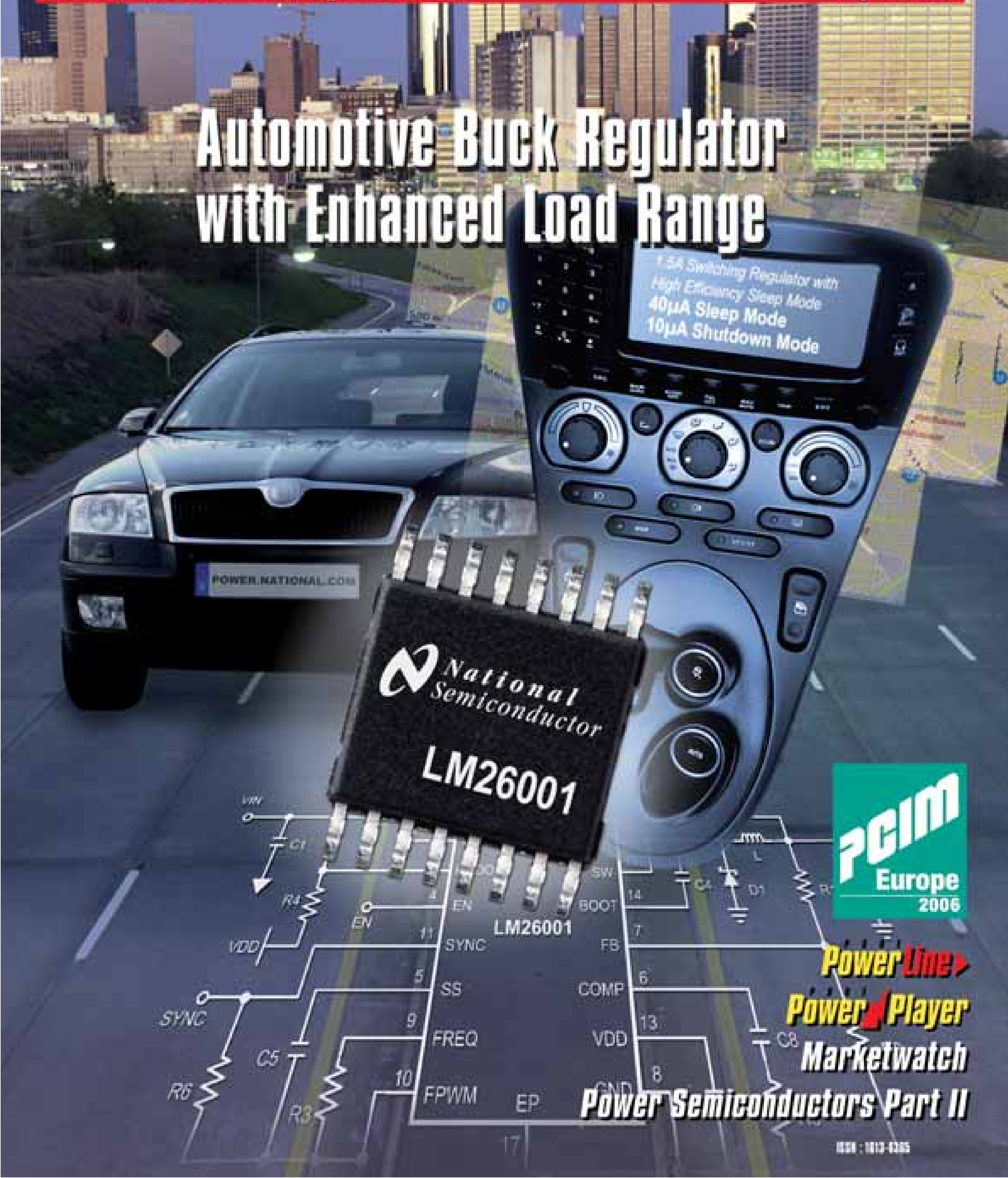
Power Systems Design EUROPE

Power Control Intelligent Motion May 2006

Automotive Buck Regulator with Enhanced Load Range



PCIM Europe 2006

Power Line

Power Player

Marketwatch

Power Semiconductors Part II

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Power Systems Design EUROPE

Power Systems Design Europe

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Volume 3, Issue 4

The Final Count Down for Nürnberg

Once again we have published in the centerfold of this issue, the layout of the PCIM Europe exhibit hall to help you find your way at the PCIM exhibition.

The tradition goes on at the podium in the exhibit hall, experts from Industry will join me for discussion.

Mark your calendar for PCIM Nürnberg. Hall12, Booth 353:
"Gate Drivers optimized for MOS Devices" for Tuesday, May 30, 12:45 to 13:30.
"Digital Power and the Application Focus" for Wednesday, May 31, 11:00 to 12:00.
"Passive Components are the Spices in Design" for Thursday, June 1, 11:40 to 12:40.

Each of the discussions are technology and design improvement driven.

Our cover story by National addresses power management and the critical usage in stand alone battery operated systems. The power supply in the car has critical subjects to follow. These subjects are not different from the ones we have with any portable industrial or consumer product, only the impact on our life is different. Changing the battery in portables is a normal procedure. Having a discharged battery in your car can make life difficult. So minimum standby current is an important subject as more equipment gets added to our cars. Every spring I take out my old beetle convertible after half a year sitting in the garage with anticipation about whether the battery is still charged. Do you know how many weeks of stand by your car will achieve today?

This months Power Player is Eric Lidow, Founder and Chairman of International Rectifier who gives us his view for powering the future.

Over the 60 years Eric Lidow has been associated with the power semiconductor industry, the needs for better efficiency and greater performance have been the key driving forces.

This issue also contains Part II of our focused series on Power Semiconductors with articles from Infineon, Fairchild and Semikron.

Silicon Carbide Schottky Diodes are a solution for a broad range of power supplies.

The power factor correction (PFC) market is highly driven by worldwide regulations related to the reduction of harmonic distortion. The second generation of SiC diodes from Infineon improves efficiency of PFC.

Fairchild shows a study of Gate to Source leakage current in epoxy mold compound devices. Development of new electronic packages has focused on low cost, small size, high performance and high reliability. A lot of effort has been made to achieve these requirements by finite element analysis (FEA).

Semikron explains that reliability is a must. Power electronic systems are used in day-to-day applications. Elevators in office buildings or escalators in department stores for instance; the only time the systems that run these elevators or escalators are noticed is when they fail to work.

Make sure you stop and see us at Booth 245 in Hall 12 at the PCIM Europe exhibition.

Best regards,

Bodo Arlt
Editorial Director
The Power Systems Design Franchise

STMicroelectronics and Semikron Team Up for Integrated Power Modules

Semikron and STMicroelectronics are teaming up to develop and deliver integrated power modules for industrial, consumer, and automotive markets, embedding ST's power devices in Semikron's SEMITOP power packages. The two companies have agreed to combine their complementary competences to offer robust and cost-effective power solutions and use the module range to expand their respective market coverage.

This collaboration creates new opportunities for traditional power devices, including IGBTs and power MOSFETs, as well as for ST's proprietary ESBT (Emitter-Switched Bipolar Transistor) devices, which cost-effectively combine power bipolar and power MOSFET structures to offer both high voltage capability and high switching frequencies.

The SEMITOP package allows several chips, such as IGBTs (Insulated-Gate Bipolar Transistor), diodes, and input bridge rectifiers, to be integrated in a single module.

The integrated power modules from ST and Semikron are set to address the rapidly growing demand for more integrated and reliable high-power platforms in a wide range of segments and applications, including Welding, UPS, Home Appliance, Motor Drive, and Switched Mode Power Supplies.

Volume production of the new integrated power modules will start in Q2 2006. ST and Semikron will market them independently, assuring a dual source and securing a better supply of these devices for customers.

www.semikron.com

www.st.com

Linear Technology Launches First European Design Center in Munich

Lothar Maier, CEO of Linear Technology.

Linear Technology announced the opening of its first European design center in Munich, Germany. With the opening of the company's eleventh design center, Linear's Munich Design Center allows the company to further expand its analog design resources at a location that provides proximity to some of the company's key European customers.

Lothar Maier, CEO of Linear Technology, stated, "We are excited to open our first European design center in the key technology hub of Munich. By centrally locating our latest design center on the European continent, this puts us in an even better position to develop the right products for our major European customers. Germany represents an ideal location for our first European design center, with its focus on the automotive, industrial and communications markets."

Linear Technology has had a deep commitment to the European market for many years. Linear has technical field sales engineers and field applications engineers throughout Europe, including three locations in Germany (Munich, Stuttgart and Ascheberg), and at offices in Finland, France, Italy, Sweden and the UK.

www.linear.com

Intersil Names Senior VP for Worldwide Sales

Intersil has announced the hire of Peter Oaklander to the position of senior vice president of Worldwide Sales, located at Intersil's headquarters in Milpitas, California. Oaklander will replace Alden Chauvin, who will retire later this year.

Oaklander spent the past 20 years at Analog Devices, most recently holding the position of vice president and general manager of Power Management products in the Analog Semiconductor division. While managing director of the Asia Pacific region for Analog Devices, Oaklander was located in Hong Kong. Oaklander holds a BSEE degree from the Rochester Institute of Technology in Rochester, New York, and an MBA degree from the Northwestern Kellogg Graduate School of Management and Hong Kong University of Science & Technology in Hong Kong.

www.intersil.com

Thermacore Europe Wins the Queen's Award

Thermacore Europe has been awarded the prestigious Queen's Awards for Enterprise: International Trade 2006 in recognition of its outstanding contribution to the UKs manufacturing industries export achievements. This award is only given to businesses that demonstrate substantial growth in overseas earnings for goods and services in relation to the size of their operations. Over the last three years Thermacore has especially seen an increase in the number of their export sales with latest figures showing 83% of turnover due to international sale with a customer base spanning across 25 countries.

Thermacore Europe designs & manufactures advanced thermal solutions for Electronics across many different industry sectors. Core technologies have been and are continuously being developed to specifically solve today's heat transfer problems.

The Awards are made each year by The Queen, on the advice of the Prime Minister, who is assisted by an Advisory Committee that includes representatives of Government, industry and commerce, and the trade unions.

The winners of the Queen's Award will be publicly announced on the Queen's personal birthday, the 21st April.

www.thermacore-europe.com

ON Semi to Purchase LSI Logic Wafer Fab

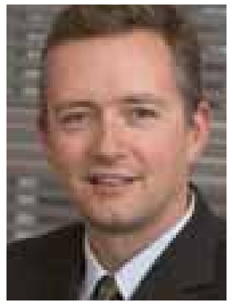
ON Semiconductor announced that its primary operating subsidiary, Semiconductor Components Industries, LLC, has executed a definitive agreement with LSI Logic to purchase LSI Logic Corporation's Gresham, Ore., wafer fabrication facility and certain other semiconductor manufacturing equipment for a total of approximately $105 million in cash. The Company paid LSI Logic a deposit of $10.5 million concurrently with the execution of the definitive agreement, is currently obligated to pay $79.5 million at closing, and expects to pay the remaining balance within 90 days after closing. The assets to be purchased include an approximately 83 acre campus with an estimated 500,000 square feet of building space of which approximately 98,000 square feet is clean room. The 200 mm capable tool-set and equipment included in the transaction is currently capable of producing 18,000 8-inch wafers per month. Pursuant to the agreement, ON Semiconductor will offer employment to substantially all of the LSI Logic manufacturing employees currently working at the Gresham facility.

In connection with this transaction, ON Semiconductor and LSI Logic will enter into several related agreements, including a Wafer Supply and Test Agreement, Intellectual Property License Agreement, Transition Services Agreement and Facilities Use Agreement.

www.onsemi.com

Fairchild at PCIM Europe 2006

Fairchild Semiconductor will feature an extensive product portfolio of solutions meeting efficiency standards and government regulations at PCIM Europe 2006. At PCIM Europe, Fairchild will exhibit (booth 601) its industry-leading Smart Power Modules (SPM), PFC controller ICs and other highly integrated, high-functionality devices. Fairchild technologists will also present papers offering designers innovative design ideas for optimizing thermal and power efficiency while saving board space in today's demanding power applications. PCIM Europe, scheduled for May 30 through June 1, 2006, in Nuremberg, Germany, is a global conference and exhibit for the electronics industry.



Alfred Hesener, director of Marketing, Fairchild.

"Meeting PFC requirements, the <1 Watt Initiative and other green regulations are of paramount concern for today's applications designers," said Alfred Hesener, director of Marketing. "Today's applications require increased efficiency even as their product features multiply and the product itself shrinks in size. Fairchild Semiconductor understands these conflicting challenges and develops products that integrate functionality and utilize proprietary packaging technologies to improve efficiency and thermal characteristics while saving board space and reducing component count. As The PowerFranchise, Fairchild offers in-house expertise for applying these advanced technologies in innovative ways to enhance performance in specific applications."

www.fairchildsemi.com/tradeshow

PSDE magazine apologises for errors in the following article, which appeared in the March issue. Please find the correct version below:

Formation of 5S Components

ABB Switzerland Ltd/Semiconductors and ABB Semiconductors Inc announce the formation of 5S Components Inc, headquartered in Pittsburgh, PA. In a management buy-out geared to giving semiconductor sales stronger focus, John Siefken (right) and Kenny Stephenson (centre) purchased the business of ABB Semiconductors Inc from ABB Switzerland/Semiconductors, effective December 1, 2005 making 5S Components the successor to ABB Semiconductors Inc. Additionally, ABB Switzerland/Semiconductors has entered into an agreement with 5S Components to be the exclusive distributor of ABB Switzerland/Semiconductor products in North America. 5S Components will continue the business of ABB Semiconductors Inc at the same location, with the same address and telephone numbers as before. Most of the ABB Semiconductor Inc employees transferred to 5S.

Kurt Hörhager, Managing Director of ABB Switzerland/Semiconductors comments that "Creating 5S guarantees focus on semiconductor sales in North America, a vital part of our growth strategy. John, Kenny and the 5S team have my full backing and ABB will be able to support the North American market and its customers even better than in the past". Roland Villiger (left), VP of Sales & Marketing adds, "We are working with 5S to insure a smooth transition and an uninterrupted flow of products. This change will in no way impact the quality and dependability of the support that customers have always received: they can expect the same service from 5S and the ABB factories now as they previously received because the team remains the same".

www.abb.com/semiconductors

Power Events

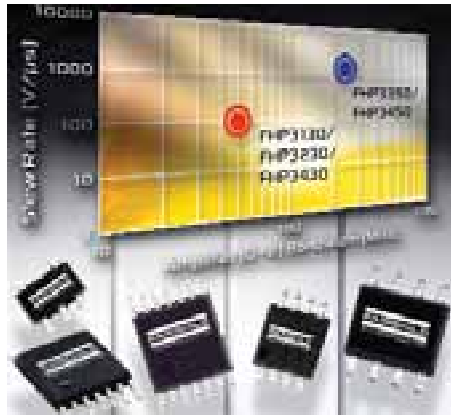
- ***PCIM Europe 2006,*** *May 30 - June 1, Nuremberg, www.pcim.de*
- ***SMT/HYBRID 2006,*** *May 30 - June1, Nuremberg, www.mesago.de*
- ***SENSOR/TEST 2006,*** *May 30 - June1, Nuremberg, www.sensor-test.de*
- ***CIPS 2006,*** *June 8.-9., Neapel Italy, www.cips-conference.de*
- ***EPE-PEMC 2006,*** *Aug 30 - Sep 1, Portoroz, Slovenia, www.ro.feri.uni-mb.si/epe-pemc2006*
- ***MICROSYSTEM,*** *October 5 - 6 , Munich, www.mesago.de*
- ***H2Expo,*** *October 25-26, Hamburg, www.h2expo.com*
- ***ELECTRONICA 2006,*** *Nov. 14 - 17, Munich, www.electronica.de*
- ***SPS/IPC/DRIVES 2006,*** *Nov. 28 - 30, Nuremberg, www.mesago.de*

Optimized Bandwidth and Reduced Power Consumption in Video Designs

Fairchild enters the high-performance amplifier market with two families of 210MHz and 50MHz bandwidth devices based on its new BCP6T technology

Fairchild Semiconductor marks its entrance into the high-performance amplifier market with five industry-leading operational amplifiers (op amps). The 210MHz FHP3x50 and the 50MHz FHP3x30 families allow designers to target a broad range of high definition (HD) and standard definition (SD) video applications including set-top boxes, digital TVs and audio/video amplifiers. These two product families were developed with Fairchild's new industry leading, proprietary "BCP6T" technology, an ultra-low capacitance, complementary bipolar process using silicon-on-insulator (SOI) and deep trench isolation (DTI) technologies. Fairchild's high-performance op amps allow designers to achieve their dual objectives of delivering superior amplifier performance and maintaining very low power consumption.

Fairchild claims to now lead the high-performance amplifier market with a range of devices offering designers the best available combination of power and performance features. The FHP3x30 family, for example, provides the lowest available power consumption combined with 33% higher bandwidth, 33% more output current and 55% better DC performance than comparable devices. And the FHP3x50 family offers best-in-class input bias current, which is an order of magnitude better than any other device in this performance range. Both families provide 1.5kV charged device model ESD protection, a real value-add to the customer.



The FHP3x50 Family

The triple- and quad-channel FHP3x50 devices were designed to optimize bandwidth in high-speed applications such as HD set-top boxes. These 210MHz full-power bandwidth <3dB) op amps exceed HD video requirements and deliver 1100V/µs slew rate for optimal pulse response. In addition, the devices' 0.07%/0.03° differential gain/phase error improves video quality. The devices in this family achieve optimal AC performance with a gain flatness of 0.1dB (50MHz), enabling them to maintain consistent gain over the entire passband of high-definition video signals. DC accuracy is also improved due to their industry-leading (0.05µA typical) input bias-current, which allows for more precise output-voltage levels and minimal droop in AC-coupled applications.

Both devices in Fairchild's 210MHz family operate with just 3.6mA of supply current per amplifier, with the triple-channel device offering a disable feature to prevent additional power consumption. Energy-saving features like these, combined with an excellent output current rating (±55mA), make these devices ideal for driving multiple video loads. The FHP3x50 products are also well suited for use in DTVs, audio/video (A/V) amps and projectors and DVD recorders.

The FHP3x30 Family

The single-, dual- and quad-channel devices in the FHP3x30 family offer industry-leading 50MHz bandwidth, 110V/µs slew rate and 0.008% /0.01° differential gain/phase to improve performance and save power in SD video designs. Targeted applications include SD set-top boxes, DTVs, CCD imaging systems and industrial imaging systems. Specifically, the FHP3230 device offers the market's best-available bandwidth (170 vs. 130MHz), output current (100 vs. 75mA) and DC performance (CMRR: 100 vs. 88dB) at the lowest power consumption (2.5 vs. 2.7mA).

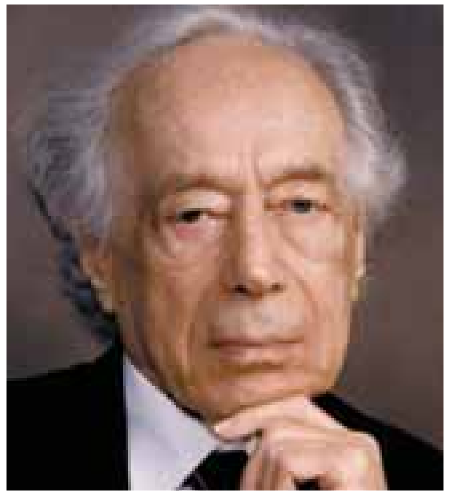
Like the FHP3x50 series, the three amplifiers in the FHP3x30 family also provide superior gain flatness (16MHz to 0.1dB) to increase system reliability and simplify designs. These devices operate with just 2.5mA supply current per amplifier while providing ±100mA output capability to effortlessly support four video loads. Additional performance features include optimal open loop gain (AOL), power supply rejection ratio (PSRR), and common-mode rejection ratio (CMRR) —all better than 100dB—for improved dynamic range and gain accuracy.

www.fairchildsemi.com/fhpamp

Powering the Future: Implications for Power Subsystem Design

By Eric Lidow, Founder and Chairman, International Rectifier Corporation

Over the 60 years I have been associated with the power semiconductor industry, the needs for better efficiency and greater performance have been key driving forces. Though the evolution of power management technologies has been great, the nature of a systems designer's interaction with those technologies, until recently, has remained largely unchanged. As a result, the power subsystem design task has grown increasingly complex in proportion to the market demand for evermore efficiency and performance.



Power management technologies have progressed over the last decade along a course that parallels the evolution of signal- and data-processing technologies even though the two sectors make distinct demands on their core fabrication processes. This trend is reflected in the designs to which these technologies are applied. For example, the traditional hierarchy of system, subsystem, circuit, and component has become far more fluid and functional segmentation has displaced subsystem-make-or-buy decisions as the most ready means of taking advantage of various technologies. Such is the power of integration. But harnessing that power requires design methods that more flexibly scale the design hierarchy.

Fundamentally, there are two types of power subsystem designer. For one, the power subsystem is the product. In the highly competitive markets being served, this designer's product must realize every last bit of efficiency and performance available from the underlying topology. This designer also must anticipate the customers' diverse needs for power system control, monitoring, and diagnostic features.

The other type of designer develops power subsystems as part of a larger system. Power, in this case, is an enabling function with substantial challenges resulting from the need to optimize the power subsystem's characteristics to a specific application.

Both types of designer must contend with the fact that power management has lagged behind other sectors in integration and, therefore, its percentage of cost on the BOM and space in the box has increased. Despite the different goals motivating these two designers, they face constraints that are remarkably similar, and that can be solved by similar methods.

These forces and trends strongly suggest that the future of power design will not center on individual power management components, though they will continue to play an important role. The change has already begun. The power designer's focus is shifting to a higher level of abstraction in the same way data- and signal-processing designers moved from transistor- and op amp-based designs to greater levels of integration. Silicon designers in the power management sector are now drawing upon digital, analog, power drive, and power control technologies in concert with advanced packaging technologies to develop integrated design platforms—chipsets, analytic-software, practical reference designs, BOM generators, and other support tools to meet the needs of next-generation products and the OEM engineers that design them. This evolution to integrated design platforms for power subsystems invites a disciplined approach to design leading to predictable performance, enabling design reuse and customization, and reducing design risk, cost, and time to market.

These benefits extend beyond power-supply subsystem designs to other power management applications, like variable-speed motion. Integrated design platforms that support motor-control applications are helping OEM appliance manufacturers adopt highly efficient drive motors. About half of the world's electricity is consumed by electric motors. All but a small percentage of these operate at efficiencies in the range of 60-70%. Efficiencies as high as 94% are attainable with advanced motors and drive systems, but designing the drives from the ground up is an extremely challenging task. Integrated design platforms comprising motion-control-specific digital, analog, and power silicon technologies and development tools enable rapid prototyping, product integration, and characterization, significantly lowering design risk. Appliances, such as air conditioners based on these designs, enjoy lower operating costs and reduced operating noise. The smaller and improved motor drive subsystem eliminates previously required components, placing its manufacturing cost on par with its predecessor.

This is only the beginning. Energy conservation is becoming a necessity throughout the world. Though greater efficiencies are available for a wide variety of applications, barriers to adoption remain high. As OEMs begin to take advantage of integrated design platforms for power subsystems, these barriers will fall.

www.irf.com

Europe Remains a Force in Power Management Semis

By Chris Ambarian, Senior Analyst, iSuppli Corporation

With good reason, there is a substantial amount of hand-wringing and general worry in the Western countries about the ascendance of the Chinese-speaking regions of the world when it comes to semiconductor design and manufacturing. Nearly 60% of semiconductors will be consumed this year in the non-Japanese Asia regions. With the vast majority of new semiconductor production facilities being installed in Taiwan and China (and the spectre of China's well-publicised efforts to gain independent design capability as they have done with end equipment), it is only natural to be concerned about losing control of this significant contributor to the European and American economies.

Nevertheless, Europe remains a significant force in the world of power management semiconductors. With powerhouse suppliers such as STMicro (the world's #1 supplier of power management semiconductors), Philips Semiconductors, Infineon, Bosch, and Semikron, as well as successful growth companies like Wolfson Microelectronics, Dialog Semi, Elmos, Austria Micro Systeme, and a myriad of upstarts, Europe-based companies continue to exert a disproportionately higher influence on power management than in any other area of the semiconductor market.

In 2005, the total world semiconductor market was approximately US$237Bn. Of this, about $27.2Bn (11.5%) was supplied by Europe-based companies.

In contrast, in 2005 the power management semiconductor market worldwide was about $22Bn in total (about 9.3% of all semiconductors). Of this, Europe-based companies supplied over $4.5Bn worth— about 20.7% of the worldwide total, much higher than Europe's 11.5% participation in the overall semiconductor market.

Equally of interest is the fact that this 20.7% figure has remained essentially unchanged for the last 3 years in a row, at least on a dollar basis. If we factor in the fluctuation in exchange rates, the news is a bit more mixed; it basically says that in 2004, Europe-based countries lost effectively 1.1% of market share with the unfavorable rise in the Euro. However, those same manufacturers responded decisively in 2005, and with the same exchange rate were able to maintain the same share they had in 2004. This is especially heartening when considering that during the same period Europe lost about 0.6% share in the total semiconductor market.

Europe's share of ww semiconductor revenues:
11.5% (declining)

Europe's share of ww power semi revenues:
20.7% (stable)

Compound annual growth rate of power semis:
10.4% (2005-2010)

So with this as a backdrop, we are heading into this year's PCIM gathering in Nürnberg with a lot of good news, and a lot of work ahead to keep things going Europe's way. The challenges for European suppliers of power management semiconductors will be in the deepening of relations with the Chinese-speaking world in the short term, and laying the groundwork for the same with the rest of the BRIC countries in the longer term. Continued technical innovations will continue to be a great door-opener, but high-level relations with key Chinese and Taiwanese equipment manufacturers is an area that North American suppliers appear to be focusing on more than their European counterparts. Such relationships could prove crucial in the next few years to maintaining (and even expanding) market share.

Wise management teams will do well to take some time while they are in Asia setting up their manufacturing facilities, and spend some quality "drinking time" with their potential customers in the region as well.

See you in Nürnberg. Maybe for a drink…

Christopher Ambarian is a senior analyst with the market research firm iSuppli Corp. El Segundo, Calif.

Contact him at cambarian@isuppli.com

www.iSuppli.com

Automotive Buck Regulator with Enhanced Load Range

Support today's stand-by operation needs

In the early days of the car, the only "always-on" component in the vehicle was the clock. As automotive designs and technology have progressed, this is no longer the case; high-end vehicles now include, as standard, sophisticated Driver Information Systems, infotainment and telematics, which need to retain information even when the car is inactive.

By Werner Berns, Application Design Center Manager, National Semiconductor GmbH

The design of these applications is becoming more demanding, particularly as high-end features are increasingly being incorporated into mid-range and low-end vehicles. This increase in functionality to providing real-time data to the driver—in essence, creating a mobile office—is not without system-level challenges.

Recent stories have emerged of drivers returning to their high-end vehicles, left at an airport for an extended period (6-8 weeks), to find the car with a completely discharged battery. This problem has focused system architects' attention on reducing the incremental power consumed by always-on systems operating at light load.

The LM26001 regulator, described herein, meets the challenge of efficient regulation at light loads through a novel, hysteretic control technique. The merits and applicability of alternative techniques for efficient light-load regulation are also discussed.

Always-ON Applications

Although this article focuses on automotive applications, there are many other applications that demand always-on functionality, including applications operating from batteries, such as portable medical devices (e.g. insulin pumps) or set-top boxes with stand-by power.

All of these devices have one thing in common: they need to maintain some basic functionality even in stand-by mode. High efficiency at light load helps to increase battery life and/or conserve energy in these and many other applications.

The ever-increasing complexities of system developments create new challenges that systems designers need to manage and resolve. As stand-by times need to be expanded, so the power demand increases, especially when the system is in full operation. Therefore, these systems usually have separate voltage rails for stand-by and for fully operation mode. This results in different rails with dedicated power solutions even if they have the same voltages.

Increasing Wide Load Range Efficiency

In the past, very low quiescent current (Iq) linear low dropout regulators (LDOs) have been used to create an always-on 5V rail. In the latest product developments, the demand for lower voltages is increasing and this is the case for the always-on rails, too.

Today we see more and more such rails coming down to 3.3V, and it is most likely to be down to 2.5V or lower in the future. However, load currents are not falling, but are actually rising because of higher overall power demand. As such, LDOs are becoming an unacceptable solution in many cases. Their very low efficiency, and thus high power dissipation at higher load currents, makes them more and more unusable.

The maximum possible efficiency, regardless of the output current, would be just 27.5% (Vin=12V, Vout=3.3V, eta max=3.3V/12V=27.5%). This ignores the LDO supply current, and the practical efficiency is lower.

Today, many available low Iq LDO solutions adapt the bias current to the load current. If the load current is low, the bias current is as little as possible, in order to come as close as possible to the above maximum efficiency value.

The regulation speed is reduced at this time. Then, if the load is reasonably high, the bias current is increased to allow better load transient response behavior.

However, the overall system complexity is increasing over time, and a total higher load current also on the low Iq power rail seems to be unavoidable.

Additionally, most low Iq high Vin LDO solutions in the market are limited to a maximum of 100mA output current, and even if these were available with higher currents, it would just increase the problem of total power dissipation in the system.

A switching solution instead?

This calls for a switching power solution that easily solves the problem of efficiency at higher output currents, but this results in real circuit challenges in light load conditions. Most automotive applications that use switching power supplies use the pulse width modulation (PWM) control scheme that comprises a fixed switching frequency.

One of the main advantages of PWM, is that the electromagnetic compatibility (EMC) can be much better predicted and all filtering, if required, can be optimized for the selected switching frequency. Unfortunately, PWM mode has its limitations when it comes to efficiency in light load conditions.

Because of the switching losses and the operational current consumption of the switching regulator itself, the overall efficiency drops significantly below the 10% load mark and can fall below 50% efficiency with loads below 1% of the maximum load. This behavior requires a major improvement before it can be used in stand-by applications.

Pulse Frequency Mode (PFM)

One possible alternative solution seems to be the PFM control scheme. It varies the switching frequency with the load current so that the lower the load current is, the lower the switching frequency will be. This behavior results in significantly reduced switching losses at low load currents.

The operational current of the switching regulator is reduced as well, because it comprises a much simpler and smaller integrated circuit (IC). This of course results in a better efficiency over a wider load range, although it may still not be good enough at the lowest load range at currents below 1mA. Another disadvantage is that because the switching frequency is not constant, EMC is less predictable and may require higher efforts in the application. Consequently, this solution is unpopular in many automotive applications.

Hysteretic Control

Another possible solution would be the hysteretic control scheme. Like the PFM, the switching frequency is not constant at light loads and will reduce when the load reduces. Basically, it results in similar efficiency advantages at low load.

Also, the switching frequency at higher loads depends very much on the variation of components' parameters and operational conditions. Input voltage, load current, inductor value, output capacitor and especially its equivalent series resistor (ESR) can all have a huge impact on the switching frequency.

Additionally, most of these values depend on temperature. Of course, all of these factors combined may result in an even less predictable switching frequency and thus EMC behavior.

Burst Mode

A pure burst mode switching regulator is another very simple control scheme which usually has a fixed duty cycle. This means the switching frequency is constant and the overall achievable efficiency over a wide load range is good.

The operational condition of a switching regulator needs to be set so that at maximum load and minimum input voltage, the device is still performing as required. The resulting waveforms at the switch node look, over the whole operational range, like an amplitude-modulated signal with 100% modulation.

The "modulation frequency" depends on input voltage and load current and can result in low frequency noise. This may create harmonics and errors in analog systems such as analog to digital converters.

So, even with a fixed switching frequency, the EMC and analog performance are less predictable and therefore make this concept less usable.

What architecture to chose?

We have established that none of the switching solutions discussed above would be the first choice to improve the efficiency over a widest possible load range. The best solution seems to be a combination of those techniques, to give the best performance over a wide load range. This could produce a device that combines: Burst mode to achieve high efficiency at light load; Reduced bias current when not switching to further improve efficiency at light load; PWM mode for best EMC behavior at normal load; Synchronizable and adjustable switching frequency for more design flexibility. The Solution: LM26001.

The LM26001 is a monolithic switching regulator that combines all the above requirements into one single device. It has been designed for the high efficiency requirements of applications with low power stand-by modes and is able to deliver up to 1.5A continuous output current. The low-current sleep mode, with a quiescent current of typically less than 40uA, maintains high efficiency even under light load conditions.

It uses a current-mode PWM control scheme for accurate regulation over a wide input voltage range. The part has a wide input voltage range of 4.0V to 38V and can operate with input voltages as low as 3V during line transients. The operating switching frequency can be adjusted from 150 kHz to 500 kHz with a single resistor and can be synchro-nized to an external clock.

The synchronization could be especially important in systems where the switching frequency needs to be tuned

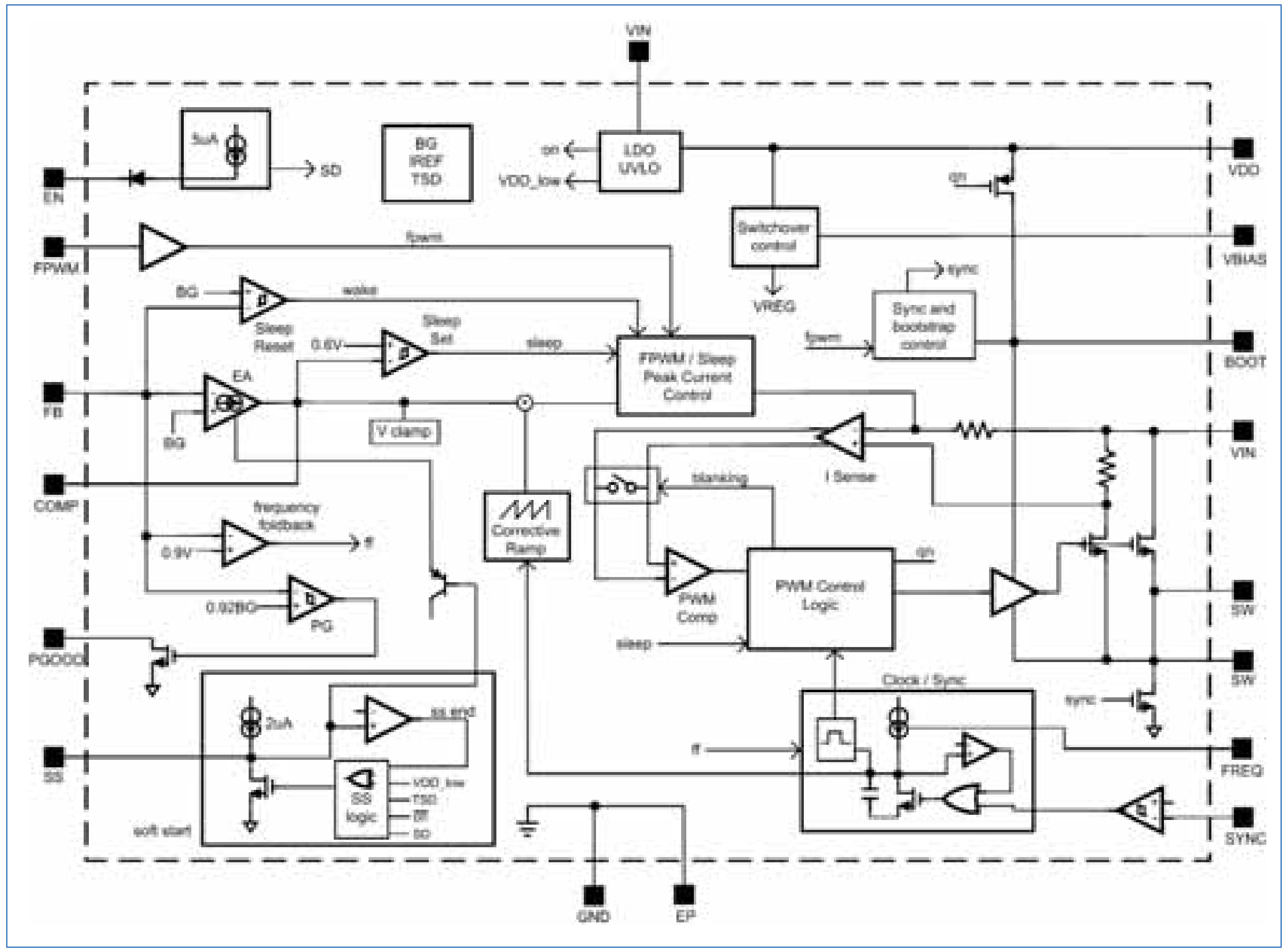


Figure 1. Internal block diagram, shows all of the typical elements of the LM26001.

out of the currently used radio band. Alternatively, it may be used just to lower the stress on the input capacitors in cases when multiple switching regulators are in use in parallel.

Figure 1, the internal block diagram of the LM26001, shows all of the typical elements of a current mode PWM switching regulator. Some additional blocks can be identified, that are related to the low Iq features as mentioned above. Those blocks are: “Sleep Reset”, “Sleep Set”, “FPWM/Sleep Control” and “Switchover control”

Sleep mode

The sleep mode is basically a combination of a burst phase (device is switching) and a low quiescent current phase (device is not switching). The device is capable of automatically switching between sleep mode and normal operating mode and vice versa. In light load conditions, the voltage at the feedback-pin (FB) increases and the voltage at the compensation pin (COMP) decreases. When the COMP voltage reaches the 0.6V clamp threshold, and the FB voltage rises 1% above nominal, sleep mode is enabled and switching stops (block “Sleep Set”).

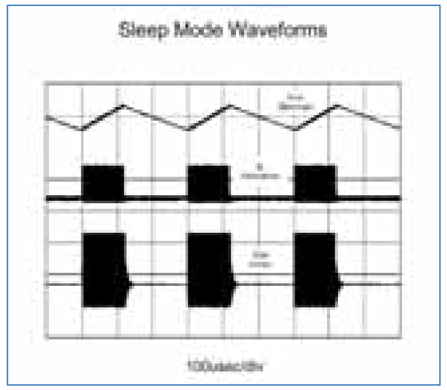


Figure 2. Typical switching and output voltage waveforms in sleep mode.

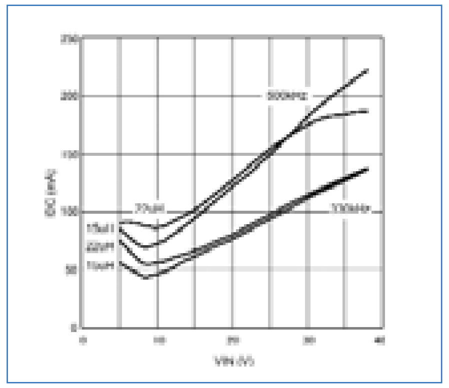


Figure 3. The dependencies over these parameters for sleep mode and normal mode.

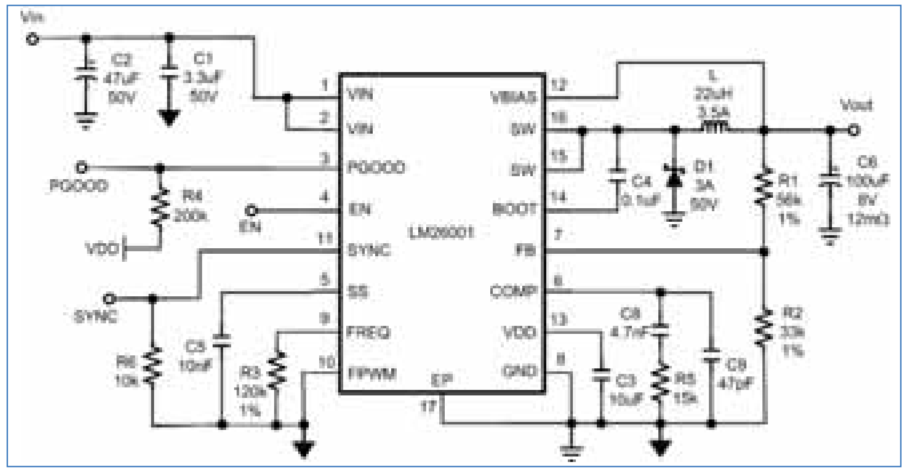


Figure 4. Typical application circuit with the few required external components.

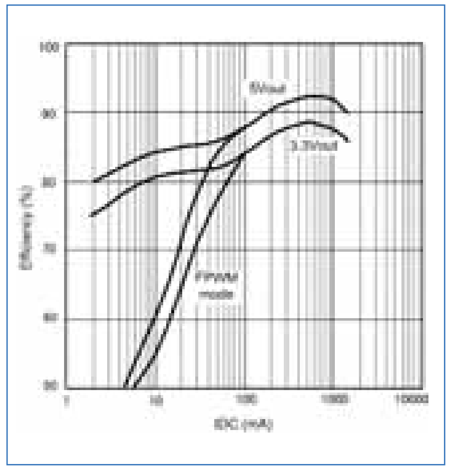


Figure 5. The resulting efficiency measurement shows a significant improvement in the efficiency for currents below 50mA load.

The regulator remains in sleep mode until the FB voltage falls to the reset threshold (block “Sleep Reset”), at which point the device resumes switching. All signals are monitored in the block “PFWM / Sleep Control”. This 1% FB window limits the corresponding output ripple to approximately 1% of nominal output voltage.

The sleep cycle will repeat until load current is increased. Figure 2 shows typical switching and output voltage waveforms in sleep mode. Any possible circuit element in the device will be turned off in sleep mode to reduce the quiescent current to 40uA.

Because the load current is not measured directly, but indirectly via the COMP voltage, the threshold where the device switches between sleep mode and normal mode varies with switching frequency, inductance, and duty cycle. Figure 3 shows the dependencies over these parameters.

Nevertheless, the minimum possible load while still operating in PWM mode is much lower. To take advantage of better EMC behavior (PWM over burst) for lower output currents, the device comprises a forced-PWM (FPWM) input pin. This allows, for example, a microcontroller to force the LM26001 to operate in PWM mode.

This is dependent on cost efficiencies, but under some circumstances (e.g. when the radio is operating) this is a better choice. Also, if a system is about to be fully operational, it’s a good choice to force the device into PWM mode, because it gives much better load transient performance. If the device is forced into PWM mode and the load is falling to a very low value, it will enter the sleep mode to ensure there is no over voltage at the output.

Reduced Bias Current

As mentioned above, all blocks not needed in sleep mode, will be turned off entirely to reduce the current consumption. Furthermore, the block called “Switchover Control” will take care of some operational current if the VBIAS pin is connected to the output voltage (e.g. 3.3V or 5V). This allows the device to mainly operate from the lower voltage, giving some additional efficiency advantages.

Real World Results

Figure 4 shows a typical application circuit with the few required external components. That implementation is also used on the evaluation board of the LM26001. It operates at 300 kHz, supports an input voltage range of 4-38V and delivers 3.3V output voltage with up to 1.5A output current. The TSSOP package of the LM26001 has 16 pins with a so-called ‘exposed pad’. This exposed pad, underneath the body of the package, results in excellent thermal performance of 38K/W in a package size of just 5mm x 6.4 mm.

The resulting efficiency measurement can be seen in Figure 5 which shows a significant improvement in the efficiency for currents below 50mA load. At 2mA, for example, it is still at 80% efficiency (5Vout); more than 30% higher than in the FPWM mode.

Switching regulators that have to operate efficiently over a wide load range are a new reality in the automotive environment. The LM26001 meets this challenge and sets a new benchmark, consuming less than 40uA of supply current when operated at light load.

A combination of switched internal bias supplies, different switching modes, each used where their advantages count most; clean switches between the modes, and an extremely wide load current range, all contribute to reducing the current drawn from the supply and widen the electronics design flexibility. The LM26001 is another step towards a new world of intelligent power solutions.

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Part II

thinQ! 2G–Second Generation Silicon Carbide Schottky Diodes

The solution for a broad range of power supplies

The power factor correction (PFC) market is highly driven by worldwide regulations related to the reduction of harmonic distortion. Along with EN61000-3-2 in Europe, which is one of the basic regulations for the ac-dc power supply market, similar standards exist for UK, Japan and China.

By Michael Hallenberger, Technical Marketing Engineer and Ms. Kerstin Hubel, Product Marketing, Power Management & Supply, Infineon Technologies AG

EN61000-3-2 set the harmonic standard for any off-line application with power consumption over 75W. As no regulations exist in North America that mandate PFC, energy savings and space-price considerations are additional drivers that force the use of PFC in the consumer, computer and communication segments.

Active PFC appears in two common modes: DCM (discontinuous current mode) and CCM (continuous current mode) using triangular and trapezable current waveforms. The DCM mode is typically used for applications with an output power of 75W – 300W; CCM mode is used for applications with an output power >300W. At >250W, PFC is cost-effective as it adds no real extra cost due to the savings trade-offs in other areas, like e.g. efficiency.

Active PFC is a requirement for Server System Infrastructure (SSI) compliance: "The power supply modules shall incorporate universal power input with active power factor correction, which shall reduce the harmonics in accordance with the EN61000-3-2 and JEIDA MITI standards". This need to offer wide range input voltage (85V – 265V) in high power density applications results in specific requirements for the semiconductors used in the PFC stage.

At 85V AC input voltage lowest R_{dson} is a must as the conduction losses scale inversely with a power law of 3 as a function of input voltage. High frequency operation of this MOSFET allows significant reduction of the boost choke. Therefore fast switching capability of the transistor is a must. The boost diode should be characterized by fast switching, low Vf and low Q_{rr}. Low Q_{rr} is a must to reduce the peak current stress for the MOSFET at turn-on. Without this feature, the boost MOSFET increases in temperature and R_{dson} which leads to higher power losses and thus reduced efficiency. Efficiency is a key factor to achieve smaller form factor (~30W/cm3inch) in high power density application, as well as the reduction of the size of passive components. Therefore high switching frequency is essential.

To design a CCM PFC stage optimized in efficiency and form factor, boost diodes have to have additionally the following characteristics: reduced reverse and reduced forward recovery, minimized stored charge Q, low leakage current and lowest switching losses. Over voltage and surge current capability are essential features which allow the handling of start up and AC-drop-out inrush and over currents in the PFC. These characteristics can only be achieved with silicon carbide Schottky diodes (SiC Schottky diodes).

Due to the absence of forward and reverse recovery charge in SiC Schottky diodes, a smaller boost MOSFET can be used which implies, besides cost reduction, a reduction in device temperature and thus higher reliability of the SMPS.

As the switching behavior of the SiC Schotty diodes is independent on forward current (I_{load}), switching speed (di/dt) and temperature these diodes are easy to design-in. The design-in of SiC Schottky diodes enables the use of

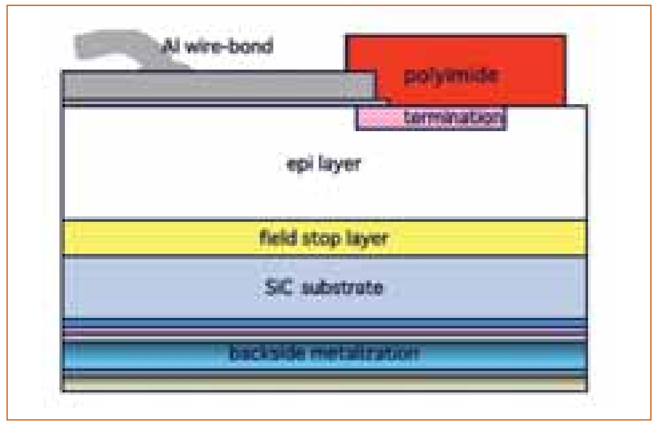

Figure 1a. Schematic cross section of a conventional SiC Schottky diode.

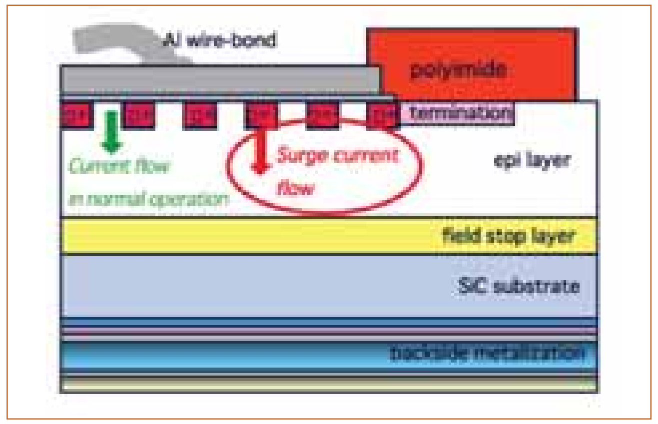

Figure 1b. thinQ! 2G SiC diode with merged p-doped islands.

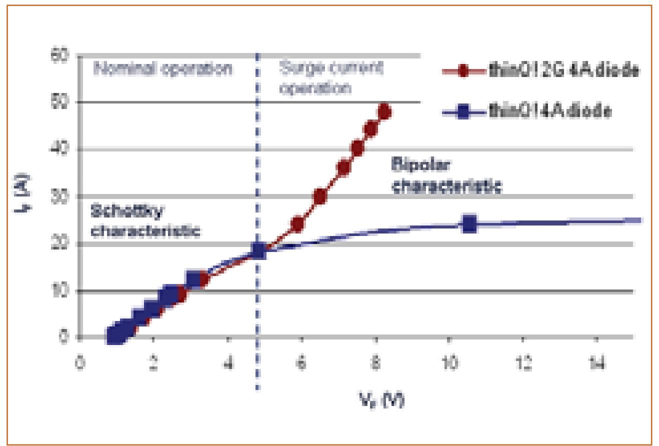

Figure 2. Surge Current Comparison SiC Schottky diode and thinQ! 2G.

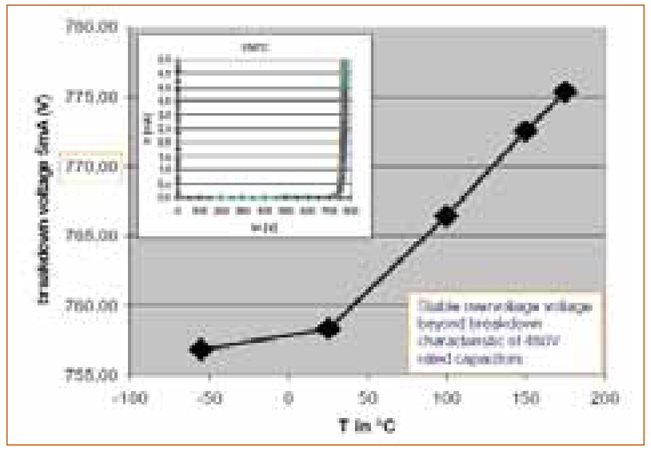

Figure 3. Stable overvoltage characteristic of thinQ! 2G.

smaller passive components due to highest switching frequency operation (up to 1 MHz).

Lowest switching losses and low Vf enable the use of a smaller heatsink or fan. Additionally, SiC Schottky diodes are easy to parallelize, thanks to the positive temperature coefficient.

thinQ! 2G–the next step towards the ideal high voltage diode

The new generation of IFX SiC Schottky Diodes (thinQ! 2G) merges the common SiC Schotty diode with a bipolar pn-structure, thus allowing very high surge current capability and stable overvoltage characteristic.

Figure 1 shows the structure of a SiC Schottky diode in comparison with the merged pn-Schottky diode concept. The p-areas have been optimized with respect to emitter efficiency and conductivity, so that they can serve as a kind of surge current bypass in the case of forward voltage exceeding ~ 4V.

The improved surge current capability

thinQ! 2G offers an improved surge current capability which allows designs for average current conditions within an application, i.e. most start up and AC-drop-out inrush and over currents can easily be handled. Fig. 2 shows that under regular operation thinQ! 2G behaves like a normal Schottky diode with zero reverse recovery charge and that at high current conditions the forward characteristic follows that of a bipolar pn-diode with significantly reduced power losses.

Thanks to the improved surge current capability, the design-in of lower current rated diodes in a given application is possible. So far, the surge current rating of a diode was an important design-in criterion. The already good surge current rating for a 6A diode I_{FSM} = 21A@10ms thinQ! was significantly enhanced to I_{FSM} 49A@10ms thinQ! 2G.

Measurement conducted in a real application (6A IFX 1st generation SiC Schottky diode, PFC, wide range) shows the improvement: the 6A 1st generation SiC Schottky diode was right good enough to handle the inrush current in the start up time and increased the junction temperature to 50°C. This is close to a thermal runaway due to the Schottky characteristic as shown in Figure 2. Under normal conditions a smaller diode would be possible.

Design in of the new 4A thinQ! 2G handles the start up condition in the same application much better. The temperature rises only to 35°C. Due to the bipolar characteristic, there is no thermal runaway up to the max junction temperature. thinQ! 2G is designed to the normal condition with enough reserves to handle abnormal condition.

The stable overvoltage characteristic

Besides the improvement of the surge current capability, the merged pn-Schottky concept, thinQ! 2G can withstand substantial avalanche current breakdown conditions. This is not possible with any other SiC Schottky diode on the market. This is enabled by the low resistivity and the design of the p-islands in the merged Schottky structure, which guarantees an onset of the avalanche before the electric field at the Schottky interface reaches a destructive value (Figure 3).

The stable avalanche and overvoltage behavior of thinQ! 2G due to the positive temperature coefficient, allow that applications like PFC stages in telecom and servern which are directly connected to the mains achieve a higher reliability, immunity and ruggedness against transient pulses and overvoltages.

During transient conditions in a PFC Stage the overvoltage will be zenered by the bulk capacitor around 500-550V (for a commonly 450V bulk capacitor). In case of such stress conditions the thinQ! 2G is far away from a critical overvoltage behavior. This improved overvoltage and surge current capability results in less stress at the diode and higher reliability for the application.

SiC Schottky Diodes – the solution for a broad range of power supplies

The unique features of Silicon Carbide as a device material allow producing boost diodes with nearly ideal performance characteristics suitable for all power ranges in PFC applications. No reverse recovery charge and independency of the reverse characteristics from switching speed, temperature and forward current reduce the power losses in PFC applications. This is vital for applications like Server and high-end PC power supplies as the need for gain in efficiency becomes more and more important, especially through legal requirements like 80plus.

thinQ! 2G adds to these valued features unique over-current and over voltage capabilities. The surge current capability helps to design the current rating for steady state operations and therefore offers cost advantages as lower current rated diodes can be designed-in. The over voltage characteristic is important in harsh environments such as Telecom and wireless infrastructure applications. Here, ruggedness against overvoltage spikes and abnormal line conditions and thus improved reliability is a must.

The gain in efficiency which can be achieved by the use of SiC diodes offering lowest switching losses is furthermore versatile in systems like UPS and Solar Inverters where every reduction in losses is directly paid back.

Looking at the ever increasing efficiency targets we expect that the entry point for Silicon Carbide Diodes will move to lower power levels. Applications with the need for higher ambient temperatures, higher device temperatures and improved reliability can be addressed with thinQ! 2G.

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FEA Study on Gate to Source Leakage Current

Epoxy mold compound (EMC) characteristics are important

Development of new electronic packages has focused on low cost, small size, high performance and high reliability. A lot of effort has been made to achieve these requirements by finite element analysis (FEA).

By Lunwen He, Shaohui Pan, LK.Wang, David Wei. Zhang; Microelectronic Institute of Fudan University, Shanghai, China and by SS.Tey, Tiger Wu, Lisa Shao; Fairchild Semiconductor (Suzhou) Corp, Suzhou, China

The test of Igss leakage current is very important for power device package after assembly. High Igss can result in tremendous power consumption loss and device's life-time descending. The Igss leakage is measured when a voltage is applied to the Gate of a MOSFET device with respect to the Drain and Source of the device which are shorted together. Due to input capacitance however, large chip size MOSFET may prove difficult to measure with automatic test equipment, some testers require a larger test time to charge the gate capacitance prior to test . Most of power device uses the DMOS structure (Figure 2). The capacitances of Cgs and Cgd can all influence the test precision, especially when the Igss value is in the range of tens of nano Ampere.

Considering the package level that influences the Igss test value, wire sweep, lead frame defect and the EMC (epoxy mold compound) characteristics are highly important. At the most basic level, plastic EMC contains five classes of raw materials: Organic resins (such as epoxy resin), Fillers, Catalysts, mold release material and pigment or colorant. Other materials, such as flame retardants, adhesion promoters, ion traps and stress relievers are added to the mold compound as appropriate. So the EMC is a balanced system to the device performance. Change in any one formulation property will result in Igss value and requires a compensatory shift elsewhere in the formulation. The moisture is the main cause of different kinds of failures, such as mechanical, electrical and so on. But the gate bus which relates to both chip fabrication and assembly has attracted little attention.

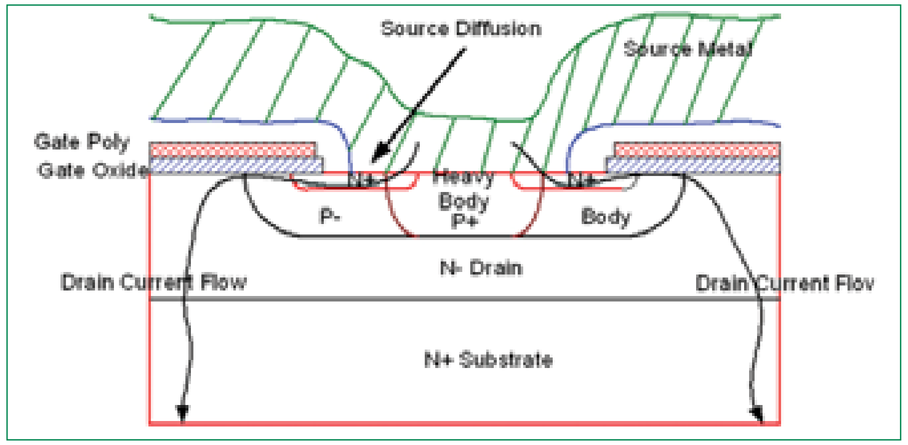

Figure 1. DMOS structure.

A non-linear finite element platform is built on the basis of JEDEC TO220 package, the chip is simply composed of pad and isolation layer. Four package level factors of the Igss high are performed: 1. EMC resistivity; 2. Wire sweep; 3. Lead frame defect; 4.The interface between EMC and chip.

FEA (finite element analysis) results and discussion

In the platform, the load is based on the real test conditions: Vg=28V, Vs=Vd=0V. Figure. 2a/2b shows the electric potential distribution of external and internal package. Gate lead current density is used to characterize the Igss value.

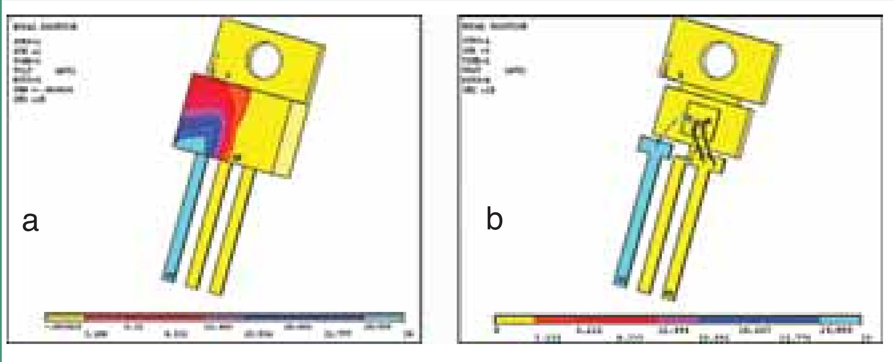

Figure 2a. Potential distribution of external package.
Figure 2b. Potential distribution of internal package.

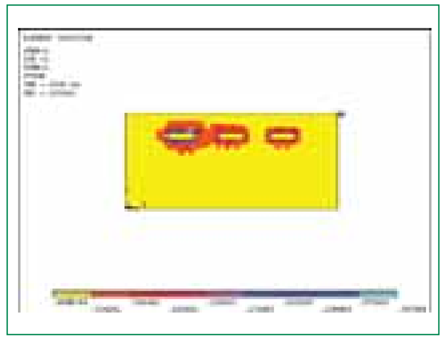

Figure 3. Gate and drain lead.

EMC (epoxy mold compound) resistivity

The EMC resistivity is of course the first factor of Igss high. FIG.5 shows us the gate lead current density increase with the EMC resistivity changing from 1.00E15Ω·mm to 1.00E10Ω·mm. We see that the current density changes linearly with EMC resistivity, and when the EMC resistivity decreases to 1.00E10Ω·mm, the Igss is about 200nA. Actually, the normal resistivity of EMC is always at 1.00E15Ω·mm, and the corresponding Igss value is about 0.02nA.

Wire sweep

Wire sweep is another factor. We compare the current density of non-wire sweep and wire sweep. The EMC resistivity is kept at 1.00E15ø·mm. The difference is so little that wire sweep can hardly cause Igss high. During the simulation, we find that the current density always concentrate at the two areas in EMC, just as Figure 3 and Figure 4 shows. One is the area between the gate and drain lead in external area, the other is interface between EMC and chip in internal area.

Lead frame defect

Based on the above analysis, the lead frame defect between the gate and drain lead is an important factor for Igss high. The most common defect is that the distance between the gate and drain lead is shortened. In the simulation results, if the gate and drain lead distance of defected lead frame is half of the good one, the changed current density is very little, as well as wire sweep. This can give us a good understanding that main leakage current path is located at interface between EMC and chip in internal area.

The interface between EMC and chip

The interface between EMC and chip is a very complicated system. EMC can form both physical and chemical bonds to the surface of the chip. Among these kinds of parameters, moisture and the gate bus between gate and source pad of the chip, which has the function of electrical isolation, are the most important ones. Moisture can cause catastrophic failure during "thermal shock". During the final test, the chip always can be heated up to 30-40 degree more than the room temperature in 100ms. Because of CTE mismatch of chip, moisture and EMC, the thermo-mechanical stress caused at interface can lead to crack the passivation layer of the chip (Figure5), and finally Igss increase. Besides chip crack, moisture can also result in the electrochemical corrosion at the interface, which will further reduce the resistivity at the corresponding area.

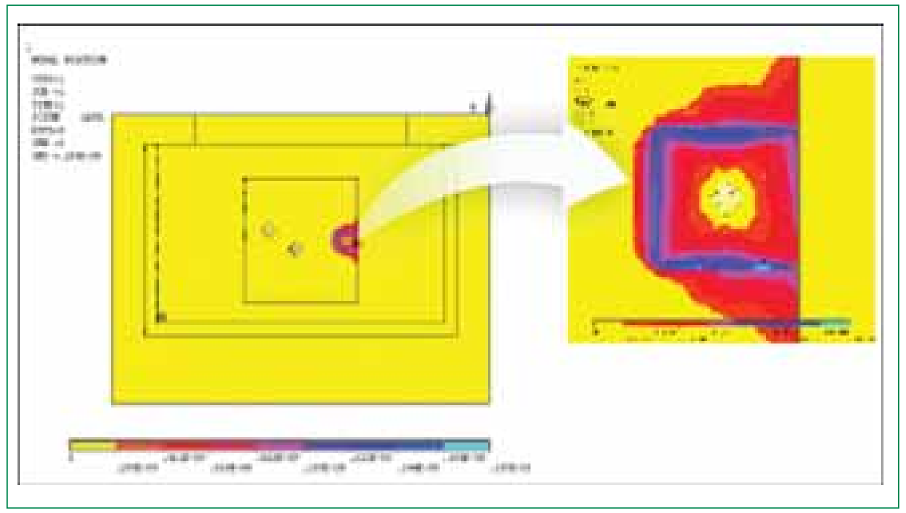

Figure 4. Interface between EMC and chip in internal area at external area.

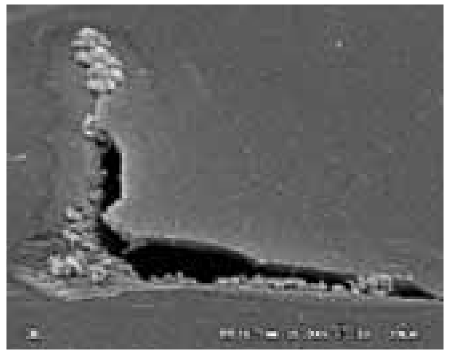

Figure 5. Passivation crack after KOH etching in Igss high sample.

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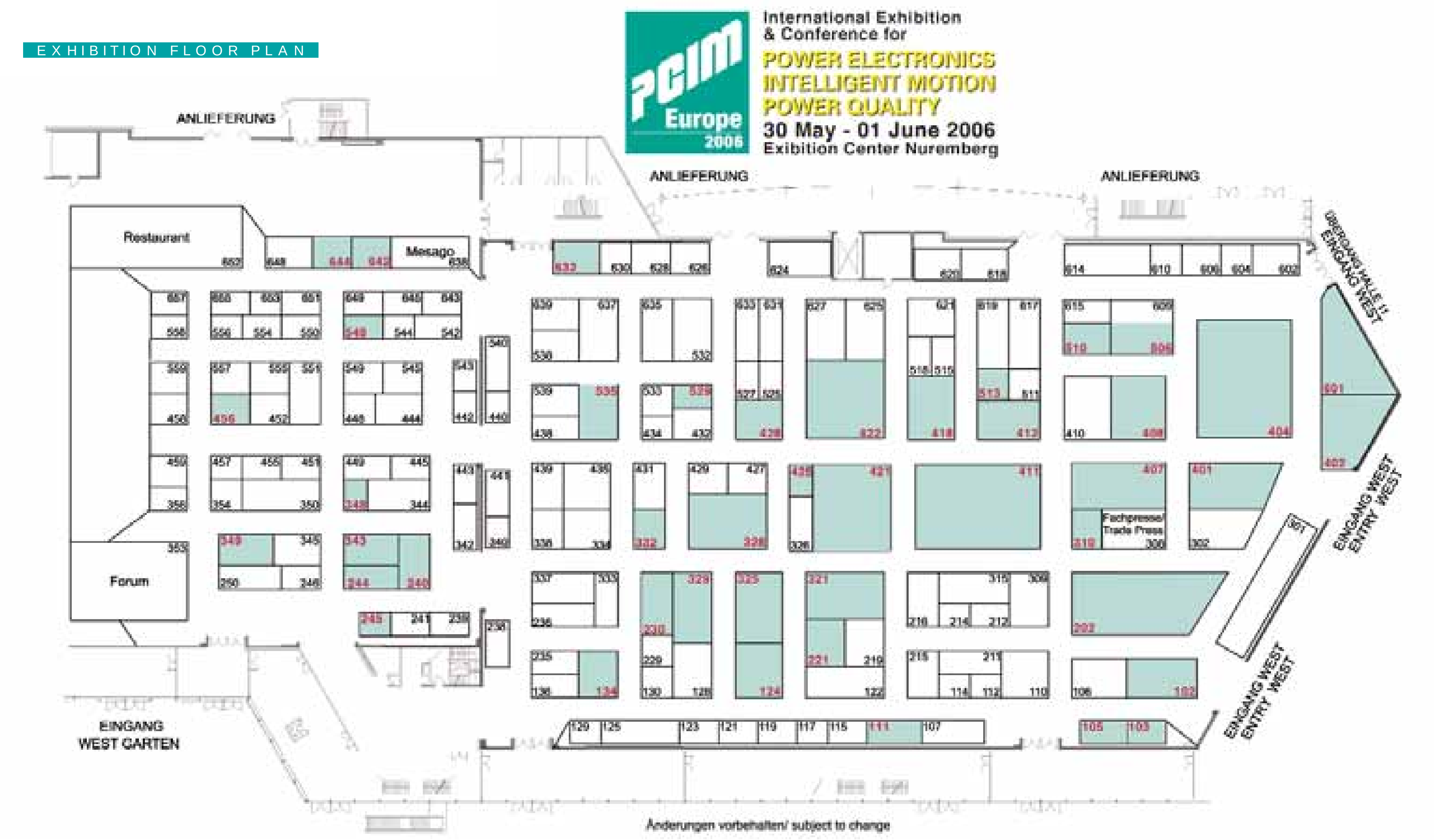

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EXHIBITION FLOOR PLAN

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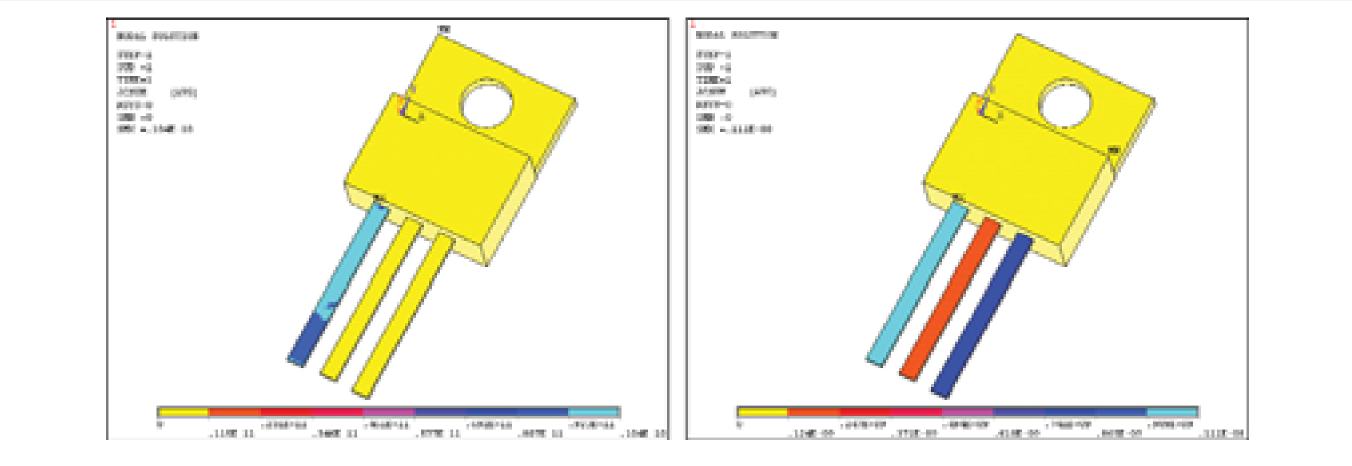

Figure 6a. Normal VS Contamination current density; 9.39E-12A/mm2 (normal)
Figure 6b. Normal VS Contamination current density; 1.04E-9A/mm2 (Contamination at gate connection)

The gate bus dimension is at micrometer scale, and any contamination that has higher conductance at this point can lead to electric connection between gate and source. Especially when the bus dimension decreases, the micro-contaminations in EMC or produced in process can easily lead this bus to conduct crossly. This course is related to both fab process and assembly process. But it's very difficult to detect it without destroying it, for any decapsulation (chemical-decap, fire-decap, mechanical-decap and EMC-polish) disposition can also influence the interface of EMC and chip. We have mentioned before that the EMC, which contains five classes of raw materials, is a balanced system to the device performance. Changes in any one formulation property resulting from material changes and process changes can all have an effect on the final test results. The contamination caused by the EMC at the gate connection of the chip should not be ignored. The platform is further performed on this factor, and the result indicates that contamination is an important factor for Igss high.

The FEA simulation results can provide us directions to find the root cause and to get it solved. The analysis results show that:

EMC resistivity have a great influence on the Igss, and Igss value changes linearly with the changes of EMC resistivity. From the simulation result, the wire sweep and lead frame defect play minor roles in the study, and it's believed that the leakage current path is mainly located at interface between EMC and chip in internal area.

The interface between EMC and chip is such a complicated system, which relates to both chip fabrication and assembly process, that it is not deeply understood yet. The moisture and the gate connection between gate and source pad are the two most important parameters. Moisture can cause both passivation layer crack during "thermal shock" in the test and corrosion in the package, all of which can lead to Igss high finally. Any contamination with higher conductance at gate bus can cause electric connection between gate and source and Igss high, the source of contamination can be from the packaging process and materials.

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Lifts Away!

Reliability is a must

Power electronic systems are used in day-to-day applications. The sophisticated technology behind the scenes, however, goes unnoticed. Take elevators in office buildings or escalators in department stores for instance; the only time the systems that run these elevators or escalators are noticed is when they fail to work properly, say if an escalator comes to a standstill or if people get trapped in a stalled elevator.

By Melanie Gill, Product Manager SKiiP Subsystems, Semikron

Besides causing inconvenience to customers, system failure of this kind also results in repair and servicing costs. Not to mention the damage to your corporate image that system failure causes. Many elevator manufacturers provide their customers with a reliability guarantee on their products of over 99%. After all, reliability is what makes things work.

Quality

Before a new elevator model is put onto the market, it often undergoes as many as a million test runs. As a product quality guarantee, the product undergoes extensive testing in the product development centres. Given the tough competition on the market, the main quality criterion here is reliability. It goes without saying that in the event of elevator malfunction, defective parts have to be replaced and the elevator put back into operation promptly.

This is where SKiiP power electronics subsystems with SKiiP technology from SEMIKRON step in, which were specially developed to meet these very demands. For behind the frequency converter that controls the speed of the elevator motor are power semiconductors.

SKiiP technology was optimized to provide high load capability. Power electronic systems in elevators are exposed to different loads and consequently many load cycles, such as soft start and brake, regardless of weight and number of elevator passengers.

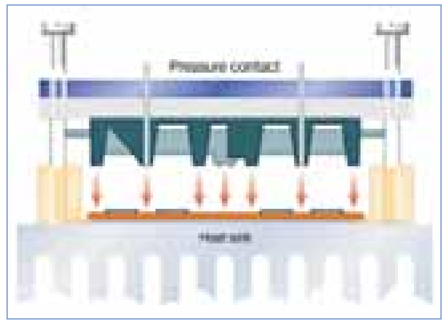

Figure 1. SKiiP technology.

SKiiP technology is a patented pressure contact technology that results in low thermal resistance and superior load cycle capability. Due to power dissipation during switching the power semiconductors briefly heat up very strongly. This load change results in high thermal stress to the chips and the bonding. In modules with baseplates this can cause thermal stress effects, especially on the solder layer between the ceramic substrate and the baseplate. The result is material fatigue, which will ultimately end in system failure. Therefore, to prevent failure in your power electronics system—in this case, a stalled elevator—it is imperative to opt for a power electronics system with high load cycle capability.

Technology

SKiiP (Semikron intelligent integrated Power) power electronics subsystems provide the necessary high load resistance. A SKiiP subsystem comprises three perfectly matched components: IGBT halfbridges, driver and heat sink. The patented SKiiP technology used for the halfbridges, i.e. using mechanical pressure via the pressure plate and the bridge element, results in homogenous pressure distribution and consequently produces a thermal connection between the ceramic substrates carrying the semiconductor chips and the heat sink. The non-use of a solder layer and baseplate results in a module with lower thermal resistance. Due to the fact that the "failure factor"—i.e. the solder layer between ceramic substrate and baseplate—has been removed from the equation, a module based on SKiiP technology—and hence your drive—will have a longer service life than a baseplate module.

Another advantage is that a thinner layer of thermal paste can be used as it is applied directly onto the heat sink surface. For a given rated current this leads to a lower thermal resistance or lower temperature hub on the semiconductor chip, which increases service life. The benefits for the customer are less downtime and, therefore, lower costs for servicing and replacement parts.

In a same-sized module, the lower thermal resistance or lower chip temperature hub results in higher current density; logically, this also means that for modules with the same current density the module size can be reduced.

Figure 2. Exploded view of the IGBT halfbridge.

Consequently, for reasons of size restrictions, the compactness of the SKiiP subsystem is a much welcomed feature. In fact, the largest standard SKiiP, which has a rated current of 2400 A, measures (including air cooler) as little as 215x360x182?mm. To achieve a higher rated current per module with lower thermal resistance or chip temperature, the IGBTs are placed in parallel. This solution eliminates the problem of hot spots, in doing so allowing for higher current densities.

Integrated current sensors continue to be used to protect the SKiiPs, as are temperature sensors which are positioned directly beside the IGBTs. The integrated driver fulfils all drive, monitoring, and electrical and thermal protection functions. This intelligent driver monitors elements such as undervoltage, overvoltage and temperature and guarantees controlled and safe switch-off in the event of system malfunction.

Expansion possibilities

With SKiiP, the elevator manufacturer can expand his product portfolio in terms of useful load easily, quickly and safely, regardless of whether he wishes to increase or decrease the useful load or add a new load to his portfolio—an important advantage especially in view of reliability demands. In fact, it is as easy as ABC for the customer to select the right SKiiP for product expansion thanks to the fact that SKiiP modules are available in different sizes (2-fold, 3-fold or 4-fold), voltage and current classes and the SKiiPs are connected in parallel. Here, Semikron provides its customers with extensive support, for example with the help of simulation software. The simulation tool Semisel can be found at www.semikron.com. Simply enter the parameters of your application—from basis circuitry to cooling parameters—and decide on the basis of the figures and graphics shown whether the IPM (intelligent power module) you have chosen is suitable for your application. The tool will offer possible configurations from which you can

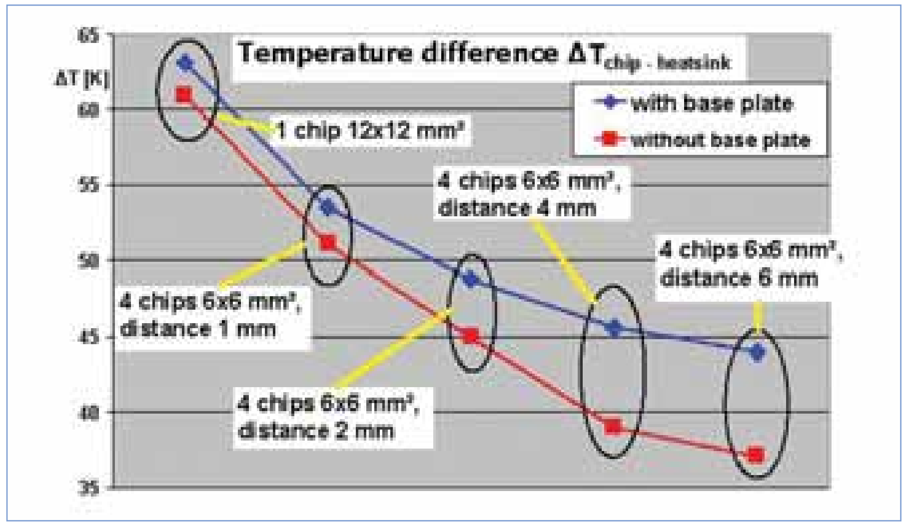

Figure 3. Chip temperature in modules with baseplate and modules based on SKiiP technology as a function of the chip clearance (simulated with 2W/mm² power loss).

Figure 4a. SKiiP3 with 3 IGBT half-bridges, water-cooled.

Figure 4b. SKiiP3 air-cooled.

choose the optimum for your application. The simulation results can also be printed and saved. This modular system means that a customized solution is created to meet your individual requirements.

Focus on core tasks

The elevator manufacturer receives a subsystem that is developed and qualified to meet the requirements of the overall system. Once the IGBT half-bridges and driver have been tested separately, the overall system qualification is carried out. All of the components used in SKiiP subsystems are perfectly matched—driver, module and cooling elements. With modules bought separately and used in combination with customers' own drivers or drivers from other suppliers, this is not the case. For our customers the use of a SKiiP subsystem means lower costs (development engineers of power electronic systems, development and test equipment), and no time wasted on in-house developments. This ultimately means that developers can concentrate on their core tasks, i.e. the development of drive systems. The SKiiP subsystem has the added advantage that all of its components have been tested 100% at Semikron.

Reliability

More than 15 000 SKiiPs used every day in elevators produced by the biggest names in elevator manufacturing prove time and again that—thanks to their high load cycle capability—SKiiP subsystems are the optimum solution for the broad range of requirements and loads in this area. As for the future, the construction of elevators with no machinery room will mean that, besides reliability demands, space requirements for elevator drives (incl. power electronics components) will become increasingly important. Here, SKiiP is one step ahead, skilfully fulfilling the future space requirements in this field.

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Designing Energy-Efficient Power Supplies

Peak power applications are the challenge

Products such as inkjet printers, data storage devices, audio amplifiers and DC motor drives require power supplies that can deliver up to threefold peak-to-continuous load ratios and provide high efficiency in no-load and standby modes.

By Stefan Baeurle, Power Integrations

A class of highly integrated power conversion ICs—built upon intelligent peak-power management technology—now exist, enabling original equipment manufacturers (OEMs) to quickly and cost-effectively design energy-efficient power supplies for peak-power applications.

This article discusses the challenges associated with energy-efficient power supply design for peak-power applications—including the need to reduce system-level component count to manage product costs. It looks at how the new class of power conversion ICs with peak-power management technology addresses these challenges. Finally, it offers a detailed circuit example showing how the ICs are used in power supply design to help address application performance requirements, meet worldwide energy-efficiency regulations, and manage overall design costs.

The PeakSwitch Family

The PeakSwitch IC family is specifically designed for applications with high peak-to-continuous power requirements (up to 3X). It incorporates a 700 V Power-MOSFET, an oscillator with frequency jittering for low EMI, a high-voltage switched current source for startup and a current limit onto a monolithic device. In addition a variety of protection features including auto-restart, line under-voltage sense and hysteretic thermal shutdown have been added. Figure 1 depicts a typical peak power application employing PeakSwitch.

The simple On/Off control scheme with four discrete current limit levels offers various advantages over traditional PWM controlled power supplies. These advantages have been proven and become well established since the introduction of the highly successful TinySwitch-II family five years ago. In short On/Off control responds to a feedback signal and enables or disables primary side switching in order to transfer energy appropriate to the load conditions at the output of the power supply. A detailed description of the On/Off operating principles can be found in [2]. Besides the fact that loop compensation is not needed it allows PeakSwitch to operate at very high switching frequencies of up to 277 kHz during peak loads. Since with On/Off control a switching cycle is only initiated when energy transfer is required the effective average switching frequency during lighter load conditions will be much lower. Figure 2 plots the average switching frequency of a 32 W, 81 W peak power supply at five distinct load conditions.

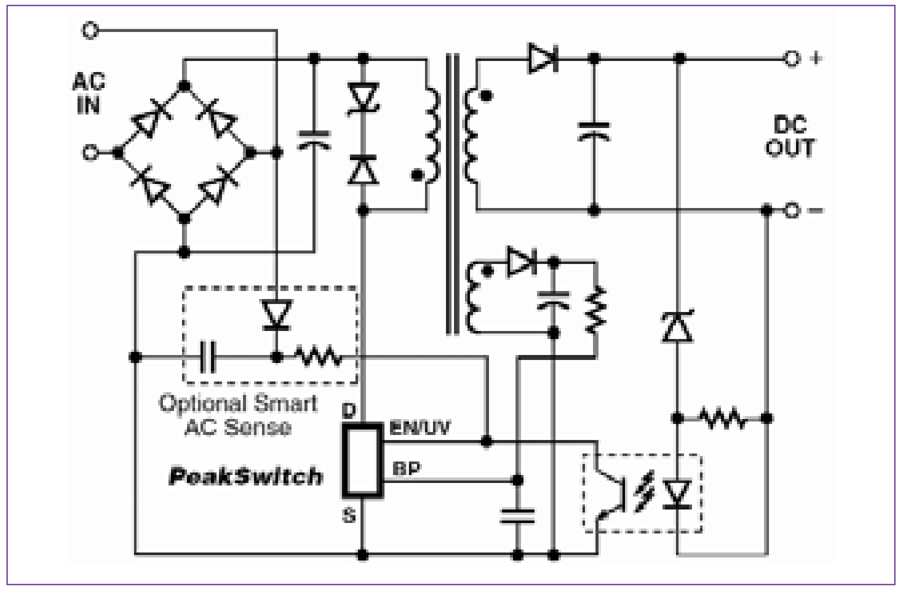

Figure 1. Typical Application Schematic with PeakSwitch.

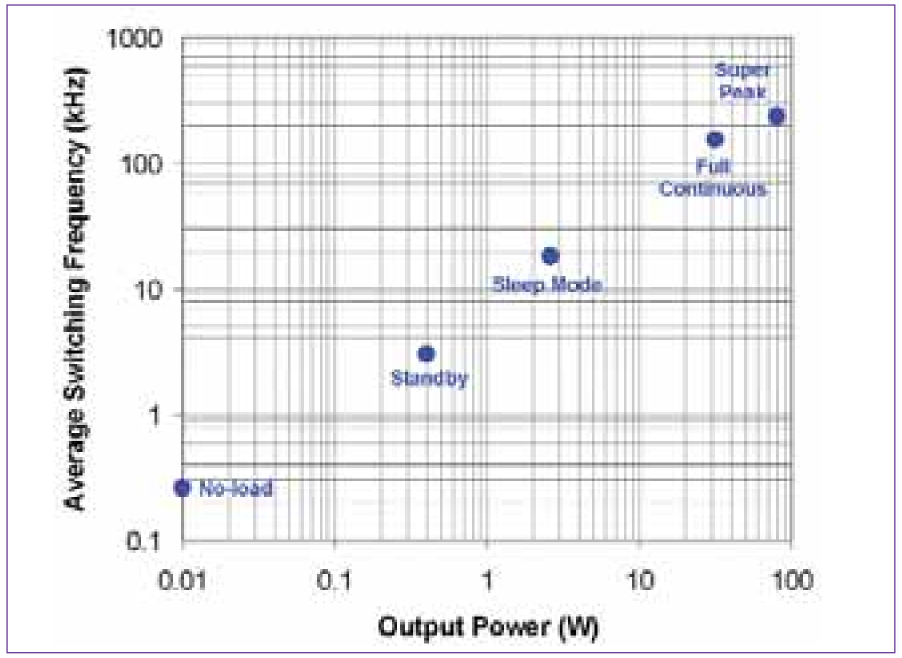

Figure 2. Average Switching Frequency vs. Output Power in a Typical Application.

During super peak power (81 W) the effective switching frequency is very high at 240 kHz. It reduces to 130 kHz at full continuous load (32 W) and further to 18 kHz during a load condition named Sleep Mode (P_{IN}= 3 W). In Standby (P_{IN}=1 W) the frequency is reduced to 3 kHz and with no load attached it drops to only 0.3 kHz. The very high effective frequency under peak load conditions allows the transformer core size to be minimized. With PeakSwitch the core size can therefore be chosen for continuous load conditions to meet the thermal requirements, since the increase of effective switching frequency at peak loads will not increase the core flux density. Traditional PWM controlled power supplies on the other hand typically run at a fixed frequency of only 60-100 kHz over the entire load range up to the maximum peak load. Therefore the transformer core size must be selected for peak load conditions to avoid saturation when the primary current is increased to satisfy the peak load requirement.

A very useful new feature is the integrated programmable smart AC line sensing with fast AC reset. In case regulation is lost, for instance due to an output short circuit, open control loop or brownout the device stops switching after 30 ms. After that period PeakSwitch checks and from there on continuously monitors the status of the AC input voltage via the sense circuit shown in Figure 1 ("Optional Smart AC Sense"). If regulation is lost but the AC input is still apparent a fault is assumed and the device latches off. For resetting the latch the power supply has to be unplugged from the AC inlet and a few seconds later connected again. Once the IC detects this sequence the latch is reset and a restart attempt is initiated when the AC input is restored. This feature provides a low cost latching shutdown fault protection with a fast AC reset with only very few additional components. If regulation is lost and the AC input is not connected or is at unusually low levels switching also ceases but the supply will not be latched off. Once the AC input returns to normal levels switching is resumed.

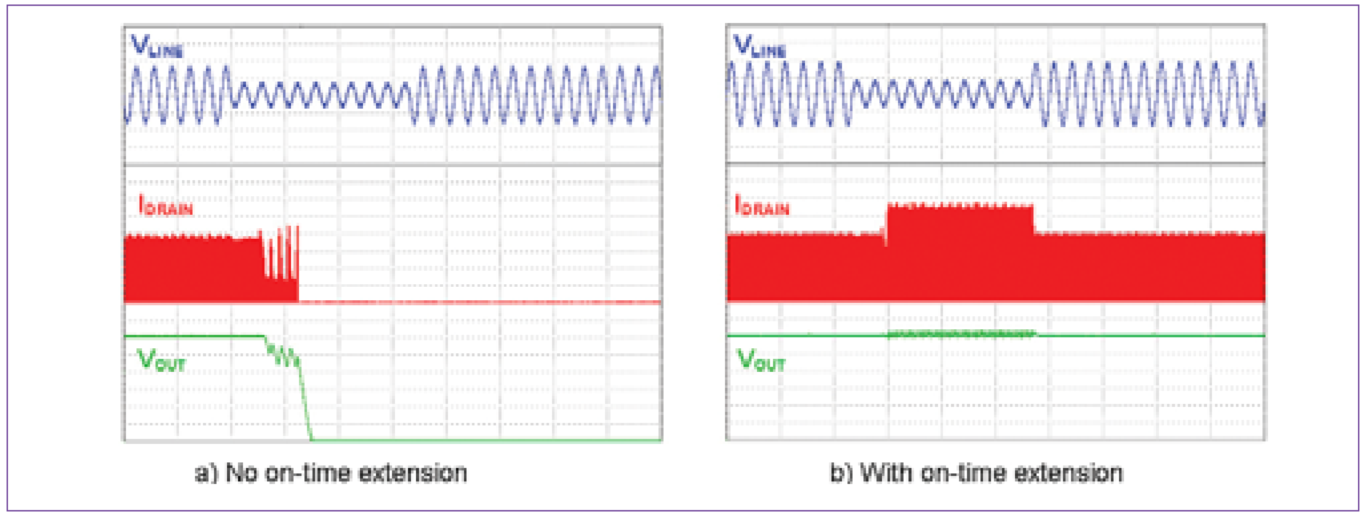

Figure 3. Impact of Adaptive On-time Extension.

POWER SUPPLY

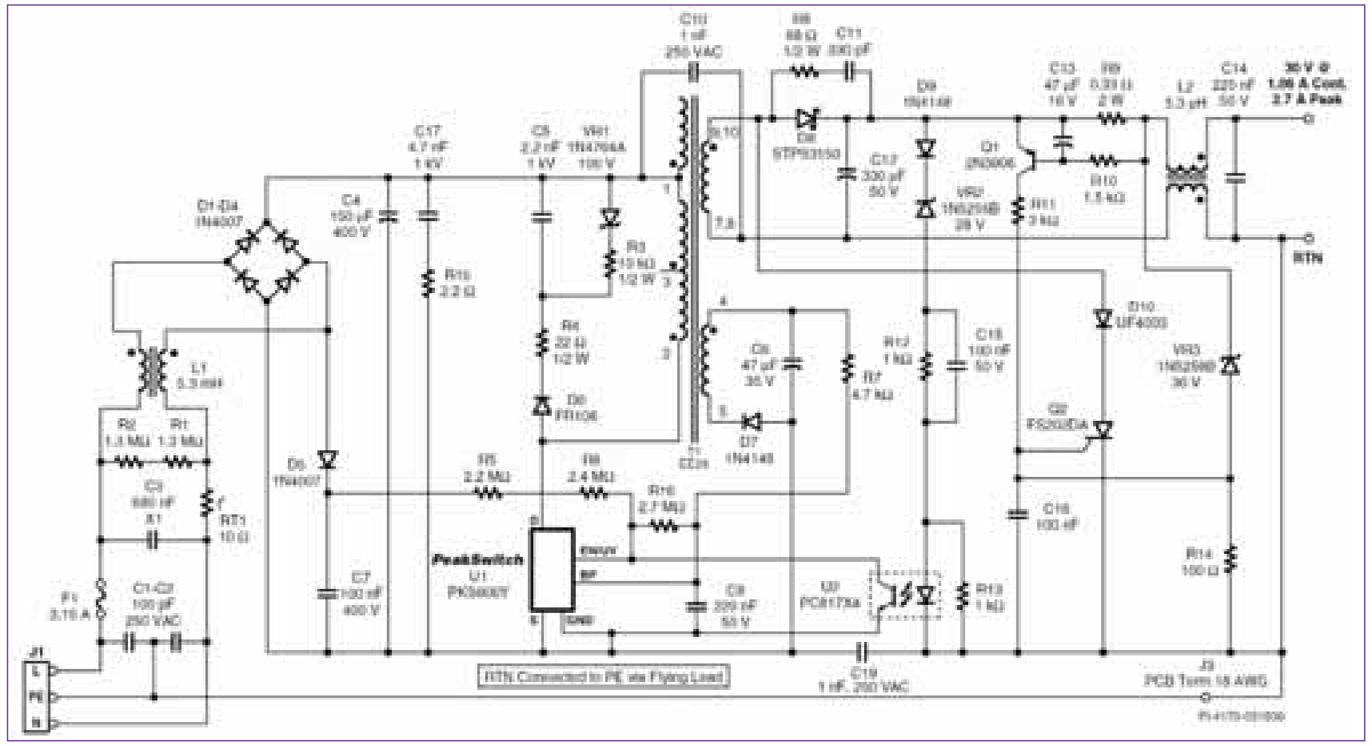

Figure 4. Schematic of 32 W Continuous Power and 81 W Peak Power Design Example with PKS606Y.

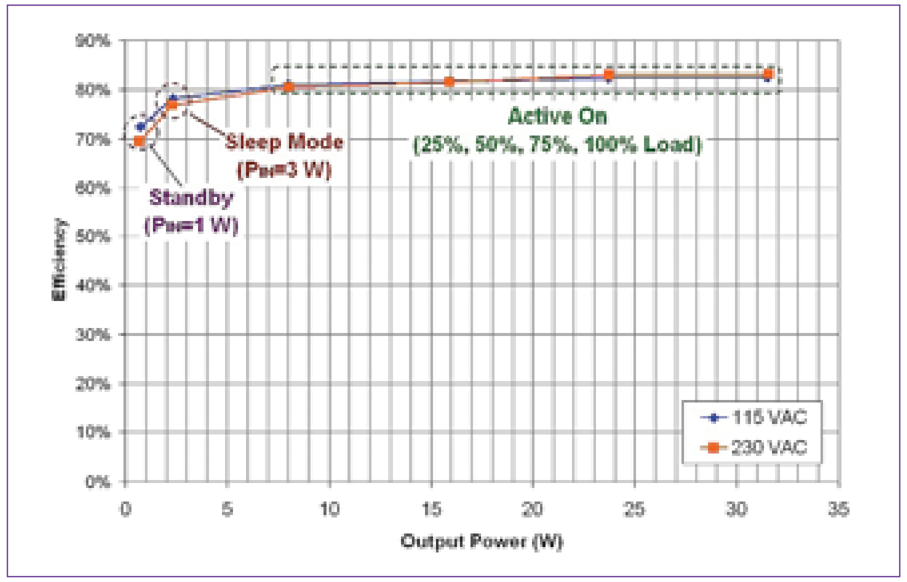

Figure 5. Efficiency vs. Output Power PeakSwitch Design Example.

PeakSwitch also offers various protection features. The tightly toleranced thermal shutdown can protect the entire power supply in case of an thermal overload condition. A large hysteresis provides auto-recovery without the need of having to add a separate reset circuit. The cycle-by-cycle current limit protects the integrated power MOSFET from excessive Drain currents. During highline operation the IC decreases the current limit by 10% in order to compensate for the normal overshoot caused by the current limit propagation delay. The available high line overload power is also therefore reduced.

Another new and very useful feature is the integrated on-time extension function. When PeakSwitch detects abnormally low input voltage conditions it adaptively extends the maximum MOSFET switch on-time (defined by the maximum duty ratio specification in the datasheet). The on-time is extended for as long as it takes the primary current to reach the device current limit. Therefore the energy transferred to the load is significantly increased. This effectively increases the available peak power during very low line conditions. The holdup time with a given bulk capacitor size can be increased which in turn can reduce overall system cost. Figure 3 illustrates on-time extension at work during a standard line sag test as defined by IEC61000-4-11 (120 VAC, 60% dip, 10 cycles at full load). Unlike in the system without this feature the peak Drain current reaches the device current limit even during the abnormal low line condition and thus keeps the output in regulation throughout the ten reduced line cycles. The power supply without this feature (Figure 3a) loses regulation very quickly and the output drops after only a few line cycles.

A full discussion of all features would go beyond the scope of this article but a more detailed description of all integrated functions and features can be found in Datasheet.

Peak Power Design Example

Figure 4 depicts a typical peak power application example using PeakSwitch. It delivers 32 watts of continuous and 81 watts of peak power. Because of the high switching frequency operation described above the design employs a small EE-25 core size for the transformer. Alternative designs using traditional control concepts switch at much lower frequencies and therefore have to use larger and more expensive core sizes such as the EER-28 or larger for instance.

Resistors R5 and R6 set the undervoltage lockout threshold which prevents startup at unsafe line voltages and output glitches during power down or brownout. Diode D5 and C7 provide the smart AC sense and fast reset function as explained previously. The load connected to the power supply is protected in case of an overload fault by the simple current sense circuit formed around transistor Q1 and resistor R9 and the integrated latch function. The low pass filter R10 and C13 add a delay before SCR Q2 is fired. The latch function of PeakSwitch significantly reduces the size and hence cost of the SCR and the output rectifier D8, as overload current only flows for 30 ms before the supply latches off. An open loop fault condition (e.g. defect opto-coupler) is sensed via the zener VR3 which then also fires the SCR Q2 and subsequently the power supply latches until the AC input is disconnected and reintroduced again.

Thanks to On/Off control the design example has an excellent efficiency performance. The efficiency is literally constant across the entire load range (see Figure 5). Table 1 summarizes the power supply performance at prominent load conditions defined by various agencies around the globe.

The active-on efficiency achieved easily meets the minimum value of (0.49 + 0.09 * ln 32) * 100% = 80.2% as specified by the California Energy Commission (CEC) and others. For printer applications the introduction of a new operating condition—the sleep mode—is currently being discussed by Energy Star. In this mode the printer appears to be inactive to the user, however is able to start printing instantaneously with the push of a button. The power consumption in this mode is limited to a target of 3 W yet the printer control circuitry has to be completely energized. The PeakSwitch powered power supply can deliver an industry leading 2.3 watts of output power with only 3 watts of input power. In standby with the input power being limited to 1 W per US Executive Order 13221 the power supply example delivers 0.7 W to the load.

Average Active-on Efficiency					
V_{IN} (VAC)	25% Load	50% Load	75% Load	100% Load	Average
115	81.0%	81.6%	82.3%	82.4%	81.8%
230	80.5%	81.5%	82.9%	83.1%	82.0%
Sleep Mode					
V_{IN} (VAC)	P_O (W)	P_{IN} (W)	Efficiency		
115	2.34	3.00	78.0%		
230	2.30	3.00	76.7%		
Standby Mode					
V_{IN} (VAC)	P_O (W)	P_{IN} (W)	Efficiency		
115	0.72	1.00	72.0%		
230	0.70	1.00	70.0%		
No-Load Input Power					
V_{IN} (VAC)	85	115	230	265	
P_{IN} (W)	0.091	0.102	0.158	0.183	

Table 1. Efficiency Performance Summary.

A detailed description of the design example including schematic, layout, bill of materials, transformer specification and performance details can be found in Engineering Prototype Report.

PeakSwitch addresses the specific needs of peak power applications with a new approach that provides nearly constant efficiency operation over the entire load range. The presented performance exceeds the requirements of all present and proposed energy efficiency regulations around the world. Because of its high frequency operation during peak loads the size of the magnetics is reduced significantly. The integration of a variety of safety feature increases product safety while reducing overall system cost.

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8MHz Buck Regulator Enables Sub-1mm Height Solutions

The next generation slim cell phone designs

The portable electronics market has consistently pushed manufacturers to constantly integrate and miniaturize its solutions to reduce solution footprint. In cell phones, by far the hottest trend currently is the drive for slimmer, thinner designs.

By Ralph Monteiro, Sr., Product Marketing Manager, Portable Products, Micrel, Inc

With the RAZR coming in at just under 0.5inches, the race to the slimmest cell phone is getting more challenging. Cell phone manufacturers must design from the ground up to address this, finding new ways to eliminate a millimeter at a time as technology progresses. More recently, cell phone manufacturers have shifted to electroluminescent (EL) lamps for backlighting of keypads. This is primarily because EL lamp keypad backlighting solutions are slimmer than those offered by LEDs. In addition, for cell phone displays, display manufacturers are pouring resources into developing OLED displays which will eventually be lower cost and thinner than the LCD displays currently in use for cell phone displays.

But the changes don't end there. On the main board of a cell phone, manufacturers have started to migrate to low profile SMT packages which offer package heights of <1mm. There are a few components however, such as inductors that remain a challenge to reduce in size. This article discusses the operation of a new buck regulator for portable applications that enables the use of a tiny surface mount inductor which reduces the power solution footprint for the baseband, camera accelerator DSPs or the multimedia processor for a portable application.

Reducing Buck Regulator Solution Size in Portable Applications

Recently, a few IC manufacturers have introduced buck regulators capable of operating at switching frequencies of 2MHz and greater. As switching frequency is increased, the output inductor value can be reduced. Buck regulators operating at 1MHz commonly use inductors in the range of 4.7uH, 2Mhz buck regulators commonly use 2.2uH inductors while 4Mhz buck regulators commonly use 1uH inductors. However, finding small surface inductors with inductance values of 1uH or greater lower than 1mm height was impossible at the time this article was written.

With package heights for buck regulators in the range of 0.6mm to 0.9mm, the limiting factor in reducing height of buck regulator solutions remains the output inductor. The only way to reduce this height would be to increase switching frequency so that a smaller output inductor value can be used. As an example, Micrel's MIC2285 operates at 8MHz and requires a tiny 0.47uH inductor and a 10uF capacitor for operation. As can be seen in Figure 1, the MIC2285 solution offers the lowest solution height since it can use a chip inductor with an 0805 case size.

Figure 1. Solution Size and Height Comparison, with Increasing Switching Frequency.

Efficiency at 8MHz

One of the concerns that customers have about increasing switching frequency is the reduction in efficiency. The higher switching frequency increases switching losses which affect efficiencies especially at lighter loads. This is because switching losses are proportional to current, while conduction losses are proportional to the square of current. Therefore, at light loads of ~100mA, the efficiency loss due to the higher switching frequency is ~4 percent, while at full loads, efficiency is only compromised by about 2 percent. Figure 2 shows the efficiency comparison of a 2MHz buck regulator (the Micrel MIC2205) with an 8MHz buck regulator (the Micrel MIC2285), which have an identical core design. The main difference is the operating frequency. As can be seen, the higher operating frequency does not result in too drastic a drop in efficiency.

Improving Light Load Efficiency and Transient Response

As cellular phones and other portable electronics become more complex, more power is consumed by both active and standby systems. Consequently, power management design for portable devices offers new challenges as designers try to maximize battery life while improving system performance.

As load currents drop below 10mA, the efficiency of a PWM mode buck regulator drops drastically. In order to improve efficiencies, the MIC2285 offers a LDO mode which can be utilized by using a pin called the LOWQ pin. Figure 3 shows a conceptual block diagram of the MIC2285. The LDO is in parallel with the DC-to-DC converter and can provide power to the output as soon as the LOWQ pin is triggered using a logic level signal.

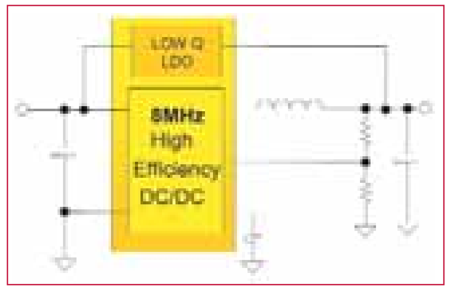

Figure 3. MIC2285 Conceptual Internal Block Diagram That Shows a LDO in Parallel with 8MHz PWM Buck Regulator.

In portable applications, the processor consumes minimal current during sleep mode. In this mode, a LDO offers good efficiency since it consumes very low quiescent current of 18uA.

The other advantage that the LDO mode offers is low noise operation. The baseband processors and DSPs require tight tolerance on output voltage. When the processor wakes up from sleep mode to full power mode, the LDO is able to provide the current step required with minimal output capacitance while the switching regulator takes over to power the processor. Other regulators commonly used in the industry today employ a PFM scheme at light loads. While this achieves good light load efficiency, transient response suffers.

Figure 4 illustrates a comparison of an industry standard buck regulator with a PFM mode light load scheme. As can be seen at loads of < 1mA, the light load mode offered by the industry standard part has more than 150mV noise. At loads of approximately 30mA, the part transitions into a PFM mode and again shows high noise. The transition from PFM to PWM mode however, is where the largest deviation of 330mV in output voltage can be seen. In order to filter this noise, large output capacitors need to be used thereby increasing both the cost and the size of the design. In comparison, the MIC2285 exhibits a stable output voltage as the load profile changes.

As the cell phones, PDA and digital still camera products converge to offer the consumer maximum functionality, reducing solution size becomes ever more important. The MIC2285 improves battery life in standby while providing designers with a high performance solution that enables more aesthetically pleasing product design.

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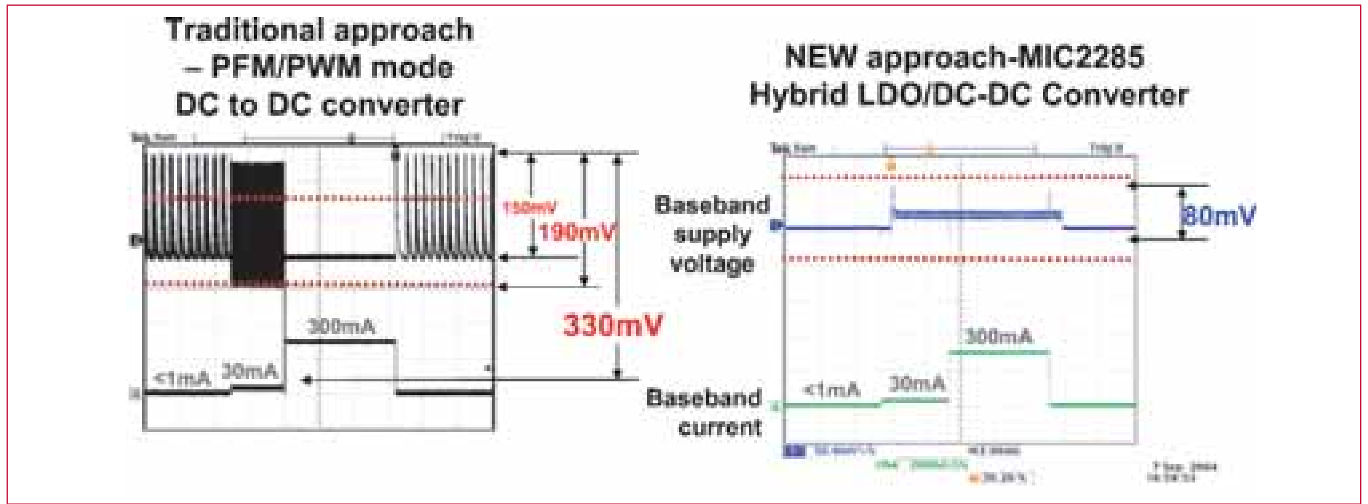

Figure 4. Comparison of Load Profiles for Industry Standard Buck Regulator Using a PFM Mode Light Load Scheme Compared to the MIC2285 Offering a LDO Mode in Light Load.

Low Standby Loss Power Material – N51

Suitable for the standby application of SMPS

Generally power ferrite materials have core loss vs temperature curves decreasing with increasing temperature reaching a minimum between 70˚C and 120˚C. In standby mode (light loading condition) a Switch Mode Power Supply (SMPS) built with such ferrite cores is at ambient temperature and the losses are contributed mainly by the ferrite.

By Somen Goswami, Senior Engineer, Material Development, Epcos Kalyani, India and Probal Mukherjee[1] Deputy General Manager–Head of Development, Epcos Kalyani, India

In order to reduce the standby loss it is necessary to modify the core-loss temperature curve of the ferrite keeping the minimum close to normal ambient (room) temperature. The power ferrite material N51 has been developed with this in view with improved performance over the EPCOS material N41.

Demand for low standby loss material

Electronic appliances as Televisions, Computers all use SMPS to convert line power to the required DC voltages. This conversion has associated losses which tend to increase with the load on the SMPS—for instance the volume setting of the Television. All these appliances can also operate in the standby mode where there is virtually no load on the SMPS and the equipment is left energized in an idle condition. Ideally the appliances should consume near-zero power in standby condition to facilitate power saving. Hence manufacturers of such appliances are aiming at strict limits of standby loss for their products. This in turn demands certain property of the ferrite material to suit the required limit of standby loss.

Salient feature of low standby loss ferrite material

A typical core-loss vs. temperature curve for power ferrite materials is shown below in Figure1. The Epcos material N87 has minimum loss at 100˚C and Epcos materials N41 and new material N51 have minimum loss close to room temperature.

The losses in a SMPS are contributed by: a) Losses in the ferrite cores; b) Losses in the windings; c) Losses in the semiconductors and d) Losses in the connecting leads etc.

The losses b), c) and d) increase with the load on the SMPS and are negligible at standby condition and the losses are mainly contributed by the ferrite. Since the total losses are less at standby, there is no significant temperature rise and the SMPS remains close to ambient. Hence if there is a specified limit for standby loss for the SMPS, the designer has to focus on the reduction of core loss at ambient. A look at Figure 1 clearly shows that materials N41 and new material N51 will be the preferred materials for such application as compared to N87. Between the two, N51 has lower loss than N41 both at room temperature and at high temperature making it a better choice.

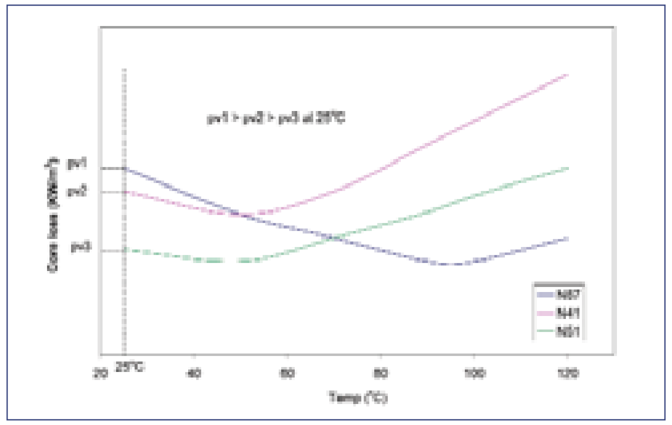

Figure 1. Core loss temperature diagram for typical ferrite materials.

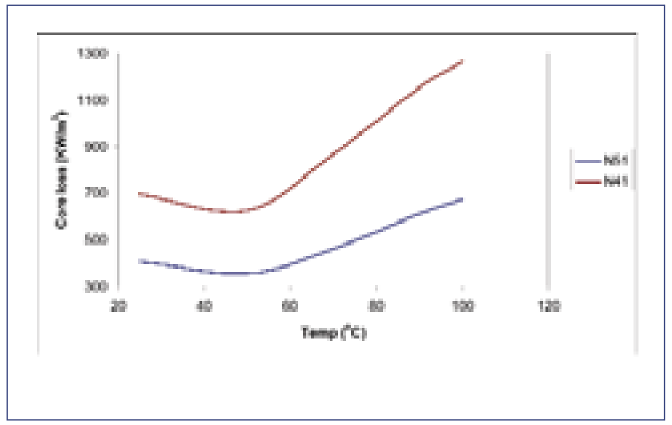

Figure 2. Core loss temperature diagram for N41 and N51.

Parameters	N41	N51	Units
Initial permeability 10kHz, 0.25mT, 25°C	2800	3000	
Core loss 100KHz; 200mT 25°C 100°C	 693 1260	 407 675	 KW/m³ KW/m³
Saturation Flux density 10KHz; 1200A/m 25°C 100°C	 490 390	 490 380	 mT mT

Table 1. Comparison of N51 and N41 properties.

Development of N51

The Epcos material N41 has core loss characteristic having low loss at ambient as shown in Figure 1. The specific core loss at 25˚C for N41 at a frequency of 100 kHz, induction of 200 mT is close to 700 kW/m³. This does not compare well with market requirement of 400 kW/m³ and the need for developing an improved material was felt to meet the customer demand.

It is generally known that optimum electrical and magnetic properties of Mn-Zn Ferrites are observed at particular temperature known as secondary permeability maximum (SPM)[2] where the magnetic crystalline anisotropy becomes zero. Hence the aim to develop a material with desired properties was to design the composition in such a way to shift the SPM close to ambient temp. As the ratio of Fe^{II} to Fe^{III} is prime responsible to this temperature sensitive magneto crystalline anisotropy and SPM the optimization has been done in main composition.

All the results are given in comparison with Epcos material N41 in Table 1.

From the above findings of the results it is evident that new material N51 would be suitable for the standby application of SMPS.

New material N51 can not totally replace N41 since the saturation flux density of N41 at 100˚C is 10mT more than that of N51.

[1]Ferrite and Accessories Data Book EPCOS 2001 Page 117.

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Reliable device composition and construction of Ultracapacitors

Mission-critical installations are routinely protected with standby power generation equipment. These installations require continuous power with absolutely no interruptions.

By Dr. Adrian Schneuwly, Senior Director Worldwide Sales & Marketing, Maxwell Technologies

Fuel cells are recently becoming a viable option for standby power, and are being adopted by telecommunications companies in their efforts to increase reliability. Super-critical installations are using waterfall architectures in which multiple power sources are available for backup power.

Bridge Power

Bridge power describes the short-term power necessary to "bridge" from one long-term power source to another. Bridge power is needed because typical standby power generation equipment is not instantly available, and takes time to be brought online.

The classic example is a diesel generator set (genset) used to back up a hospital facility. During a power outage, batteries or capacitor banks are employed locally to temporarily feed power to mission critical equipment (as either a stand-alone uninterruptible power supply (UPS) or integrated into equipment such as monitors and infusion pumps), until a genset can brought online. The combination of both bridge and long term power generation is necessary because the cost associated with extending bridge power beyond a few minutes is high, and maintenance and reliability issues where batteries are employed may make a single "long-term bridge" prohibitive.

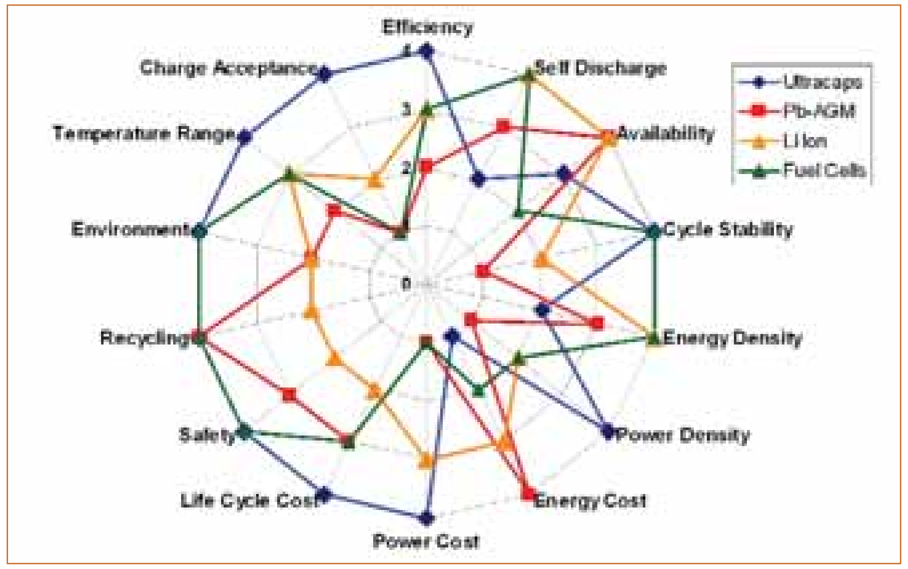


Figure 1. Characteristics of energy storage solutions.

Fuel Cells

To meet the needs of standby power, a fuel cell (FC) backup system must be able to instantaneously deliver power at the full demand of the load. In some installations, the FC system is operating in parallel with the utility, delivering power to the system full-time, while the utility provides load leveling and back-up. In a standard FC system, when the grid is lost, the FC system does not have adequate response time to handle fast transients, and therefore is not considered as a backup system. A typical fuel cell has a start up time of about 20 seconds, with some being up to a minute to achieve full power. In other installations, the FC system is augmented with integrated energy storage to provide fast transient response. When tied with the grid, energy storage is a "bridge" from one continuous power source to a second.

In a stand-alone fuel cell system (one that is independent of the grid), the fuel cell can deliver the maximum power required by the load, but cannot respond fast enough to smoothly deliver power through transients; in this case, energy storage "bridges" across the transients. Bridge power is a vital component of a robust fuel cell standby power system.

As can be seen in figure 1, each energy storage solution has advantages and disadvantages. No technology by itself can satisfy the entire spectrum; therefore, for applications that require broadly based demands we must look at the best possible combination. As can be seen, this is using ultracapacitors and fuel cells together. This combination results in an energy rich, reliable, maintenance free solution that is also very environmental friendly.

Numerous companies are putting fuel cells into the field to make their systems more robust. According to Citigroup Research's report "Switch Signals: Fuel Cells in Distributed Telecom Backup,", the telecom industry identifies reliability as one of the main benefits of fuel cells, despite an inaccurate perception that fuel cells are more expensive than standard lead-acid battery backup power systems. A key factor contributing to this perception of reliability is that fuel cells have already racked up more than 1 billion hours of operation over 10 years, in applications such as hospitals.

Life cycle costs are another key consideration when specifying backup solutions. Citigroup's research report also included data that revealed the replacement costs of batteries at telecom sites run into thousands of Euros. The report noted "fuel cells are 32% and 35% less expensive than battery backup power solutions based on a 10- and 15-year useful life and a five-year battery replacement cycle."

Waterfall Architecture

Historically, a single power generating solution, typically a diesel generator, was used with a simple battery-fed inverter uninterruptible power supply (UPS) as a bridge. For installations where a minor power glitch was only a nuisance, this is adequate, considering that the typical UPS only can supply the load for 8-20 minutes.

One of the major issues with diesel generators and battery UPS systems is reliability and maintenance. Telecom companies require much more reliability that a typical genset/battery combination provides. "Waterfall" systems use a cascading set of different technologies (e.g. engines, fuel cells, micro-turbines), bridging between each transition with short-term bridge power technologies (e.g. batteries, ultracapacitors, flywheels). With the many options in bridge technology, one must consider the overall reliability requirement. With the maturation of the ultracapacitor industry, ultracapacitors are highly competitive with, and in many cases superior to, older bridge technologies.

Ultracapacitors Provide Functionality

Ultracapacitors offer the functionality, life cycle costs, and reliability necessary to make mission-critical power backup systems successful. Since the ultracapacitor is used strictly as a bridge, its high power density is ideally suited to supply high power for short periods of 30-100 seconds. A battery is more typically sized to deliver power over longer periods, making them larger than necessary. If a battery is sized for the actual duration required, it may have difficulty supplying the necessary power.

Additionally, since ultracapacitors operate on a different principal than batteries, the ultracapacitor is capable of sitting on a charge voltage for extended periods without any loss of capacity, unlike a battery.

One key challenge with batteries is the difficulty in measuring their state of charge. The charge of an ultracapacitor, however, is measured solely by its voltage.

Ultracapacitors have another distinct difference when compared with batteries, which makes them ideally suited to support fuel cells. A fuel cell's output varies with load (which is then regulated by power electronics). A battery's output is fairly fixed, and therefore will affect the fuel cell's performance by loading the fuel cell's output (unless it is employed on the output of the power electronics in a dc system, in which case the battery output is then unregulated). An ultracapacitor, on the other hand, has no fixed operating voltage, and therefore can operate directly across the output of the fuel cell, directly into the power electronics.

Ultracapacitor Power Delivery

Ultracapacitors deliver energy by reducing the electrostatic field across the electrolyte. When this occurs, the voltage on the ultracapacitor drops.

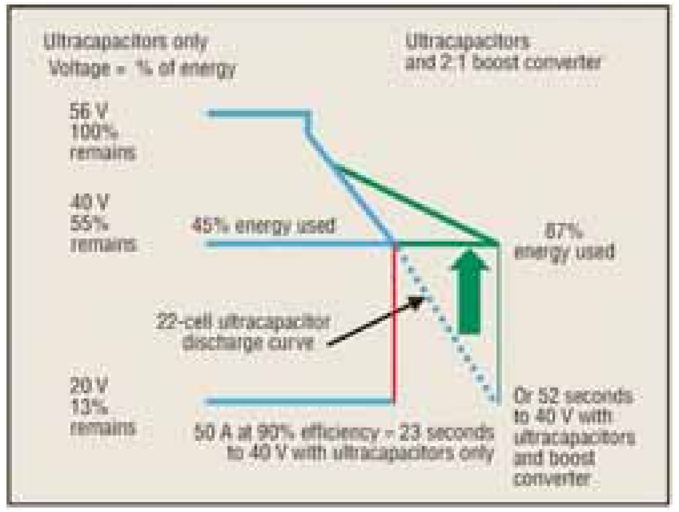


Figure 2. Discharge curves for ultracapacitors with and without power electronics.

Following the standard square law, when an ultracapacitor must deliver 75% of its energy, it must be discharged to 50% of its initial voltage. For installations that require a narrower voltage range or that wish to discharge greater than 75% of the ultracapacitor's energy, power electronics can be used in between the ultracapacitor and the load, providing a more manageable voltage range to the load.

A dc-dc converter can narrow the voltage range experienced by the rest of the power system. The input to the dc-dc converter will be the wide operating voltage range of the ultracapacitor. The output will be the narrower (perhaps even constant) dc voltage required by the load. This allows the ultracapacitor to be deeply discharged, while providing a relatively constant voltage to the load.

Figure 2 shows two discharge curves, one with and one without power electronics. This shows how integrating a dc-dc converter, isolating the output voltage from the ultracapacitor voltage, a much deeper discharge can be achieved without exposing the load to excessively low voltage.

Reliable Operation

Ultracapacitors are reliable devices because of their composition and construction. A cycle life of more than 1 million cycles has been demonstrated with minimal degradation. There are no mechanical moving parts as in a flywheel, eliminating all maintenance.

Furthermore, cycle depth isn't an issue, so ultracapacitors can be micro-cycled (cycled less than 5% of their total energy) or full-cycled (cycled greater than 80% of their total energy) with the same long life.

Combined with the wide temperature range, long life, and flexible voltage range, ultracapacitors provide an extremely reliable solution for bridge power.

www.maxwell.com

Navigating the Transition to Digital Power Management

In 1970s the move from Linear to Switch Mode was regarded as expensive and unreliable

Digital power today is a small fraction of overall power industry revenue but is commanding a large share of industry attention and discussion.

By Deepak Savadatti, Vice President of Marketing, Primarion

According to reports from iSuppli and Lehman Brothers, the entire digital power market will generate around $168M in revenue for 2006—this is nothing compared to the overall power management market today, soon the digital power market will represent a very significant piece of the power market, with industry estimates running at more than 100% CAGR for the next few years.

As the digital transition begins to build force in the critical area of power management, it's worthwhile—even necessary—to clarify the key issues involved in enabling the transition toward a profitable and productive momentum that benefits everyone in the supply chain, as well as to offer practical decision-making support for designers and OEMs facing challenges in selecting cost-effective and efficient solutions for each application.

Among the growing pool of solutions from a crowd of providers, it is generally accepted that two general flavors of digital power are available: digitally controlled power conversion and digital feedback loop-based power conversion. The first flavor emerged from the traditional analog players that have been building controllers with an analog control loop—these players are now forced to address issues beyond power conversion, such as adding monitoring functions or providing a digital interface to talk to the system. The second flavor is a totally new concept from the ground up, in which you are replacing the traditional error amplifier from the feedback loop with an all-digital feedback loop. Naturally, the digital loop concept is driven by the start-ups in the power industry.

Traction for digital power solutions is evident based on a slew of product announcements from a multitude of suppliers, all playing to their strengths. Traditional analog power houses are rolling out products that have a "digital wrapper" around an analog controller, while the traditional DSP and microcontroller houses are rolling out products that provide customers infinite programmable options to address all possible power management needs. But neither of these options offers a cost–effective, space-saving solution to their customers. The pure-play digital solutions are challenging these two sets of players with offerings that introduce the flexibility of digital features at cost parity with analog solutions.

Today's power customers have a multitude of digital solutions available to them if digital is, indeed, the right approach for their needs. So, the real question is not "Which flavor tastes good?" but "How does the customer decide which flavor to buy?" The answer to this question lies in examining the costs and capabilities of each flavor to meet all of the customer's challenges for a given application.

So, what are the customers adding to their wish list from silicon suppliers these days? Over time, power customers have demanded an increasing level of real-time system-level information to better manage their power:

- Real-time monitoring and reporting of voltage, current, temperature and faults
- All aspects of controller can be set without any hardware changes
- Programmed over the serial bus
- Optimized and debugged quickly
- Personalization
- One "standard" part can be configured into multiple roles
- Auto-calibration
- Accuracy beyond precision of off-board components
- Compensate for aging and drift over time
- Nonlinear and asynchronous control modes
- Improved transient response with lower BOM cost
- System-level determination of fault responses
- Flag only, soft/hard shutdown, hiccup mode
- Dynamic phasing
- Phase awareness, map, add, drop, redundancy
- Increase low-current efficiency, greater system reliability
- Adapt automatically to changes in system configuration

With the customer's wish list in front of us, we can begin to answer the question of which of the above-mentioned flavors does the job at hand. From a functional perspective, digitally controlled, analog loop-based products can meet most of these requirements but they can't meet all without adding a bunch of external components. In contrast, the true digital controller with the digital loop can meet all of these requirements without any additional external components. However, because these all-digital solutions are more capable from a features perspective, they are also more complex from a user's perspective. Commercially successful digital solutions must be able to provide the features while minimizing the complexity and the risk (read: fear) of making a change.

To make things even more interesting, the top five drivers in selecting a power (be it digital or not!) solution are cost, cost, cost, cost—and size. No new technology will play a major role in the mainstream market unless the overall solution cost is compatible with the existing technology—electrical and thermal performances are "expected" capabilities.

There are two major misconceptions and unwarranted beliefs about the value of true digital power that are holding back digital progress in our industry:

Misconception #1: DIGITAL IS COST-PROHIBITIVE

In the past, "digital" has carried the stigma of being more costly than traditional analog solutions - a big negative relative to the other benefits that digital brings, such as size reduction, flexibility, adaptability, improved testability, diagnostic capability and extensibility. It costs less to implement a digital feedback loop in a commercially available CMOS technology compared to an analog feedback loop built using larger geometry proprietary technology. Also, the overall solution cost using true digital is much lower than the other available options.

Misconception #2: DIGITAL INTRODUCES TOO MUCH COMPLEXITY

The belief that the power supply designers are analog by nature and thus don't want to deal with the complexity of programming. Proponents of digital power management propose not only that we are not giving enough credit to the innovative designers who are not threatened by the emergence of digital power but also that in reality, programming doesn't mean coding but rather simply dealing with a wizard-driven GUI to get all the system-level benefits, including:

- Simplified system-level thermal management via real-time telemetry
- Reliability enhancement via real-time telemetry to predict and prevent failures before they happen
- Manufacturability enhancement via fully automated check out and trim of VR at final module or motherboard test

In fact, the slow acceptance of digital power stems from customers' traditional views of digital technology as unproven, complex and expensive. This is not surprising, as the industry experienced the same emotions in late 1970s when the power industry moved from Linear to Switch Mode, which was initially regarded as expensive and unreliable with high output noise. However, once customers recognized the benefits (higher performance and smaller size) and learned about implementing the new switch mode technology, linear power supplies quickly became obsolete. In a few years, digital technology will see a similar transition as customers become familiar with the benefits, have access to more providers and solutions, and see more results without additional costs relative to analog solutions.

As is the case with any new technology adoption cycle, digital power's impact will be felt first at the high-end and then make its way into the mainstream market: digital power has started its journey by capturing sockets in servers, high-end graphics cards, datacom, telecom and storage. Once there is critical mass among digital power management players, the desired cost structure will be accessible for the high-volume consumer electronics desktop/mobile computing and handheld appliances.

In the meantime, the power industry has to look past the spin and competitive messaging battles to discover that analog will always have a place and that digital solutions are quickly carving out a legitimate and viable space for benefits throughout the supply chain.

www.primarion.com

NEW PRODUCTS

Compact USB Battery Charger IC

AnalogicTech has introduced a highly integrated battery charger IC designed to operate from USB port inputs. The AAT3688 features an innovative charge reduction loop that reduces charge time by automatically monitoring the USB port voltage and dynamically adjusting the current while the battery is charging. The function dramatically simplifies this task, allowing users to charge faster and more efficiently from the USB port by automatically adjusting for voltage sags and reducing the charge current as other functions on the host device consume more power.

Part of AnalogicTech's rapidly expanding BatteryManager product family, the compact AAT3688 integrates a charging device, reverse blocking diode, and current sensing circuit in a small 3x3mm TDFN package. Covering a 4V to 5.5V input range, the device is designed to regulate voltage and current for 4.2V lithium ion/polymer battery cells.

Charge current on the AAT3688 can be programmed for two separate levels, USB High and USB Low, between 50mA and 500mA, depending upon port type.

To ensure safety and system reliability, the AAT3688 offers a number of safety features including the ability to monitor battery temperature and charge state for fault conditions. If an over-voltage or over-temperature failure occurs, the device automatically shuts down to protect the charging device, the control system, and the battery under charge. Status monitor output pins can be used to directly drive two external LEDs to indicate battery status. The AAT3688 also includes a serial interface output that reports any one of 14 status states to a microcontroller.

www.analogictech.com

Transient Tolerant Voltage Monitoring Networks

Caddock is pleased to announce Type VMN Transient Tolerant Voltage Monitoring Resistor Networks. These Precision Film Resistor Networks are designed for use in the voltage measurement circuits of Power Quality Meters, Kilowatt-Hour Meters, Power and Energy Measurement Equipment, and other devices where precision electrical service voltage monitoring is required.

Caddock's Transient Tolerant Precision Resistor Networks are manufactured with Tetrinox, Caddock's Ultra-Stable, Low TC,Resistance Film System. The Tetrinox Resistance Film System combined with Caddock's Ceramic Sandwich Construction provides for the exceptional transient capability and the outstanding long term stability of these Transient Tolerant Precision Resistors.

Caddock's Ceramic Sandwich Construction also provides excellent long term stability in applications that have extreme humidity exposure. These Type VMN Resistor Networks can be optimized to handle Transient Impulses from 6 kV up to 15 kV electrical power system transient (1.2/50 µsecond impulses). Even higher Transient voltage handling capability is also possible in other Caddock resistor products.

PCIM Hall 12, Booth 107/ 344 (AMS)

www.caddock.com

15A Digital POL Converter

Power-One announces the availability of its 15-amp ZY1015 No-Bus Point-Of-Load (POL) converter. Featuring a low-profile horizontally-mounted package, this hardware-configurable digital POL provides sophisticated power management capabilities without the need for programming, external controllers, or bus interfaces. Simple pin strapping, an external trim resistor, and a capacitor are all that is required for configuration.

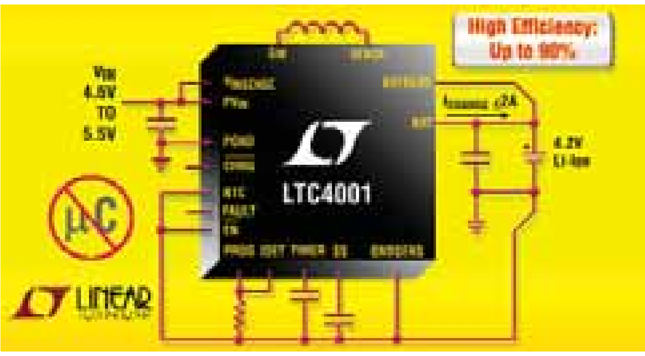
Utilizing an ultra-wide 3 to 14V input range, the ZY1015 provides a 0.5 to 5.5V user-configurable output that can start up into pre-biased loads. Users can readily configure a comprehensive array of power-management functionality at any time during development or use:

- Sequencing with configurable delays, tracking, and cascading between multiple outputs
- Feedback-loop compensation parameters that can be optimized for specific applications
- Noise and EMI control via frequency synchronization and programmable phase interleave
- Output current and temperature measurements via monitoring pins
- Current sharing of up to 10 No-Bus POLs

The ZY1015 combines a compact 16x32mm SMT footprint with a low-profile 8mm height. Protections include overvoltage, undervoltage, overcurrent, and overtemperature. Samples are usually available from stock.

www.power-one.com

Monolithic Li-Ion Battery Charger



Linear Technology Corporation introduces the LTC4001, a 2A capable, high efficiency switchmode battery charger for single-cell 4.2V Li-Ion/Li-Polymer batteries that minimizes heat dissipation without compromising board space. Standalone operation eliminates the need for an external microprocessor for charge termination. For safety and autonomous charge control, the LTC4001 includes features such as automatic shutdown, battery preconditioning, a thermistor input for temperature-qualified charging, remote sensing, end-of-charge indication and a programmable charge termination timer.

The device is intended for 5V wall adapter input power and is suited for applications including handheld medical devices, handheld computers, charging docks and cradles, digital cameras and smart phones. It may also be used with current limited wall adapters for even further reduction in power dissipation.

The LTC4001's synchronously rectified, buck switching topology enables efficiencies as high as 90% @1.5A. Final float voltage accuracy is specified at ±1% with charge current accuracy of ±10%. The LTC4001's high operating frequency of 1.5MHz and current mode architecture allow the use of small inductors and capacitors, minimizing noise and filtering needs. The LTC4001 automatically enters sleep mode, dropping the battery drain current to 5uA and increasing battery run time.

The LTC4001 is housed in a compact 16-lead, low-profile (0.75mm) 4mm x 4mm QFN package. It is guaranteed for operation from –40°C to 85°C.

www.linear.com

IGBT/MOSFET Power Module

Danfoss Silicon Power introduces the smallest member of its E-Type power semiconductor module packages. The E0 Package was created for high volume, cost sensitive power switching semiconductor applications.

The heart of the E0 Module is a DCB-substrate. As a reference, this substrate is large enough for the semiconductors required to build a 600V, 20A PIM circuit with brake and temperature sensor.

E0's frame is made from an injection molded, glass-filled polymer known for its high rigidity, strength and dimensional stability. The frame can be populated with as many as 32 signal pins, according to the customer's requirement. Spacing between pins is large enough to maintain creepage and clearance distance for 480V inputs and 2500V isolation to the heatsink.

Although easily configured for standard motor drive converter/inverter circuits, the creative power circuit designer should consider the E0 Module a palette for other circuit ideas.

Synchronous buck converter, active PFC front end, 2phase and 3phase BLDC inverter, full-wave converter and forward converter/synchronous rectifier circuits using MOSFET or IGBT die are all possible. Thermistors, current shunts, SMT resistors and capacitors can be used in the module design.

The E0 Module is fully RoHS Directive compliant. Pins are made from tin-plated copper.

Only lead-free solders are used. Danfoss Silicon Power has many years experience with lead-free, void-free vacuum solder processes.

The E0 Module easily integrates into either robotic or manual assembly processes. They are available in reusable trays for robotic pick-and-place assembly. Locking clips molded into the frame positively fasten the E0 Module to a printed circuit board. Asymmetric pin placement prevents incorrect insertion into the printed circuit board.

PCIM Hall 12, Booth 325

http://siliconpower.danfoss.com

Isolating Gap Filler

Bergquist's latest edition to the ultra soft 'S-Class' gap filler family is the 3500S35, a high performance, thermally conductive, electrically isolating, liquid gap filling material that combines both an excellent conductivity of 3.6W/m-K and exceptional softness.

A key feature of the new product is its superior ability to 'wet-out' the interface surface. This reduces air gaps, which increases surface area contact and so increases thermal conductivity at the interface. Prior to curing, Gap Filler 3500S35 maintains excellent thixotropic characteristics which makes it easy to dispense. The result is a gel-like material that fills air gaps and voids yet flows readily when required in the dispensing and assembly process.

The material is an excellent solution for interfacing fragile components of various heights and stack-up tolerances to one heatsink or casing.

Typical applications include automotive electronics, computers and peripherals, telecommunications and any other assembly where multi-height heat generating components must be efficiently thermally bonded to a heatsink.

A two part material, Gap Filler 3500S35 also provides a more flexible cure schedule. Requiring no refrigeration during storage it can be used immediately and will cure in 15 hours at room temperature, or 25 minutes at 100°C. Once cured it remains a low modulus elastomer designed to assist in relieving thermal expansion stresses during thermal cycling yet maintain enough elastic modulus to prevent pump-out from the interface.

PCIM Hall 12, Stand 632

www.bergquistcompany.com

Comprehensive Battery Monitoring Sensor

LEM announced Sentinel, the most comprehensive battery monitoring sensor, designed for monitoring standby batteries. The sensor measures voltage and impedance per cell, and uniquely offers the ability to monitor internal temperature of individual cells. By monitoring standby batteries, the life, performance and reliability of systems providing backup power in applications such as industrial UPSs, telecommunications, safety-critical systems and computing can be dramatically increased. Many of these applications already use LEM current measuring transducers for monitoring standby batteries.

The LEM Sentinel sensors feature a custom intelligent SoC (System on Chip) device that processes the signal and interfaces to the digital S-Bus control bus. In standby applications, the failure of one cell can prevent the operation of an entire chain of batteries, causing large systems to fail to deliver the desired operating time. Monitoring voltage, current and impedance allow users to accurately predict which cells are likely to fail, and to replace them ensuring higher system reliability. Monitoring temperature allows engineers to ensure that the lifetime of the batteries is maximised, and also ensures that thermal runaway situations can be detected and corrected before they cause potentially catastrophic failures.

PCIM Hall 12, Booth 402

www.lem.com

Inductor-less White LED Drivers

National Semiconductor introduced three new inductor-less white LED drivers for display backlighting in mobile phones, PDAs, portable gaming devices and MP3 media players. Using no external inductors, the LM27951, LM27952 and LM27964 significantly reduce the size of LED lighting solutions, while providing highly efficient switched-capacitor technology to extend battery life in portable devices.

These white LED drivers feature a dual-gain architecture that enables the regulators to automatically select between one of two gains from input voltage to output voltage, maximizing the efficiency of the regulator. The selection is based on the input voltage of the regulator and the forward voltage of the LED.

For uniform brightness across the display, the white led drivers offer current matching at just one percent between each LED. The LM27951, LM27952 and LM27964 are adaptive 1.5X/1X switched-capacitor current drivers that include pulse-width modulation (PWM) brightness control. The LM27964 also includes an I2C compatible interface to easily control the brightness of the LEDs, for a total output current of 180 mA.

PCIM Hall 12, Booth 124

http://power.national.com

SAW Filters: Smaller Ceramic Packages

Epcos now offers SAW filters and two-port resonators as SMDs in ceramic packages on quartz substrate with a footprint of 3 x 3 mm. This represents a reduction in area of 40% against the previous package's footprint of 3.8 x 3.8 mm and even 64% for the two-port resonator, which used to measure 5 x 5 mm. Insertion height has also been reduced significantly, from 1.5 to 1.0 mm in the SAW filters and from 1.35 to 1.0 mm in the two-port resonators.

This means that all SAW components for short-range devices are now available in a package with a footprint of 3 x 3 mm. The filters and resonators are available for the ISM (industrial, medical and scientific) band with center frequencies of 315, 433.92 and 915 MHz.

Despite miniaturization, typical insertion loss is only 2.4 dB in the passband. Typical applications include wireless headphones, garage door openers, access control systems, fire alarm systems or remote control systems for cranes or other machines.

Thanks to their rugged hermetically sealed ceramic packages, these filters can be used in ambient temperatures ranging from -40°C to +95°C.

PCIM Hall 12, Booth 535

www.epcos.com/rke

Power MOSFETs in Compact Package

STMicroelectronics announced its first power devices to be assembled in the metal topped PolarPAK package, which provides superior thermal performance and increased power density for components used in high current power supplies. The STK800 and STK850 are 20A and 30A power MOSFETs needing only the same 5mm x 6mm board area as a standard SO-8 package, and with an even lower profile of just 0.8mm, as a result of both top and bottom heat dissipation paths.

ST announced a license agreement with Siliconix in March 2005 to use the PolarPAK technology. The new package's leadframe and plastic encapsulation are similar to those used for most standard power MOSFET packages, ensuring good die protection and easy handling in manufacturing. Yet compared to the standard SO-8, the PolarPAK dissipates heat so efficiently that it can handle twice the current within the same footprint.

The devices are manufactured using the optimization of ST's proprietary STripFET technology—which is based on significantly increased cell density and smaller cell features—to achieve very low ON-resistance and losses while using less silicon area. Typical RDS(on) of the 20A STK800 is 6.0mOhm, and of the 30A STK850 is 2.9mOhm, at 10V. The package contributes to the low ON-resistance of both MOSFETs by providing ultra low junction-to-case thermal resistance and lower junction temperatures.

With its low capacitance and total gate charge, the STK800 is the ideal choice as a control FET in non-isolated DC-DC step down converters, while exceptionally low RDS(on) makes the STK850 an excellent solution as a synchronous FET.

PCIM Hall 12, Booth 412

www.st.com/powermos

3-A SWIFT Converter for Industrial POLs

Texas Instruments announced a high efficiency, 500-kHz, step-down DC/DC integrated circuit (IC) with integrated FET that delivers 3-A of continuous output current and supports input voltages of 5.5 V to 36 V. The small, simple-to-design switcher speeds time to market for point-of-load systems, such as industrial applications, digital television, DVD, battery charging and 12-V/24-V distributed power systems. See: www.ti.com/sc06013.

TI's non-synchronous TPS5430 SWIFT converter provides greater than 90 percent power efficiency and two percent output voltage accuracy (down to 1.23 V). Delivering 3-A of continuous current (4-A peak) at full temperature and operating over a junction temperature range from -40°C to +125°C, the device excels in hot environments where good thermal performance is needed, such as an LCD digital TV display that operates without the use of a cooling fan. The TPS5430 is ideal for powering low-voltage digital signal processors (DSPs), FPGAs and general purpose processors. Additionally, for applications that require higher output voltage levels, such as high power LED or automotive systems, the TPS5430 can step-down voltages as high as 30-V.

PCIM Hall 12, Booth 134

www.ti.com

6A MOSFET Driver Product Family

Micrel launched a new line of tiny, high speed MOSFET drivers. The MIC44F18/19/20 MOSFET driver family is a series of new 6A devices targeted at power supplies and synchronous rectification applications operating at frequencies as fast as 2MHz.

The MIC44F18/19/20 MOSFET drivers are tiny single drivers for inverting and non-inverting solutions. They are fabricated with Micrel's proprietary BiCMOS/DMOS process for low power consumption and high efficiency TTL and CMOS input logic level compliance. Output voltage levels can swing within 25mV of the positive supply ground, in comparison to bipolar devices, which are only capable of swinging within 1V of the supply. These chips are capable of symmetrically sinking and sourcing current up to 6A with an industry break-through propagation delay of 10ns and switching times of 15ns.

The MIC44F18/19/20 series feature an input voltage range from 4.5 to 13.2V, ideal for a wide range of power applications with 5V and regulated 12V voltage buses. The solutions also include enable function, latch-up protection, and programmable UVLO functions. They are offered in thermally enhanced packages, an exposed Pad MSOP-8 and 2 x 2 mm MLF-8 package options.

PCIM Hall 12, Booth 343

www.micrel.com

DC-DC Converter for Wireless Power Amplifier

Tyco Electronics Power Systems announced the availability of the JHW250 series of DC-DC converters, delivering up to 250W output power in an industry standard half-brick format for radio frequency power amplifier applications. Suitable for wireless base stations and other similar telecom equipment, the JHW250 provides a lower cost solution for RF power amplifier applications, distributed power architectures, and wireless networks.

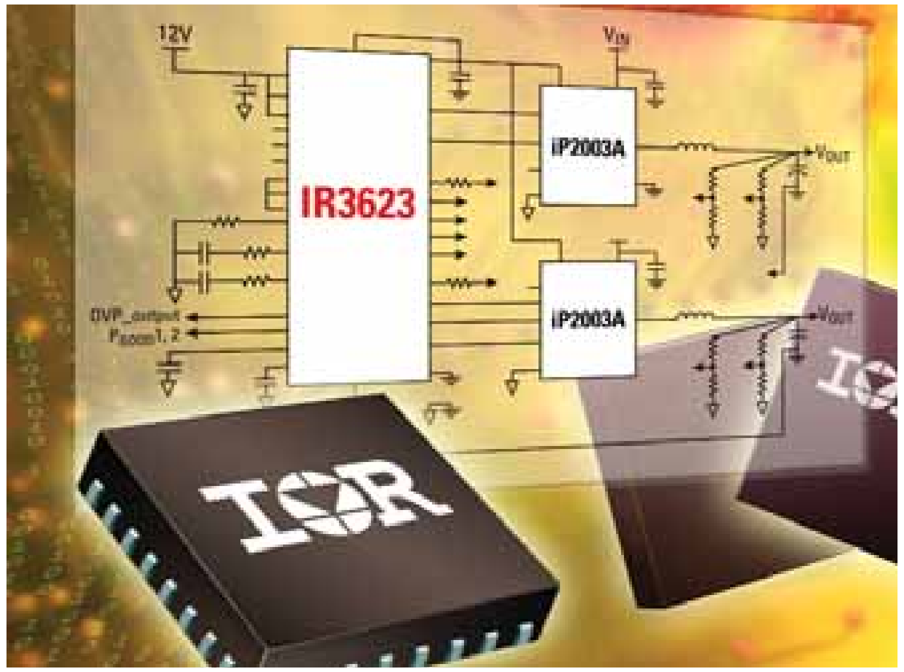
The JHW250 series power modules are isolated DC-DC converters that operate over a wide input voltage range of 36 to 75 Vdc and provide a single, precisely regulated output of 30.2V. These modules incorporate synchronous rectification technology and innovative packaging techniques to achieve ultra high efficiency–typically 92% at 30.2V with full load. The 5-sided encapsulated case package allows for excellent performance in a strict, thermal environment. The output is fully isolated, allowing versatile polarity configurations and grounding connections. In addition, the built-in filtering for both input and output minimizes the need for external filtering.

The JHW250 series is rated for a wide operating temperature range of -40°C to 85°C in an industry standard half-brick package of 57.9 mm x 61.0 mm x 12.7 mm (2.28 in. x 2.4 in. x 0.5 in.). Standard features include: remote on/off, remote sense, low output ripple and noise, over-temperature protection, 2:1 input voltage range, output overcurrent/voltage protection, and output voltage adjustment. Threaded or non-threaded through-holes are available to allow for easy mounting to a cold wall; or the addition of a heatsink may be used for high-temperature applications. The converters are designed to be fully compliant to RoHS EU Directive 2002/95/EC and to be used at ISO 9001 certified manufacturing facilities.

PCIM Hall 12, Booth 421

www.power.tycoelectronics.com

80A Point-of-Load Chipset



International Rectifier has introduced the IR3623, a high performance dual synchronous buck PWM control IC. Designed to be used with iP2003A iPOWIR integrated driver-MOSFET power building blocks, the chipset reduces component count and footprint in non-isolated, DC-to-DC buck converters delivering up to 80A in embedded networking and communications systems, point-of-load (POL) regulator modules and high-density blade servers.

The chipset can be configured to operate either as a high current (80A), single output converter, or as two independent 40A converters, switching 180 degrees out of phase. For example, in a 12V input, 1.75V output application with 500kHz switching frequency and a dual-channel configuration, the IR3623/iP2003A chipset achieves greater than 90 percent efficiency at 25A per channel without a heatsink.

The PWM control IC offers a full array of protection features. For start-up, the IR3623 features a dedicated enable pin, an input under-voltage lockout circuit, and the ability to start-up into a pre-biased output voltage. In addition, the device features hiccup mode over-current protection, output over-voltage protection and thermal shutdown.

For true dual-channel operation, the chipset offers two independent programmable soft starts, and two independent power-good outputs. The IR3623 offers full support for output voltage tracking and power sequencing for multi-rail applications. Flexibility is included to allow for sequential, ratio metric or simultaneous voltage tracking of both channels without the need for any external components.

The iP2003A power stage block integrates a synchronous gate driver, high- and low-side power MOSFETs, a synchronous Schottky diode and passive components required for each converter phase, simplifying design and layout. The devices are lead-free and compliant with the Restriction of Hazardous Substances Directive (RoHS).

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8kV ESD protected USB 2.0 Switch

Fairchild Semiconductor introduced a new Hi-Speed (480Mbps) USB 2.0 switch with the industry's highest ESD protection (up to 8kV). The FSUSB31 offers the best combination of function, performance and packaging available for applications such as media players and cell phones. The FSUSB31 is ideal for port isolation based on its ability to protect against ESD (electrostatic discharge), excessive capacitance, noise and other factors that can negatively affect performance in ultra-portable products.

The FSUSB31 also saves battery power by drawing less than 1A of current and its tiny (1.6 x 1.6mm) package fulfills the small-footprint requirement of ultra-portable designs.

The next generation of the ultra-portable market is expected to be driven by a demand for new applications with more and more product features. Personal media players (PMP) and cell phones, for example, are being designed to share USB and other types of connectors. Ultra-portable designers need switches with multi-function capabilities, such as USB and audio, combined into one device. With the industry's broadest portfolio of switches, Fairchild is at the forefront of this market trend to pack additional functionality into increasingly more compact, high-performance USB-enabled switches.

The FSUSB31 is available in a lead (Pb)-free MicroPak package that meets or exceeds the requirements of the joint IPC/JEDEC standard J-STD-020C and is compliant with the European Union now in effect.

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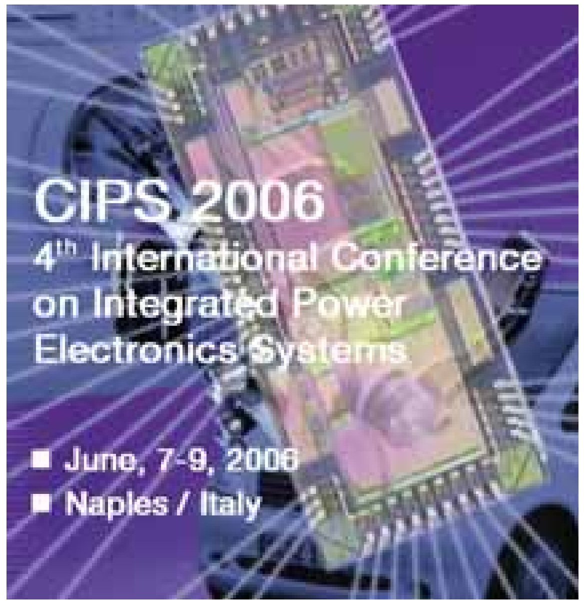

Companies in this issue

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