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Power Systems Design EUROPE

Power Control Intelligent Motion March 2005

6.5kV-SPT IGBT HiPak Module

Power Player

Marketwatch

Portable Power - Part II

ISSN : 1613-6365

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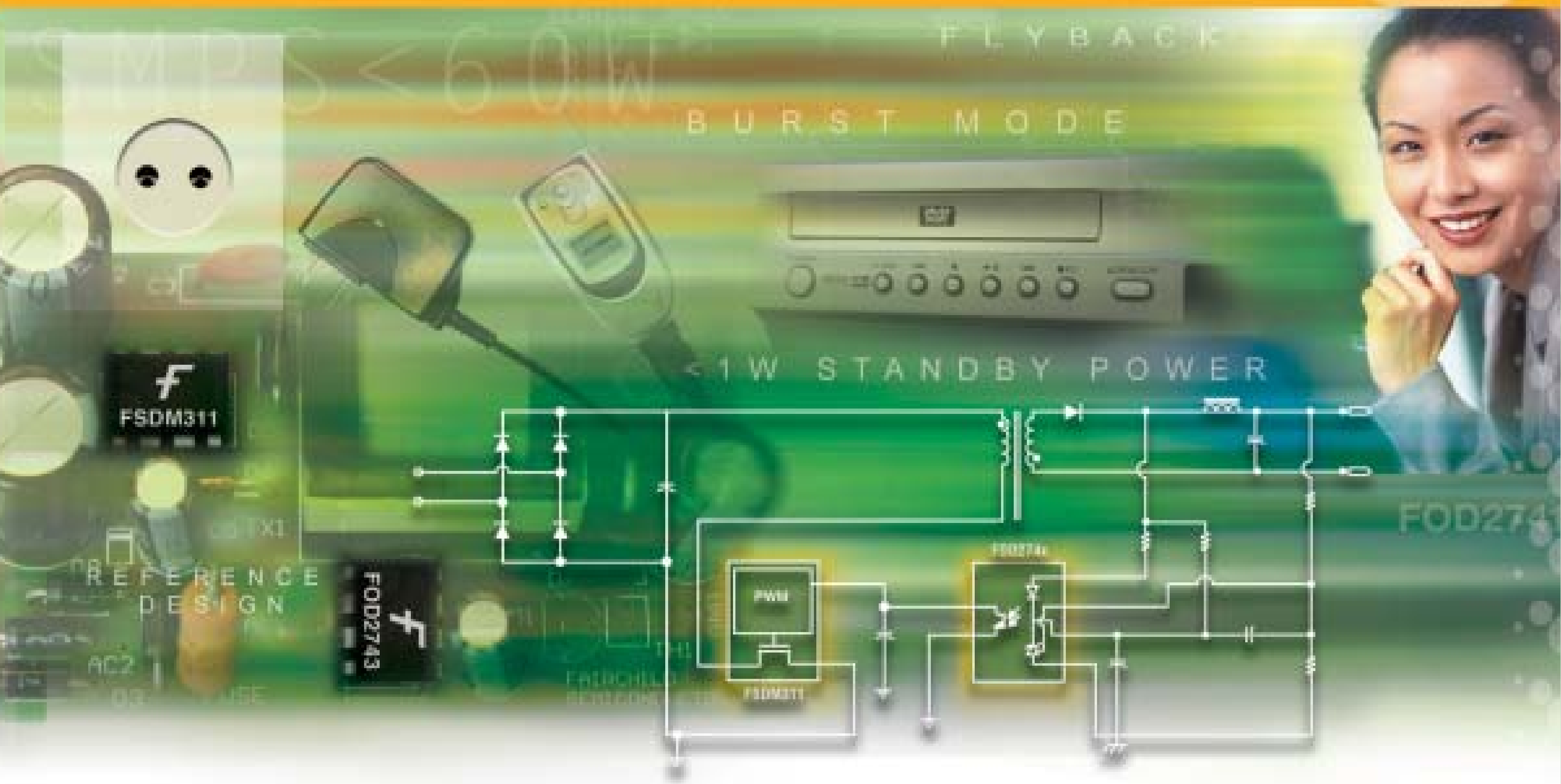

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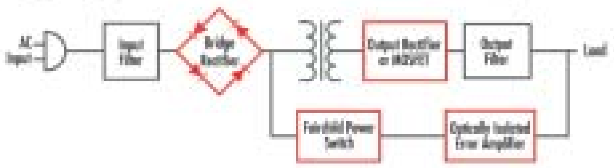

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Portable Power: Part II

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Volume 2, Issue 2

The Texas Smell of Spring

Going to Austin and meeting our friends in the power family is a highlight to start the new year. Austin brought warm weather and the first signs of Spring on the trees, Spring has not arrived in Europe, we are still shuffling snow around , playing with the electric toy trains and looking forward to more daylight and warmer weather.

So it was nice to be in Austin and enjoy APEC. Attendance to the conference is up over 40% from last year with the exhibit area completely sold out. If you want to reserve space for APEC 2006, which will be held in New Orleans, better to reserve now.

PCIM China immediately follows APEC March 13-17 in Shanghai. Our new Power Systems Design China magazine is the sole media sponsor and will carry the program for the conference. PSD China, published in Simplified Chinese, is the first and only International publication devoted entirely to power electronics to enter the Chinese market. PSD China partners with our PSD Europe publication to extend our footprint and influence in the power electronics market.

The popular PCIM Europe show will be meeting in early June in Nuremberg, this show is selling out quickly, another good sign that the power electronics market is continuing momentum. So altogether spring starts busier and stronger than ever for power electronics. Keeping with tradition for the PCIM Exhibition in Nuremberg, I will moderate the podium discussions during the lunch break each day on the show floor.

This year we will include more system level focused subjects for discussion. “Power Management controlled by analog or digital” will be the Tuesdays topic. “Portable Power, charging and optimizing operating time” will highlight the Wednesday. “Thermal Management and the design and simulation tools” will be on Thursday. The topics complement the conference subjects.

In this issue, we publish part two of our “Portable Power” series. Portable power has become more and more important as stationary equipment was the way of operating in the last millennium.

“Portability” is what everyone is looking for in the end product. We all have so many “portables” starting with the cell phone and the lap top surrounded by all kind of power tools in our basement work shop. It is important to extend the operating time of portable equipment to the maximum. Modern technology for batteries and capacitors create solutions that match the requests for performance.

Most of the efficiency enhancements have been stimulated by device improvement. The electronic switches have become better and better in respect to conduction and switching losses, all this boosts the efficiency in Power Conversion.

Power management and conversion together with the intelligent motion solutions will fuel our publication for the upcoming year. We are focused to provide our readers with the most up to date solutions in power electronics. The dialog is always open to contact me to provide your technical articles bodo.arlt@powersystemsdesign.com

Best regards,

Bodo Arlt
Editorial Director
The Power Systems Design Franchise

PSMA Takes Position on Power Supply Efficiency

The Power Sources Manufacturers Association (PSMA) has taken a strong position on voluntary and mandatory standards regulating the minimum acceptable efficiency of power supplies. In an open letter to manufacturers, regulatory agencies, and other participants and stakeholders in the power supply industry, the PSMA has called for the development of a unified set of global standards and testing methods. The letter goes on to say that "PSMA and its members stand ready to provide whatever assistance and guidance is needed to assure that the obtained data is an accurate and thorough reflection of present state of the industry's products."

This letter is a statement of the unanimous position taken by the PSMA Board of Directors on this important subject at its meeting in December, 2003. In the letter, Arnold Alderman, PSMA's Chairman pointed out the challenges in developing such standards. "The standards and guidelines should be fair to both supplier and user yet encourage significant improvement in efficiency based on cost effective technologies we know to be available." In addition, he said, "PSMA encourages further technology development that will provide continuous improvement of power conversion efficiency while respecting both safety standards and the competitive pressures of the commercial world."

While urging the adoption of a unified set of standards, PSMA calls for every effort to be made to avoid compromising the development of improved efficiency standards in favor of the single standard. In other words, PSMA calls for manufacturers and regulatory agencies to work together in ways which will lead to the convergence, over time, of existing individual standards into a single global standard.

Please visit the Energy Efficiency Forum on the PSMA website to read the complete text of the letter.
(http://psma.com/HTML/FILES/forums/energy/PSMApositionLtr_2005-01-14.pdf)

www.psma.com

National Adds Distributor SASCO

To complete Arrow Central Europe distribution relationship, National Semiconductor Corporation and Arrow Electronics, announced today an effort to increase mutual demand creation activities for National's analogue integrated circuits throughout Central Europe. As an important element, National has appointed SASCO GmbH, Arrow's specialised design-in distributor, to capitalise on the companies' demand creation strengths throughout the Central European distribution network.

With 18 experienced field application engineers and proven expertise in providing complete solutions from a focused line-card strategy, SASCO will make a powerful addition to National's strength in Central Europe. Working in collaboration with complementary partners across the SASCO line-card will allow National to further deliver high-quality analogue design wins including its industry-leading power management and amplifier products.

Michael Knappmann, managing director of SASCO stated, "We are extremely pleased to work with National and to use our unique design-in expertise to bring Nationa's leading-edge analog solutions to our customers. I believe National's strong analog portfolio is the perfect complement to our line-card. We are all delighted to be National's distribution partner for its industry leading power management and amplifier products."

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Inverter Use in White Goods Set to Explode

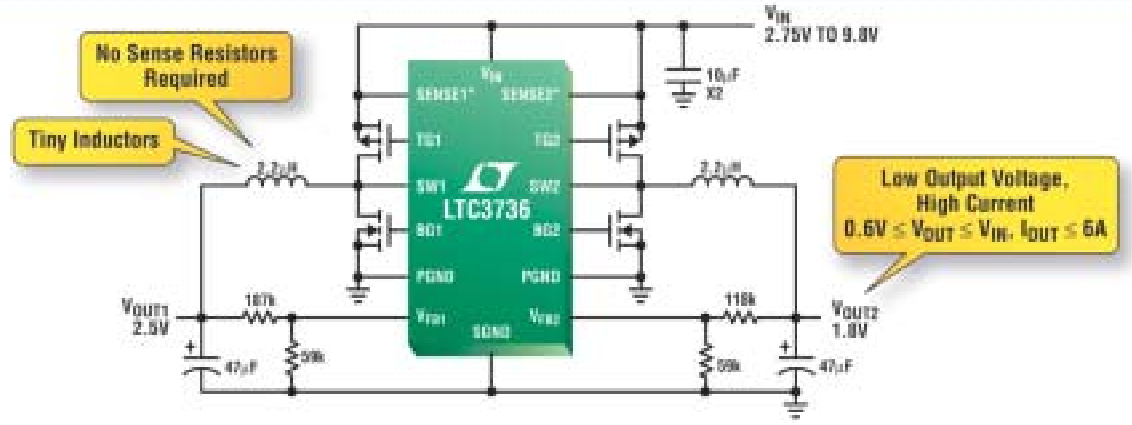
The number of major home appliances using inverter-based variable speed control solutions is forecast to multiply four-fold between 2003 and 2008, according to a recent report on the worldwide major home appliance market from IMS Research.

The report reveals that the electronic content of major home appliances (MHA) is set to rise sharply over the next five years, partly driven by this growing adoption of inverter-based variable speed control solutions. "Total volume shipments of inverter-based, variable speed controlled home appliances are forecast to rise from 25 million units in 2003 to nearly 100 million units in 2008. Most of the volume growth is forecast to come from refrigeration appliances, room air conditioners and washing machines" commented Ann Bird, one of the report's authors at IMS Research.

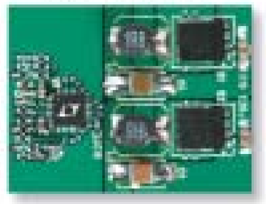
"The main drivers for this increased use of inverters in major home appliances are the consumer's desire for better performance in their appliances, the trend towards increased energy efficiency and the declining cost of inverter-based VS control solutions." continued Bird. The report found that Japan was easily the leading country for the use of inverter-based VS control solutions in 2003. However, high growth is forecast for Western Europe, North America and China over the next few years.

www.imsresearch.com

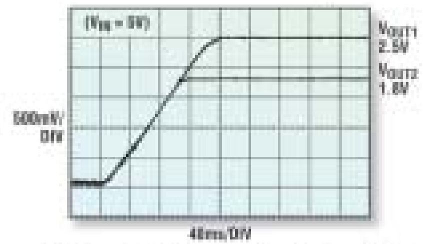
Low Volts, High Amps



Tiny Solution
(2.3cm x 3.0cm)



Precision Tracking*



(*Allows coincident or ratiometric tracking)

As IC operating voltages are driven lower, corresponding currents are driven higher. Linear Technology's DC/DC controllers meet the need for very low voltage outputs at very high currents – without sacrificing efficiency. These feature-rich controllers offer multiple outputs with up/down tracking for CPUs, DSPs and FPGAs, high frequency operation to keep inductors and capacitors small, phase-locked loops for easy synchronization to system clocks, fast transient response and easy loop compensation.

Selected DC/DC Controllers

Part Number	Notes	PolyPhase™	No R_{SENSE}™	PLL Sync.	Output Tracking	I_{OUT} (A) Max	V_{IN} (V)	V_{OUT} (V)
LTC®1778	Single Output		Yes			20	4 to 36	0.8 to 90% of V_{IN}
LTC3808			Optional	Yes	Yes	6	2.7 to 9.8	0.6 to V_{IN}
LTC3778			Optional			20	4 to 36	0.8 to 90% of V_{IN}
LTC3703	High Voltage Single Output		Yes	Yes		15	9.3 to 100	0.8 to 100
LTC3703-5			Yes	Yes		15	4.1 to 60	0.8 to 60
LTC3831-1	DDR Memory Termination		Yes		Yes	20	V_{DDQ} 1.5 to 2.5	0.4 to 1.25
LTC3713	Very Low V_{IN} Single Output		Optional			20	1.5 to 36	0.8 to 90% of V_{IN}
LTC3729L-6	High Power Single Output	Yes		Yes		40 to 200	4.5 to 30	0.6 to 90% of V_{IN}
LTC3709		Yes	Optional	Yes	Yes	40	4 to 30	0.6 to 90% of V_{IN}
LTC3731		Yes		Yes		60 to 200	4.5 to 30	0.6 to 5
LTC3714	Output Adjustable Digitally; Single Output		Optional			20	4.5 to 36	0.6 to 1.75
LTC3730		Yes		Yes		60	4.5 to 36	0.6 to 1.75
LTC3732		Yes		Yes		60	4.5 to 36	1.1 to 1.85
LTC3733-1		Yes		Yes		60	4.5 to 36	0.8 to 1.55
LTC3738		Yes		Yes		60	4.5 to 36	0.83 to 1.6
LTC3708	Dual Output	Yes	Optional	Yes	Yes	20, 20	4.5 to 32	0.6 to 90% of V_{IN}
LTC3802		Yes	Yes	Yes	Yes	25, 25	3 to 30	0.6 to 90% of V_{IN}
LTC3736		Yes	Yes	Yes	Yes	6, 6	2.75 to 9.8	0.6 to V_{IN}
LTC3737		Yes	Optional	Yes	Yes	6, 6	2.75 to 9.8	0.6 to V_{IN}

Info & Online Store

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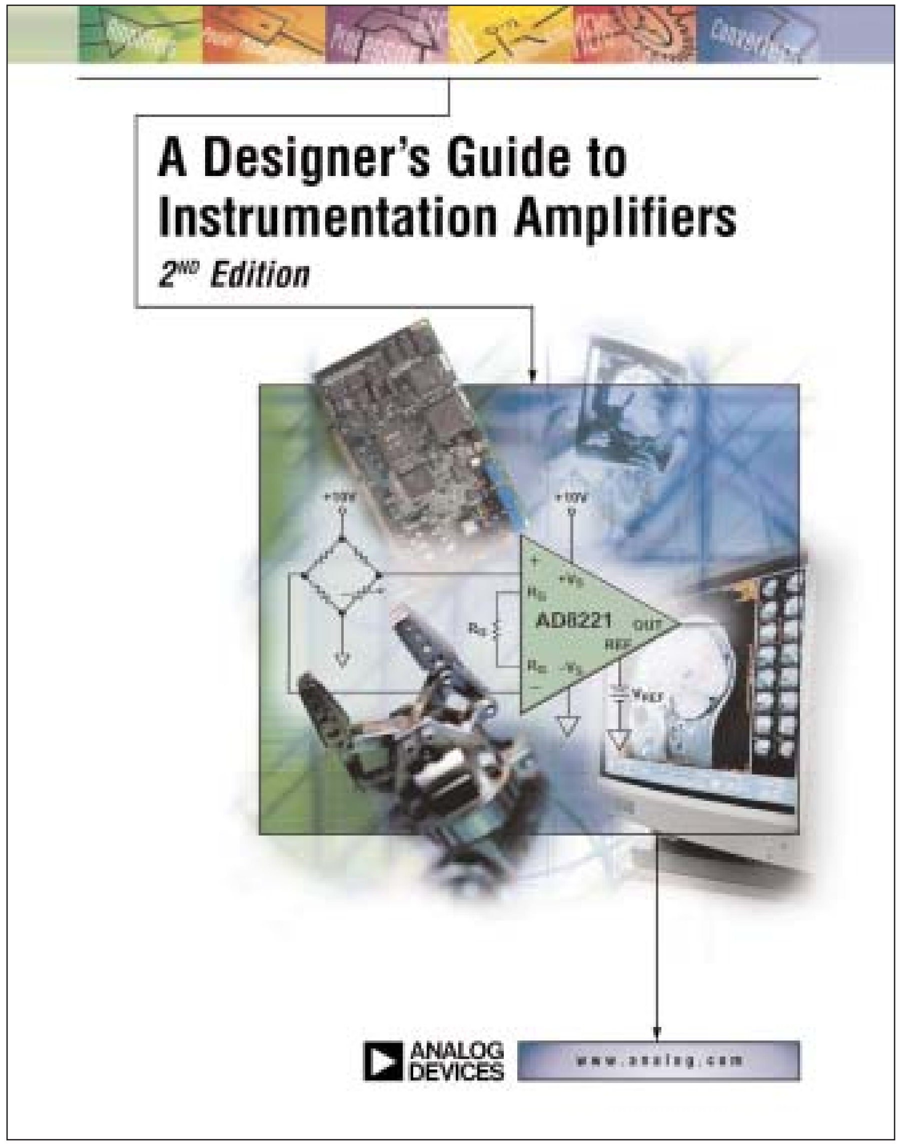
Free Guide for Design Engineers



Analog Devices is introducing a free "hands-on" applications guide, A Designers Guide to Instrumentation Amplifiers - Second Edition, authored by senior design engineers Lewis Counts, design fellow and vice president of the Linear Products group and Charles Kitchin, hardware applications engineer. Between them they have more than 60 years combined experience designing and managing the development of analog integrated circuits. The greatly expanded second edition of the amplifier guide contains tables, graphs and data presented in an easy-to-understand "cookbook" format. It also provides the latest information about Analog Devices' amplifier products, including difference amplifiers. To view the online version, or to order the hard copy, please visit: www.analog.com/inampguide.

www.analog.com

ASSET Integrates Lattice's ispVM

The number of major home appliances uASSET InterTech an leader in boundary-scan (JTAG/IEEE 1149.1) test and in-system programming (ISP), has integrated into its ScanWorks boundary scan environment Lattice Semiconductor's ispVM System, a programming engine that supports the IEEE 1532 Standard for In-System Configuration.

The same ScanWorks system that applies boundary scan tests to an assembled circuit board can also program multiple on-board logic devices concurrently, reducing programming time and increasing the efficiency of manufacturing operations. Benchmark tests by ASSET have shown that programming times can be reduced by 30 percent or more.

Lattice Semiconductor, Hillsboro, OR, designs, develops and markets a broad range of programmable logic devices and software design tools. ASSET's easy yet powerful ScanWorks boundary-scan test and ISP environment is currently used by leading electronics companies such as Cisco, Lucent Technologies, Alcatel, Agilent, BAE, Hewlett-Packard, Ericsson, Intel, Raytheon, Solectron, Rockwell Collins, SBS, EMC and others.

www.latticesemi.com

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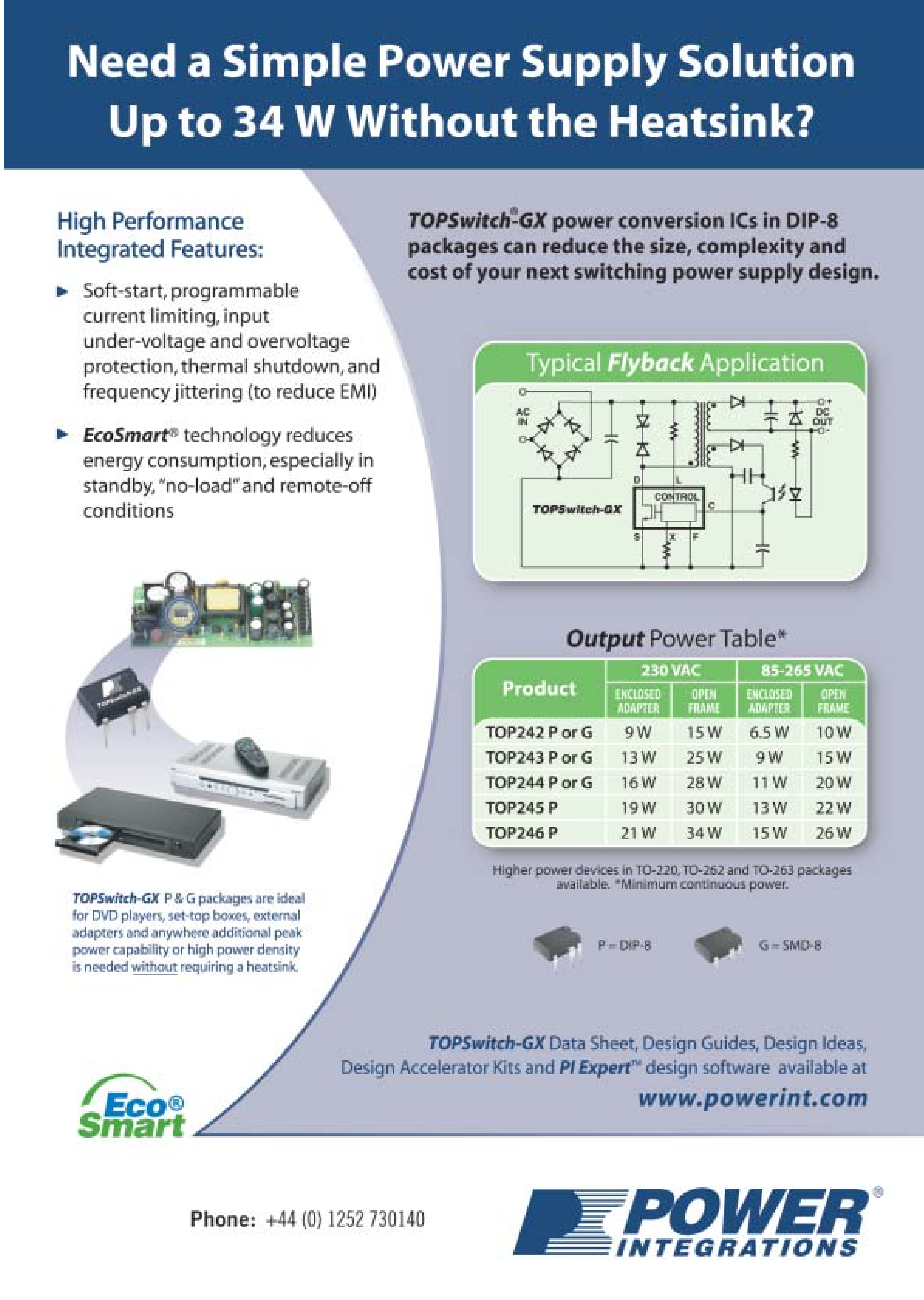

Environmental Commitment

Phihong USA, a global leader in electronic accessories and power supplies, today announced it is the first manufacturer of external power supplies to be named a partner of the Environmental Protection Agency's ENERGY STAR Program. As a partner, Phihong's products must meet strict energy-efficiency guidelines set by the EPA and the Department of Energy. On average, ENERGY STAR models are 35 percent more efficient than conventional designs, and often are lighter and smaller in size.

At the Consumer Electronics Show in Las Vegas, the EPA presented Phihong with a Certificate of Recognition to acknowledge the company's involvement in helping the group develop energy standards and specifications for manufacturers.

Photo: From left to right, Keith Hopwood, vice president of sales & marketing for Phihong USA, Andrew Fanara of EPA ENERGY STAR, Peter Lin, chairman and CEO of Phihong, and Steve Ryan of EPA ENERGY STAR, at the presentation of the Certificate of Recognition to Phihong.

For more information about ENERGY STAR, call 1-888-STAR-YES or visit http://www.energystar.gov.

For more information about Phihong Europe contact Steve Smith, Swallow Court, Suites 3 & 4, Devonshire Gate, Tiverton, EX167EJ, England, or call +44 (0) 1884 849300, email steves@phihongeu.com or visit http://www.phihong.com.

www.energystar.gov

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Intelligent Motion at PCIM Europe 2005

lThe statement of the PCIM Conference Directors Intelligent Motion, Prof. Helmut Knöll, Fachhochschule Würzburg-Schweinfurt, Germany and Prof. Mario Pacas, University Siegen, Germany reflect the following: In Intelligent Motion we see a steady progress in all fields of drive technology. Only to point out some trends and highlights of our conference: The trend of this year in motors and actuators are fault-tolerant systems, direct drives and improved design methods.

Concerning variable speed drives we concentrated on low power drives as they are today very important in automotive and in white goods applications. Vorwerk, Germany presents a high speed switched reluctance motor drive for kitchen machines. EBM-Papst, Germany reports on high speed PM drives for automotive applications.

Mechatronics continues to be one of the main driving forces for novel and improved drive technology. We observe an increase in both, applications as well as new solutions in machine building. Siemens, Germany reports on improved control of elastically coupled machine tool axis as well as compensation of structural oscillations of large gantry machines. ELAU, Germany presents flexible mechatronic machines in the packaging industry.

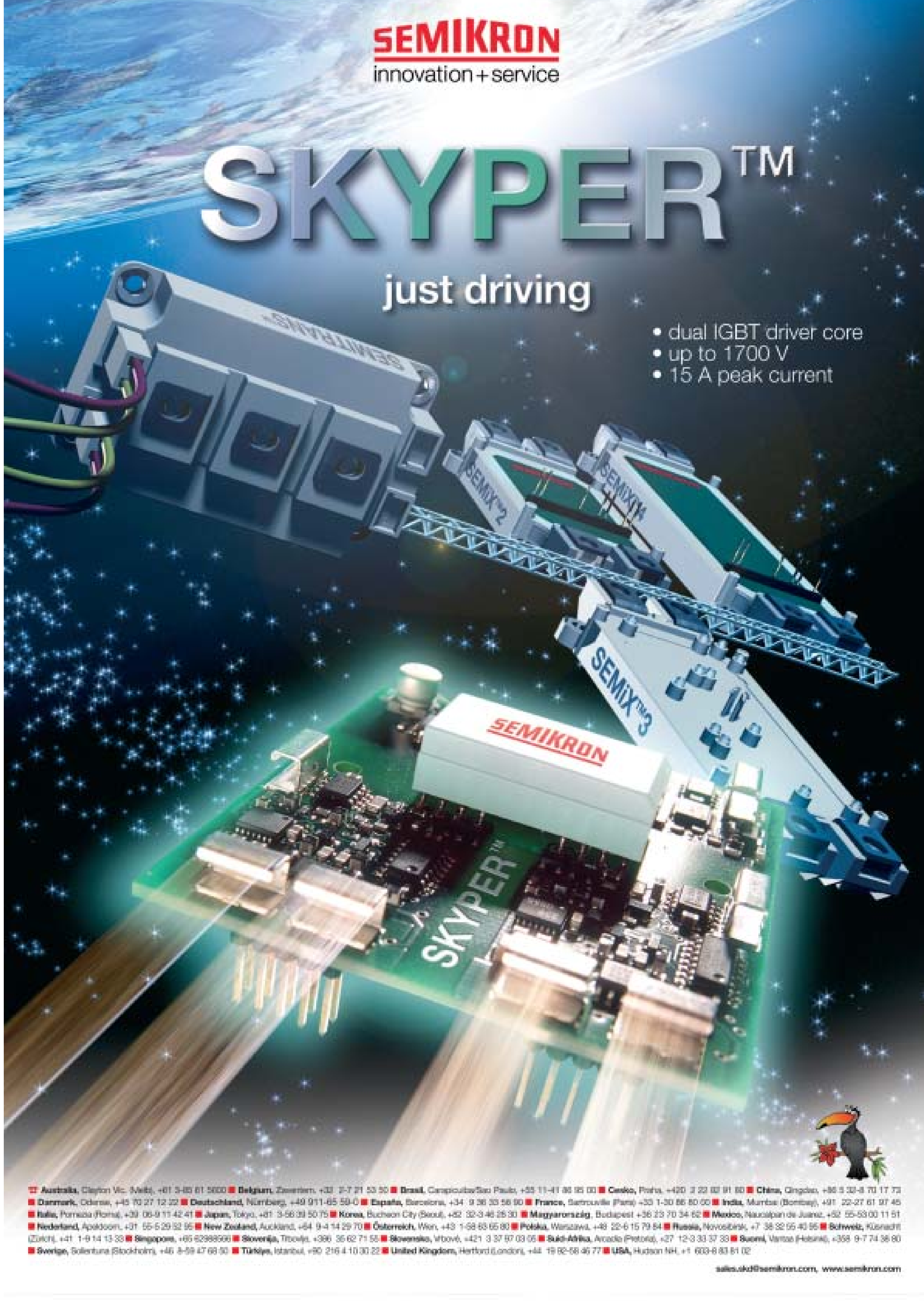
Furthermore, sensorless drives still represent a challenge to our engineers. We invited Prof. Holtz, Germany to report on perspectives and concrete solutions of sensorless ac drive technology. International Rectifier, Canada speaks on a novel position sensorless PMSM drive.

In the topics covering components for system integration as well as control and measurement you will find applications dedicated to all of our specialities.

www.pcim.de

Power Events

- ***EMV 2005**, March 15-17, Stuttgart, www.e-emc.com*
- ***PCIM China 2005**, March 15 – 17, Shanghai, www.pcimchina.com*
- ***PCIM 2005,** June 7-9, Nuremberg, www.pcim.de*
- ***SEMICON Europa 2005**, Munich, April 12-14 http://www.semi.org/semiconeuropa*
- ***Texas Instruments 2005 European Power Supply Design Seminar Series** 22 cities beginning April 4, information and registretion at http://power.ti.com/mr.*
- ***EPE 2005,** September 11-14, Dresden, www.epe2005.com*
- ***INTELEC2005,** September 18-22, Berlin, www.intelec.org*



The Evolution of Power Management and Conversion

By Todd Hendrix, Vice President of Worldwide Marketing & Business Development, Artesyn Technologies, Inc.

There is a lot of hype and confusion in the market right now. Digital control may be one of the most overused and misunderstood terms in the electronics vernacular. Depending on your perspective—design, marketing, executive management, industry analyst—you probably have different ideas.

Much of the confusion is in the board level power arena. Complexity has been increasing for years and looks set to continue. The story should be familiar to everyone: lower and more diverse silicon operating voltages, increases in switching speeds and currents, etc.

Until 2003, power supply manufacturers concentrated R&D effort on power conversion. There were a lot of new product requirements as system designers embraced distributed power architectures (DPA). We developed higher performance isolated DC/DC converters, a new class of loosely regulated converters called IBCs (intermediate bus converters), and a plethora of non-isolated point-of-load (POL) converters.

While we toiled away on all the new converters, board designers came up with ways of controlling and monitoring the conversion process. Sequencing techniques were introduced for ASICs and other complex ICs that require different voltages for their internal cores and I/O interfaces. The use of voltage margining increased, to test design robustness in the face of highly voltage-sensitive silicon. Monitoring of converter output currents and temperatures became common practice to improve system reliability.

Initially, each board designer or engineering group created their own power

management solution. Sequencing involved sending 'output enable' signals to different converters at different times. Voltage margining was achieved by switching resistor values on the 'voltage trim' pins of converters. Currents and temperatures were sensed and the information digitized by ADCs. And a programmable device such as an FPGA or microcontroller was employed to generate the timing and control signals.

Semiconductor companies soon recognized the opportunity for ICs to simplify power management. Some produced specialized silicon for the task, like the multi-channel controllers from Analog Devices, Lattice Semiconductor, Summit Microelectronics and Xicor (now part of Intersil). These ICs are mixed-signal devices that produce, store and manage digital and analog control data for converters, and digitize information for board-to-system feedback via a serial bus. While similar in effect, each IC solution is unique and demands its own programming software.

The number of such solutions continues to grow – even some power supply companies have got in on the act. Each product touts some improvement, such as more POL converter control channels, or fewer signals to simplify PCB routing. However, from a board-level design perspective they are all evolutionary and proprietary. The ICs are single-sourced, expensive and essentially serve one purpose—as a 'translator' for the power converters.

Now that converter products to support DPA are widely available, the industry is focusing on power management. Only collaboration among power supply and semiconductor manufacturers, and system OEMs, will achieve the desired result of a truly open standard, board level digital power management architecture. Benefits include reduced time-to-market of cost effective, multi-sourced silicon chips, power converters, and other board level components.

The PMBus initiative pioneered by Artesyn Technologies is the first and most visible action to holistically address power management and conversion. During Q1 2005 it will finalize a standard digital communications protocol to communicate with DC/DC converters, discrete solutions, other board level components, and in the future even AC/DC supplies. While the initial coalition comprised a small core of power supply and semiconductor manufacturers, most major power companies have now endorsed the protocol and intend developing compliant standard products.

For further information go to www.powerSIG.org.

www.artesyn.com

The 6.5kV SPT-IGBT HiPak Module

A new standard in IGBT ruggedness

The high voltage SPT-IGBT and diode technology has established record-breaking standards in ruggedness. Now, the latest expansion of this design platform to 6.5kV confirms this planar technology's unparalleled robustness.

By A. Kopta, M. Rahimo, U. Schlapbach and D. Schneider, ABB Switzerland Ltd, Semiconductors

One of the main challenges in the development of 6.5kV IGBTs and diodes has always been to obtain a sufficiently large safe operating area (SOA) as required by many power electronic systems operating under hard-switching conditions. Under these high stress conditions, previous device generations suffered from ruggedness limitations caused by shortcomings in the device designs. To overcome the insufficient IGBT and diode ruggedness, device manufacturers and system designers in the past resigned themselves to a number of operational limits such as de-rating and the use of voltage clamps, snubbers and high gate resistances, to achieve the necessary switching capability. Last year ABB announced a breakthrough in SOA performance for high voltage IGBTs and diodes employing the planar Soft Punch Through (SPT) design platform. This new technology enables the devices to withstand the critical, formerly unsustainable, phase of dynamic avalanche resulting in a remarkable increase of ruggedness. Based on this design platform, ABB now introduces a newly developed 6.5kV chip-set, confirming the excellent switching SOA of this technology.

Packaged in the new HV-HiPak module (Figure 1), the 6.5kV chips offer the ease-of-use long awaited by designers of high power, high voltage converters. The high dynamic ruggedness, combined with the SPT technology smooth switching behaviour gives users the greatest freedom in designing their systems without the need for any dv/dt or peak-voltage limiters such as snubbers or clamps. The extended SOA furthermore allows higher switching speeds, which in turn translate into lower switching losses. As will be demonstrated in this article, the 6.5kV HV-HiPak module simply sets new standards in terms of robustness and overall electrical performance for high reliability applications.

Figure 1. The new 6.5kV/600A HV-HiPak module with SPT-IGBT and diode technology.

The 6.5kV HV-HiPak module is an industry-standard housing with the popular 190 x 140 mm footprint. It uses Aluminium Silicon Carbide (AlSiC) base-plate material for excellent thermal cycling capability as required in traction applications and Aluminium Nitride (AlN) isolation for low thermal resistance. The HV-HiPak version utilized for the 6.5kV voltage class is designed with an isolation capability of $10.2kV_{RMS}$.

To achieve the high reliability required by its targeted applications (e.g. traction), the HV-HiPak module has been optimised for operation in harsh environments. This has been accomplished by designing the 6.5kV SPT chips to have smooth switching characteristics and rugged performance, qualities that are essential in the high-inductance environments of high voltage power electronic systems. The internal wiring and layout of the module were optimised in order to minimise oscillations and current imbalances between the chips. Finally, the whole design was qualified by standard reliability tests including HTRB (High Temperature Reverse Bias), HTGB (High Temperature Gate Bias), THB (Temperature Humidity Bias 85°C/85% relative humidity), APC (Active Power Cycling) and TC (Temperature Cycling).

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Are you looking for a real opportunity? We are looking for qualified employees

Analogue Designer (m/f)

A design engineer working in the Portable Power Management organization will become involved in all aspects of the product development process; these include product definition, design and verification of mixed-mode integrated circuits with a strong emphasis on the analogue side.

Tasks involve
- Discussing specifications with our systems engineers and translating these into design requirements.
- Top-down design of switch-mode power supplies to ensure the product meets the system level specifications.
- Transistor level design of analogue blocks such as op-amps, comparators, linear regulators, oscillators and gate drivers to ensure design-for-manufacturability requirements are met.
- Working closely with test and product engineers to ensure that design-for-test standards are considered up front.
- DMonitoring and supervision of the IC layout to avoid parasitic effects.
- Evaluation of the design in the lab.

Challenges include
- Managing current levels from sub-micro Amperes to several Amperes on the same chip.
- Choosing the best-suited topology or design solution to help bring the product to market on time, within the cost budget and with better-than-the-rest performance.

Skills required
- Thorough understanding of analogue circuits.
- Familiarity with common CAD tools such as Cadence Analog Artist, SPICE, VerilogA, AMS.
- Good working level in English, both spoken and written, for communicating with overseas colleagues and customers and also for documentation of work.
- Good inter-personal communication skills are required for working in teams with multiple nationalities and potentially multiple locations.

The high level type of products a Portable Power Management designer can expect to work on are
- Switch-mode power supplies using inductors.
- Charge-pumps.
- Low Drop Out linear regulators.
- Integrated devices containing multiple instances of the above components.

Our designs are implemented in leading edge BICMOS processes tuned specifically for power management products.

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The newly developed 6.5kV chip-set was designed to reach high levels of dynamic SOA capability, combined with a carefully selected trade-off between losses, high immunity against cosmic ray induced failures and smooth switching behaviour.

The new HV-IGBT design platform uses an advanced and extremely rugged planar cell, which was primarily developed in order to significantly increase the cell latch-up immunity during dynamic avalanche in order to achieve large SOA. The use of the Soft-Punch-Through (SPT) buffer concept allows a substantial reduction of the n-base region thickness without compromising any other electrical parameters. One of the main features of the SPT buffer is that it allows the current curve to smoothly decrease during the turn-off transient, hence, the term “Soft” in SPT. Thanks to the combination of cell design and thin wafer, the new 6.5kV IGBT has low overall electrical losses. The SPT-buffer, in combination with the anode design, further ensures good short circuit controllability with a high Short Circuit Safe Operating Area (SCSOA). In the design of today’s high voltage IGBTs and diodes, the trade-off between cosmic ray withstand capability and switching characteristics has become critical. Cosmic ray ruggedness can be improved by increasing silicon thickness, resistivity or by a combination of both. Increasing the silicon thickness inevitably leads to higher losses, whereas a high resistivity degrades switching behaviour and controllability of the chip. The starting material of the 6.5kV chip-set was designed to reach a cosmic ray induced failure rate of 100 FIT/HiPak module at a DC rail voltage of 3800V, while the SPT buffer and anode design was optimised for turn-off waveform smoothness.

To complement the advantages of the 6.5kV SPT-IGBT, a new 6.5kV fast/soft recovery SPT-diode was developed. The main advantage of this new diode is its large SOA combined with very low on-state and reverse recovery losses. The design uses a highly doped p^+ anode, which gives the diode its rugged reverse recovery performance. A highly doped p^+ anode eliminates problems such as inhomogeneous current distribution and “reach-through” effects during dynamic avalanche, normally associated with low-doped p-anode designs. The high p^+ doping also facilitates the creation of a robust junction termination to eliminate high fields and current crowding at the anode periphery during reverse recovery, which would jeopardise ruggedness. The electrical parameters of the diode were adjusted using a novel dual local lifetime control method. This method allows an optimal shaping of the electron-hole plasma for tailoring the electrical parameters and further enhancing SOA. In this way, the new diode design achieves the best trade-off to-date between forward voltage drop and turn-off losses. Furthermore, the dual lifetime control method also assures a strong positive on-state voltage temperature coefficient, required for good current distribution between the individual diodes in the module.

To demonstrate the excellent electrical performance of the new 6.5kV HV-HiPak module, extensive testing of both the static and dynamic characteristics was carried out. Figures 2a and 2b show the on-state curves of the 6.5kV SPT-IGBT and diode at room temperature and at 125 °C respectively. At a nominal current of 600A, the IGBT has a typical on-state voltage drop of 4.2V at 25 °C and 5.4V at 125 °C. The on-state curve exhibits a strong positive temperature coefficient even at very low current levels, which ensures good current sharing in the module. The diode has a very low forward voltage drop of 3.2V at 25 °C and 3.4V at 125 °C at 600A, showing a positive temperature coefficient already well below the nominal current.

Figure 3 shows the turn-off waveforms of the 6500V/600A HiPak under nominal conditions, i.e. a DC rail voltage of 3600V and a current of 600A, at a

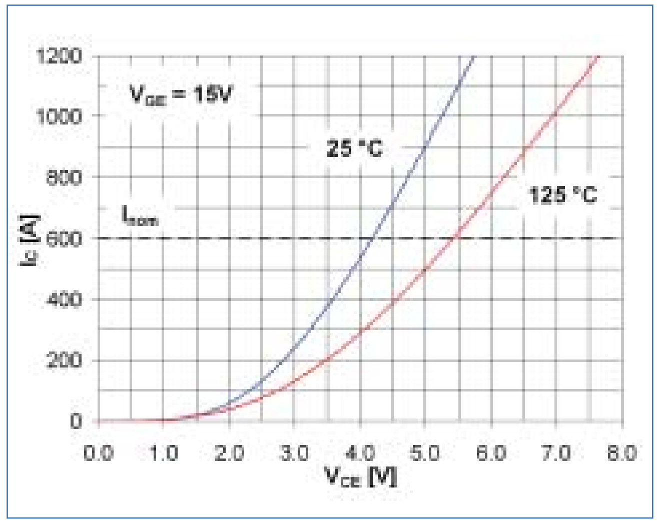


Figure 2a. 6.5kV/600A HV-HiPak forward I-V characteristics of the 6.5kV SPT-IGBT.

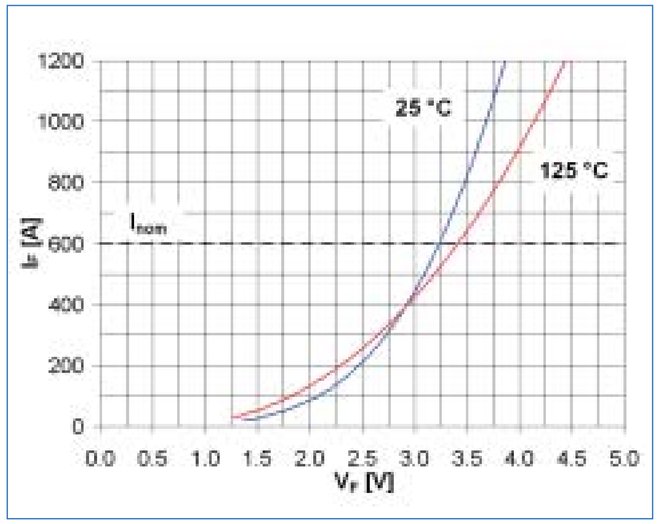
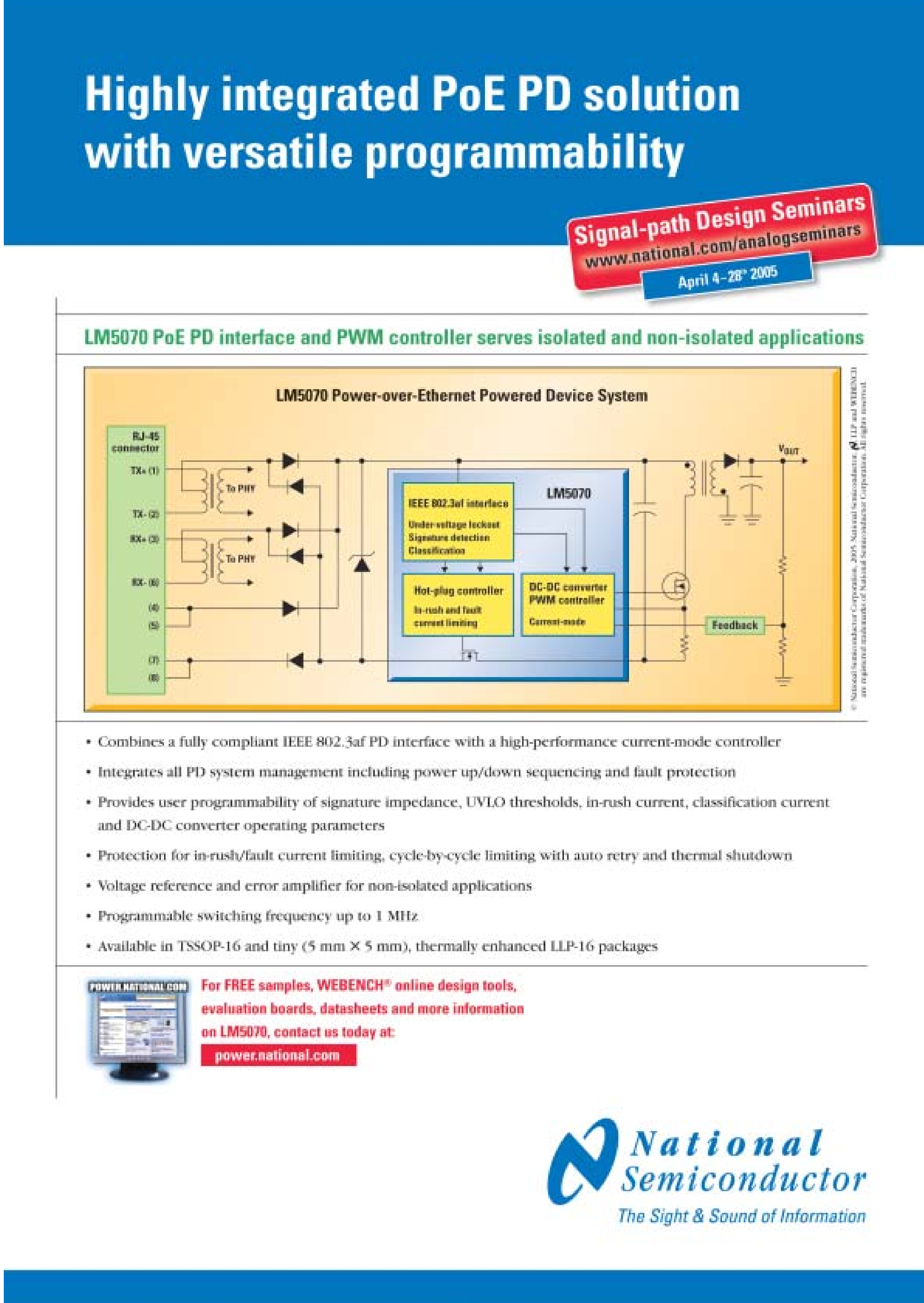


Figure 2b. 6.5kV/600A HV-HiPak forward I-V characteristics of the 6.5kV SPT-diode.



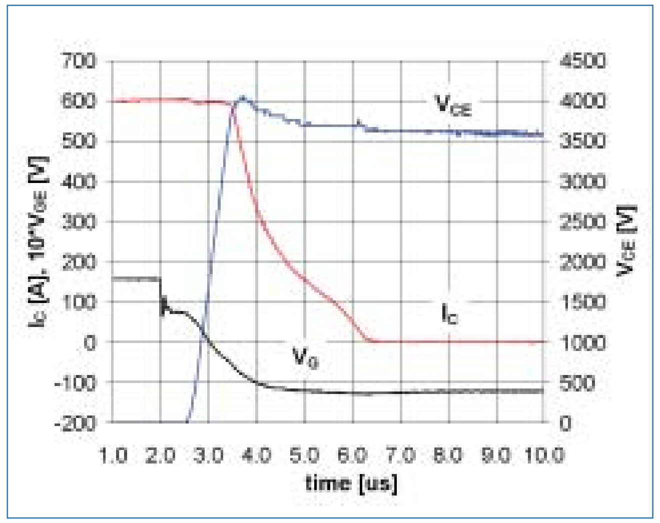


Figure 3. 6500V/600A HV-HiPak IGBT turn-off waveforms at nominal conditions. V_{CC} = 3600V, I_C = 600A, V_{GE} = 15V, R_{Goff} = 2.7Ω, L_σ = 300nH, T_j = 125 °C.

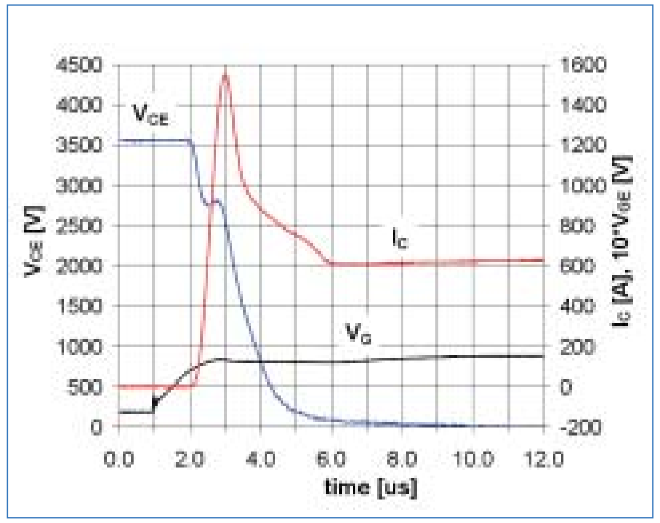


Figure 4. 6500V/600A HV-HiPak™ IGBT turn-on waveforms at nominal condition. V_{CC} = 3600V, I_C = 600A, V_{GE} = 15V, R_{Gon} = 3.9Ω, L_σ = 300nH, T_j = 125 °C.

temperature of 125 °C. The test was conducted using a circuit stray inductance (L_σ) of 300nH. In spite of this high stray inductance, the current and voltage waveforms of the SPT-IGBT are both still very smooth, showing no abrupt changes or oscillations. This excellent switching behaviour was achieved by a careful optimisation of the SPT buffer layer. The anode was designed to have a low emitter efficiency, which results in a short turn-off current tail and low turn-off losses, since less charge has to be extracted during the turn-off transient. In this way, a perfect balance between low losses, short tail current and low EMI levels is achieved. Thanks to the optimised planar cell design and the thin-wafer SPT-concept, the 6.5kV IGBT reaches a very competitive point on the $V_{CE,on}/E_{off}$ technology curve with typical turn-off losses of 3.25J at nominal conditions.

In Figure 4, the module turn-on characteristics under nominal conditions can be seen. The combination of the new low-loss SPT-diode and an optimised IGBT input capacitance brings the turn-on switching losses down to a typical value of 4.25J.

One of the biggest advantages of the new 6.5kV SPT-IGBT is its unmatched turn-off ruggedness. In Figure 5, the waveforms of an RBSOA test, in which the module was switched under extreme conditions, can be seen. The device was tested at 125 °C with a current of 1500A (corresponding to 2.5 times the rated current) and a DC rail voltage of 4400V. In addition, a large stray inductance of 300nH was used and a low gate resistance of only 1.5 ohms. No active clamps nor snubbers were used in the test. Another major advantage of an extremely rugged IGBT is that it offers the possibility of operating the device with significantly lower gate resistance values (R_{Goff}) than those required by conventional technologies. This results in shorter delay times during device turn-off, which not only lowers the turn-off losses but also improves the current sharing between individual IGBT chips in the module. The new 6.5kV/600A HV-HiPak module takes full advantage of this feature and is the first 6.5kV module ever to reach operational modes previously attained only by devices of lower voltage classes. A further advantage is that no dv/dt nor peak voltage restrictions apply to these devices such that snubbers and clamps are not required for high turn-off capability.

Figure 6 shows the 6500V/600A HV-HiPak diode reverse recovery under SOA conditions with a high DC rail voltage, a large stray inductance and a low gate resistance (R_{Gon}) in order to achieve a high commutation di/dt. Thanks to its large SOA capability, the new 6.5kV SPT-diode can be switched significantly faster than conventional 6.5 kV diodes. As a result, the turn-on losses of the IGBT can be significantly lowered. The dynamic diode behaviour exhibits soft recovery and rugged performance under all operating conditions including adverse combinations of low current, high DC voltage and low temperature. Thanks to the new dual local lifetime control method, the diode achieves the best trade-off between static and dynamic losses in this voltage class, with a reverse recovery charge (Q_{RR}) of 1.15mC and reverse recovery losses (E_{REC}) of 2.10J at nominal conditions.

Finally, Figure 7 shows the 6.5kV HV-HiPak during a short circuit pulse of 10µs with a subsequent soft turn-off. The test was conducted at a DC rail voltage of 4500V and a temperature of 25 °C. The SPT buffer and anode designs employed in the 6.5kV IGBT have been optimised in order to obtain a high short circuit SOA capability, even

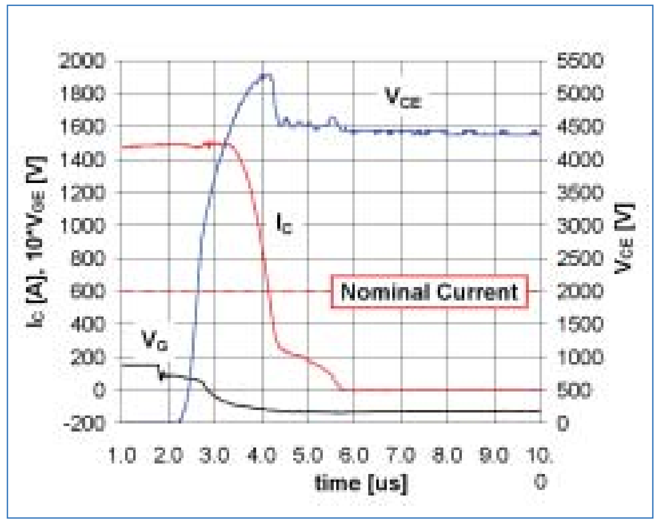


Figure 5. 6500V/600A HV-HiPak™ IGBT turn-off characteristics under high SOA conditions. V_{CC} = 4400V, I_C = 1500A, V_{GE} = 15V, R_{Goff} = 1.5Ω, L_σ = 300nH, T_j = 125 °C. No clamps were used in the test-setup.

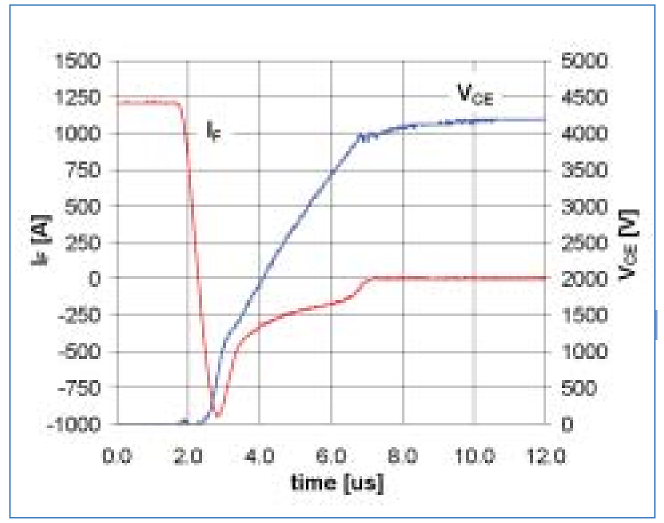


Figure 6. 6500V/600A HV-HiPak™ diode reverse recovery characteristics under high SOA stress. V_{CC} = 4400V, I_F = 1200A, R_{Gon} = 3.9W, L_σ = 300nH, T_j = 125 °C.

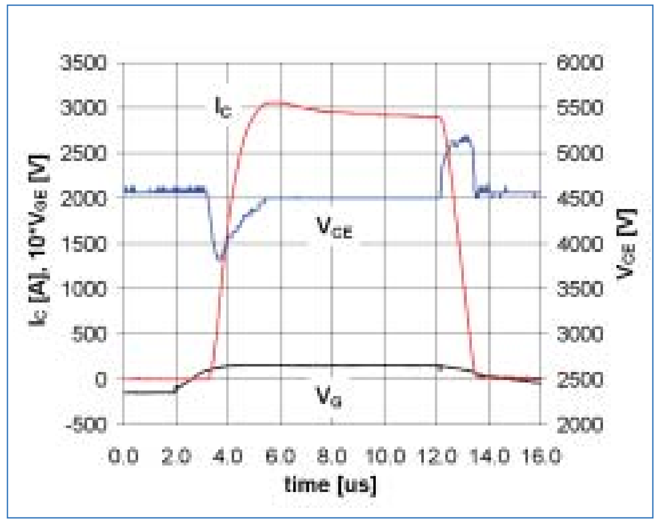


Figure 7. 6500V/600A HV-HiPak™ SCSOA characteristics. V_{CC} = 4500V, R_{Goff} = 3.9Ω, VGE = 15V, L_σ = 300nH, T_j = 25 °C.

withstanding the short circuit conditions at gate voltages exceeding the standard drive voltage of 15V. This is important for the following two reasons: Firstly, if a short circuit occurs during IGBT conduction, the effective gate-emitter voltage (V_{GE}) can increase significantly as a result of gate-voltage "pumping" caused by the charging of the gate-collector capacitance during the collector-emitter (V_{CE}) voltage rise. Secondly, at lower temperatures, the short-circuit current level will increase due to a reduction in the MOS-channel resistance. Since the short-circuit capability strongly depends on the short-circuit current level, low temperatures will be more critical for the IGBT in this mode. As the temperature decreases, the short-circuit failures will consequently occur at decreasing gate voltages. Hence, to be able to withstand a 10 _s short-circuit pulse with a gate voltage of 15V at –40 °C, the 6.5kV SPT-IGBT was designed to have a room temperature short circuit capability with V_{GE} above 17V.

The above-described module has been designed with the objective of eliminating the heretofore-inherent weaknesses of HV IGBTs, which were particularly apparent at 6.5 kV. This has been achieved by endowing the present devices with the dynamic avalanche capability seen only in lower voltage IGBTs. HV-SPT technology has been extended to this voltage class to ensure smooth, controlled switching under all adverse conditions most notably those of the inevitably high stray inductances found in HV systems, while respecting the low losses and low cosmic-ray failure rates demanded by the targeted applications. The resulting module, by simplifying gate-drive and protection requirements, will greatly contribute to the reliability and cost-effectiveness of HV converters.

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Decision Time for Power Operating Systems

Companies must develop POS strategies now—before competitors sew up the market

By Chris Ambarian, iSuppli

How can an electronics system designer produce the most capable equipment for the least amount of money, as quickly and as flexibly as possible?

Many in the industry seem to think that the answer is Digitally-Controlled Power (DCP), which iSuppli Corp. defines as the use of processors for system monitoring, internal and external communication and control of power. However, DCP by itself doesn't address the larger issues of how to cut costs throughout a piece of electronic equipment, while simultaneously improving performance, flexibility and time to market.

The real answer to the question appears to be a technology that builds upon the development of DCP: the Power Operating System (POS). Used in conjunction with DCP, a POS is software that can conduct multiple tasks, including system- and component-level performance monitoring, system configuration, system and component debugging, management of communications-bus protocols and real-time parametric programming at the system, bus and power-management component levels.

With the POS playing such a pivotal role in future products, a battle is looming over which company or group of companies will dominate this area. Because of this, it is essential for power system suppliers to decide upon and implement a strategy for the POS now, rather than to wait until their competitors sew up the market.

To DCP or not to DCP—That is Not the Question!

New digital techniques are generating a great deal of excitement, and power-supply engineers and their managers must contend with a significant learning curve in order to be able to take advantage of the new digital paradigm.

While this transition to DCP is nearly revolutionary from an engineering standpoint, in the larger scheme of things, the benefits this transition brings can be considered only evolutionary in nature.

How can this be? The reason is that while DCP will enable some new features and functionality, its ultimate impacts will still be restricted to the component level. Thus, the questions addressed by DCP will be component-level issues like cost, or switching speed, or transient response, or power density. And while these are important subjects for power-supply designers, they do not address the entire universe of significant cost and performance issues involved in the power management of a modern piece of electronic equipment.

When examining how to reduce the overall costs of the activities of OEM system designers, it becomes clear that DCP is not the answer. While it's nice to save a few dollars per power supply, it does hot have as great of an impact as, say, reducing a $1,000 per-unit design cost amortization for a high-end server system.

The System-Level View

So, if DCP is not the answer, what is? In order to answer this question, it makes sense to first look at the power supply from the standpoint of the equipment designers. The figure below presents the concept of the POS and how power supplies fit into the overall context of electronic systems.

From a functional-block standpoint, this diagram essentially presents a picture of how power supplies are already used—but with the all-important addition of an arrow denoting information flow through the system.

The basic supposition here is that there are many places in the creation and operation of such a system where significant costs can be extracted, or where significant performance benefits could be created. The appropriate communication and use of information

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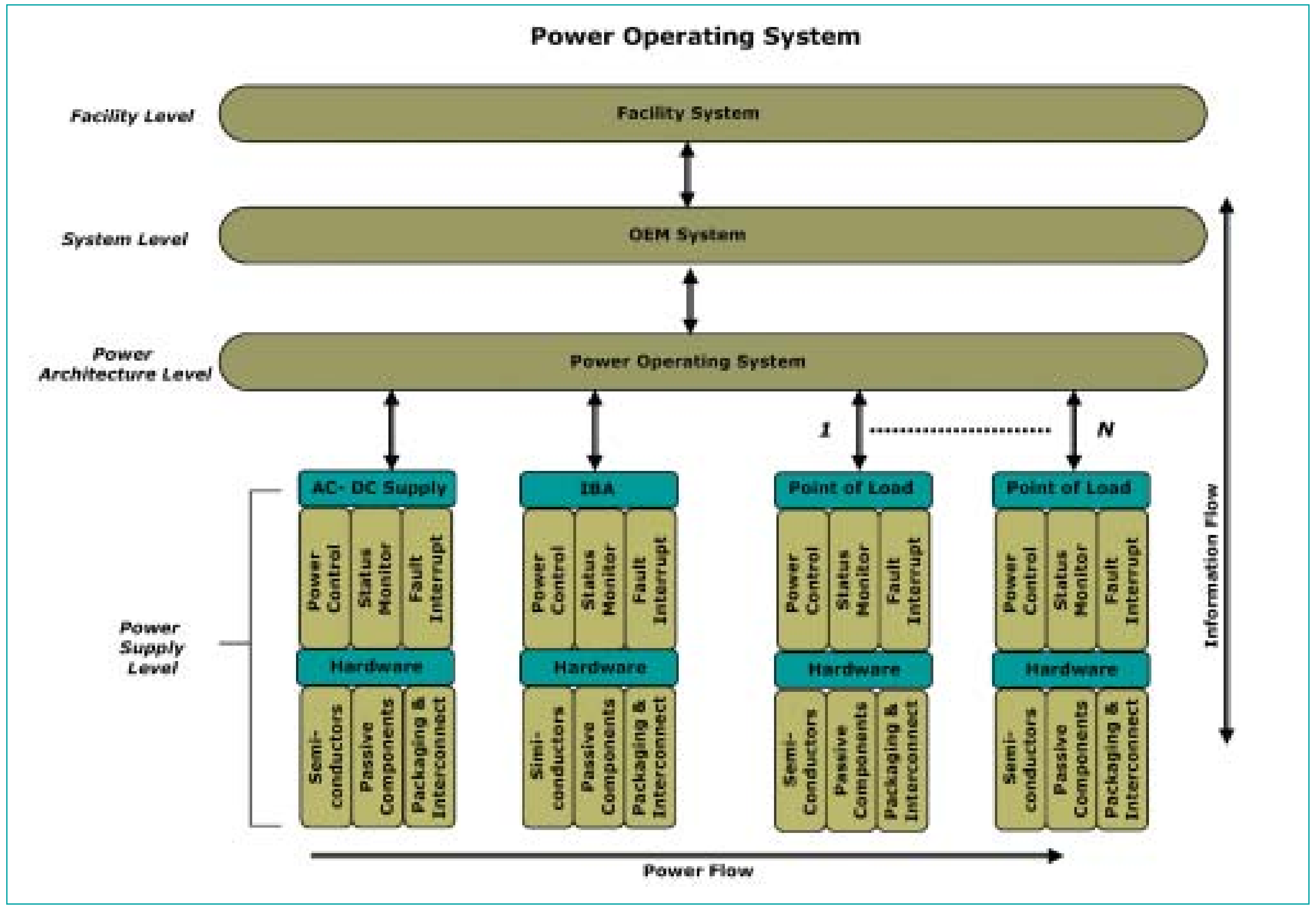

Figure 1. Power Operating System Diagram.

enables these improvements. In this context, then, DCP primarily facilitates the flow of some of the information.

However, there's much more involved in achieving cost reduction and performance optimization.

The Power of POS Thinking

This supposition about available benefits has been borne out in consultation between iSuppli and its clients regarding POSes.

We are only beginning to scratch the surface of the potential for improvements in speed of design, time to market, footprint, cost, reliability, efficiency and real-time performance optimization. And the types of improvements yielded by POSes we are seeing are not percentages, but more on the order of multiples, or orders of magnitude—such as man-years of effort reduced to man-months, or even man-weeks.

The challenges for implementation of the POS are many, but are addressable once they are understood. The larger challenge is deciding upon a strategy that will succeed when everyone joins the struggle for POS domination. Of course, several factors come into play whenever a company is faced with choosing an appropriate strategy, including timing, resources, competition, alliances and positioning.

The Danger of POStponing

Often, such a strategic decision can be put off for some time—while the industry philosophers discuss the concepts. However, in the power supply industry today, several parties already are in the process of making key decisions regarding their POS strategy.

With the entire future of POS suppliers at stake, these companies must embark on the decision-making process now, enlisting whatever resources they must in order to choose a strategy that will allow them to survive and prosper in the new world of POSes.

iSuppli believes that for companies that already are considering this issue—as well as for those that aren't—it is critical to make the basic strategic decisions related to the POS now, and to begin putting in place all of the elements required in order to make the new paradigm work. The companies that choose to make a decision now will have an advantage compared to those that decide to wait and see, iSuppli believes.

Christopher Ambarian is a senior analyst with iSuppli Corp. Contact him at cambarian@isuppli.com

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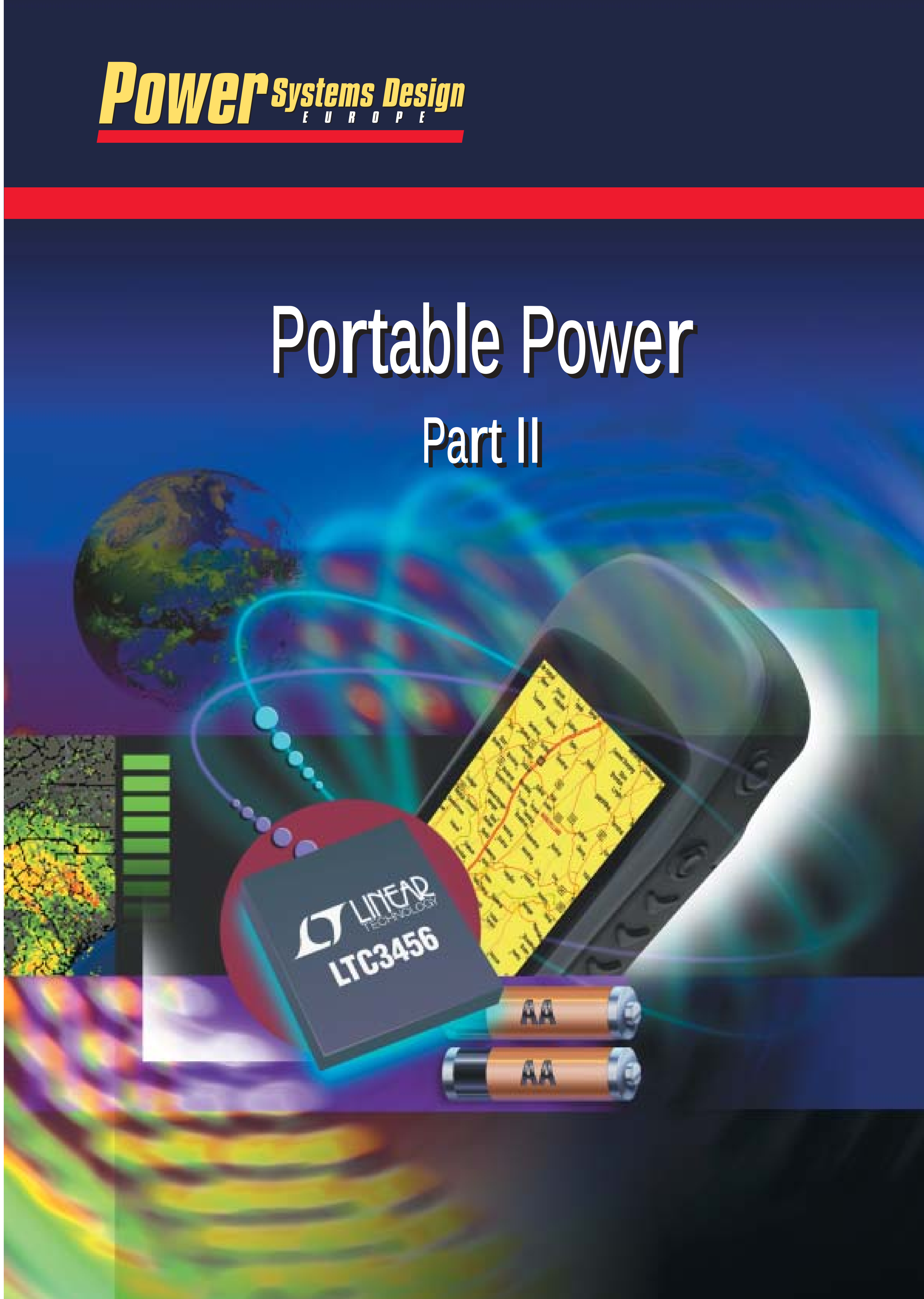

DC Bus Converter and Point of Load Modules

Technologies for next generation Distributed Power Architectures

Distributed Power Architectures emerged to meet the power delivery challenges facing integrators of large systems such as telecom racks or server rooms.

By Carl Smith, Marketing Manager, Networking and Communications DC-DC Products, International Rectifier

Two topologies have come to dominate but neither completely satisfies designers' wishes for high conversion efficiency, low overall component count and bill of materials costs, small on-board footprint, and easy design. A new evolution, the Intermediate Bus Architecture (IBA), promises answers. Implementation of this scheme allows designers to use as simplified power blocks to quickly configure a compact and cost-effective solution.

Evolving from the traditional two dominant DPA topologies, one approach converts the DC input voltage to a level required by the majority of components in the system, say 3.3V. This rail is used to supply the 3.3V components directly, as well as further point of load (POL) converters that generate the other system voltages. But converting directly from 36-75 VDC to a logic supply level such as 3.3V leads to poor efficiency. This will become worse as low voltage logic moves below 2.5V supply. Also, a large amount of filtering is necessary to protect the 3.3V load, and sequencing FETs are required which impose additional Rds(on) losses.

Alternatively, the DC input is converted to a 12V rail feeding an array of POL converters, which then generate the individual system voltages required. However most of the 12V output modules available are actually full-featured bricks. These are relatively inefficient and provide a fully regulated 12V output, which adds unnecessary cost and complexity since modern POL converter solutions accept a wide input voltage range. The bricks also have high RMS currents, and require secondary side FETs rated to a relatively high voltage; as much as 40V – 100V. These generally have higher Rds(on) than would be used if the average output voltage was lower.

But two-stage conversion has inherent advantages. An unregulated intermediate bus allows better efficiency and lower costs. Distribution losses are lower since the current is lower for the same given power level, when using an intermediate bus voltage of ~8V, versus the 3.3V DPA. Sequencing can also be performed at the POL converter, thereby eliminating the conduction losses of multiple sequencing FETs. Also, when using a bus voltage in the 8V range, versus the 12V DPA, the switching losses are reduced in the downstream POL, since switching losses are input voltage dependent. Overall throughput efficiency is key when designing two-stage DPA, and using a DC bus converter in this manner allows for best optimization of the complete power architecture.

A new type of module, known as a DC bus converter, is now available to perform this first stage conversion to unregulated 6-8 VDC. The bus voltage can be varied based on a simple alteration to the transformer turns ratio. For higher power systems, beyond 200W, it makes more sense to design for an unregulated 12V nominal bus voltage, and for systems in the lower power range, a 6-8V bus voltage makes more sense. It uses an isolated converter running at a fixed 50% duty cycle to allow simple, self-driven secondary synchronous rectification. This enables high power conversion efficiency, reduces the need for input and output filtering, and improves reliability. For the second stage, board-mounted, non-isolated POLs have also now emerged. They require only a few external passives, and therefore reduce board space and design complexity compared to a discrete or modular approach.

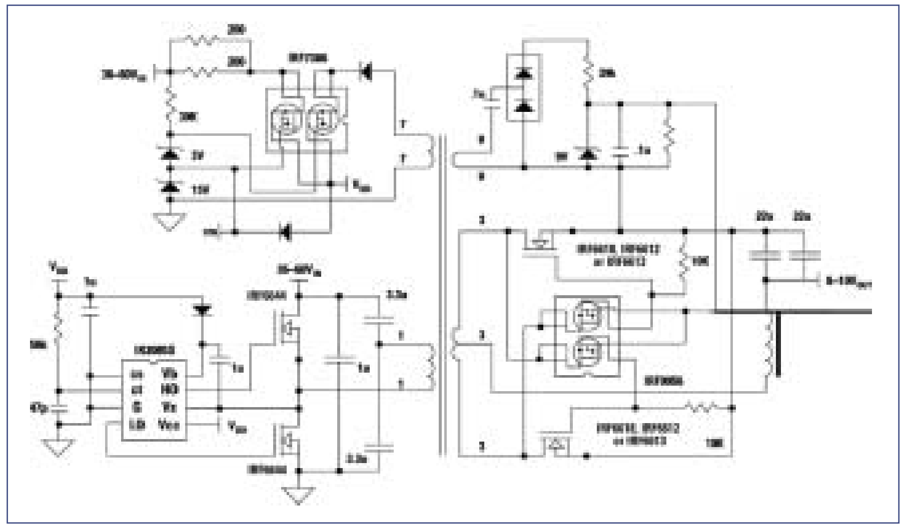

Figure 1. 48VDC input for wide range 36-75Vin, 220W DC bus converter circuit.

DC Bus Converter Design

To deliver the maximum benefit of this new topology, DC bus converters need new half-bridge and full-bridge controllers, as well as optimised power MOSFET technologies.

As an example of the new breed of controllers, the International Rectifier IR2085S integrates a 50% duty cycle oscillator with a 100V, 1A half-bridge driver IC into a single SO-8 package, and has externally adjustable frequency and dead time for various application requirements. Enable and current limit controls are also provided. An internal soft-start feature limits in-rush current during start-up by gradually increasing duty cycle up to 50% during approximately the first 2000 pulses of gate drive signals. A similar approach can also be used for full-bridge DC bus converters, using the new IR2086S, for up to 240W in a similar form factor, with ~96.4% efficiency at full load current.

Figure 1 shows the schematic for a 48 VDC input, that can be used across a wide range 36-75Vin, 220W DC bus converter circuit. On the primary side, the IR2085S controller and driver IC is driving two IRF6644 low charge DirectFET Power MOSFETs, 100V n-channel power MOSFETs. The primary side bias is obtained through a linear regulator for start-up, and then from the transformer in steady state. The IRF7380, a dual 80V n-channel power MOSFET in an SO-8 package, is used for this function. on the secondary side, novel 30V n-channel IRF6612 or IRF6618 DirectFET power MOSFETs are used in a self-driven synchronous rectification topology. For 12V output applications the new 40V n-channel IRF6613 can be used as the synchronous rectification MOSFET. The unit has achieved over 96% efficiency in smaller than 1/8th brick outline. This is approximately 3-5% higher efficiency and 50% smaller size than conventional, fully regulated, board mounted power converters.

When comparing the performance of DirectFETs with standard SO-8 products in DC Bus converters, there are some impressive results. The SO-8's limit power to around 150W, due to thermal capabilities. Beyond this, paralleled SO-8s are usually required. For comparison purposes, when comparing the effect of using 100V So-8 versus 100V DirectFETs on the primary side of half-bridge bus converter, the DirectFET (IRF6644) achieves ~1% better efficiency, or 95.7% at 220W (27.5A @ 8Vout), which is a significant incremental efficiency gain, when considering the converter is running at around 95-96% at this power level. This is only half half of the story, as the DirectFETs also offer significant thermal advantages, allowing ~40degC lower junction temperatures on the primary side FETs versus SO-8s. This is a huge potential improvement in system reliability, where FIT rates are a function of junction temperature. The use of DirectFET on the primary side of the bus converter, also now allows for balanced temperatures versus secondary side FETs, and eliminates the hot spots that are generated on the primary side when looking at standard products. It has also been demonstrated that when comparing DirectFETs against paralleled SO-8s on the primary side, the DirectFET still achieves approximately 0.4% higher efficiency, validating the fact that DirectFET semiconductor packaging practically eliminates MOSFET packaging effects from overall on-state resistance, which maximises circuit efficiency. The DirectFET packaging also allows for extremely good thermal resistance to the PCB of ~1°C/W, and through the top-side (case) of the device of ~1.4°C/W. The IRF6612 or IRF6618 gate drive voltage is clamped to an optimum value of 7.5V with the IRF9956 dual 30V SO-8 MOSFET. The size of a potential 220W DC bus converter can be 2.05" x 0.85", which is some 25% smaller than an industry standard 1/8th brick, which measures 2.30" x 0.90". Some full featured solutions offered today are in _ brick form factors, which have a standard size of 2.30" x 1.45", offering a potential of up to 53% space savings if the DC bus converter design approach is used.

The choice of switching frequency also influences the efficiency, size and cost of the converter. Increasing switching frequency reduces output voltage ripple, and also allows smaller magnetic components since the magnetic flux density is reduced. The transformer core can also be smaller, with lower losses. On the other hand, higher primary and secondary switching losses reduce overall circuit efficiency. The converter of figure 1 achieves optimum performance at a primary side switching frequency around 220kHz. The pulse width difference between the high side and low side is less than 25ns to prevent magnetic flux imbalance, which is the main concern in the bridge topology. The frequency and dead time between the low side and the high side pulses for half-bridge circuits can be adjusted based on an external timing capacitor

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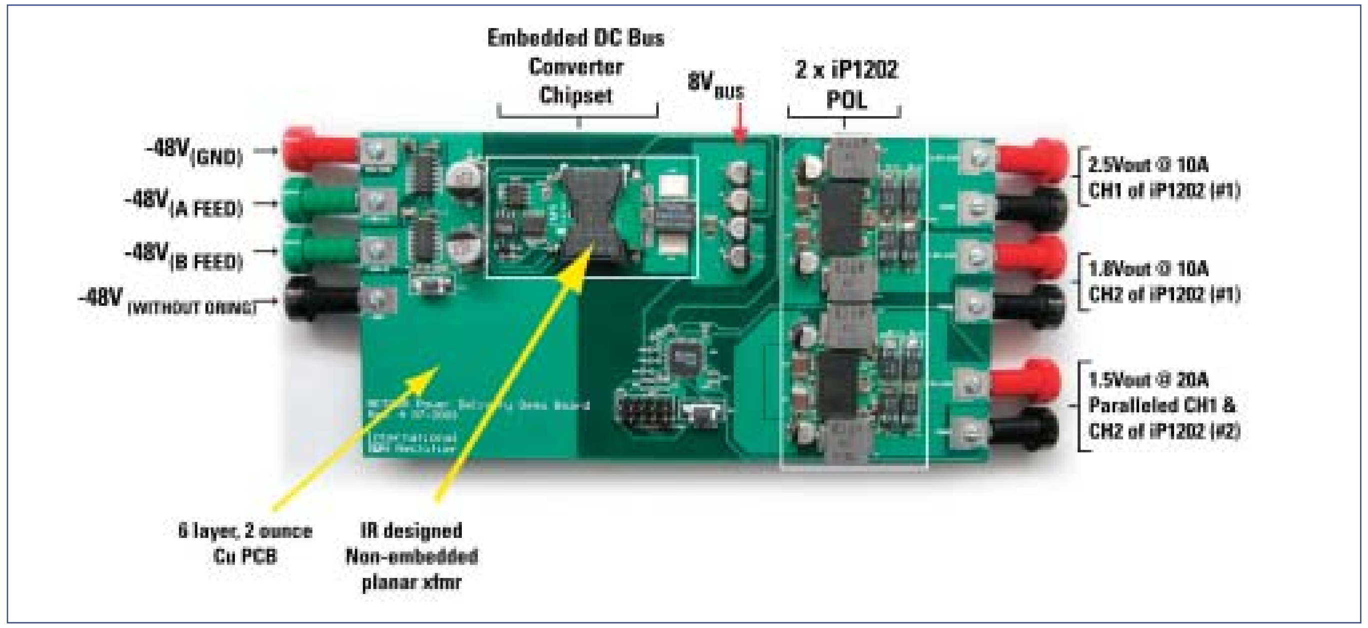

Figure 2. The DC bus converter has been combined with two iP1202 POLs to create the 3-output unit.

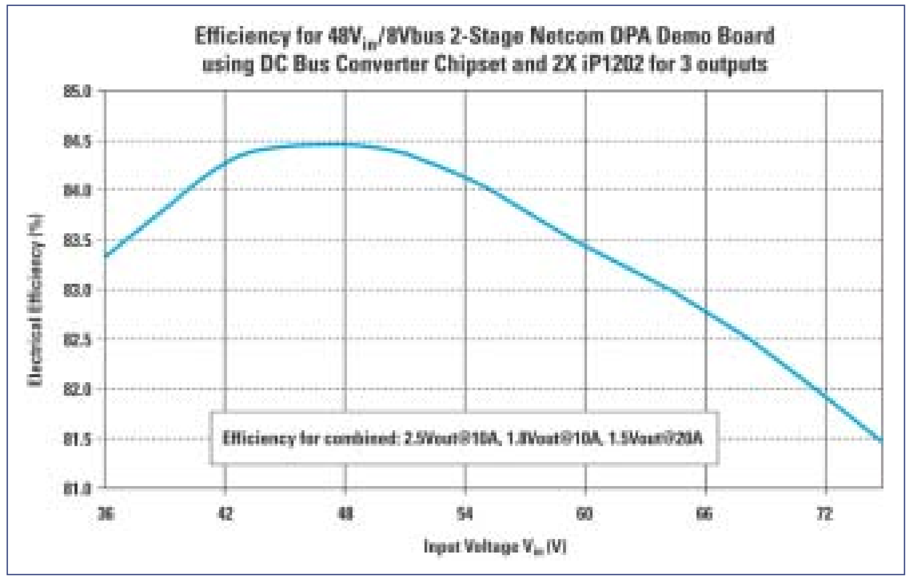

Figure 3. The IBA achieves up to 84.5% overall electrical efficiency.

to fit various applications, power levels, and switching devices.

At the POL, a 2-phase, dual-output synchronous buck converter requiring only output inductors, output capacitors and input capacitors, plus a few other passives, enables easy completion of IBA designs and can save up to 50% footprint versus alternate equivalent discrete solutions. A high ripple frequency also allows these components to be smaller than otherwise required.

Among the first of these "power building blocks", the International Rectifier iP1202 uses IR's iPOWIR packaging technology to integrate PWM controller and driver functions with associated control and synchronous MOSFET switches, Schottky diodes and input bypass capacitors in a single package measuring only 9.25mm x 15.5mm x 2.6mm.

Further footprint savings, as well as reduced design time, are possible because the device can be powered directly from the DC bus converter output voltage, eliminating the need for external bias circuits. It can also be externally synchronised with other POLs, allowing simpler input EMI filtering.

To test the performance of the new intermediate bus architecture, implemented using modules designed from the outset to enable an optimised IBA, the DC bus converter of figure 1 has been combined with two iP1202 POLs to create the 3-output demonstration unit shown in figure 2. Figure 3 shows how the IBA achieves up to 84.5% overall electrical efficiency, making it an attractive alternative to meet the demands of modern systems incorporating low-voltage logic, processors and ASICs.

IR response management is:
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California Legislates Against Inefficient External PSUs

Cell phone, appliance, AV equipment makers forced to rethink

All over the world, governments, companies and individuals are trying to reduce the amount of energy wasted. For some, environmental concerns are the main driving factor.

By John Jovalusky, Technical Marketing Engineer, Power Integrations

The problem is more immediate: in 2000, for example, a shortfall in available energy in California led to rolling blackouts. While new power plants are being constructed in California and elsewhere, in addition to simply turning on new energy sources, clearly much more effort needs to be focused on using the existing, available energy more efficiently.

Against the background of the power cuts in 2000, California state legislators recognized the need for tighter energy standards. More, they realized that to make a significant impact on levels of energy waste that are currently tolerated within the state, compliance with any new energy standards would have to be mandatory. Therefore, in December 2004 the California Energy Commission (CEC) approved the world's first mandatory energy efficiency standards, when it amended the state's current Appliance Efficiency Regulation. The new standard defines mandatory efficiency requirements for items as diverse as major appliances, water heaters, plumbing fixtures, fluorescent and incandescent lighting, exit signs, traffic signals, external power supplies, and consumer audio and video equipment.

While other regions of the world have recently created voluntary energy efficiency regulations, this is the first time that compliance with any group of standards has been made mandatory. China is currently working on similar regulation, and chances are good that compliance with its standards will also be mandatory, especially since a precedent has now been set by California.

Linears Are Dead

Perhaps the greatest impact of California's new standards will be felt by manufacturers of linear transformer-based battery chargers and adapters, and the OEMs whose products use them as power sources. Most chargers and adapters are plugged into an AC wall socket, and left there indefinitely. Those that are built around low-tech, copper and iron line frequency transformers typically waste from one to five watts or more, even when plugged into the wall but disconnected from the device they power.

California's new standards make demanding requirements for active mode operating efficiency and no-load power consumption. Compliance will require a maximum no-load consumption of 500 milliwatts from all external power supplies (EPS) that deliver less than ten watts. Making a linear transformer-based EPS comply with a half-watt, no-load consumption limit would increase its cost to more than that of a compliant switched mode power supply (SMPS) of an equivalent power rating. Similarly, making a linear PSU capable of meeting the active efficiency standards would require significant additional circuitry, further increasing cost. California's new standard will make most linear transformer-based chargers and adapters obsolete.

18 months and counting

The new California Energy Commission regulations come into force on July 1, 2006 – less than 18 months away. By this date, EPS manufacturers will have had to purge their supply channels of all the models that do not comply, while redesigning any products that can be easily made to comply. However, for

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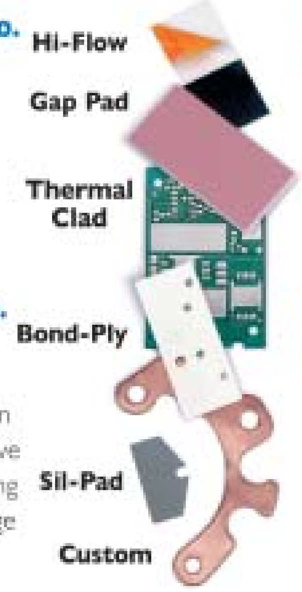

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many applications, such as those in the linear-dominated sub 3W range, most manufacturers will be faced with the task of designing new power supplies, and then getting certification from all of the usual regulatory agencies - all in less than 18 months.

Given the short timescale, this is quite a challenge – especially for those companies that do not have expertise in designing switched mode power supplies. However, recent developments in integrated power supply IC technology by Power Integrations, a Silicon Valley-based IC manufacturer that has pioneered the development of high-voltage, analog, monolithic power conversion ICs, will ease the situation considerably.

When Power Integrations (PI) introduced its first off-line power supply IC—TOPSwitch—in 1994, it began to capture a substantial share of the offline, AC-DC power supply market. Since 1998, all of PI's new product families have incorporated its EcoSmart technology, which enables power supplies to be designed that meet stringent efficiency, no-load, and standby power consumption requirements. In 2002, PI addressed the sub 3W charger and adapter market when it introduced its LinkSwitch® product family. An abbreviation for 'Linear Killer', the LinkSwitch IC enables SMPS battery chargers and adapters to be designed that are cost competitive with linear transformer-based units, but which are far superior in their efficiency and no-load power consumption performance. With over 1 billion devices shipped, PI is the leading supplier of monolithic power conversion ICs in the world.

PI has a suite of freely-available reference designs—called Design Accelerator Kits - that detail tested power supplies that comply with the standards in the new California Energy Commission regulations. Also available are an array of design aids including application notes, design ideas, and a powerful, yet easy-to-use power supply design software tool called PI Expert. PI Expert creates a fully documented paper design within minutes, including information necessary for a high frequency transformer vendor to produce a sample of the transformer the supply will require. The software also estimates the efficiency of the power supply, allowing the designer to know whether or not the SMPS will comply with the latest efficiency regulations, before building the first prototype.

California's new energy efficiency standards will significantly reduce the energy waste associated with inefficient external power supplies. Power Integrations not only supplies the most highly integrated, power conversion ICs, but also provides its customers with all of the tools they need to design low-cost, compact, energy efficient power supplies that comply with the new California efficiency standards, as well as other current or upcoming worldwide standards. Power Integrations has Field Applications Engineering laboratories, located around the world, to assist designers in creating cost effective, energy efficient power supplies.

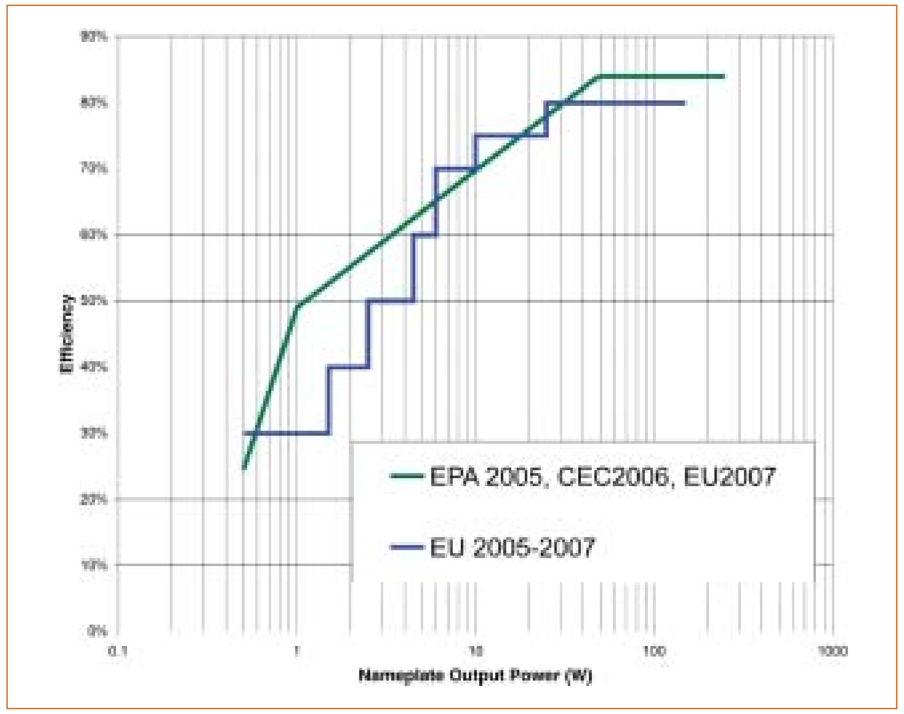

Figure 1. Efficiency by law at power levels in California and the EU.

www.powerint.com

STripFET III Using Schottky Diodes to Enhance Efficiency

The CPU power supply in mobile applications is the target

The continuous need for power of the new processors has prompted MOSFET producers to develope new low voltage power switches in order to meet new PC market demands. Several silicon makers have developed specially designed families of MOSFETs devoted to this kind of application.

By Gaetano Belverde and Maurizio Melito, STMicroelectronics MLD Group Catania

The first STripFET was made by STmicroelectronics in 1997, but significant changes have been added in the last four years. Now, with the third generation of STripFET, it is possible to obtain both very low on-resistance, by increasing the Strip density, and very low gate charge, by means of a new silicon lay-out. By using the patented STripFET technology it is possible to modulate these parameters to optimize the performance of both the high and low side switches for a buck converter. Aiming at a total optimization process, a new more efficient power package family has also been introduced. The STripFET can be assembled both on bondless and bottomless packages, minimizing the parasitic components due to the standard bonding wires, thus obtaining better thermal performances. In any case the "pin-to-pin" compatibility is guaranteed, so that a single PCB can be used in a wide range of converters by just replacing the switches.

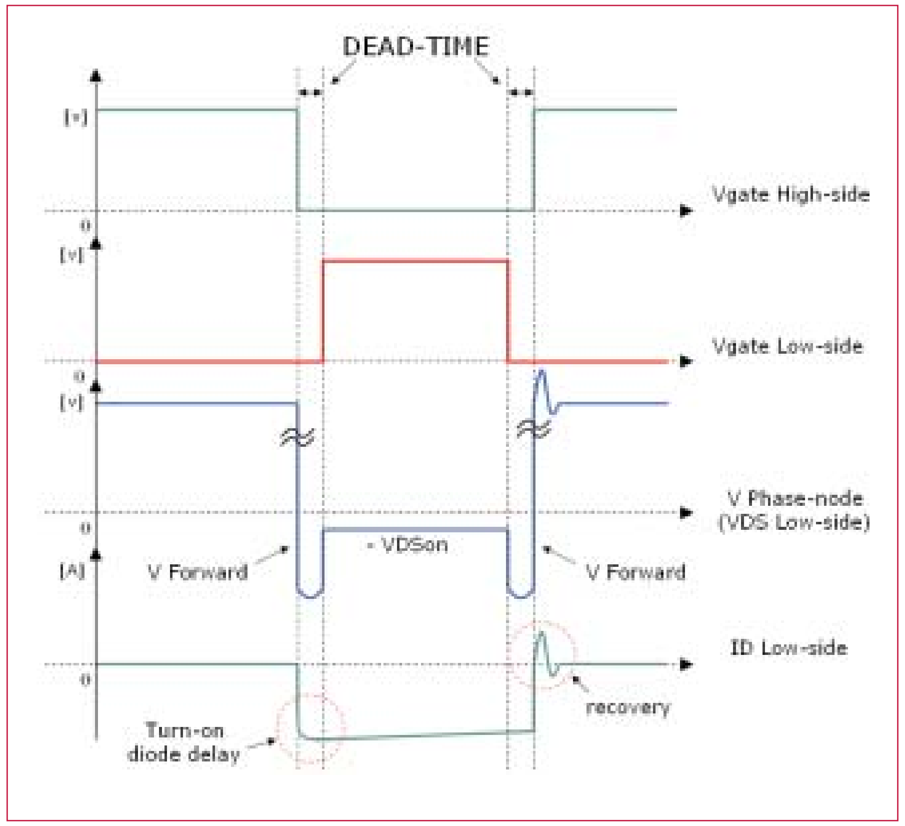

Figure 1. Typical waveform in modern sync buck converter.

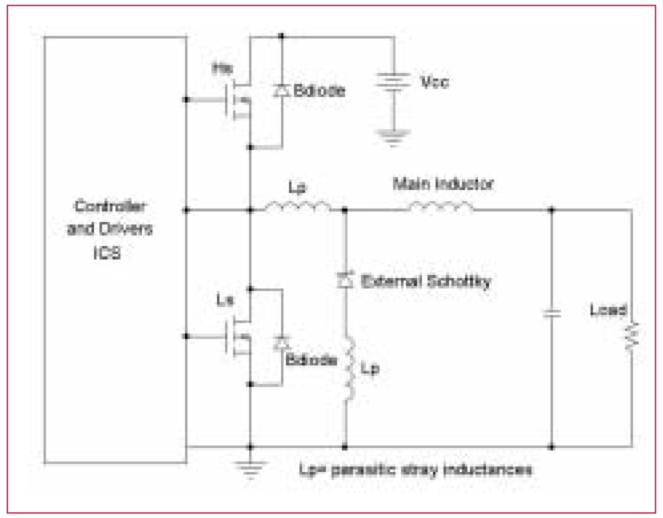

Figure 2. Synchronous buck converter circuit with external Schottky diode. Parasitic stray inductances (Lp) decrease effectiveness of Schottky diode.

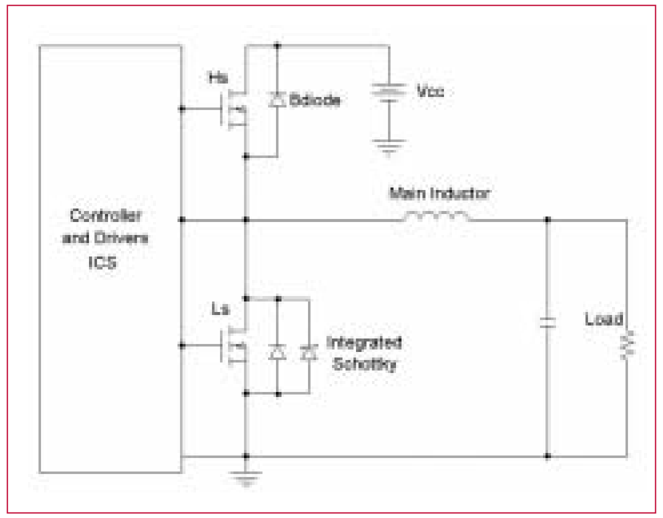

Figure 3. Synchronous buck converter circuit with integrated Schottky diode. No Parasitic stray inductances.

The latest step forward is a Schottky diode integrated inside the standard STripFET structure is the latest innovation aimed at obtaining a higher performance switch for DC-DC converters in mobile applications. After the silicon and package optimization, ST's designers have introduced a new MOSFET family to the market. By using an integrated Schottky diode it is possible to enhance efficiency and reliability thanks to a reduction in losses and heat. This paper will present a practical comparison using a single-phase synchronized buck converter over a wide range of frequencies and load currents. Replacing the low-side standard MOSFET with a new STripFET plus Schottky we have observed an improvement in efficiency of about 1-2%, depending on both load conditions and switching frequency. The benefits linked to the faster Schottky become higher when the frequency increases. The thermal and electrical performance of the new Schottky STripFET will also be compared with the standard ones.

Schottky diodes on a synchronized buck converter works with a suitable dead-time between the turning on and off of the high-side and low-side MOSFETs, in order to prevent a shoot-through phenomenon. The new gate drivers are able to reduce the dead time to a minimum value, but this can never be zero. During the dead time, the current, previously stored on the main coil, flows either through the body diode of the low side MOSFET, or through the external Schottky diode if connected (see Figure 1-2-3).

Discrete Schottky diodes are currently used in modern synchronized buck converters, but due to the parasitic stray inductance of both PCB and package, the benefits deriving from the Schottky diode can be very low. In order to minimize the parasitic components due to the PCB-traces/package (Figure 2), it is possible to assemble a discrete Schottky diode into the same package as the MOSFET. In this case, the space available for the MOSFET chip becomes significantly smaller due to the fact that the diode chip is mounted on the same frame. A smaller MOSFET die size means, at the same time, a higher on-resistance value. Thanks to the new ST technology, it is now possible to integrate a Schottky diode inside a STripFET structure and the silicon die can be assembled in a single package. The technology offers a performance similar to that of a separate MOSFET and Schottky rectifier in one package. But using ST's solution the parasitic inductances have been eliminated because the Schottky diode is made directly inside the STripFET structure without compromising the MOSFET die size.

The Schottky diodes are connected in parallel to the MOSFET body diode in order to reduce the losses. The reasons are mainly linked to the forward voltage drop and both the body diode turn-on and reverse recovery losses. Schottky diodes are faster and have a drop voltage lower than the intrinsic body diode. In addition, the recovery behaviour typical of Schottky diodes might help reduce EMI.

The only problem deriving from the use of an integrated Schottky is the higher leakage, but thanks to the patented ST technology the leakage current is kept under a safe design margin (see Figure 4).

Thanks to a new patent pending integration process it is possible to perform the highest Schottky contact integration into the active area of the STripFET technology. Such a technology is designed to optimize the trade-off between the Schottky area and the source area percentage, to obtain the lowest forward voltage drop with little Rdson increase compared to standard MOSFETs. To improve the STripFET technology, an additional mask for building Schottky contacts, along with innovative bulk engineering, which achieves a good barrier to high Schottky leakage current, have been used. Table 1 shows the electrical comparison between a standard STripFET device

Device Type	Trr dI/dt=100Aμs Tj=25°C	Qrr [nC] dI/dt=100Aμs Tj=25°C	VFEC [mV] @ 12,5A [typ.]	Rdson [mohm] @Vgs=4.5V [max]
STS25NH03LL	32@ Id=25A	56 @ Id=25A	800	3.5 @ Id=12.5A
STS20NHS03LL MOSFET + Schottky	30@ Id=25A	50@ Id=25A	660	4 @ Id=12.5A

Table 1. Electrical comparison.

(STS25NH3LL). The analysis has been completed by measuring the switch temperatures based on different operating frequencies @ I load=16A. Figure 6 shows the electric schematic of the converter implemented. No voltage feedback exists and that regulation is done manually via a pulse generator. Also just one switch is used in both the low and high side.

The power stage implemented represents a typical single phase stage of a multiphase application. The input voltage is 12V while the output is regulated at 1.2V. The driver's supply voltage Vreg is 5V, derived from Vreg12V by means of a series regulator. The main characteristics of all the MOSFETs are shown in Table 1. The comparison was made using the combination of MOSFETs reported in table 2; all the devices are housed in bondless SO-8 cases. The faster STS12NH3LL has been kept as a high-side for the two boards against a new Schottky version. No differences have been observed in terms of MOSFET switching performance with or without integrated Schottky.

As shown in the table, the STS20NHS03LL has about 20% lower forward voltage and about 10% less Qrr. This means lower losses both in switching and static fields. It is worth noting the higher "on-resistance" due to the Schottky diode implementation inside the standard structure. The following experimental tests will demonstrate that the benefits of the Schottky diodes are more evident than the losses due to the high on-resistance value. Figure 4 shows the breakdown voltage comparison and Figure 5 the forward voltage comparison.

The comparison has been performed using a high efficiency converter stage. The new STripFET plus Schottky STS20NHS3LL has been compared to state-of-the-art STripFET III devices

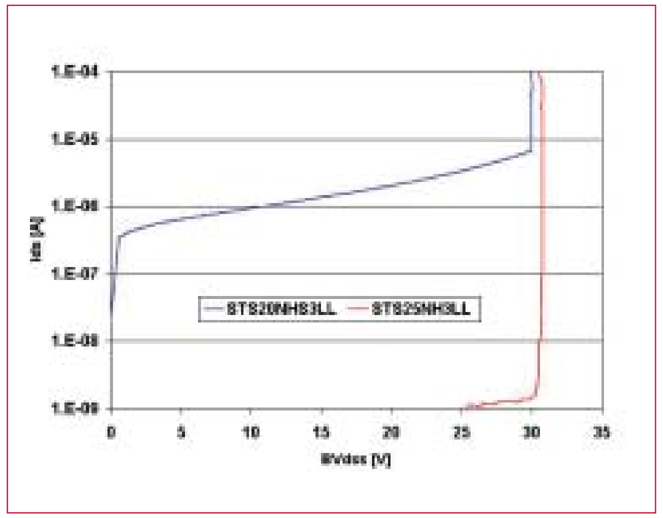

Figure 4. Breakdown voltage and current comparison.

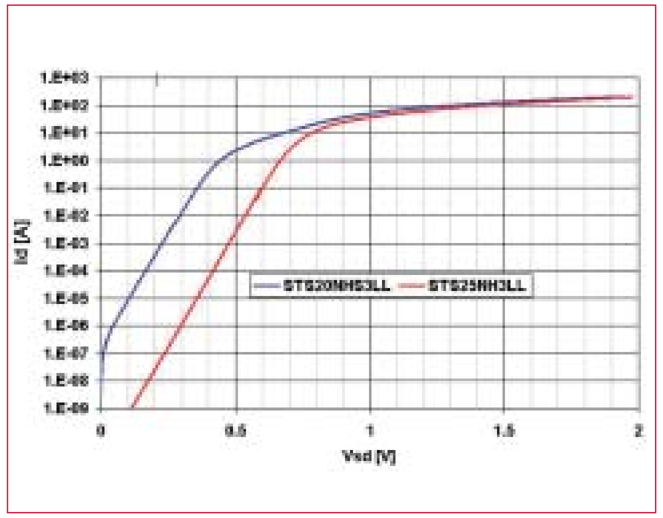

Figure 5. Voltage forward comparison.

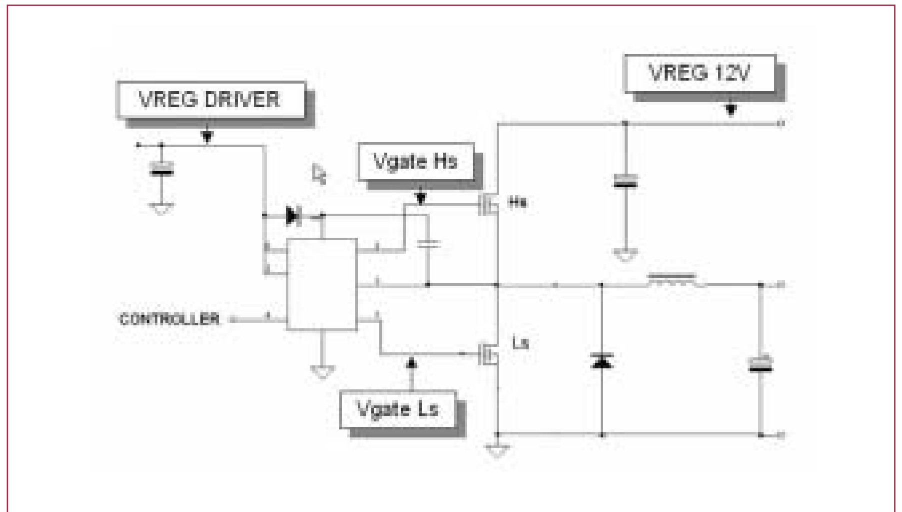

Figure 6. Electrical schematic.

Board #	high-side	low-side
A	STS12NH3LL	STS20NHS3LL MOSFET + Schottky
B	STS12NH3LL	STS25NH3LL

Table 2. MOSFETs used for each position.

	Frequency = 300 KHz		Frequency = 500 KHz	
Temperatures °C	High-side	Low-side	High-side	Low-side
Board A STS20NHS3LL	98	100	110	109
Board B STS25NH3LL	98	101	116	112

Table 3.Temperatures comparison @ I load= 16A.

Figures 7 and 8 show the converter efficiency given at 300 and 700kHz, in the range of load current 2/20A. The results are normalized to the higher efficiency peak. The better performance obtained with the Schottky MOSFET is clearly demonstrated over the whole current and frequency range. Moreover, the temperature behavior of each device has been monitored (see Table 3). The working temperature of the low-side MOSFET is similar at 300kHz. But at 500kHz Board A is cooler. Note that on board #A (with Schottky MOSFET) the high-side device works at a lower temperature due to the smaller recovery pulse current of the Schottky.

Another step forward in efficiency maximization has been made by the introduction of a Schottky diode integrated into the standard STripFET. Replacing the low-side STS25NH3LL (standard MOSFET) with an STS20NH3LL (STripFET plus Schottky) gives an increased efficiency of about 1-2%, depending on both load conditions and switching frequency, even if the Schottky has an on-resistance value slightly higher due to the diode implementation inside the structure.

The benefits linked to the faster Schottky become greater when the frequency increases.

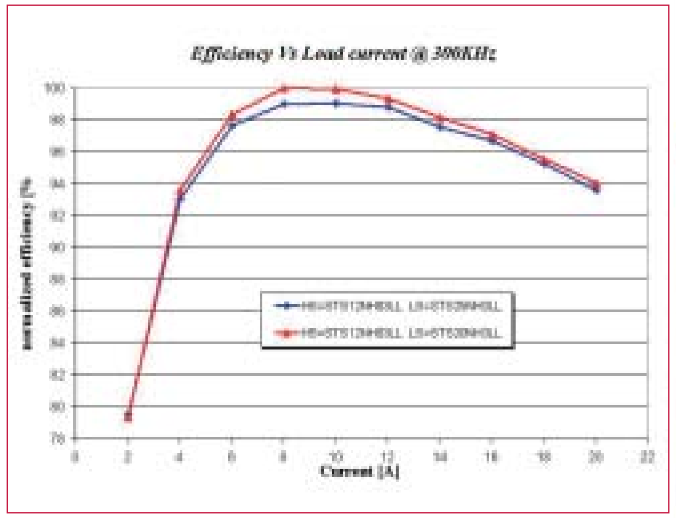

Figure 7. Efficiency versus load current @ freq=300 KHz.

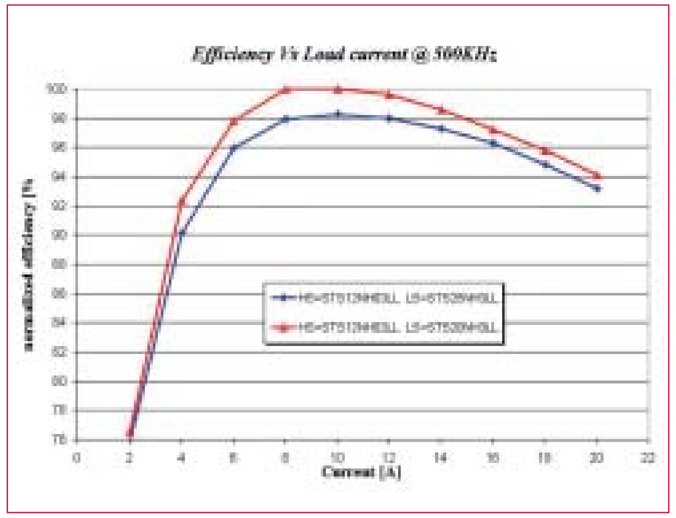

Figure 8. Efficiency versus load current @ freq=500 KHz.

Thanks to the new devices, about 50% of the total space is saved due to the fact that an external Schottky diode can be avoided. In addition, thanks to the lower losses both efficiency and reliability have been enhanced.

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PORTABLE POWER PART II

Drawing Power from Multiple Sources

Controlling battery charge and discharge current to optimize power management in portables

With the introduction of mulitiple power sources in portables, designers must devise new strategies to incorporate into their product design.

By Bruce Ferguson, Microsemi Corporation

Designers of portable devices are accustomed to implementing efficient though complex power control solutions involving rechargeable batteries and external power sources such as AC/DC converters. But with USB (Universal Serial Bus) ports becoming commonplace in handheld portable devices, they must now devise strategies to accommodate a third power source – the USB connection itself – into their designs. And they must do this while minimizing circuit volume, maximizing the use of available power, and preventing premature aging of the battery.

The power control system must be able to accommodate several modes of operation with three power sources available. First of all, if no external power source is available, the portable device must be able to draw current directly from the battery. If there is an external power source like an AC adaptor or USB port connected, the power control system may then have sufficient power available to operate the device electronics and also charge the battery. Occasionally, the input power source may be current limited and can not provide enough power to operate the portable device without assistance from the battery. This can occur when the current that can be drawn through the USB port is limited at a level too low to power the portable device completely. In this case, current would be drawn from the battery to supplement the power from the USB port; of course, this mode can't be sustained indefinitely. Several power control techniques are available to support this type of power control activity.

Figure 1: Multiple Power Sources For Portable Device

Power Source Isolation Strategies

There are at least two ways to handle power from multiple sources. The simplest way is to use the battery terminal as the common system power bus. In this case all the portable device internal power converters connect directly across the battery and the battery charger serves as a buffer between the input power source and the internal system power bus. The system power bus is impervious to the application or removal of the external power source and remains at the relatively constant battery terminal voltage. A better and more efficient way to handle multiple power sources is to "wire-OR" the various power sources to the system power bus. In this case, the system power bus will move up and down as it tracks the highest voltage power source. This places a requirement on the portable device internal power converters to be able to withstand a wider range of voltage inputs, but in almost all cases, this is not an issue.

With one of the power sources being a rechargeable battery, the battery charger and battery OR-ing diode provide power paths in opposite directions between the battery and system power bus. If the system bus is a greater voltage than the battery voltage, the battery is charged and the diode is reverse biased off. When the battery voltage is greater than the system power bus, the battery charger turns off and the diode becomes forward biased allowing the battery to power the bus. To improve efficiency, typically the diode is shorted out by a MOSFET to reduce the voltage drop. Until recently, this battery to power bus interface took a number of ICs and discreet devices to implement which took up precious space in a portable device.

There are several advantages to the wire-OR topology. The battery is isolated from the system power bus and only is required to discharge if the external power source is removed; the battery will not be exercised unnecessarily and will not be float charged. Studies have shown that float charging a battery shortens its useful life. If the battery should fail in a short circuit or low impedance condition, the system can still be brought up with the wire-OR-ed approach. With a current limited external power source, the wire-OR-ed approach is the fastest way to charge the battery; because the system bus can be a higher voltage than the battery terminal voltage, so the portable device internal switching power supplies will consume less power (draw less current) which leaves more power available to charge the battery. In fact, wire OR-ed topology cuts the USB powered battery charge time by initially charging at a 57% higher current as shown in Table 1.

Figure 2: Two Topologies for Portable Device Power Distribution

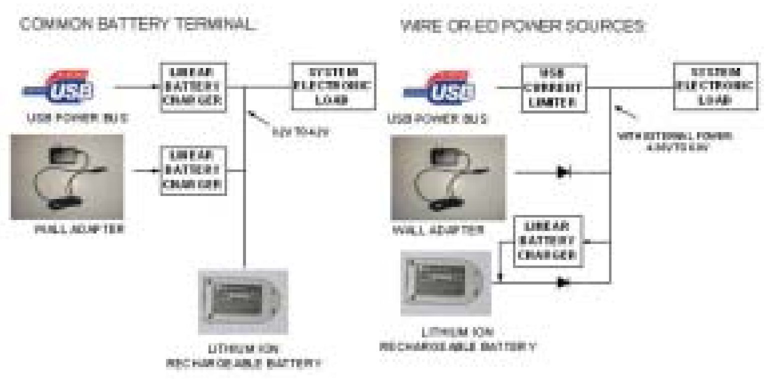


Table 1. Topology Available Charge Current Comparison

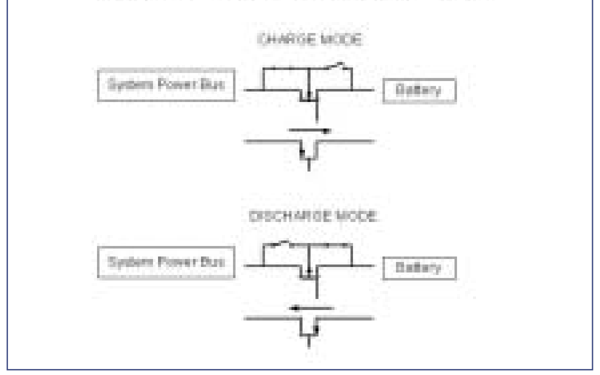
Hardwired Battery Topology:
System Load = 1W
System Power Bus Voltage = 3.9V
USB input = 500mA
Power Available to charge battery = (3.9V x 0.5A) – 1W = 950mW
Maximum charge current = 0.95W/3.9V = 244mA

Wire OR-ed Topology:
System Load = 1W
System Power Bus Voltage = 5.0V
USB input = 500mA
Power Available to charge battery = (5.0 x 0.5A) – 1W = 1500mW
Maximum charge current = 1.5W/3.9V = 385mA

The wire OR-ing of the battery requires a circuit element that allows charge current to pass from the system power bus to the battery when the system bus voltage is greater than the battery voltage and discharge current to flow from the battery to the system power bus when the battery voltage is greater than the system power bus. Microsemi identified this problem and worked toward implementing both the charge and discharge circuit inside the battery charger. A battery should never need to be charged and discharged at the same time; because of this, in theory, a bi-directional pass element placed between the system power bus and the battery could be used for both charging and discharging the battery. As it turns out, a MOSFET in its simplest form is a bi-directional device. We make a MOSFET a unidirectional device when we wire the body contact to one side making that the MOSFET source. Recognizing this, Microsemi filed for patent protection for the concept of using a MOSFET with a configurable body contact as a bi-directional pass element for a linear battery charger.

Control of the MOSFET switch is somewhat complicated. Detecting the charge and discharge thresholds accurately inside the integrated circuit, is a difficult problem to address. In discharge mode, the bidirectional pass element needs to be low impedance for high discharge currents to minimize the power loss; however, it is difficult to measure tiny threshold currents across low impedance in the presence of noise. In charge mode, if the power supply is current limited, the pass element may

Figure 3: Bi-Directional Pass Element



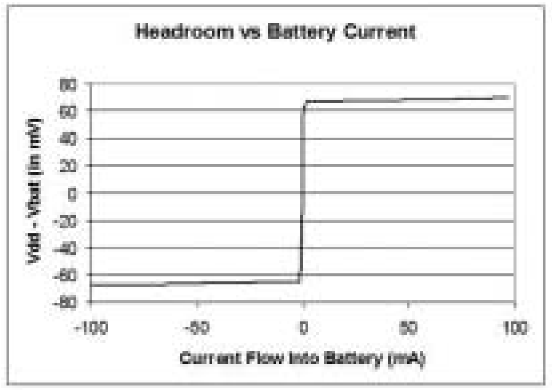


Figure 4. Pass Element Voltage at Low Current.

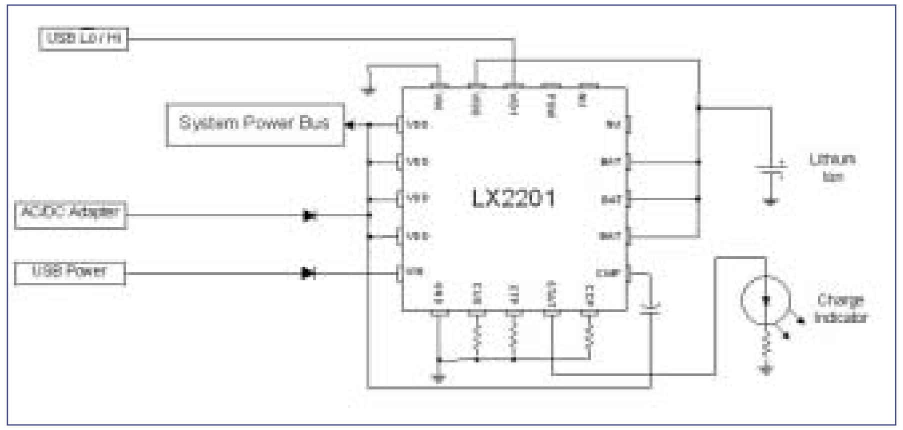


Figure 5. Schematic for implementing battery charger that handles two power sources.

be fully enhanced and the input voltage can drop to be nearly equal to the battery voltage.

With a load on the system power bus, the battery may need to toggle between charge and discharge modes to meet a varying load power demand. To help detect the charge and discharge thresholds, a circuit is used to increase the impedance of the pass element when the charge or discharge currents are small; this insures a minimum headroom of about 65mV in either charge or discharge mode as is shown in the Figure 4, below. The pass element impedance may need to increase to several kilo-ohms at very low charge or discharge currents. The "headroom" circuit must also be designed to be responsive to transient load currents to prevent voltage drops when a heavy load is instantly applied.

Fortunately for the portable device designer, the battery charger IC designers address these issues so that the board level of design is simplified as shown in Figure 5. Using the bidirectional pass element allows the battery discharging voltage to be considerably lower than a Schottky diode (less than 100mV) to avoid wasting battery power. Also there is no reverse leakage from the system bus to the battery to trickle charge the battery as might be the case with an actual Schottky OR-ing diode.

Bruce Ferguson is a Senior Systems Engineer for Microsemi Corporation's Integrated Products Group. He holds a bachelors degree in electrical engineering from the University of Washington and a masters degree in business administration from the University of California at Irvine. He is a California Board Certified Professional Electrical Engineer.

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Mobile Freedom Through Efficient Components

Comprehensive power management capability

Compact and cost-effective systems with maximized battery time are now possible thanks to efficient power management of portable devices.

By Andreas Biss, Sven Stegemann and Gunter Wagschal, Sharp Microelectronics Europe

Modern handheld devices such as mobile phones, digital cameras, PDAs and media players have now developed into real multimedia centres which enable almost endless possibilities: make phone calls, take photos, read e-mails, listen to music, watch videos—and all at the highest quality. Product differentiation for portable devices is increasingly achieved through such additional functionality. Due to these improvements in performance, the amount of energy consumed by individual components has reached significant levels. Sharp Microelectronics is firmly committed to power-saving solutions for key elements such as the display, background lighting, and processor, and, in so doing, is also promoting the development of mobile multimedia services.

Device power consumption is not an altogether new topic: Since both music and telephone calls became mobile when mobile phones and walkmans conquered markets in the 1980s, developers have been trying to curb the demand for power by our mobile companions. In the meantime, however, many changes have taken place: mobile phones now come with digital cameras and Internet access. PDAs are electronic diaries and car navigation systems, rolled into one. Multimedia players can store up to 20 movies or thousands of photos and simultaneously serve as MP3 players. In the competition to offer an ever-higher number of pixels, manufacturers of compact digital cameras have now reached eight megapixels. The main feature of these mobile devices is a bright, high-resolution colour TFT. Playback of movies and photos on these displays creates huge volumes of data; thus, an especially strong processor is imperative.

Given these features, the issue of power consumption has taken on an entirely new meaning in the case of handheld devices. In fact, it is practically a miracle that the batteries of these mobile, multi-feature devices are not fully depleted after 20 minutes, which would put an end to mobile independence from the power grid. In order to extend the battery times of portable, high-end devices, energy-saving components are indispensable.

Furthermore, energy management helps to maximize the expected life of components while controlling heat levels in the compact housing.

In order to achieve efficient power management, it is important to follow a comprehensive approach to optimize all the major components in portable devices. Consequently, Sharp Microelectronics concentrates on the components with especially high levels of thermal power loss—TFT and background lighting, as well as the CPU (Central Processing Unit).

Pulsating LEDs cut down on thermal power loss

Developers of mobile devices are concentrating overwhelmingly on white light-emitting diodes (LEDs) to provide background lighting for high-resolution TFT displays. Compared with other backlighting solutions, they are very small, bright and are characterized by their long lifespan. The LEDs are usually parallel connected to backlight displays—for example in sets of four. In this case, a white light-emitting diode needs a supply voltage of about 4 V. However, the typically used lithium-ion batteries, supplying power for many different mobile devices, can normally only provide 3.0 to 4.2 V of power. Thus, in order to drive the LCD backlight alternatively a charge pump or an upstream step-up regulator is required. These

PORTABLE POWER PART II

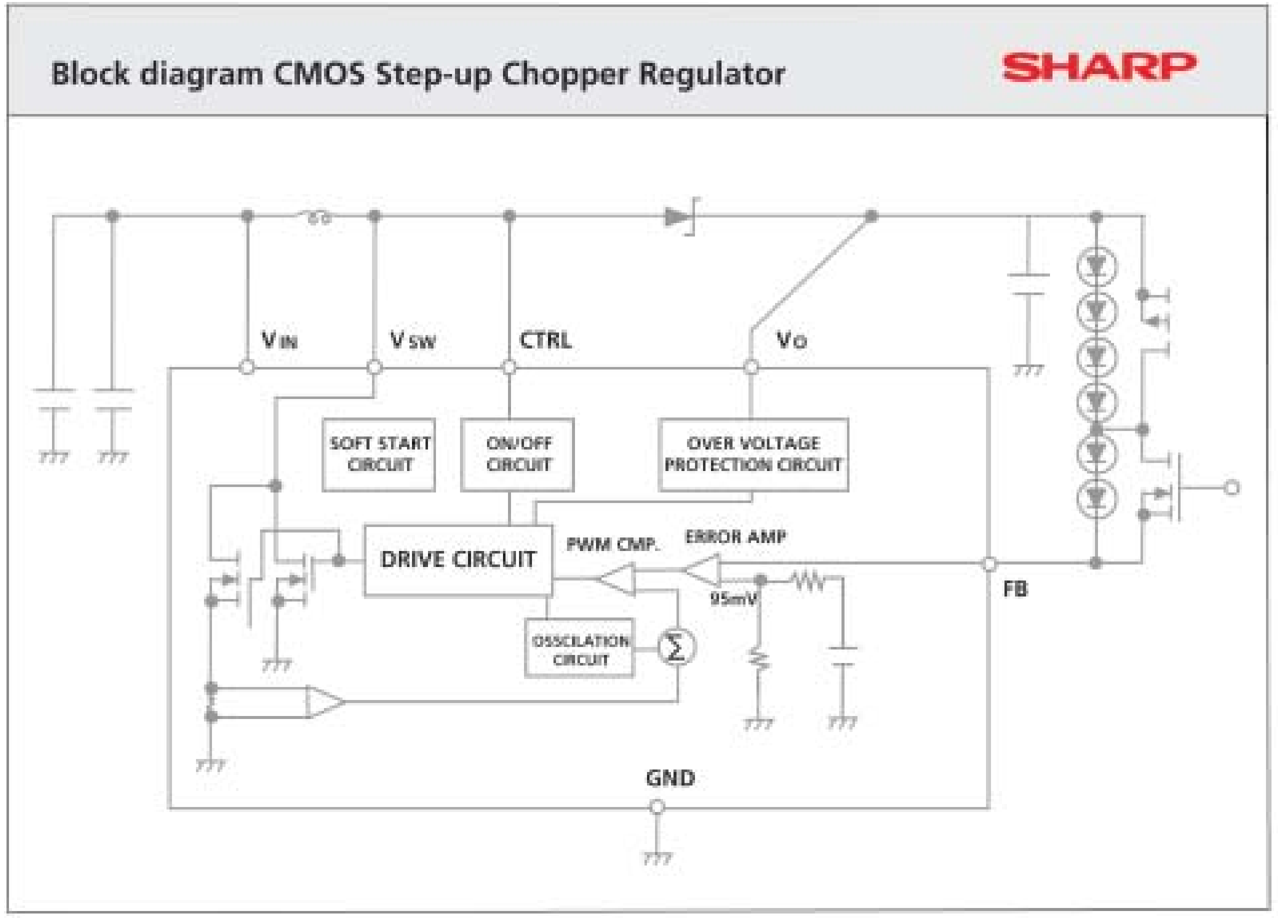


Figure 1. CMOS Step-up Chopper Regulator Block Diagram.

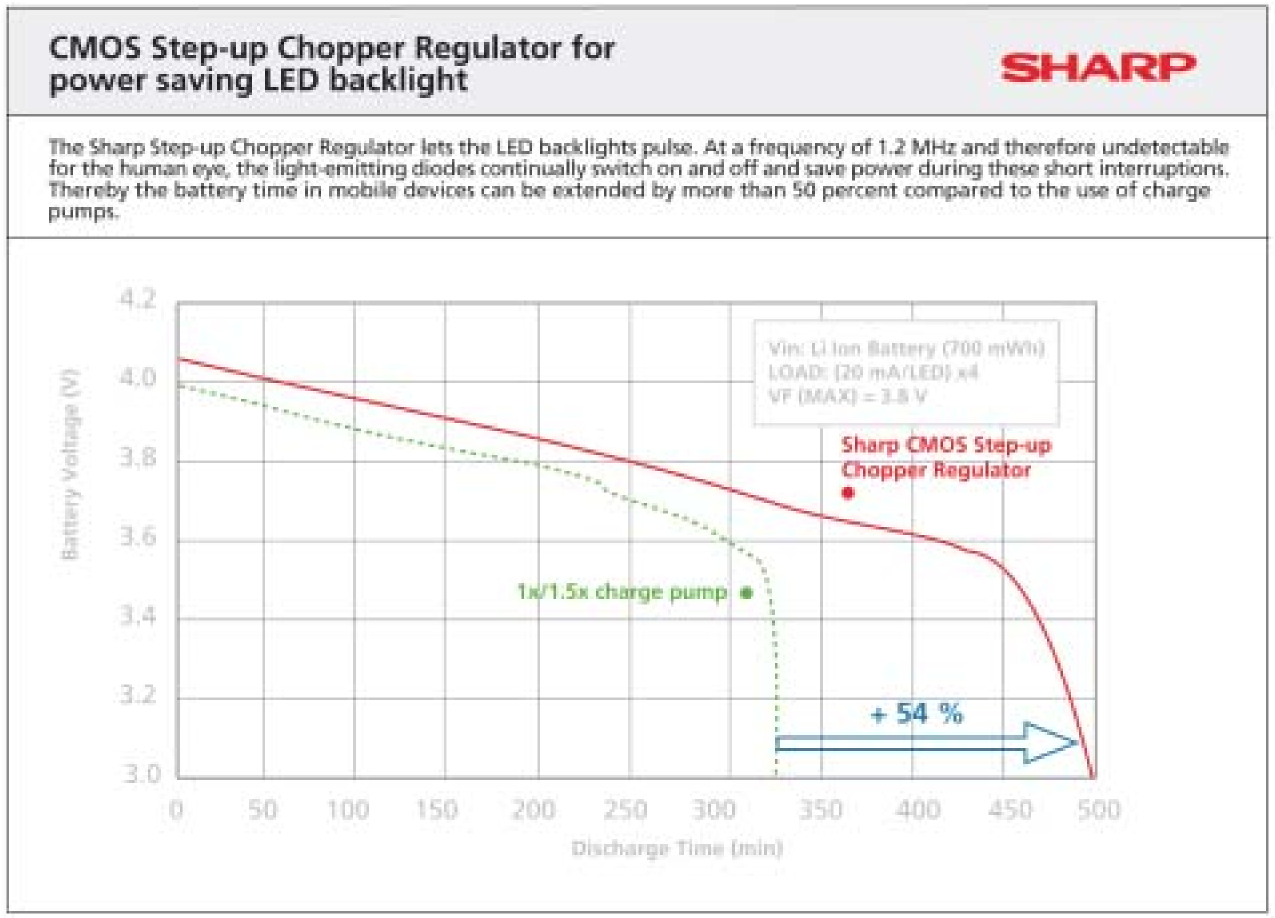


Figure 2. CMOS Step-up Chopper Regulator Power Savings.

components connect the LED with the power supply unit and generate a higher supply voltage for the LED circuit from the lower input voltage. The advantage: in order to generate a constant output voltage of about 4 V, only low energy is used by the regulator itself. The serious drawback to this parallel circuit, however, is the uneven voltage supply to the individual light-emitting diodes. This leads not only to fluctuations in the brightness of the LEDs, but also to different loads, which over the long term decreases the lifespan of the light-emitting diodes.

The Sharp CMOS Step-up Chopper Regulator (PQ6CU11X1APQ/PQ6CB11X1AP) represents an improvement on previous parallel-LED technology. This makes it possible to connect up to six light-emitting diodes in series, each of which receives exactly the same forward current. The result is a very high and consistent light-emitting efficiency. In contrast to the parallel arrangement of the light-emitting diodes, which calls for a total supply voltage of about 4 V, the step-up chopper regulator has to generate a switching voltage of 16 V (e.g. in order to drive a set of 4 LEDs), and therefore consumes relatively more energy. Still there is a high potential for savings here: the Sharp component provides light pulses for LEDs. The light-emitting diodes continually switch on and off at a frequency of 1.2 MHz. To the human eye, these pulses of light are indistinguishable from continuous light, but they are significant for energy management; the step-up chopper regulator uses these short interruptions to save power by radically reducing the operating voltage of the LEDs during this time. Thus, the new component combines high performance with a conservative use of energy. By deploying the step-up chopper regulator with oscillating light, the battery time in mobile devices can be extended by more than 50 percent compared to the use of charge pumps.

The step-up chopper regulator operates over an input voltage range of 2.7 to 5.5 V with a very high efficiency rate of 90 percent. Thanks to a built-in overvoltage protective device, the resulting load on the component is not allowed to be unacceptably high. The new regulator can generate an output voltage of up to 30 V. The switching current totals a maximum of 250mA, while current consumption in stand-by mode can be reduced to under 1 µA. With respect to environmental management certification in accordance with ISO 14001 standards and the RoHS (Restrictions on the use of Hazardous Substances) guidelines which come into effect by mid 2006, Sharp already offers this product as a “lead-free” alternative.

The flat, six-pin SOT23-6 package reduces the space required on the circuit board; this, combined with its low energy consumption and minimal size (1.3x2.9x1.6 mm), means that it is i deally suited for portable, battery-powered devices.

Ultra Low Consumption Technology turns Display into a Power Saver

In addition to the low consumption background lighting, the physical level of the TFT and the TFT driver level offer opportunities for efficient energy management. Sharp Microelectronics is combining various processes under the Ultra Low Consumption (ULC) Technology label in order to curb the power consumption of TFTs.

On the physical level of these liquid crystal displays, the goal is to optimize the capacity of conductors and, consequently, their ability to store an electrical charge. In this case, the ULC technology focuses on power supply and bus conductors with the smallest possible diameter (and consequently lower capacity) in order to keep power consumption as low as possible. The display can thereby refresh more rapidly and thus offers better performance than before while consuming less power. Thus, this technology not only provides longer battery life but also lowers operating temperatures.

Another step Sharp has taken at the physical level of the LC display is to utilize the inactivity of the TFT’s liquid crystals and the associated “memory effect”. Since the indicators on mobile phones or PDAs primarily show static images, the brightness level of the pixels does not need to be recreated each time from zero. What is undesirable in the case of large-area LCDs may also be able to substantially reduce energy consumption in the case of small-format displays.

Due to the many functions they offer, handheld companions such as mobile phones or PDAs are used almost 24 hours a day. The active time they are used is, nevertheless, much shorter. Thus, activation of the TFT is an important starting point for an effective standby mode. In the idle state, or for simple indicators such as displaying the time or signal strength, the driver automatically switches to a lower resolution, less colour depth, or activates only certain parts of the display, shutting off the remaining sections of the display.

Thanks to the ULC measures, the power consumption of a mobile phone TFT (128x160 pixels, 65k colours), for example, can be reduced from 9mW to 3mW. The battery time is thereby doubled to 250 hours. In contrast, if the

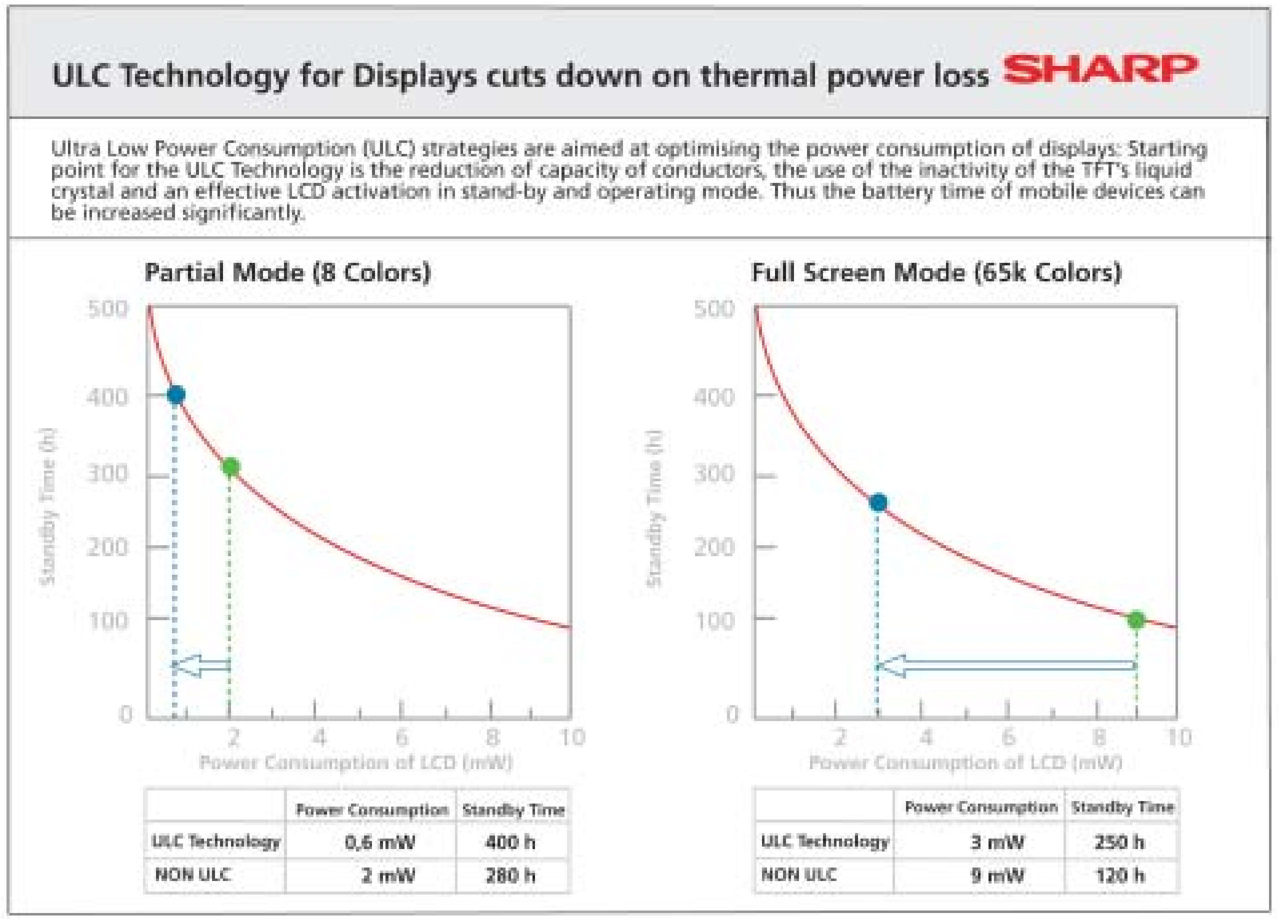


Figure3. Ultra Low Consumption Technology for TFTs.

LCD is operated in the savings mode with lower colour depth, the energy consumption can be reduced to as low as 0.6mW. A battery will then hold its charge for up to 400 hours, compared with 280 hours without ULC technology.

Continuous Grain Silicon for high electron mobility

Progress in the LCD coating process has also contributed to a reduction in energy consumption. In the Continuous Grain Silicon (CGS) technology, the silicon is applied to the mother glass in uniform, comparatively large crystals. The result is that the electrons move up to 600 times faster than in the amorphous material. This lowers both the supply voltage and the power consumption. In addition, the CGS also makes it possible to integrate previously peripheral control technology directly into the LC glass, thereby enabling a more compact module design. This is also an important advantage when dealing with portable devices.

Energy-saving processor switches off peripheral units

At the core of mobile, high-end devices is an efficient processor that rapidly decodes compressed audio, video, and picture files while managing numerous interfaces. Therefore, the central processing unit (CPU) is potentially the largest consumer of power in the system (2nd only to the LCD panel). Without power management, today's highly integrated processors would be inconceivable. The LH7A404 microcontroller, the most recent member of Sharp's BlueStreak family, is based on an ARM9 core and is ideally suited for multimedia applications. With 80KB of on-chip memory and a clock speed of 200 MHz, the MCU processes up to 220 million commands per second. Different processes such as the decompressing of MPEG-4 video files and the processing of audio files can be performed in parallel. The CPU allots the appropriate power for each operation. In addition, the processor has numerous on-board peripheral units: the programmable LCD controller supports a display resolution of up to 1,024x768 with up to 64,000 colours or 15 greyscales with direct interfaces to STN, Colour STN, TFT, and advanced TFT displays. The interfaces for AC97 audio, CompactFlash, MMC/SD, USB 2.0, NAND Flash, and SDRAM support have been specially designed for media applications.

Alternatively, operating systems such as WinCE, Linux, or OSE 5.0 may be used.

Despite such high performance, an operating voltage of 1.8 V is sufficient for the MCU - the result of sophisticated power management. The Sharp microcontroller's flexible design hereby offers numerous opportunities for cutting power consumption. If no demands are made on the CPU for a substantial time, the MCU may be programmed to switch into sleep mode. The frequency and power consumption are reduced to the point where basic processor information such as the working register and caches can still be maintained and the processor can "wake up" again with a minimum lapse of time.

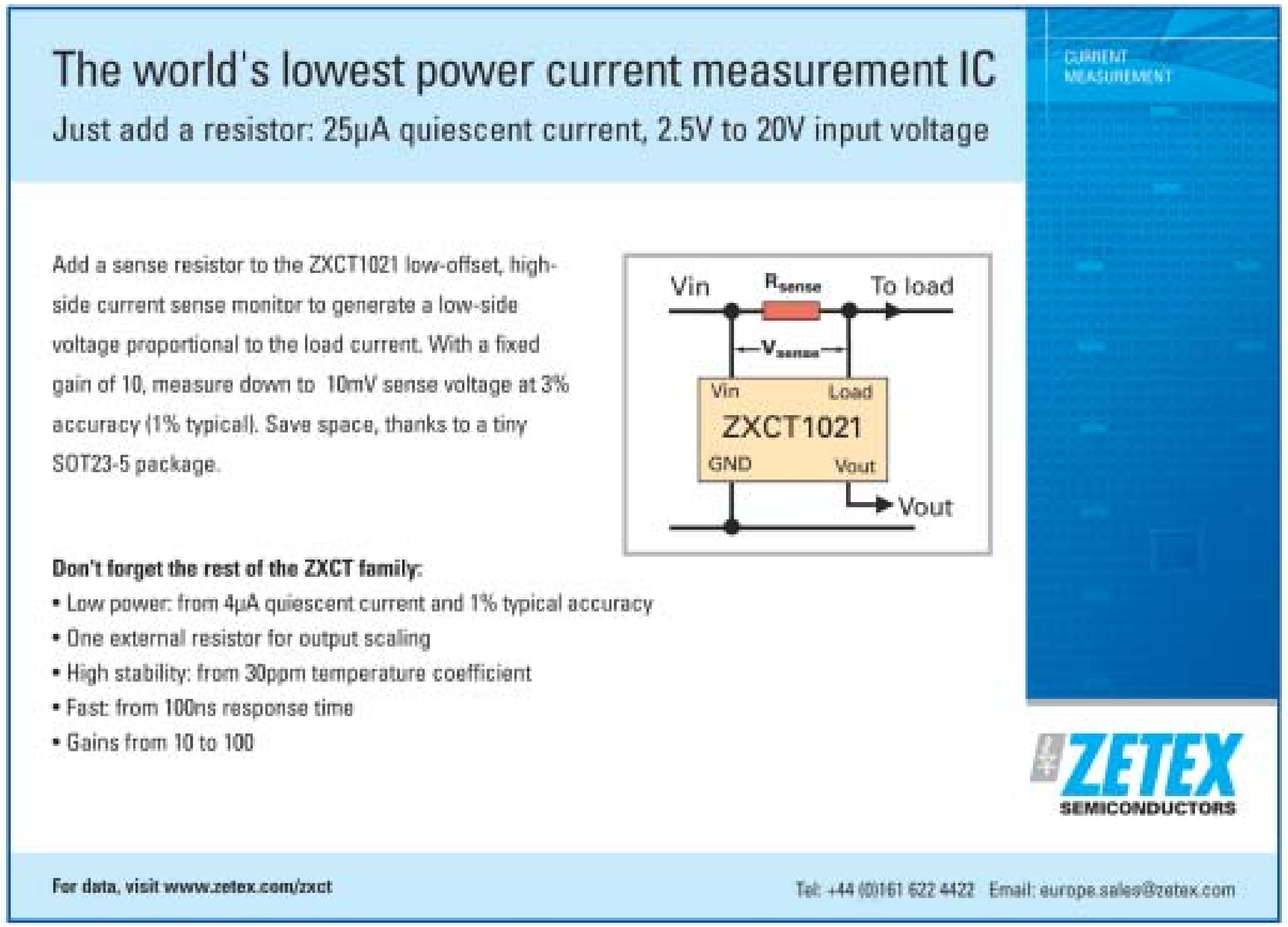
However, the Sharp microcontroller's energy management goes beyond this well-known sleep function. By using dynamic power management, the clock frequency of individual peripheral blocks can be reduced and even shut off independently of the CPU's timing device. In addition, the processor also dynamically adjusts its clock speed to fit the current workload. In this way, the entire system gains flexibility and does not make inordinate use of the power source.

Convergence is the trend

The trend towards convergence will keep setting the agenda in the coming years and consequently will drive the need for energy-saving components. Following the sustained boom in mobile phones with cameras, the initial success of smart phones, in which mobile phone and PDA functions merge, is now showing where the path is likely to take us. There is no end in sight to the increase in performance of mobile devices. Therefore, a comprehensive power management capability is, more than ever, the key to market success.

The market for mobile devices is characterized by very short product life cycles. By offering efficient and energy-saving components, Sharp Microelectronics is helping to reduce market launch times and development costs.

www.sharp-eu.com



High Reliability Sensors

Providing design engineers with a rugged sensor capable of delivering stable position sensing over a wide range of temperatures, TT Electronics OPTEK Technology has developed a Hall-effect sensor for space and other harsh environments. The sensors provide accurate position sensing in even the most severe environmental and temperature conditions and operate over a broad range of supply voltages, which makes them ideal for military and space applications.

The bipolar latching sensors, designated the OMH3075B and OMH3075S Series, contain a Hallogic monolithic integrated circuit, which incorporates a Hall element, a linear amplifier, and Schmitt trigger on a single silicon chip.

Supply voltage for the OMH3075 Series devices is 4.5 to 24V, with up to 25mA of sink current in the "on" state. Output characteristics are constant at switching speeds from DC to more than 100 kHz. Operating temperature range is—55°C to +125°C. Custom designs and specifications are available to meet specific individual requirements.

The OMH3075 sensors are screened to the test methods per MIL-STD-883, Class B and Class S. OPTEK is a fully integrated high reliability manufacturer and offers a comprehensive range of products that can be QCI tested (Groups A, B, C & D) per MIL-PRF-19500 to the methods of MIL-STD-750 and MIL-STD-883. Full assembly and testing are performed in the company's ISO and QS9000 certified Juarez, Mexico facility. The sensors have a gold lead finish (a lead finish in hot solder dip can be provided) and are contained in a hermetic ceramic package. They are compatible with high temperature (260°C) soldering processes.

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Very Low Dropout Regulator

Linear Technology Corporation announces the LTC3025, a 300mA Very Low Dropout Regulator (VLDO) with input voltage capability down to 0.9V. It has a very low dropout voltage of only 45mV while delivering up to 300mA of output current. The low VIN capability is important, as many emerging hand-held applications are using a 1.5V main bus rail, and require output voltages from 1.25V to 0.5V to drive low voltage microprocessor and microcontroller cores. The LTC3025 can also be used for 3.3V/5V down to VOUT ≤1.20V, since it has a 0.4V reference. In addition, the LTC3025 offers micropower operation with only 54uA of quiescent current, and less than 1uA in shutdown, maximizing run time in handheld applications.

The LTC3025 regulator optimizes stability and transient response with low ESR ceramic output capacitors as small as 1uF. Other LTC3025 features include ± 2% voltage accuracy over temperature and supply load, fast transient recovery, current limiting and thermal overload shutdown. Its shutdown disconnect feature disconnects both VIN and VBIAS from the output in shutdown mode. The LTC3025 regulator is available in a low profile 6-lead DFN (2mm x 2mm x 0.75mm) package with an exposed pad, offering a very compact and thermally efficient solution.

The LTC3025 is packaged in a 2mm x 2mm QFN-6 and is available from stock.

www.linear.com

IGBT Sixpack and CBI

In line with its ambitions for growth in the IGBT market, IXYS has extended its portfolio of IGBT modules, MWI 30/50-12E6K and MWI60-12T6K.

Sixpack configuration and Converter Brake Inverter (CBI) modules are new offered in low loss NPT, NPT3 and trench technology.

Sixpack IGBT modules,MWI15 /MWI60, 1200V type with current capabilities varying from 19-58 Amp @25 °C complete this product line.

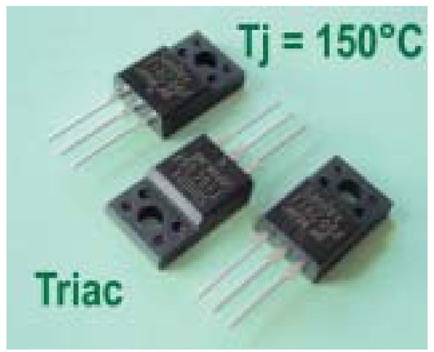
In addition the CBI,IGBT modules, MUBW10/MUBW35,are now offered in 600V, current rating 12- 42 Amp@25 °C and in 1200 version,MUBW15/MUBW30 with current rating 19-30 Amp@25 °C.

Typical applications for this product are AC drives, UPS, AC servo and robot drives.

All modules are UL approved an readily available in stock.

www.ixys.com

Triacs with Tj (max) = 150°C



Sansha Electric Manufacturing Co. Ltd. the parent company of SanRex Europe GmbH introduced a series of new triacs with extended working temperature range.

SanRex added to their standard triac line the new TMG – CQ/DQ family with a guarantied maximum junction temperature of Tj (max) = 150°C.

In reason of SanRex new "Isolated Diffusion Technology" was it possible to increase the maximum junction temperature of the TMG – CQ/DQ series by 20% against the today's standard triacs.

The users of the new triacs are now able to work up to Tj (max) = 150°C Instead of Tj (max) = 125°C only. One of the benefits for the user of TMG – CQ/DQ is he can shrink the size of the heat sinks or eliminates the heat sinks completely which are needed for standard triacs under same working conditions. The user can get lower system cost, higher system reliability and higher efficiency in using TMG – CQ/DQ devices. The new 600V triacs are available in a current range from 1A to 25A, as standard gate (CQ) or sensitive gate (DQ) types in different packages (trough hole and SMD).

In addition the new SanRex devices are environmentally friendly, lead free and fully compliant to the European RoHS requirements.

www.sanrex.com

Power Broadband Services

LCombined with the successful introduction of the remote power solutions to power broadband xDSL services over copper pairs, Cherokee announces the launch of their local power sub-system.

The system is designed to host two rectifiers 400W, a DC distribution unit and a controller unit which allows control over the whole system, including rectifiers, distribution and battery management.

The system operates in a wide temperature range from –25°C to 70°C with a field replaceable fan unit.

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www.cherokeepwr.com

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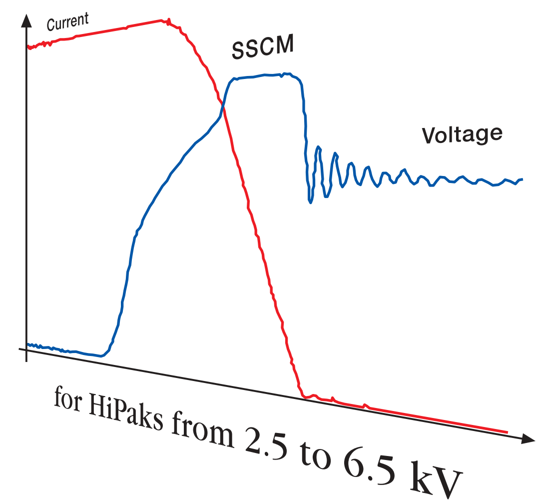

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