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

### Features
- 50A gate drive current
- 2 x 6W output power
- +15V/-10V gate voltage
- Separated gate paths (on/off)
- 150kHz switching frequency
- 80ns delay time
- ±1ns jitter
- 3.3V to 15V logic compatible
- Integrated DC/DC converter
- Short-circuit protection
- Embedded paralleling capability
- Superior EMC (dv/dt > 100V/µs)
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XPT-IGBT the newest generation of short-circuit rated IGBTs

Drive with the XPT-IGBT

Features:
• Easy paralleling due to the positive
  temperature coefficient
• Rugged XPT design results in:
  – Short Circuit rated for 10 \( \mu \)sec.
  – Very low gate charge
  – Square RBSOA @ 3x \( I_C \)
  – Low EMI
• Advanced wafer technology results in low \( V_{ce(sat)} \)
• 10-50 A in 1200 V

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For more part numbers, go to www.ixys.com

Efficiency Through Technology
www.ixys.com

For more information please email XPT@ixys.de or call Petra Gerson: +49 6206 503249

www.bodospower.com  September 2009  Bodo’s Power Systems®
We offer the widest range of Aluminum Silicon Carbide (AlSiC) Metal Matrix Composite (MMC) materials to help you solve your thermal management problems arising from coefficient of thermal expansion (CTE) mismatch, thermal cycling and thermal stress.

Our HEATWAVE™ high performance AlSiC materials combine excellent thermal conductivity and controlled thermal expansion with low density and stiffness to match the high performance characteristics of modern power semiconductor device packaging solutions and systems.

As an ISO 9001 and ITAR registered company, we provide highly reliable quality and service. From standard to highly custom designs and low to high volume requirements, we work side by side with you to design and produce the best value AlSiC product for all your demanding thermal management applications.

For more information, visit www.rogerscorp.com/tms
**Viva España!**

See You in Barcelona!

The next major power event, EPE in Barcelona, will focus on renewable and more efficient solutions. Engineers will get together in the second week of September to discuss university-driven results leading to practical designs. For all of you that cannot travel to participate personally and gather crucial information, my publication brings it to you in print each month, on the web around the clock and in bi-monthly e-newsletters for instant updates.

The magazine has this year so far provided 504 pages of good up-to-date information to drive engineers towards better designs and a more efficient use of the world’s energy resources. It has been up to you, my readers and supporters, to select quality in power publications. Page count and on-time delivery show that I am on the right track. I would like to thank my friends in the industry for their constant and uninterrupted support which I hopefully can reciprocate. In these days, when businesses struggle, mutual support provides a good foundation for the better times to come.

Industry is showing signs of recovery and optimistic forecasts are starting to appear. We have learned that consolidation and even stagnation is survivable but can be difficult to manage. Banks and their financial support system are often of no help. Nevertheless, banks have granted bonus payments to their employees, eating into government money provided for their survival. This has happened all around the world. It is a shame to see, once more, how selfishly top level bankers operate their businesses. There is no ethic in this. Hard working society must make up for their losses with taxes, while bank managements pamper their own needs. How silly must we be and what must we do to make our governments prevent such behaviour? As long as top-level bonuses bear no relation to performance, banks will continue to resemble a Vegas gambling operation.

One good thing in this unfortunate situation is that less activity has reduced pollution. Has our quality of life suffered - maybe not (presuming we are still employed)? My observation is that life frequently changes, and we must adapt quickly, accepting the facts and not dreaming about the sky.

My Green Power Tip for the coming months:

When sitting on the patio to enjoy an upcoming evening, use a blanket or a sweater to keep away the chill – forget about turning on the heater.

See you in Barcelona at EPE.

Best regards
Ready for mass production.
The new LEM surface mount transducer.

HMS
Taking open loop technology to the next level:
introducing a surface mount device.

- Automatic assembly
- Dedicated LEM ASIC inside
- Compatible with the microcontroller or A/D converter, reference provided outside or forced by external reference, 5 V power supply
- Improved offset and gain drifts and enhanced linearity over traditional open loop designs
- Test isolation between primary and secondary: 4.3 kV_{RMS}
- \( V_{\text{Ref IN/OUT}} \) on the same pin
- 8 mm creepage and clearance distances + CTI: 600
- No insertion losses
- Several current ranges from 5 to 20 A_{RMS}
- Faster response time versus shunt and insulation solution

www.lem.com

At the heart of power electronics.
Online Simulation Tool to Select Right Products

ROHM Semiconductor has further enhanced its service offering and has set-up a new interactive web-based simulation service that facilitates part selection for design engineers. After performing the design simulation, they receive an immediate measureable result and can be sure that the chosen parts exactly fit their requirements.

By simply registering for ROHM’s electronic laboratory (http://www.rohm.com/ad/sim/index.html), users can freely vary and customize the external components and choose and adjust input signals. While the interactive tool is leading them through the entire process, they easily design their circuits and evaluate the characteristics and operation of their application. Finally, they receive a part list based on the simulation results.

In detail, the single steps comprise of the selection of the product family, the specification of the in- and output conditions, the selection of the ICs, the determination of required parameters, the simulation as well as the confirmation of the results and the display of the parts list.

Currently the ROHM Electronic Laboratory is available for switching regulators and H-bridge drivers and will be expanded to include additional product groups in the near future.

www.rohmeurope.com

Acquisition of Danfysik ACP A/S

LEM the market leader in providing innovative and high quality solutions for measuring electrical parameters, announces the acquisition of the Danish company Danfysik ACP A/S.

The deal is a strategic bolt-on acquisition in order to strengthen the position of the LEM Group in the field of very high precision current measurements.

Danfysik ACP (Advanced Current Products) is the world’s leading company in the development and manufacturing of highest precision current transducers for three main markets: medical scanners, precision industrial motor controls and test & measurement.

LEM has acquired the transducer activity with a turnover of CHF 7.6 million in 2008 and 15 employees. The company is based near Copenhagen, Denmark. The acquisition was finalized for an undisclosed amount.

Paul Van Iseghem President & CEO of LEM said: “Danfysik and LEM can already look back at a successful 12 year relationship. We are taking advantage of this strategic bolt-on acquisition to create a new focus on the high precision current transducers market.”

www.lem.com

ECPE Calendar of Events 2009 Update

10 - 11 September 2009, Residencia d’Investigadors, Barcelona, Spain
3rd SiC User Forum Potential of SiC and other Wide Bandgap Semiconductors in Power Electronic Applications
Chair of seminar: Prof. A. Lindemann, Otto-von-Guericke-University Magdeburg, Prof. J. Millan, CNM Barcelona and Thomas Harder, ECPE e.V.

ECPE Tutorial “Thermal Engineer”; Part 2: Thermal Management and Reliability
13 – 14 October 2009 in Nuremberg, Germany
Course Instructors: Prof. Eckhard Wolfgang, ECPE e.V., Germany and Dr. Uwe Schueermann, Semikron Elektronik, Germany

ECPE-Double-Workshop on “Advanced Power Electronics Packaging and Mechatronic System Integration”, held on 30th September – 1st October 2009 in Paris, France. On the 1st day – chaired by Prof. Dr. Bruno Allard (INSA de Lyon – SEEDS ISP3D) Advanced Power Electronics Packaging developments and trends will be presented and discussed with focus on the low-power side.

The 2nd day – chaired by Dr. Gerard-Marie Martin ( Valeo) will focus on Mechatronic System Integration.

ECPE Tutorial EMC in Power Electronics will be repeated in the 2nd week of October 2009 in Berlin, Germany.

Course Instructors: Dr. Eckart Hoene, Fraunhofer Institute IZM, Germany and Prof. Jean-Luc Schanen, Institute Nationale Polytechnique de Grenoble (G2ELab), France

The ECPE Calendar of Events 2009 with all ECPE Seminars, Workshops and Tutorials is available on the ECPE web site for download.

www.ecpe.org

Collaborations in Hydrogen and Fuel Cell Science and Technology

The International Energy Agency (IEA) Hydrogen Implementing Agreement (HIA) is the largest and longest lived global collaboration in hydrogen RD&D. Founded in 1977, the IEA HIA (www.ieahia.org) now has 22 members, including the European Commission, and it continues to grow. IEA HIA facilitates and manages a coordinated portfolio of RD&D and analysis activities in hydrogen production, storage, conversion, safety, integrated systems, economics and marketing.

The IEA Advanced Fuel Cell Implementing Agreement (IEA AFC) was created in 1990, with 19 members. Its aim is to enhance understanding in the field of advanced fuel cells. The IEA AFC (www.ieafuelcell.com) program includes RD&D and system analysis on Molten Carbonate (MCFC), Solid Oxide (SOFC) and Polymer Electrolyte Fuel Cell (PEFC) systems.

www.hydrogenassociation.org

www.lem.com
Intersil’s Zilker Labs delivers the most power-efficient, flexible and easy-to-use digital power solution on the market today. Our patented Digital-DC™ technology and proprietary algorithms deliver unmatched, better-than-analog power efficiency of >90% across a wide range of operating conditions. More magical than that, you can easily customize your power solution to match your unique system requirements without changing components or programming. Finally, there’s a small, one-chip solution that delivers all the power efficiency, design flexibility, component reduction and simplicity you’ve been expecting from digital power.
SEMICON Europa has always been the place where industry leaders met and prepared for future challenges. But with the changing environment, the SEMICON Europa 2009 show and conferences, held for the first time in Dresden, have been adapted and are focused on the real needs and challenges of the Semiconductor industry in Europe.

This year’s event will focus on the real needs! The SEMICON Europa show and conferences have been adapted and are focusing on the real needs and challenges of the Semiconductor industry in Europe.

1. Fab Enhancement - SEMICON Europa is focusing on the issues surrounding fab enhancement include sustainability, cost control and productivity. Tool Life-Cycle Management Agility and Productivity Energy Conservation Pushing Lithography Limits

2. Science Park - Research and Innovation SEMICON Europa will spotlight the technologies and trends emerging from Europe’s world class labs and research institutions. Meet with the most prime institutes at Semicon Europa’s Science Park: Fraunhofer CNT, ENAS, IISB, IPA, I2M, IWs, IWS and VfE, IMEC, EFDS - European Society of Thin Films, Semitec, Dresden, MifPlaza, ... and many more

3. Secondary Equipment, Services and Technology Pavilion - The secondary and refurbishment equipment market is growing each year, especially in Europe. Customers looking for carefully refurbished equipment that is fulfilling their production needs and making use of a cost advantage. Meet at the dedicated pavilion and discuss your requirements with the leading suppliers.

In addition to the above, programs are held as in previous years on the following topics.
- MEMS / MST Advanced Packaging and Testing
- SEMI Industry Standards
- Market Briefing
- Executive Summit

www.semiconeuropa.org

Increased Growth through Strategic Acquisition

Waytronx, Inc., the leading provider of open-ly licensable advanced systems cooling solutions, announced that, effective July 1, 2009, it has acquired Comex Instruments Ltd and 49% of Comex Electronics Ltd, along with the associated distribution network, both Japanese based providers of electronic components. Effective immediately, Comex Instruments and its distribution network shall become CUI Japan Ltd, a wholly owned subsidiary of Waytronx. Kunio Yamagishi, Comex’s current Managing Director, shall remain as Managing Director of the new entity, while Matthew McKenzie, Waytronx’s Chief Operating Officer, will become the COO of CUI Japan Ltd. William Clough, Waytronx’s President & CEO, shall become Chairman of the Board of CUI Japan Ltd. Said Board to consist of Mr. Yamagishi, Mr. McKenzie, and Mr. Clough. Dan Ford, Waytronx’s Chief Financial Officer, shall become CFO of the new entity. Those same individuals will takeover the same positions with Comex Electronics. The company does not expect any organizational changes to CUI Japan Ltd’s operations in Asia.

www.waytronx.com
www.cui.com

PV Inverter Efficiency Exceeds 99 Percent

The Fraunhofer Institute for Solar Energy Systems ISE has set a new world record of 99.03 % for the efficiency of inverters used in photovoltaic systems. By using new components and improving the circuit technology, the researchers have thus reduced losses compared to their own previous top-level performance by a further third.

“We now use junction field-effect transistors (JFETs) made of silicon carbide (SiC) manufactured by SemiSouth Laboratories Inc.. This is the main reason for the improvement”, explained Prof. Bruno Burger, leader of the Power Electronics Group at Fraunhofer ISE. “In addition, we have optimised the gate units and many other details of the circuit.”

The world record was measured for a complete PV inverter, including its internal power supply, a digital signal processor (DSP) for controls, an LCL grid filter and a relay for connection to the grid. Further advantages result when the improvements are transferred to series production: Higher efficiency means lower thermal losses, smaller cooling devices and a more compact construction.

www.ise.fraunhofer.de
High Frequency Artists!

**1SC2060P Gate Driver**

The 1SC2060P is a new, powerful member of the CONCEPT family of driver cores. The introduction of the patented planar transformer technology for gate drivers allows a leap forward in power density, noise immunity and reliability. Equipped with the latest SCALE-2 chipset, this gate driver supports switching at a frequency of up to 500kHz frequency at best-in-class efficiency. It is suited for high-power IGBTs and MOSFETs with blocking voltages up to 1700V. Let this versatile artist perform in your high-frequency or high-power applications.

**Features**

- Ultra-compact single-channel driver
- 500kHz max. switching frequency
- ±1ns jitter
- +15V/-10V gate voltage
- 20W output power
- 60A gate drive current
- 80ns delay time
- 3.3V to 15V logic compatible
- Integrated DC/DC converter
- Power supply monitoring
- Electrical isolation for 1700V IGBTs
- Short-circuit protection
- Fast failure feedback
- Superior EMC
EPE 2009, Barcelona 8-10 September 2009

EPE 2009, the European Power Electronics and Applications Conference in Barcelona, sponsored by the EPE Association and the National Organizing Committee, goes strongly renewable and industrial. Do not miss an outstanding opportunity!

EPE 2009 will offer, co-organised with ECPE, state-of-the-art keynotes and several industrial sessions, running in parallel with the regular conference sessions, with invited presentations from industry world leaders as well as from relevant academic institutions and round table meetings to discuss in depth and focus on future developments in new or emerging topics as well as advanced industrial applications, of special interest to the power electronics community.

Active and Passive Components will be discussed on the first day of the Conference. The day will begin with a Keynote Presentation, coming from the University of Bremen on the state-of-the-art and future of wide gap devices. After the keynote, industrial sessions will highlight High Frequency Semiconductors for Industrial Power, with contributions from Infineon, CREE and Mitsubishi, High Power Semiconductors for Industrial Power, with speakers from Siemens, ABB and Infineon Tech Bipolar and Passives/Related Topics with contributions from In-Power Systems, EPCOS and Semikron. The first Conference day will end with an Invited Lecture, coming from the Technical University of Chemnitz, on design for reliability with IGBT modules and a Round Table on the topic of the day.

Mass Transportation Technologies presentations will happen on the second Conference day. Two Keynotes Speeches are planned, the first one, coming from the University of Nottingham, is devoted to the more electrical aircraft and its future technologies. The second one, from the Technical University of Munich, is related to hybrid electrical vehicle, heavy duty, fuel economy and hybridization factor. The following industrial presentations will cover, The More Electrical Aircraft Systems with speeches from Rolls-Royce, Liebherr and GE Aviation, Advanced Railway Systems, with presentations coming from Siemens, Alstom Transport and Shinkansen R&D, and The More Electrical Ship Technologies with contributions from Converteam, Ingeteam and Wartsila. The Invited Presentation of the afternoon, conducted by ECPE, will discuss reliability of power electronics systems ending, the second Conference day industrial sessions, with the corresponding Round Table discussion.

Offshore Wind Becomes a Priority for the Obama Administration

Calling it a major step forward in President Obama’s new energy frontier, Secretary of the Interior Ken Salazar, joined by New Jersey Gov. Jon S. Corzine, issued five exploratory leases for renewable wind energy production on the Outer Continental Shelf offshore New Jersey and Delaware.

“We are entering a new day for energy production in the United States – a time of clean energy from renewable domestic sources on our Outer Continental Shelf,” Secretary Salazar said. “Other nations have been using offshore wind energy for more than a decade. We made the development of offshore wind energy a top priority for Interior. The technology is proven, effective and available and can create new jobs for Americans while reducing our expensive and dangerous dependence on foreign oil.”

Offshore Wind becomes a top priority for Interior, Obama administration

Secretary Salazar issued the exploratory leases, the first of their kind ever issued by the Federal Government, to Bluewater Wind New Jersey Energy, LLC; Fishermen’s Energy of New Jersey, LLC; Deepwater Wind, LLC; and Bluewater Wind Delaware, LLC.

The German Solar Energy PV Market

Germany has been leading the way towards a healthy solar energy market for some years now. Despite the global economic crisis, and a decreasing feed-in tariff, the German market has been reporting growth figures of around 20-30% per year, and solar energy companies in Germany are reasonably optimistic about the near future.

German installers certainly have sufficient reason to be optimistic with lower prices for solar energy systems sparking new consumer interest. According to the results of the BSW’s recent business climate index, solar companies’ commercial expectations are at their highest level since measurement began back in 2005.

The future of the German market, and the dynamics in other top ten markets, will be discussed at the third Global PV Demand Conference in Hamburg on 22 September 2009.
American Superconductor Corporation, a global energy technologies company, announced that it has amended its multi-year contract with Beijing-based Sinovel Wind Corporation Limited, China’s largest wind turbine manufacturer, to enable Sinovel to meet increased demand in China for its 1.5 megawatt wind turbines.

The original contract called for AMSC to ship core electrical components for Sinovel’s 1.5 MW wind turbines beginning in January 2009 through the end of December 2011. Under the terms of the amended contract, AMSC will increase its core electrical component shipments to Sinovel in calendar year 2009 and 2010 and will complete all shipments by the end of April 2011. The contract was also amended to include a greater number of AMSC’s wind-specific PowerModule PM3000W power converters. Optimized for wind turbine applications, the PM3000W enables Sinovel to include in its wind turbines grid-friendly features such as Low Voltage Ride Through. The initial contract included a larger fraction of PowerModule PM1000 power converters. As a result of this power converter upgrade, the overall contract value (excluding value added tax) has been increased by approximately US$20 million to more than US$470 million.

Rogers Corporation, a global supplier of specialty material solutions, has launched a new Chinese language website. The comprehensive site provides engineers, product designers and other site visitors with the highest level of regionalized service. The new Rogers’ China site provides streamlined links from markets to applications to products in order to help customers create innovative product designs that deliver high performance and reliability. Chinese-speaking customers can not only search Rogers’ extensive range of unique materials, but can also find technical data and design tools to help in their design process. Rogers’ engineered materials and technical solutions address a wide-array of applications requiring superior performance, reliability and design. Products include high performance foams for sealing, cushioning and impact protection; advanced circuit materials for high frequency applications; unique lighting solutions for electronics, signage and automotive interiors; customized power distribution systems; thermal management solutions, and more.

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Pulse Electronics has launched a new family of mil-spec', low-voltage power modules. Called Cheetah II, the family debuts with output powers of up to 150W; but with 200W expected to be available later in the year. Standard input voltages will be 28 and 48V; and outputs can be single, dual or triple with voltages of 12, 15 and 24V available in the debut modules. The full range is expected to span from 3.3 to 48V (output).

Unlike other power modules, which tend to be just enclosed DC-DC power boards, Pulse Electronics’ Cheetah II family members also include input conditioning boards. Here, the conditioning includes differential and common-mode filtering, input current limiting, input reverse protection and transient ride-through. This last feature has given the Cheetah II modules a wide (input) dynamic range: from 15 to 120V.

Alarm signals, all of which are opto-coupled, included in the new modules are: ‘Output Voltage Good’, ‘Input Voltage Good’ and ‘Over-temperature’. David Blofield, Pulse Electronics’ Sales & Marketing Manager, comments: “The Cheetah II low-voltage power modules are probably the most advanced, high-reliability mil-spec’ modules on the market, and they have very small footprints considering their output power - and the fact that conditioning and alarm circuitry is also included within the volume.”

The modules feature Pulse Electronics’ Planar Technology, which sees transformers formed within the layers of the PCB - as opposed to having traditional wound components fixed to the circuit board. The benefits of Planar include improved EMC characteristics, reduced PCB sky-line and greater tolerance to physical shock and vibration.

Each module in the range weighs less than 100g. In a standard [internal] configuration, in which the conditioning circuitry board is located above the power board, a module has a quarter-size PCB footprint; measuring 40(W) x 20(H) x 70mm(D).

However, in applications where a low profile is required, the conditioning and power boards can be placed side-by-side: which lowers the height to around 10mm (whilst increasing the module’s width to about 80mm. Blofield adds: “Advice on structural configurations and topography is available from Pulse.”

The modules have passed MIL-STD-461E (EMC) for aircraft use and environmental test passes include shock, vibration and acceleration to MIL-STD-810E. Typical operating temperatures range from -40 to 70oC, though thermal protection can be provided for up to 115oC at the base plate.

Blofield concludes: “Whilst targeted at aerospace and defence applications, the Cheetah II modules are also suitable for other embedded applications - including medical and telecommunications - in fact, anywhere where efficiency and reliability are of paramount importance.”

In addition, a module evaluation card is available that can accept any Cheetah II low voltage module plus hold-up capacitors (if required). Input and output voltages, plus alarm signals, are brought to D-type edge-connectors of the evaluation card.

Established in 1975, Pulse Electronics specialises in the design, development and manufacture of high-efficiency power systems for aerospace, defence, industrial, telecommunications and other demanding embedded applications. The company is also servicing upper professional and scientific power supply markets.

The company is based in St Neots, in the United Kingdom, and its engineering capabilities include: electronic and mechanical design; PCB layout, production and test; system integration; and through-life product support. In addition, Pulse Electronics invests heavily in design and modelling tools, including those used for thermal and vibration modelling, and has in-house facilities for environmental evaluation and qualification, including preliminary EMC examinations.

Pulse Electronics’ manufacturing department is configured to handle small to medium volume, high quality production runs. Furthermore, the company’s continual investment in the latest SMT automated assembly and inspection equipment serves to optimise the manufacturing process to deliver consistent product.

www.pulse-electronics.co.uk
The Power Conversion World Is Changing. Are You Ready To Go Digital?

Digital power technology is advancing rapidly... is your controller flexible enough to keep up?

If you’re considering digital power for improved power density, reliability, efficiency and lower system cost, you need a controller that offers:

- Digital power-specific peripherals
- Flexible peripheral interconnect to reduce CPU workload
- Small size (6x6 mm footprint)
- Efficient compute engine
- Low cost

Microchip has developed its next-generation, low-cost “GS series” of dsPIC® Digital Signal Controllers (DSCs) specifically for digital loop control. These 16-bit devices are flexible enough to adapt to your technology advancements for years to come.

GET STARTED IN DIGITAL POWER

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2. Use our online Digital Power Design & Simulation Tools
3. Download a Digital Power Webinar
   www.microchip.com/SMPS

Intelligent Electronics start with Microchip

www.microchip.com/SMPS
LED lighting is coming up everywhere – from streetlights to cars, from architectural lighting to lamp replacement in our homes. The advantages are plenty – better efficiency than incandescent bulbs (that are on their way to extinction), a very long lifetime (so that in many cases the lamp may not need replacement), and the color rendering is better, too. It is surprising that the LED lighting market is not growing even faster!

The two main reasons for this delay can be found easily when regarding the system level: First, in many cases we are trying to retrofit LED lamps into existing housing and sockets – a problematic approach, since the LED cannot radiate its generated heat away like an incandescent bulb, simply because it does not produce infrared. Second, dimming with phase-angle cutting works with incandescent bulbs, and to a certain extent with halogen lamps, but not really with LED lighting, plus a few other issues.

It is clear that if a LED-based light source can be used with the existing infrastructure of sockets and housing, the penetration rate can be faster. But, is that really true? Up until today, LED lighting has been a much higher initial investment than traditional lamps, with the advantages of lower energy consumption and longer lifetime only paying out over time. So, it could be argued that as long as regulations are not forcing the use of a more eco-friendly lamp, unfortunately the cheaper lamps will prevail.

At the same time, introducing new concepts, with new cooling concepts or different power supply systems will have to gain customer acceptance, a process that can be time-consuming. Interestingly, one example stands out: LED streetlighting. The cities and communities are spending up to 40% of their budget today on streetlighting, mostly electricity cost but also significant amounts on maintenance. They did understand pretty fast that a lamp that consumes less electricity, also because it can be dimmed easily in line with the ambient light, and that has a very long lifetime, avoiding expensive and proactive repair work, will save them a lot of money.

It seems that individual lamps can greatly benefit from a primary-side-regulated (“PSR”) power supply, such as the FAN102 from Fairchild Semiconductor, since it has low component count at very good regulation, and the design for safety is greatly improved, since it is all concentrated in the transformer – a well-known component. For higher power and demanding applications like streetlights, new concepts using high-PFC flyback converters or LLC converters such as the FSFR2100, combined with active PFC like the FAN9612 offer high power density and efficiency, low EMI and very good reliability.

LED lamps fitting traditional sockets will find their place, as well as systems that accept phase-angle dimming. But the future is elsewhere - in lighting systems that really exploit the advantages of LED lighting, with a distributed light generation and its associated power conversion, high-efficiency power supplies that can be integrated in a home network, and color and luminosity regulation to make sure the whole factory floor sees the same light. And, the components to make these systems do all exist – all it takes is to convince the end customers to their own better.

LED lamps fitting traditional sockets will find their place, as well as systems that accept phase-angle dimming. But the future is elsewhere - in lighting systems that really exploit the advantages of LED lighting, with a distributed light generation and its associated power conversion, high-efficiency power supplies that can be integrated in a home network, and color and luminosity regulation to make sure the whole factory floor sees the same light. “The fact is that the components to make these systems already exist. The challenge is to ‘enlighten’ the end customers to the benefits it will bring them.”
Solutions for windpower systems
Energy-efficient components for high system reliability

THE INFINEON PRODUCT PORTFOLIO provides components for the highest energy efficiency in windmill power converter and pitch control solutions.

OUR POWER MODULES with newest 1200V/1700V trench fieldstop IGBT4 and Emitter Controlled diode chip technology offer best in class power density solutions in conjunction with extended lifetime. The modules feature low on state losses, optimized soft switching behavior and a wide operation temperature range up to 150°C maximum junction operation temperature. The newly introduced stack assembly ModSTACK™ HD leads to more than 50% higher power density at same footprint.

The following benefits are provided to our customers:
- Extended module utilization by 150°C maximum junction operation temperature
- Highest power density
- Supreme power cycling and thermal cycling capability

[www.infineon.com/highpower]
Almost double and spending on equipping in fab construction projects are expected to increase in 2009, so SEMI. In 2010, investments over-year basis is expected to fall by 51 percent if their revenues are measured in Euros. Spending on front-end fabs (construction and equipping) has seen a consistent quarterly decline since 2008, with their combined revenues falling 30.8 percent since the third quarter of 2008. Companies headquartered in the Americas fared better during the downturn, with a combined revenue decline of 30.8 percent since the third quarter compared to the fourth quarter, so iSuppli. On a sequential basis, revenue will rise by 7.1 percent in the second quarter, by 4.9 percent in the third quarter and by 10.4 percent from the fourth quarter, so iSuppli. Around $ 2.7 trillion globally have been announced, so Siemens. Around one third of this total – or almost $1 trillion - is slated for investment in infrastructure projects. The remainder is accounted for example by tax cuts for private households. The total volume of planned infrastructure expenditures relevant for Siemens comes to about $ 210 billion globally. At slightly more than $ 120 billion, the share of the U.S. stimulus program’s portion relevant for Siemens represents the largest share of the worldwide total. China is in second place with a Siemens-relevant share of approximately $ 35 billion, followed by Germany with a share of around $ 7 billion. Major parts of these amounts are earmarked for green technologies.

**SEMICONDUCTORS**

Worldwide semiconductor revenue in the first quarter declined to $ 44.3 billion, down 18.8 percent from the fourth quarter, so iSuppli. On a sequential basis, revenue will rise by 7.1 percent in the second quarter, by 10.4 percent in the third quarter and by 4.9 percent in the fourth quarter. Of the 130+ semiconductor suppliers tracked by iSuppli, only six managed to expand their revenue in the first quarter compared to the fourth quarter of 2008. Overall revenue was down 36.2 percent from the start of the present sharp downturn in the third quarter of 2008. Companies headquartered in the Americas fared the best during the downturn, with a combined revenue decline of 30.8 percent since the third quarter of 2008. European-headquartered companies suffered the worst decline, with their combined revenues falling by 44.5 percent during the same period. But European supplier revenues fell by only 36.1 percent from the start of the present sharp downturn in the third quarter of 2008. Overall revenue was down 36.2 percent from the fourth quarter, so iSuppli. The 28nm alliance builds on the success of earlier joint development work in 32nm HKMG technology. The alliance, based at IBM’s facility in East Fishkill, now includes Charter Semiconductor, Globalfoundries, Infineon Technologies, NEC Electronics, Samsung Electronics, STMicroelectronics, and Toshiba. TSMC has raised its capex budget for 2009, according to company chairman and new CEO Morris Chang. The foundry plans to raise its 2009 capex to around $ 1.9 billion, which is close to the 2008 level of $ 1.89 billion. The majority of the capex will be used on R&D for advanced processes.

**OPTELECTRONICS**

The TFT-LCD panel market has entered into a definite recovery phase, so Displaybank. May 2009 large-area TFT-LCD panel shipments indicate all time record-high shipments with 43.73 million units which increased 5.4 percent Y/Y. The LCD TV panel shipments increased 13.7 percent MM and 41.6 percent from Y/Y. The LCD TV shipments are about 28 percent of the total large-area panel shipments and 56 percent of the total revenue.

**PASSIVE COMPONENTS**

The new edition of the worldwide passive & interconnection component markets database from Decision is available. The worldwide passives market in 2013 should be equivalent to 2008 level as growth is expected to come back in 2011, after a 10 percent decline in 2009. Decision also estimates a 2009 decline of the world connector market at -7 percent over 2008. Geldern and Pflülingen, the German locations of Ruwell, a German manufacturer of PCBs, have now passed the TÜV audits for certification of their quality assurance system in accordance with ISO TS 16949.

**DISTRIBUTION**

Future Electronics announces a pan-European franchise agreement with Multitech (USA), a supplier of interchangeable (socket) modems covering a wide range of wired and wireless technologies. PLX Technology, a supplier of semiconductors and software solutions, announced the addition of Avnet Advanced Power Components (APC), the UK specialist distributor and manufacturers’ representative of electronic components, has signed a distribution agreement with AVX to distribute its established range of high reliability capacitors including tantalum, ceramic and other advanced devices. The products will be distributed through the APC Hi-Rel unit. EBV Elektronik has chosen renewable energies as the topic for the latest edition of its knowledge magazine.

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: eids@europartners.eu.com or by fax 44/1494 563503.
Intelligent Power Modules for Photovoltaic Application

- 5th Generation trench chip (CSTBT™) for lower saturation voltage $V_{CE(sat)} = 1.55\, \text{V}$ at rated current and $T_j = 125\, \text{°C}$
- Integrated high speed control ICs for switching frequencies up to 30kHz
- Low noise (controlled di/dt)
- On-chip temperature sensing and individual OT protection
- With one, two or without boost converters built in for multi-string operation
- Rated currents of 50A and 75A with a rated voltage of 600V
New Drivers in Digital Power

By Linnea Brush, Senior Research Analyst, Darnell Group

The “mainstream” adoption of digital control has happened relatively recently and includes the introduction of dedicated, digital controller ICs. Since these products have only been around for the past few years, we are still a few years away from a 50% market penetration of digital control into the general power supply market. Darnell estimates that the worldwide digital power controller IC unit market share will reach nearly 50% by 2014, with the overall digital IC market (controller, converter and system ICs) growing from about 5 billion units to 12 billion units between 2009 and 2014. This includes embedded and external ac-dc power supplies, all dc-dc converters, along with some lighting ballasts and inverters.

It took 10 years for switch-mode to go from mainstream commercial products to 55% of the market. If digital follows this line, it has a lot of market potential ahead of it. In fact, Darnell sees digital just starting to enter its “growth phase,” with the lifecycle curve not even flattening in the next five years. It is still rare to find a “pure digital solution,” for instance.

What does this mean for power supply companies? First, the digital power management and control market is not only alive, it is just entering its adolescence. Its biggest growth spurts are immediately ahead, and maturity is still years away. This is always an exciting time for any market, since the groundwork has already been established and companies don’t have to “make a case” for the technology anymore. Even though the major players are established, the way is now open for companies to differentiate themselves in specific application segments and product lines.

Like switch-mode regulation, digital control is not a limited technology. It has applications in embedded and external ac-dc power supplies, isolated and non-isolated dc-dc converters, telecom rectifiers, and lighting ballasts. Most importantly, digital has penetrated nearly all application segments, from high-performance computing to high-volume consumer products. Companies are also offering products for newer segments such as medical and solid-state lighting, and newer functions such as power factor correction and regenerative power.

New digital product designs and architectures are expected, as well, including those emphasizing efficiency, configurability and reliability, along with more accurate voltage and current regulation. Centralized control and multi-phase system architectures are increasingly being deployed. Controller IC architectures can take the “state machine” approach or the “microcontroller-based” approach; the two are not mutually exclusive, but recent trends are clarifying where and how these two approaches can be best utilized.

Customers continue to demand efficiency, with regulations and the cost of energy driving this demand. Power supply prices are at historic lows, and the global economic downturn has made efficiency an important differentiating factor. The concept of “intelligent power management” is being extended to higher-level system implementation, as well.

Although the adoption of digital control is occurring in a more measured fashion, several developments are being cited as “likely to have the biggest impact on the digital control power supply market” over the next year or so. Recent acquisitions of digital solution suppliers by large semiconductor makers is one such trend. Acceptance in the mainstream desktop, server and graphics markets will also push adoption, proving an advantage (as well as being able to compete) at a competitive cost level. Auto-compensation and auto-tuning are seen as important developments in digital control technology.

Digital power management and control is on the cusp of widespread implementation, and despite a slower economy, the technology developments are not only likely to continue, but are likely to enable the very efficiencies and cost-effectiveness that customers are looking for. The next couple of years should see the emergence of an even more-established market for digital control products.

Standards are helping to drive this adoption. For example, the European Directive 2005/32/EC encourages manufacturers to produce products that are designed to minimize their overall environmental impact. According to the Directive, “Energy efficiency improvement – with one of the available options being more efficient end use of electricity – is regarded as contributing substantially to the achievement of greenhouse gas emission targets in the Community... Energy saving is the most cost-effective way to increase security of supply and reduce import dependency. Therefore, substantial demand side measures and targets should be adopted.” The Directive further states that, “As a general principle, the energy consumption of EuPs in stand-by or off-mode should be reduced to the minimum necessary for their proper functioning.”

Ericsson notes that, in the consumer industry, areas such as plasma/flat screens have started to implement digital techniques to gradually replace analog pulse width modulation (PWM) with digital PWM, and ultimately to use a digital dc controller. “The immediate benefit of this transition has been the reduction of power consumption achieved by supplying time-controlled, extremely accurate voltages to control specific functions, facilitating compliance with the European Directive 2005/32/EC.”

The company goes on to say that, “Implementing optimized power management and higher efficiency converters and regulators at all points on the curve is the only way to meet future requirements. As well, the results of optimizing such parameters will improve thermal performance, reducing unnecessary power burn, increasing equipment lifetime, and avoiding noisy cooling equipment resulting from previous forced air circulation, etc.”

Motor drives, white goods and other appliances that could be unsafe to operate if one or more of their mechanical or electronic components fail are now subject to the testing and qualification requirements of International Electrotechnical Commission (IEC). The IEC 60730 standard covers mechanical electrical, electronic, EMC and
abnormal operation of ac appliances. This is a European safety standard, but Texas Instruments says it is expected to come to the US, as well. Even though IEC standards and certification criteria are primarily used in Europe, companies wishing to market products worldwide typically opt to comply with the IEC criteria rather than have separate designs and manufacturing plans for every geographic region of the world.

The goal of IEC 60730 is to assure safe operation by shutting the system down if a fault is detected. When this occurs and the MCU initiates a system shut-down, the limp mode allows the shut-down to proceed gracefully without damaging other components or, in some instances, configuration information. On-chip supervisory circuits such as brown-out reset and power-on reset are two additional features that preserve the MCU and the surrounding system.

The introduction of IEC 60730 into white goods and other appliances adds a new level of safety for consumers operating their ever-more-sophisticated appliances. Digital control allows design teams to comply with these regulations while maintaining or reducing electronic system cost, creating a strong system-level development platform, and providing increased performance and energy efficiency.

Texas Instruments uses their Piccolo product line as an example of MCUs that can replace multiple electronic components to lower overall system cost, while enabling advanced power electronics management in white goods such as air conditioners, washing machines, induction cooking, refrigerator compressors, and so on. Piccolo devices “add hardware enhancements specifically targeted at making IEC 60730 system-level compliance easier and more cost-effective.” Two on-chip oscillators are integrated on chip to address the time-base requirements of IEC 60730. Other hardware features, such as write-protected registers, limp mode and supervisory circuits, have been integrated, as well. These features have been tailored to the test requirements of IEC 60730, making compliance in the electronic segment of the tests easier and the results more predictable.

Digital Power Forum (DPF)
http://digitalpower.darnell.com/

Digital Power Reports
http://www.darnell.com/digital

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As a result, power semiconductor components have to meet new demands in terms of efficiency, service life and compactness. Manufacturers are striving to meet these very demands by developing new assembly and connection technology, offering higher current densities and reliable chip temperatures, as well as using new semiconductor materials.

Over the next 2 decades, the global primary energy demand is expected to grow by an average of around 2% per year. By 2030 this would mean a 50% increase in demand. At present, one third of the primary energy is used in power generation alone. In 2004, the average global consumption of electric energy was around 12 billion KWh (Source: CPES 2004). And around 40% of this total is used for driving – in most cases - non-controlled electric motors.

Rethinking the climate policy
Today, the majority of the primary energy demand is covered by burning fossil fuels such as oil, gas and coal, contributing substantially to the global greenhouse effect. In recent years, increased awareness of the adverse effects of global warming has led to the introduction of targets for reduced greenhouse gas emissions. One cornerstone of this new climate policy is the global development and expansion of regenerative energies and the increase of energy efficiency.

Europe is a forerunner in modern energy and climate policy, and Germany a prime example of the use of new energy technologies. In view of the climate protection aim to reduce CO2 emissions by 14% by 2020 (as compared with emissions levels in 2005), the proportion of renewable energies in the primary energy consumption must be increased to 18% by 2020 (as compared to 6% in 2005). For the gross electricity consumption in Germany this means that the regenerative energy share is to be more than doubled by 2020 as seen in the figure 2. Looking further ahead, as much as 70% is planned for 2050.

Today, wind power is the largest segment in the regenerative energy market. In Germany, wind energy enjoys a 45% share, followed by biomass, hydropower and photovoltaics. (Source: Germany Ministry of Environment, March 2008)

Reducing electricity costs
Parallel to the implementation of political requirements and financial incentives offered by net metering programs, the cost of regenerative power generation is falling steadily.

Take, for example, the area of photovoltaics, which is still regarded as the most expensive alternative to conventional power generation. In September 2008, the price of a crystalline solar module was around €3.5/Watt; today, by contrast, a comparable module costs 35% less. This is owing to excess capacities, strong competition, in particular from Chinese manufacturers, the transition to mass production and, last but not least, a relaxation on the raw silicon market. By the end of 2010, prices as low as €1/Watt are possible. Given these cost factors, the price for one kWh of electricity produced using solar power will move into the price ranges for electricity produced by conventional means (Source: Spiegel Online, March 2009; Photon).

Profitable to the power semiconductor industry
The power semiconductor industry will profit from the forthcoming growth in the renewable energies market in two respects. Firstly, power semiconductors are needed for energy conversion itself – for instance in inverters in wind power plants. Secondly, semiconductors are the core element of variable-speed drives, which are indispensable in wind, solar and biogas installations. Such control drives are used, for example, in solar trackers to adjust the solar panel to the path of the moving sun or in wind turbines for optimum blade pitch adjustment. In biogas plants, control drives are responsible for the precise feed and mixing of the biomass material.
Owing to their technical superiority as well as for reasons of user-friendliness, modules are used predominantly as electronic switches in regenerative power generation applications. A module is a component that comprises a silicon chip, an insulated ceramic substrate and a module case with the necessary power connections. These modules come in different versions as regards assembly and connection technology, as well as in respect to the integration stage, for example including integrated driver, current sensor and heat sink.

In 2008, power semiconductor modules for renewable energy applications had a mere 7.5% share of the modules market. That said, this market boasts the fastest growth rate, with an average of 25% growth per year. By 2012 this market is expected to generate US$ 380 million in sales (Source: IMS quarterly update, Feb 2009).

In wind power and solar power plants, supply reliability is top priority as this is what guarantees economic operation. Next in line are a high efficiency rate and compactness of the system. For manufacturers of power semiconductors, this means a particularly difficult challenge: how to meet these in some respects conflicting requirements. Furthermore, as inverter power increases, parallel module connection and heat management will become increasingly important. Let us take, for example, a wind turbine with an output of 3MW: here, around 45kW of thermal losses occur in the power semiconductor alone – a value that is comparable with the requirement for the heating system of 3 private homes.

New challenges for manufacturers
1. Solder connections
In a conventional soldered power module with base plate, the solder connections often constitute the mechanical weak point of the module. Due to the materials’ different coefficients of thermal expansion, high temperature fluctuations and excessive load cycling during operation will result in material fatigue of the solder layers. This is seen in the increased thermal resistance, which in turn leads to higher temperatures. This feedback mechanism will ultimately lead to component failure.
In connections which are soldered to a PCB, cold solder joints are an additional reliability issue.

2. Base plate
Base plates for modules with large dimensions and, consequently, high power output, can only be optimised with some difficulty and/or at considerable cost in view of best thermal and mechanical performance. The single-sided soldering for substrate connection results in a bimetal effect, causing non-homogenous warping. Consequently, a good thermal connection to the heat sink is not provided. Instead of optimum thermal connection with total material closure, thermal paste with poorer heat conducting properties has to be used to fill the gap between base plate and heat sink. The result: deterioration in the system’s thermal resistance.

3. Internal module layout
For modules of 200A and above, several semiconductor chips have to be connected to the DCB ceramic in parallel in order to achieve modules with increased current ratings. Owing to mechanical restrictions in the design of conventional modules with base plate, however, it is not possible to design fully symmetric DCB’s. As a result, differences in switching properties and in current levels at the different chip positions occur. The module specifications therefore have to be based on the weakest chip. Internal circuitry with bond wires or connectors can worsen the internal module resistance and stray inductance.

4. Chip temperatures
Improvements in semiconductor technology allow for finer silicon structures. In recent years this has led to smaller chip sizes, hand in hand with increased current densities. For example, a 150A/1200V IGBT has shrunk in size by more than 35% over the past few years. At the same time, the maximum permissible chip temperatures have increased to today’s standard 175°C. This means that more compact modules are possible. One shortcoming of this trend, however, is the higher temperature gradient within a module.
module, which results in solder fatigue, a common cause of failure, as described in Section 1. In other words, overall module reliability is reduced.

Innovative technologies provide solutions

The problems described above are all interdependent factors. It therefore makes sense to search for an integral solution rather than looking at the problems as isolated matters. A solution to the problem with the base plate and solder connections can be found in SKiiP technology, where the base plate and thus large fatigue-prone solder connection to the substrate was removed entirely, and a patent-protected pressure contact system used instead. In the pressure contact system, the substrate is pressed onto the heat sink by way of mechanical pressure. As the ceramic substrate is relatively flexible and the pressure applied by way of mechanical "fingers" located at several points, very close contact between the ceramic substrate and the heat sink is guaranteed. As a result, the thermal paste layer can be reduced to a minimum of just 20-30 μm. By way of comparison, the thermal paste layer in modules with base plate is 100μm.

This pressure contact system can be adapted to the given conditions, irrespective of the module geometry. In MiniSKiiP modules, the pressure contacts are located on the plastic module case itself. In SKiiP and SKiM modules, pressure is applied by way of suitable pressure elements. The main terminals are also connected to the ceramic substrate using the same pressure contact system. Spring contacts are used instead of soldered gate terminals, as well as for load connections of up to 20A. Spring contacts have proven to be particularly suitable in cases where excessive vibrations occur.

The latest technological achievement is the use of silver sintering alloys rather than solders for chip connection. Table 1 shows a comparison of the chief parameters for solder and sinter connections. What is striking here is the far higher melting point of the sinter connection, meaning that the connection will age at a much lower rate at a given temperature swing. Thus, material fatigue and, consequently, failure will occur at a much later stage of lifetime. Using the approaches described here, the thermal cycling capability in power modules can be increased by a factor of five. As a result, higher chip operating temperatures are possible at no compromise to module reliability.

A final point warranting consideration is the internal mechanical design in the new SKiM modules. Figure 5 shows the layout of the ceramic substrate with the chip positions. Note the highly symmetric layout. On the right, the internal power busbars, which double as a mechanical pressure contact system, can be seen. The laminar busbars and current draw directly across each chip result in a very low stray inductance of less than 20nH between the DC+ and DC terminals. As for IGBT turn-off, no difference can be found between the chips at the different positions.

Renewable energy sector

Despite the current economic situation, the renewable energy sector will play an important role in boosting a country's industrial production and employment rates in the future. The power semiconductor industry, it seems, has already taken on the challenges ahead. The technological demands posed by hybrid and electric vehicles, as well as new materials such as SiC and GaN will pave the way for new developments.

<table>
<thead>
<tr>
<th>Property</th>
<th>SnAg (3) solder layer</th>
<th>Ag sinter layer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquidus °C</td>
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<td>395</td>
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<tr>
<td>Thermal conductivity W/mK</td>
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<td>250</td>
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<td>CTE ppm/K</td>
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<td>19</td>
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<tr>
<td>Tensile strength Mpa</td>
<td>30</td>
<td>38</td>
</tr>
</tbody>
</table>

Table 1: Comparison of the main parameters for solder and sinter connections. Note the far higher melting point in sinter connections.
Third-generation digital control technology has arrived.

Digital power controllers have reached price parity with analog.

Where is the only place that all of the important developments will be showcased and discussed?
Bucking the Trend

Simplified design of electronic ballasts for HID lamps

While offering benefits of efficiency, lifetime and good colour rendering high intensity discharge lamps (HIDs) present designers with the challenge of ballast implementation. Electronic ballasts are smaller, lighter and more efficient than electromagnetic ballasts but, to date, have been more complex to implement.

By Peter Bredermeier, International Rectifier, Germany

Now, however, the latest semiconductor developments are enabling multi-mode buck control circuits that simplify ballast design and reduce component count.

A typical electronic ballast for a high intensity discharge (HID) lamp comprises three key functional blocks: a boost PFC stage to maintain sinusoidal input current and generate a stable DC bus voltage; a buck converter responsible for optimising lamp current and power; and an output stage to drive the lamp.

The ignition voltage for cold lamps may be up to 4kV, but a hot lamp can require more than 20kV. Before ignition the lamp behaves like an open circuit. After ignition the lamp displays a low resistance characteristic that causes the voltage to drop quickly from the open circuit value to around 20V. The ballast has to restrict the current during this phase so as not to exceed the lamp manufacturer’s specified limit. During lamp warm-up the current decreases as the voltage and power increase. After some warm-up time the lamp voltage stabilises to around 100V. The ballast must then regulate the power to the correct level.

HID Ballast Design

Referring to Figure 1, the boost PFC stage shapes the line current into a sinusoidal waveform to meet the requirements of high power factor and low current harmonics. This power stage is also responsible for providing a stable, constant DC bus voltage - typically 400V DC - for the lamp power control stage. The boost converter operates at a free-running frequency, with approximately constant ON time and with OFF time varying according to changes in the peak current demand.

The buck converter controls the voltage and current delivered to the load during warming up and running. Typically the buck would be managed using a separate controller IC and a high-voltage level-shift IC to boost the gate drive signal up to the buck switch’s potential. Controlling the buck presents the most complex challenge to ballast designers. During the ignition phase the buck must regulate its output voltage to the minimum take-over voltage to ensure reliable ignition. The take-over voltage for ceramic lamps is 250V and for quartz lamps is 280V. Immediately after the lamp ignites, the buck must supply sufficient current to keep the lamp from extinguishing as the resistance of the lamp falls quickly. On the other hand, the buck must limit the current to prevent the inductor from becoming saturated. While the lamp is running the buck’s ON time is adjusted to keep the lamp power constant.

The output stage comprises a full-bridge circuit to supply the lamp with a low-frequency square wave voltage and an ignition circuit for striking the lamp. The top of the full-bridge circuit connects to the buck output voltage and the two half-bridge midpoints oscillate 180 degrees out of phase to produce the necessary AC voltage. The driver for the bridge can be implemented using a self-oscillating full-bridge driver IC such as International Rectifier’s IRS2453D. This device combines high-voltage IC (HVIC) and latch-immune CMOS technologies to integrate a high-voltage full-bridge gate driver with a front-end oscillator. Using the IC’s shutdown pin external protection circuitry is able to turn off the driver to protect against damage that can be caused by lamp failure shutdown pin.

The ignition circuit comprises a diac (DIGN), transformer (TIGN), capacitor (CIGN), resis-
tor (RIGN) and switch (MIGN). An ignition control signal is required to turn on switch MIGN, which causes capacitor CIGN to discharge through resistor RIGN. When the voltage across the diac reaches the diac threshold voltage, the diac turns on and a current pulse flows from the buck output, through the primary winding of the ignition transformer (TIGN) and into capacitor CIGN. This arrangement generates a high-voltage pulse on the secondary to ignite the lamp. The capacitor CIGN charges up until the diac turns off, and CIGN then discharges down through resistor RIGN until the diac voltage again reaches the device’s threshold and another ignition pulse occurs. When the lamp ignites, the buck output voltage decreases quickly to the lamp voltage as the converter provides the lamp current. The ignition controller must be able to turn switch MIGN off after the lamp has ignited to disable the pulses.

**Figure 3: Buck-control scheme of integrated ballast controller**

Historically, control of the main blocks has been achieved using multiple ICs. For ballasts built using a combination of discrete controller and driver ICs, specific protection circuits are also necessary to enable the ballast to be safely shut down or reset in the event of lamp faults. These may include failure to ignite or warm up, open-circuit or short-circuit faults, or instability indicating end-of-life.

**Integrated HID Ballast Control**

Clearly implementing the ballast with as few components and in as short as time as possible is particularly important. It is with this in mind that International Rectifier has developed a new ballast control IC dedicated to HID applications. The IRS2573D implements buck control, ignitor-circuit control and fault-protection capabilities in a single device, minimising component count and improving ballast performance.

The integrated controller is able to operate the buck in critical-conduction mode or continuous-conduction mode, to optimise the voltage level and current delivery for the various operating stages of the lamp. Figure 3 illustrates the architecture of the buck-control circuit, showing the off-time control, on-time control, current sense, zero-crossing detection and feedback blocks that allow this device to operate the buck in either mode.

**Built-in Protection**

The IC includes an overvoltage fault counter at the VSENSE pin, which counts the time during which an overvoltage condition at the output of the buck exists. This allows the controller to detect an open-circuit condition, lamp removal or end-of-life, or turn-off of the lamp. If the voltage at the VSENSE pin remains above 0.4 times the overvoltage threshold (OV), and the overvoltage fault counter times out (typically 1180 seconds), then the IC will enter Fault mode and shut down. If the voltage at the VSENSE pin decreases below 0.4xOV before the overvoltage fault counter times out, then the lamp has successfully ignited and the IC will enter General mode. The ignition gate-driver output, presented at the IGN pin, will remain ‘high’ until the ignition timer has timed out.

There is also an undervoltage fault counter at the VSENSE pin. Once the lamp has ignited, the lamp voltage will decrease sharply to around 20V but will subsequently rise slowly to a nominal 100V running voltage as the lamp warms up. If the lamp voltage does not rise as expected, the lamp may be faulty and the ballast must shut down. To detect this, the VSENSE pin includes an undervoltage threshold of 0.133xOV. If the voltage at the VSENSE pin remains below this level and the undervoltage fault counter times out (typically 295 seconds), the IC assumes that a fault is preventing the lamp voltage from rising and shuts down. If the voltage at the VSENSE pin increases above 0.133xOV before the undervoltage counter times out, this indicates successful warm up and the IC will remain in General mode.

**Summary**

HID lamps are known to offer high lighting efficiency, good colour rendering and long lifetime, but their negative impedance presents a complex lamp-control challenge to designers of electronic ballasts. Consolidating the control functions for the ballast’s buck converter and driver/ignition circuit in a single IC, however, significantly simplifies the ballast design challenge to make the size, weight, power-factor, efficiency and stability advantages of electronic ballasts accessible to a wider range of markets.

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Conserving Energy through Statistical Adaptation

Efficiency is becoming more relevant due to lack of available power

With operating expenses becoming a larger part of equipment purchasing decisions, manufacturers have been continuously looking for ways to reduce the energy consumption of their products. Most look for architectural changes or lower power technologies to incrementally improve the efficiency of their systems while maintaining or improving the performance level. In this article we will examine a concept I will call Statistical Adaptation – a method for improving the overall efficiency by adapting to current conditions.

By Richard Zarr - National Semiconductor

It is widely known that energy prices are increasing as world demand continues to grow. Even in weak economic times, people still need power. With the emergence of cloud computing and the associated increases in infrastructure bandwidth as well as growing capabilities of Personal Mobile Devices (PMD), improving energy efficiency has risen greatly in priority.

In many cases, system architects and engineers have looked to suppliers of semiconductors (and other energy consuming components) to provide lower power alternatives to improve energy consumption. By simply replacing a function with a lower power version, total energy consumption can be reduced. Additionally, by improving the conversion efficiency of power supplies, gains can also be realized. However, there are diminishing returns in attempting to improve efficiencies much past 95%. Cost and size begin to overtake the improvements.

There is another method of reducing power in systems through statistical use models that has been applied periodically appearing mostly in portable devices to extend battery life. The idea is quite simple and can be observed in laptop computers... as the user stops typing, the processor is slowed down and if enough time goes by with inactivity (determined by settings), back lights are reduced and hard drives shut down. The system “adapts” to the users behavior and statistically the laptop will run longer than if these features were turned off.

Continuous Adaptation

The previous example illustrates gross adjustments in system power consumption accomplished mostly by either slowing clocks or powering off subsystems. There are finer levels of adaptation that can provide even higher levels of power savings. This is referred to as continuous adaptation which uses extremely fine levels of adjustment and closed loop monitoring to get extremely close to the lowest possible power levels without failure.

An example of such a system could be an LED back light controller for a DVD player. In this scenario, the back light cannot be simply turned off if the user stops typing for a few minutes. The unit is used continuously while watching a video, however the back light can adapt to the viewing environment. As ambient light levels change, the backlight can be adjusted to compensate. Users that always watch their DVD player in very bright light will not see an advantage to this method, but statistically users that watch videos in average light will see improved run times. Figure 1 shows a Gaussian distribution approximating the ambient lighting model for a DVD player. Other distributions could be used as well depending on other usage models, but we’ll use the classic “bell curve” and associated error functions. At any point in time most users will be between -3σ and 1σ which represents around 84% of the population (a majority). This also represents a light intensity range from almost complete darkness to moderately bright – where most of us would watch a DVD.

Continuous Adaptation

The previous example illustrates gross adjustments in system power consumption accomplished mostly by either slowing clocks or powering off subsystems. There are finer levels of adaptation that can provide even higher levels of power savings. This is referred to as continuous adaptation which uses extremely fine levels of adjustment and closed loop monitoring to get extremely close to the lowest possible power levels without failure.

An example of such a system could be an LED back light controller for a DVD player. In this scenario, the back light cannot be simply turned off if the user stops typing for a few minutes. The unit is used continuously while watching a video, however the back light can adapt to the viewing environment. As ambient light levels change, the backlight can be adjusted to compensate. Users that always watch their DVD player in very bright light will not see an advantage to this method, but statistically users that watch videos in average light will see improved run times. Figure 1 shows a Gaussian distribution approximating the ambient lighting model for a DVD player. Other distributions could be used as well depending on other usage models, but we’ll use the classic “bell curve” and associated error functions. At any point in time most users will be between -3σ and 1σ which represents around 84% of the population (a majority). This also represents a light intensity range from almost complete darkness to moderately bright – where most of us would watch a DVD.

Figure 1- Gaussian distribution of DVD light levels

To understand the average amount of energy saved based on this distribution, we’ll need to calculate the area intersected by the linear function of brightness (dark to full sun) for all users and distribution function from figure 1. We should assume the lowest light level would be 20% at -3σ and 100% at +3σ. This is illustrated in figure 2 and equation 1. The calculations are shown in figure 3.

As you can see from the calculations, only 42% of the back-light energy (relative to “full on”) would be consumed by the 84% of the population that watch their DVD player in dark to moderate lighting conditions. That is if a continuous method of back-lighting control is
implemented that senses ambient light. Even if we include the remainder of the distribution, the energy consumed only rises to around 60% (assuming a Gaussian distribution). Not everyone will see such an improvement, but over a large population these savings can be observed.

Adaptive Power

The same applies to systems that vary in other parameters such as temperature, process or aging as found in CMOS semiconductor devices. The power consumed in modern digital devices can be very large (see equation 2). The larger component of the power dissipation is the dynamic component (V^2 term) due to the exponent. However, in modern small geometry processes, the gate and sub-threshold leakage can be quite significant. Both components are dependant on supply voltage which provides a means of control over the power dissipated if a system could monitor the process performance.

\[ P_{BL} = \frac{2}{15} x^2 + \frac{3}{5} \]

Equation 1 – Backlight Level

\[
\frac{1}{\sqrt{2\pi}} \int e^{-\frac{x^2}{2}} dx = 1 \\
\text{Normalized Gaussian distribution function}
\]

\[ y = \frac{2}{15} x^2 + \frac{3}{5} \]

Relative power intersection line

20% (-3\(\sigma\)) to 100% (+3\(\sigma\))

\[ P_{BL} = \frac{1}{\sqrt{2\pi}} \int e^{-\frac{x^2}{2}} (ax + b) dx \]

Relative energy over distribution

Integrating:

\[ P_{BL} = b \text{erf} \left(\frac{x}{\sqrt{2}}\right) - a e^{-\frac{x^2}{2}} \]

Solving:

\[ P_{BL} = 0.3 \text{erf} (0.7x) - 0.13e^{-0.5x^2} \mid_3 = 0.427 \]

Figure 3 – Calculations

Applied a similar analysis on the example Gaussian curve shown in figure 4 yields a theoretical savings of over 30% (dynamic only) in a system with many large digital devices or many systems with one large device (See equation 3). The lower energy consumption is accomplished simply by controlling the supply voltage to match the energy requirements of each individual device while maintaining timing closure. It does not include additional techniques such as frequency scaling which will improve the energy savings even further.

Conclusion

If all systems were created identically and used in the exact same manner every time, the worse case condition would always be the best case condition… however in our world of ever drifting environments, processes and user tendencies it is best to create systems that continuously adapt their power consumption to the current system state. Energy efficiency is becoming more relevant due to user preference, regulation and simply a lack of available power such as in remote installations. Adaptive power management can greatly improve system energy consumption and reduce operating expenses in large scale installations such as network infrastructure and cloud computing as well as in personal mobile devices.

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Don’t be Restrained by Power Constraints

Battery powered devices must operate from a single charge.

In a fast paced business such as integrated electronics, suppliers who don’t foresee significant sea changes in customer demand are at risk of missing opportunities, particularly if they’re not able to respond quickly and with the right solution. For some time, semiconductor providers have raced along the road to produce faster devices that operate at lower power. However, the direction current trends are taking has caused some forward-looking manufacturers to check that long standing objective.

By Jason Tollefson, Microchip

This is creating demand for solutions that have been developed specifically for power constrained applications, and that demand is growing. The sales of rechargeable batteries are increasing at around 20% per year, while portable consumer device sales figures continue to rise at around 10% growth rate. As the vast majority of portable devices are powered by storage cells of some description, it reflects the need for devices that aren’t only conscious of the power drawn when active, but their overall power envelope.

An increasing application area for battery powered devices is consumer appliances that are designed to remain sealed and must therefore operate from a single charge. This class of application typically includes any that use sensitive sensing equipment which is protected from other potential contaminants. Examples include smoke or carbon monoxide detectors as well as the emerging market for home medical diagnostics. These are joined by other advanced metering or monitoring equipment such as thermostats, asset tracking or door entry systems.

These and many other applications have one overriding commonality: they spend the majority of their time turned on but inactive. This is a crucial qualification and sets them apart from those applications that are normally turned off when not in use. It also means the power conserved while the device is inactive represents the single most significant factor when determining the lifetime of the device, and the most important aspect to focus on when looking to extend that lifetime.

This trend, which many semiconductor manufacturers have yet to react to, demands integrated devices that have been developed from the transistor level up, to consume as little power as possible under standby conditions. It is this class of application that Microchip is targeting with its latest introduction, the nanoWatt XLP range of PIC microcontrollers (MCUs).

Devices within the nanoWatt XLP portfolio represent the world’s lowest power MCUs when in sleep mode, consuming just 20nA or less. It means they consume less power during the majority of their operational lifetime than any other MCU offered today, realistically extending the useful life of power constrained devices to up to 20 years or more.

Key to their low power operation is the advanced nanoWatt XLP extreme low power technology, developed by Microchip specifically for this class of device. On complex devices, it introduces an additional Deep Sleep mode, which allows progressively more of the MCU’s architecture to be switched off during long periods of inactivity. This has the effect of physically removing power from large parts of the integrated cir-
cuit, thereby eliminating the leakage or ‘static’ power losses associated with integrated transistors. It is these losses that have incrementally increased the leakage current of modern integrated devices and which renders less sophisticated architectures unable of reducing standby current to anywhere approaching 20nA.

Microchip’s nanoWatt XLP technology is initially available in more than 30 members of the PIC MCU range, across six families encompassing both 8-bit and 16-bit devices. This gives engineers significant scope for choosing the right device for the application without sacrificing the advantages of extreme low power. Microchip is also planning to bring out further nanoWatt XLP technology enabled devices, in a range of packaging and memory configurations.

A suite of compatible peripherals is also integrated into the nanoWatt XLP devices, which complement the application area. They include full USB support and Microchip’s mTouch capacitive touch sensing technology, which provides a low cost, low power user interface solution.

These advanced peripherals are joined by Microchip’s Peripheral Pin Select technology allowing peripherals to be mapped to different I/O pins if necessary. Together these peripherals enable the nanoWatt XLP devices to address the most common low power applications, with flexible user interface options.

An important consideration for engineers targeting power constrained applications is how to move in and out of low power modes, something nanoWatt XLP technology handles extremely well. Often, MCUs targeting low power applications achieve low standby current by implementing sleep modes that inhibit many of the interrupt features of the MCU. In practice this effectively renders sleep mode inaccessible for many applications, because the device relies on an element of the architecture that must be kept active at all times in order to exit hibernation.

Microchip has overcome this obvious disadvantage by implementing flexible sleep modes which operate in conjunction with a range of wake-up sources. Application dependent, engineers can use one of the conventional sleep modes which significantly lower standby current, or the new Deep Sleep mode, which reduces standby current to an industry low of just 20nA. It achieves this by removing power from almost all of the device’s functional blocks and is best used when long periods of inactivity are predicted, as outlined in the application examples cited earlier.

This flexibility maximises the benefits of nanoWatt XLP technology without incurring the sacrifices normally associated with hibernation. By entering Deep Sleep mode, power is physically removed from most of the MCU’s functional blocks, which completely overcomes the problems associated with power leakage. While in Deep Sleep mode, the Real Time Clock/Calendar remains active, allowing applications that are time critical to remain synchronised. Also active are the Deep Sleep Watch Dog Timer and Deep Sleep Brown-out Reset circuits, providing crucial wake-up sources for the MCU.

These functional blocks have been redesigned using the latest low power techniques and transistor technology, in order to minimise their power requirements.

Other sleep modes offer a greater variety of wake-up sources, depending on the application’s requirements. Using the various sleep modes available, therefore, provides progressively greater power savings, while matching the application’s needs.

The demand for extremely low power MCUs has yet to be met by most semiconductor manufacturers. Only Microchip has taken the bold and innovative step of redefining its underlying technology to answer this need, a need that is only set to increase as we become more dependent on portable and power constrained products.
In cooperative with Isabellenhütte, the leading manufacturer for high precision shunts, and Siemens AG Drives Division in Erlangen, Infineon Technologies has developed a power electronic module combining highly reliable, solder-free connections to the PCB with innovative packaging along with current-sensing shunts for peak currents up to 150A.

Reliable Connections
In addition to soldering, new contact technologies have evolved over the last couple of years. Spring-force contacts and pins that rely on being pressed into the PCB came up as coexisting ideas. Infineon has decided to offer PressFIT pins in the Econo2 and Econo3 series and has recently expanded this method to products of its Easy series as well. At the PCIM 2009, Infineon introduced the SmartPIM and SmartPACK that all feature PressFIT pins as well. When it is inserted into the PCB, the PressFIT pin is deformed in a predefined manner, forming a cold welded connection with the surrounding material as shown in Fig. 1.

Cold welded connections qualify as gas-tight connections that are very insensitive hazardous atmospheres. They are also resistant to vibrations and cyclic mechanical load. These qualities make PressFIT the predestined technology for high current density contacts as well as for sense and control connections. This is reflected in the Siemens Standard SN29500-5 Edition 2004-06 relating to the failure rates of components. The standard lists FIT-rates for different connection techniques as summarized in Table 1.

It can be concluded from the standard that PressFIT has a higher reliability than soldered connections but offers drastic improvement compared to spring force contacts.

Innovative Packaging
With the Smart package, Infineon invented a module concept that provides a self-acting PressFIT within a mounting procedure that decouples the mounting forces from joining forces. The so called Duplex Frame is separated into an inner module and a surrounding frame. The construction ensures that only a predefined portion of the forces applied by the mounting screw is transferred to the inner module thus protecting the DCB from being damaged. The construction, as displayed in Figure 2, is especially designed to apply the necessary forces to form an excellent thermal interface using thermal grease.

Table 1: FIT-rates for different contact technologies

<table>
<thead>
<tr>
<th>Process</th>
<th>Conducting area in mm²</th>
<th>Failure rate λ_{ref} in FIT</th>
<th>Notes: Standards/guidelines</th>
</tr>
</thead>
<tbody>
<tr>
<td>PressFIT</td>
<td>0.3 to 2</td>
<td>0.005</td>
<td>IEC 60352 – 5</td>
</tr>
<tr>
<td>Soldering</td>
<td>–</td>
<td>0.5</td>
<td>IPC 6102), class 2</td>
</tr>
<tr>
<td>manual</td>
<td>0.5 to 16</td>
<td>0.03</td>
<td>DIN EN 60999 – 1</td>
</tr>
<tr>
<td>automatic</td>
<td>0.5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1) 1 FIT = 1 x 10^{-9} 1/h → one failure per 10^9 component hours
2) Acceptance conditions for printed circuit boards

Figure 1: Micro sectional view of a PressFIT-pin after insertion

By Dr.-Ing. Martin Schulz, Infineon Technologies, Warstein, Germany, Dipl.-Ing. (FH) Reinhold Dillig, Siemens AG, Erlangen, Germany and Dr. rer. nat. Ullrich Hetzler, Isabellenhütte, Dillenburg, Germany

The most fundamental challenges in connecting power electronics to PCB materials relates to reliability and lifetime expectations. Today the majority of connections regarding power electronic modules of up to 200A rated chip current today consists of soft-soldered joints. Nevertheless, cost pressure and the demand to speed up manufacturing have pushed the development of alternative contact technologies making the time consuming soldering process obsolete.
Besides the ruggedness and the controlled forces applied to the module, the straightforward mounting procedure only needs a single screw to be tightened to establish the connection between the PCB, power module and heat sink in a single, time saving step as highlighted in Figure 3.

Depending on the size of the PCB in use, additional bolt spacers close to the module can be omitted.

A customized version of the Smart module - as a member of the MIPAO™ family - was engineered to specially suite the needs of Siemens. The module is integrated in a braking chopper within the Sinamics S120 drive system. It has a half-bridge topology utilizes shunts to measure the outgoing current. The cut away diagram in figure 4 shows the shunt and the PressFIT pins in detail.

The shunt’s resistance is calculated to provide 150mV at the rated chip current. It is obvious, that the connection between the shunts and PCB is critical; a voltage drop or contact failure at the connection would falsify the measured instantaneous current value. Two pins transfer the signal from each shunt forming the sense connection while groups of six pins conduct the load current of up to 150A with 25A_{rms} being the rated current for a single pin.
Exhaustive tests have been performed to ensure that the connection’s high initial quality is retained over the module’s lifetime. As the connection between the shunt and the DCB could also influence the measurement, tests were made to determine the lifetime of this particular joint regarding power and thermal cycling. The results of these tests formed the basis for specific design rules for the shunt’s DCB-layout. The results also clearly indicated that under typical application conditions the cycle life of the material drastically exceed expectations - reaching more than ten million cycles.

Figure 4: Customized Smart module featuring shunts and self-acting PressFIT

High Precision Current-Sensing Shunts
According to Ohm’s Law, the voltage across a resistor is proportional to the current flowing through it. However losses inside the shunt inherently occur. Mounting the shunt in the IGBT module makes it easier to dissipate these losses through the inverter’s heat sink. Despite the losses, using low resistive shunts as current sensors provides numerous advantages when compared to other solutions:
- wide temperature range of -50°C to >150°C
- easily integrated using well established processes
- insensitive to EMI
- no hysteresis
- no offset
- immune to overcurrents caused by short circuit
- small dimensions
- single part solution
- excellent long term and temperature stability despite the large temperature range
- outstanding power- and thermal cycling stability
- very low weight reduces mechanical stress if vibration occurs

Isabellenhütte as the leading manufacturer for high precision measurement devices has created shunts based on ISAOHM®. This is a patented alloy with extraordinary temperature and long-term stability. In cooperation with Infineon, a new shunt was developed based on the BVR-series. This particular shunt now perfectly suits both the requirements of the application in which the module is used and the demanding environment of the module itself.

The measurement in Figure 5 shows that despite the temperature swing due to power losses inside the shunt the relationship between current and measured voltage is truly linear:

Figure 5: Voltage and temperature increase as a function of DC-current; DUT: Shunt with 1mΩ at 25°C case temperature

An increase of the case temperature increases the thermal stress on the shunt but the result stays within reasonable limits, as can be seen in Figure 6.

Figure 6: Changes in the measurement due to an increase in the temperature; DUT: Shunt with 1mΩ, I=100ADC

These measurements prove, that the utilized shunts provide an accurate reading under full power and even in a temperature range that can exceed 200°C. This particular attribute makes shunts the sensors of choice for the integration into power electronics. Over the last years, the operating temperature of IGBTs has continuously increased and it is fair to assume that this trend will continue. Today IGBT4 can operate at temperatures up to 150°C. This has been driven by the market demand for higher power densities. Any future-proof sensor technology to be integrated into power electronic devices will have to cope with these harsh conditions. Today, despite numerous developments of the last years, shunts remain the only technology that can fulfill all of these requirements.

Summary
The new self-acting PressFIT technology reduces mounting time and simultaneously increases mounting ruggedness and connection reliability. Along with the Duplex-Frame concept that has been introduced, it has become easier to mount power electronic components and failures due to mounting can be excluded. Integrating the current sensor into the power module saves valuable PCB-space and the shunts can easily dissipate power losses to the heat sink. This way, the shunt can handle higher currents compared to being mounted on the PCB and hot spots on the printed circuit board are avoided. Despite the high temperature levels, the sensor used provides an excellent accuracy.

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innovation all along the line
Today’s designers must fully understand whether their product will comply with current and pending energy-efficiency specifications and standards. Further, they must take into consideration the operating mode requirements of the systems in which their products will be used.

The energy-efficiency regulation landscape is constantly changing. Finding time to keep up-to-date with those changes, to make sure current and future products comply, has become a daunting task for design engineers. In the beginning, it was easy because regulations were relatively uncomplicated, targeting only standby or no-load power consumption. Over the years, however, energy-efficiency programs have evolved, becoming more complicated and covering multiple operating modes in order to capture as much energy loss as possible.

A prime example of this is the evolution of External Power Supply (EPS) efficiency programs. Beginning in 2001, the European Commission’s Code of Conduct (CoC) for EPS simply specified the maximum no-load power consumption. Today’s CoC EPS (version 4) includes two minimum average active-mode efficiency specifications (one for low-voltage models <6V and ≥550 mA, and one for all other EPS under 250 W), as well as three sets of no-load power consumption limits (one for mobile phone chargers <8 W, one for AC-AC EPS, and one for AC-DC EPS). Other government EPS efficiency regulations have also emerged that target both active-mode and no-load efficiency, including the ENERGY STAR EPS specifications, the U.S. EISA 2007 EPS standard, and both tiers of the European Commission’s Ecodesign Directive for EuPs. Figure 1 illustrates the efficiency specifications of these four programs.

To further complicate matters for power supply designers, new application-driven EPS efficiency requirements have recently begun surfacing. China’s Communication Industrial Standard of PRC (YD/T 1591-2006), mandates a USB connector and power output with a minimum active-mode efficiency of 50% and a no-load power consumption of ≤300 mW for mobile telecommunication terminal equipment EPS. In 2008, a group of leading mobile phone manufacturers, through the European Commission IPP process, developed a “five-star rating” for mobile phone adapters / chargers, specifying no-load power consumption down to ≤30 mW (five stars) – well below any current or proposed government programs. In early 2009, the Open Mobile Terminal Platform group adopted this star rating, proposing standardization of mobile phone chargers and specifying that chargers meet a four-star rating minimum (≤150 mW no-load).

There is a ray of sunshine in this regulation maze in that all of the current major EPS efficiency programs have harmonized...

---

**Figure 1. Comparison of major EPS efficiency regulations**

**NOTES:**
- AC-AC is ≤0.5 W for all power levels.
- No-load specification for mobile hand-held, battery-powered applications ≤8 W is ≤0.25 W until December 31, 2010; ≤0.15 W after January 1, 2011.
- Low-voltage power supply defined as ≤6V and ≥550 mA.
- For Ecodesign Directive, power levels are ≤51 watts and >51 watts.
around the same test method, Test Method for Calculating the Energy Efficiency of Single-Voltage External AC-DC and AC-AC Power Supplies, found at http://www.efficientpowersupplies.org. Also, the mathematics used in calculating the average active-mode efficiency of an EPS (the arithmetic average of measured efficiency at 25%, 50%, 75%, and 100% of load) and the minimum efficiency level allowed by the spec (based on nameplate output power) are simple and straightforward. However, while there has been an effort by worldwide agencies to harmonize EPS specifications to simplify design, recent revisions have caused differences to appear, making it necessary for design engineers to research agency requirements on a regular basis.

There are many ways an engineer can keep abreast of new efficiency programs and pending changes to current specs. These include becoming an active stakeholder and attending (worldwide) government agency meetings, subscribing to efficiency newsletters, blogs, and databases (which may not always be up-to-date or include information relevant to an EPS), or regularly searching the internet for news on EPS efficiency programs. Unfortunately, all of these tasks can be very time consuming and may not provide a clear picture of whether the designer’s product will comply.

In an effort to assist power supply designers, Power Integrations has developed a web-based tool to determine compliance to major worldwide EPS regulations. The EPS Efficiency Compliance Calculator covers all major EPS efficiency programs, is simple to use, and applies to all types of EPS designs. The tool quickly calculates the average efficiency (based on the user’s measurements), compares the user’s EPS performance to the major efficiency regulations (showing both sets of data), and displays a pass/fail status. Figure 2 shows a screenshot of the calculator.

Designers begin by inputting the EPS output voltage, output current, and input voltage. The drop-down menu offers single input voltages (115 VAC and 230 VAC), as well as the universal input voltage range, important for determining compliance to ENERGY STAR EPS (version 2.0). The EPS measured no-load power consumption and the four active-mode efficiency levels can then be input. The tool calculates the average active-mode efficiency in real-time. After the user inputs are completed, the calculator displays compliance (green cell) or non-compliance (red cell) to the following efficiency programs:

ENERGY STAR EPS (version 2.0)
• European Commission Code of Conduct (version 4)

The calculator also determines the EPS no-load power consumption “star rating” as described in the European Commission Integrated Product Policy Program (IPP) for mobile phone adapters. An adapter can earn from one star (no-load ≤500 mW) to five stars (no-load ≤30 mW) based on its no-load consumption. When the user inputs the measured no-load power consumption, stars appear (or disappear) according to the IPP specification.

The calculator is also adept at helping avoid embarrassing non-compliance moments due to the subtleties of some areas of the regulations. For example, a 3 W EPS with a 5 V, 0.6 A output and a 65% average active-mode efficiency will easily pass all six of the regulations. However, a similarly rated 3 W EPS with a 6 V, 0.5 A output and the exact same average efficiency will fail ENERGY STAR, EC Code of Conduct, and tier 2 of the EC Ecodesign Directive because those programs have tighter efficiency requirements for a standard voltage EPS compared to those designated as low-voltage models (>6 V and ≤550 mA), even with the same output power.

EPS energy-efficiency regulations will continue to evolve, as device efficiency and design methods improve. The EPS Efficiency Compliance Calculator provides power supply designers with a single resource for verifying and calculating compliance to all major EPS specs and standards. Try it now at:

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Simulating Losses and Semiconductor Junction Temperature in Power Electronics

Temperature rise in the SixPack IGBT module can be predicted within a few seconds.

When it comes to the simulation of entire drive systems, the thermal cycling is becoming more and more a designers issue. The lifetime of semiconductor components is strongly depending on thermal cycling. Therefore a detailed analysis is required of the maximum junction temperature in the IGBT and MOSFET.

By Peter van Duijsen; Simulation Research, and Pavol Bauer, TU Delft, The Netherlands

Thermal simulations are usually carried out in FEM or in specialized products such as CFD packages. To determine thermal cycling, the maximum junction temperature should be simulated. This requires a coupled thermal-circuit/system simulation using FEM and a circuit/system simulation. However closed loop coupled System-FEM simulations take too much time. Therefore thermal models are developed that can be used in a circuit/system simulation to predict the temperature rise on the semiconductor junction. First the loss prediction models are introduced and used in a simple single-phase inverter. Second, a Reduced Order Model is approximated in FEM and coupled to a three-phase inverter simulation. Third, a thermal model for a SixPack IGBT module build from different layers is coupled to an inverter simulation and briefly discussed.

Thermal cycling and loss predicting models
An analysis of thermal cycling is required to predict the lifetime of a component. Also important is that the thermal cycling of the semiconductor can simultaneously be simulated with the electric and thermal circuit, from which the temperature dependent losses are determined. Converter efficiency, cooling requirements and heat sink dimensions are in this way calculated. In Caspoc the dynamic non-linear semiconductor models standard have a thermal connection to a thermal model. Using this thermal node, the temperature rise on the junction of the semiconductor can be calculated and the temperature depending parameters of the semiconductor change their value during the simulation. If only the thermal cycling is of interest, the detailed semiconductor models, with their long simulation times, are not always required. In Caspoc loss-prediction models can be used that replace the detailed non-linear dynamic models. Using these loss-predicting models, the thermal cycling and the temperature dependent losses are approximated on basis of parameters and characteristics in data sheets provided by the semiconductor manufactures. The losses in the switches are approximated based on the temperature, gate driver data, computed currents and voltages of the ideal switches. The data sheet provides the parameters and/or characteristics for the conduction and switching losses.

The loss predicting models replace the detailed semiconductor models in a power electronics simulation when the overall system simulation is of importance. The detailed waveforms are now approximated by ideal waveforms, since an ideal semiconductor switch replaces the detailed dynamic model of the switching semiconductor. The advantage is the increased simulation speed. Figure 1 shows the application of a single-phase inverter with inductive load.

Figure 1: Single-phase inverter with IGBT loss predicting models and equivalent thermal network
The IGBT modules, PWM controlled including deadtime, are connected to a simple thermal network represented by a Cauer model [5] of the fourth order. The losses are temperature depending and are calculated on base of the worst case data sheet parameters for the conduction, switching and reverse recovery losses. The conduction losses are calculated from the on state voltage and on resistance of the IGBT and diode. These parameters are temperature depending. The switching inductor current is shown in detail in this simulation, as is the PWM pattern of the voltage across the inductive load. Switching turn-on and turn-off details like reverse recovery are omitted in this simulation, since ideal models are used. The advantage is the
improved simulation speed. Figure 2 shows the junction temperature of one of the IGBT junctions.

Since the simulation is performed for only the first 10ms, the heat sink remains at nearly the same temperature (blue line in figure 2). However the junction temperature is rising fast towards 150 degrees Celsius (red line in figure 2). From this simulation it becomes obvious that a simulation is preferred over a measurement to identify the junction temperature, simply because a measurement of junction temperature of a closed IGBT module during such a short transient is very difficult, if possible at all. A shortcoming in this simulation is that the thermal model is not a good approximation of the applied heat sink. A more realistic heat sink model is required, but this would require many equivalent thermal components building up the 3D geometrical structure of the heat sink.

More detailed thermal model
In a one-dimensional model heat flow is only possible in one direction. In reality the heat flow is a 3-dimensional process.

Figure 2: IGBT junction temperature rising compared to the heat sink temperature.

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The identification of such a thermal model is based on the approximation of the FEM model into a Reduced Order Model (ROM). The reduced order state space model is approximated from the internal FEM model. This model includes all details regarding material and geometry of the thermal path and can be used to model the transient temperature rise as function of the injected losses.

In [2] a study is presented of the base-plate with components of an IGBT module with free wheeling diodes. The module is designed for a hybrid electrical vehicle and contains all the semiconductors required in the inverter. Since the components are closely packed together, thermal problems are expected in this assembly.

The thermal model in FEM includes all layers in the module of the IGBT components. There are various materials such as copper, solder, ceramic and silicon that build the IGBT and the free wheeling diode. For each component, IGBT and diode, a thermal node is defined in FEM. This thermal node is the connection to the circuit/system simulation. Using the ROM approximation method, a reduced order model is calculated from the full model in FEM. This model is included in the circuit/system simulation as shown in figure 3.

A library block MOR30 covers the reduced order model, since in this case there are 30 thermal nodes that have to be connected. The inverter is modeled with parallel IGBT and diode branches. Each IGBT and diode has a thermal node that is exported from the IGBT module. Since there are two IGBT’s in parallel in this model there are also two gates per parallel IGBT set. The gates are controlled by a symmetrical PWM signal of 10kHz. The inverter has a V/f regulation and is modulating signal rises to a maximum of 50Hz. The left side of the MOR30 block shows the thermal nodes that are connected to the thermal nodes of the IGBT module. The right side of the Mor30 block only has temperature sensor outputs without any physical connection. They are used to view the temperatures in scope 2 in figure 3. Scope 3 in figure 3 shows the output waveforms of the inverter in the electrical load. Scope 4 shows the V/f characteristic and in scope 1 the angular speed and electric torque of the induction machine is displayed.

SixPack IGBT module thermal model
The disadvantage of the ROM is that, since it is a state space approximation of the FEM model, it is a linear model. This means that only linear relations between power loss and temperature are modeled. Radiation or forced water-cooling is a non-linear relation between power and temperature where the mathematical relation includes the fourth power of the temperature. Another disadvantage is that a costly FEM analysis is required to get the reduced order model. A simple change in geometry of the cooling systems requires a complete new evaluation of the ROM. By examining the heat sink a reduced order model can also be build using discrete thermal models that are interconnected. This is shown in the simulation below. Here the thermal model of the SixPack IGBT module is combined with a thermal model of the base plate that is mounted onto a forced water cooling system. A simple change of water flow, water temperature or geometric size of the base-plate, directly result in a different temperature profile in the inverter. Combined with a detailed space vector modulation and electric load, the temperature rise in the SixPack IGBT module can be predicted within a few seconds.

Conclusions
To investigate the temperature rise on the semiconductor junctions, an overview is given on the methods for thermal modeling for power electronics simulations. First the loss predicting models are presented and simulations are presented where this model is connected to an equivalent thermal network. Second a reduced order method is shown, where a thermal ROM is derived that is coupled to the fast loss predicting models. Third a thermal model of a complete SixPack module is connected to the inverter simulation for fast and flexible simulation. In the third simulation the non-linear models of forced water-cooling and convection can be included in the simulation.

References
[4] Bauer P., Duijksen P.J. van, Challenges and Advances in Simulation, PESC 2005, Brazil
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Efficient Pulse Frequency Modulation Mode for 6MHz Step Down Converter

Modern cell phones tend to embed more and more functionalities while solution size is shrinking, driving innovation both towards smaller size and efficiency improvement. Texas Instruments’ new step down converter, TPS62620 is addressing size and efficiency issues by operating at 6MHz in PWM mode, allowing use of very small external components, and implementing a high efficiency PFM mode using the same small external components.

By Michael Couleur, Texas Instruments

The PFM architecture used in TPS62620 is a single pulse scheme. The energy is transmitted in the output filter using one unique inductor current pulse each time the feedback voltage is falling below the reference. The PFM operation operates as follows: The output capacitor is being discharged by the converter load until the feedback voltage crosses the internal voltage reference. At this point a comparator triggers a monostable which turns ON the output PMOS for a given time and allows the current to build up in the inductor. At the end of the PMOS phase the inductor current reaches its peak and the output NMOS is being turned ON, allowing the inductor current to decrease until it eventually reaches zero, which is detected by a current reversal comparator and ends the PFM phase, turning the output stage high impedance and letting the output capacitor being discharged again by the converter load.

The higher the load, the faster the output capacitor is being discharged and hence, the faster the next PFM pulse happens. The PFM frequency is increasing with the load, until PFM pulses merge which is one of the entry conditions in PWM mode.

This architecture is very efficient because it minimizes the capacitive and switching losses due to output switch commutation, since the output switches are only switched ON and OFF once per cycle. In order to maximize the efficiency it can be understood that the PFM frequency must be minimized, maximizing the energy transmitted each cycle to the output capacitor, inducing a bigger peak current at the cost of higher output voltage ripple. A trade-off must then be found between efficiency and output voltage ripple. TPS62620 exhibits typically 15mV output ripple using a 2.2uF effective output capacitor, which corresponds to a 300mA inductor peak current.

Power switch width optimization:
For every inductor current pulse and for a given pulse amplitude there is an optimum way of sizing the widths of the FETs used to commute the current in order to maximize the efficiency. This optimum size minimizes both resistive losses through the ON FETs and capacitive losses needed to charge and discharge the gate of the FETs.

The resistive losses can be expressed as follows:

\[ P_{\text{res}} = R_{\text{ds(on)}} \cdot I^2 \]

Where \( R_{\text{ds(on)}} \) is the ON resistor of the switch and can be expressed first order as follows:

\[ R_{\text{ds(on)}} = \frac{1}{K'} \cdot \frac{W(V_{\text{GS}} - V_T)}{L} \]

is the product of the electron mobility and the gate oxide capacitance per area, \( V_{\text{GS}} \) the gate-source voltage and \( V_T \) the threshold voltage, \( L \) the FET length and \( W \) the FET width.

From these two definitions, it can be noticed that resistive losses are inverse proportional to \( W \), the width of the FET.

The capacitive losses are expressed as follows:

\[ P_{\text{cap}} = C_{\text{gate}} \cdot V_{\text{GS}}^2 \cdot f \]

where \( C_{\text{gate}} \) is the FET gate capacitance, \( V_{\text{GS}} \) the gate source voltage and \( f \) the PFM operating frequency.

\[ C_{\text{gate}} \]

is the following function of \( W \), the FET width:

\[ C_{\text{gate}} = C_{\alpha} \cdot W \cdot L \]

where \( C_{\alpha} \) is the gate oxide capacitance per area, \( L \) the FET length and \( W \) the FET width. From the two previous equations, we noticed that the capacitive losses are proportional to the FET width.

Capacitive and resistive losses being the two only loss mechanisms being a function of the FET width, the total power loss dependent on the FET size can be summarized as

\[ P_{\text{total}} = P_{\text{res}} + P_{\text{cap}} = C_{\alpha} \cdot W + \frac{C_{\alpha}}{W} \]
where $C_1$ and $C_2$ are two coefficient independent of $W$.

This function is of second order in $W$ and admits a minimum, which is minimizing the FET losses and maximizing the global converter efficiency. Note: $C_1$ and $C_2$ are functions of the PFM peak current and consequently this optimum is only valid for this given peak inductor current. In TPS62620, optimization is computed for a PFM peak ripple current of 300mA.

**Entry/exit of PFM mode and hysteresis:**
TPS62620 imbed an auto transition between PFM and PWM mode. The system enters PFM mode when the inductor current reverses in PWM mode. The system exits PFM mode when PFM pulses merge.

For a given input/output voltage combination of typically 3.6V and 1.8V, the PWM current ripple is fixed to appreciatively 200mA. The system will then enter PFM mode when the converter load is equal to half the current ripple, i.e.: 100mA.

The PFM inductor current ripple is also typically fixed, i.e.: 300mA. As the pulses merge, the load that the PFM mode is supporting is equal to half the current ripple, i.e.: 150mA.

Because of these two different entry and exit thresholds, the system exhibits a PFM entry exit hysteresis of appreciatively 50mA allowing good noise immunity and preventing the system from unintentionally switching between the 2 modes.

**Transient response:**
In order not to sacrifice the converter load transient response, the system implements a second PFM exit condition. When the internal comparator indicates that the output voltage is still lower than the reference voltage after the PFM pulse, the system goes into PWM mode. Hence, when the load increases quickly and the energy transmitted by the PFM pulse is not sufficient to bring the output voltage back above the reference, the system will instantaneously detect the load transient and switch to PWM mode in order to bring back the output voltage faster into the regulation limits. TPS62620 exhibits best in class PFM load transient behaviour.

TPS62620, Texas Instruments’ high performance new 6MHz converter features an optimized auto PFM/PWM mode of operation, with PFM mode entry/exit hysteresis, allowing high PFM efficiency without compromising load transient response, making the TPS62620 device an ideal choice for application where solution size as well as low load efficiency are critical.
UltraVolt, Inc. announced another addition to its new microsize/micropower product family – the “D” Series. Continuing with UltraVolt’s standard of high reliability and high performance, the new “D” Series offers low ripple (<0.02% peak to peak), tight line/load regulation, output current limit protection, low noise, and buffered voltage and current monitoring. The micropower “D” Series is ideal for a wide range of applications including avalanche photodiodes (APD), electrostatic chucks (E-chuck), gas chromatography, high voltage testing, image intensifiers (II), micro-channel plates, (MCP), photomultiplier tubes (PMT), scanning electron microscopes (SEM), spectrometers, and much more.

Output voltages for this new microsize line range from 0 to 6kV at up to 6W of output power, with output current from 166μA to 6mA. The volume for “D” Series modules is just 2.22in³ [36.3cc] for 1-4kV, 1-4W units or 2.98in³ [48.9cc] for 1-4kV, 6W and 1-6kV, 1-6W units. Although bigger than UltraVolt’s other recently launched microsize products, “D” Series modules still represent a dramatic reduction in size (up to 33%) from the smallest standard line of UltraVolt high voltage power supplies, the “AA” Series.

http://www.ultravolt.com

KOA Europe introduced the WK73 wide terminal resistor in size 1206 (3216 metric). The 90° rotated design has several advantages compared to standard resistor footprints.

The 3 times higher power rating of 750mW is the most visible. It is based on the improved heat dissipation through the solder joint. The much higher terminal strength of the WK73 relates to the bigger solder pad. Additionally the lower distance between the terminals results in less expansion stress on the solder joints.

All the above mentioned benefits combined, result in a higher reliability of the part compared to standard thick film resistors. You can now find the WK73 in size 1206 available in the ohmic range from 10mOhm up to 3.3kOhm. The operating temperature ranges from -55°C up to +155°C. The WK fully complies with EU RoHS and China RoHS requirements.

Amongst other applications, the product can be mainly used in Power Supplies, Control units and Current measurement applications. For further information and labkits of the WK73 wide terminal resistor please contact:

www.koaeurope.de

Sensor Products Inc. introduces Pressurex®, a pressure indicating film that reveals pressure magnitude and distribution between any contacting or mating surfaces. In the Photovoltaics Industry, the need to reduce peripheral cracks on solar cells has received much attention. Thin film modules of CdTe or CIGS on glass or flexible substrates are particularly susceptible to moisture ingress and require stringent quality control checks. Pressurex® provides a low cost solution for quality control checks during equipment setup, calibration, as well as re-qualification of a solar module production line. Negative occurrences such as cracked substrates, squeeze out of materials from the module, and unwanted encapsulant thickness can be reduced, if not eliminated, by measuring and optimizing the quantity of applied pressure.

Pressurex® uniquely provides a quick and low-cost solution for measuring applied pressure magnitude and distribution. When placed at the interface of two contacting surfaces that are compressed together (as in a lamination or heat press for example), Pressurex® measures pressure from 2 - 43,000 PSI (0.14 - 3,000 kg/cm²). Pressurex® assures proper pressure magnitude to cause polymerization and securely bond multiple layers together during EVA and PVB lamination.

www.sensorprod.com
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Battery Fuel Gauges Supporting JEITA Charging Profile

Texas Instruments introduced the bq20z4x and bq20z6x family of battery fuel gauge integrated circuits (ICs) with enhanced charging, including the Japan Electronics and Information Technology Association (JEITA) profile. The new battery fuel gauges feature TI’s Impedance Track™ technology and provide the highest degree of capacity measurement for two- to four-cell battery packs used in next-generation notebooks and netbooks, portable industrial and medical equipment. For more information on this product and to order samples, please see www.ti.com/bq20z4x-pr.

The bq20z4x and bq20z6x devices are pin-compatible with TI’s popular bq20z7x and bq20z9x series of products with Impedance Track. The bq20z45 and bq20z65 are single-package ICs with integrated battery protection, while the bq20z40 and bq20z60 are dual-package ICs requiring a companion bq29330 analog front end device. The bq20z6x family supports LED functionality. Full configurability of all JEITA parameters: Configurable according to temperature, charging currents and charging voltages. Charging voltage and cell over-voltage threshold varies with temperature.

www.ti.com

GenX3 IGBT Family with SiC Anti-Parallel Diodes

IXYS Corporation announces the expansion of its family of 600V GenX3 IGBTs product range to include a portfolio of IGBTs with Silicon Carbide (SiC) co-pack diodes. For demanding applications like solar inverters and switch mode power supplies, the combination of the GenX3 IGBT and the extremely fast SiC diode create a solution that can allow the customer a solution in markets where efficiency is the main design requirement.

The GenX3 platform is manufactured using IXYS’ robust HDMOS IGBT process and are optimized in two speed classes. Both of which take the benefit of IXYS’ proven Punch-Through (PT) technology that includes, lower saturation voltage and lower energy losses offering designers a new viable option for improved switching applications at the 600V range. The B3 range of GenX3SCTM IGBT are optimized for 20kHz hard switching applications and the SiC diode combination will be essential for such efficiency critical applications at mid-range frequencies such as Solar Inverters. The C3 range of GenX3TM IGBT extend the range to higher frequencies and can facilitate the fastest switching IGBT available on the market today. These devices are co-packed with high performance SiC ultra-fast diodes offering minimal switching losses due to the absence of reverse recovery charge (Qrr) in High Band Gap technology, further extending the barriers of switching frequency of the IGBT. The square reverse bias safe operating area (RBSOA) featured in the 600V GenX3SCTM ensures safe operation in snubberless, hard switching applications. Products are offered in various standard packages (TO-220 to TO-247) with collector current ratings from 30A to 48A.

http://www.ixys.com

Second Generation of Wi-LEM Wireless

LEM has extended its Wi-LEM (Wireless Local Energy Meter) family to allow the remote measurement and monitoring of electricity, water and other metered utilities as well as temperature and humidity. It allows industrial and commercial enterprises to break down energy and water usage and identify areas of efficiency improvement. All the new Wi-LEM components feature a tenfold increase of RF power from 1mW to 10mW, increasing the distance between nodes compared to the previous LEM generation of components.

By using the 802.15.4 wireless communication standard, which has proven reliability, and the use of split-core transducers, Wi-LEM greatly reduces the time, cost and disruption involved in deploying a sub-metering installation.

The Wi-Pulse is a new and additional dual-input pulse counter used to count and transmit pulses generated by utility meters. It can easily be connected to an existing Wi-LEM network, expanding the range of utilities that can be monitored - in addition to electricity. Wi-Pulse therefore enables readings from existing stand-alone water and energy utility meters and sub-meters with a pulse output to be monitored centrally using a Wi-LEM network. The new Wi-Zone is a temperature and humidity transducer that connects to a Wi-LEM network, allowing environmental conditions to be monitored. Both new devices are battery powered, simplifying installation as they require no external power supply. They also both feature an internal integrated antenna, making the transducers compact and ideal for retrofit applications.

www.lem.com
Energy-Efficient Chokes for Inverters in Wind Turbines

SMP Sintermetalle Prometheus (SMP) introduces chokes for inverters in wind turbines. These inductive components feature low losses, very low stray fields, a highly compact design, and energy efficiency for the power inverters based on these chokes. SMP uses core materials made of powder composites that are specifically engineered for each individual application.

“The direct current from the modules must be converted into a sinusoidal waveform with the values required by the grid. The converter’s filters, which consist of capacitors and filter chokes, ensure that the current being fed into the grid exhibits a near sinusoidal waveform”, explains Stefan Schauer, technical sales manager at SMP. To meet the ever more demanding requirements of modern wind turbines, SMP has developed high-performance, low-loss chokes. Developed by SMP especially for inverters used in wind turbines, the materials used have low magnetostriiction and exceptionally low eddy current and hysteresis losses. This means that the inverters in which they are used are highly efficient, so that a larger proportion of the generated power can be fed back into the grid. This results in a faster return of investments. “The profitability of a wind turbine is directly related to the efficiency of the inverters, which, in turn, is determined by the energy efficiency of the components used”, ads Stefan Schauer. “The manufacturers pay very close attention to the components’ efficiency, which must be as high as possible.”

In addition to low losses, components in power converters are required to have low-intensity stray fields. SMP chokes achieve this through an encapsulated design. This offers the advantage that other components can be placed in close vicinity to the chokes without the risk of magnetic interaction. Compact choke design is another important aspect. In comparison to conventional designs, SMP chokes occupy 25 percent less space.

The chokes are maintenance-free and have a long lifespan – a significant contribution to reducing the expensive maintenance of wind turbines. SMP chokes have also been tested and approved for use in offshore installations.

For use in photovoltaics, railway engineering, drives, power electronics, power generation, and instrumentation and control, SMP supplies inductive components for frequencies up to 200 kHz and current ratings up to 1000 amperes. Depending on their application, they are constructed either as single-conductor choke for high-current applications, 1 ph individual chokes, 3 ph choke modules, or LC filters. These components offer a high energy storage capacity in a compact and cost-conscious design as well as reduced losses and good EMC characteristics. SMP manufactures all components to customer specifications using in-house developed powder composites. All products are RoHS- and REACH-compliant and the materials used are UL-listed. To allow for a wide range of requirements, components can be made to all common international standards.

Low-Noise EL Lamp Driver IC

The Durel Division of Rogers Corporation has announced the latest addition to its high-performance electroluminescent (EL) lamp driver integrated circuits (ICs) - D392A. The D392A EL lamp driver delivers the programmable output voltages needed to power a wide range of EL lamps, including in portable applications such as cellular telephones, data organizers and PDAs, remote controls, monochrome LCDs, and DFLX™ EL keypad lamps.

Operating with supply currents ranging from 16 to 35 mA and a minimum enable voltage of 1.3 V, the high-efficiency EL lamp driver generates typical peak-to-peak output voltages of 170 to 230 V, with maximum rating of 250 V peak-to-peak. It uses patented wave-shaping technology with slew-rate control to produce clean, low-noise output voltage waveforms for noise-sensitive applications.

Durel’s D392A EL lamp driver, which supports a wide range of lamp frequencies, incorporates a unique dimming feature which can be controlled through discrete components, an analog voltage or a PWM signal. The robust lamp driver IC features a high +/- 15 kV ESD (Human Body Model) rating and output over-voltage protection for high reliability in a wide range of applications. The lamp driver is compatible with external clocks and supplied in a “Green,” RoHS-compliant (lead-free) 14-pin DFN package.

The easy-to-use D392A lamp driver IC can be implemented in most practical circuits with low-profile inductors and a few other passive components. In addition, designer’s kits for the D392A, complete with evaluation board, are also available. The lamp driver IC is rated for operating temperatures from -40 to +85°C and storage temperatures from -55 to +150°C.

LoPro™ Laminates for Low-Loss

The Advanced Circuit Materials (ACM) Division of Rogers Corp. recently introduced RO4730™ LoPro™ laminates for base station, RFID and other antenna designs. RO4730 LoPro laminate materials combine low-loss dielectric with low-profile copper foil for reduced passive intermodulation (PIM) and low insertion loss.

The specially formulated RO4730 LoPro thermoset resin system incorporates a hollow microsphere filler to achieve a low weight, light density laminate, which is approximately 30% lighter weight than woven-glass PTFE materials. RO4730 LoPro laminates have a matched dielectric constant of 3.0, providing a much lower cost solution for high frequency circuit boards used in base station and other antennas.

www.rogerscorp.com
**Supervisor Monitors Up to Six Power-Supply Voltages**

Maxim Integrated Products introduces the MAX16055, hex-voltage microprocessor supervisor with integrated reset timing, which eliminates the need for an external capacitor. Having an ultra-small, 3mm x 3mm footprint, this device is ideal for low-voltage monitoring in multivoltage systems such as telecommunications, networking equipment, storage devices, high-end printers, and computers. Whenever one of the six monitored voltages falls below its threshold, the open-drain reset output asserts and remains asserted for at least 140ms after all six voltages exceed their respective thresholds. The reset output is internally pulled up to Vcc to eliminate the need for an external resistor, but can be overdriven to accommodate other logic devices. A manual reset is also provided.

**Octal Switch Provides Unmatched Design Flexibility**

Intersil Corporation announced the ISL54230, a new octal switch that is ideally suited for high-end cell phone applications. The ISL54230 has 8 individual Single Pole Double Throw (SPDT) switches whose performance has been carefully designed to enable them to pass a wide range of precision voice and data signals, including high-speed USB, UART, PCM, audio and power. With the addition of simple logic control, the switches can be configured to multiplex between pairs of signals like USB 2.0 high-speed ports, or between groups of signals like SIM card clock, data and power lines. To minimize board space, the signal pins on the ISL54230 have been arranged in a ‘flow-through’ manner to avoid signal crossovers on the PCB. Unused switches can be powered down as required under logic control.

**SMD shunt resistors save space and offer a number of advantages:**

- High pulse loadability (10J)
- High total capacity (7W)
- Very low temperature dependency over a large temperature range
- Low thermoelectric voltage
- Customer-specific solutions (electrical/mechanical)

**Areas of use:**

Power train technology (automotive and non-automotive applications), digital electricity meters, AC/DC as well as DC/DC converters, power supplies, IGBT modules, etc.
**Star-Shaped Heatsinks for LEDs**

High Power LEDs (HP) and High Brightness LEDs (HB) for lighting purposes offer great opportunities for the lighting industry, as LEDs are energy-efficient and potentially highly reliable.

In view of the high power density of these HP/ HB LEDs the major challenge is safe and effective heat dissipation, in order to ensure trouble free functioning, good light yield and a long service life.

The shape of lamp housings or the positions in which they are situated is often rotationally asymmetric, so that round bodies are required for heat dissipation.

In order to dissipate the heat from these LEDs Fischer Elektronik have developed a range of aluminium heatsinks the dimensions of which match the majority of current round housing designs.

These heat sinks, which are offered with different diameters and contours, are available in different sections of different lengths to suit specific heat dissipation applications. The LEDs are fastened onto the heat sink using thermally conductive, double sided adhesive tape, 2-component thermally conductive adhesive or screws. In the standard version, the surface is black anodised or of natural colour.

**Mega Flux ER-4917 Series of Filter Inductors**

MRC offers state of the art Filter Inductor Series ER4717 with excellent performance. As example MRC’s inductor with a helical Winding on Mega Flux Powder Core Construction offers a rated current of 250A. This new inductor can achieve up more energy storage!

MRC use Flat Helix winding to reduce DCR, lower copper loss, reduce size, even out heat dissipation and achieve up to 80% of copper fill factor.

The DCR is 0.75 milli-ohms max. The tested High Pot for winding to core isolation is 1000VDC. The inductance is 12 μH ± 15% measured at 10 KHz, 0.25V, Zero AC Bias. Dimensions are 49.4 x 50 mm with a height of 35 mm. MRC can gap the core to follow customers specification, as example to make the 8.5 μH + - 15%.

**Ultra Low Dropout Voltage Regulator**

Available in the tiny USP-6C package (1.8 x 2.0 x 0.6mm), as well as in standard SOT-25 and SOT-89-5 versions, the new XC6222 Series of voltage regulators from Torex Semiconductor offer exceptionally low dropout voltage – typically 120mV with a 300mA load (VOUT=3.0V). These high current, ultra-low dropout voltage regulators with reverse current protection provide a highly stable, low noise supply that meets the demands of battery-driven circuits as well as being optimised for use in back-up power circuits.

The XC6222 Series consists of a voltage reference, an error amplifier, a current limiter, a thermal protection circuit, a reverse current protection circuit and a phase compensation circuit plus a driver transistor.

Output voltage can be factory set anywhere from 0.8V to 5.0V in 50mV steps, and the operating voltage range is from 1.7V to 6.0V.

The LDO is also compatible with low ESR ceramic capacitors, which give added output stability.

The reverse current protection circuit prevents damage to any connected products such as batteries which could occur as a result of current flowing from the VOUT pin to the VIN pin. Reverse current flow is limited to 1.5uA or less when the VIN voltage level is lower than the VOUT voltage level. An over current protection circuit and a thermal shutdown circuit are also built in. The over current protection circuit will operate when the output current reaches its limit current level. When the junction temperature reaches its limit temperature (150°C), the thermal shutdown circuit takes control, it then releases at 125°C.

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Powerful from SPT to SPT+
With performance improvement of up to 50% over competing devices, the new TO-247 MOSFETs from International Rectifier can help extend battery life in motor applications, improve efficiency in solar inverter systems, and deliver the wattage required for high power Class D audio systems.

Applications

• High Power Synchronous Rectification
• Active O’Ring
• High Power DC Motors
• DC to AC Inverters
• High Power Class D

Features

• 40V to 250V in TO-247AC Package
• Industrial grade, MSL1
• RoHS compliant

N-Channel MOSFETs

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* Based on data compiled October 2008
** Package limited

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