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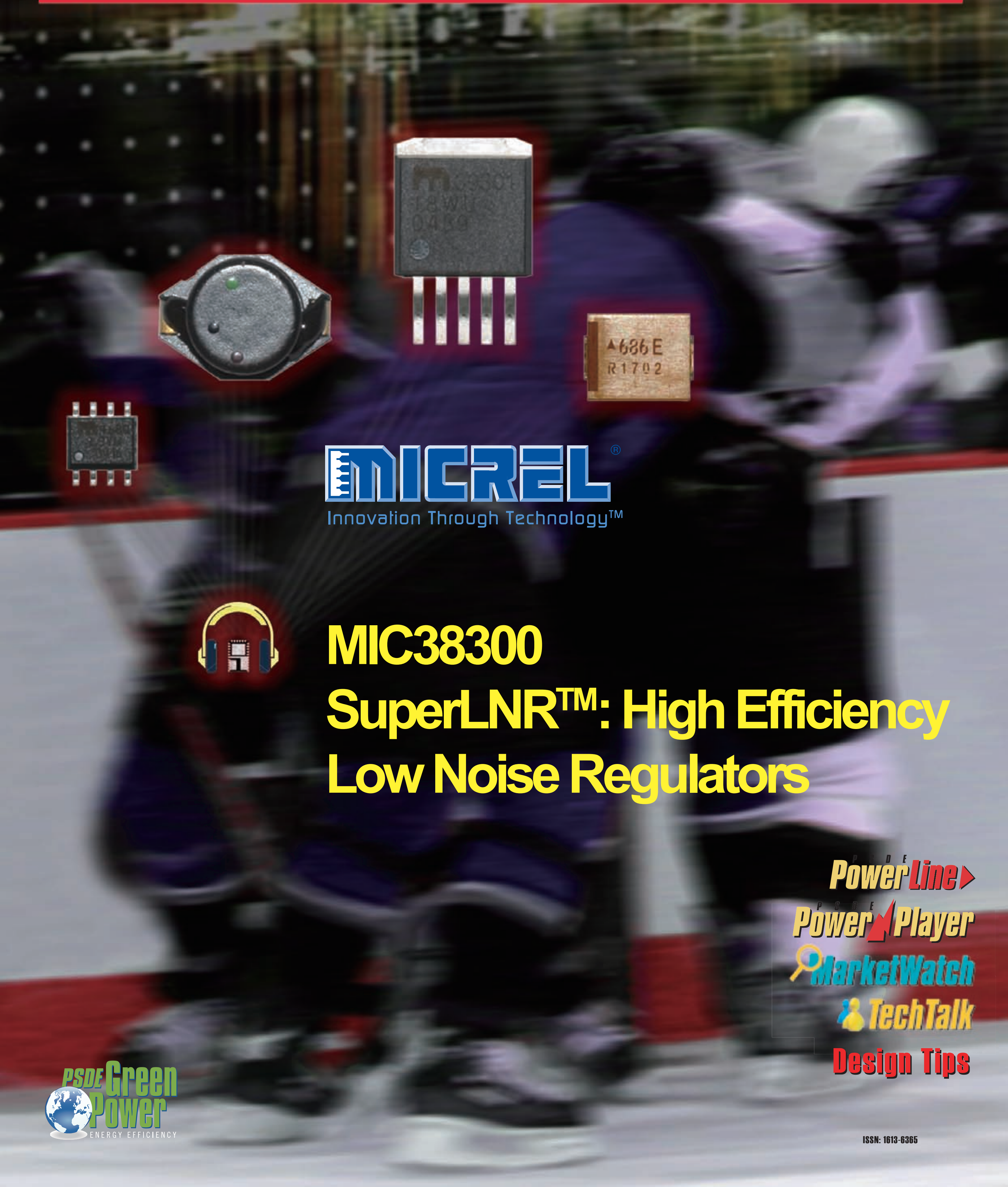
Empowering Global Innovation

November 2007



MIC38300 SuperLNR™: High Efficiency Low Noise Regulators

PSDE PowerLine

PSDE PowerPlayer

MarketWatch

TechTalk

Design Tips

PSDE Green Power ENERGY EFFICIENCY

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Powering Perfection

As I write this, I'm in the midst of a month's intensive tour of major companies throughout 12 states in the US. There is a lot going on here and the clear message I'm getting is that there is a great deal of design and development of new products in our area of power together with some very healthy bottom lines being achieved through the innovation that is power. Apart from working with my publishers, we have traveled together through Florida, California, Texas, New Hampshire, Maine, Massachusetts and several other states…a long trip, but with much pleasure in getting the ideas, achievements and future plans of these great companies.

One thing is for sure, power is the key area for many end products...unlike many years ago when energy was considered 'for free' - with today's striving for efficiency, EMI and thermal issues not even a consideration. What a huge turn-around we see now.

Green issues are becoming ever more important, with many corporations now jumping on, but the way our industry is moving, we are at the very center of the renewable energy revolutions such as wind power. You can see more on this more on this on the 'Green Page' feature at the back of the magazine.

As I talk with great performing companies such as Linear, Intersil, TI, Silicon Labs, IR and Fairchild, I can see roadmaps that will propel us into even more exciting areas of technology in the very near future. Not just as a result of these companies listening to customer requirements today, but with designers who have the creative insight to know what they will need in the future. So it's not just a case of 'giving them what they want', but more 'designing and delivering what these talented companies know they will be needing'. What a wonderful industry power design has become.

Areas such as packaging, always important in the semiconductor industry, have now become key differentiators for these companies. The creativity demonstrated in thermally enhanced packages to enable high density PCB loading, usually without heat-sinks, is truly outstanding. When these 'in the pipe' developments become fully developed, I'll bring them to you in a future issue.

The mood is very up-beat, and I'm not surprised. Looking at the numbers, business is looking good for the future. The challenges will go on as ever, competition will always be tough, but with the new era of digital power and system integrated power coming in the future, there will evolve practical solutions where they will do the most good. Not just 'because we can'. Analog designers, traditionally difficult to find and to keep, are naturally wary. It is clear that only a solution that makes real design sense and that can be implemented without a major retraining in digital programming will succeed. In this issue, my TechTalk with Intersil's Davin Lee gives a clear outline on what the company is doing to overcome the hurdles and to deliver the benefits of this 'new' technology.

Also in this issue we bring as always a broad selection of contributed industry articles, some reporting from my On-the-Road tours and TechTalk features, plus the latest Industry News and New Products.

Have a look at the GreenPage at the back and don't forget to check out this issue's Dilbert.

All the best!

Cliff Keys

Editor-in-Chief, PSDE
Cliff.Keys@powersystemsdesign.com

New Distribution Agreement for ACAL Technology and Integration Associates Inc.

Meni Biran, European Sales Director, Integration Associates (left), shaking hands with Martin Kemp, RF & Wireless European Product Manager, ACAL Technology (right).

A new franchise agreement between ACAL Technology, and Integration Associates Inc., brings ACAL-level design support, on Integration's wireless, wired and power management ICs, to customers in the UK and France.

ACAL Technology will provide specialist design support and inventory of Integration's popular EZ family of products, which includes the latest EZLink™ USB dongle which integrates a fully-compliant 802.15.4 wireless interface and the CompXs® ZigBee® protocol stack into many platforms such as computers, gateways and bridge devices. Integration's wireless products also include the popular EZRadio® family of wireless transmitters, receivers and transceivers which are commonly used extensively in point-to-point, star, and mesh networks for consumer and industrial applications.

For wired applications such as dial-up computer modems, set-top boxes, point-of-sale terminals, PBX, VoIP and multifunction peripherals, Integration's EZ DAA™ (Distributed Application Architecture) V.92 and optical chipsets provide worldwide programmability with a distinct price/performance advantage.

The EZSwitcher™ power management ICs include highly-integrated LDOs and converters designed to help customers to reduce bill-of-material costs and board-space.

Nick Dutton, Integration's Director of Customer Marketing, explained, " Although our products are designed to provide high levels of integration and simplify design, ACAL's expertise in network development across a wide range of sectors, can deliver insights which can help even the most experienced customers minimize development risk and bring sophisticated products to market, faster."

ACAL's Martin Kemp, RF & Wireless European Product Manager, explained, "Adding wired or wireless connectivity to existing and next-generation products is the biggest opportunity, and the biggest challenge, for many of our customers. Integration's products are field-proven and give us even more scope to deliver end-to-end support for customers developing commercial and industrial networks."

ACAL Technology's product range supports proprietary and standard wireless platforms based on as ZigBee™, MiWi, infrared and Radio Frequency (RF) connections, as well as wired networks using USB, TCP/IP, Ethernet Can or LIN™. The range includes popular embedded and external device servers and modems, PIC®-based RF modules, RF and microwave filters, frequency generation and frequency control devices.

www.acaltechnology.co.uk

www.integration.com

International Rectifier Announces Executive Management Promotion

International Rectifier has announced a new organizational appointment to the company's leadership team.

Dr. Michael A. Briere, 45, previously Executive Vice President, Research & Development for the company, has been appointed to the role of Executive Vice President, Research & Development and Chief Technology Officer. In his new role, Dr. Briere will be responsible for the company's technology and product development strategies.

Dr. Briere joined International Rectifier in 2003 and most recently served as the company's Executive Vice President, Research & Development. In that role, Dr. Briere led a team of 250 engineers and scientists on all aspects of International Rectifier's research and development programs. Prior to that role, Dr. Briere served as the company's Vice President of Integrated Circuit Development where he was responsible for the company's global research and development of its wafer fabrication processes, device design, and characterization. He also led the electronic design automation and test technologies for integrated circuits used in power management applications.

Dr. Briere holds a BSEE and MS in Physics from Worcester Polytechnic Institute, and a Doctorate in Solid State Physics from the Technical University of Berlin. He also served on the IEEE subcommittee on power devices and ICs, the program committee for the International Symposium for Power Semiconductor Devices and ICs, and was a member of the Advisory Board for the Center for Surfaces and Thin Films at the University of Rhode Island, where he also served as an Adjunct Associate Professor of Physics.

www.irf.com

Cree Announces Corporate Conversion to LED Lighting

Test Results Show 48% Reduction in Energy Usage

Cree has announced plans to convert all lighting at its Durham headquarters and manufacturing facility to LED lighting and released the results of the first phase of the conversion. The parking lots, entryways, lobby and conference rooms at Cree's headquarters building are now 100-percent lit by energy-efficient, environmentally friendly XLamp® LEDs. Cree's LED WorkplaceTM conversion validates the energy savings, quality of light and reality that LED lighting is now a viable option for business and residential consumers.

In a study of the energy usage before and after the lighting conversion, Cree confirmed the energy savings of the newly installed LED lights. The findings indicate that in total the new LED lights use 48% less energy than the incandescent, fluorescent and high-pressure sodium lights they replaced. The combination of the energy savings, reduced maintenance and disposal costs and the environmental savings demonstrate that LED lighting is now a real alternative to traditional lighting solutions.

Cree's local utility, Duke Energy, is collaborating with Cree to explore the benefits of LED lighting.

Cree also announced that it has launched a new website to share the results and implementation details of the LED Workplace lighting conversion with other organizations. The new LED Workplace site, www.ledworkplace.org, will include lighting vendor information and the light, energy and maintenance metrics that form the basis for LED lighting's cost savings. This site will also feature other LED Workplace installations.

www.duke-energy.com

www.cree.com

NI LabVIEW 8.5 Wins Best of Show at 2007 Embedded Systems Conference

National Instruments has announced that LabVIEW 8.5, the latest version of the graphical system design platform for test, control and embedded system development, was named by Venture Development Corporation (VDC) as the Best in Show winner at the 2007 Embedded Systems Conference. VDC, a Massachusetts-based technology market research and strategy firm, recognized LabVIEW 8.5 for empowering embedded developers to rapidly build, optimize and debug designs based on increasingly challenging and complex multicore hardware. Introduced in August, LabVIEW 8.5 extends the LabVIEW embedded platform to program multicore, real-time processors. Engineers can combine LabVIEW 8.5 software with commercial multicore hardware to achieve significant performance gains. Additionally, LabVIEW 8.5 introduces the LabVIEW Statechart Module to help engineers run higher-level designs on targets including field-programmable gate arrays (FPGAs), real-time systems, PDAs, touch panels and a variety of microprocessors. With the LabVIEW Statechart Module, which is based on the Unified Modeling Language (UML) standard, developers can design applications at a higher level of abstraction than previously possible. Statecharts are commonly used to design state machines that model the behavior of real-time and embedded systems to depict event occurrences and responses for creating digital communication protocols, machine controllers and system-protection applications. Embedded developers can use the LabVIEW Statechart Module to design software combined with real-world I/O running on deterministic real-time or FPGA-based hardware with familiar, high-level statechart notations. Developers can shorten their time to market by combining high-level design tools, including statecharts and simulation diagrams, with the low-level multicore support that a single platform provides. To explore resources involving multicore technology or to fully take advantage of processing capabilities in test, control and embedded design applications, visit:

www.ni.com/multicore

Hans Vestberg Appointed CFO of Ericsson

Hans Vestberg has been appointed Chief Financial Officer of Ericsson. Hans Vestberg is presently head of business unit Global Services and Executive Vice President. He will remain in the position as head of Global Services until a successor has been appointed. Vestberg will also remain in his position as Executive Vice President.

"With his experience Karl-Henrik Sundström has been a key contributor to Ericsson's industry leading position," said Carl-Henric Svanberg, President and CEO of Ericsson. "Since Karl-Henrik Sundström took on the position as CFO, in the middle of the industry crisis, he has been instrumental in turning the company around and rebuilding it into the strongest in the industry."

Vestberg joined Ericsson's Group Management Team in 2003 as Senior Vice President and head of Business Unit Global Services. He became Executive Vice President in 2005. He was born in Hudiksvall, Sweden, in 1965. He earned a Bachelor of Business Administration degree from the University of Uppsala, Sweden, in 1991.

www.ericsson.com

Power Events

- ***APEC 2008,*** *February 28-28, Austin, Texas, USA, www.apec-conf.com*
- ***PCIM China 2008,*** *March 18 – 20, Shanghai, China, www.mesago.de/en/PCChinamain.htm*
- ***Productronica,*** *November 13-16, Munich, Germany, www.productronica.com*
- ***PCIM Europe 2008,*** *May 27-29, Nuremberg, Germany, www.pcim.de*

AnalogicTech Launches Low Noise Switching Regulators for Mobile Devices

Advanced Analogic Technologies a developer of power management semiconductors for mobile consumer electronic devices, has announced the first in an extensive family of switching regulators designed for low-noise operation. Based on an innovative new architecture, the AAT2120 and AAT2158 synchronous step-down converters deliver significantly lower spectral noise and output ripple than competing switching regulators. These low-noise switching regulators represent the first of several generations of new switching regulator topologies now under development at AATI that target high performance and high efficiency applications.

At lower currents, the AAT2120 and AAT2158 switching regulators produce half the ringing amplitude of competing switching regulators. This characteristic translates directly into lower noise injection into the system. In system tests, spurious energy injected by the switching regulators was reduced by 3dB. At higher currents, the two new converters produce approximately 25% less output ripple. By reducing injected noise and output ripple, these two new devices can improve the dynamic range performance of RF systems compared to powering these systems with traditional switching regulators.

At the same time the AAT2120 and AAT2158 offer all the traditional power efficiency advantages of traditional switching regulators. Power efficiency for the AAT2120 and AAT2158 reach up to 96% and 95% respectively. Moreover, by operating at high switching frequencies, both devices minimise the size of external components.

The AAT2120 supplies up to 500mA output current, while the AAT2158 delivers up to 1.5A output for applications requiring higher levels of power. Both devices operate from an input range of 2.7 - 5.5V DC and support output voltages as low as 0.6V.

For protection purposes, both step-down converters offer internal soft-start, over-temperature and current limit protection. The new converters also extend system run time by adding 100% duty cycle low-dropout operation.

Qualified across the -40 C to +85 C temperature range, the AAT2120 is available in a Pb-free, 8-pin 2 x 2mm^2 STDFN package. The AAT2158 is also qualified across the -40 C to +85 C temperature range and comes in a Pb-free, 16-pin 3 x 3mm^2 QFN package.

"Designers of noise-sensitive systems, such as mobile phones, media players or Bluetooth™ accessories, prefer to use higher efficiency switching regulators to maximise battery life, but are often unable to do this because traditional switching regulators inject too much noise into the system," commented Bill Weiss, product line director for AnalogicTech. "Instead they turn to low-noise, but lower efficiency linear regulators. Using a unique architecture, which dramatically reduces spectral noise and output ripple, the AAT2120 and AAT2158 offer designers their first chance to take advantage of the power efficiency advantages of switching regulators in noise-sensitive communication, high speed interface and other applications."

www.analogictech.com

System Engineering, a Critical Aspect of Power Management Solutions

By Paul Greenland Sr. Marketing Director, Leadis Technology

A decade ago the power MOSFET became the DRAM of power electronics, a true commodity. Now simple power management building blocks, such as buck regulators, boost regulators and low dropout linear regulators are due to suffer the same fate. Over the years, many semiconductor manufacturers have been attracted to the power management field because of the favorable ratio of tacit to codifiable knowledge; in other words, hard-won applications experience versus that which can be written down, cookbook style. This is all changing at the building block level, mainly due to the efforts of semiconductor manufacturers in Taiwan and China, who can leverage low-cost bipolar and CMOS processes to clone generic functions in record time. One answer to this inexorable transition to commodity is to invest valuable time and applications resource in understanding the target system as well as, if not better than, the potential customer. The alternative is to attack the three power management vectors of performance, space and heat, achieving a commanding lead in one or more. The latter will certainly attract customers who have no viable alternative. In recent years the reduction in CMOS features size has offered a valuable opportunity to manufacturers switching at higher frequency. Specifically, the low noise, ripple and dynamic output impedance offered by high-frequency switching regulators with the inductor inside the package is a better match to next generation CMOS loads, especially below 90 nm. The main reason behind this is the noise susceptibility of analog peripherals designed with small geometry

CMOS transistors. Putting it succinctly, Moore's Law doesn't apply to analog circuitry.

A vital element in the success of the systems engineering approach is the ability to engage with the customer early in the product life cycle, when the technology is emerging, or in the growth phase where it is starting to proliferate. In both these phases the engineer to engineer interface pays dividends as the applications engineer and power management IC designer gain by understanding the customer's situation and design constraints firsthand. This is especially the case with high performance analog IC manufacturers with boutique processes. Unfortunately, once a product reaches the maturity phase the opportunity to interact with the system designer is replaced with meeting Purchasing and the soul destroying multi-vendor cost down environment.

Understanding how effective power management can differentiate a particular end product is an invaluable skill. The sales equivalent of this high yield product definition and promotion activity is known as "consultative selling". The downside of engaging early in the product life cycle is development risk and the time required to research the target application thoroughly. Strong applications engineering, price control and the ability to disengage once a product becomes mainstream or generic are the characteristics of a company which can be successful in emerging technologies.

Customers who employ emerging technology value partners, suppliers who offer the system insight and foresight which comes with a focus on solving problems at the system level. IC designers who focus on the key aspects of the circuit which will yield tangible benefits to the end customer have to clearly understand the parameters which influence overall system performance. Applications engineers in the field frequently have to address questions at the system level, outside the particular device that they are supporting, in order to secure a design-in. The upside of this process is that customers frequently seek out the resourceful application engineer once they have built a track record solving system problems. This creates over-the-horizon radar for new technology; the application engineer becomes an essential product definition resource.

www.leadis.com

Vehicle Infotainment Moving Toward Navigation

Many platforms—endless opportunities

By Marijana Vukicevic, iSuppli Corporation

The rapid expansion of infotainment in vehicles is providing users with a multimedia environment that has the capability to exceed the entertainment systems found in the home. The increased capability has required vehicle manufacturers to look for quality and reliability from their audio and video delivery systems, with playback from a range of prospective storage formats such as optical, hard drive and flash, all of which principally developed to serve the home/PC market.

One of the big areas of interest of infotainment in vehicles is navigation systems. The awareness of GPS-based navigation technology has exploded into the public mindset from early 2006 moving rapidly from a "nice-to-have" to a "must have" product. However, the market for navigation systems still remains largely un-penetrated, with device ownership in 2006 bellow 5 percent of the total available market in the U.S. and approximately 14 percent of the total available market in Europe, leaving immense growth opportunities in these

two market regions in particular.

The market for navigation systems in vehicles is distributed over several navigation device types—embedded navigation systems, Portable Navigation Systems (PNDs) and smartphones.

Embedded navigation systems have been available for more than 15 years but have not gained significant traction until recently in either the European or U.S. markets because of a range of issues, including feature/benefit awareness as well as price. Vehicle manufacturers are now aware of many of the issues and are developing alternatives to the current design philosophy based on improving the perceived value for many of the installed systems. The main obstacle in vehicles ramping up faster with navigation capabilities is that vehicle manufacturers feel pressured to maintain current pricing levels regardless of the price of the vehicles. Navigation systems are an important revenue generator for many vehicle manufacturers with approximately 50 percent gross margins with most systems selling in the range of 1,500 to 2,200 dollars. In the case of the premium vehicle buyer, navigation might add as little as 3 percent to the total car price, while midrange customers would be expected to find an additional 10 percent to 15 percent.

The total available market in 2006 for navigation was 305 million vehicles in Europe and 270 million vehicles in the Americas. Europe and Americas account for more than 90 percent of total portable navigation devices sales worldwide. Both regions are very under-penetrated. In 2006, the install base for PNDs in Europe was just 4.1 percent while in the Americas the rate was a mere 1.3 percent.

Penetration rates for PNDs are expected to reach 31 percent in Europe and 17.5 percent in Americas in 2010.

Smartphone navigation market penetration is mostly dependent on the rate of inclusion of GPS functionality in mobile handsets. As the growth rate of subscribers for mobile handset market with GPS-enabled capability grows, this segment can reach high numbers quite soon.

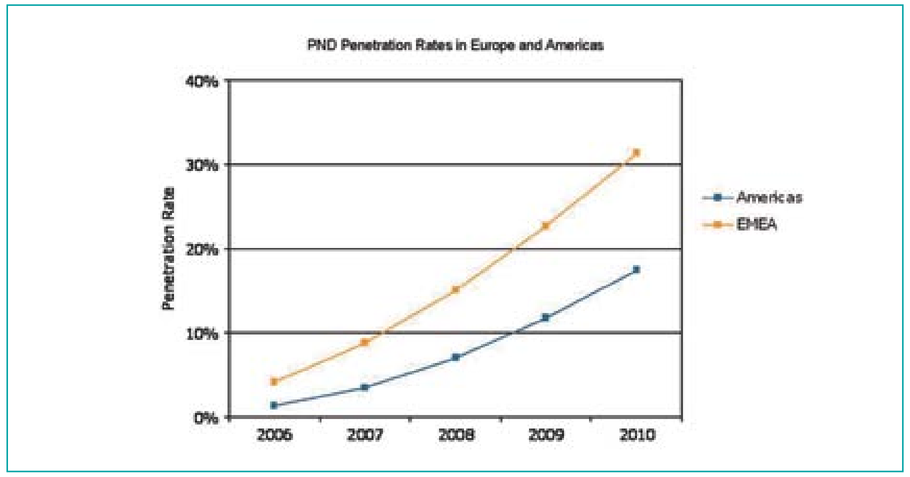


Figure 1: presents the portable navigation device penetration rates for Europe and the Americas for the period of 2005 through 2012.

www.isuppli.com

Digital Power Progresses Onwards

I had the opportunity on my US tour to meet with Davin Lee, Vice President and General Manager of Intersil's Industrial and Communications Power Products group. The hot, although not so popular topic of digital power has been around for some considerable time. Analog designers are naturally nervous about adopting this technology. I asked Davin to give me an insight into the barriers to-date, the advantages and Intersil's unique solution.

Reported by Cliff Keys. Editor-in-Chief, PSDE

What is the status of the digital power market?
The adoption and growth of digital power has been much slower than predicted.

One esteemed IC vendor in the industry predicted in March 2006 that digital power supplies would be $3 billion by 2008 and $8 billion by 2010 but we're not even close to that today. Even so, there are now many digital power products on the market to choose from with papers published from industry and academia on digital power and many solutions demonstrated at trade shows and conferences.

But why is adoption so slow?
We asked customers and what we heard when we asked the question "Why?" was that there was just no time to re-learn power supply design. Power supply designers these days have little extra bandwidth. Not only this, but there are so few power designers out there that they cannot be spared to learn the new technology disciplines. Digital power is seen as having a steep learning curve and using digital power parts requires new workflows and methodologies. Additionally, there is limited reuse of existing infrastructure and knowledge base in power design with analog power chips. Digital power parts are complex compared to existing analog power ICs and digital control loops come in many forms (PID, nonlinear,

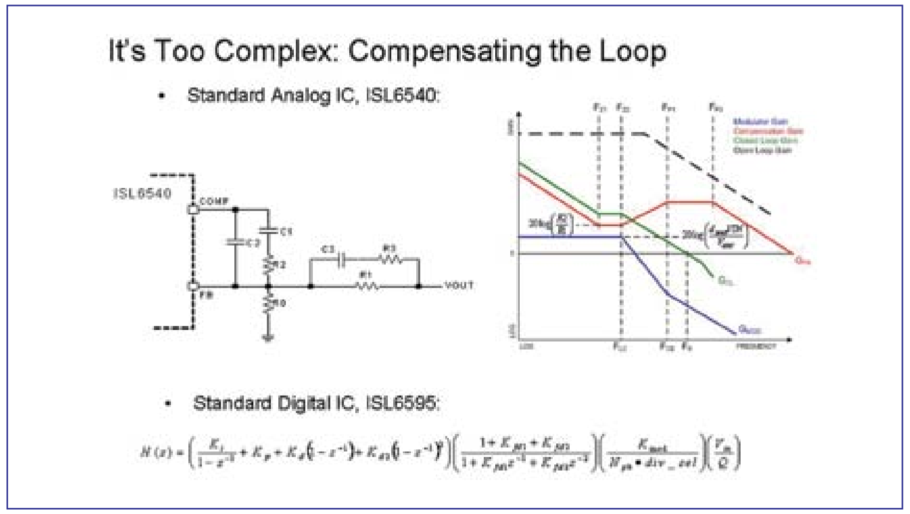
etc.), loop dynamics can differ greatly from one product to another.

Regarding the question of the need to learn digital, there are two camps: the "Old School" and "New School". IC's with digital control loops are eschewed both by young and by experienced power supply designers alike.

The "Old School" power designers equate digital with software. Power supply engineers are hardware experts not software gurus. They perceive that they must write code to use a digital power chip.

But even the "New School" power designers also resist digital because it doesn't look like what they learned in college. On the job training focuses on mainstream solutions and job mentors are the "Old School" engineers.

A new workflow is required. Using digital control loop ICs requires more resources than analog power ICs. It needs a computer for setup, vs. a soldering iron and passive components with specialized software to compensate the loop, instead of well-known design equations and personal intuition/experience.



If we take an analysis in multiple time domains (Continuous, Frequency, and Discrete), for example to achieving desired dynamic performance, it is just too complex:

Analog IC loop dynamics are controlled by passives around the error amp. Voltage-mode, current-mode loops are proven and well-understood. Loop dynamics are a strong function of compensation network and only weakly dependent on actual IC performance.

Digital IC loop dynamics are controlled by programmed coefficients with the performance of the loop depending strongly on the IC implementation.

Ease of use of the loop depends on the provided software and the loop may not behave as an analog engineer would expect and may require multiple iterations to achieved desired performance.

What are the requirements for the perfect digital IC?
There should be no new architecture to learn and it must regulate power like any other analog IC with no new learning to achieve deliverables, no new workflows or design methodologies. It must use existing tools and engineering know-how utilizing the same setup effort as an analog IC. Compensating its loop should be achieved with equal or fewer iterations than for an analog IC and it must provide a simple path to reuse old designs with easy, clear, and familiar instructions.

So, what's the real solution?
What engineers need is an analog heart with a digital brain; effectively a "Hybrid" to provide a digital power IC that looks and feels familiar: an analog control loop with a digital command and control interface, i.e. PMBus.

The architecture of a hybrid chip comprises voltage-mode or current-mode control loop implemented in traditional analog way but with a digital communication interface with digital control logic to provide command & control, data acquisition and loop interface (ADC's and DAC's).

Intersil's ISL8601 PMBus Compliant Hybrid IC features this notion of an analog heart with a digital brain. There are many benefits of using the ISL8601 vs. a standard analog IC. It is clear that there are practical benefits of a hybrid's analog heart such as rapid power supply development and importantly, the reuse of R&D work flows.

The ISL8601 allows use existing in-house design tools. Design procedures do not change and the device can use any pre-existing voltage mode compensation loop and output stage combinations.

But what about existing validation procedures?
Core automated test programs need not change to accommodate designs with the ISL8601 and there are only limited changes to QA procedures. One of the practical benefits of hybrid's digital brain is in addressing specification changes.

The first of kind (FOK) chipset requires a different core voltage whereas the ISL8601 needs only to be commanded to the new Vout via software.

The FOK chipset draws more Power, but ISL8601 needs only to be commanded to the new over-current protection (OCP) via software.

Power sequencing requirements change. ISL8601 needs only to be commanded to change startup mode via software.

Inrush current specifications change. ISL8601 needs only be commanded to change soft-start time via software.

There are also many practical benefits of hybrid's digital brain in terms of saving debug time, cost and in verifying chipset power consumption. Load current can be reported by ISL8601 via PMBus.

To resolve interaction issues with upstream or downstream power supplies, soft start times of ISL8601 via PMBus can be easily adjusted as can turn-on and turn-off delay times, also via PMBus.

In diagnosing non-operating power supplies, simply check status register for monitoring for example, input under voltage, output over voltage, output over current, over temperature faults – among others.

Accelerating testing and debugging by masking faults requires no BOM changes. The ISL8601 provides separate control of fault response from fault detection.

So, we have the best of both worlds featuring an analog control loop with digital communication, the power supply designer can use the hybrid chip in exactly the same way as for an analog Power IC. There is no need to think about digital to get power regulation which is the primary objective. First and foremost, the system is a POWER SUPPLY, the digital aspects are secondary.

The power supply designer can reuse existing power design methodologies and infrastructure; CAD tools, design procedures, know-how, etc. and obtains all the many benefits of PMBus such as configuration, control, and monitoring. Hybrid provides the proven performance of analog with the advantages of precision and control of digital technology.

In summary
Hybrid power IC's provide benefits of digital power IC's while exploiting analog power IC workflows

Hybrid power IC's remove key barriers to the adoption of digital power by established designers

Hybrid power IC's provide a quick path to power supplies with the benefits of PMBus and digital communication

www.intersil.com

DESIGN TIPS

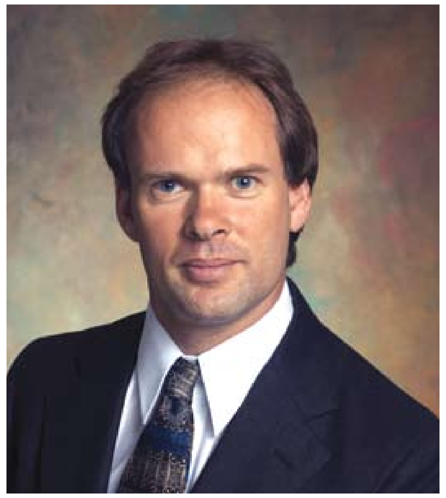
Flyback Converter with No Snubbers

All PWM converters have parasitic components that lead to ringing waveforms which must be properly suppressed. Without this, semiconductors can fail, and noise levels will be higher than necessary. This article describes the most commonly-used RCD clamp circuit used for the popular flyback converter, together with its design equations.

By Dr. Ray Ridley, Ridley Engineering

Without a snubber, the leakage inductance of the flyback transformer rings with stray capacitances in the circuit, producing large amplitude high-frequency waveforms as shown in Figure 1.

Many application notes and designs ignore the ringing waveforms and operate the converter without addressing the issue. There are two problems with this: firstly, there is excessive voltage on the drain of the FET which can lead to avalanche breakdown and eventually failure of the device. Secondly, the ringing waveform will be radiated and conducted throughout the power supply, load, and electronic system, creating noise



issues and even logic errors. The ringing frequency will also show up as a peak of the EMI spectrum in both radiated and conducted EMI.

In most designs, this is not acceptable, and it is necessary to add circuit elements to damp the ringing (using an RC snubber), or to clamp voltages (with RCD clamps), or both. The design of these networks is a combination of measurements and analysis to ensure a rugged and dependable result.

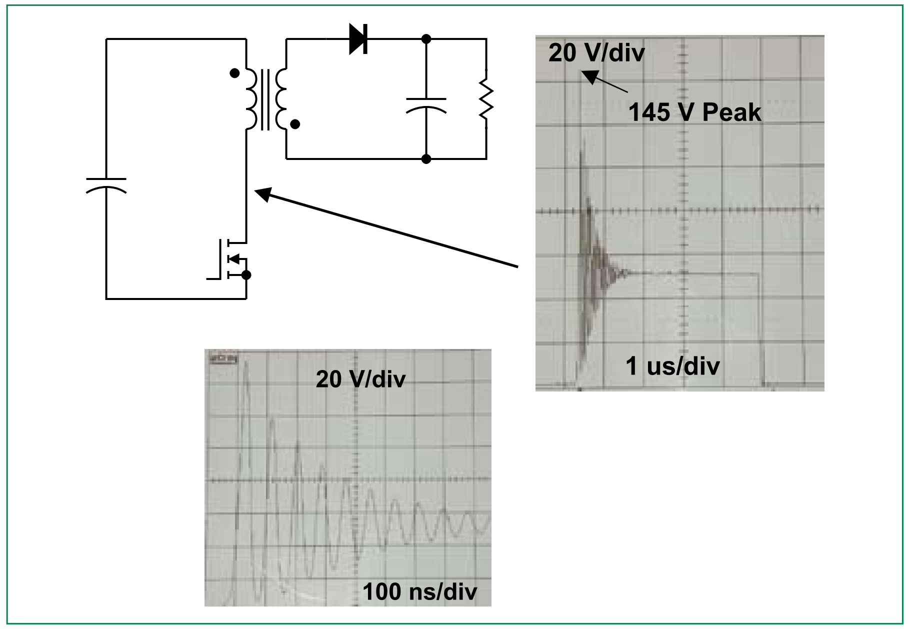


Figure 1: Flyback converter drain voltage.

Primary RCD Clamp for the Flyback Converter

Figure 2 shows an RCD clamp circuit used to limit the peak voltage on the drain of the FET when an RC snubber is insufficient to prevent switch overvoltage. The RCD clamp works by absorbing the current in the leakage inductor once the drain voltage exceeds the clamp capacitor voltage. The use of a relatively large capacitor keeps the voltage constant over a switching cycle.

The resistor of the RCD clamp always dissipates power. Even with very little load on the converter, the capacitor will always be charged up to the voltage reflected from the secondary of the converter, vf. As the load is increased, more energy will flow into the capacitor, and the voltage will rise by an additional amount, vx, above the ideal square wave flyback voltage. The waveform defining these voltages is shown in Figure 2.

Design Step 1 – Measure Leakage Inductance

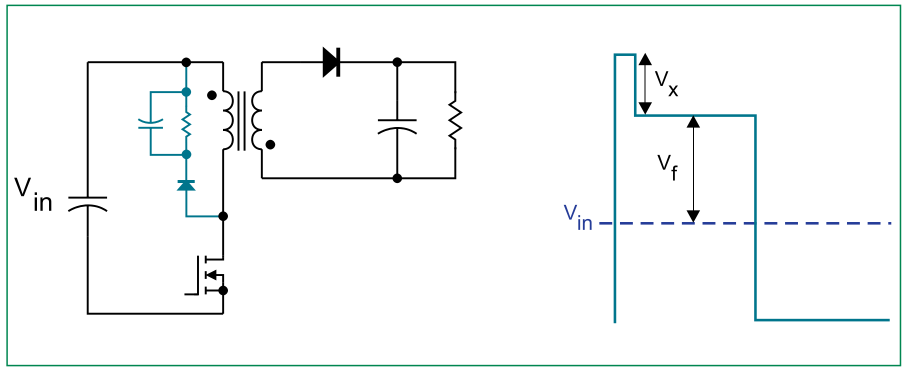


Figure 2: Flyback converter with primary RCD clamp.

It is important to measure the leakage inductance of the flyback transformer prior to designing the snubber. Details of how to do this are given in[1]. Do not just guess at the value of inductance, and be aware that worst-case specifications from magnetics manufacturers are often not accurate enough to use for design. Also, as explained in[2], the leakage inductance is a frequency-dependent, and must be measured at the proper value of frequency.

Design Step 2 – Determine Peak Clamp Voltage

Now you must decide how much voltage can be tolerated on the power MOSFET, and calculate the amount of power that will be dissipated in the clamp with this clamp level. The power associated with the leakage inductance, L, with a current worst-case current Ip at turn-off is given by:

$$P_l = \frac{1}{2} L I_p^2 f_s$$

Analysis of the RCD snubber has appeared in papers and numerous application notes. It is assumed that there are no stray capacitances to charge, and that all the leakage energy is conducted into the snubber capacitor from the leakage inductance. The capacitor is assumed to be large enough that its value does not change significantly during one switching cycle.

With these assumptions, the power dissipated by the RCD clamp can be expressed in terms of the energy stored in the inductor as follows:

$$P_{sn}^{max} = P_l \left(1 + \frac{v_f}{v_x^{max}} \right)$$

In other words, the higher we let the clamp voltage rise on the switch, the lower the overall dissipation. But of course, we must balance this against the total voltage seen across the power FET, so we cannot arbitrarily reduce dissipation.

A typical design is for the voltage v_x to be equal to ½ the flyback voltage. In this case, the dissipation is equal to 3 times the stored energy in the leakage inductance, which is not an immediately intuitive result. This is a conservative estimate, however. It does not account for lossy discharge of the inductor, nor for stray capacitance. In reality, the design will have less loss in the clamp than anticipated due to these effects.

For high-voltage offline designs which are often constrained to use a FET with a maximum voltage of 650 or 700 V, the voltage vx will have a hard limit set by the maximum input line, maximum current, and FET breakdown voltage. Do not exceed the stated Vds of the FET, and be aware that the breakdown can vary with temperature. Some designers rely on the avalanche capability of the FET to let them regularly exceed the breakdown voltage. This is not recommended for rugged power supply design.

Design Step 3 – Select Clamp Resistor

The capacitor of the snubber needs to be large enough to keep a relatively constant voltage while absorbing the leakage energy. Apart from this consideration, its value is not critical, and will not affect the peak voltage when the snubber is working properly.

The resistor is the element that is crucial in determining the peak voltage vx, and it should be selected with the following equation:

$$R = \frac{2 v_x T_s (v_f + v_x^{max})}{L I_p^2}$$

A larger value of resistor will slow the discharge of the clamp capacitor, and allow the voltage to rise to a higher value. A smaller value will result in a lower clamp voltage, but the dissipation will be increased.

Design Step 4 – Calculate Power Loss

The snubber design is now complete, but we often need to know what the dissipation will be for currents other than the worst case current, Ip, in the equations above. Use the following equation to calculate the voltage rise in a known snubber for a given peak current I, and leakage inductance L.

The value of the voltage rise, v_x, above the flyback voltage is given by:

$$v_x = \frac{1}{2} \left(\sqrt{v_f^2 + 2 \frac{L I^2 R}{T_s}} - v_f \right)$$

The power dissipation is given by:

$$P_{sn} = \frac{(v_x + v_f)^2}{R}$$

Design Step 5 – Experimental Verification

Experimental verification of the design is essential since there will be effects

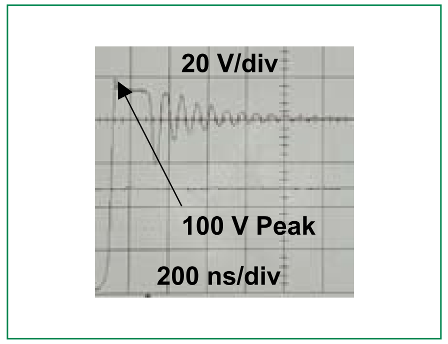


Figure 3: Flyback converter drain voltage with primary RCD clamp.

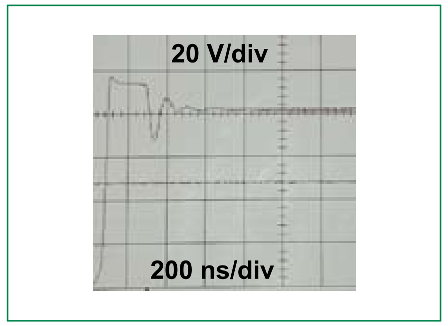


Figure 4: Flyback converter drain voltage with primary RCD clamp and RC snubber.

not accounted for in the equations, and your circuit will have nonideal components. Figure 3 shows the effectiveness of the circuit in clamping the peak value of the FET drain voltage.

This figure also shows a limitation of the RCD clamp. After the clamping period is finished, the circuit resumes ringing. With ideal components, this would not happen. However, the diode of the RCD clamp has a finite reverse recovery time which allows the leakage inductor current to flow in the opposite direction in the diode, resulting in ringing. The type of diode chosen for the RCD snubber is crucial. It must be as fast as possible with the proper voltage rating.

The severity of this ringing will depend on the reverse applied voltage across the RCD diode. The higher you allow the clamp voltage to climb, the lower the dissipation, but higher voltage and dv/dt is applied to the diode, and the ringing increases.

The ringing can subsequently be damped out again by introducing the RC snubber, designed as described in[1]. Figure 4 shows the drain waveform with both an RCD clamp and RC snubber in place. This provides the best protection for the FET, and the lowest EMI signature, but results in the highest power dissipation.

Summary

The RCD clamp circuit is useful for all flyback converters to reduce the stress on the power FET. Make sure that the clamp is designed to restrict the voltage under worst-case operating conditions (high line, and maximum current limit) to less than the voltage rating of the part. The design equations in this article remove the guesswork from the clamp design.

Additional Reading

[1] "Flyback Converter Snubber Design" http://www.switchingpowermagazine.com/downloads/12Flyback Snubber Design.pdf

[2] "High-Frequency Power Transformer Measurement and Modeling" http://www.powersystemsdesign.com/design_tips_janfeb07.pdf

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PSDE Green Power ENERGY EFFICIENCY

SuperLNR™ High Efficiency Low Noise Regulators

DC-to-DC converter with integrated inductor plus series LDO regulator provides the solution

Currently, the most commonly used regulator for voltage conversion is the linear regulator. Requiring only input and output capacitors to filter noise, the popularity of linear regulators stems from its ease-of-use and rapid design times, but there are issues.

By Mike Voong, Applications Engineer, Micrel

There are other numerous advantages of the linear regulator a; they feature low output noise, offer the potential for the highest PSRR of any traditional regulator, produce no noise generating signals that can contaminate other parts of the system and have fast transient response. Combine all these factors, and it is easy to see why linear regulators are so frequently used.

All these excellent qualities aside, the linear regulator does have a disadvantage that prevents it from being used in many applications, namely, unwanted power dissipation. Being a linear element, calculating the power lost in the conversion process is a simple matter; the input voltage minus the output voltage multiplied by the output current. However, as the market trend for lower output voltages outpaces the lowering of common input voltage rails, the linear regulators power dissipation is becoming too high of a burden. Therefore, in order to minimize power dissipation, designers have leaned towards using DC-to-DC converters which produce less heat over a wide input voltage range. In most respects, DC-to-DC converters are inferior to linear regulators as they require higher a degree of design expertise to use and generate higher noise signals, both on the input and output. This can interfere with neighboring devices. With supply

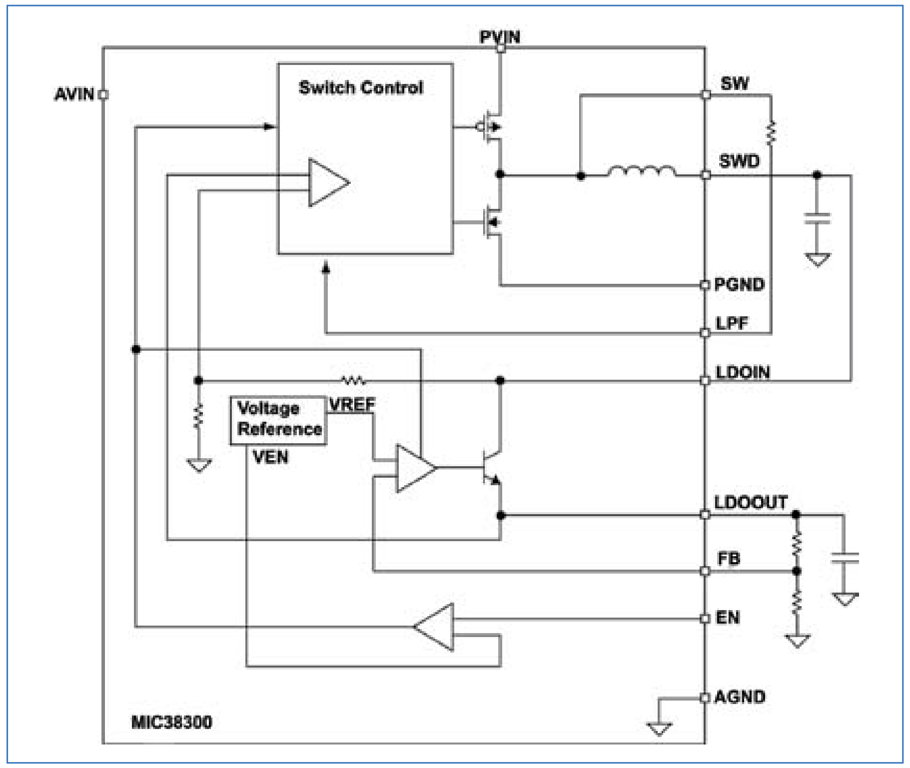

Figure 1. Block Diagram of MIC38300.

voltages of microprocessors, ASICs, and FPGAs reaching 1V and below, the margin for voltage fluctuations is significantly decreased since margins are based on percentages rather than an absolute threshold. Most high-end ICs require supply voltages to be regulated within ±5 percent including any transient voltage deviation due to load swings. This translates to ±50mV on a 1V supply. Factoring in load and line regulation, as well as transient conditions, a 50mV total noise band will then become very difficult to accomplish using switching regulators. In addition, it will normally require high output capacitance as part of trying to minimize the noise and maximize the energy storage for transient performance.

Micrel's SuperLNR Family

Micrel's new SuperLNR™ architecture combines a simple DC-to-DC converter and an integrated internal inductor with a series Low Dropout Regulator (LDO). By using a DC-to-DC converter in the first stage, the efficiency is utilized to help minimize power dissipation. The DC-to-DC converter essentially drops the excess voltage that causes the heat generation in the LDO, but still leaves just enough voltage 'headroom' on the LDO. In this configuration, the second stage LDO still maintains its high PSRR, fast transient response, and low noise without the power dissipation normally associated with the linear regulators. Using a linear regulator as the second stage also allows for a smaller inductor to be used. A small inductor is critical to the SuperLNR™ architecture, as the internal inductor needs to fit inside the one chip solution. However, smaller inductors go hand-in-hand with lower saturation current ratings, thereby creating large output ripples when driven into saturation. With a linear regulator on the output stage, the PSRR of the LDO reduces the effects of a saturated inductor.

The first to be released in the SuperLNR™ family is the MIC38300, a 2.2A continuous, 3A peak regulator. With an inductor built into the chip, this one-chip solution requires minimum external components. Figure 1 shows the block diagram of the MIC38300. The Switch Control sets the switching frequency of the inductor by turning on and off the high and low side FETs. This switcher output drives the LDO pass transistor, while the feedback input ensures a stable output voltage. The Switch Control block also compares the LDOIN to LDOOUT voltage drop, monitoring and keeping the 'headroom' to a minimum. This minimum dropout voltage is accomplished by implementing a voltage divider on LDOIN and comparing the voltage to the LDOOUT voltage. In the block diagram, there is a resistor between the SW and LPF pins controlling the hysteretic frequency controller. This resistor adjusts the frequency of the switching regulator to adapt to the external components, reducing inductor ripple and minimizing output noise. Selecting the LDO pass transistor is also key to minimizing output noise. By electing to use a NPN bipolar transistor, the MIC38300 is capable of providing more than 70dB (at 1kHz) of PSRR, thereby rejecting the majority of noise from the switching output.

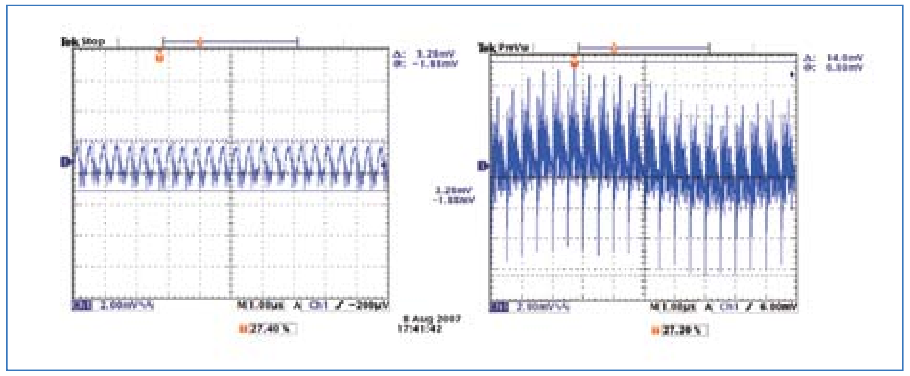
Figure 2. (a) MIC38300 Output Noise (b) 2MHz Buck Regulator Output Noise.

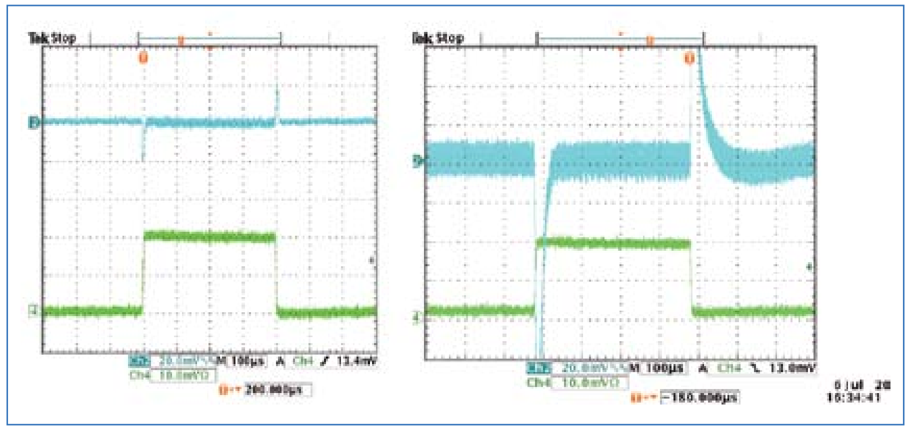
Figure 3. (a) MIC38300 Transient Response (b) Generic Buck Regulator Transient Response.

Performance Advantages

The biggest concern when using a switching regulator lies in meeting the ±50mV tolerance on a 1V supply where there is a significant amount of intrinsic output ripple. A synchronous, fully loaded, single-phase DC-to-DC converter can have between 10mV to 100mV of voltage ripple on the output. Figure 2 compares the output noise ripple from the (a) MIC38300 SuperLNR™ with the noise ripple from, (b) a generic 2MHz Buck regulator when driving a 2A load. The output of the buck regulator has more than four times thee output noise of the SuperLNR™.

Output ripple is not the only challenge designers face when supplying today's advanced processors. The operating frequencies of ASICs and FPGAs have risen to GHz speeds, creating dramatic dynamic load changes. In turn, these fast load changes result in fluctuations on the supply voltage depending upon the response time of the voltage regulator used. The response of the regulator to load changes is referred to as load transient performance.

In general, switching regulators have slower response times to load changes when compared to linear regulators. With proper loop design, the output of a LDO can have gain-bandwidth loops as fast as 10MHz. A switching regulator is limited by the switching frequency, which is generally between 1MHz to 2MHz. Moreover, in order to remain stable under all conditions, the switching regulator needs to roll off its gain and operate with a gain-bandwidth product of one-tenth to one-fifth of the switching frequency. This slower response from the switching regulator translates to a load transient response 10 to 100 times worse than a LDO. Figure 3 illustrates this point by comparing the fast transient response of (a) a generic 2MHz buck regulator to, (b) the MIC38300. It is observed that the switching regulator has larger deviations and slower response times compared to the SuperLNR™ family.

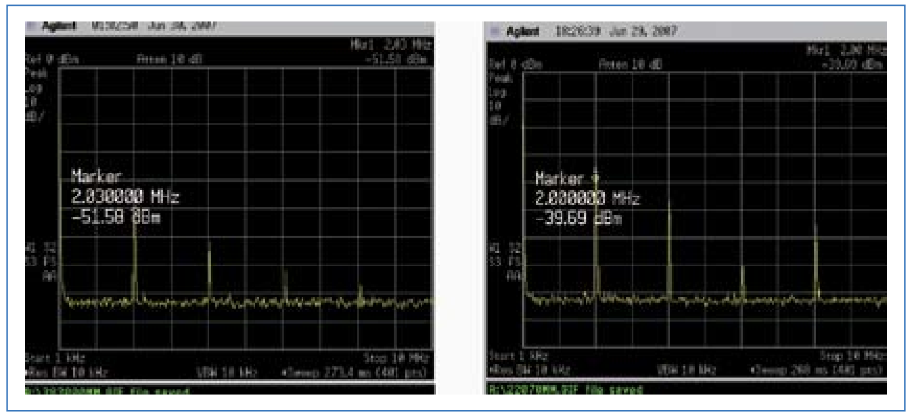
Figure 4. (a) MIC38300 EMI (b) Generic 2MHz Buck Regulator EMI.

An often overlooked characteristic of switching regulators is the electromagnetic inference (EMI) radiated from the external inductor. This added noise affects adjacent power rails and signals close to the external inductor of a switching regulator. The MIC38300 provides an internal inductor within the chip, dampening the area of effect of the EMI. Figure 4 compares the EMI radiated from a generic buck regulator with an external inductor against the MIC38300 at 1-inch from the inductor.

With less noise and faster transient performance, it would seem that a linear regulator is the only solution needed to power processor applications. However, the essential drawback to using linear regulators remains their efficiency. This poor efficiency is caused by the power of the input to output voltage drop being dissipated within the device. For example, the efficiency of a 3.3V to 1V conversation will be 30 percent, and 4.6W of power would be dissipated as heat to provide a 2A output. Even using a TO263- packaged LDO, the die temperature will still rise above the ambient temperature and would be 115-degC. Figure 5 compares the power dissipation within the device of a generic 3A linear regulator to the MIC38300 SuperLNR. With a 2A load, an ideal lossless LDO would have almost three times the power dissipation of Micrel's MIC38300.

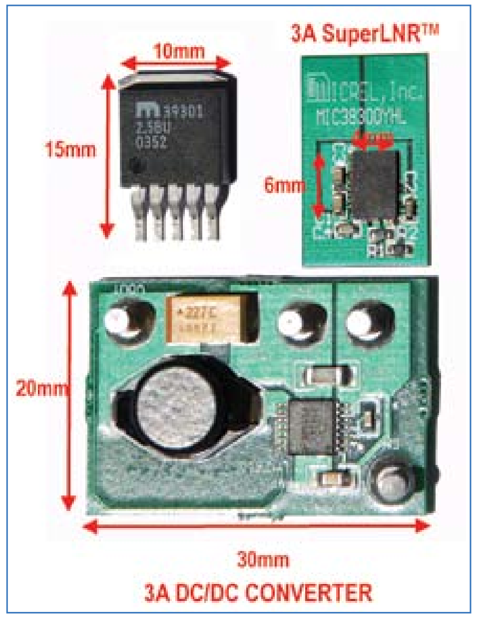

Figure 6. Size Comparisons of Linear, Switching, and SuperLNR™ Solutions.

The SuperLNR™ architecture is designed to save power, but by implementing the architecture into a discrete one chip solution, the MIC38300 is able to save valuable board space. Figure 6 compares the solution size of a linear regulator, switching regulator and the MIC38300. For a 3A LDO solution, a package capable of dissipating that much power would require 150mm^2. A switching regulator solution also requires a bigger footprint to allow for a low DCR inductor with a saturation current rating of 3A. Already hindered by the inductor size, a well laid out DC-to-DC regulator solution size requires more than 300mm^2 of footprint. The MIC38300, with the benefit of being able to drive the internal inductor past saturation, requires a mere 50mm^2 of footprint.

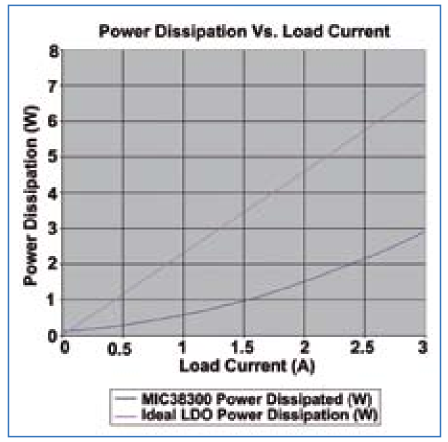

Figure 5. Power Dissipation Comparison of Ideal LDO Versus MIC38300.

Conclusion

Micrel's SuperLNR architecture allows the MIC38300 to achieve ultra-fast dynamic performance and maintain less than 30mV of output deviation during fast load transients. Furthermore, the MIC38300 fits into a 4mm x 6mm x 0.9mm MLF® package that produces less than 5mV of output noise up to a 3A load. This low noise solution benefits both devices down the line as well as adjacent devices due to its lower EMI. Because this package already includes an internal inductor, layout is simplified, providing a solution as easy-to-use as linear regulators. Power supply designers are no longer restricted to either noisy switchers or inefficient LDOs, the SuperLNR™ architecture provides another solution to the low noise versus efficiency trade-off.

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Extreme Capacitance

Bridging the technology gap between conventional capacitors and batteries

SuperCapacitors are increasingly being used to store and supply fast bursts of emergency or supplemental current, particularly in applications which also need compact, lightweight and essentially maintenance-free components.

By Louise Early, General Manager - Passive & Inductive Products, ACAL Technology

SuperCapacitor technology is not new. It is based on the Helmholtz principle of energy storage, first discovered around 1856 by the physicist, von Helmholtz, and realised as a viable component in Japan in the 1980s. Whilst other capacitor technologies can reach capacitance values in the region of 10 micro-Farads, even the early, thumb-sized SuperCapacitor delivered the relatively vast capacitance value of 10 Farad (F), or the equivalent of one million, conventional 10 micro-Farad (µF) capacitors.

The latest generation of SuperCapacitors, developed by WIMA, has extended the capacitance range still, further, reaching values from 100 to 400 Farad for a single SuperCapacitor, with ongoing developments to design products that reach up to 3300 F. When connected in a series or parallel array (cascading) higher rated voltage of higher rated capacitance can be achieved. This allows SuperCapacitors to reach far beyond the conventional range of capacitor functions and to bridge the technology gap between capacitors and batteries, delivering considerably higher, short-term currents than batteries, in a package which is compact, lightweight and, above all, can provide long-term maintenance-free operation.

SuperCapacitor Construction

The working principle of the electrochemical SuperCapacitor is a double-layer of charge carriers which are formed on an electrode in a conductive liquid when voltage is applied. Basic physics states that capacitance value for a conventional plate capacitor is determined by the size of the plate or electrode, the distance between the plates, and the dielectric value of the insulation material which separates them.

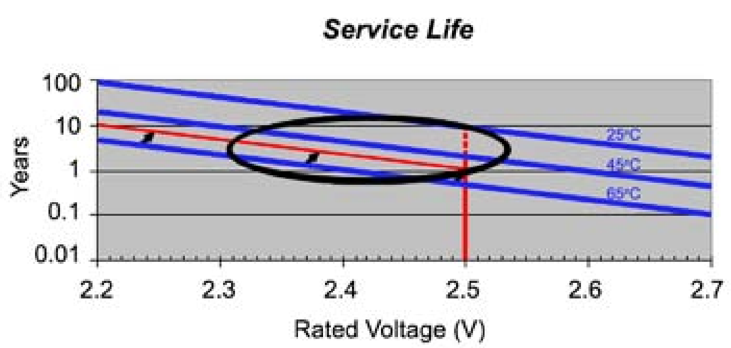

Fig. 1: Life-time of WIMA SuperCapacitors at 2.5V.

WIMA SuperCapacitors, use a carbon-layered electrode attached to an electron-conductive foil. The dielectric strength is tiny, corresponding to half the diameter of an ion, the double layer consists of ions which attach to the positive or negative electrode, opposite to their poles, to create a dielectric of just a few angstrom. However, the carbon-layer electrode delivers an extremely large surface area, roughly equal to the area of a football stadium, packed into a match-box sized case. This allows SuperCapacitors to achieve values of up to 100 Farad per gram of the active mass of the electrode resulting in their light weight and extreme capacitance.

Maintenance-free operation

One of the key advantages of SuperCapacitors is reliability. Immune to breakdowns and short-circuits, SuperCapacitors exhibit only a 10% temperature-dependent derating of capacitance during the first 15,000 charge and discharge cycles. This is followed by a long stable period which can last for a number of years, guaranteeing long-term, maintenance-free operation. Figure 1 shows that, at 2.5V and 65 degrees Centigrade, the life-time of WIMA SuperCapacitors improves by a factor of more than two. In long-term climatic tests series-connected, WIMA SuperCapacitors can withstand changes of over 100 degrees centigrade ranging from -35 to 65 degrees Centigrade, and back, over a number of years.

SuperCapacitor applications

SuperCapacitors occupy the centre ground between the performance of conventional capacitors, and that of batteries. They combine the advantage of the capacitor in providing a fast supply of electricity, with that of the battery as an energy reservoir. Whilst SuperCapacitors can only store around 10% of the total storage capacity of a battery, they are essentially maintenance-free and, at a working voltage of 2.5V, can provide reliable operation over a period of years and even decades, realising considerable savings in maintenance costs. These characteristics are bringing SuperCapacitors into a wide range of applications both as a stand-alone source of power, and as support for existing battery packs.

Green power is a major application for SuperCapacitors. They are, for example, being used as energy buffers in photovoltaic solar panels where they provide an energy conversion system which is relatively maintenance-free and lightweight.

They are also being used to provide the power for the pitch control of turbine blades in wind farms. Mounted high in the gondola, the pitch control system ensures that the speed of the rotary blades remains constant and does not over-rotate even in storm conditions, reducing traction by turning the slim side of the blade into the wind. The pitch control must function self-sufficiently in all weathers and at temperatures ranging from -40 and +70 degrees Centigrade. Given the inaccessibility of the gondolas, reducing maintenance is essential not only for increasing the profitability of land-based systems but also for ensuring the commercial viability of sea-based wind farms.

Automotive manufacturers are also looking for more energy-efficiency, with increased research and development focused on vehicles powered by fuel cell drive. State-of-the-art fuel cells are most reliable when they operate continuously, using a power reservoir to provide load leveling. With low internal resistance, an array of lightweight SuperCapacitors is ideal for this and supports the growing demand for de-centralised on-board electronic equipment without the need to increase the voltage.

Recovery of braking energy is another green application for SuperCapacitors. New research into this topic has shown that 80% of the kinetic energy can be wasted as the car comes to a halt at traffic lights, accumulating currents in the range of kilo amperes. SuperCapacitors can collect, store and make this energy available when the vehicle drives off. Key beneficiaries of this could be the public transport sector, railways and airports which could use SuperCapacitors for reliable and emission-free start-up of vehicles as a means of reducing pollution. Even underground networks could use SuperCapacitors, connected in series at high voltage, as a way of saving space in busy tunnels.

Mainstream applications are also using SuperCapacitors, for example, as emergency generators in uninterruptible power supplies (UPS) and to supply emergency energy for switch-over in telecommunications stations transmitting calls from mobile phones.

Conclusions

By bridging the technology gap between conventional capacitors and batteries, state-of-the-art SuperCapacitors combine the best of both technologies and add a few eco-friendly advantages of their own. Like conventional capacitors, they can store and supply fast bursts of emergency or supplemental current; unlike conventional capacitors, their extreme capacitance allows them to reach values 400 F for a single device with ongoing developments to design products that reach up to 3300 F. When connected in a series or parallel array (cascading) higher rated voltage of higher rated capacitance can be achieved. This makes them a compact and lightweight alternative to batteries, particularly in applications which higher, short-term currents than batteries can supply, combined with long-term reliable and maintenance-free operation over a number of years, or even decades.

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Assessing Device Rds(on) at Wafer Level

New measurement capability for power device engineers

Reducing the electrical and thermal resistance of the wafer-chuck interface enables full characterization of wafer-level power devices.

By Terry Burcham, Technical Support Manager, Cascade Microtech

Known-good-die (KGD) sorting is a commonly used technique in semiconductor processing that allows IC-device engineers to bypass the packaging of defective semiconductor devices while they are still on the wafer, saving time and money. Due to inadequate probes and probe stations, power-device engineers have not been able to take advantage of this powerful technique for the parameter of $R_{DS(ON)}$ in power devices, a key characteristic, and have had to resort to a lengthy and costly packaging process prior to characterization.

However, using a recently developed probe technology, the capability now exists to perform these $R_{DS(ON)}$ measurements directly on the wafer over a broad temperature range. This provides power-device designers with the capability to obtain a wafer map of device $R_{DS(ON)}$ values for each die on the wafer. With this capability, they can determine known good die (KGD) much earlier in the manufacturing process, reducing both development times and manufacturing costs for the device.

As a general rule of thumb, every manufacturing step in the design-and-development process increases total project cost by a factor of ten. The elimination of unnecessary packaging enabled by on-wafer $R_{DS(ON)}$ measurements can therefore substantially reduce design-cycle times and development costs for power devices.

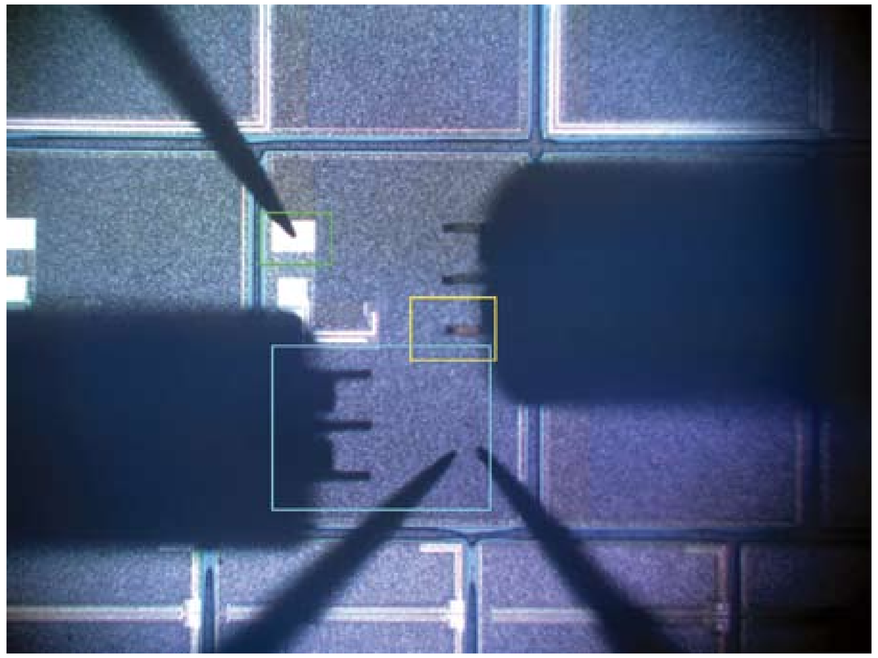

Fig 1. All parameter analyzer SMUs offer "force-and-sense" connections, such as those shown here on an VDMOS device, enabling true Kelvin test conditions.

Key Power Measurements

In the engineering design and development process, it is vital to verify as many parameters of a manufactured device as possible, and also to do so as early in the manufacturing process as possible. The worst thing that can happen is to get to the end of the process and discover that a package failure may have rendered a device un-testable. Without KGD data, the cause of the failure cannot be known.

By testing on wafer, the painful process of finding the root cause of failure in a packaged device is precluded: if a device fails the wafer testing, it will not be packaged. Conversely, if a packaged device fails, either the packaging design or the packaging process is the most likely cause, because the device would have tested good prior to being packaged.

Power MOSFET engineers are confronted with the conflicting demands of providing ever-increasing efficiency and power ratings, while using ever-shrinking process geometries. The solution has traditionally been to drive device $R_{DS(ON)}$ values to lower and lower levels. In general, lowering the on-state resistances of power devices improves their performance. Therefore, $R_{DS(ON)}$ is a key parameter for power-device manufacturers, and can be used as a basis for KGD sorting.

The ability to sort devices based on drain-source resistance, or even the capability to measure the through resistance of the device early in the manufacturing process, is important. This is because these capabilities can enable power-device engineers using leading-edge process technology to design better, more stable fabrication processes for their devices. Processes with these capabilities can also be controlled, modeled, characterized and optimized more effectively by fabrication-process development engineers, dramatically improving process yield.

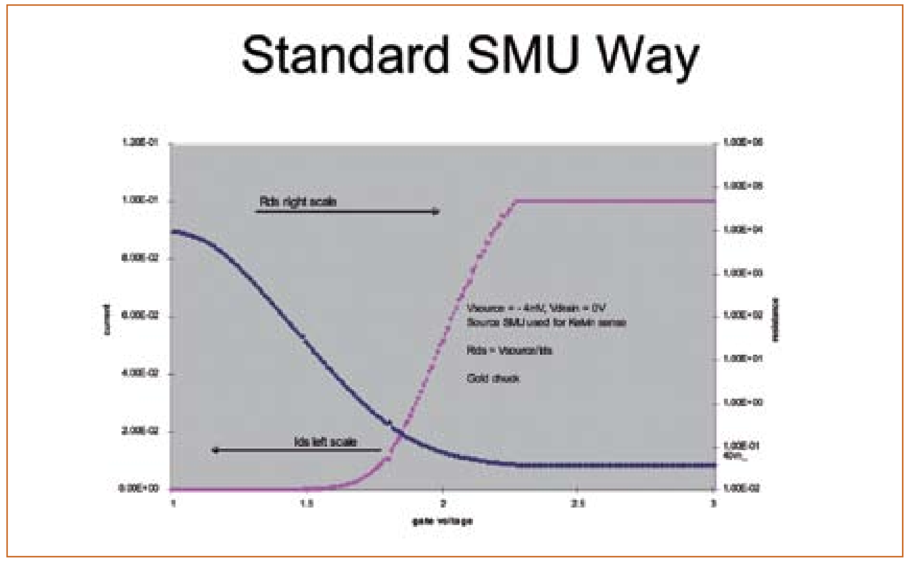

Fig 2. This graph of $R_{DS(ON)}$ measurements for a MOSFET using a standard parametric-analyzer-SMU approach produces an inaccurate reading caused by probe-contact voltage drops being sensed by the voltage probes (compare with Fig. 3).

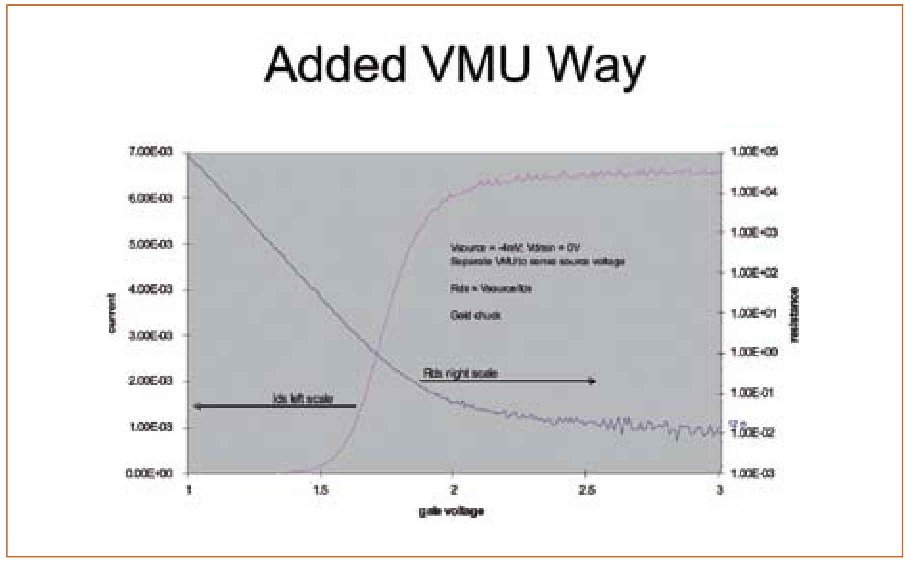

Fig 3. $R_{DS(ON)}$ measurements for the same MOSFET measured in Fig. 2, but using the superior VMU approach, improve accuracy by compensating for high-current voltage drops developed across the contact resistance of the wafer probes.

The basic steps for performing and verifying the key power measurements of a field-effect power semiconductor device are essentially the same for both on-wafer testing and in-package testing. $R_{DS(ON)}$ of the device is derived by dividing the drain-source voltage by the drain-source current. The maximum current rating of the device for a given power rating that might be assigned for a given package type can then be determined by sorting based on the key parameter of $R_{DS(ON)}$. YES

Both voltage and current can usually be measured directly and accurately from the parameter analyzer's source monitoring units (SMUs) for low-power, on-wafer testing. This is accomplished by using the proper Kelvin connections (shown in Figure 1). However in the case of high drain-source currents in a power MOSFET the resistance of the device under (DUT) test may be much lower than the resistance of the SMU test leads, causing significant voltage drops that easily distort the voltage measurements.

To avoid test-lead voltage drop errors for large currents, all parameter analyzer SMUs offer "force-and-sense" connections, enabling true Kelvin test conditions. As the drain-source current increases, it causes a proportionally higher voltage drop, or "force", in the test leads. The "sense" connection measures this voltage drop, which is then supplied to the SMU for calculating the actual drain-source voltage.

Most engineers try to make the key $R_{DS(ON)}$ measurement directly from a parametric analyzer's Kelvin-connected SMUs. However, even when the parameter analyzer SMUs are connected in a true Kelvin measurement, significant errors in the derived value for $R_{DS(ON)}$ have been observed. These errors are mostly due to the voltage accuracy or resolution of the SMU itself. Illustrated in Fig. 2 is an attempt to measure $R_{DS(ON)}$ of a medium-power MOSFET device. The $R_{DS(ON)}$ values were derived using the voltage read from the current-source SMU, yielding 40 mΩ.

Fig. 3 shows the same device measured with a voltage monitoring unit (VMU) added to accurately measure the source voltage used in the $R_{DS(ON)}$ calculation, yielding 12 mΩ. If very-high-power devices are to be fully characterized directly from the parametric analyzer, it requires a VMU to be applied to the source probe (or in some cases both the source and drain probes) in order to get accurate measurements at high currents.

$R_{DS(ON)}$ Die Sorting

In the packaging process, the die is bonded to the package; therefore, there is no significant resistance between the package and the die. Measuring $R_{DS(ON)}$ in a packaged device is beneficial because it accurately simulates the behavior of the die in the situation where it is going to be used. The drawback is the time and cost required to package the die.

Wafer-level measurements are convenient and provide a time and cost savings that are invaluable to process development engineers. The ideal scenario is to marry the accuracy of in-package measurements with the time and cost savings of on-wafer testing.

Until recently, the primary roadblock to performing wafer-level measurements lay at the wafer-to-chuck interface. The electrical resistance between the chuck and the backside of the wafer was significant. Consequently, when engineers tried to sort die by the value of the $R_{DS(ON)}$ measurement, the outcome was actually the sum of the $R_{DS(ON)}$ of the device plus the resistance of the chuck-to-wafer interface, degrading the measurement and skewing results. With such poor measurements, it is not possible to accurately characterize the die.

What is needed is a methodology and tools to test the wafer under the exact conditions it will encounter once packaged. As with all measurements, the goal is to make the measuring tool's effect on the measured parameter negligible. Therefore, the test tools should be transparent to the DUT. For the ideal solution to the problem of measuring power devices on the wafer, this kind of transparency can be achieved by minimizing the resistance between the chuck and the backside of the wafer.

Vacuum Technology Minimizes Contact Resistance

As a designer or consumer of a manufacturer's devices, it is important to know that there has been a paradigm shift in $R_{DS(ON)}$ measurement methodology. Until recently, there were no wafer-chuck technologies that allowed an on-wafer $R_{DS(ON)}$ measurement to correlate wafer-level measurements with in-package measurements.

Cascade Microtech's VacuChannelÔ technology provides the solution to the on-wafer, $R_{DS(ON)}$ measurement challenge. The unique chuck distributes the vacuum more evenly to the wafer than standard holes or ring technologies. The evenly-distributed vacuum, coupled with a highly polished gold top surface, ensures 10 to 100 times lower contact resistances between the wafer and chuck than what is offered by standard chuck technologies.

Another advantage of the VacuChannel technology is its superior handling of thin wafers. The advanced micro-channels will hold down wafers as thin as 80 µm. Prior to now, thermal warping, or "potato-chipping", of the wafer compounded the problems of wafer-level probing for power devices. This occurs because the thickness of power-device wafers are typically reduced for improved die performance, reducing their lateral thermal conductivity. VacuChannel technology significantly reduces the thermal resistance of the contact between the backside of the wafer and chuck, providing superior hold-down capability of the power device wafer.

Using this technology, a true parametric measurement of a particular die for multiple gate-source voltages can be performed at the wafer level, as shown in Fig. 4. This figure contains data for three different metals used for the top surface contact of the chuck. The critical $R_{DS(ON)}$ measurement can be made for each device much earlier in the engineering-development manufacturing process. This eliminates the need to dice, package, test, and then finally sort faulty power devices that might have passed conventional low-power functional testing.

With effective wafer-level testing, all of these steps can be eliminated. For example, referring to the wafer map in Fig. 5, 109 devices were tested in less than 15 minutes using the wafer-testing methodology, as opposed to the conventional multi-step process previously described.

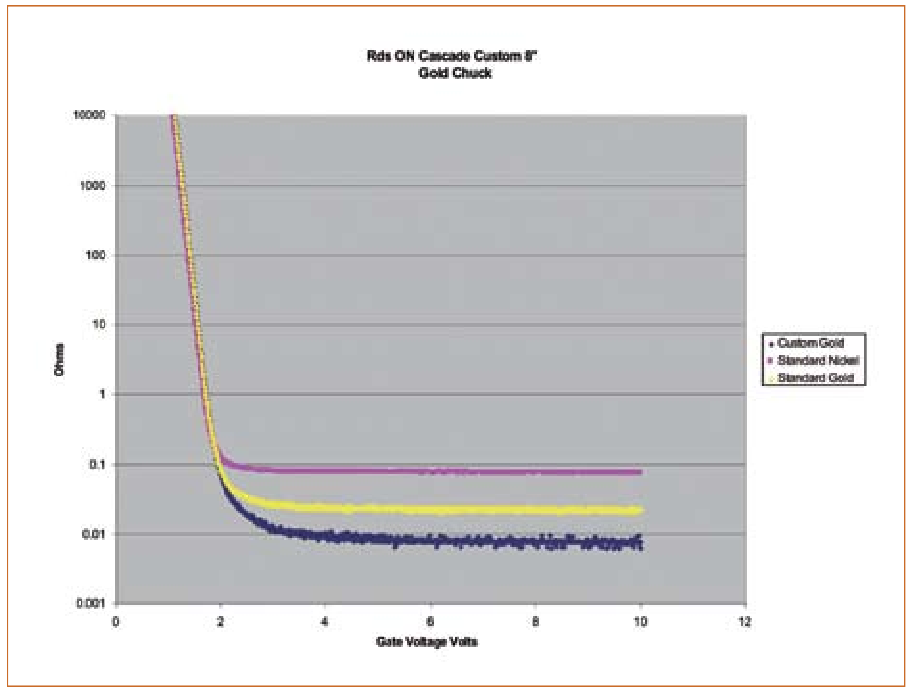

Fig 4. This data for gate-voltage-vs.-resistance was obtained with a wafer chuck using Vacuchannel technology and different metals for the polished top surface.

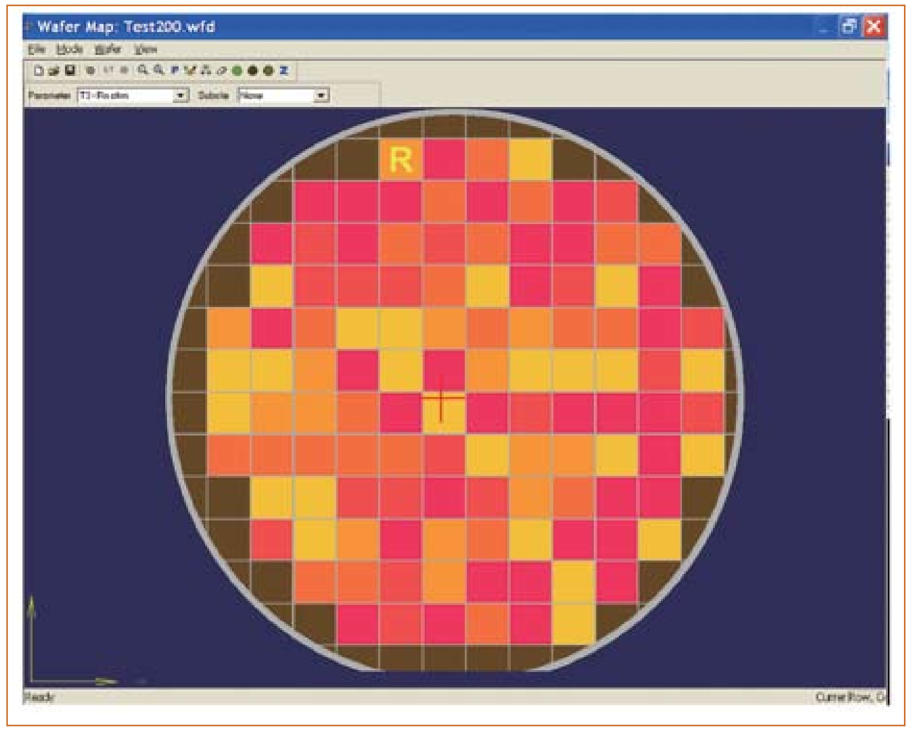

Fig 5. This wafer map illustrates how individual die can be binned on a wafer according to $R_{DS(ON)}$, allowing for the identification of faulty devices before they are packaged, as well as the identification of superior devices that can be sold at a premium.

In order to replicate the results obtained from wafer-level $R_{DS(ON)}$ power-device engineers would need to use the following procedure: first, perform a voltage test; second verify each good die with repeated testing; third, sort out the good die from the bad die; fourth, mark the location of each good die on a wafer map; fifth, cut the wafer into individual die; sixth, pluck and package each good die; and seventh, individually measure $R_{DS(ON)}$ for each packaged device.

Clearly, this conventional process is prone to error. It also takes at least three to four hours of processing, whereas the on-wafer method takes only 15 minutes. Furthermore, when testing system-on-chip (SoC) devices—as opposed to the discrete devices that have been the focus of this discussion—the potential savings from using full on-wafer testing are even greater.

Wafer-level testing also has tremendous advantages for intelligent power modules (IPMs). Without wafer-level testing, the final yield of a module is potentially reduced, starting with the yield of a single die, and decreasing for each additional semiconductor device in the module. Moreover, perfectly good devices are wasted when co-packaged with faulty devices within the same module. The best solution for this problem is the use of a pre-packaging test methodology, such as that enabled by wafer-level testing.

Testing Over Temperature

Another important SoC testing capability for power devices is to test the device over a broad temperature range. For example, when designing a power supply, it may be necessary to guarantee operation in both the heat of remote deserts and the cold of Earth orbit. Thermal characterization in conjunction with full functional testing of the SoC is therefore critical.

This means that each SoC device on a wafer requires full functional testing and characterization for all possible system voltages and all logical input combinations. These tests must be conducted over the operating as well as the storage-temperature ranges for KGD sorting. This level of testing is especially important for military/aerospace applications.

With the dramatic improvement in the heatsinking properties of the VacuChannel chuck technology, testing on-wafer over a wide temperature range is possible. Thermal conditions once restricted to the testing of packaged devices can now be created for the testing of wafer-level devices.

On average, the thermal resistance of a normal chuck is 1°C/W, and a typical wafer chuck can exhibit a 50°C temperature rise. This has effectively prevented on-wafer thermal testing. Specifically, thermal runaway can render electrical measurements useless and can even cause electrical shorts in the measurement path.

VacuChannel technology provides a heat-sinking capability that is an order of magnitude greater than that of conventional wafer chucks, enabling full temperature range measurements from -55°C to 200°C. During testing, it was found the temperature rise on any DUT using the technology was less than 0.1°C/W, reaching 75 W/cm^2 and even 100 W/cm^2 on power-dissipating devices. During these tests, the small temperature increases in the DUT allowed testing across a broad temperature range. This is in contrast with a standard thermal chuck, which could not restrict the temperature, and frequently caused thermal runaway in the DUT.

The VacuChannel technology that provides this capability is available in the Tesla on-wafer power device characterization system. This system performs full-temperature-range, low-contact-resistance measurements of wafer-level power devices at up to 60A and 3000V. Its ability to identify and sort KGDs in the early stages of manufacturing during the design-and-development phase of a power device can dramatically lower costs and reduce time to market.

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PROGRAMMABLE POWER MANAGEMENT

Programmable Power Management Solutions

Power supply sources increase, even as power supply management algorithms become more complex

Today's circuit boards contain diverse and complex technologies.
As the process geometries of current silicon devices shrink,
the power requirements on the individual printed circuit board conversely increase.

By Shyam Chandra, Product Marketing Manager, Lattice Semiconductor

The mix of differing technologies utilized by design engineers is now such that there can be many different voltage and current requirements needed in order to create a robust system design. Not only must the designer choose which DC to DC converters may be required, but also grapple with additional issues of power management techniques such as power supply sequencing, voltage monitoring and current regulation, to name a few.

In this article, power management is defined simply as the management of all power sources (including DC-DC Converter, LDOs, etc.) on the circuit board. Power management includes the following functions:

- Managing circuit board DC-DC controllers – e.g. hot swap, soft start, sequencing, tracking, margining and trimming
- Generation of all relevant power supply status and control logic signals; e.g. reset signal generation, supply fault indication (supervision) and voltage measurement

In the example shown in Figure 1, the hot swap/ Soft start Control Function is used to limit the current inrush in order to reduce the start up load to the power supply. This is an important function in circuit boards that plug into a live back plane; back EMF's and noise spikes could be introduced into the system at this point with potentially catastrophic results.

The Power Supply Sequencing and Tracking function controls how multiple power sources are turned on/off while meeting the sequencing requirements of all the devices on a circuit board.

All supply voltages are monitored for faults (over voltage and under voltage) to warn the processor of an impending power supply failure. This function also is referred to as the Supervisory Function.

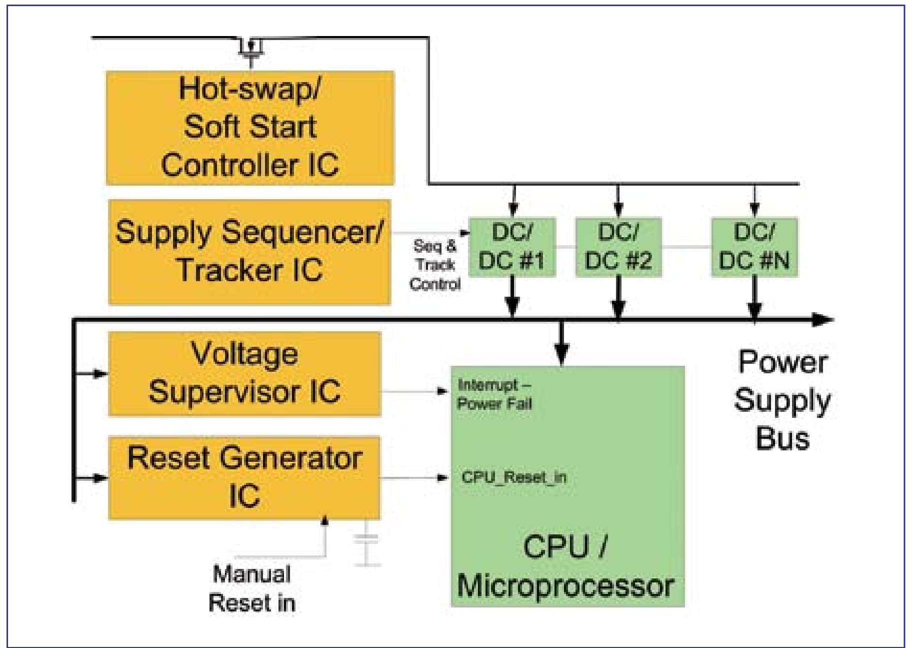

Figure 1: Typical Power Management Functions on a Circuit Board.

The Reset Generation Function provides a reliable start-up for the processor upon power on. Some processors require the reset signal to be active for an extended period of time after all power supplies to the processor are stable. This is also called Reset Pulse Stretching. The function of a reset generator is to hold the processor in the reset mode during power supply fault conditions in order to prevent inadvertent on-board Flash corruption.

Traditional Power Management Solutions

Here, each of the power management functions on a circuit board is implemented using individual, single function ICs. These ICs have a separate part number for each power supply voltage combination. Consequently, hundreds of single function IC part numbers are available, from various vendors, to address multiple power supply management needs. In order to select the Reset Generator IC, for example, would require the following information:

- Number of supply voltages that the Reset Generator IC will monitor
- Combination of supply voltages (3.3, 2.5,1.2 or 3.3,2.5, 1.8, etc.)
- % Fault detection voltage (3.3V-5%, 3.3V-10%, etc)
- Accuracy (3%, 2%, 1.5%)
- Reset pulse extension capability programmed with an additional capacitor
- Manual reset input

In order to address all the possible permutations of these variables, there can be any number of part numbers just for a Reset Generator IC from each of several vendors. Additionally if during the design process the engineer needs to add another voltage to monitor, then yet an additional and different part number may need to be selected. The same is true for each of the other single functions: hot swap controller, supply sequencer and voltage supervisor/ detector. A system with multiple boards will require different sets of these singe function ICs for each board, increasing the Bill of Material (BOM) cost.

Single function ICs may increase the circuit board area and reduce reliability due to the many associated interconnections, which statistically reduces the reliability of a board. Multiple sourcing of different components from different vendors could increase the risk of production delays if even one component is not available. The cost of assembly and testing increases proportionately with the number of components used in a system and the cost of a component is inversely proportional to the number of units procured. Because there are many components required in a given system, fewer components of each type are required to build that system, increasing the overall system cost.

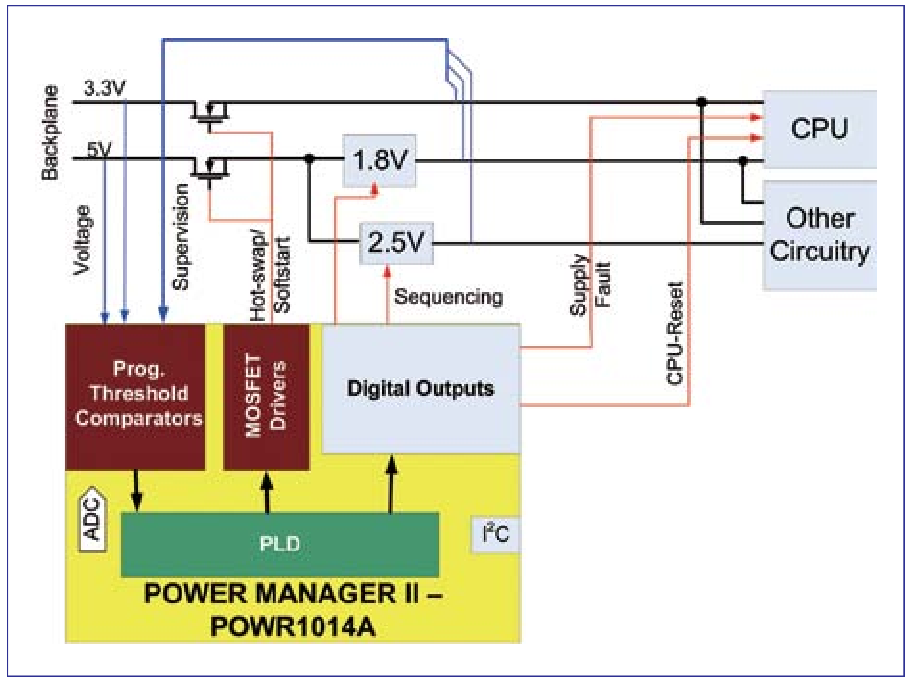

Figure 2: Block Diagram of System using a Power Manager II Device.

If the use of single function power management ICs was ever possible, that time is past. Most circuit boards typically now use several multi-voltage devices, each with a power sequencing requirement. Devices with smaller transistor geometries require lower power supply voltage with increased current. Designers often are required to use one point of load supply per multi-voltage IC. Consequently, the number of power supplies used in a circuit board is increasing. With the increase in the power supply rails, and with the need for multiple sequencing arrangements, power management becomes more complex.

As circuit boards become more complex, the traditional power management solution becomes more unwieldy. Today, a designer implementing power management functions with traditional single function ICs either has to sacrifice monitoring some of the power supplies, or use multiple single function devices for each of the power management functions.

A Programmable Power Management Solution

Because neither of the above alternatives is acceptable, a new approach is urgently needed. This approach is at hand: coupling programmable logic with the traditional power management building blocks results in integrated controllers that bring many benefits to design engineers.

A programmable power management device requires programmable analog and digital sections to facilitate integration of multiple traditional single function power management devices. A designer can configure the programmable analog section to monitor a combination of supply voltages without resorting to using a configuration-specific, factory programmed single function device.

The programmable digital section of the power management device is required to define the board-specific logic that combines the results obtained from the programmable power supply monitoring section to implement functions such as reset generation, power supply fault interrupt generation and the sequencing of individual supplies.

A programmable, software-based design methodology enables the power management device to provide a breadth of board dependent power management functions.

Using a Programmable Power Management Device

One example of a programmable power management solution is Lattice Semiconductor's Power Manager II device. The Power Manager II integrates several programmable digital and analog sections to enable integration of multiple single function power management devices.

The device outlined in Figure 2 is the Power1014A, one of several members of the Power Manager II family. This particular device can monitor 10 power supply rails and, with 14 outputs, implements all the power management functions.

At the heart of the device, and what enables the device's versatility, is a 24 Macrocell CPLD. This CPLD drives twelve open-drain outputs that enable DC-DC converters for sequencing, generating a CPU reset signal or driving LEDs.

Two of the 14 outputs can drive the gate of an N-Channel MOSFET using the on-chip programmable charge pump(generates 12V) to control the MOSFET turn on and turn off ramp rate. Typically, N-Channel MOSFETs are used to implement hot-swap / soft start or as a high side switch for enabling multiple power planes.

Using 20 on-chip programmable threshold precision comparators, the device can monitor up to 10 supplies for over- and under-voltage conditions. The typical precision is 3%, which is sufficient for the majority of applications. The digital monitoring inputs can be used to interface with signals such as manual reset in power and supply shutdown.

For controlling sequence delay, reset pulse stretch and watchdog timer functions, four programmable timers are included on chip, each programmable from 32us to 2 seconds in 122 steps.

A microprocessor can be connected via an I^2C port. Using the on chip 10-bit analog to digital converter allows the measurement of any power supply voltage. The I^2C port also can be used for monitoring the status of power supply comparators, inputs and outputs.

Programmability Enables the Standardization of Power Management

By simply reconfiguring the programmable power management device, a designer can implement all board-specific power management functions. The same programmable device can be used across multiple circuit boards instead of using unique single function ICs. Consequently, designers can standardize on a single programmable power management device across the entire design.

Advantages:

One of the main advantages of integrating multiple single function ICs into one device is the reduction in the circuit board area. Reducing the number of components and associated routing, results in reduced circuit board area and associated cost. Statistically, reducing the number of components also results in increased circuit board reliability.

Meeting Complex Power Management Requirements

The number of power supplies used in today's circuit boards is increasing. Furthermore, the complexity of the monitoring and control functions also is increasing. Because a programmable power management device integrates many more power monitoring inputs (compared to the single function ICs) as well as a programmable digital logic section, these devices are better suited for the implementation of complex power management functions. In addition, programmability offers the flexibility to adapt quickly to changing specifications.

Reduced Overall System Cost

Programmable power management devices typically are less expensive than the sum of the cost of individual single function ICs. In addition, standardization of power management across multiple circuit boards in a system further reduces cost due to increased volume purchase discounts.

Power Management Functions can be implemented in Software

Designs are implemented in programmable power management devices using software. Typically, the software design tools also enable verification of power management algorithms using the on-board simulators. Because power management designs are verified fully before committing them to the circuit board, the likelihood of first time success is high, which further reduces time to market.

Summary

The number of power supply sources used on today's circuit boards continues to increase, even as power supply management algorithms become ever more complex. Yet all too often a "horse and buggy" traditional power management solution is applied to these "turbo-charged" power management requirements, resulting in circuit board designs that are inefficient, costly and usually compromised by tradeoffs.

This article has proposed a design solution to this complex power management problem: the use of a programmable, mixed signal power management device. Designers can standardize on this "power management PLD," using the device across all the system's circuit boards, resulting in reduced cost, increased reliability and faster time to market.

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Renewable Energy Using Solar Inverters

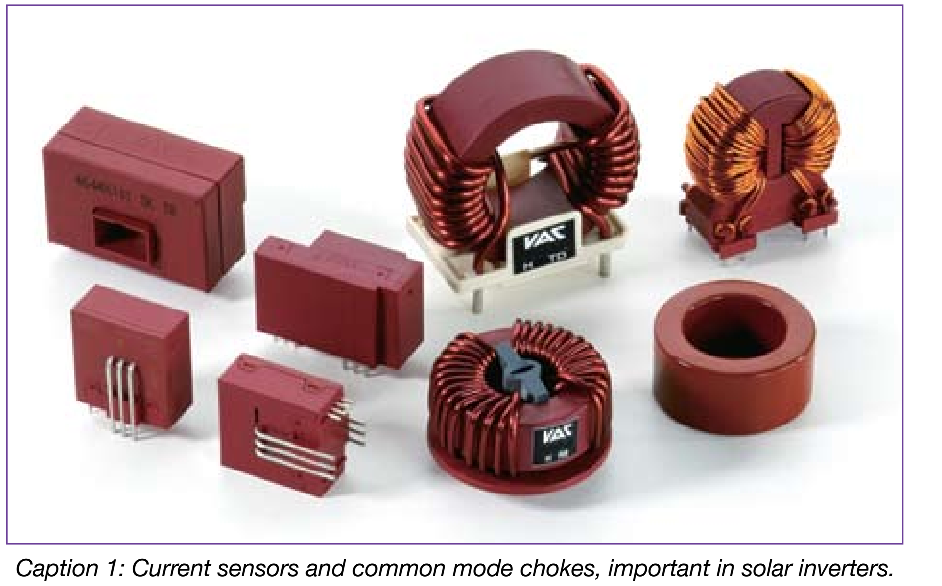
High efficiency and precise power detection

The advancement of photovoltaic technology is not only a vital step towards environmental protection, but also the pathway to almost inexhaustible sources of energy. Solar inverters must deliver maximum efficiency and precision through years of operation, while achieving high energy and cost efficiency.

By Dipl.-Ing. Roman Klinger, Product Marketing Manager, Vacuumschmelze GmbH&Co KG

Solar energy is an eco-friendly and almost inexhaustible source of power. In times of imminent climate change, attention and interest turn to sustainable forms of energy. The regenerative energy market has boomed in recent years, reaching record levels in 2006; according to figures supplied by the German Renewable Energy Federation (BEE), Germany's renewable-energy power generation rose by 11.1% to 71.5 billion kWh in 2006, equal to 11.6% of the country's gross power consumption. At a political level, the resolutions passed at the EU summit early this March have resulted in plans to increase the proportion of the energy mix supplied by renewable energies (such as water, wind and solar energy) from its current level of 6.5% to 20 % by 2020.

As market volume has risen, using solar power to generate electricity has become increasingly profitable. According to a survey by the International Business Forum for Regenerative Energies (IWR), prices for solar power plants of up to ten kilowatt output have fallen from around 14,000 euros to under 5,000 euros since 1991. While the boom in solar power has occasionally resulted in shortages, pushing up prices in the short term, we can assume that the long-term trend of lower unit prices will continue as production technologies continue to advance and solar cell factories expand.



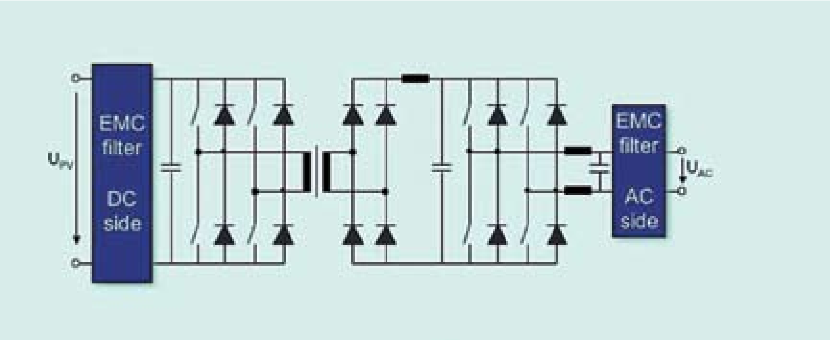
Caption 1: Current sensors and common mode chokes, important in solar inverters.

From solar power system to power grid: current sensors measure grid input

In grid-connected solar power systems, the DC current produced by the solar modules is converted into the AC current (voltage 115V / 230V) by an inverter before feeding into the power grid. Small-scale inverters have a typical output range of between 1.5 and 6 kW, with peak levels of 2 to 4 kW. Larger inverter systems may have outputs of 30 – 100 kW and over.

Current sensors of VACUUMSCHMELZE (see Fig. 1) perform a range of functions in solar inverters, monitoring the AC output current that is fed into the grid and its DC part. For owners of solar power systems, high-precision current measurement is important since it forms the basis of the feed-in tariff. Unlike conventional Hall-effect sensors, VACUUMSCHMELZE current sensors use a patented magnetic field probe of Co-amorphous alloys as a zero-field detector, which offers an array of superior benefits such as minimal offset current and negligible long-term drift. Since the offset current is practically temperature-independent, the current sensors deliver ultra-precise readings under all conditions of use and operation.

The maximum direct current for grid feed-in varies from country to country;



Caption 2: Inverter topology with middle frequency transformer.

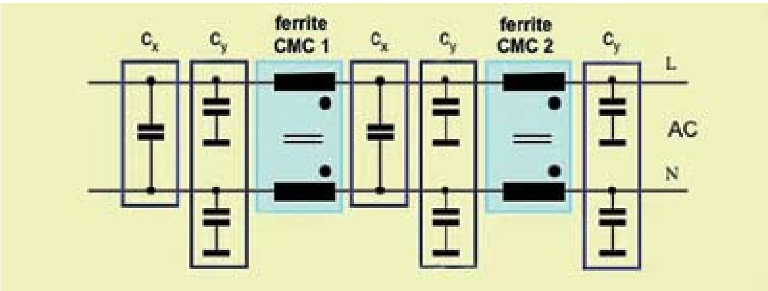
at a maximum of 1 ampere in Germany, it may be as little as a few milliamperes in other European countries. Because the DC component of grid current can saturate distribution transformers or transformers of other grid-connected devices, or trip an earth leakage circuit breaker, permitted maximum tolerances are laid down. Thanks to their design, VACUUMSCHMELZE current sensors are able to deliver readings of both DC and high-frequency AC to error levels typically lower than 0.3%.

Reliability and efficiency

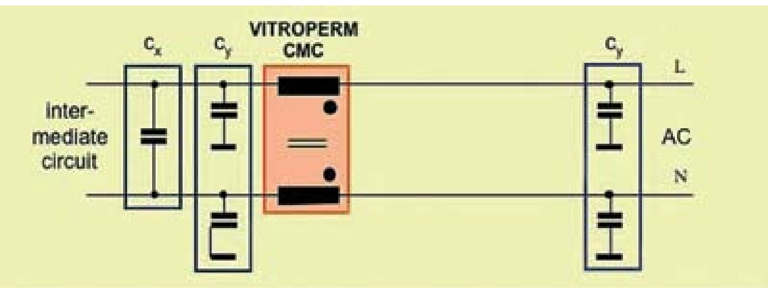
VAC also supplies further innovative products such as Common Mode Chokes for use in the EMC filters of solar inverters. As Fig. 2 shows, they are installed at the input of the inverter (between solar panel and inverter) and at the output to the grid. They are designed to block or damp undesired interference voltage levels which could cause electromagnetic interference between electronic devices. Peak noise levels are specified by international regulations (e.g. EN 61000-6-3) and may not be exceeded by solar inverters. VAC supplies a broad range of common mode chokes for 250 V or 380 V mains operation plus high-insulation models for intermediate circuit voltages of up to 800 V to 1000 V. The chokes are designed to comply with the relevant safety standards EN 50178 or UL1741/UL840.

The main elements of common mode chokes are highly permeable tape-wound cores of VITROPERM®, a nanocrystalline alloy. Primarily composed of Fe, Si and B with additions of Nb and Cu, these materials are produced using Rapid Solidification Technology in the form of thin tapes. They serve as the basis of ultra-compact, high-performance EMC filters with good long-term properties and high temperature consistency, increasing the inverter's reliability and enhancing its efficiency. Recent surveys show that in some filter configurations, overall system efficiency can be improved by reducing the number of filter stages.

Two-stage EMC filters comprising two common mode chokes, multiple capacitors and other components are commonly in use (see Fig. 3). Due to the broadband damping of nanocrystalline common mode chokes a second filter stage is not necessary, reducing the total number of filter components (as shown in Fig. 4) and minimizing system losses to enhance the inverter's efficiency level of over 95 % still further. Since this is reflected in the attractive feed-in payments for solar power, each percentage point of added efficiency can thus be directly translated into return on capital. Manufacturers of solar systems thus strive to increase the efficiency of their designs by even the smallest amount in order to gain competitive edge and win market share.



Caption 3: 2-stage EMC filter with common mode chokes with conventional ferrites.



Caption 4: 1-stage EMC filter with nanocrystalline VITROPERM CMC.

With the specific property profile of low loss and high induction swing, nanocrystalline core materials are ideally suited for pulsed power converters, too.

In general, solar inverters are available both with power transformer and transformerless. In both types, the DC generated by the solar modules is converted to 50/60 Hz AC current which is fed into the power grid or used directly by consumers. Low-frequency transformers serve as galvanic isolation between the inverter and the grid and transfer the 50/60 Hz current generated by the inverter to the grid. Medium-frequency converters, on the other hand, are located between the solar panel and the intermediate circuit of the inverter (see Fig. 2), maintaining intermediate circuit stability despite voltage fluctuations in the solar panels and also functioning as galvanic isolation between the solar modules and power grid.

Switching frequencies of medium-frequency transformers typically range from approx. 30 kHz to 100 kHz. In comparison to conventional core materials, power transformers with VITROPERM® nanocrystalline tape-wound cores feature significantly higher induction and low core loss, delivering a high level of efficiency despite their extremely compact dimensions.

Safety and Personnel Protection

Transformerless inverter designs achieve even higher efficiency of up to 98% and over, and according to expert forecasts are facing major unit-based growth in the future. Statutory provisions stipulate that transformerless grid-feed solar inverters must feature personnel protection in the form of residual current monitoring units. These devices protect operating personnel from high voltage in the separate sub-network, while also protecting the solar plant itself from power surges and undesired frequencies.

In practice residual current monitors are used, which must be able to detect leakage current of only a few milliamperes (at operating current levels of several tens of amperes) and disconnect the system from the grid in the event of fault current. VAC offers very special high-precision current sensors and special tape-wound cores from rapidly solidified materials to perform this complex and critical function.

Solar power systems that meet these requirements will become increasingly important players in the energy mix of the future - and VACUUMSCHMELZE's innovative materials, high-precision current sensors, broadband common mode chokes and low-loss power transformers play a key role in this process

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When Packaging is King

Enhanced MOSFET PolarPAK packaging increases current density in power conversion applications

Two trends in the computing and fixed telecom industry drive the need to remove more heat away from the PCB during power conversion – increased current requirements of next-generation microprocessors and the need to reduce PCB space to enable smaller end products

By Spiro Zefferys, Kandarp Pandya, Jingen Qian, Vishay

This is especially the case for higher-end video and gaming systems, but the trend doesn't stop there. In fixed telecom applications with AC-DC power supplies and point-of-load converters, power densities will double in the near term. For all these dc-to-dc applications, higher currents and miniaturization are resulting in the need to decrease the number of phases in voltage regulator circuits and increase the current per phase. One way to enable these higher current densities is to run more power MOSFETs in parallel so they can share the current. But this approach fails to address the board space issue and may result in more cumbersome designs. A solution has been developed by Vishay, called PolarPAK, which is a robust, manageable double-sided cooling package with a higher current rating that allows the number of phases to be reduced without increasing the number of parts.

PolarPAK is the industry's first plastic encapsulated double-sided cooling MOSFET package for high-current switching applications in servers, VRM modules, graphics cards, POL converters, and power supplies. PolarPAK is named for its ability to cool the MOSFET from both the top and bottom surfaces of the package. When airflow is present or a heat sink is attached, package thermal resistance is reduced and maximum drain current ratings are increased allowing for higher current densities compared to standard SO-8 or PowerPAK® SO-8 packages. The unique construction of the package also provides the benefits for manufacturing, solder joint reliability, and a fixed footprint. The numerous advantages of PolarPAK technology provide an edge to designers seeking robust, high-performance voltage regulation solutions to power the most demanding microprocessors.

Figure 1a. PolarPAK top side.

Figure 1b. PolarPAK bottom side.

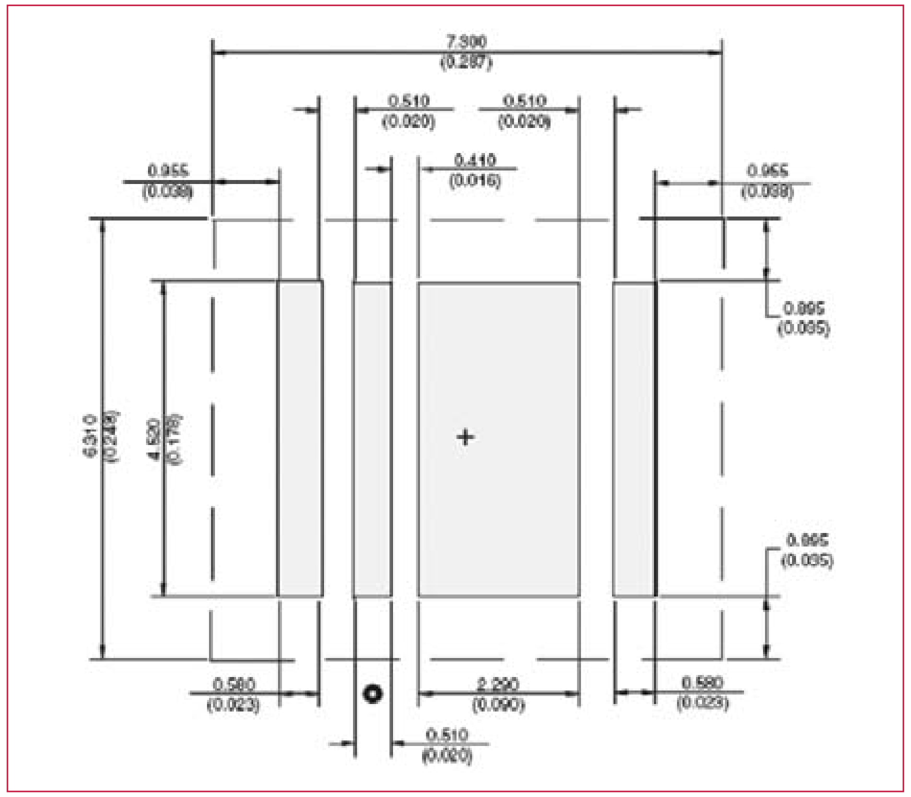


Figure 2. Recommended Minimum PAD Layout.

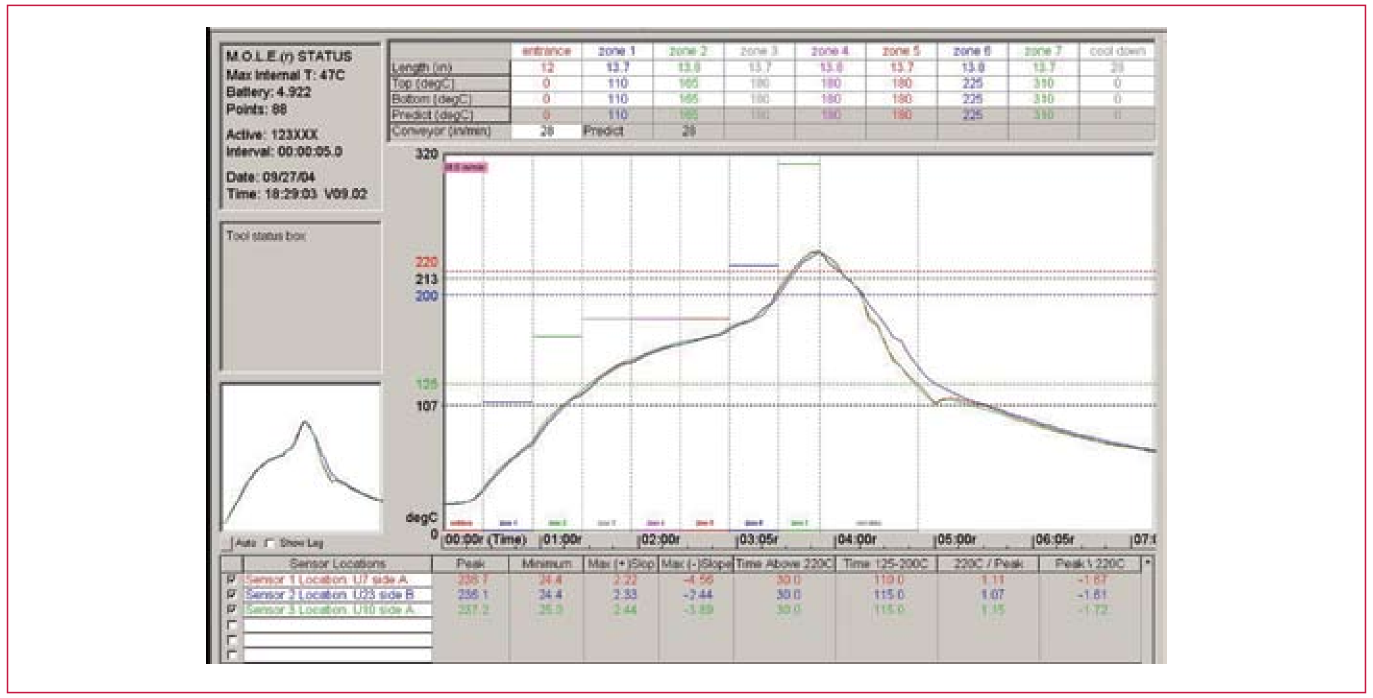


Figure 3. RSS profile for lead (Pb)-free solder paste [Peak temperature: 237°C; Time above 220°C: 30 seconds; Soak time (120-200°C): 115 seconds].

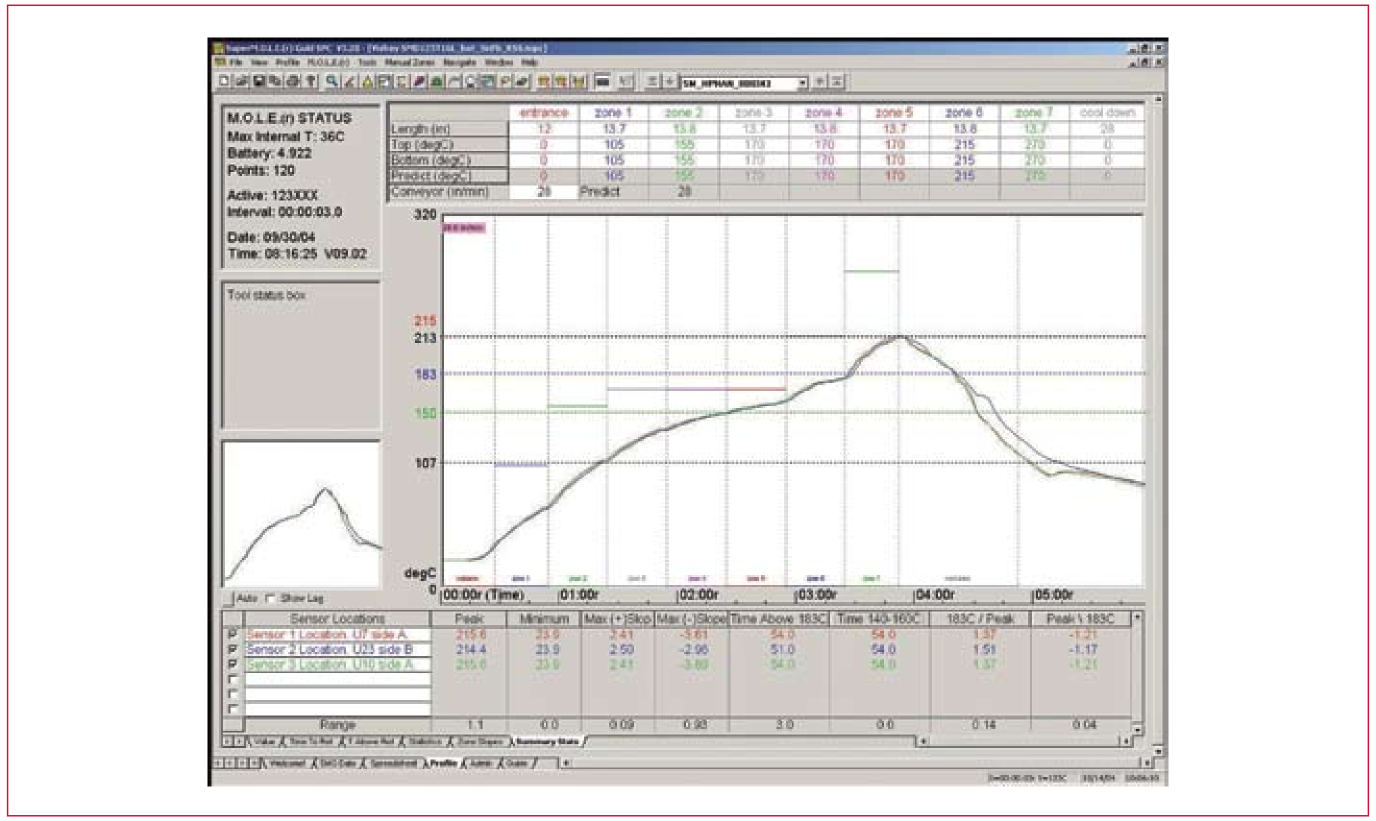


Figure 4. RSS profile for tin-lead (Sn63/Pb37) solder paste [Peak temperature: 215°C; Time above 183°C: 54 seconds; Soak time (140-160°C): 54 seconds].

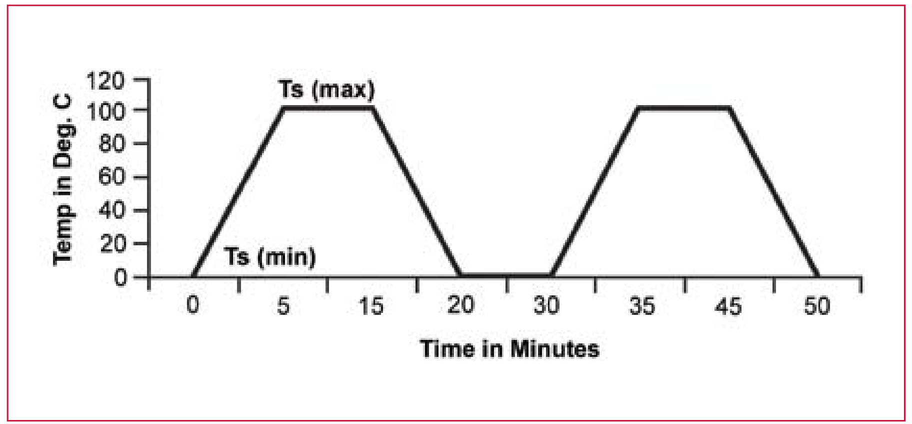


Figure 5. Temperature Cycle Profile TC1 0°C to 100°C tolerance +/-5°C.

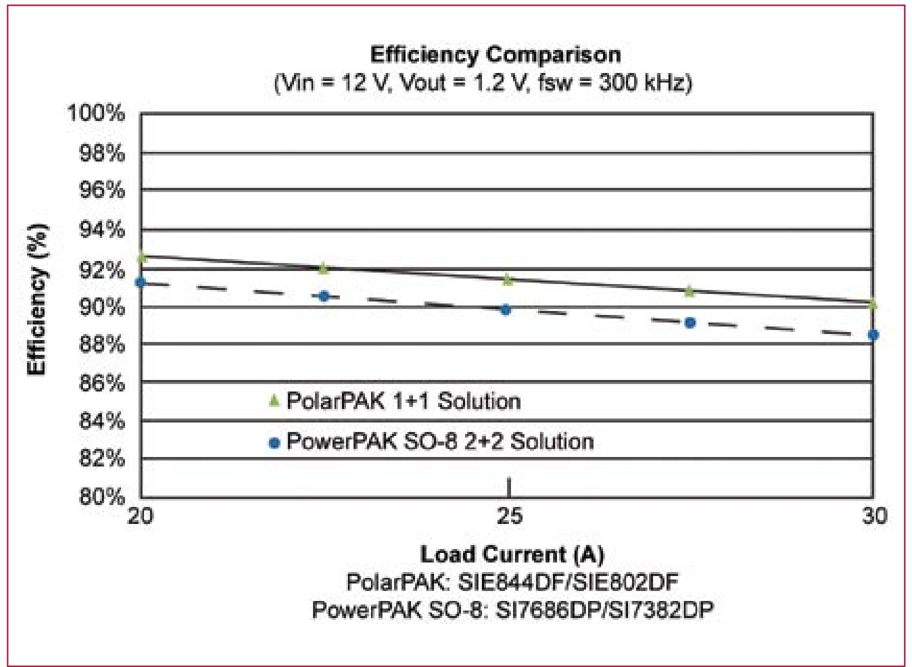


Figure 6. PolarPAK Efficiency vs. PowerPAK SO-8.

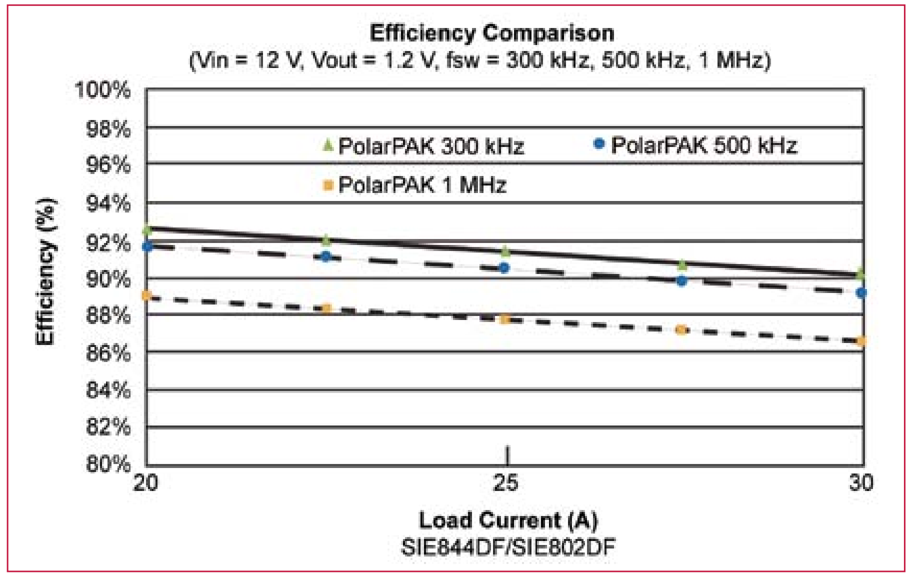


Figure 7. PolarPAK Efficiency at Various Switching Frequencies.

Innovative Package Construction

To maximize performance, PolarPAK relies on an innovative package design. The die is sandwiched in a unique lead frame structure. The drain lead frame is an inverted cup that terminates drain connections at two outer edges of the package. The top surface is exposed to the ambient, which also facilitates mounting a heat sink. With the drain on top, the die is upside-down, with the source and gate terminated directly through the corresponding source and gate lead frames. Therefore each terminal has an adequately large contact area both for electrical and thermal connections. The large termination also enhances solder joint reliability, as we explain below. The unique package design has each termination running the entire width of the package. This arrangement facilitates paralleling of the device without adding complexity to the PCB layout. Additionally, the solder pads extend to the edge of the package, allowing for visual inspection of the solder joints and eliminating the need for X-ray inspection. PolarPAK also provides a fixed pad footprint. Each package, regardless of the size of the die inside, has the same layout. This means that different devices can be interchanged until the desired performance is achieved.

Board Layout and Manufacturing Benefits

When it comes to paralleling the PolarPAK package, PC board layout is greatly simplified. As shown in Figure 2, “Recommended Minimum Pad Layout,” ease of paralleling parts in a vertical column is no problem at all. Copper traces or copper spreading can be used as needed. For copper spreading, Vishay provides minimum pad dimension recommendations that can be used to develop solder masks that ensure accurate part placement and soldering during manufacturing.

Vishay established the manufacturability of PolarPAK by conducting a DOE (design of experiments) with a contract manufacturer. Various parameters related with manufacturing environment have been established for assembly of PolarPAK on a 16-layer PCB. Table 1 lists the solder profile and stencil information used in the experiment to obtain satisfactory results for lead (Pb)-free and

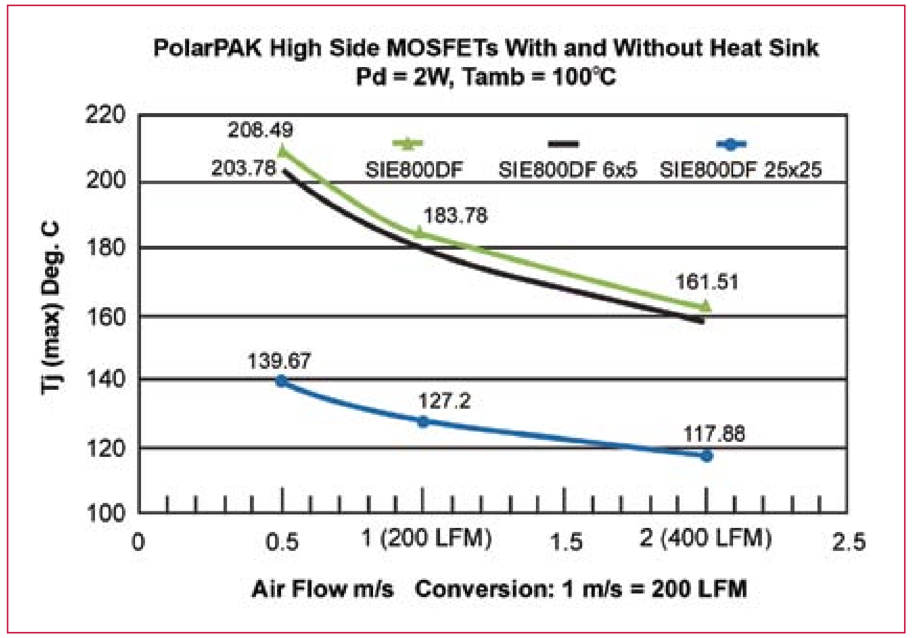


Figure 8. PolarPAK Thermal Performance with Different Heat Sinks and Air Flow.

tin-lead solder processes. For additional details please refer to AN611 Lead Free Solder Process for PolarPAK.

Table 1. PolarPAK Recommended Solder Process Parameters.

Design	Comp Type	Profile	Stencil Thickness	Aperture Design Signal Best
CA	POLARPAK	RSS	5 mils	Component

Additional recommendations are summarized below:

• The minimum acceptable aspect ratio (smallest aperture opening / stencil thickness) is 2.5

• The minimum acceptable area ratio (L x W / 2 (L+W) x T) is 0.8

• The RSS profile shown in Figure 3 is recommended for lead (Pb)-free solder paste

• The RSS profile shown in Figure 4 is recommended for tin-lead solder paste

Solder Joint Reliability

The solder joint reliability of PolarPAK has been established according to the industry-standard IPC-9701 guidelines. A study was conducted on a sample size of 42 parts, including 10 reworked parts distributed on 7 PC board assemblies.

A worst-case PCB design was selected for this experiment using an FR-4 board designed with 16 layers and a thickness of 3.175 mm [0.125 in.] as per IPC-9701 (Figure 3). The layer stack consisted of two outer copper layers of 35 µm [0.5 oz.] and 14 inner copper layers of 12 µm [0.5 oz.] each. Each insulation layer of the FR-4 in between is 231 µm [7,709 µin.]. The alternate signal, power, and ground planes from both sides have copper coverage on each layer of 40 %, 70 %, and 70 % respectively. A concept of a daisy chain layout on PCB facilitates resistance measurement of each solder joint. As per IPC-9701 guidelines, each solder joint was subjected to 3,000 temperature cycles as per the profile shown in Figure 5. PolarPAK passed the 3,000 cycle test with zero solder joint failures, meeting the lead (Pb)-free solder joint guidelines stipulated by the IPC spec. (Additional details of the study can be found in AN610 “PolarPAK Solder Joint Reliability.”)

In-Circuit Evaluations

Table 2. PolarPAK Solder Joint Reliability Test Summary

Package	First Fail	# Failed	% Failed
PolarPAK		0	0%

Simulated in-circuit efficiency evaluations suggest that PolarPAK can be used to increase current density compared to the PowerPAK SO-8 package, which sends heat into the PCB only. Using a buck converter application with 12 V_{IN} and 1.2 V_{OUT}, Figure 6 compares PolarPAK (one high-side and one low-side MOSFET) to the PowerPAK SO-8 (two high-side and two low-side MOSFETs). Efficiency is improved and space is reduced by going from four components per phase to two. Figure 7 shows the performance of PolarPAK operating at various switching frequencies up to 1 MHz. As frequencies increase to enable more compact boards, PolarPAK remains a very attractive solution.

Thermal Analysis

We used ThermaSim, an online thermal simulation tool available on the Vishay web site, to study the thermal performance of PolarPAK. Our comparative analysis used an FR4 double-sided PBC measuring 1 in. x 1 in x 0.062 in. with 2-oz. copper layers on both sides. We specified a power dissipation value of 2W and an ambient temperature of 100°C. The variables were heat sink and air flow. The two simulated heat sinks were aluminum plates with dimensions of 5mm x 6mm and 25mm x 25mm respectively, both with a thickness of 3mm. Figure 8 shows a graphical representation of the thermal simulation results. The clear advantages of using PolarPAK with a heat sink and airflow are apparent in the comparison. Using the double-sided cooling package with a heat sink and airflow can effectively keep the junction temperature of the MOSFET cooler during higher current operation.

Conclusion

The PolarPAK package features a double-sided cooling technology that allows for greater currently density in voltage regulator applications when used with a heat sink and/or air flow. The benefits of the package construction and pad layout make it simple for designers to integrate the device into new designs and maximize ease of use during manufacturing. PolarPAK can be used to power the next-generation processors for computing, graphics cards, and POL applications, as well as high current OR-ing applications in redundant power supplies.

www.vishay.com

Comparison of Front-End Power Supplies to Rectifier Modules

Safety and simplicity are key factors

The convergence of voice, video, and data requires engineers of many service providers to become experts in specifying multiple types of power solutions, including rectifier and front-end systems. This is similar to many purchasing tasks…but they need to know the differences.

By Jim Gaudet, Power-One

The obvious engineering considerations include volts, amps, battery requirements, and compatibility with existing site-level communications protocols. More subtle aspects include implementing safety levels that are inversely proportional to the maintenance-staff's training. As an example, the AC connector on many front ends is front-mounted so that maintenance personnel, with minimal training, can safely disconnect power when doing routine replacements.

Front-End Power Solutions

The input of a front-end is connected to an AC voltage, and its output is a regulated DC bus voltage. This bus voltage, commonly 12V, 24V, or 48V is typically used to power other DC-DC converters; however, it's important to note that front-ends should not be used in applications where batteries are to be charged and monitored. Batteries require sophisticated charging circuitry, and front-end supplies do not have this capability.

Markets Served by Front-Ends

- Networking equipment/datacom
- Enclosures / Cabinet power
- Data storage
- Data Centers
- Blade Servers

The AC input voltage range for a front-end is typically from 87 VAC to 264 VAC, and front-ends will usually be powered from a single-phase input. Some front-ends can be operated from a DC source; however, the AC input version is much more common. The connection to the AC input voltage is usually located at one end of the power supply chassis, while the connection for the output DC bus voltage is located at the opposite end of the power supply.

The AC input connector, e.g., an IEC-type AC plug, is usually located at the front of the supply, and the DC output is located at the rear. Power–One also offers a family of AC front-ends whose input and output connectors are located on the same end.

Figure 1: Power-One FNP1800, 1800-Watt Front-End.

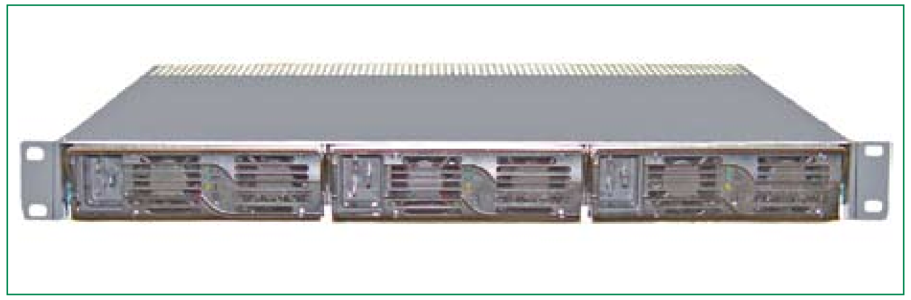


Figure 2: Power-One's FNR-3 Shelf provides up to 5400 Watts in a 1U-High, 19" Rack.

Figure 3: XR04.48/XR08.48 1U-High Rectifier Module (400 Watts / 800 Watts).

Figure 4: AspiroTM Shelf System comprised of a PCC Super-vision Module, Two (2) XR04.48/XR08.48 Rectifier Modules, and a front-access, 5-position Fuse Distribution Module.

The typical output power rating of an individual front-end ranges from 300 watts to 1800 watts. Cooling is provided by internal fans, and the direction of airflow is usually from front-to-rear, although models with reverse airflow are available. All front-end supplies from Power-One incorporate internal ORing FETs and employ a droop method technique for current sharing.

Front-ends are often mounted into a power shelf, such as the one shown below, that accommodates more than one front-end when additional or redundant power is needed.

The typical operating ambient temperature range of a front-end is 0 to 50ºC. These supplies can be operated in ambient temperatures exceeding 50ºC; however, the output power will usually begin to derate above 50ºC. The maximum operating temperature for front-ends is usually 70ºC, and the common derating from 50ºC to 70ºC is 2.5%/ºC, such that the supply will provide 50% of its rated output current at 70ºC.

Status information is provided from the front panel LEDs, logic signals, and via the I^2C management interface. The I^2C bus can also enable the power supply, control fan speed, and adjust the output voltage. Status LEDs give indications of the input voltage, the output voltage, and the presence of an overtemperature condition.

Rectifier Modules in a DC Power System

A typical DC Power System is comprised of a minimum of four components: rectifier modules, a controller/supervision module, and distribution modules mounted in one or more power shelves. Batteries are often part of a DC Power System, as well. Rectifier modules are similar to front-ends, but there are important differences. Perhaps the most notable difference is that rectifier modules, when used in conjunction with a controller/supervisor module, provide sophisticated battery management to adjust their output voltage as required for charging batteries. In general, a rectifier module and assoc-iated power system could be used in a front-end application, but a front-end could not be used in a DC Power System application that requires battery management.

Typical Output Rating of DC Power Systems by End-Application

Micro <3kW	Small <18kW	Medium <400kW	Large <800kW
1. Broadband access 2. Data networks 3. Wireless Base Stations 4. Enterprise	5. Wireless Base Stations 6. Transmission	7. Central Office 8. Data Centers 9. Mobile Switch Sites 10. Distributed Power	11. Central Office 12. Data Centers 13. Mobile Switch Sites

The AC input and DC output connectors are both located at the rear of a rectifier module. The rectifier module's regulated output bus voltage is typically +24VDC (27.25VDC float voltage), or -48VDC (-54.5VDC float voltage), with -48VDC being the most prevalent. Rectifier module cooling is usually provided by internal fans, and the airflow direction is typically from front to rear. Natural convention-cooled rectifier modules are also available. The operating temperature range of today's DC Power Systems will often be from -40ºC to 65ºC with no derating at the complete operating temperature range. Derating will occur between 65ºC and 75ºC. All the rectifiers incorporate internal ORing FETs and employ an active technique for current sharing. Virtually any number of AC rectifiers can be operated in a parallel mode.

Rectifier modules are available in many output power ratings, from 400 watts to several kilowatts. Power-One offers the Magnum REC-J200EH, a 3U-High, 12kW rectifier module which can be used as a building block in an 800 kW Power System. The basic functionality of the individual components of a DC Power System is the same, regardless of the total system power.

The PCC (prime controller card) Supervision Module in the Power System shown above performs several functions. This module is a pluggable microprocessor controller that monitors all system parameters including DC voltage, rectifier current, rectifier temperature, system capacity, battery information, and circuit breaker status. Alarm and warning notifications are indicated

Rectifier – Front-End Comparison

Description	Front-End	Rectifier	Comments
Input voltage range	85 to 264 VAC; 300 VAC for 60 ms	85 to 300 VAC; 300 VAC continuous; >315 VAC disconnect	
Output voltage range	48V ±8% (margin/I^2C). Not designed for battery charging.	44V to 57.5V (temperature/RS485). Designed to adjust output voltage for battery management.	
AC input, DC output locations	AC input available on either front or rear; DC output always on rear.	AC input and DC output always on rear of AC rectifier.	No input/output connection options on rectifier
Input overvoltage protection	VDR, immunity level 3	VDR, NEBS, input overvoltage disconnection, immunity levels 3 & 4, high surge current protection (5 kA)	Disconnect relays require special circuit in rectifiers
Input fuse	1 fuse	2 fuses	
Turn-on behavio	Continuous rise to nominal output voltage	Specific walk - in profile due to possible battery connection	
Output characteristic	U- I (hiccup or latch)	U-P-I (Power limit and constant current)	
OVP threshold level	54V	59.5V	
Redundancy	ORing device	ORing device or fuse with special supervisor circuit	
Current sharing	Droop; optional Active Current Sharing	Active Current Sharing is required.	
Communication	I^2C (industry standard for front-ends); galvanic isolated	RS485; not galvanic isolated	
Ambient temperature	0 to 50°C; derates between 50°C and 70°C	-40°C to 65°C; derates between 65°C and 75°C	Rectifier has wider operating temperature range with less derating
Standby output	Yes; e.g., 12V @ 1A	Not required	Rectifier has no standby output.
Controller, communications	I^2C communication ports built-in.	Communication and control done via Power-One controllers.	Rectifier has no standby output.

on the front panel by LEDs and through potential free alarm contacts that allow remote signaling. External user-selectable alarm parameter monitoring is accomplished through an RS232 port using PC-based PowCom Software. The PCC controller can also provide a wide variety of intelligent battery management, such as: low-voltage disconnect, temperature compensation with programmable compensation factor, automatic and manual load testing, load shedding, and monitoring of remaining battery capacity.

The table below compares various parameters of front-end power supplies and rectifiers. General comparisons were done using Power-One's FNP600-48 front-end and the XR04.48/XR08.48 rectifiers.

Power-One products power high-availability infrastructure applications such as alternate energy, routers, data storage and servers, wireless communications, optical networking, medical diagnostics, railway controls, and semiconductor test equipment.

With its headquarters in Camarillo, California, Power-One has global sales offices and manufacturing and R&D operations in China, the Dominican Republic, Hungary, Ireland, Italy, Slovakia, Switzerland, and the United States.

www.power-one.com

New Low-Profile 720W PFC Module

Emerson Network Power has launched a 720 watt power factor correction module that has a 61 x 89 mm footprint and a mounting height of just 14 mm, making it ideal for space-constrained applications. The new AIT02ZPFC module features a universal input that accepts any voltage in the range 85 to 264 Vac at any frequency from 47 to 63 Hz and from 360 to 800 Hz.

The AIT02ZPFC module presents a near unity power factor to the incoming power line, and generates a typical output of 393 Vdc, which is intended for feeding to one or more high voltage dc-dc converters for further down-conversion to the low voltages required by the application. Emerson Network Power produces a number of compatible high voltage half-brick and full-brick dc-dc converters, with outputs ranging from 1.8 to 48 Vdc. This fully modular approach enables users to build complete high performance, low profile ac-dc power supplies with minimal non-recurring engineering costs and fast turnaround.

When fed with a 230 Vac input, the AIT02ZPFC module has a typical power conversion efficiency of 93%; it can deliver up to 1.83 A @ 393 Vdc and achieves a power density in excess of 155 watts per cubic inch. The module uses active power factor correction to minimise input harmonic current distortion and ensure compliance with the RTCA/DO-160D avionics standard at 115 Vac at full load, and EN61000-3-2.

A number of built-in control and monitoring functions make the AIT02ZPFC module easy to integrate within a system. Remote-enable and temperature monitoring functions are provided as standard, and the output voltage can be adjusted from 79% to 100% of nominal via a single control pin. Inrush current is limited by an external resistor.

AIT02ZPFC modules are fully encapsulated and have an aluminium baseplate for conduction cooling. They have no minimum load requirement and operate over a wide baseplate temperature range of -20 to +100 degrees Celsius. Input-to-baseplate and output-to-baseplate isolation is rated at 2,700 Vdc, and leakage current is held to less than 3 ma at 800 Hz input frequency. The modules are fully protected against over-voltage and over-temperature conditions and carry a full set of international safety agency approvals, including EN60950 TUV and UL/cUL60950.

www.emersonnetworkpower.com

New 60 HV ICs Integrate Host of Protection Features

International Rectifier has introduced a set of next-generation 600V high-voltage integrated circuits (HVIC). This IRS212x family of 600V single-channel gate drivers is suitable for motor control applications at low-, mid- and high-voltage levels and in a variety of circuit topologies including three-phase inverter, H-bridge, and other topologies utilizing MOS-gated power devices.

The IRS212x family provide a gate voltage up to 20V, a typical turn-on current of 290mA, a typical turn-off current of 600mA and accept input logic levels of 3.3V, 5V, and 15V. Integrated protection features include under-voltage lockout protection, over-current detection and protection, and fault reporting.

The new ICs utilize an advanced high-voltage IC process platform, known as G5 HVIC, which enables a host of new features and enhancements. A next-generation high-voltage level-shifting and termination technology delivers superior electrical over-stress protection and higher field reliability.

Platform Technical Details

All G5 HVICs have passed extensive quality and reliability testing. Long-term reliability testing was performed to validate robustness beyond the expected useful lifetime of products in certain application environments. This qualification required the devices pass several stress conditions including a 2000 hour, high-temperature biased test.

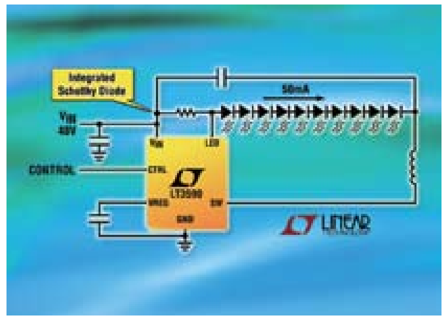
Additionally, the devices benefit from improvements in reliability due to silicon technology and packaging enhancements. The advanced packaging equipment and materials, for example, combined with recent advancements in mold-compound injection techniques, allow these devices to be less sensitive to moisture and provide improvements in the plastic-to-die interface, an important consideration as peak soldering temperatures have increased with the adoption of lead-free soldering materials.

The surface mount SO-8 packages are qualified to MSL2 (moisture sensitivity level 2) while all other surface mount packages are MSL3 qualified. In addition, the new HVICs are qualified to the J-STD-020C standard and comply with International Rectifier's environmental goals and policy.

Data sheets and application notes are available on the International Rectifier Website:

www.irf.com

48V Buck Mode LED Driver Powers Ten 50mA LEDs from a 2mm x 2mm DFN



Linear Technology has announced the LT3590, a 48V, buck mode DC/DC converter designed to operate as a constant-current LED driver. An internal 55V, 80mA switch and Schottky diode enable it to drive up to ten 50mA LEDs in a single series string from a 48V input, making it ideal for industrial and LED signage applications. Series connection of the LEDs provides identical LED currents up to 50mA, resulting in uniform brightness and eliminating the need of ballast resistors. Dimming is adjusted via the CTRL pin and ratios as high as 200:1 can be attained. Its switching frequency of 850 kHz enables the use of tiny inductors and ceramic capacitors while providing efficiency as high as 91%. Combined with a 2mm x 2mm DFN or SC-70 package, it offers a very compact solution for driving high current LEDs.

The LT3590 utilizes a fixed frequency current mode architecture which offers stable operation over a wide range of input and output voltages. A 200mV feedback voltage offers ±5% accuracy, ensuring consistent LED brightness.

The LT3590 is available from stock in either a 2mm x 2mm DFN-6 or 8-lead SC-70 package.

www.linear.com

New IP67 Pushbutton Switch for Harsh Environments

Live Electronics, new specialist electromechanical distributor, released Dailywell's PA pushbutton switch series, for cost sensitive applications in harsh environments. A robust, IP67 rated unit with standard circular bezel new PA pushbutton switches come with encapsulated flying lead or rear gold plated silver solder lug terminations as standard, and a choice of snap-in or 12mm diameter threaded mounting with anti-rotation bushing.

With nine button colours, a further four LED options, 1.5mm travel, and typically a 3N operating force the PA momentary action push-button switch series is at home in harsh, all weather environments. The illuminated versions afford simple, easy identification, whilst the non illuminated range offers optional customized button marking.

Practical for use with panel thickness of 0.8 - 4.00mm PA switches feature a mechanical life of 1 Million operations, for manufacturers of golf trolleys, lawnmowers, invalid carriages, sporting equipment, instrumentation, control panels and more. Cost effective, UL-94V-0 PA switches are rated with an operating temperature of -40/+85 deg C, initial contact resistance of 50mOhm max, dielectric strength of 1,000VAC rms, and max C/V rating (with resistive load) of 400mA @ 32VAC; 100mA @ 50VDC; and 125mA @ 125VAC.

www.liveelectronics.co.uk

Microsemi Expands Power Module Portfolio for Solar Inverters

Microsemi

Microsemi has expanded its line of standard power modules for solar inverters with four new devices in compact SP4 and SP6-P packages.

All four modules feature a boost stage for input power conditioning, associated with a full bridge configuration, for unipolar switching. They combine low saturation "Trench & Field Stop" IGBT top switches that operate at line frequency with fast NPT IGBT bottom switches designed to switch in the 15 kHz to 50 kHz range.

"The introduction of these new power modules shows our commitment to support the solar market with unique products. The implementation of a boost stage, generating a regulated DC supply from the solar cells energy, to feed a full bridge configuration within the same module package achieves a highly integrated inverter power core from the solar panels input up to the inverter's output," said Serge Bontemps, Power Modules Products Development Director in Merignac, France. "These devices in the high power range, offer minimum losses for best system efficiency and size,".

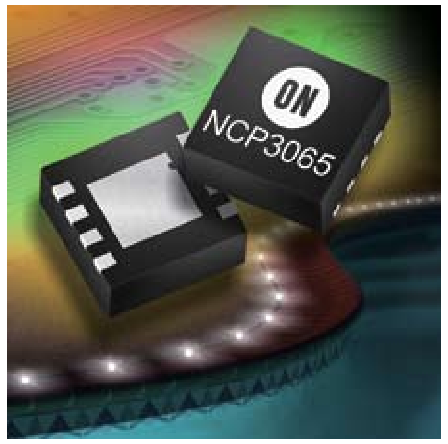
As the previously introduced modules, the diodes in the full bridge section of the new devices are matched to the power transistors for improved solar inverter efficiency as well. High speed, soft recovery DQ series diodes are designed in parallel with the top IGBTs to provide low recovery losses in combination with the bottom fast IGBTs. Low forward voltage diodes protect the bottom IGBTs during output current zero crossings. Integrated thermal sensors monitor the module case for over-temperature protection for SP6-P modules.

These new Microsemi power modules include two 600V and two 1200V models. For each voltage rating the two lowest power devices are offered in the SP4 package while the two higher power ones are integrated in the very low profile, 12mm height, SP6-P housing. The Boost stage of the 600V products is made of COOLMOS(tm) devices while for 1200V modules it is featuring fast NPT IGBTs. In all cases, the boost diode is a high speed, soft recovery DQ type but SiC diode is possible as an option to further increase switching frequency or to reduce switching losses and disturbance.

Technical data sheets of the new power modules for solar inverters are available on the Microsemi website:

www.microsemi.com

New Constant Current Switching Regulators for High Brightness LEDs in Low Voltage and Automotive Lighting



ON Semiconductor has introduced the NCP3065 switching regulator designed to efficiently drive high brightness LEDs (HB-LED) typically used in, low voltage lighting, landscape path and solar lighting, Halogen bulb replacements, and automotive and marine lighting. Several reference designs are available that drive the industry's latest HB-LEDs in various buck, boost and SEPIC applications.

NCP3065 is a 1.5 A monolithic switching regulator that features a very low feedback voltage of 235 mV. The feedback voltage is used to regulate the average current through the LED string in a constant current regulator configuration. The low feedback voltage also allows the use of a smaller and more cost competitive sense resistor. The power dissipation in the sense resistor is reduced by 80 percent compared to competitive devices which utilize a standard 1.25 V feedback voltage. This can result in up to 2 percent savings on the overall system efficiency. The internal reference voltage is trimmed to 2 percent to provide very accurate current regulation even with wide variations in input voltage, LED forward voltage and inductor tolerance.

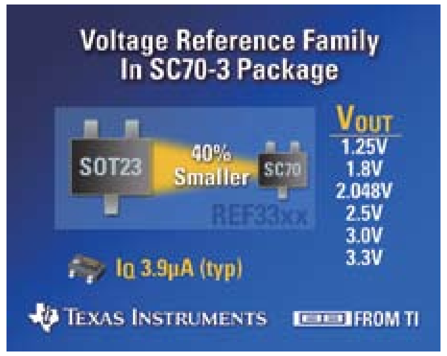
The device has a wide input voltage range from 3 V up to 40 V to allow operation from 12 Vac and 12 Vdc supplies commonly used for lighting applications and unregulated power supplies such as Lead Acid batteries. The devices can be configured in a controller topology with the addition of an external transistor to support higher LED currents beyond the 1.5 A rated switch current of the internal transistor. In a boost configuration, the external switch also enables the capability of higher output voltages.

"The NCP3065 offers our customers a versatile and easy-to-implement regulator for High-Bright LED (HB-LED) applications", said Tim Kaske, ON Semiconductor product line marketing manager for the Power Regulation Product Group. "We had a customer recently looking to utilize a HB-LED in a handheld lighting application. It needed to fit into the existing area and thermal solution of an incandescent bulb. The NCP3065 in the small 4 x 4 mm DFN package was the only solution available that could meet the efficiency, thermal, size and voltage requirements. We are already seeing that with the flexibility and performance of the NCP3065, it is becoming the standard for dc-dc conversion in HB-LED applications at our customers."

The NCP3065 is also available in automotive grade as the NCV3065. The NCP3065 and NCV3065 are offered in a 4 mm x 4 mm DFN-8 package.

www.onsemi.com

Low-Power Series Voltage Reference Family in SC70-3 Package



Texas Instruments has introduced a family of low-power (5µA), series voltage references featuring high accuracy (+/-0.15 percent max) and low temperature drift (30ppm/°C max) in a SC70-3 package – 40 percent smaller than a SOT23. The combination of micro-size packaging and low current consumption make the REF33xx family suitable for portable and battery-powered consumer applications, and its high accuracy and low temperature drift make it a good choice for medical equipment, handheld instrumentation, test equipment and data acquisition systems.

High initial accuracy, low noise (28uVpp/V output) and a robust output drive of +/-5mA enable precision, low power ADC (such as ADS1000 and ADS7866) and MSP430 applications. The low temperature drift minimizes system error over temperature. Additionally, the low dropout voltage of 110mV (typ, 25°C) supports precision spot voltage regulation for battery-powered applications.

The REF33xx family offers six output voltages: 1.25V (REF3312), 1.8V (REF3318), 2.048V (REF3320), 2.5V

(REF3325), 3.0V (REF3330) and 3.3V (REF3333). The devices can operate at a supply voltage 110mV above the output voltage under specified load conditions, except the REF3312 which requires a minimum supply voltage of 1.8V. All models in this family are designed for the wide industrial temperature range of -40°C to 125°C.

The six versions of the REF33xx family are available now in SOT23-3 and SC70-3 packages from TI and its authorized distributors.

www.ti.com

New Family of P-Channel MOSFETs with Lowest On-Resistance per Unit

Built on a new-generation TrenchFET® silicon technology, the new Vishay Siliconix devices offer maximum on-resistance ratings of 29 milliohms in the PowerPAK® SC-70 package (2.05mm by 2.05mm) and of 80 milliohms in the standard SC-70 (2.0mm by 2.1mm) and 130 milliohms in the SC-89 (1.6mm by 1.6mm).

The new p-channel TrenchFETs will be used for load switching, PA switching, and battery switching in portable end products including cell phones, MP3 players, PDAs, and digital still cameras, where their low conduction losses will help to extend battery run times and their miniaturized packages will save valuable board space, allowing increased functionality.

In portable electronic systems, p-channel MOSFETs perform an essential role by turning off features such as the display or the power amplifier when these are not being used, or by switching the system from active mode to sleep mode, and thus saving on battery life. These new Vishay Siliconix devices perform these switching tasks with less power than any previous p-channel power MOSFETs on the market since their very low on-resistance ratings translate directly into lower power conduction losses.

The p-channel TrenchFETs released today include single-channel devices with breakdown voltage ratings of -12 V, -20 V, and -30 V. Offered in the 6-pin SC-89, standard SC-70, and PowerPAK® SC-70 packages, all are lead (Pb)-free to meet today's environmental concerns.

Vishay Siliconix was the first supplier to introduce TrenchFET technology. With these new devices, the company adds to a rich portfolio which includes both n-channel and p-channel TrenchFETs in a wide range of package types.

www.vishay.com

Dedicated Chipset for MR16-Compatible LED lamps

Zetex Semiconductors has developed a novel dedicated chipset and reference design for MR16-compatible LED lamps. Reducing the component count of existing solutions by up to 50%, the chipset significantly decreases the size and weight of the PCB in the neck of the lamp and the overall cost of lamp manufacture.

The highly integrated MR16 chipset handles all associated power rectification, LED current control and protection functions. MR16, the standard format for halogen reflector lamps, is used extensively in directional lighting applications in residential, retail and office environments. LED based variants can offer dramatic improvements in efficiency and reliability.

Chris Jolly, VP Marketing, Smart Application Specific Products at Zetex Semiconductors said, "The chipset is an optimized and highly robust solution for the MR16 application and confirms Zetex' technology standing in the lighting sector. Customers were telling us that existing MR16 LED lamp designs simply weren't optimised for efficiency and ease of manufacture, so we took a tailored, top-down approach to make sure ours was."

He continued, "It's also important not to overlook a significant green argument for switching to MR16-compatible LED lamps. Not ignoring the fact that LED based lamps have a lifetime some five times longer than their halogen counterparts, they also play a key role in the fight to reduce energy consumption and the carbon footprint of residential and commercial properties. Over its lifetime each LED based lamp can help reduce green house gas emissions by up to a ton when used instead of a traditional halogen lamp.

Paul Thieken, Cree Director of Product Marketing for XLamp™ LEDs said, "We have worked closely with Zetex for a number of years and firmly believe that this chipset, when combined with Cree LEDs, can provide MR16-compatible lighting manufacturers with an optimized overall solution for what is a technically demanding application."

Irving Pun, Director, Global Markets Development at Civilight Shenzhen Semiconductor Lighting Company said, "In the manufacture of MR16-compatible LED lamps, the electronic control solution that's deployed needs to be reliable. What Zetex has given me here is a very simple and highly manufacturable solution that allows me to focus my attention on optimising the thermal and optical performance of our MR16 product."

A design note on the Zetex MR16 LED lamp solution can be found at:

http://www.zetex.com/3.0/appnotes/design/dn86.pdf

www.zetex.com

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Power Systems Design Europe

Green Page

PSDE Green Power
ENERGY EFFICIENCY

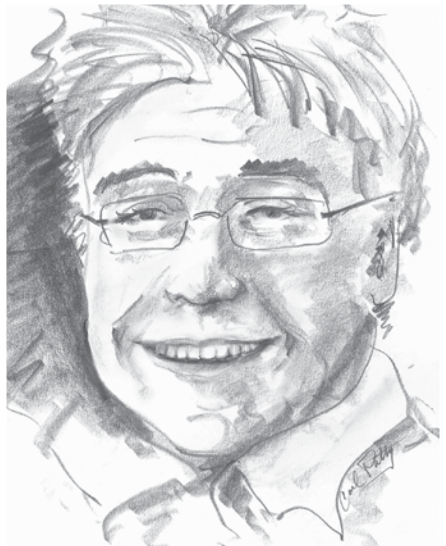
Renewable Energy Needs Driving

An excerpt from Vinod K. Sharma/ New Delhi, as recently published in the Business Standard

Reported by Cliff Keys, Editor-in-Chief, PSDE

These days, we see a whole raft of proposals and general head nodding for the use of wind power as a source of green energy. These have been implemented in varying degrees by European member states and it seems everyone is basically in agreement that this is the way to go. The proof of this will be in trade and investment rather than committee outputs.

The European Wind Energy Association (EWEA) reported that legislative uncertainty is by far the most dangerous enemy for a growing industry such as the wind energy sector. Any shift from the current successful situation must be well prepared in order to maintain investor confidence and the current speed of development. Therefore, EWEA strongly recommends that the creation of a truly competitive Internal Energy Market should precede the establishment of a single trading mechanism for renewable electricity in Europe rather than following it.



EWEA fears that “virtual trading”, as currently debated, would lead Member States to engage in strategic gaming exercises where Member States would frequently adjust their national frameworks to ensure that their support system is attractive enough to maintain domestic action (CO_2 reductions, employment, economic activity) while avoiding catching the attention of foreign exporters. Such frequent adjustments would increase the risk dramatically compared to the present framework and would certainly not be a cost effective solution.

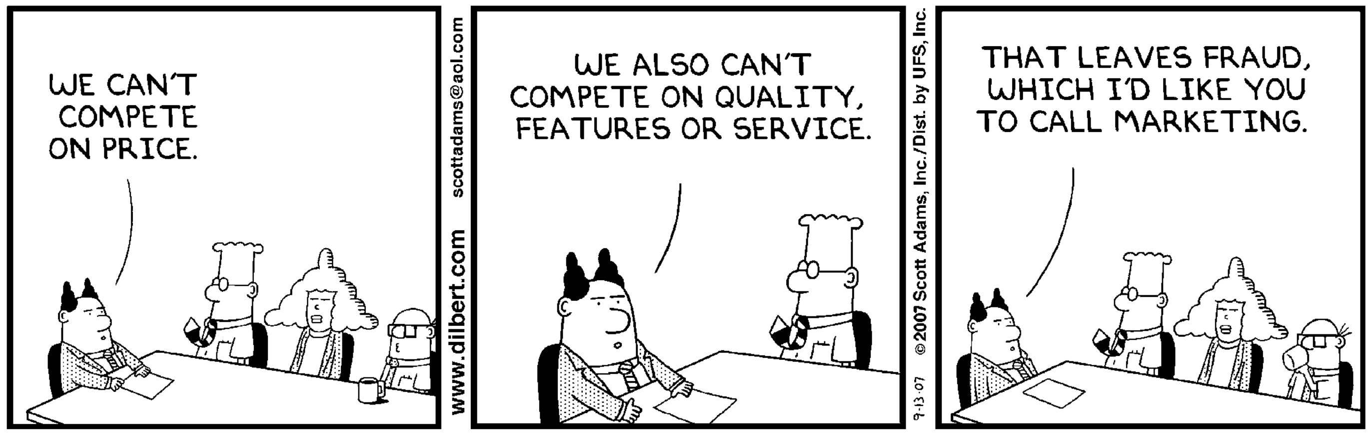
In a trading context, if each national plan for renewables is affected by decisions taken in other member states, there is a major risk that the market becomes highly distorted.

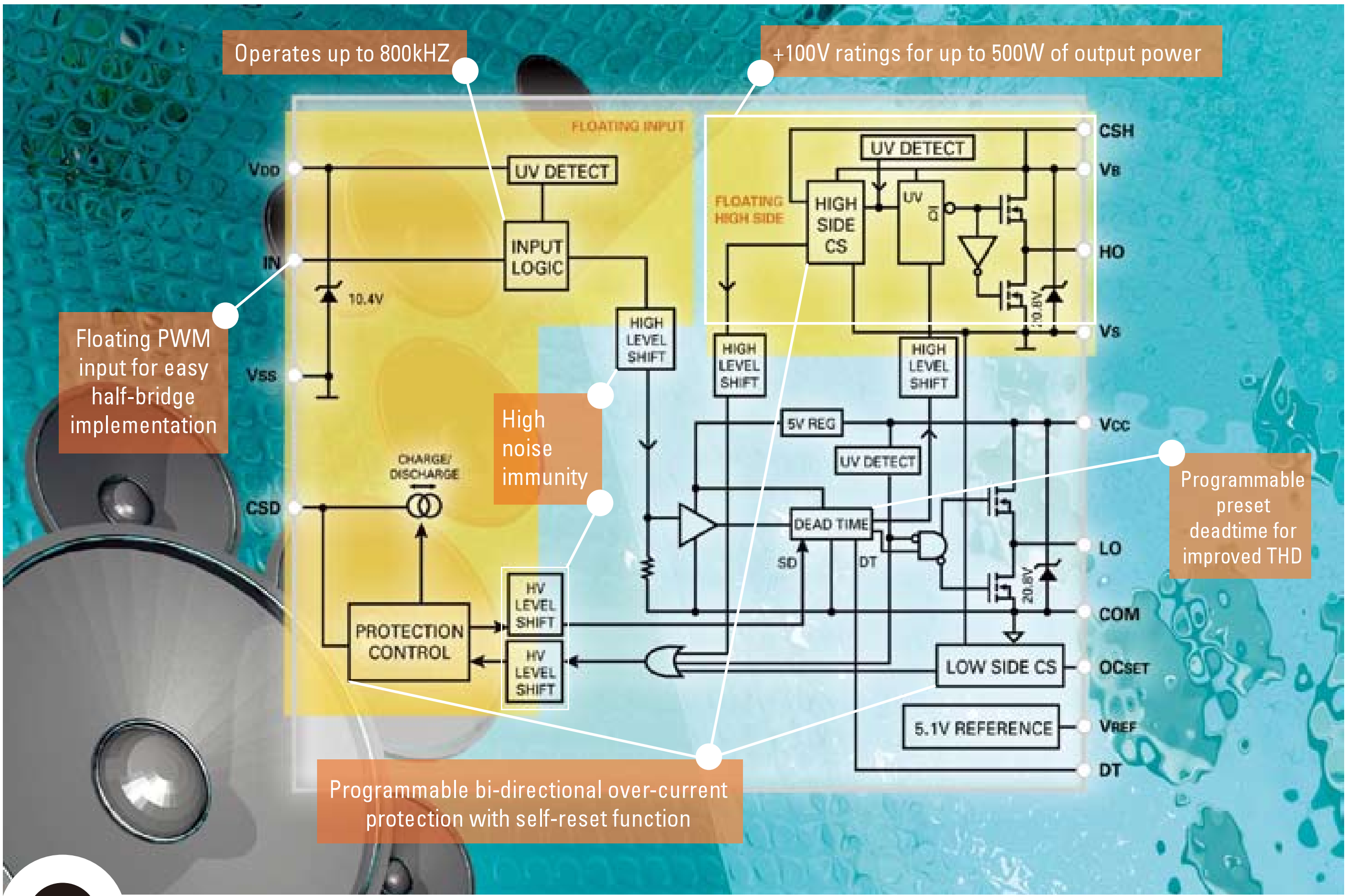
“Nobody can be against trade. But the discussion should focus on the preconditions for trade rather than trade itself. Otherwise the discussion becomes tantamount to debating how we re-enter the Earth’s atmosphere and land at Cape Canaveral before having even thought about how to build the space shuttle,” commented Christian Kjaer, EWEA chief executive.

Introducing a virtual trade system that allows one country to import part of its renewable energy target from another only makes sense if the country which acts as the seller is over-performing in comparison with the target it has been assigned, and the country which acts as a buyer is underperforming. Otherwise, we run the risk of creating a market without liquidity, and where all the parties involved are lagging behind their obligations.

The EWEA is doing great work here; I will follow this vital topic and report.

www.powersystemsdesign.com/greenpage.htm





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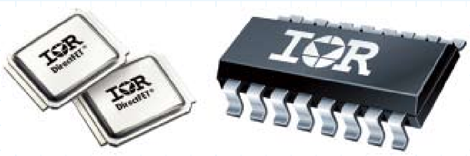

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