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June 2009

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Special Reports - GreenPower Leadership Awards & Green Power

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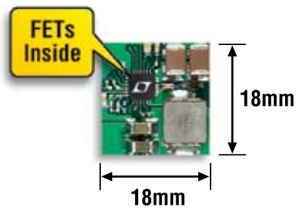
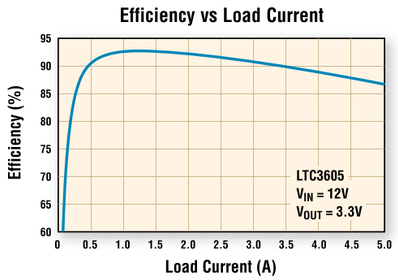
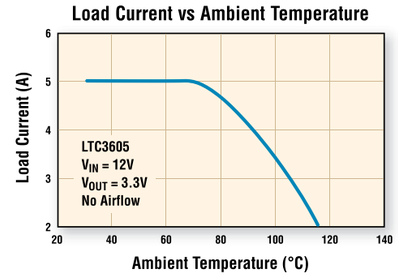
2A to 12A, High V_{IN} Synchronous Bucks



LTC®3605
Demo Board
(Actual Size)





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Our high voltage monolithic synchronous buck converters offer input voltages as high as 32V and can deliver output currents ranging from 2A to 12A full scale with minimal thermal derating. Operating efficiencies up to 95% are possible while operating at switching frequencies of 1MHz or more. Our converters greatly simplify point-of-load conversion in systems with intermediate bus architectures while simultaneously keeping the external inductor and ceramic capacitors small and low profile.

High V_{IN} Monolithic Synchronous Buck Converters

Part Number	V_{IN} Range	Output Current	Switching Frequency	Synchronizable	Architecture	Package (mm)
LTC3601*	4V to 15V	2.5A	800kHz to 4MHz	Yes	Controlled On-Time	3x3 QFN-16, MSOP-16E
LTC3603	4.5V to 15V	2.5A	300kHz to 3MHz	Yes	Constant Frequency	4x4 QFN-16, MSOP-16E
LTC3605	4V to 15V	5A	800kHz to 4MHz	Yes	Controlled On-Time	4x4 QFN-24
LTC3609	4V to 32V	6A	300kHz to 1MHz	No	Controlled On-Time	7x8 QFN-52
LTC3608	4V to 18V	8A	300kHz to 1MHz	No	Controlled On-Time	7x8 QFN-52
LTC3611	4V to 32V	10A	300kHz to 1MHz	No	Controlled On-Time	9x9 QFN-64
LTC3610	4V to 24V	12A	300kHz to 1MHz	No	Controlled On-Time	9x9 QFN-64

*Future product. Contact LTC marketing for information.

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PSDE GreenPower ENERGY EFFICIENCY

Green Shoots for Green Power?

Now with the PCIM show firmly behind us, it's a good time to reflect and consider the messages given by the companies I interviewed there. You can see my report roundup on our website. But even in these troubled and travel-restricted times, it was good to see so many companies from our industry supporting the show and its associated forums and conferences.

At the time of writing I'm busy visiting companies in the US over a two week tour to 'top up' my understanding of where many of the international companies, headquartered here are going, and their plans to break through the gloom to emerge leaner, meaner and stronger. This is certainly the message I'm getting so far; not a hint of wound-licking, but a dogged determination for better business health and success.

The power industry is one of the few that has all the positive components driving it forward: Energy efficiency and renewables, vital for fighting our dependence on 'dirty' and politically unstable sources of fuel for power generation together with all the environmental issues, make it the one area where growth is not only likely, but necessary.

While on this topic, I would like to congratulate Fairchild Semiconductor on winning PSDE's annual GreenPower Leadership Award competition (GPLA) for their commitment and outstanding contribution to 'green' power issues. This is well deserved and decided entirely by our readers' votes.

A welcome positive forecast from iSuppli Corp: The global semiconductor manufacturing industry is expected to take one small step back from the precipice in the second quarter, as utilization rises for the first time in a year.

Utilization of worldwide semiconductor capacity is expected to rise to 60% in the second quarter of 2009, up from 49% in the first quarter. This will mark the first quarterly sequential increase in total semiconductor utilization since the second quarter of 2008.

It seems the unwelcome and painful cuts in fab workforces across the industry are having the desired effect in boosting utilization rates at these fabs.

So, as we enter the second half of the year, I sincerely hope the 'little green shoots' we are encouraged to look for, finally start appearing in material terms. We have a lot of good people who want to work and do not wish to remain 'parked' with the state.

I hope you enjoy this issue of PSDE, please keep your design reports and feedback coming, and check out our fun-strip, Dilbert, at the back of the magazine.

All the best!

Cliff Keys

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

Fairchild Wins PSDE GreenPower Leadership Award

Fairchild Semiconductor, a leading global supplier of high performance products driving energy efficiency, has been named the overall winner of the Power Systems Design Europe (PSDE) magazine 2nd annual, prestigious "GreenPower Leadership Awards" competition.

Fairchild's article titled "Solar Power Shines" by Alfred Hesener, Marketing Director, Europe, was announced as the overall winner at PSDE's recent forum and awards session at the PCIM Europe Exhibition & Conference in Nuremberg, Germany.

Hesener's article points out that the market drivers vary significantly from country to country, but all shared one characteristic- a need for the highest levels of efficiency in solar cells and photovoltaic inverters and the pivotal role that semiconductor solutions play in this application space. The article also examines the implications of different solar panel technologies and system power ranges, and explains the different technical requirements and how to solve them.

Alfred Hesener, Fairchild's Marketing Director, Europe, at PSDE's GreenPower Leadership Awards.

The PSDE GreenPower Leadership Awards competition is structured to recognize editorial contributions from the engineering community that promote energy efficiency in the electronic content of product designs. Finalists and the winner were elected from articles included in PSDE's digital edition, voted exclusively by subscriber readership.

www.fairchildsemi.com

National's SolarMagic™ Receives Worldwide Compliance Certifications

National Semiconductor Corp. has passed rigorous testing and received product safety, emissions and environmental compliance certifications for its SolarMagic power optimizers. SolarMagic improves the output of solar arrays when affected by real-world conditions such as shade, debris and panel aging.

TUV Rheinland of North America performed the safety and emissions compliance testing and certified National's SolarMagic power optimizers to meet requirements for UL1741 and IEC 61010 safety standards as well as FCC Part 15 (Class A&B) and EN 61000 emissions and immunity standards. The SolarMagic power optimizers comply with a standard well recognized by the photovoltaic industry, the UL1741 standard.

MET Laboratories Inc. performed the environmental compliance testing and certified SolarMagic to meet the requirements for IEC 60529 (IP68, the highest possible ingress protection) and NEMA250-2003 Type 6 enclosure. This ensures the product's electronics are well protected against elements including dirt, water and ice.

Ralf Muenster, Director of National's Renewable Energy Segment.

"Customers are looking to National Semiconductor for a system that can ensure both safety and system reliability. Achieving this set of stringent worldwide certifications is the culmination of months of rigorous testing and inspection" said Ralf Muenster, Director of National's Renewable Energy Segment.

Using distributed electronics throughout a solar installation, SolarMagic recoups up to 57 percent of energy lost due to real-world conditions. SolarMagic power optimizers will be available to customers in North America and Europe in May 2009.

solarmagic@nsc.com

Digi-Key Stocks Tyco Fully Shrouded Post Headers

Digi-Key Corporation, recognized by design engineers as having the industry's broadest selection of electronic components available for immediate shipment, announced today that it has in stock Tyco Electronics' new fully shrouded post headers. Available in 2 through 12 positions, these post headers have been added to Tyco Electronics' popular Economy Power (EP) connector family.

Digi-Key part numbers A99845-ND, A99846-ND, A99847-ND, A99848-ND, A99849-ND, A99850-ND, A99851-ND, A99852-ND, A99853-ND, A99854-ND, and A99855-ND are now available for immediate shipment on Digi-Key's global websites and will be featured in future print and online catalogs.

Intended for secondary power circuit applications, the through-hole headers have a

current-carrying capacity of 7.5A maximum per contact. To lessen the chance of mismating, the full four-sided shrouding aids proper alignment during engagement of the plug connector. These new headers are compatible with existing EP connectors.

Contacts are on a 0.156-inch (3.96-mm) pitch. The header includes a positive-lock feature. During mating, the positive locking lever on the outside of the plug housing engages the mating header housing to provide greater retention. Housings are 94V-0 rated nylon; contacts are tin-plated brass. The connectors are UL Component Recognized, CSA Certified, and RoHS compliant.

EP connectors are a wire-to-board system widely used in household appliances, HVAC, gasoline pumps, coin changers, vending machines, and industrial machinery.

www.digikey.com

Maxwell Lands Hybrid Bus Ultracapacitor Orders Worth €9.8 Million

Maxwell Technologies Inc. has announced it has received purchase orders with a total value of approximately €9.8 million from three of China's leading transit bus producers for BOOSTCAP® ultracapacitor modules to support braking energy recuperation and torque assist functions in diesel-electric hybrid transit buses.

David Schramm, Maxwell's president and chief executive officer, said that deliveries of the company's 48-volt BMOD0165 P048 modules, which are assembled by one of its contract manufacturers in China, have already begun and will continue through the balance of the year.

Maxwell's sales and applications engineering teams have been working with heavy vehicle OEMs in China for the past two years. The company estimates that more than 150 hybrid buses with BOOSTCAP ultracapacitor-based energy storage systems already are in service, and that number is now expected to grow to nearly 1,000 by year-end.

Maxwell's 48-volt BMOD0165 P048 modules.

BMOD0165 P048 modules are encased in a rugged, splash-proof, aluminum chassis. They weigh 14.2kg and are 12.6 liters in volume (416.2mm x 190.1mm x 156.7mm). These durable "smart boxes" include temperature and voltage monitoring and internal cell voltage management that give designers "plug and play" solutions and makes them versatile building blocks for systems with higher voltage requirements

www.maxwell.com

EPCOS Honored for Top Logistics Performance

EPCOS was the first-time winner of the "Supplier of the Year" award in the category "Logis-tics" presented by Siemens Motion Control Systems. Outstanding achievements in delivery capacity and reliability clinched the award for EPCOS, which fought off competition from more than 250 rivals.

Motion Control Systems is part of the Drive Technologies unit in Siemens' Industry sector. Headquartered in Erlangen, the division leads the world in business with drive systems for machine tools, production machinery and large crane installations. EPCOS supplies this customer mostly with EMC filters and large aluminum electrolytic capacitors that are made in Szombathely/ Hungary. Forward-looking expansion of EPCOS' production capacity in Szom-bathely in recent years prepared the ground for such outstanding delivery performance.

"For EPCOS, this award confirms the quality of our close collaboration over many decades," said Ralph Bronold, who was presented with the prize. "But it also spurs us on to strive for excellence every day as we serve this important customer."

www.epcos.com

ABB Wins Frame Order for 2,100 Robots

ABB, the leading power and automation technology group, has signed a frame agreement with BMW Group to deliver 2,100 industrial robots over five years, beginning in 2010, to support the carmaker's operations in Germany, the U.K. and the U.S.

The robots will be applied in parts handling, gluing and spot welding on car-body assembly lines for BMW's 1-series, 3-series, X5-series and Mini models.

"We are delighted that this major customer has entrusted production lines in three countries to ABB's innovative industrial robotics," said Anders Jonsson, head of ABB's Robotics division. "Our expertise in products, systems and service for manufacturing ensure high and consistent production quality that helps our customers stay competitive."

ABB's technology convinced the purchaser in the course of comprehensive endurance tests during the tendering phase.

The company's industrial robots are reliable, strong, accurate and easy to maintain. ABB will supply and commission a variety of robot models for BMW, including the IRB 6640, 6620, 7600 and the new mid range robot IRB 4600; a compact, light-weight industrial robot with the longest vertical reach in its class.

www.abb.com

Excelsys Waterproof LED Power Supplies

Excelsys Technologies, technology leaders in high efficiency power supply design, launched a new range of products for professional LED lighting applications. The constant current output LXC series and the LXV constant voltage series offer up to 300 watts output power in extremely compact, rugged IP67 enclosures.

The constant current output LXC series is available with either 30 watts or 50 watts of output power with efficiencies up to 88%. Both models have universal input over the range 90-264VAC and an operating temperature range of -20 to +75 degC. The LXC series is protected against over voltage, short circuit and over temperature and meets EN550022 level B for conducted and radiated emissions. Output voltages are available in the ranges 6-12, 9-18, 12-24, 18-36, 21-42 and 24-48VDC.

The LXV series of constant voltage LED power supplies is comprised of 6 models with output power of, 75W, 100W, 120W, 150W, 200W and 300W with no minimum load and efficiency up to 95%. All feature over current and over voltage protection as well as short circuit and over temperature protection and are rated to IP67. The 75, 100 and 120W models have a wide Input voltage range of 90-305VAC and the 150, 200 and 300W models have a universal input range of 90-264VAC. All models meet EN55055 level B for conducted and radiated emissions as well as EN61000-4-5. A wide range of output voltages are available to suit specific LED requirements, these include 12, 24, 36, 42, 48, 54, 81 and 105VDC.

All Excelsys LED power supplies are CE marked and RoHS compliant and are fitted with input and output cables.

Gary Duffy, Managing Director of Excelsys Technologies, asserted, “Our new LED lighting solutions are a prime example of the flexibility of Excelsys high efficiency power solutions and our ability to provide a fast and competitive response to new market requirements. Many OEM manufacturers are considering LED lighting solutions in domestic, industrial, architectural and display products because of their small size, high efficiency and long life. Our new range of LED power supplies provides a state of the art power solution for these applications.”

Excelsys will be increasing the range of both its constant voltage and constant power LED power supplies throughout 2009 to provide high quality, high efficiency, IP67 power solutions for manufacturers of street lighting and architectural lighting installations. The new LXC and LXV LED power supplies may be modified to meet specific customer requirements on request.

Typical applications for the LXC and LXV families include ‘brown’ and ‘white’ goods such as refrigerator lighting, general LED lighting and sign applications including outdoor and architectural and street lighting systems.

www.excelsys.com

De-Mystifying Power Supply Design with Digital Power Technology

By Peter Oaklander, Senior Vice President, Power Management Products Group, Intersil Corporation

Traditionally analog power systems design has been a “black art” that is shrouded in mystery. It takes years to educate, train and nurture analog power system designers to reach full productivity.

In our otherwise high-tech world, analog power system design is one of the few true remaining apprenticeship-based training systems, where the art of fine design is passed down from master craftsmen.

But that is about to change. Here’s why we believe digital power supply design has reached a tipping point and is poised for explosive growth.

Historically, analog power controllers have been—and continue to be—difficult to customize. It can take up to one year or more to customize a power supply controller and spin out the new silicon. As a result, designers have learned to live with what given or use extra components. If the controller design does change, the new controller may have additional silicon-based technical problems.

On the other hand, many designers believe that digital solutions are so complex that they require much investment in training and design cycle time to customize them to specific applications. They might believe that this could add a lot of risk and delay to a program. We’ve even seen situations where customers have designed out new devices and replaced them with older, more familiar products when the new devices present too much of a design challenge.

Probably every power supply designer has experienced some professional or technical pain in their careers. There is the pain of trying to compensate a regulator. There is the challenge of selecting inductors and capacitors. Designs need stable regulators. There are challenges of multiple voltage domains, design complexity, voltage scaling, and overall system reliability. Today, solutions to these issues are often derived through trial-and-error, with addition design time which may stretch into weeks or months.

Digital power supply solutions have been in the works for many years. But here’s the inflection point: only very recently have they become truly economically feasible. Digital power management solutions are emerging that shield the designers from the underlying complexity of the solution. By combining digital technology, non-volatile memory, firmware and an easy-to-use software GUI, a designer can do point-and-click configuration of a controller.

Digital power management and conversion solutions are excellent choices for high-density systems with thermal and board space challenges. Digital designs typically use about half the space of traditional designs. They’re efficient over a wide load range, flexible, easy to use, and require fewer discrete components. Digital designs are easier to integrate, and depending on the application, may offer a lower overall BOM. And as the technology advances, costs will certainly become even more competitive with traditional analog-only solutions.

The Gartner Group, a respected market research firm, predicts that the digital controller market will grow to about $400 million by 2011. That represents less than 4 percent of the total voltage regulator markets. Digital power IC’s are poised for rapid expansion in communications, data processing, industrial equipment, and energy management (smart building) applications.

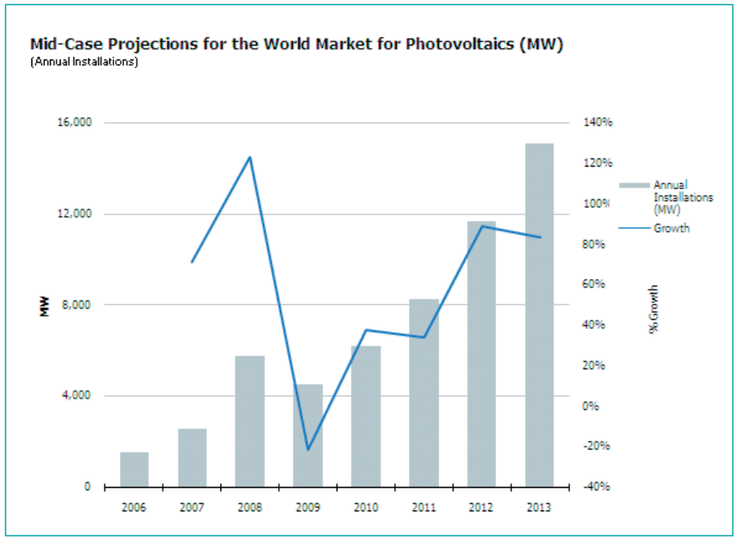
www.intersil.com

Solar Power – Spanish Sunshine Clouds the Market in 2009

By Ash Sharma, Research Director, Power & Energy Group, IMS Research

For some years I've been writing articles highlighting how concerns over energy usage and demand for 'green power' solutions will drive growth for most components of the power industry. If you had asked me six months ago which sectors would be most resilient amid the economic gloom of 2009, I wouldn't have hesitated to say "renewable energy", and specifically solar power. This was based on the assumption that generous incentives around the world, which were fixed and guaranteed for 10 or 20 years regardless of economic conditions, would mean that investment in this sector continued unabated.

Now, with the first quarter of the year behind us, and having seen the full picture of what actually happened in 2008, the outlook for the solar power industry in 2009 looks quite different. You might have seen this in a press release we issued back in March where we predicted the PV market would see a double-digit drop in both revenues and MW installations this year.



In spite of this, I should stress that the underlying drivers of long term growth for the solar market have not changed. I should also stress that the solar market isn't seeing weakened demand per se in the same way as almost every other industry. The 2009 decline is partly the result of the incredible growth seen in 2008. In a way, the solar market has become a short-term victim of its own success. New solar installations grew by a staggering 125% in 2008 and with an average annual growth rate of "just" 50-60% expected between 2007 and 2013 the market seemingly achieved two-years' worth of growth in just 12 months.

So what has caused this sudden retrenchment in the solar industry in 2009? This is one decline that can't be blamed solely on the "credit crunch" or the ongoing global recession, although the scarcity of finance availability has had some impact for larger installations. In fact, of the top 45 PV markets we have analysed for our current research *The Global Market for Photovoltaic Inverters 2009*, all but two countries are anticipated to grow in 2009. The problem is that one of these countries, Spain, accounted for almost half of all global PV installations last year and is certain to shrink by some 80% due to the 500MW annual cap imposed by the Spanish government.

The Spanish market saw an unprecedented surge in demand in 2008, growing to some 2.5GW (it was just 560MW in 2007), driven by overly generous feed-in incentives offered, and compounded by the threat of removal or restriction of these incentives. This led to a rush to install solar plants in Spain, in turn causing a sudden boom-bust cycle. The knock-on effects are being felt outside Spain, with an oversupply of modules and other components to the global market, leading to downward price pressure.

Despite this short term impact, it seems very clear that 2009 will just be a "blip" and that market growth will resume in 2010 (and most likely late this year). In fact, IMS Research's latest report predicts annual growth rates varying between 30% and 70% over the next five years. New incentives and changes in government policy, most notably in the US, will ensure that investment in PV remains attractive and that stellar growth continues to be achieved.

www.IMSResearch.com

Frequency Response of Switching Power Supplies – Part 5

Loop gain signal injection size

In this article, Dr. Ridley continues the topic of frequency response measurements for switching power supplies. This fifth article shows how the injected signal size can impact the quality of the measured results, and demonstrates how to optimize the level of injection.

By Dr. Ray Ridley, Ridley Engineering

Fixed Loop Gain Injection Signal

Making successful loop gain measurements is a laboratory skill that must be acquired with practice. Very few engineers are taught this skill during their university days, and they must learn for themselves that such measurements are still necessary with switching power supplies, and they must be done carefully in order to obtain trustworthy results.

Once the measurement test setup is properly implemented, as described in the previous article in this series, the right level of signal injection must be used to drive the control loop properly at all frequencies.

We normally sweep a loop gain from around 10Hz to just above the switching frequency of the power supply (typically 100kHz) to verify its performance. Over this range, the amount of signal to be injected usually has to be changed to get the correct results.

Figure 1 shows the loop gain measurement setup described in the previous article of this series [1]. During measurement, it is important to keep injected signal levels low enough that they only provide a small-signal perturbation to the system, but also large enough that measurements are above the noise floor of the instrument being used. Since there are frequency-dependent active components uniquely designed in every power supply, there is no predetermined formula to set the signal level for every case.

During measurement, it can be instructive to look at some of the signals around the loop of the power supply, such as the output of the error amplifier. However, great care must be taken in doing this. Connecting an oscilloscope probe can introduce noise problems in a high gain and high-noise system such as a switching power supply. Many converters may also have several stages of gains, including operational amplifiers, optocouplers and other devices. All of

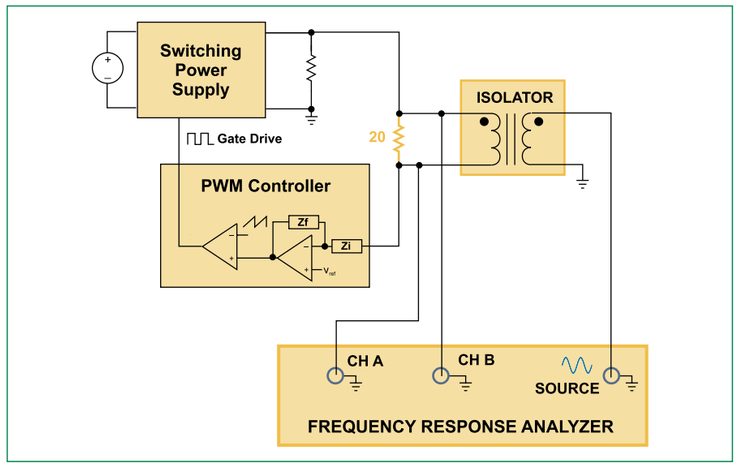


Figure 1: Open Loop Gain Measurement with the Loop Electronically Broken.

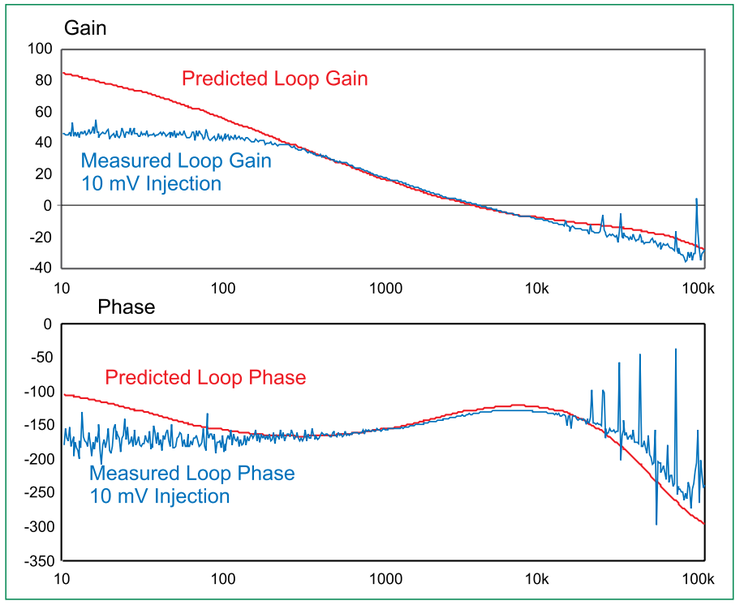


Figure 2: Measurement with 10 mV Injection Signal. Measurement is Noisy, and Limited Gain can be Resolved.

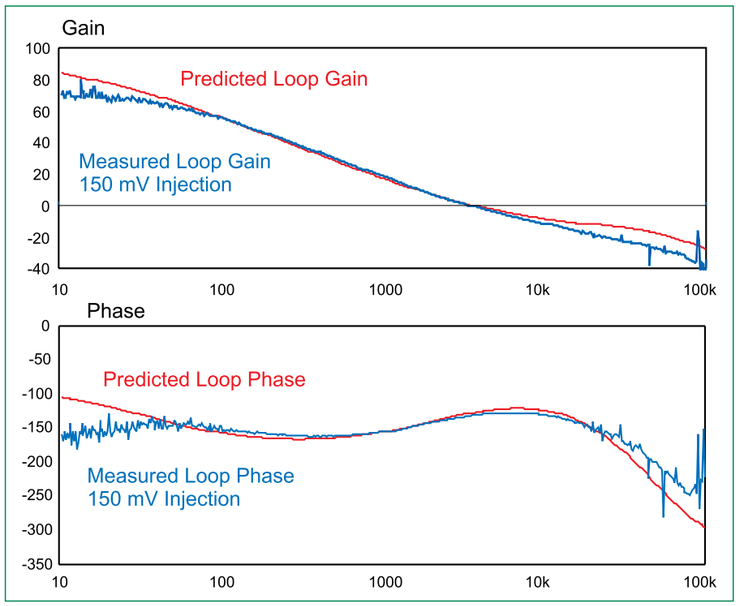


Figure 3: Measurement with 150 mV Injection Signal. Noise is Reduced, and Higher Gain Can Be Resolved.

these must be kept in the small-signal region of operation, and monitoring them all is usually not practical.

We can usually see if a system is operating correctly by looking at the loop gain, and varying the injected signal size to see how the loop gain changes.

Figure 2 shows a measured and predicted loop gain of a power supply with a fixed 10mV injected signal. In the frequency range from 500Hz to 10 kHz, there is close correlation between the measurements and predictions. Below 500Hz, there is not enough signal to resolve the high gain of the system. Above 10kHz, the noise generated by the converter generates spikes in the measurement due to insufficient signal-to-noise.

Figure 3 shows the same system measurement with a fixed 150 mV input signal. The low frequency gain is now much more accurate, down to about 50Hz. At high frequencies, the noise is greatly reduced to the increased injection signal. (For all measurements described here, the analyzer used a fixed bandwidth of 100Hz when measuring the response.)

In figure 4, the signal has been increased further to 1.5V. Now the measurements are accurate down to 10Hz, with low noise. However, at about 500 Hz, there is now a sharp deviation of measurements from the predicted response, and the measurements from here to the ending frequency are very inaccurate.

The system is now being overdriven, and components in the loop are being driven to limits that prevent proper small-signal operation. When a power supply is being overdriven like this, it is usual that the error in measurement begins before the crossover frequency, and continues to the end of the measurement.

Variable Loop Gain Injection Signal

Clearly what is needed for a power supply is an injected signal that changes with frequency. At low frequencies, where the loop gain is high, we want to inject a very large signal. At higher frequencies, the signal must be reduced to prevent overdrive of the circuit. There is no set formula for this – each power supply design has unique power stage characteristics, with unique designs of feedback compensators.

Figure 5 shows the loop gain results with a variable signal injection. At low frequencies, as shown by the green curve, 1.77 Vrms is injected into the system. At high frequencies, the ideal injected signal is about 30mV, a reduction of more than 50 times. From about

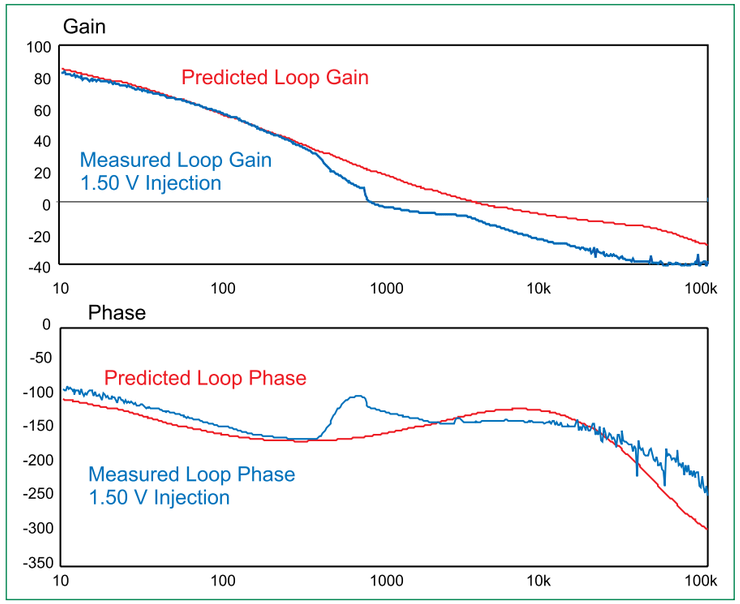


Figure 4: Measurement with 1.50 V Injection Signal. Noise is Reduced Further, Higher Gain Can Be Resolved, but Measurement is Distorted Approaching Crossover Due to Overdrive.

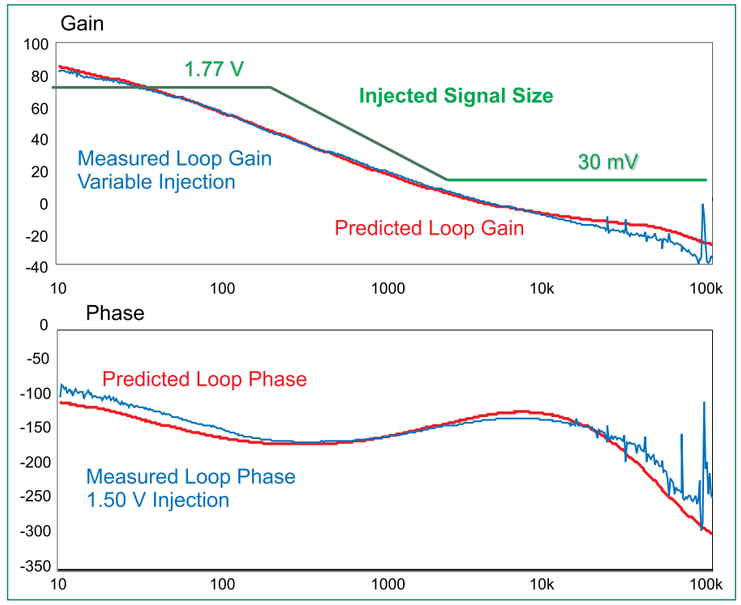


Figure 5: Measurement with Variable Injection Signal. High Signal Levels are Used at Low Frequency, and Reduced Approaching Crossover Frequency to Optimize Measurement.

200Hz to 2kHz, the signal is reduced between these two values. For most analyzers, this must be done manually during the sweep, but it is automated for the AP Instruments Analyzer [2].

Loop Gain Measurements without Predictions

Ideally, we like to plot a measurement of loop gain versus predicted loop gain to show when the measurement is in error. However, many power supplies are very difficult to model and predict, which is one of the reasons why measurements are so important. In this case, we have no reference to tell us when the signal injection is correct.

If you have this situation, the technique is to apply a large signal at low frequencies, and a small signal, perhaps starting at 50mV, at high frequencies. When the loop measurement is valid, you will find that reasonable changes in the injected signal, over a range of perhaps 3:1, will not materially affect the loop measurement. This is the technique that is used to verify the measurement is good – varying the signal injection, and making sure the loop measurement stays constant.

With experience, you will also find that you begin to recognize characteristics that are indications of system overdrive versus actual system response. Loop gain curves tend to be smooth and continuous. Abrupt changes, such as those shown around 1kHz in Figure 4, are unlikely to be the result of a real system response.

Summary

Proper loop gain measurements are a function of proper signal injection. In most cases, the signal must be varied in a repeatable manner to ensure a good result. Too little signal results in too much noise, and too much signal introduces distortions in the measurements and gross inaccuracies. Once this signal level is correct, moderate changes in signal size will not affect the loop gain measurement.

In the next article of this series, the topic of interpreting and specifying loop characteristics will be discussed.

References

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On the Road

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

Dialog Semiconductor

Normally known for its success in the high-volume ASIC market for portable devices, Dialog Semiconductor has launched the first in a new family of power management ICs (PMICs) designed to optimize the power efficiency of applications using the Intel® Atom™ processor Z5xx series which is being broadly adopted today. In 2008, Dialog achieved an impressive $160 million in revenue and was the fastest growing European public semiconductor company, achieving a growth rate of more than 85%. Dialog employs approximately 290 staff worldwide.

System PMIC for Intel Atom Cuts power consumption and board space

Dialog's new DA6001 provides all power supplies, power management and clock supplies in a single chip, improves battery life, simplifies design, improves system reliability, requires less than half the board space and cuts the bill-of-materials compared with using discrete power management parts.

The DA6001 supports the Intel Atom processor for embedded computing applications, automotive applications like in-vehicle infotainment, netbooks and mobile Internet devices. The device family will expand to support future Intel Atom processors and platforms for the embedded and portable space.

Mark Tyndall, Dialog's VP for Business Development and Corporate Strategy together with Michael Maurer, Embedded Marketing Manager, explained the company's new offering and the rationale behind this new venture.

"The Intel Atom processor is power-optimized, delivering robust performance-per-watt for cost-effective embedded applications. The DA6001 as a companion IC, adds the ability to minimise

Mark Tyndall, VP for Business Development and Corporate Strategy

power consumption across the complete platform, not just the processor, without adding the cost and complexity of multiple power management and clocking devices to achieve this. Embedded developers are designing products used in thermally constrained environments and require very low-power solutions. The combination of the Intel Atom processor Z5xx series and the DA6001 provides our customers with more choice in the way they can deliver extremely power-efficient solutions to a variety of embedded market segments."

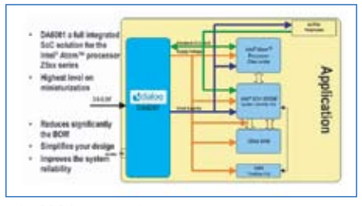
From a single supply voltage, the DA6001 provides low noise supplies to all platform voltage domains and current for system DDR2 memory. Four DC/DC buck converters power the platform hardware engine, the SCH core and FSB, both internal and external system memory and the CPU core - meeting IMVP-6 specification for the Intel Atom processor.

Further platform power demands are supplied by 6 high performance, low dropout (LDO) voltage regulators, using Dialog's patented Smart Mirror™ technology, removing the need for a low power mode and simplifying power control in the system. A dedicated push-pull LDO is integrated into the device to terminate the address lines of the external RAM, further minimising external components.

The DA6001 includes a clock synthesiser/driver according to Intel's CK610 specification providing all the necessary

clocks via 3 separate fractional divisions PLLs.

Two analogue signal inputs can be multiplexed to a 10-bit ADC converter for signal measurements and a charge pump, which is integrated to generate the 5V reference domain even if the input voltage drops below 5V. An autonomous state machine manages the complete system start-up and shutdown procedures as well as the state transitions of the Intel Atom processor during all operational modes.



DA6001 Application example

The company is now setting in place sales channels for distribution and following Intel's roadmap to keep in step with future Atom issues.

Engineering samples are available from June 2009 with volume production and AEC-Q100 qualified volume parts, for automotive applications, in the second half of 2009.

www.dialog-semiconductor.com

Microchip

Microchip launches new nanoWatt XLP™ microcontrollers. Its next generation low power PIC® microcontroller (MCU) families with nanoWatt XLP eXtreme low power technology, for sleep currents as low as 20nA. These three new 8- and 16-bit MCU families join three other recent 8-bit families that are all part of Microchip's nanoWatt XLP portfolio, providing designers with a rich and compatible low-power migration path that includes on-chip peripherals for USB and mTouch™ sensing solutions.

Industry's lowest sleep current

The three new nanoWatt XLP MCU families announced include the 16-bit PIC24F16KA family, which features typical sleep currents as low as 20nA; and the 8-bit PIC18F46J11 and PIC18F46J50 families, both of which feature typical sleep currents of les than 20nA. The six general-purpose members in the PIC18F46J11 family provide up to 64kbyte of Flash program memory and the peripheral set of a typical 64- or 80-pin device in only 28- or 44-pins. The PIC18F46J50 family also features six members, which in addition integrate full speed USB 2.0 to enable connectivity for embedded applications requiring remote field upgrades or the downloading of data.

Examples of consumer applications may include portable and battery powered devices, such as: sealed disposable electronics, portable electronics white goods, game controllers, digital photo frames, and coffee machines. Industrial applications include energy harvesting/scavenging, utility meters, security systems, sprinkler timers and sealed/harsh environment sensors.

The three new nanoWatt XLP MCU families are available now for general sampling and volume production.

8-bit Microcontrollers

The PIC18F46J11 and PIC18F46J50 MCUs feature Microchip's new nanoWatt XLP™ eXtreme Low Power Technology, which enables typical sleep currents of less than 20nA. The new nanoWatt XLP technology gives designers the flexibility to customise their applications for the lowest power consumption through multiple internal wake-up sources, such as Real-Time Clock and Calendar alarm; Brown-Out Resets, and interrupts and watch-dog timers, all while maintaining I/O states.

The general purpose PIC18F46J11 MCUs enable designers to easily and inexpensively add new features to a variety of applications, while maintain-

Microchip's three new nanoWatt XLPTM MCU families.

ing extremely low power and small size. The PIC18F46J50 devices include Full Speed USB 2.0 for designs requiring connectivity, for remote field upgrades or the downloading of data. Both MCU families include a unique mTouch™ sensing peripheral, which lowers system cost by enabling capacitive touch user interfaces. Additionally, a Peripheral Pin Select (PPS) function gives designers the flexibility to map the desired digital peripherals to I/O. With all of these features, the new MCUs provide the peripheral set of a typical 64- or 80-pin device in only 28 or 44 pins. Numerous applications can benefit from the extreme low power and peripheral integration of the PIC18F46J11 and PIC18F46J50 MCUs, across consumer, industrial, automotive and medical markets.

The six PIC18F46J50 USB 8-bit family members are available now for general sampling and volume production. The 28-pin package options for the PIC18F24J50, PIC18F25J50 and PIC18F26J50 MCUs are: QFN, SSOP, SOIC and SPDIP. The 44-pin package options for the PIC18F44J50, PIC18F45J50 and PIC18F46J50 MCUs are: QFN and TQFP.

16-bit Microcontrollers

The PIC24F16KA family of 16-bit microcontrollers (MCUs) with new nanoWatt XLP™ eXtreme low power technology, combined with integrated EEPROM in a small footprint and low pin-count package makes the MCU family ideal for battery powered, energy harvesting and other power-constrained applications.

The PIC24F16KA MCU's 20nA sleep currents are achieved by isolating power to various circuits during sleep, with a fast wake-up time. The new nanoWatt XLP Technology gives designers the flexibility to customise their applications for the lowest power consumption through multiple internal wake-up sources, such as Real-Time Clock and Calendar alarm, Brown-Out Resets, interrupts and watchdog timers, all while maintaining the I/O states.

Ideal for low power and space constrained applications, the 16-bit family has high C-code efficiency and 16MIPS of computational horsepower, making it well suited for applications using advanced algorithms. In addition, it features two rail-to-rail comparators and an mTouch™ capacitive touch sensing peripheral, as well as SPI, I2C and two UART modules for serial communications. Example applications for the new PIC24F16KA MCUs will cross the medical, industrial and consumer markets.

The four PIC24F16KA 16-bit family members are available now for general sampling and volume production. The 20-pin package options for the PIC24F08KA101 and PIC24F16KA101 MCUs are: QFN, SSOP, SOIC and PDIP. The 28-pin package options for the PIC24F08KA102 and PIC24F16KA102 MCUs are: QFN, SSOP, SOIC and SPDIP. For additional information visit:

www.microchip.com/XLP

ABB Powers the New Grid

I had the pleasure to talk with Tammy Zucco, Manager, Strategic Marketing for Power Products & Power Systems Divisions for ABB Inc., based in Raleigh, North Carolina. Tammy, who works closely with utility customers and U.S. government officials to demonstrate what kinds of "Smart Grid" related technologies and equipment are already at their fingertips, told me about the huge task ahead for the power grid and about ABB's key resources to help revitalize this aging and fragmented network.

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

"ABB has built a long-term reputation in the power industry as a primary innovator and manufacturer of power equipment and systems, and this has opened the door for us to become a pioneer in the 'Smart Grid of the 21st century,'" said Tammy. "We already have the technology in hand, but we're now striving to align costs and benefits so that utilities have a sound business case for making investments in grid modernization."

ABB recently showcased Smart Grid innovations for U.S. Senate and Federal Energy Regulatory Commission (FERC) personnel in Washington, DC. The company's worldwide expertise in end-to-end transmission and distribution technologies and bold research initiatives make ABB's commitment to making grid modernization a reality.

Incidentally, ABB also hosted U.S. Vice President Joe Biden at its Jefferson City, Missouri transformer facility in April for a major announcement to recognize the plant's contribution to a new 150-megawatt wind farm to be built in northwest Missouri. This wind farm will be built, and new jobs will be created, using U.S. federal stimulus funds. At the same event, U.S. Secretary of Commerce Gary Locke announced the creation of a new White House task force on Smart Grid issues.

The U.S. power grid system is not a single system, but made up of regionally developed systems developed over time to different specifications. As one can imagine, bringing all this together and modernizing will take an experienced and resourceful company that can bring expertise from the 'real-world' and a proven track record. Not only this, but budgets are limited in these difficult times; there is not the time or money to fund a learning curve. It just has to be right the first time.

New technologies and power generation systems need to be integrated into the new system. Wind and solar generation systems will certainly play a

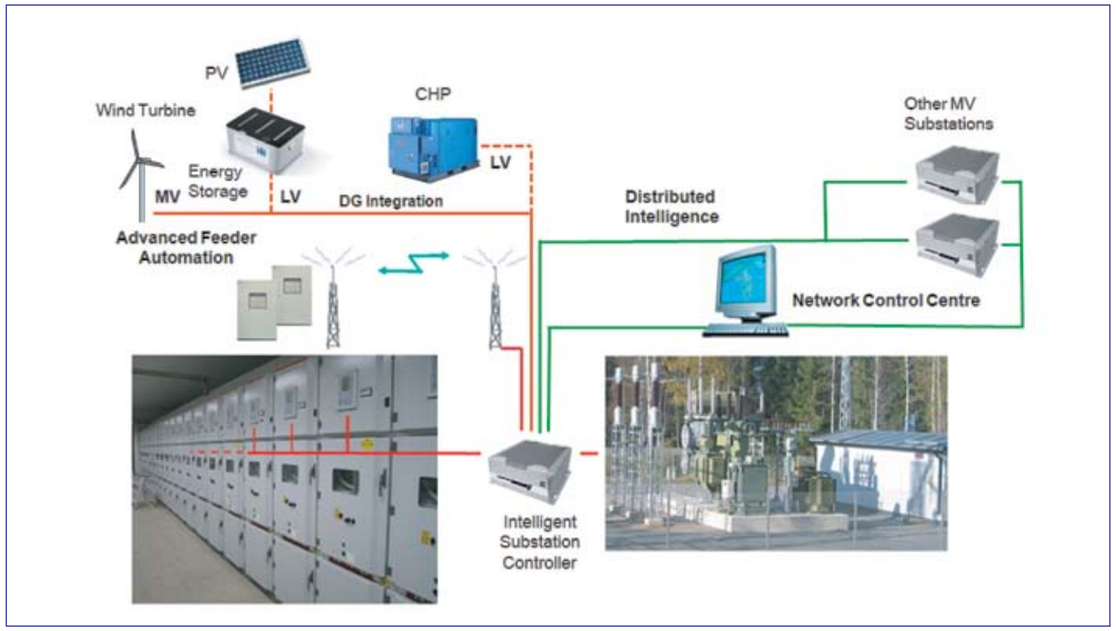
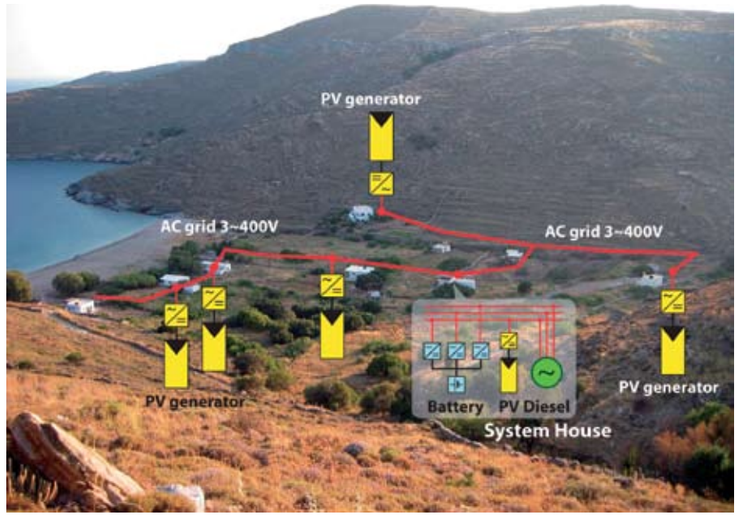


ABB Decentralized control schematic.



A low voltage Gaidouromantra microgrid deployed in Kythnos Island, Greece. Future interconnection with a public medium voltage grid is planned.

large part and the increasing sensitivity to environmental issues all need to be considered.

At the Washington D.C. Smart Grid Demo Day, ABB demonstrated cutting-edge technologies and equipment designed for the emerging Smart Grid for United States Senators and staff including its smart grid equipment designed to build greater efficiency, reliability and intelligence into a modernized power grid. This included ABB's 'amorphous metal distribution transformer,' an environmentally-friendly, high-tech transformer with low losses, high efficiency and BIOTEMP®, a superior natural ester fluid made out of sunflower seeds.

Tammy explained the term "Smart Grid" refers to a wide range of technologies and operating procedures that will transform today's power system into a grid that is largely automated. This modernized grid will apply greater intelligence to operate, monitor and even heal itself. She told me that much of ABB's success with Smart Grid-related innovations is due to its unwavering support of technology and product development by the company's Corporate Research Center.

Displays and demonstrations to the U.S. Senate included:

* **Asset Data Management to** deal with emerging grid issues such as the aging infrastructure, loss of personnel and expertise, and cost-reduction pressures

* A field-based **Feeder Restoration** demo, using Feeder Automation products only

* An integrated **Feeder Restoration and Outage Management System**

* **Substation Automation utilizing open global IEC 61850 standards** for applications in utilities, industries, solar and wind farms

* **High Voltage Direct Current (HVDC)** systems for renewable power integration and long distance transmission

* **Energy storage** battery applications

Breakthroughs and Pilots

In addition, ABB continues to showcase its collaborative participation in several major award-winning energy system pilots:

More microgrids

ABB is an active participant in this pilot program which spans seven European countries and provides architecture and protection control systems. These microgrids are comprised of medium or low-voltage distribution systems with distributed energy sources, storage devices and controllable loads, and are interconnected to the main power network in a controlled, coordinated way. This microgrid concept is a logical evolution of simple distribution networks with a high penetration of distributed generation, enhancing reliability and efficiency, and lowering costs of energy supply for customers. From a utility point of view, the application of distributed generation located close to loads reduces flows in transmission and distribution grids, with the effect of loss reduction and enhanced network support in times of stress by relieving congestion and aiding restoration after faults.

MEREGIO – ABB is also involved with MEREGIO, an emissions-free zone in Germany that will be a model for carbon reduction practices in the power industry.

Sharyland HVDC (USA/Mexico)

Another milestone reached last year involved a new high voltage DC (HVDC) tie providing power sharing between United States (Texas) power grids and Mexico's national power grid. The Sharyland asynchronous interconnection, located along the Rio Grande River, now supports both emergency power exchanges via its unique black start capability and energy trading between the two countries.

Based on ABB's HVDC thyristor-based technology, Sharyland is the first large-scale asynchronous interconnection to support both emergency power exchange and commercial energy trading between the United States and Mexico and the growing economies of the Rio Grande Valley. The $40 million HVDC back-to-back tie connects the state power grid of Texas and the national power grid of Mexico, operated by Electric Reliability Council of Texas (ERCOT) and Comisión Federal de Electricidad (CFE) respectively. It enables 150MW of power to be transferred in either direction and allows each grid to support the other during peak demand and grid emergencies. It is also equipped with short-term overload capacity in excess of its continuous rating of 150MW.

Each of these projects is huge tasks, requiring the collaboration of world-class companies to execute. With the strength of ABB's worldwide successes and a proven track record, ABB is well placed to play a significant role in the new power grid system.

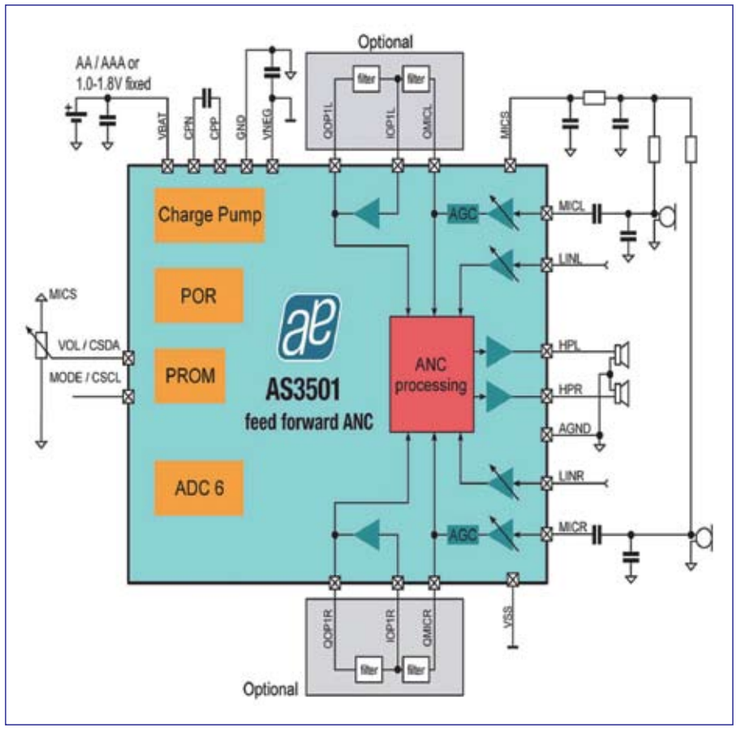
www.abb.com

austriamicrosystems Launches Active Noise Cancellation High Quality, Low Power Audio

I had the pleasure to talk with Oliver Jones, Marketing Manager Audio at austriamicrosystems recently. The topic was the power savings achievable in top quality audio designs without sacrificing quality, indeed, enhancing the listening experience using state of the art noise canceling techniques.

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

Recently, austriamicrosystems, industry renowned for its high performance analog ICs for communications, industrial, medical and automotive applications, announced the introduction of two more products of its high performance Audio product family. The AS3501 and AS3502 are innovative ICs enabling the design of receive path active noise cancelling solutions providing superior system performance and low power consumption.



AS3501 block diagram.

I asked Oliver to tell me what this technology is and what these two new devices would bring the consumer in terms of power savings and audio quality.

Oliver explained the AS3501 is a highly integrated cost competitive solution for feed-forward noise cancellation and the AS3502 enables active noise cancellation for feed-back solutions where the microphone of the system is acoustically close to the loudspeaker. Both ICs operate from a single 1.0V to 1.8V supply and combine true ground headphone amplifier stages with flexible noise cancelling architectures, reducing a manufacturer's typical bill of materials by at least 60% enabling the most integrated solutions on the market. Internal user definable register settings allow different device configurations which lead to differentiation and flexibility for a broad end-product portfolio.

The devices operate in either stand-alone mode, ideal for accessories, or embedded mode, ideal for integration

into music players and other portable multimedia equipment. The high level of integration implies PCB area is reduced by at least 50% of comparable competing solutions. The optimized system architecture enables an industry beating, low power consumption which significantly increases the battery life for the end-user.

Oliver told me, “Especially travellers and commuters know the influence of ambient noise on the limitations to really enjoy music and get the most out of their phone conversations. By effectively reducing the external noise austriamicrosystems’ AS3501 / AS3502 active noise cancelling solutions improve dramatically the dynamic range of the sound playing through the headset, implying you can listen to conversations and music with improved clarity without having to turn up the volume to unreasonable levels. In fact you can often even turn the volume down. With no compromise between audio quality and noise cancelling behaviour, our solutions combine superior system performance, simplified manufacturing and innovative features with low power consumption, ideal for portable high quality audio applications”.

These products look to be a step function improvement over traditional products in this field. DSPs are often used in this market to ‘predict’ the noise pattern. But with these devices, there are no potentiometers to set at the factory; no manual calibration is necessary thereby eliminating a source of error. There is a patent-pending auto-calibration facility built in and with no ‘mechanical’ potentiometers. This results in a higher level of integrity; these custom optimized settings will not go out of balance due to physical vibration.

The AS3501 and AS3502 are able to provide up to 34mW in single ended mode and over 100mW in BTL into 16Ohms loudspeakers from a 1.5V supply. The devices offer this performance together with the ANC function and still guarantee superior sound quality, ensuring >100dB SNR and <0.1% THD. This high audio quality is a big competitive advantage over existing active noise cancellation solutions which in many cases introduce artificial noise when being activated. In addition, an innovative (patent pending) calibration solution removes the need for manual intervention during the manufacturing process and improves field reliability, avoiding challenges typically encountered in today’s best in class solutions.

The AS3501 is available in a 24pin 4x4mm QFN package; the AS3502 is available in a 32pin 5x5mm QFN package. Both are suitable for operating environments ranging from -20°C to +70°C. For product specific information, to download data sheets and other documentation, visit www.austriamicrosystems.com/audio .

www.austriamicrosystems.com

2009 GreenPower Leadership Awards

Winners and Finalists Announced at PCIM Europe

For the past year the readers of Power Systems Design Europe have been voting for the best editorial contribution in the area of “energy efficiency”. The 2009 GreenPower Leadership Awards program has been made possible by the financial contributions of our two Gold Sponsors: Intersil and Linear Technology.

The Winner is: Company: Fairchild Semiconductor, Article: “Solar Power Shines”, Author: Alfred Hesener.

The four finalists (in alphabetical order by company) are: Company: Coilcraft, Article: “Designing for Efficiency at the Component Level”, Author: Len Crane • Company: Linear Technology, Article: “Solving Current Source Design Challenges”, Author: Robert Dobkin • Company: Microsemi, Article: “SiC Impacts ‘Greening’ of Power”, Authors: Philip C. Zuk & Bruce Odekirk • Company: Philips Lumileds, Article: “Avoiding Current Spikes with LEDs”, Author: Pat Goodman.

Educational Donation. A significant component of the *2009 GreenPower Leadership Awards* program is an educational donation, given to the European Engineering University of choice by the article author. This year’s donation is awarded to: The Institute of Robotics at the University of Maribor, Maribor, Slovenia. The University conducts research on motion control solutions.

2010 GreenPower Leadership Awards. Voting has already begun for our expanded *2010 GreenPower Leadership Awards Program* and will continue through the April 2010 issue of Power Systems Design Europe. If you want to summit editorial content on “energy efficiency” to be judged for next years program, contact Cliff Keys, Editor-in-Chief, **cliff.keys@ powersystemsdesign.com** • For sponsorship opportunities, contact Julia Stocks, Publisher, **julia@powersystemsdesign.com.**

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The Challenges of PoE+

Standardized PSE module simplifies switch design

The IEEE is close to completing the PoE+ standard and network equipment makers are rushing to upgrade their designs, but making the transition can be challenging. A new industry-standard PSE module makes the job a lot easier, reduces time-to-market, and simplifies testing.

By Alison Steer, Product Marketing Manager,
Mixed Signal Products for Linear Technology Corp., Milpitas, CA.

PoE+ is nearly here

The Power over Ethernet (PoE) market has grown tremendously over the past few years. PoE has become almost ubiquitous, with millions of PoE-enabled switches installed all over the world.

The primary application of PoE is still to remotely power IP telephones and wireless access points. Engineers have dreamed of using PoE for many other applications, but too often these dreams have been frustrated by the small amount of available power. Under the original IEEE 802.3af standard, a Powered Device (PD) could only draw up to 12.95W.

The IEEE is about to improve the situation with the eagerly anticipated 802.3at revision (sometimes called PoE+) that is nearing completion. This latest revision will increase the power limit, allowing a PD to draw up to 25.5W, and will open the door to a host of high volume applications such as Pan-Zoom-Tilt (PZT) cameras, multimedia kiosks, industrial controllers, and laptop battery chargers.

Making the transition to PoE+

The challenge now is for Power Sourcing Equipment (PSE) manufacturers to get those high-power PoE+ ports into the field rapidly. High-power PDs won’t become commonplace until high-power PSE ports are widely available.

Upgrading an existing PSE design for PoE+ requires:

- Improved Ethernet magnetics that can take more bias current without increased bit error rates at full gigabit line rate.
- New PSE controller chips with higher cutoff current thresholds.
- Depending on which controller chip is used, larger MOSFETs with larger Safe Operating Areas (SOA) may be needed.
- Larger main power supply.
- Miscellaneous components such as connectors, fuses, common-mode chokes, transient voltage suppressor diodes, current-sense resistors, and EMI filters may need to be upgraded for higher currents.

These components are already available and vendors have tried to make their new PoE+ magnetics and chips simple drop-in replacements for 802.3af components as much as practical. But unfortunately, upgrading a PSE design for PoE+ will rarely be as simple as changing the bill of materials; usually, significant PCB layout changes are needed.

For example, designs that use discrete Ethernet magnetics may need layout changes. The traces that carry gigabit Ethernet data and power from the RJ45 connectors to the transformers must have controlled impedances, but also must be heavy enough to carry

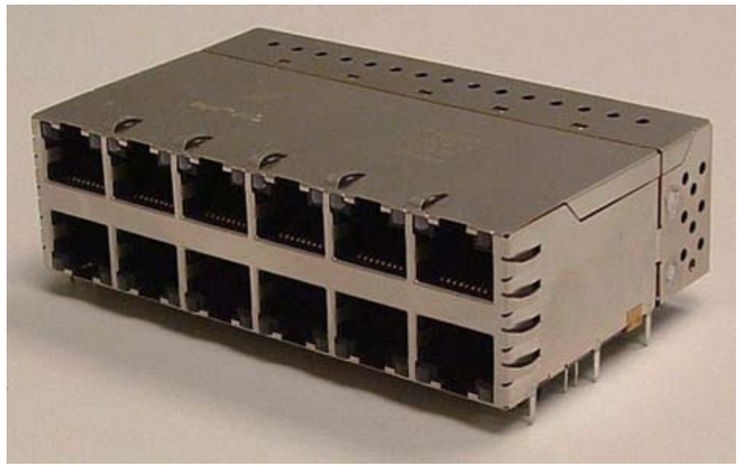

Figure 1: 12-Port PSE-ICM, COURTESY OF Tyco Elecronics.

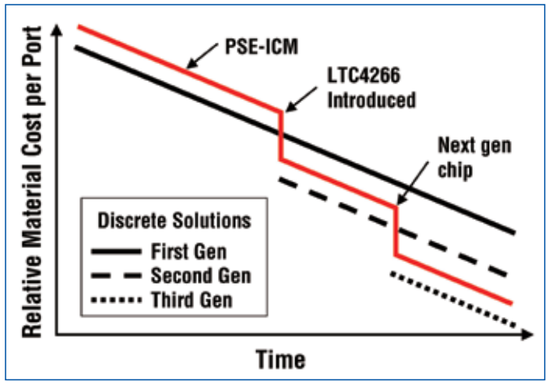

Figure 2: Block Diagram.

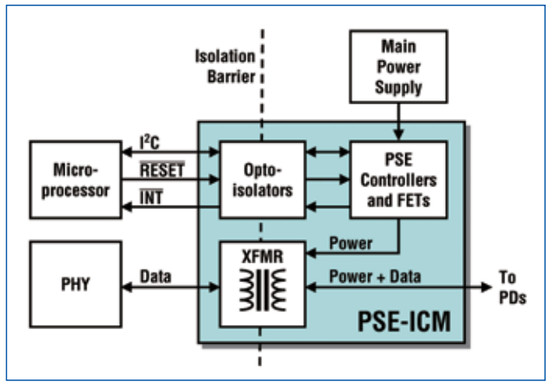

Figure 3: PSE Cost vs. Time.

the increased current. Many existing designs use single-ended 50Ω traces on inner layers which are typically 6 mils wide in 0.5 oz. (14g.) copper; some designs use closely coupled differential traces where the widths are even narrower. While these layouts may have worked at 400mA for 802.3af, there could be a serious risk of overheating at 600mA for 802.3at. Therefore, a PoE+ switch may need to route these traces on the outer layers where 50Ω line widths are typically 8 to 10 mils. What is more, surface layers are typically 1.5 oz. (42g.), after plating.

But the list of headaches for the switch designer is even longer: the increased heat dissipation may require additional or stronger fans; the whole industry is under pressure to make network equipment more energy efficient; and the upgraded PSE design will have to repeat qualification and certification testing. All of the above mentioned tasks can put a significant burden on switch designers who, in many cases, are already overburdened.

One solution is to use a multiport PSE module. There have been some module assemblies available for 802.3af PSE in the form of DIMM cards, or power supplies with PSE port circuitry built in. But these types of modules leave the designer some significant challenges because they don't include the Ethernet magnetics or RJ45 connectors. The Ethernet signals must be carefully routed from the connectors through the magnetics to the PHY chips, and power must be routed from the transformer center-taps to the PSE port circuits. As mentioned above, this can be tricky: maintaining controlled impedances, maintaining clearances for high potential (hipot), and making the traces heavy enough to carry maximum current under worst-case thermal conditions is not trivial.

PSE Integrated connector modules

Probably the most elegant approach is to put all of the PSE circuitry and Ethernet magnetics inside a ganged connector assembly. This really simplifies the task of laying out a board because all of the Ethernet signal pins are on the PHY side of the transformers; they don't carry DC currents, so you don't have to worry about the ohms per square of the traces, and you don't have to worry about maintaining clearances for hipot. Just route these signals directly to the PHY chips as normal impedance-controlled traces.

Some PSE modules like this have been available for 802.3af switches but one of their main drawbacks has been a lack of standardization. Each vendor has a specific footprint and electrical characteristics. Once you pick a vendor you're locked into their design.

But that's changed now, thanks to PoETec. PoETec is a consortium of leading manufacturers of network equipment and components, dedicated to advancing and promoting PoE technology. PoETec has developed, and will soon publish a specification for the industry's first standardized PSE module, which they call the PSE Integrated Connector Module (PSE-ICM). The specification defines all aspects of the PSE-ICM characteristics including footprint, signal functions, and the internal register set. So a PSE design that uses one brand of PSE-ICM can simply drop in another brand without changing the board layout or the system software.

Figure 1 shows a 12-port PSE-ICM from one vendor. At the time of this writing, two PoETec member companies (Molex and Tyco Electronics) are shipping PSE-ICMs and two more companies are about to start shipping. Presently, there are 12-port and 8-port PSE-ICMs available; 16-port PSE-ICMs may be coming in the near future. There are also versions with and without LEDs. Passive modules without the PSE circuitry, just the magnetics, are also available.

Figure 2 shows a simplified block diagram of a 12-port PSE-ICM. It includes an isolated I^2C interface for control and monitoring of PSE functions. Also included, but not shown, are common-mode chokes and terminations. All that's needed is the main power supply and an external microprocessor to run the power management software. The PSE-ICM can also be configured for AUTO mode in which standalone operation is achieved. In this mode, the external microprocessor is not required.

The PSE-ICMs were made practical by some pretty advanced technology, and probably couldn't have been built at a reasonable cost just a year ago. One key enabling technology is the new LTC4266 quad PSE controller chip from Linear Technology Corp. The LTC4266 has the smallest package (5x7mm QFN) and lowest power dissipation of any quad PSE controller in the industry: just 165mW/port at 600mA, including current-sense resistors and MOSFET on-resistance. What is more, the LTC4266 has a unique non-linear foldback feature that protects the module from short circuit faults; without this feature, larger MOSFETs with bigger Safe Operating Area (SOA) would be needed to support the higher current levels reliably.

PSE-ICM advantages

These days, switch designers face many tough engineering challenges. All of the digital and software tasks are difficult enough, without having to worry about analog issues. For example, hipot, EMI, UL certification, lightning surge protection, and heat dissipation are several areas where problems often crop up near the end of a project, when it's most costly and time-consuming to fix them. In fact, these are probably the most common reasons why products miss their launch dates.

The primary advantage of the PSE-ICM is that it's already been through all these tests. Therefore it not only reduces the switch designer's workload, but also reduces the risks of last minute problems. Of course, it's still possible for a switch to fail hipot or EMI because of layout issues outside the PSE-ICM, but the chances of that happening are reduced.

The PSE-ICM also reduces risk because there are multiple sources. This not only creates price-competition, but reduces the risk of late delivery that sometimes occurs when using sole sources for components.

Poor technical support can also lead to project delays and cost overruns. Suppose you're testing a new PSE prototype and one of the MOSFETs overheats. Was the failure due to a bad MOSFET or a bad controller chip? The two vendors will likely point their fingers at each other, while your project slips further behind schedule. But with the PSE-ICM there is no finger pointing; if one PSE-ICM brand seems unreliable, you can simply switch to one of the others with no changes to your board layout or software.

The cost issue

Of course cost is king in the network equipment industry. Some designers may take one look at the PSE-ICM and say it's too expensive, but a smart designer won't be so hasty. The real objective is to reduce overall costs; that's rarely as simple as picking the cheapest parts.

Figure 3 shows a qualitative cost comparison between a discrete design – where the designer places all the PSE components (controller chips, FETs, magnetics, etc.) on the main board – and a design that uses the PSE-ICM.

The graph is intended to illustrate three points:

- The costs of both alternatives decrease over time.
- There are sudden drops in cost when new technologies are introduced.
- The material cost of the discrete approach will always be slightly lower.

Think about the second bullet. One of the advantages of the PSE-ICM is it allows you to more easily keep up with advancing technology and take advantage of the savings. For example, when a new chip that reduces cost is introduced, it may be difficult to use that chip in the discrete design because a new PCB layout would be needed. But when that chip is incorporated into a new PSE-ICM, you can just drop it on your board because the PSE-ICM footprint hasn't changed.

Now think about the third bullet. The discrete approach has a slightly lower material cost, but the PSE-ICM offers a lot of added value that makes up the difference.

For example:

- Shorter time to market. Some products have market windows only 8 to 12 months before they're obsolete. If the launch of such a product were delayed just 2 months, due to PCB layout problems for example, then the overall revenue from that product would be severely reduced. The PSE-ICM can greatly reduce the risk of these delays, and that has economic value that should be counted.

- Lower assembly and test costs. The PSE-ICM obviously reduces assembly cost, but its benefit of reducing test costs should not be overlooked. A designer who goes with the discrete approach must develop test setups and software sufficient to catch all the defects that might occur during the assembly process: at a minimum one would need to verify basic functions such as detection, classification, and disconnect sensing. All these functions are pre-tested in the PSE-ICM; the only testing required would be to verify there are no bent pins or bad solder joints when the PSE-ICM is stuffed on the board. You get almost complete coverage just by running Ethernet traffic on all the ports and verifying the PSE-ICM acknowledges when it is addressed via the I^2C bus.

- Lower configuration management costs. For example, PSE-ICMs are available without the PSE electronics in the same footprint. This means a switch maker can design two products (a PoE-enabled switch, and a switch without PoE) that use the same main board; the only difference being which type of PSE-ICM is stuffed.

Conclusions

As the new IEEE 802.3at standard nears completion, many companies are preparing to launch their new PoE+ products. In this environment, where designers have a long list of technical challenges and a wave of competing products is imminent, shortening the design cycle time can be critical for success.

The PSE-ICM can greatly reduce time to market, but offers many other advantages described in this article. The two main drawbacks of previous modules were lack of standardization and high cost, but both of these are addressed by the new PoETec industry standard: Multiple sources are already on line, with more coming. The new PSE-ICMs are already lower cost than their predecessors, and over time competition and technological advances will drive costs down even further.

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Power Systems Design EUROPE

PSDE Green Power ENERGY EFFICIENCY

2009 GreenPower Leadership Awards

2009 GreenPower Leadership Awards Anounced at PCIM Europe

At the recent PCIM Europe Exhibition & Conference in Nuremberg, PSDE presented the GreenPower Leadership Awards for the second year running. These awards are given to recognize outstanding achievements in energy efficiency and green power in the power electronics industry and are selected purely by measurement of the interest from readers of PSDE in articles published online. This is a totally democratic process from within PSDE's engineering community.

These coveted awards are most prestigious to the winning companies and authors and demonstrate a resonance with the magazine's readership of 22,000 plus in Europe's power engineering sphere.

Jim Graham, Power Systems Design's Worldwide Publishing Director of the company's three power design titles in Europe, North America and China, commented, "We wanted to recognize and reward the great work in energy efficiency that often goes unnoticed in our industry. We reward the achievement of the winner by an educational donation from Power Systems Design Europe and sponsors to further the cause of energy efficiency. Our sponsors for this year's awards campaign are Intersil Corporation and Linear Technology."

The outright winner of the GreenPower Leadership Award campaign for 2009 is Fairchild Semiconductor with an article by Alfred Hesener, entitled 'Solar Power Shines'.

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

Educational Donation

As a significant component of the GreenPower Leadership awards there is an educational donation given to the European Engineering University of choice by the article author.

This year's donation is awarded to: The Institute of Robotics, University of Maribor, Maribor, Solvenia
Institution Selected by: *Alfred Hesener, Fairchild Semiconductor*
Donated by: *Intersil Corporation, Linear Technology & Power Systems Design Europe Magazine*
Donation: *€ 3.000*

The winner of the 2009 GreenPower Leadership Award is:

Company: Fairchild Semiconductor
Article: "Solar Power Shines"
Author: Alfred Hesener

Gary O'Donnell, Fairchild Semiconductor accepts award

Special Report – 2009 GreenPower Leadership Awards

The four finalists (in alphabetical order by company) are:

Company: Coilcraft
Article: "Designing for Efficiency at the Component Level"
Author: Len Crane

Paul Liebman & Len Crane, Coilcraft accept award

Company: Linear Technology
Article: "Solving Current Source Design Challenges"
Author: Robert Dobkin

Joachim Preissner, Linear Technology accepts award

Company: Microsemi
Article: "SiC Impacts 'Greening' of Power"
Authors: Philip C. Zuk & Bruce Odekirk

Bertho Simons, Microsemi accepts award

Company: Philips Lumileds
Article: "Avoiding Current Spikes in LEDs"
Author: Pat Goodman

Steve Landau & Rudi Hechfellner, Philips Lumileds accept award

Gold Sponsor
Intersil Corporation

Adam Latham, Intersil Corporation accepts Gold Sponsor award

Gold Sponsor
Linear Technology

Joachim Preissner, Linear Technology accepts Gold Sponsor award

2010 GreenPower Leadership Awards

Voting has already begun for our expanded 2010 GreenPower Leadership Awards Program and will continue through the April 2010 issue of Power Systems Design Europe. If you want to summit editorial content dealing with energy efficiency to be judged for next years program, contact Cliff Keys, Editor-in-Chief: cliff.keys@powersystemsdesign.com

For sponsorship opportunities: Julia Stocks, Publisher: julia.stocks@powersystemsdresign.com

www.powersystemsdesign.com/greenpower

CEO Opinion – Intersil Corporation

As part of PSDE's GreenPower Leadership Awards, I wanted to investigate the opinions of our sponsors. I asked Dave Bell, CEO of Intersil Corporation, Milpitas, California USA, a few direct questions to get his take on what is going on in our industry, the economic climate and his insight for the future.

How helpful do you find awards for Green Power to our industry?

I believe it's important to focus on Green Power since it will be the dominant technology trend for the coming decade. A couple of decades ago, the PC drove growth in our industry. During the last decade, it was the web and consumer products. For the coming decade, energy will be the key driver.

I recently visited Washington, DC with the Semiconductor Industry Association (SIA). During that visit I emphasized to members of the U.S. Congress that the semiconductor industry has a huge role to play in the efficient generation, transmission and conservation of power. Semiconductor companies must create technologies that produce dramatically more efficient energy use in appliances, lighting, transportation, industrial equipment, Information Technology and many other areas. These awards will motivate individuals and teams to make significant contributions to developing power-saving technologies.

What is the role of semiconductor companies in the use of renewable resources?

With conventional fossil-fuel power plants, or even nuclear plants, heat generates steam which drives a turbine. The turbine then drives a generator that directly produces AC power. No electronic conversion of power is necessary.

Alternative energy technologies produce electricity in entirely different ways. A solar cell may generate only 0.7 volts of direct current. You have to combine many of these cells, and then convert the DC power to AC. It takes efficient power conversion to transform an alternative energy source into a usable 50Hz or 60Hz AC form. That power conversion and control creates opportunities for semiconductor companies.

Dave Bell, CEO, Intersil Corporation

Within Intersil, what are the main drivers for Green Power?

We have created new department and have a growing team of experts that are investigating green power technologies. There is a unique opportunity to grow our business, and at the same time, do something that is beneficial to the planet. We are helping to develop technologies that reduce dependence on foreign oil, and reduce carbon emissions.

Intersil has a strong position in DC-DC conversion, which is necessary in solar panel power or fuel cell power conversion. It's also essential in hybrid and electric vehicles. We also have expertise with technologies that are used in battery charging and monitoring. One real-world example is the lithium-ion battery arrays that will be used in electric vehicles. Lithium ion batteries are great from an energy-density standpoint, but they have to be charged and monitored very carefully to prevent what the battery industry calls "rapid disassembly."

How much are global financial constraints affecting your outlook?

I've often said that a crisis is a terrible thing to waste. We'd prefer not to have this worldwide economic downturn, but it's out of our control and we're all in the same boat. However, it does create unusual opportunities for us to re-structure and re-focus our company in ways that we might have been reluctant to do in the past.

For example, we are being much more strategic with our R&D spending. We are de-emphasizing investment in some less strategic areas, and increasing investment in others. Alternative energy is clearly very strategic for Intersil, so we will definitely invest more in this area. Despite the downturn, and despite the fact that our 2009 sales will be well below those in 2008, we are actually investing an equal or greater amount in R&D this year. That's a bold commitment.

What about the engineers of the future—how do we find, recruit, and train the best and the brightest?

We have been explaining to universities our need for more analog design engineers and they, in turn, are encouraging more students go into engineering. During the last decade, we have seen a decline in the number of electrical engineering students. Not surprisingly, many of them have gone into software with the opportunities created by the web. We are working to turn this tide.

The best engineers in the world seek a challenging work environment. And more and more, they seek work that will make a difference in the world – work that will improve the environment in meaningful ways. Energy provides a huge opportunity for the best and brightest engineers and scientists to have challenging work in fast-growing companies, and to make the world a better place.

Do you think we need to see more tax credits to encourage more investment and innovation?

Tax credits are a good thing, and many countries around the world are utilizing them. In the US, the R&D tax credit has been extended once again, but this is typically done only on a year-by-year basis. We need longer-term thinking. More government incentives for basic research and engineering investment are extremely important. In the US, something in the range of $60 billion is budgeted for energy programs. This vast sum of money has the potential to create many new technologies and large numbers of engineering jobs.

Across the industry, what do you see as the major growth drivers for power technologies?

There are three key areas that will drive growth in power semiconductors: production, distribution and consumption. Semiconductors are essential in all three areas.

Let's take production first. In the U.S., about 70% of the electric power we generate results in carbon emissions since we're still burning enormous amounts of coal and oil. Even so-called "zero-emissions" vehicles are still mostly powered by a coal or oil fired power plant located some distance away. There's a lot of room for improvement with solar farms, wind farms and other renewable sources, making the label "zero emissions" closer to reality. Most of these alternative energy sources rely heavily on semiconductors for energy conversion and control.

Second, we need to do a much better job of distributing and monitoring power. For example, we should run appliances and charge vehicles when surplus power is available, and store energy for peak demand periods. The deployment of smart power meters and more sophisticated power distribution will make our limited power capacity go a lot further.

And finally, we must significantly reduce overall energy consumption in many places -- from energy conversion in hybrid vehicles, to more efficient motor systems in appliances to replacement of incandescent and fluorescent lights with efficient LED lamps.

A lot of energy conservation will be accomplished in little pieces. For instance an increasing percentage of the electric power in the U.S. is consumed by huge sever farms. Just improving the efficiency of the server power supplies by a few percent can have a significant impact, especially when reduced air-conditioning power needs are also considered. Thousands of small improvements in many areas can add up to big power savings and reduced carbon emissions.

How are you taking advantage of these challenging times?

Just as this downturn is creating opportunities worldwide, it creates opportunities within Intersil. We're stepping out with big and bold ideas. We're making big investments. We're creating a culture that encourages people to think outside the box.

The semiconductor market has been maturing during the last decade, and growth is slowing. This environment will reward companies such as Intersil that are aggressive, agile and inventive. It's an exciting time to be in the semiconductor business.

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Special Report – 2009 GreenPower Leadership Awards

2009 GreenPower Leadership Awards

Winners and Finalists Announced at PCIM Europe

For the past year the readers of Power Systems Design Europe have been voting for the best editorial contribution in the area of "energy efficiency". The 2009 GreenPower Leadership Awards program has been made possible by the financial contributions of our two Gold Sponsors: Intersil and Linear Technology.

The Winner is: Company: Fairchild Semiconductor, Article: "Solar Power Shines", Author: Alfred Hesener.

The four finalists (in alphabetical order by company) are: Company: Coilcraft, Article: "Designing for Efficiency at the Component Level", Author: Len Crane • Company: Linear Technology, Article: "Solving Current Source Design Challenges", Author: Robert Dobkin • Company: Microsemi, Article: "SiC Impacts 'Greening' of Power", Authors: Philip C. Zuk & Bruce Odekirk • Company: Philips Lumileds, Article: "Avoiding Current Spikes with LEDs", Author: Pat Goodman.

Educational Donation. A significant component of the *2009 GreenPower Leadership Awards* program is an educational donation, given to the European Engineering University of choice by the article author. This year's donation is awarded to: The Institute of Robotics at the University of Maribor, Maribor, Slovenia. The University conducts research on motion control solutions.

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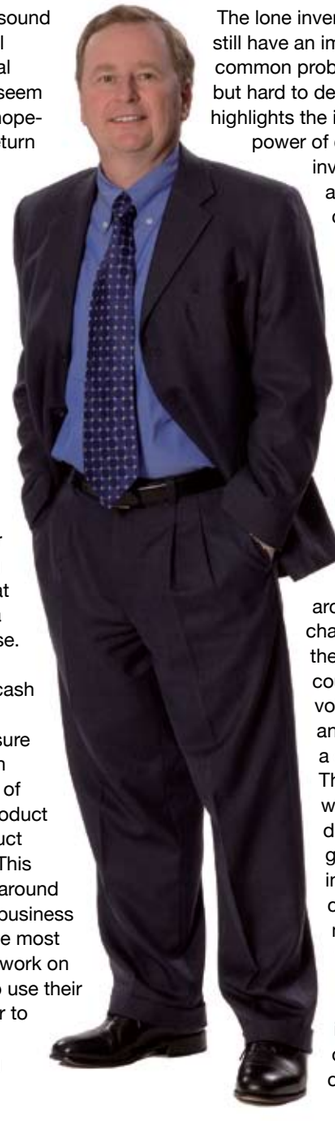
www.powersy intersil LINEAR TECHNOLOGY Power Systems Design EUROPE

CEO Opinion – Linear Technology

As part of PSDE's GreenPower Leadership Awards, I wanted to investigate the opinions of our sponsors. I asked Lothar Maier, CEO, Linear Technology Corporation, Milpitas, California USA to give us his perspective on Innovation and Green Power. He explained as follows.



It's probably too early to sound the all clear on the global finance crisis but financial markets and the economy seem to be gaining traction and hopefully we will soon see the return of stability and growth. In today's economy, economic value comes from the making and selling of ideas and solutions. Historically economic value was derived from selling commodities in high volume with little margin. It's clear that the companies that will succeed in today's market must be focused on innovation and customer support. Now is the time that most companies have revved up their R&D with a goal of bringing to market new products that will draw on, what is now, a much smaller customer base.

Invention, creativity and cash are the hallmarks of a successful business. The measure of invention and creativity in business is not the number of patents or awards that a product receives, but how the product is valued by the customer. This simple concept is the core around which Linear Technology's business is built. We've found that the most talented engineers want to work on products that allow them to use their creativity. This allows Linear to attract, develop and retain over 200 of the best analog engineers.

The lone inventor in analog can still have an impact. Solving common problems with simple, but hard to design, solutions highlights the importance and power of creativity and inventiveness in analog. Anyone can solve a problem by throwing millions of transistors at it, but done the right way, it can be done better and simpler by a creative engineer. Products like our LT3080 low dropout linear regulator exemplify this concept. The 3-terminal adjustable linear regulator has been around since 1976 and its basic architecture has changed little since then. But what if you could eliminate the voltage reference and replace it with a current source? This is precisely what the LT3080 does, resulting in a giant leap forward in linear regulation capability, performance and versatility.

The inevitable increasing cost of energy has a created a lot of interest around green power. The need to manage energy is nothing new to engineers at Linear. We have been at this for over 20 years, inventing new ways to improve and optimize energy efficiency. What has changed is the value that our customers place on improved efficiency. Buyers now understand that energy consumption in large installations like data centers or basestations can rival the cost of the equipment itself. So our customers now place much more weight on energy efficiency and are looking at a products total solution cost, not just the cost of the component.

Green power is just another color added to an engineer's palette of design and product opportunities. The goal of green power is to improve our life experience, not to make us learn how to pedal on bikes to work or to live by one 50 watt light bulb. The move to hybrid and electric vehicles presents engineers many new product opportunities. All next-generation vehicles will use Li-Ion batteries. Lithium battery packs offer the highest energy density of any current battery technology. Having a well-designed battery management system can make a significant difference in the performance and lifetime of Li-Ion batteries. Battery management systems using our LTC6802 battery stack monitor extract the most driving distance and lifetime from a battery pack while lowering overall system cost. Hybrid and electric vehicles will also need electrical solutions to replace prior mechanical or hydraulic systems. This necessitates electronic products that can withstand the harsh automotive environment, that have low quies-

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Power Systems Design EUROPE

intersil

LINEAR TECHNOLOGY

cent current to reduce power use when the vehicle is off, and that have wide input ranges to protect against voltage transients from cold crank and load dump conditions.

While hybrid and electric cars grab the headlines, there are a multitude of electronic improvements yet to be made in conventional cars. The use of LED lighting in vehicles has just started. LEDs were initially implemented for task and display lighting, then in tail lights and now with new high power LEDs for automotive headlights. LED lighting has the advantage of using a fraction of the energy of a conventional incandescent light bulb, operating up to 50,000 hours. And products like Linear's LT3755 LED driver enable a wide dimming range and the ability to eliminate the color shift normally associated with LED dimming.

Although automakers are currently in a challenging market environment, our customers tell us that the amount of electronics in new cars will continue to grow, but with an increasing emphasis on efficiency and reliability. For these reasons, the automotive market continues to be an important area of emphasis for Linear.

Interest in green power has led to products that put a new spin on old problems. There is plenty of energy in the ambient world around us, and the conventional approach for energy harvesting has been in solar panels and wind generators. New products are now emerging that use small temperature gradients or even vibration to convert to energy that can be stored or used by nano-powered products. These products can be placed in remote locations and can operate autonomously, not dependent on batteries or wires. The energy from these products can be stored in supercapacitors, which have carved a niche in the market between conventional capacitors and batteries. Compared to batteries, supercapitors provide higher peak power burst in smaller form factors, have longer charge cycle life and operate over wider operating temperature ranges.

As you can see, there is no shortage of ideas for innovative new products at Linear Technology. Our engineers' challenge is to understand and define the future new products that our customers need and will place a premium on having for their future designs. The current interest in green power opens up many product areas. These alone won't solve the world's energy needs, but you can be certain that the semiconductor industry will play a key role.

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PSDE Green Power ENERGY EFFICIENCY

The Mantle of Energy Efficiency

The quest for green electronics places a significant challenge upon the industry to embrace power conservation and increase system-level efficiency in common electronic applications. Semiconductor suppliers are at the forefront of this innovation with solutions that drive higher levels of efficiency, reduce standby power, conserve board space, correct power factor and facilitate adoption of more energy-efficient motor drive designs. Each product innovation can have a tremendous impact on the efficiency of electronics consumers use every day and contribute to a more sustainable world.

By Alfred Hesener, Fairchild Semiconductor, Europe

Green Power Supplies

The industry continues to embrace the need for Power Factor Correction (PFC), since PFC cuts the energy-wasted in the electrical distribution networks by reducing peak currents and minimizing harmonic currents. The demand will continue to increase as new energy-saving regulations place a stronger emphasis on PFC in off-line, power supply applications. Higher levels of integration in analog control circuits have enabled new PFC techniques that further enhance efficiency. For output power levels from 300W to over 1000W, the interleaved boundary conduction mode (BCM) PFC approach such as the FAN9612 is an excellent alternative to single phase, continuous conduction mode (CCM) PFC methods. By interleaving and synchronizing two power stages at precisely 180 degrees out of phase timing under all operating conditions, this lowers conduction losses. Not only does this solution allow high power conversion efficiency in AC-DC power supplies, it is integral in meeting key energy-efficiency initiatives such as the latest ENERGY STAR® and Climate Savers Computing Initiative requirements. These solutions have strong implications in saving electrical energy in power supplies for digital TVs, front-end telecom systems and industrial power

Extending Battery Life in Portable Applications

Portable electronics are an integral part of people's lives. Since batteries are not evolving in line with the power-rich functionality in these applications, semiconductor suppliers are the drivers of solutions that extend battery life, shrink the form factor and yet offer robust performance and protection, with the ultimate goal of increasing consumer satisfaction with the portable application. Reducing power losses in components such as MOSFETs and switches, but in turn, striving to shut down as much of the IC in standby mode is a key challenge. Designers wrestle with the challenge of developing power conversion products that offer higher switching frequencies without paying the penalty of lower efficiencies, yet providing this all in a low profile and compact package. Semiconductor suppliers need to come up with solutions that offer a carefully optimized and integrated design to mitigate switching losses, reduce the need for external components and offer less heat dissipation – all in a small footprint. Process technology such as Fairchild's PowerTrench® MOSFET technology plays a pivotal role in reducing $R_{DS(ON)}$, total gate charge (QG) and Miller charge to deliver significant enhancements in switching performance and thermal efficiencies. Packaging technologies such as MicroFET™ are instrumental in delivering excellent power dissipation and conduction losses to reduce heat.

Since portable applications operate from batteries that need to be recharged, each of these applications has a charger that contains a power supply. Considering typical consumer behavior, these chargers stay plugged in all the time and consume standby power. On average, it is assumed that every household has between five to twelve chargers. The more efficient that these power supplies can become, the less electrical energy they take from the power grid. The smaller the form factor of the charger, the smaller the power supply needs to be. Semiconductor suppliers again offer the building blocks for these power supplies such as Fairchild power switches (FPS™) to drive higher levels of efficiency, reduce standby power, eliminate extraneous circuitry and ease the complexity of design in these power supplies.

Energy Efficiency Matters

Every mW of energy saved may appear to be only a small in-road in saving our world. However it can make a global difference to today's environmental challenges. It is up to all of us - designers, manufacturers and consumers - to collectively embrace this principle and to creatively come up with ways to save our world 1mW at a time.

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Power Systems Design EUROPE

PSDE Green Power
ENERGY EFFICIENCY

Green Power

Green Power Goal for Set-Top Boxes

Meeting Energy Star® program requirements

The stigma of the Set Top Box (STB) long-running inefficient performance is finally coming to an end. For as long as desingers can remember, STBs have been notorious for running hot during "on" and "standby" modes, leading consumers to wonder if it is worth it to change the STB's mode of operation.

By Mike Voong, John Lee and Cam Jackson, Product Marketing, Micrel, Inc.

A Set Top Box used for watching or recording a television program can use up to 30 watts, but only falls to about 20 watts in "standby" mode, resulting in high heat dissipation in both modes. Fortunately, from January 1st 2009, the Environmental Protection Agency (EPA) issued new Energy Star® Program Requirements for Set Top Boxes. These new standards require 30 percent less energy for qualifying STBs. The two main methods for reducing the power requirements in Set-Top Boxes lie in software and hardware improvements. The software method encompasses better software control and energy management; i.e., how often the STB should download the Enhanced Program Guide (EPG) information in "standby" mode. The hardware method consists of improvements that can and should be made in power supply design in order to achieve higher efficiency and reduce heat dissipation. Here, we discuss the advances in power supply design and the impact they can have on Set Top Boxes.

Meeting the Energy Star® Requirements

To meet the new demands of the Energy Star® requirements, STBs must not only be designed to be efficient at high loads, but also during low current operation. Due to the increases in functionality, more computing power has lead to higher currents. Traditionally, linear regulators are used, but the increase in currents, coupled with the high power dissipation of linear regulators at high loads, has opened the door to switching regulators.

Figure 1 shows the typical power consumption of Set Top Boxes. The CPU core requires the most power of 1.2V at 5A. A 5V input voltage would equate to more than 19W of energy dissipated to achieve just 7.2W of output power. This comes out to an efficiency of 24 percent. A switching regulator, having efficiencies of up to 80 percent under the same conditions, would only dissipate a mere 1.8W to achieve the same output power.

Switching regulators are easily the better regulator choice for this application, but not all switching supplies are the same. For switching regulators at high loads, the ON resistance (R_{DSon}) of the high side and low-side MOSFETs dominate their power losses. In most cases, the value of the ON-resistance is inversely proportional to the dimensions of the FET. This means that smaller FETs have higher R_{DSon} resistance. Bigger transistors lead to bigger dies, leading to bigger packages, which take up more of the expensive real estate of the Set-Top Box's board. To achieve this level of power dissipation, linear and switching regulators used in the past would have to require external FETs. Fortunately, a technological advancement utilized by Micrel, called SuperThermal™ FETs, is now able to maintain a low R_{DSon} while keeping the package size small. To accomplish this, the package does not use traditional bond wire connections from the die to the pads. Instead, Micrel uses a thicker and shorter copper connection which helps to provide lower R_{DSon} in a smaller package size. This technology benefits the resistance from input to output, but also reduces the inductance, shrinking any voltage spikes due to line and load transients.

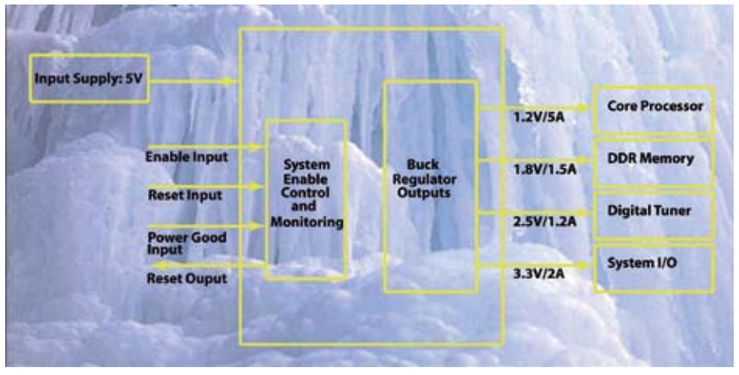


Figure1: Typical power consumption of a Set Top Box.

Efficiency may be important for all Set Top Boxes, but all STBs are different. Power requirements and startup sequences for the STBs core, system, I/O, hard drive, and tuner supplies, all vary depending upon the manufacturer of the Set Top Box. This variation requires that the power supply of the STB be flexible in terms of timing. Functionalities such as full sequencing and tracking can mean the difference between the system running and crashing. Control pins such as Power Good (PG), Delays, Enable, and Ramp Control (RC), provide total control over the STBs supplies. The system works thus: once an enable signal asserts high, the output voltage ramps up at the rate of the RC capacitor. As the feedback voltage approaches its nominal value, the delay capacitor charges and then releases the PG signal. By controlling the timing of these signals, delayed and windowed sequences and normal and ratio-metric tracing are easily implemented.

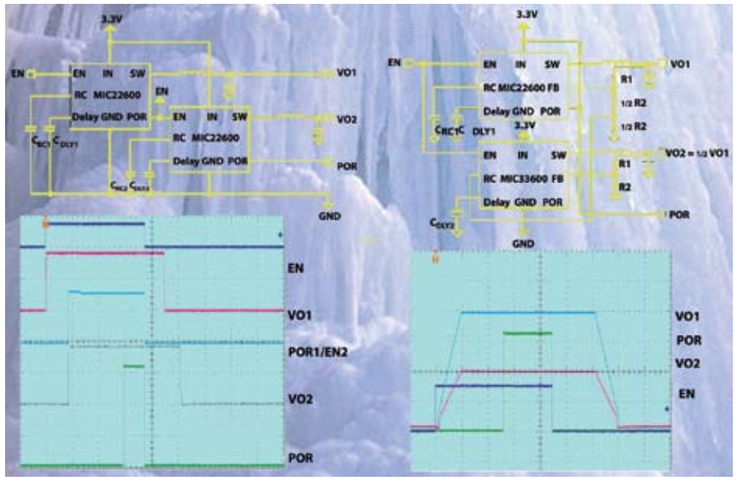


Figure2: Two example sequences accomplished through different applications of the control pins.

Figure 2a (left) describes the standard windowed sequencing ability of using Power Good and Enable Pins. By tying the Enable pin of the second supply with the Power Good pin of the first supply, the power up and power down of supply 2 is controlled by the enable signal of supply 1. Figure 2b (right) shows a typical application of ratio-metric sequencing used in DDR termination. In DDR memory supplies, the V_{TT} voltage is half of V_{DDQ} voltage and both should come up simultaneously. By tying the V_{TT} supply's Ramp Control pin to half of the feedback voltage of V_{DDQ}, achieved through a simple resistor divider network, ratio-metric sequencing is applied to the circuit.

SuperThermal™ FETs Technology

Micrel has released a new family of products using the new SuperThermal™ FETs technology. Already released are the Company's MIC22400, MIC22600, and the MIC22700, capable of 4A, 6A, and 7A output current respectively. By using the SuperThermal™ technology with the MIC22700, Micrel has achieved one of the highest power densities available in the industry. The comparison of output power to the package size gives one the power density measurement. Since board space on a television is expensive, the designer cannot increase the size of the power supply without bound. This will lead the designer to choose the part with a highest power density to ensure the circuitry receives adequate power while still not taking up any unnecessary valuable board space. The MIC22700 has a power density rating of 0.4375 Amperes/mm^2, while most others in the industry are still under 0.23A/mm^2. The closest competitive synchronous buck regulator in the market offers only 0.375A/mm^2.

The MIC22700 is capable of achieving more than 95 percent efficiency while operating at 1MHz switching frequency. A high switching frequency benefits the user by requiring small external components, further reducing the overall solution size. The device will work with a small 1µH inductor and 47µF ceramic output capacitor. Another advantage of the high-speed loop response of the MIC22xxx family is the performance during extreme load transients seen frequently in CPU cores, FPGAs, and low voltage ASICs. A fast loop response like the one in the MIC22700 can keep up with these swift load transients and pull the output voltage back into regulation quickly.

Conclusion

With 148 million Set Top Boxes installed across America and many burning high energy regardless of the mode of operation, change is inevitable and needed. The long awaited new Energy Star® requirements are calling for approximately 30 percent less energy use for qualifying Set-Top Boxes. The savings of meeting these new requirements have been estimated to be $2 billion a year while reducing the greenhouse effects of 2.5 million vehicles. The MIC22xxx family facilitates meeting these requirements by providing high efficiency across the low current to high current load range and by providing multiple internal control pins, reduces the need for extra devices to control the startup and sequencing of different supplies, thus saving board space as well as overall system power. The high efficiency of the MIC22xxx family, coupled with the complete sequencing control, is a good start to meeting the new Energy Star® Specifications.

www.micrel.com

High Efficiency 'Green' Planar Transformers

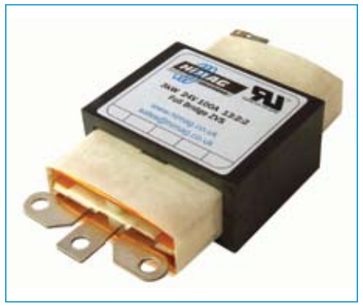
Ideal magnetics choice for the emerging green market

The Planar market is set for significant growth over the next few years and one thing is certain; using a Planar Transformer with its inherent higher efficiency, reduced weight and size plus improved performance, will give a differentiated competitive edge to future designs.

By Danny Ireland, Director of Engineering, Himag Solutions Ltd., United Kingdom

PLANAR TRANSFORMER technology has been used in high frequency Switch-Mode Power Supplies (SMPS), and other general electronics fields, for a couple of decades now and despite an initially slow uptake, the past few years have seen a sharp increase in the demand for this high-efficiency transformer technology – Why? It used to be the case that you only used planar if you couldn't manage it in a conventional transformer, but as people require higher efficiencies, reduced weight/size, and improved performance, planar magnetics is now becoming the first stop for many engineers developing their power supplies. Planar transformers often offer an efficiency of up to 99.5%, considerably better than their conventional counterparts, and when you consider the added efficiency that their reduced weight provides to a moving vehicle, it is easy to see why the demand is increasing.

Advantages of Planar Transformers
- *High Efficiency*
- *Low Weight*
- *Low Profile*
- *Low Leakage Inductance*
- *Highly Efficient Cooling*
- *Multiple Topologies*
- *Multiple Winding Options*
- *Customised Terminations*
- *Dimensional Accuracy*
- *Tightly Controlled Parasitics*



Himag Solutions E64 1kW-9kW Planar Transformer. (length max. 118mm, width max. 64mm, height max. 30mm)

The huge increase in emphasis on 'green' technologies, such as hybrid/electric vehicles, wind and solar has driven the increased demand for planar transformers. Additionally, a general "green" efficiency approach to all new products, from household appliances to welders, has meant the role of power electronics engineers has become increasingly important.

These new 'green' application areas bring increased demands for greater efficiency, performance, power density and, of course, cost. As a result engineers are facing important design decisions and challenges when selecting the best topologies, switching frequencies and, just as important if not more, the magnetic components for their designs.

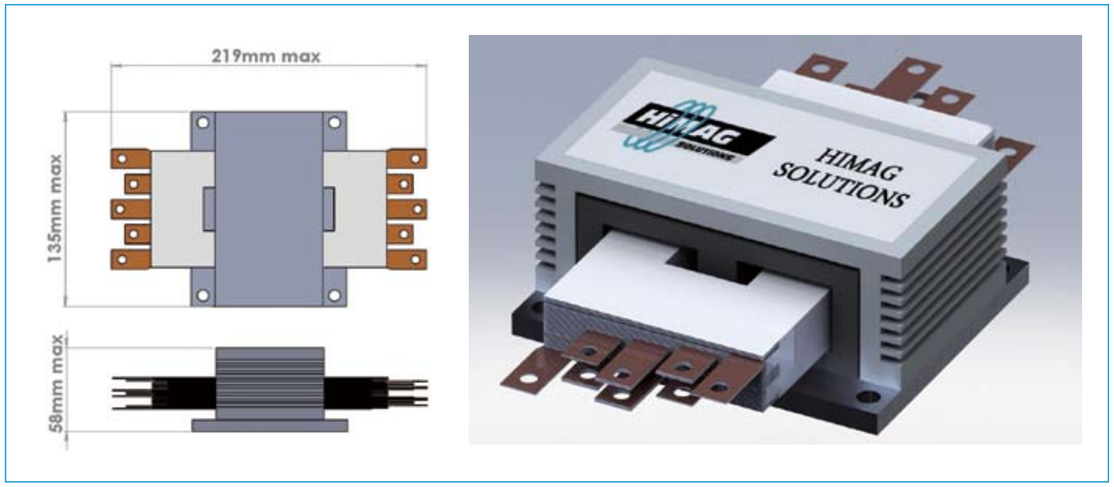
Himag Solutions have found there are a few common misconceptions about planar transformers in general:

"Planar transformers are only suitable for low power, low voltage applications":

This is a very generalist approach and whilst it may be the case in some applications, it most certainly is not the rule: each design must be evaluated based on its own merits. Since 1999, Himag Solutions has manufactured a fully integrated Planar DC-DC Converter for one of the largest telecoms manufacturers in the world. The converter can deliver up to 4kV@1A and can be used in modules to provide up to 12kV output voltage. Moreover, Himag Solutions are now able to offer a single Planar Transformer with a 30kW capability.

"Planar transformers are always constructed using PCBs"

Whilst the use of PCBs is common, copper lead-frames and occasionally aluminium are also used. Copper lead-



Himag Solutions E102 7kW-30kW Planar Transformer.
(Possible minimum dimensions 194mm x 102mm x 22.5mm if no heatsink is required)

frames are usually used in low voltage, high current applications such as battery chargers and welders, yielding a better window utilisation factor compared to a PCB based planar.

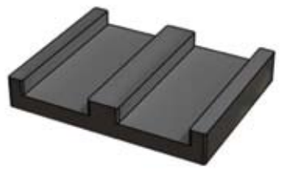
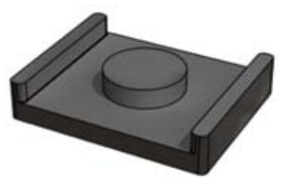
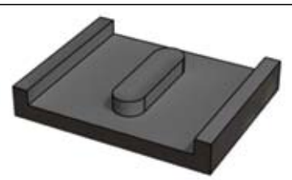
"Planar transformers are always expensive":

The material costs of a planar transformer have significantly reduced over recent years. Himag Solutions' copper lead-frame design system allows for very low cost prototyping, particularly in the 2kW-9kW power range, and volume pricing is reducing year on year.

Where custom lead-frames and PCBs are required, there are always tooling costs associated with their fabrication but the pre-fabricated nature of the materials does reduce the labour element.

"Planar transformer technology is patented":

The 'planar transformer' is not patented. Whilst a few planar transformer 'construction methods' are patented, Himag Solutions uses its own open construction system. Some manufacturers use a bobbin as part of their construction and whilst this may have its advantages in terms of isolation etc, it does reduce the thermal performance by restricting the thermal path. Himag Solutions' open construction method is very flexible and also provides an excellent thermal path from the planar structure to the main heatsink via the ferrite cores. In addition to this, it is also very easy to incorporate "spacers" between the windings to allow airflow through the windings, improving thermal performance yet further.

Planar E Core		**Largest Window Area:** Planar E-cores have a very similar *effective area* as their conventional equivalents, but their lower profile provides a reduced *volume of ferrite* and an improved thermal footprint. Usually planar E-cores have the largest *window area* of the three geometries shown here.
Planar ER Core		**Lowest Losses:** Planar ER-cores have a similar *effective area* and *volume of ferrite* to the planar E-core. However, the circular centre limb allows the windings to be circular, which results in lower winding losses with a reduced transformer length. However, these benefits come with a trade-off: The window width is much narrower than for a planar E-core, resulting in fewer or narrower tracks.
Planar EL Core		**Compromise:** Planar EL-cores offer a real compromise between the large window area and lower losses offered above as the centre-limb offers width with reduced length. They also have a similar *effective area* and *volume of ferrite* to the other two geometries.

Planar Core Geometries.

Interleaving

Whilst 'planar' cores provide many of the advantages of planar transformers, other more conventional cores are also utilised in planar designs: from PQ, RM, to conventional E and ETD cores. The planar 'structure' is of as much interest to customers as the core geometry and height savings; particularly as planar winding stacks are much easier to interleave than that of a conventional wound transformer. Himag Solutions has seen designs where the primary winding has been split up to 5 or 6 times with the secondary windings interleaved between each primary group. This is where many of the benefits of a planar construction are fully realised, with particularly improved coupling between windings, significant reduction in leakage inductance and reduced skin effect.

Retro-Fitting Planars into Conventional Footprints

Non-planar cores are often used when retro-fitting a planar into a conventional space. Himag Solutions has been asked on several occasions to design a retro-fit planar to replace a conventional transformer which ran too hot. This is due to a combination of factors, but in particular the interleaving that a planar transformer construction allows as well as reduction of skin effect. Retro-fitting can present its own problems in terms of core selection and lead-frame/PCB design options, but has nevertheless yielded benefits. The reduction in thermal conduction area can be detrimental but as long as careful attention is paid to the interleave structure the majority of the benefits are still achievable.

Lead-Frames vs. PCB

The choice between a copper lead-frame or a PCB construction is usually down to volts and amps (as well as isolation). Lots of volts means lots of turns, which are usually at lower currents, which together usually dictates a PCB design. Conversely, lower voltages at high currents require large "usable" copper cross-sections and hence copper lead-frames are usually the best solution in these cases. Usable copper cross-section is an important factor in the design of planar transformers, indeed any transformer. Simply having a copper 10mm^2 cross section of doesn't mean it's all being utilised. Skin effect and proximity effect need to be kept to a minimum, and the interleaved nature of a planar transformer, together with the use of thin copper lead-frames or PCB tracks, means that these two loss mechanisms are much less of a problem. Himag Solutions uses preformed copper leadframes in single and multi-turn forms to achieve virtually any desired turns ratio. This flexible approach speeds up design iterations and ultimately time to market.

Isolation

Large isolation voltages tend to dictate the window utilisation of a planar design. It necessitates a need to either use PCB windings or reduce the copper cross-section in order to meet the strict requirements.

The growth of the renewables markets, and in particular the use of more grid-tied inverters, creates even greater isolation requirements. However, with the range of materials that are now available to the planar designer, planar magnetics are ideally positioned to meet these demands.

www.himag.co.uk

Power Management

The key to green power?

In recent years many initiatives have been created by governments and organizations to decrease energy consumption, to steer initiatives that improve systems' efficiencies, to drive new regulations and targets, and to encourage individual initiatives that will contribute to create a sustainable community for future generations.

By Patrick Le Fèvre, Marketing Director, Ericsson Power Modules, Stockholm, Sweden

A tangible example of this is the number of ongoing projects concerned with energy saving, and also in activities that are visible to all of us, e.g. the EPA releasing a new Energy Star requirements for commercial refrigerators and freezers that on average are more than 30% higher than federal minimum standards, the Green Grid launching new datacenter energy efficiency reporting guidelines, OEMs reconsidering their processes to reduce the amount of energy consumed by operation and transportation, and the development of new ways of working based on mobile communications and fixed access broadband.

In addition to that, research and development into new sources of energy, new ways to use those energies, and the optimization of renewable energies already available, are driving a tremendously high level of innovations, which has never happened before.

Think out of the box

It might sound strange, but from a single mobile phone to a huge datacenter, energy management and the optimization of that energy are a very similar process!

From the original analog phone to the latest multimedia phones available on the market, therein lies a hidden component that the vast majority of users do not even suspect exists; tremendously evolved in silence, it is…. the energy management controller.

The level of success of an efficient energy management controller is not bound by pure technology. It also requires designers to think 'out of the box'; to dare to challenge what has stood as accepted and unquestioned for a long time. Patching 'bulletproof' platforms may not always be the most sustainable way.

A very good example

For those of you who remember 1960, when Intel co-founder Gordon Moore forecast that the number of transistors in a given area of silicon will approximately double every two years, and have since followed the evolution of that industry, you will recall the amazing innovation race to develop faster processors, doubling the number of transistors every two years (figure 1). The collateral effect being a growing power consumption generated by the millions of transistors hosted in an Intel 486, and the subsequent ten million or more buried in its successors.

At that point in time, the energy required by those components - and even more critically - the power dissipated by billions of junctions started to physically limit the development of such monochip processors, generating not only a wave of innovation from which resulted multi-core technology, but also a brand new approach in managing energy

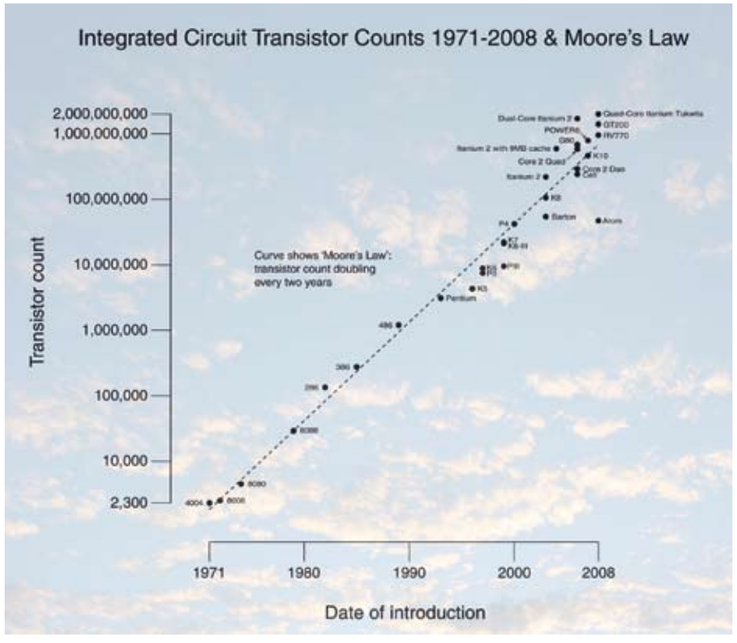


Figure 1: Gordon Moore's forecast (Moore's Law).

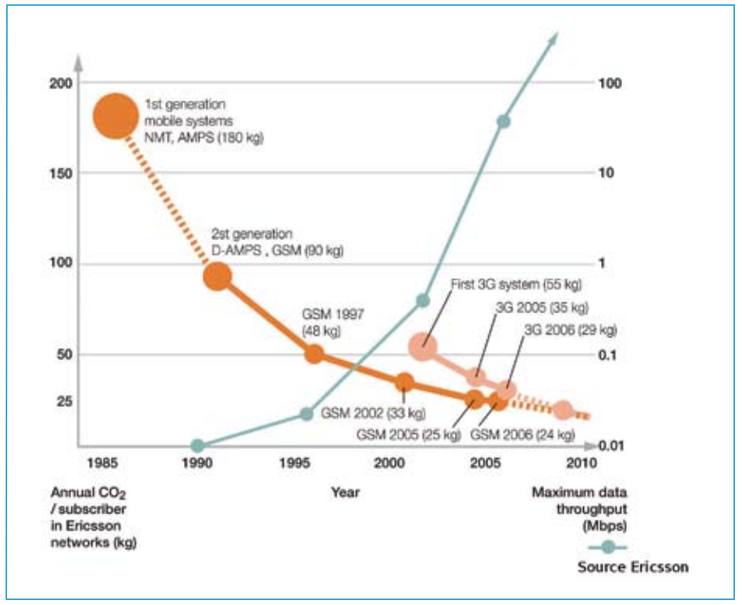


Figure 2. Ericsson Life Cycle Assessment curve.

consumption at both cores level and outside the cores.

Without entering into great detail, when moving from single core to multi-cores, the processor industry completely revisited each core, and even within each core, identifying where and when energy would be required, resulting in a very advanced energy management topology. That result is very impressive, but would not have been achieved without thinking out of the box at a time when the trend was to increase the power density even further.

If we expand what the processor industry developed to the rest of the boards, and even to larger systems such as datacenters, we can see that in addition to more efficient power systems, energy management becomes the strategic key element that will be the highest contributor to improve system efficiency.

Recall the mobile phones that I mentioned earlier, and think what would have happened without those phones' embedding dynamic energy management control? They probably wouldn't be able to bring the world into your pocket, making it possible for you to conduct your business without (energy consuming) long hours commuting!

Here again, mobile phone and nomadic equipment designers had to think out of the box, combining new components such as low power consumption ICs with innovative ways to manage distributed energy from a single battery.

In any case, without efficient energy management, technology would be stuck at the same level as it was in 2000. So considering the gigantic steps forward that processors, mobile phones, and other equipment have made in less than a decade, it is easy to imagine that expanding this approach to broader applications will contribute to the creation of a sustainable environment for future generations.

Managing energy in practice

Battery powered applications have always (by necessity) been very energy focused, and besides new technologies such as fuel-cells, or micro-organics compounds, energy management has become state of the art; something that everyone appreciates when the green energy gauge never empties!

However, in the information and communication technology arena, mobile radio and equipment makers such as Ericsson have begun several initiatives to reduce energy consumption, and to improve energy management, from which has resulted a significant reduc-

Figure 3. Ericsson digitally controlled DC/DC converter BMR453.

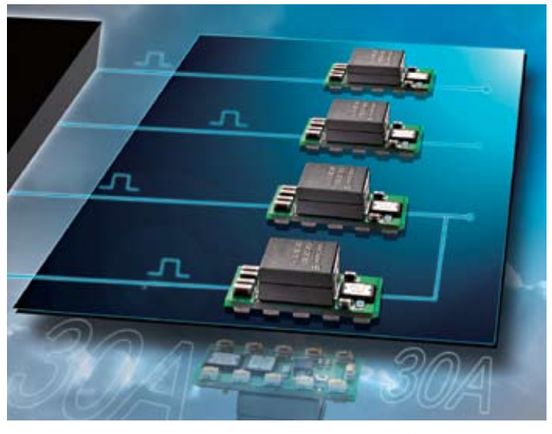


Figure 4. Ericsson power blocks ROA 128 3003.

tion in CO_2 emissions (figure 2).

By different methods, managing energy at system level has been in practice for decades, but recent technologies and so called 'digital power' are making it simpler for systems' designers to interface from site to single component level.

As for the latest generation of microprocessors with embedded power management intelligence which makes it possible for the processor to switch from core to core, to privilege speed or mass analysis and many others, systems too are now embedding energy management controllers that are able to talk to any part of your boards, and to effect the correct level of energy being delivered at the right time, to the right part of your system.

To achieve that, power designers working in close collaboration with systems' architects had to think out of the box, and to consider new power architectures, and new ways to combine switching power and digital intelligence.

Application examples

One possibility offered by the open standard PMBus when used with a digitally controlled DC/DC converter such as Ericsson Power Modules' BMR453 (figure 3), is to adjust the intermediate bus voltage to a very accurate level at a certain point of operation i.e. at full operation the bus voltage is set at 12V and decreased to 9V when lower power is required, and that in direct conjunction with the microprocessor, which through its VRM and PMBus interface can shift the VID table and ensure that the intermediate bus converter delivers the most optimized voltage to secure the operation while reducing the drop-out losses.

Another example is the flexibility offered to designers to locally host power switchers e.g. power blocks such as Ericsson's ROA 128 3003 (figure 4) close to the load while having the controller hosted on the backplane or in another part of the board, and the flexibility to control those power blocks in accordance with the power required by the application. For example several power blocks switched in parallel when high current is required, and only one block when in stand-by mode.

New high density equipment may require over 600W per board, which in terms of efficient power distribution requires one to think a little out of the box, and to consider the adoption of new power architectures such as 'Fragmented Power Distribution'. That used to be very complex, but the new generation of digitally controlled converters and the ability to simply parallel them are making the implementation of such architectures as simple as traditional ones.

Conclusion

Very often power supplies' efficiency figures are considered as the key element when considering energy saving - though that is less and less the case. Energy management and the ability to interface and communicate from site level to load have become very crucial, but very exciting for designers, with many opportunities to think out of the box.

www.ericsson.com/powermodules

Cool Power

Increase airflow with the right connector

With data centers continuing to grow in size and energy consumption, server manufacturers try to squeeze as much efficiency out of their systems as possible. A new approach to low profile connectors enables a greater airflow through the power supply.

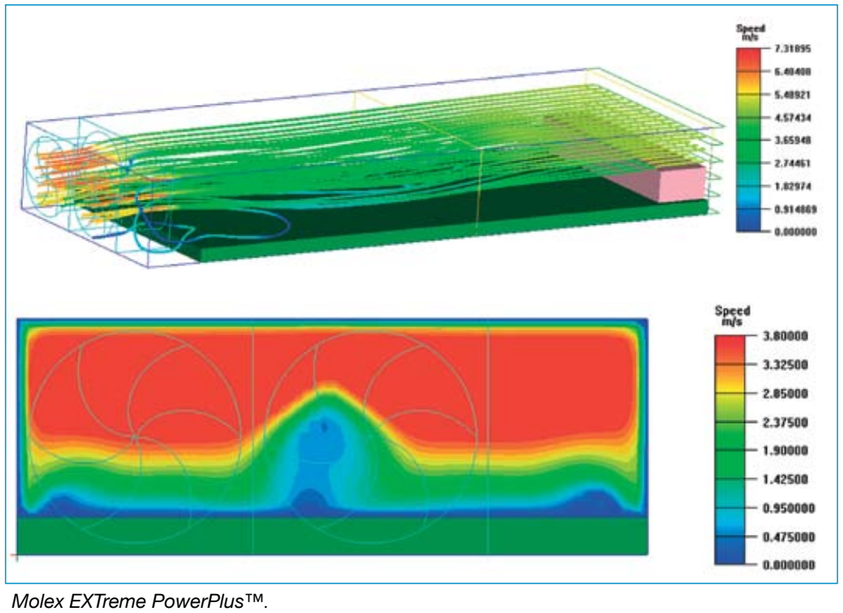
By Michael Bean, Global Product Manager, High Current Power, Molex Inc., Lisle, Illinois

Why suffocate your power supply?

System cooling is one of the biggest challenges facing server architectures today. For every 100 watts generated to power the system, another 50 watts is consumed just to cool it. In the average high-capacity server, microprocessors, chassis fans, and power supply losses combine to account for 50%-80% of the total server energy used. If better cooling efficiencies could be implemented, companies, cities, and nations could benefit immensely from major cost savings in energy usage, and drastically reduced carbon dioxide (CO_2) emissions.

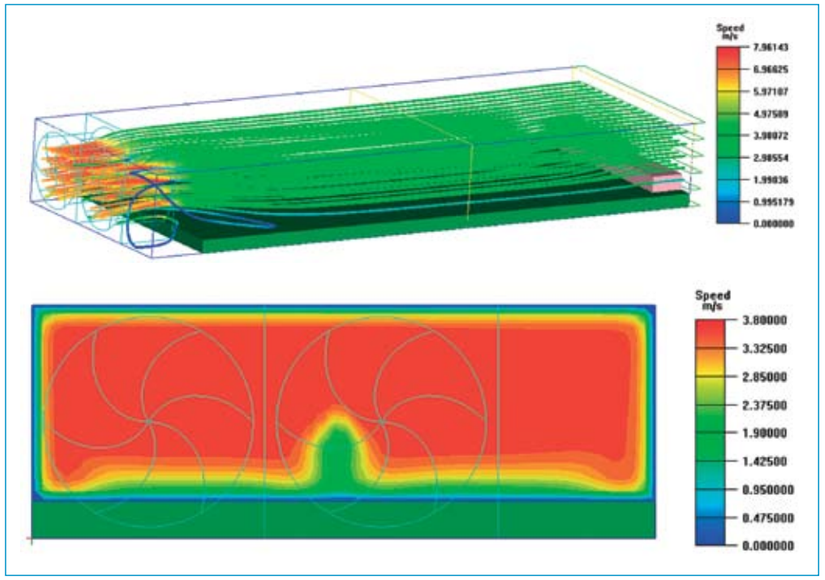
Power supplies are often a key part of the system cooling equation and a critical part of the thermal development, as they are not only heat generators by necessity, but they also have to provide cooling for themselves as well as other system components. If power supplies are an integral part of the thermal dynamics of the overall system, then the power connector becomes a very key consideration, directly linked to the efficiency and cooling of the power supply. In this case, the connector becomes a critical part of the power supply thermal design, since it can enable better cooling of both the power supply enclosure and the connector itself.

How does the connector play such an important role? The size (height profile and length) of the connector, which also determines current densities, can have a profound effect on airflow within a power supply enclosure. It seems simple yet very logical, that the flow of air must not be interrupted by the connector. The stronger the airflow, the more cooling that will take place. If the flow is not allowed to enter (or exit) the enclosure uninhibited, recirculation increases, static air mounts, and draft is limited. Without the proper connector, at best, only limited cooling of internal components takes place.



Molex EXTreme PowerPlus™.

Let's put some numbers to this important theory to reinforce the importance of correct connector selection for energy savings and efficiency. First however, we must create a "typical" power supply, and let's say this is an 1800 watt, 12.0V power supply with an 87% efficiency rating running two parallel 40mm fans. The enclosure size is 295.0mm long x 106.0mm wide x 40.0mm high. The two connectors we will compare both have 10 power blades and 32 signal pins integrated into a single housing. One connector is a standard SSI type (Molex EXTreme PowerPlus



Molex EXTreme LPHPower™.

™) which is 100.3mm long x 14.5mm high. The other connector is a low profile version by Molex called EXTreme LPHPower™ that is only 92.3mm long x 7.5mm high. Note that LPH is half the height profile of the standard connector, and that difference in height will prove to be a big advantage in airflow.

We set up both thermal models with a 60% free air ratio at the non EMC boundary grate over and around each connector, which would be typical on a given power supply. At 1800 watts and 87% efficiency, there are 200 watts of heat to exhaust from the power supply enclosure ((watts/efficiency)-watts). Since many manufacturers target 20°C temperature rise for rating (safety) purposes, one can calculate the basic airflow required to meet the intended design specifications. The calculation for CFM using heat to be dissipated and desired temperature rise is:

Q = 1.76 W / Tc

Where:
Q = Airflow required (in CFM)
W = Heat to be dissipated (in watts)
Tc = Temperature rise above ambient
1.76 = slope

So in our example above, the required airflow should be 23.67 CFM to meet our design goal. Let's take a look at how our two different connectors contribute to our airflow requirements.

The first example of the EXTreme PowerPlus (SSI type) indicates 22.70 CFM at the measurement point, midway through the power supply, which is shy of the goal to cool the system. This requires the fans to run at full RPM to cool the supply, not allowing any additional system cooling – using more energy than needed.

Something else you will notice is the draft of the airflow. The taller connector tends to keep the movement of air to the upper half of the enclosure, producing stagnant and recirculated air to the bottom of the supply. Recirculation may be desirable for large computer cabinets, but in small enclosures such as power supplies, most, if not all, of the airflow can be lost due to recirculation. The cross-sectional view you see above demonstrates how much airflow blockage takes place with the traditional connector, based on velocity contours. The red indicates areas of high velocity, which is most desirable.

Our second example is of the Molex EXTreme LPHPower™ connector used in the same environment. The LPH connector, being half the height of the SSI style, indicates airflow of 25.90 CFM – an increase of 14% over the taller connector. That may not seem like a lot, but think about the fact that you could increase your power supply to 2000 watts while keeping to your 20°C temperature rise without changing your thermal specifications or connector. The extra airflow headroom also allows the power supply to pull through additional system cooling.

Our contour plot of velocity for LPH shows that draft is also vastly improved and promotes greater air circulation and velocity to reach the lower extremes of the enclosure, meaning more components will get cooled more efficiently.

The effects you see above are even greater on the smaller sized 850 watt to1200 watt power supplies where you may only have a single 40.0mm fan squeezed next to the standard AC input IEC connector. In these cases, the Molex LPH connector can gain up to 25% better airflow with much better draft through the enclosure over the traditional style power connectors.

Conclusion

All the current industry trends of more performance in less space will continue to adversely affect thermal performance and cooling efficiencies. Smaller power supply enclosures lead to smaller, higher speed fans needed to get the heat out, which increases energy consumption, noise, and reduces MTBF of the fans and other internal components. The connector selection is a critical aspect of the overall design and performance specification on each power supply. EXTreme LPHPower is an excellent solution to enable better power supply performance over current connectors in the market. In fact, Molex has introduced a whole family of space-saving, high current density power connectors in the EXTreme Power™ family to help solve the mounting energy consumption and thermal design challenges you face every day.

www.molex.com/link/ext-power.html

Green Inductive Components

Meeting Energy Star® program requirements

Demands for ever higher efficiency calls for inductive components with improved properties. Tape wound cores based on nanocrystalline materials have properties beneficial for high-end power electronics devices. The high permeability and broadband frequency characteristics of Vitroperm® enable filter common-chokes with superior noise attenuation properties. The low core loss and high saturation flux density results in compact power transformers and DC chokes with possibilities of reducing switching frequencies, which also reduces semiconductor switching losses.

By Lars Kvarnsjö, Key Account Manager, Vacuumschmelze, Sweden

The market for Switched Mode Power Supplies is constantly increasing. Different applications require conversion of type AC/DC, DC/DC, DC/AC or AC/AC. Rectifiers (AC/DC) are used in a broad range of applications in commercial and domestic areas for driving electronics and for charging batteries, e.g. PC computers, mobile phones, telecom base stations, automotive and domestic appliances. DC/DC converters are used for adapting DC voltage levels to fit electronic circuits and devices. Examples of applications for inverters (DC/AC) are connection of solar panels to the power grid and in cars to obtain mains voltage for consumer electronics. Frequency converters (AC/AC, rectifier-inverter combination) are used in modern motor drives for efficient controlling of torque and speed.

The power levels of different types of switched converters range from a few Watts for single chip DC/DC converters, up to the 100 MW range for the largest frequency converters for motor drives and rectifiers for the metal industry. They all have a common need of inductive components, e.g. transformers for galvanic isolation and for voltage transformation and inductors for current smoothing and noise filtering. Depending on power level, switching frequency and topology, different types of magnetic materials are considered for inductive components and the material choice is often decided by a combination of what is commonly used in the company/industry and the price/ performance ratio.

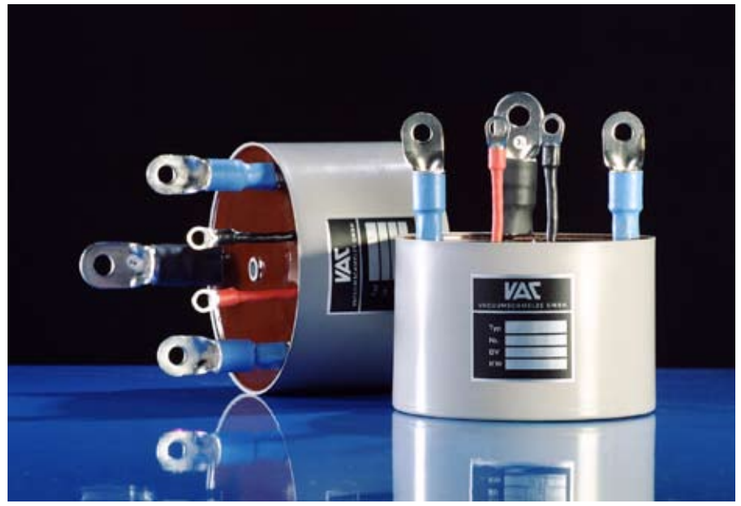


Figure1: Examples of inductive components and cores made of VAC VITROPERM® material.

The increasing focus on energy efficient solutions has introduced additional parameters for consideration when choosing magnetic materials. These are the cost of power losses, the environmental effects of energy waste, and increasing market competitiveness by having highest efficiency solutions.

Vacuumschmelze is developing and producing inductive components utilizing tape-wound cores made of the soft magnetic material Vitroperm 500F. This is a nanocrystalline material manufactured in thin ribbons, ~20µm thick, by a rapid solidification technique. Different heat treatments result in material that is well suited for both power transformers and for noise attenuation purposes.

Power transformers

The most important requirements for the core material for power transformers are low core losses and a small magnetizing current resulting from high permeability. Power ferrites are often used for low and medium power levels. Fig. 2 shows published core loss data of Vitroperm and a state-of-the-art lowest loss power ferrite (3C96 from Ferroxcube). Depending on the type of application, e.g. stationary or mobile, weight or volume is the most important parameter when choosing core mate-

rial. Therefore the typical core losses are shown comparing per unit weight and per unit volume. At magnetization levels > 100 mT and switching frequencies <100 kHz Vitroperm is the optimum choice in terms of core losses. Another important parameter to consider is the much higher magnetic saturation level of Vitroperm in comparison to that of power ferrites. At switching frequencies ≤ 40 kHz ferrite core power transformers are not loss limited but flux limited, leading to bulky and heavy designs. More compact and energy efficient designs can be obtained using a nanocrystalline core. Typical fields of application for this are traction and welding.

As shown in Fig. 3 the core losses of Vitroperm are stable over the whole active temperature range, with the core loss temperature coefficient even being slightly negative. This implies that inductive component designs with these cores have optimum energy efficiency over the whole load and operational temperature range. The stable core losses of Vitroperm with respect to temperature also ensure a robust design with no risk for positive feedback of temperature.

DC and PFC chokes

DC and PFC chokes bear a DC or low frequency current with a superposed high frequency current ripple. For low power switched converters toroidal powder cores are often used. At higher power levels it can be difficult to achieve reasonable designs with powder cores. In comparison to Vitroperm the core losses of different types of powder cores, e.g. Sendust, MPP, High-Flux, iron-based amorphous and iron powder are about 10 times higher or even more. In order to keep the AC flux and hence core losses at a reasonable level, a high number of turns is needed. On the other hand this action causes an increase of the copper losses. A gapped-core design with a low loss core material, such as Vitroperm will automatically lead to a more energy efficient solution. Due to the extremely low core losses and high saturation flux density, compact inductor designs can be realized. For these a high ripple current (high flux ripple) can be allowed without leading to excessive heating. Because of their very high saturation flux density, tape wound cores made of iron-based amorphous material, such as Metglas 2605SA1, are also sometimes used in high frequency high power DC and PFC chokes. The published core loss data of 2605SA1, though, given in Fig. 2, shows that core losses of iron-based amorphous cores are an order of magnitude higher than those of nanocrystalline cores. Another significant property of Vitroperm is the magnetostriction of around zero ($1 \cdot 10^{-7}$). Compared with the high values of iron based amorphous material ($27 \cdot 10^{-6}$), you get no disturbing noises in low frequency applications (f ≤ 16 kHz). Taking all aspects into account, the high saturation flux density and the low core losses of Vitroperm make it an optimum choice for energy efficient designs of high power DC and PFC chokes.

Common-mode chokes

All switched converters generate noise that has to be suppressed to fulfill EMC standards for the different application fields. The noise is separated into conducted and radiated noise. Conducted noise is differentiated into differential mode (DM) and common mode (CM). Attenuation of common mode noise can be done with common-mode chokes (CMC's) and

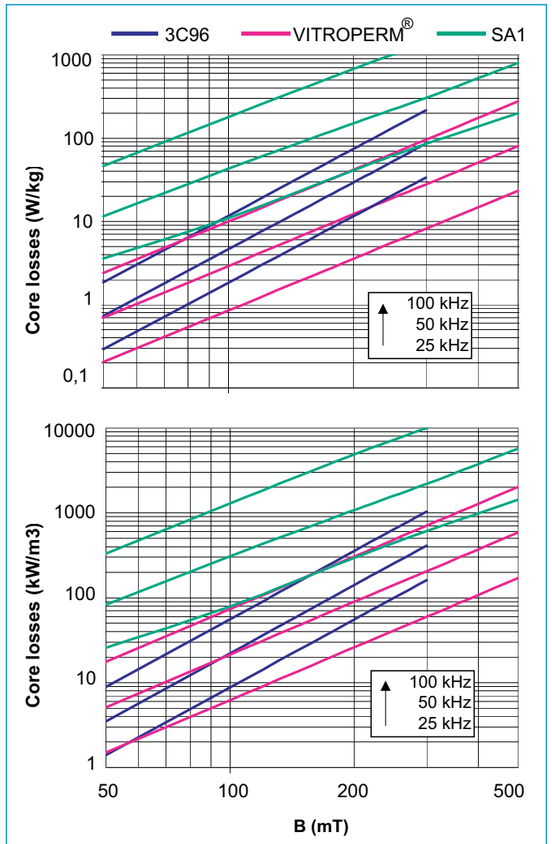


Figure2: Published core losses of Ferroxcube 3C96, VAC Vitroperm® and Metglas 2606SA1.

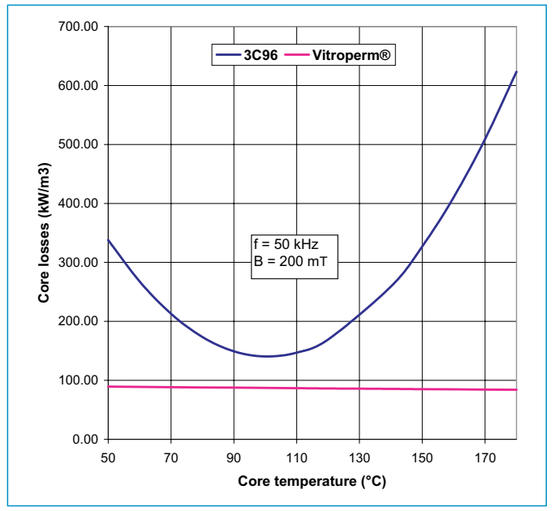


Figure3: Core losses of Ferroxcube 3C96 and VAC Vitroperm® as function of temperature.

Y-capacitors (C_y).

Vitroperm is proven to be an excellent core material for CMC's. The upper part of Fig. 4a shows the absolute value of the complex permeability |μ| as function of frequency. This typical characteristic of Vitroperm is compared with some well-known state-of-the-art EMI ferrites: Ferroxcube 3E5 and 3E25 and Epcos T38 and T65. The complex permeability is a combination of the inductive and the resistive part, defined as μ = μ' - jμ". For ferrites, μ' and μ" are found in most ferrite data books.

Vitroperm has higher permeability over the whole frequency range compared to ferrite CMC materials, and a detailed view will show that this holds for both μ' and μ". Two additional properties should be mentioned: a) the negative slope of |μ (f)| at higher frequencies is not so steep for Vitroperm as for ferrites, implying wide band suppression of chokes with a Vitroperm core, and b) the permeability of ferrites varies significantly over temperature while the permeability of Vitroperm is stable over the whole temperature range.

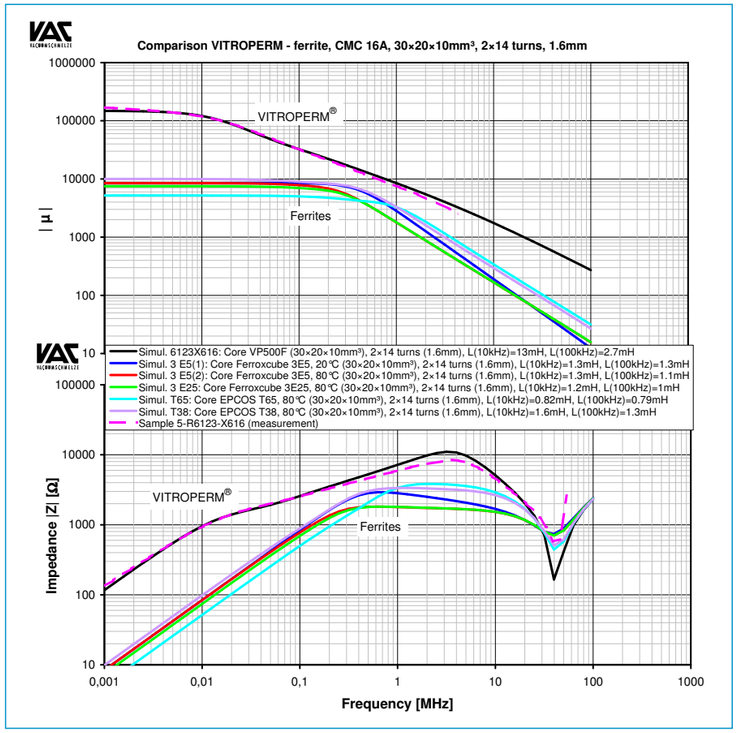


Figure4: Vitroperm® and different ferrite grades.
a) Absolute permeability.
b) Simulated CMC impedance.

	VAC VITROPERM® 500F (power and noise)	Ferroxcube 3C96 (power)	Metglas 2605SA1 (power)	Ferroxcube 3E5 (noise)
Saturation flux density (T) 100°C	1,2	0,44	1,56	0,23
Permeability 25°C	~ 15000 - 100000	2000	-	10000
Typical losses P_{Fe} (mW/cm³) 50kHz, 200 mT, 100°C	90	140	1000	-

Table 1: Comparison of soft magnetic core materials for power and noise suppression applications.

A CMC with the highest impedance is of interest for a filter design since this blocks the noise path most effectively. Fig. 4b shows an example of simulated impedances of a 2x14 turns 16 A CMC. The different characteristics correspond to CMCs with cores of the different materials from Fig. 4a. The CMC with a Vitroperm core has the highest impedance. In real designs, often a specific impedance is required in order to fulfill the EMI standard. In such case a CMC with a Vitroperm core can have a smaller core and/or fewer turns than a corresponding CMC with a ferrite core. This implies that the Vitroperm design will be more energy efficient since smaller values for the DC resistance are possible, and hence the normal conduction losses will be smaller. Vitroperm CMC's also allow good possibilities of reducing 2-stage ferrite filter designs to 1-stage Vitroperm designs.

A single phase CMC contains two windings, wound in a way that the normal load current is compensated. Therefore no magnetic flux is generated in the core. The magnetic flux leakage however will cross the core between the two windings with a risk of local saturation, which disables the function of the CMC completely. Due to the better conduction of the magnetic flux (high permeability) and the 3 times higher saturation flux density; this risk is smaller for Vitroperm cores in comparison to ferrite cores. For applications with large unbalanced currents, e.g. for motor drives with long cables or for attenuation of bearing currents, VAC has invented an alternative grade: Vitroperm 250F. This material has the same high saturation flux density as Vitroperm 500F (1.2T), but with a permeability in the range of 5000, similar to typical EMI ferrites, and therefore in comparison, its resistance against saturation effects is three times higher.

Designing inductive components for power electronics with nanocrystalline magnetic cores will help significantly to increase the overall efficiency of power supplies.

www.vacuumschmelze.de

Green Power Semiconductor Technologies

Bringing efficiency to the next level

A growing trend in the power conversion world is green. Governments and organizations are introducing ever more stringent regulations every year. Consumers are increasingly becoming aware that saving energy is beneficial to them as well as the environment. In order to save energy, improving the efficiency of power conversion is a vitally important part of modern power supply design.

By Sungmo Young, Staff Applications Engineer, Fairchild Semiconductor, Bucheon, Korea

A good example of this trend is the Climate Savers Computing Initiative that suggests a gradual improvement in efficiencies for server power supplies and desktop PC power supplies.

There are many discussions in the field regarding achieving higher efficiency by implementing techniques such as a digital control loop, using better components, innovative packaging, or optimizing thermal management. Although digital control holds much promise in improving efficiency and dynamic response, it is only at an early stage and not sufficiently cost effective. Major efficiency improvements are expected on the overall system level through digital power management such as communication between digital controllers.

Many soft-switching techniques have been introduced for higher efficiency by reducing power losses during the on/off transition of power switches. For an example, a LLC resonant topology is now a mainstream topology for flat panel TV and telecom power supplies and even for high-end game console power supplies. For the secondary-side of switch-mode power supplies, a synchronous rectifier becomes an essential building block for greater efficiency and higher power density. It replaces rectifiers in terms of providing better efficiency.

Power losses can be lowered when the product of a MOSFET's on resistance and drain current is less than the diode forward voltage drop. It is very popular in applications ranging from high-end servers to laptop adapters. This synchronous rectification is even used in desktop PC power supplies that never have been considered as 'high-end' applications. These applications are often referred to as 'silverbox' application because their outer housing is made of silver colored steel, and a cost is everything to them. But things are changing after the 80 PLUS guideline is introduced.

This guideline suggests a requirement for over 80% efficiency at 20%, 50%, and 100% of full load conditions. The synchronous rectifier was not considered though because it increases not only efficiency, but also cost. Now, the guideline is moving towards a higher level. With the new 85 PLUS guideline or higher, both soft-switching topology and synchronous rectification are required to make the switch-mode power supplies meet this target efficiency level. This stringent guideline also forces silverbox design to be changed to single 12V output with local DC-DC converters for 5V and 3.3V outputs.

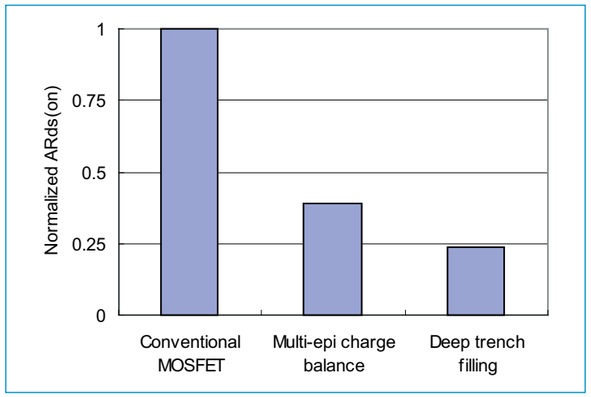


Figure1: Specific RDS(on) trend in high voltage power MOSFET.

New products must meet this high level of efficiency. With an innovative new device, designers can go back to conventional hard switching topologies that are usually less complex. Recently, silicon-carbide (SiC) is coming into the spotlight as a new material for power semiconductors. It is very useful for a higher breakdown voltage and extended maximum junction temperature. Schottky diodes based on SiC are already commercially available. By applying the SiC Schottky diode, switch-mode power supply

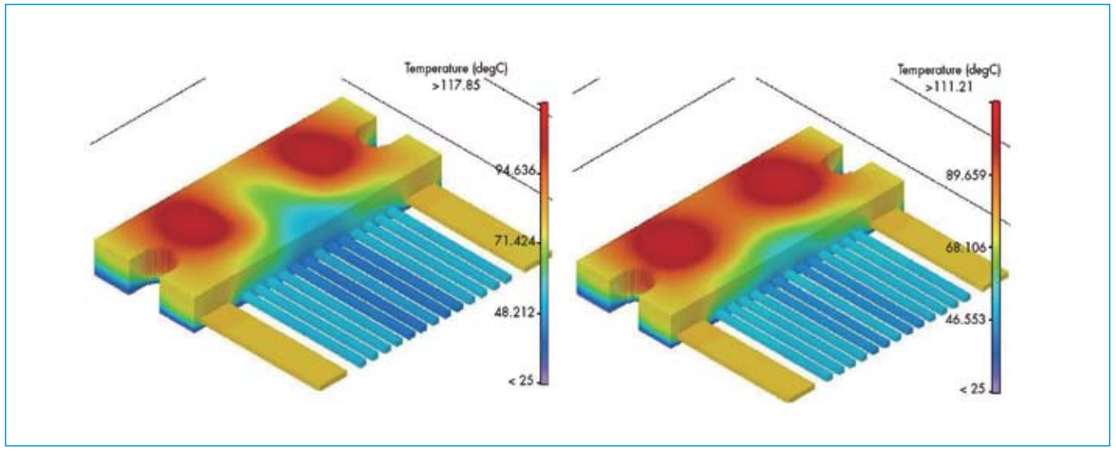


Figure2: Thermal characteristic analysis with various designs.

designers can improve the efficiency by several percentage points while eliminating many components. Now, there are many research projects to bring SiC JFET and even SiC MOSFET into real world.

A drawback of SiC based devices is cost, but the price gap is quickly getting smaller. Innovative new silicon devices also enable better power conversion efficiency. Good examples in the area of high voltage devices are Field-Stop IGBTs and charge-compensated MOSFETs. The Field-Stop IGBTs have even lowered $V_{CE(sat)}$, a voltage drop across the switch at on-state, and perfectly fit for motor drives and induction heating applications. Faster switching versions of the Field-Stop IGBTs are being introduced too. Deep-trench filling MOSFETs utilizing charge-compensation theory have ultra low $R_{DS(on)}$ and extremely fast switching speed. Their $R_{DS(on)}$ is less than one fourth of standard power MOSFETs. This is the almost ideal switch, and greatly improves the efficiency of power supplies.

Fig. 1 shows specific $R_{DS(on)}$ improvement of high voltage power MOSFET. More active cells in the same area allows a smaller chip size for a given $R_{DS(on)}$ value, which means a more cost-efficient device. It also provides much smaller parasitic input capacitance. This is really important to highly efficient switching power supplies as the light load efficiency is taking priority with the new efficiency guidelines.

New package developments are usually related to component integration while packages for discrete power semiconductors are focused on cost reduction. Integrating components into a single package reduces board space, offers a smaller number of components, accelerates time-to-market, provides higher reliability and enhanced performance.

Subsequently, these benefits help to reduce the overall cost of the system. This integrated solution has reduced parasitic components that can be problematic during high frequency switching transition. As there are fewer components to be tested and manufacturer screens all defective parts during production, power supply designers can get more reliable device for their system.

The shipping and quality records of module products show a decrease in system-level failure rates. Thermal consideration is another important factor in the integrated solution because multiple power components are closely located in a single package. This can be done through selecting optimized power devices, substrate material and size, and internal layout.

Fig. 2 shows thermal simulation result for two different internal designs. The thermal performance has improved by modifying the die attach pad. Since thermal characteristics parameters are affected by application environment, it is important to verify thermal performance according to target conditions. This analysis is also helpful to find out an optimized heatsink and mounting condition.

The substrate material and internal layout are also critical to EMI which greatly affects embedded controllers. During switching on and off transitions of power devices, displacement current is induced across the parasitic capacitance of the substrate. The induced currents interfere with the sensitive signals for the controller. Several techniques are commercially available such as endmills, low dielectric materials, or lamination of FR4 on IMS.

Leading power semiconductor suppliers have introduced many technologies and integrated solutions to the market, and these products are widely accepted in flat panel displays, power supplies, and motion control for white goods and even automotive applications. For power supplies, there are new power modules such as the FPP06R001. This device includes two low $R_{DS(on)}$ trench MOSFETs and a high current gate driver, optimized to synchronous rectification applications. Its package resistance is far less than that of a standard discrete package. With reduced total on-resistance, demo board test results show the new device can improve the efficiency by 1%. These innovative power semiconductors are able to relieve designers' headaches in making more efficient systems.

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Green Powered Protocols

The effects of virtualization

When hypertext transport protocol (HTTP) was invented, no one foresaw the vast loading of modern Web 2.0 infrastructure with the capabilities of modern browsers providing web surfing, communication via web-based tools such as Facebook, MySpace and Flickr, purchasing on-line and of course, conventional email. There are now also machine-to-machine (M2M) applications that work in the background updating data bases, gathering weather information and other tasks.

By Richard F Zarr, Chief Technologist, PowerWise® Solutions, National Semiconductor, Florida

All of these systems are based on the server-client model. That is, there is a client (e.g. a browser), and a server that provides the content or gathers information. In the beginning, servers would be assigned an IP address (or several) and server software would provide content to the clients. When a new "web site" was created, the server software would then have dedicated storage space and resources assigned.

Normally, this model works fine if the loading is fairly flat. For example, if I know a server can provide 10 million web pages per second (assume available communication bandwidth) and you also know the maximum "page hit rate" for each website hosted, you can calculate the loading on a server to maintain peak performance for the customers (those hosting and those using).

The Impact of Web 2.0

That worked fine when website content was static– that is, with content that rarely changed, the loading here is fairly easy to figure out. Statistically, everyone in the world will not want to look up the definition for "Stochastic" at the same time… you can figure the loads will vary by time of day, but on a global scale, someone is always working.

Web protocol works by opening a session with the server, receiving the content and then ending the session releasing resources from the server for other tasks. The "content" now lives in the browser. So when you look up a word, the definition and any graphics are sent back to you and you can read them at a human pace. The server has

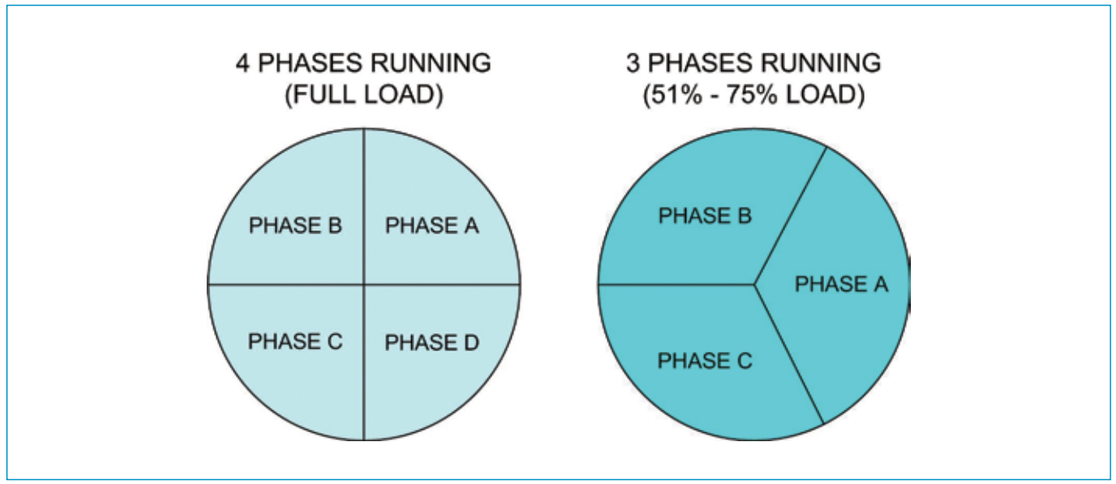

Figure 1: Phase shedding with varying loads.

moved on to other things.

But that's not the case anymore. What happens when you download a music video? The server no longer simply provides a web page and moves on. It is now actively engaged in moving a 40 megabyte file to your machine. Add an embedded player object in the web page, and now the server is streaming the video – real time – to the client. Still, loading can be statistically monitored and the websites modified as this occurs. Sites can be moved to dedicated servers that only handle a single domain as popularity or demand increases.

That was Web 1.0. The problem today with Web 2.0 is that much of what we do is done at the server side. For example, Google Docs is a complete document editing and archiving system that lives on the server side. It uses the computer's browser as the user interface tool, but very little of the client resources are used. Now when people start using the web, more is happening in the background. There is a great deal more interaction between the server and the client. This can wildly swing the loading of servers and lead to poor performance unless something is done to ensure adequate resources.

Finding a solution

The old energy-inefficient way to make sure the site was never overwhelmed was to dedicate statistically maximum loaded resources to a web site's domain. Most of the time, these servers might only be running at 40-60%, but during peak hours the loading would approach 100%, but the site would continue to work effectively. It was quickly recognized that most of the time the servers were not maxed out. They were simply working part time until the peak loads occurred – the time this would happen was not always known. A news site for example may get a normal level of traffic on any given day. A breaking story could overwhelm the site if everyone was checking for photos or video of the event.

The answer was to "virtualize" the servers – that is, create software that looks like a dedicated server, but can dynamically move to more resources on the fly if required. When the high loads disappear, the software could "down size" the server by consolidating more sites to one machine (a blade in a modern server). The other unused blades can be placed into stand-by greatly reducing the amount of power used by the center. This new idea allowed server farms to cut energy cost by not only reducing the power consumed by the servers, but also the HVAC costs of removing the heat.

The Impact to Servers

This was a great move forward toward "greening up" data centers and server farms. Energy consumption was reduced, but as so often true – the software affects the hardware (and visa versa). What effect did shedding load have on the hardware of the system and the surrounding infrastructure?

The first place to look is the blade server power supplies. Typically in a blade server there two redundant power supplies that convert the incoming utility power to a DC bus. The bus runs the length of the backplane (where all the blades plug in) and each blade has its own regulators for providing the correct voltages and currents. In larger systems, the DC bus may run the height of the rack and service many sets of blades stacked on top of the other.

When power supplies are designed, there is a specification required which is the target load. This tells the designer where to place the highest conversion efficiency when choosing components. The design equations provide the values of these components where system will work most efficiently. It is a fixed point, so moving the load up or down (mostly down) will change the efficiency curve. If the peak efficiency is 92% at the target load, then reducing the load to 25% of the target specification may drop the efficiency down to 75%.

Power supply designers suddenly had a new challenge. Provide high efficiency power supplies that work over very wide load ranges. Modern switching supplies use high power FET transistors to "switch" power using pulse width modulation (there are other methods as well). The output of these techniques is a complex waveform whose average is the new lower voltage. High power filters made from inductors and capacitors smooth the output providing a clean DC voltage. The output is monitored by a controller and the switching of the FETs is modified to keep the output steady over load and input changes.

The FETs, inductors and capacitors are all selected to meet the load specifications and once in the circuit are fixed – their values cannot be dynamically changed. So if the load drops below the design target, energy will be lost in the system due to losses in these components. One solution is to build a multi-phase converter. In high current power supplies (like those found in PC mother boards that supply the core voltage to the processor), it is very common to create 3 or 4 power supplies that work together – each taking turns to supply current to the load.

The beauty of this topology is that when loads are reduced, phases can be turned off and the remaining phases expanded to cover for the missing one (see figure 1).

This adds complication to the power supply for making sure the output never varies during the transition of dropping or adding phases. All the power converters run near their peak efficiencies or they are turned off. Expanding this idea to the large DC bus supplies now allows the blade servers to run efficiently over a wide range of loading. However, power supplies are becoming increasingly more complex to address these dynamic loads.

The Impact to Infrastructure

As in the case of the power supplies, the communications infrastructure that carries the information is also affected. Each blade communicates via one or more gigabit Ethernet connections to a switch. The physical layer devices in both the server and the switch consume many watts of power each and can add up quickly. If a blade is placed in stand-by, the phys are typically not powered down – the links are maintained, but the traffic has stopped. In most cases, this does not dramatically reduce the energy consumed by the PHY since it is still required to maintain the link. Even if the server side PHY is powered off, the switch side PHY must remain on to watch for link activity – again burning power.

This problem is being addressed by several methods. A PHY that can move to stand-by when the link is lost or intentionally placed into low power state would reduce energy consumption. The IEEE has a working group called the 802.3az Task Force. Their objective is to develop protocols for new PHYs that would allow the link to remain active while reducing power at times of low utilization.

Another method is to simply throttle the semiconductor process itself. CMOS processes dissipate power linearly with frequency and exponentially with supply voltage (see equation 1).

$$E = (\alpha \cdot C \cdot f_{CLK} \cdot V^2 + V \cdot I_{LEAK}) t_{TASK}$$

Reducing these losses has been done in the past using techniques such as Dynamic Voltage Scaling found in PC processors. A more modern technique is called Adaptive Voltage Scaling or AVS pioneered by National Semiconductor which can be found in PHYs such as the 10 gigabit base-T Teranetics TN2022. Basically, AVS technology continuously monitors the performance of the process inside of the device and automatically throttles up or down by adjusting the supply voltage. This can save anywhere from 20% to 50% in energy compared to a fixed supply voltage. In addition, it can compensate for temperature and process variation (aging) on the fly. This technology combined with other techniques can significantly reduce the power consumption in infrastructure applications and adapt automatically to load variations caused by servers joining or leaving the network.

Conclusion

So what else may be coming? The flood of Netbooks that have minimal local processing power is pushing more resources back to the servers. Soon, very little software or disk storage may reside on these computers – the majority would reside in the "cloud". All the conventional software tools for producing and sharing documentation or presentations will be server side.

Also, virtual gaming is coming. Most gaming computers require extremely high performance computing to render the life-like scenes depicted in these games. That may move to the server side and only a stream of real-time video will be sent to the client PC. This would enable low performance Netbooks and other computers (including hand-held mobile terminals such as the iPhone) to play high performance games.

Humans are mobile and the growth of mobile terminals will push more resource requirements back into the data centers and infrastructure. With widely fluctuating network activity, virtualization will continue to provide energy savings and the hardware will need to find new ways to adapt to the ever shifting loads.

www.national.com

Solar and Wind Power Advances

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

As I talked with companies at the recent PCIM show in Nuremberg, and since, in the US, I have been fascinated by the heavy, high power sector of our industry; Companies that are driving forward and managing power in the kilowatt and megawatt ranges for wind and solar power generation. I shall explore these companies in depth in the near future. Indeed, PSDE will dedicate the September issue to 'Supplying the Power Grid' which I am convinced will prove both informative and enlightening.

Danish researchers have recently connected a polymer solar cell plant to an electrical grid in a successful world-first demonstration of how the promising renewable energy technology can be integrated into power systems.

Risø, the National Laboratory for Sustainable Energy at the Technical University of Denmark – DTU, is conducting research into polymer solar cells, a less costly alternative to existing silicon-based solar cells. Research is now at such an advanced stage that a demonstration plant has been built at Risø DTU.

The research has a strong focus on production, demonstration and application. As part of an experiment made in cooperation with the companies Mekoprint A/S and Gaia Solar A/S, polymer solar cells have now been connected to the grid at Risø.

Risø DTU has manufactured large panels upon which the solar cells are mounted. Gaia Solar A/S specializes in module construction of silicon solar cell panels and has built Riso's polymer solar cells into their design. The panel is placed on a tracker which follows the movement of the sun. The generated power is added to the grid.

After much refinement and cost reduction, by the end of 2009 the cost of generation is expected to be 4-5 € / W. Further collaboration within the industry will promote the industrialization of polymer solar cells in Denmark and if this succeeds, could become a groundbreaking energy technology both for the home market and for export.

The whole industry of power generation, control and transmission, particularly in wind and solar - both of which have already achieved wide-scale implementation - is forging ahead relentlessly. Power technology is continually advancing with higher power handling capacity and reliability required for this potentially huge industry. These high power modules and assemblies must not only perform with the highest efficiency and be able to operate in the harshest of environments, but must also be manufacturable at a competitive cost. This is a very tough call, but one that companies are taking on, and winning. PSDE will report more on this in future issues.

www.powersystemsdesign.com/greenpage.htm

Same Package, 60% More Current

Part Number	B_{VDSS} (V)	$R_{DS(on)}$ (mΩ)	I_D @ 25°C (A)	Qg typ (nC)	Package
IRFS3004-7PPBF	40	1.25	240*	160	D2PAK-7
IRFP4004PBF	40	1.7	195*	220	TO-247AC
IRFB3004PBF	40	1.75	195*	160	TO-220
IRFS3004PBF	40	1.75	195*	160	D2PAK
IRFS3006-7PPBF	60	2.1	240*	200	D²PAK-7
IRFB3006PBF	60	2.5	195*	200	TO-220
IRFS3006PBF	60	2.5	195*	200	D²PAK
IRFS3107-7PPBF	75	1.85	195*	380	TO-247AC
IRFS3107PBF	75	2.6	240*	160	D²PAK-7
IRFP4368PBF	75	3.0	195*	160	D2PAK
IRFB4115PBF	100	2.6	195*	360	TO-247AC
IRFS4010-7PPBF	100	4.0	190	150	D²PAK-7
IRFS4010PBF	100	4.7	180	143	D²PAK
IRFS4127PBF	150	5.9	171	151	TO-247AC
IRFS4115-7PPBF	150	11	104	77	TO-220
IRFB4127PBF	150	11.8	105	73	D²PAK-7
IRFS4115PBF	150	12.1	99	77	D²PAK
IRFP4668PBF	200	9.7	130	161	TO-247AC
IRFP4568PBF	200	20	76	100	TO-220
IRFP4468PBF	200	22	72	100	D²PAK
IRFP4768PBF	250	17	93	180	TO-247AC

* Package limited

International Rectifier has expanded its portfolio of high performance MOSFETs with a new series of HEXFET Trench MOSFETs ranging from 40V to 250V. The new devices feature a package current rating of up to 195A, delivering a 60 percent improvement over typical package current ratings. The new MOSFETs also provide improved on-state resistance ($R_{DS(on)}$) compared to previous offerings and are available in the popular TO-220, D²PAK, 7 pin D²PAK, TO-247 and TO-262 packages.

Applications

- Industrial battery
- Power supply
- High power DC motors
- DC to AC inverters
- Power tools
- Synchronous rectification
- Active ORing

Features

- Industrial grade
- Moisture sensitivity level 1
- Lead-free
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