- RoHS Compliant Containing no Lead or Bromide

for more information call +49.6102.884.311 or visit us at www.irf.com

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