

Power Systems Design

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June 2009



PoE+

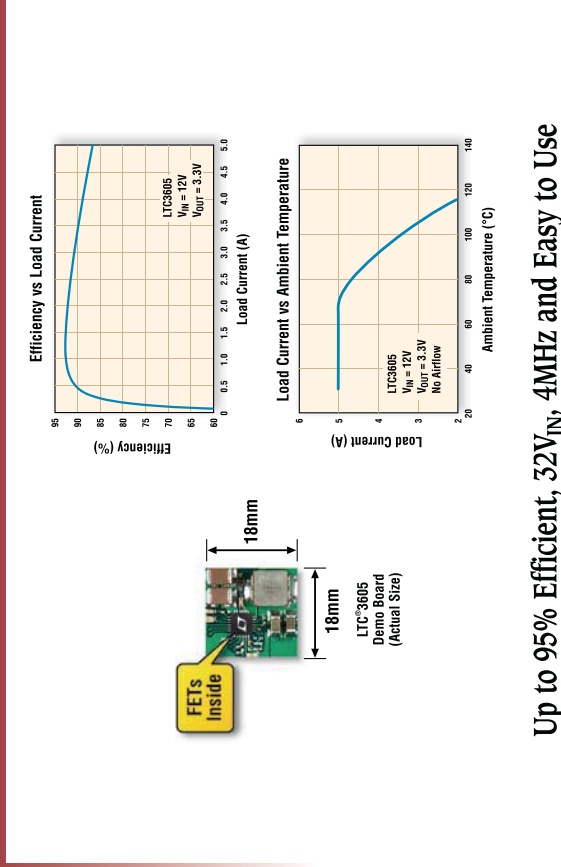
PowerLine ▶
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Special Reports - GreenPower Leadership Awards & Green Power

ISSN: 1013-0365

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



► High V_{IN} Monolithic Synchronous Buck Converters

Part Number	V_{IN} Range	Output Current	Switching Frequency	Synchro-nizable	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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- 3W output power
- 20A gate current
- 80ns delay time
- Direct and half-bridge mode
- Parallel operation
- Integrated DC/DC converter
- Electrical isolation for 1700V IGBTs
- Power supply monitoring
- Short-circuit protection
- Fast failure feedback
- Superior EMC

Power Systems Design

Viewpoint

Green Shoots for Green Power? By Cliff Keys, Editor-in-Chief, PSDE 4

Industry News

Fairchild Wins PSDE GreenPower Leadership Award..... 6
National's SolarMagic™ Receives Worldwide Compliance Certifications 6
Digi-Key Stocks Tyco Fully Shrouded Post Headers 6
Maxwell Land Hybrid Bus Ultracapacitor Orders Worth €9.8 Million..... 8
EPCOS Honored for Top Logistics Performance 8
ABB Wins Frame Order for 2,100 Robots 8

PowerLine

Excelsys Waterproof LED Power Supplies 10

PowerPlayer

De-Mystifying Power Supply Design with Digital Power Technology, By Peter Oaklander, Intersil Corporation 11

PlanetWatch

Solar Power- Spanish Sunshine Clouds the Market in 2009, Reported by Ash Sharma, IMS Research 12

Design Tips

Frequency Response of Switching Power Supplies - Part 5, By Dr. Ray Ridley, Ridley Engineering 14

On The Road

Dialog Semiconductor & Microchip, Reported by Cliff Keys, Editor-in-Chief, PSDE 18

TechTalk

ABB Powers the New Grid, Reported by Cliff Keys, Editor-in-Chief, PSDE 21

ausmicromicrosystems Launches Active Noise Cancellation High Quality, Low Power Audio, Reported by Cliff Keys, Editor-in-Chief, PSDE 23

Cover Story

The Challenges of PoE+, By Alison Steer, Linear Technology 25

Special Report - 2009 GreenPower Leadership Awards

2009 GreenPower Leadership Awards Announced at PCIM Europe..... 29

CEO Opinions- Intersil Corporation..... 32

CEO Opinions- Linear Technology..... 34

The Mantle of Energy Efficiency, By Alfred Hoesener, Fairchild Semiconductor 37

Special Report - Green Power

Green Power Goal for Set-Top Boxes, By Mike Voong, John Lee and Cam Jackson, Micrel..... 40

High Efficiency Green Planar Transformers, By Danny Ireland, Himag Solutions Ltd..... 42

Power Management, By Patrick Le Pevre, Ericsson Power Modules..... 46

Cool Power, By Michael Bean, Molex, Inc. 49

Green Inductive Components, By Lars Kvarnsjö, Vacuumschmelze 51

Green Power Semiconductor Technologies, By Sungmo Young, Fairchild Semiconductor 54

Green Power Protocols, By Richard F. Zarr, National Semiconductor..... 57

GreenPage

Solar and Wind Power Advances, Reported by Cliff Keys, Editor-in-Chief, PSDE 60

Special Report - Green Power

Web Exclusive Content - Go to: www.powersystemsdesign.com

Fairchild Semiconductor Receives 2009 GreenPower Leadership Award

Video link, go to: www.fairchildsemi.com/company/videos/2009/greenpower/Power_Systems_Design_01.html

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Green Shoots for Green Power?



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

While on this topic, I would like to congratulate Fairchild Semiconductor on winning PSDE's annual GreenPower

Power Systems Design Europe June 2009

HB LED drivers for the widest range of lighting applications



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Maxim's HB LED drivers reduce the size, cost, and complexity of lighting designs. Our portfolio includes 29 ICs covering the full range of linear and switch-mode topologies. All devices operate over -40°C to +125°C, support wide input-voltage ranges, and integrate advanced protection features.

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- MAX16826
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- MAX16824/MAX16825
- 3-string linear drivers with SPI™



MR16 lighting

- MAX16834
- Compatible with electronic transformers and triac dimmers
- Enables flicker-free, dimmable MR16s
- Up to 12W of LED power
- Patent pending



Offline lighting

MAX16834

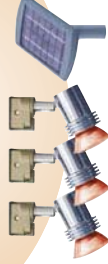
- > 0.90 input power-factor correction
- Compatible with triac dimmers
- Low component count
- Patent pending



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MAX16821

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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 Hiesener, 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.

Hiesener'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.

The PSDE GreenPower Leadership Awards



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

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



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

dirt, water and ice.

"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.

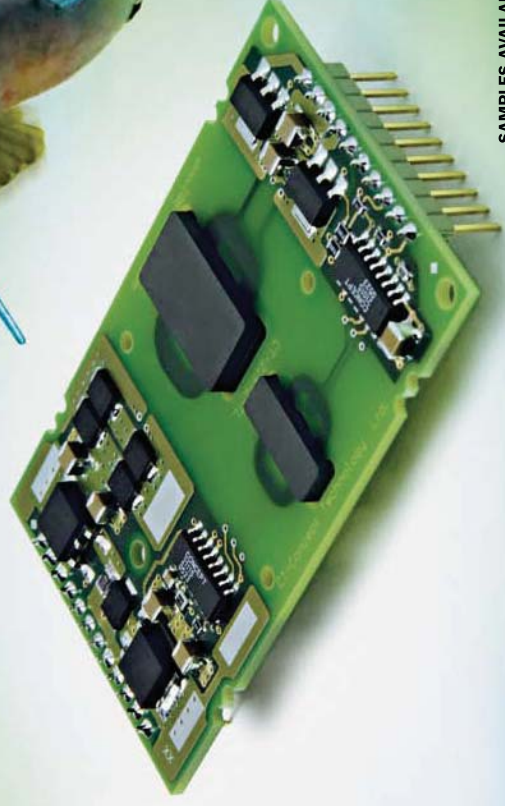
Digi-Key part numbers A99845-ND, A99846-ND, A99847-ND, A99848-ND, A99849-ND, A99850-ND, A99851-ND, A99852-ND,



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

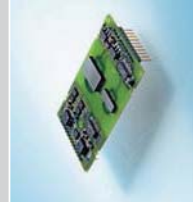
High Frequency Artists!



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1SC2060P Gate Driver

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



Features

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

current-carrying capacity of 7.5A maximum per contact. To lessen the chance of misalignment, 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)

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 engineer-



Maxwell's 48-volt BMOD0165 P048 modules.

ing 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.

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



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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."

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 filter and large aluminum electrolytic capacitors that are made in Szombathely, Hungary.

Forward-looking expansion of EPCOS' production capacity in Szombathely in recent

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,



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The AP300 Analyzer and POWER 4-5-6 Software are designed specifically for the power electronics engineer. Now, they communicate with each other to show measurements overlaid on theoretical curves.

The analyzer has advanced features including a high power output, variable source vs. frequency curve, and high noise immunity from 0.01 Hz to 30 MHz.

POWER 4-5-6 greatly accelerates your design process in topology choices, magnetics, and control. A special version of the software predicts the response of your power supply and compares it with data collected from the AP300.

Each product is the best available in the industry. Together, they will take your design and testing skills to the next level.



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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 EN55022 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



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.

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

www.excelsys.com

Power Systems Design Europe June 2009

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 the older, more familiar products when the

www.powersystemsdesign.com



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 selecting inductors and capacitors. There is the challenge of designing 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 additional 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



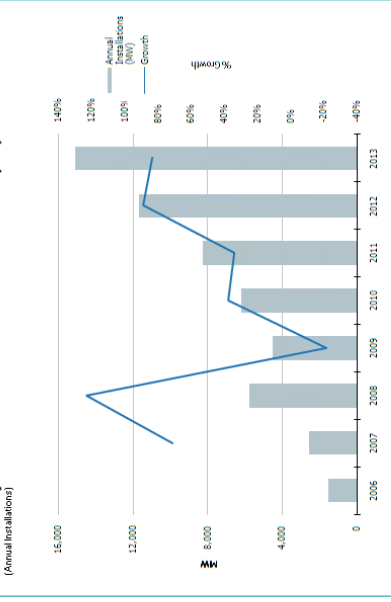
sued back in March where we predicted the PV market would see a double-digit drop in both revenues and MW installations this year.

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,

Mid-Case Projections for the World Market for Photovoltaics (MW)



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.

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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 series¹⁰. 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

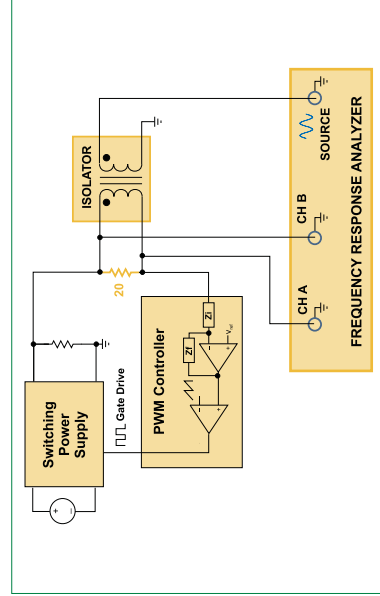


Figure 1: Open Loop Gain Measurement with the Loop Electrically Broken.



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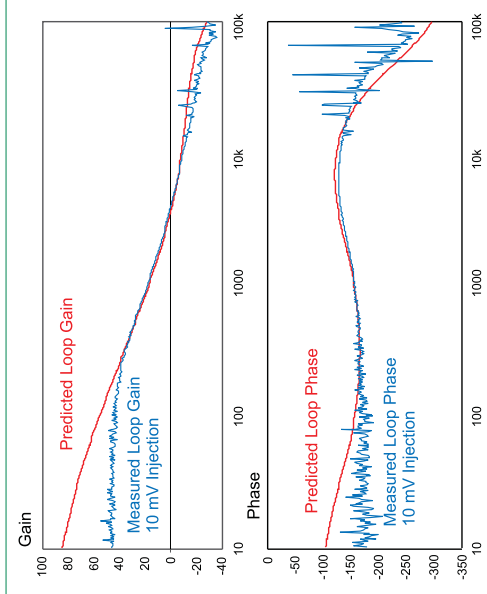


Figure 2: Measurement with 10 mV Injection Signal. Noise is Noisy, and Higher Gain Can Be Resolved.

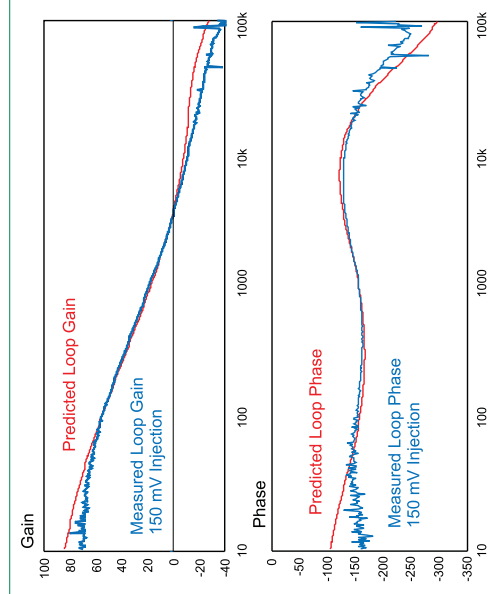


Figure 3: Measurement with 150 mV Injection Signal. Noise is Reduced, and Higher Gain Can Be Resolved.

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

Figure 2 shows a measured and predicted loop gain of a power supply with a fixed 10mV injected signal. In the operating correctly by looking at the loop

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

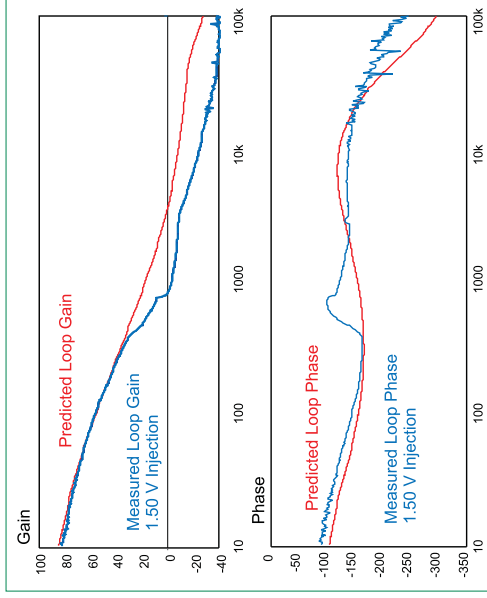


Figure 4: Measurement with 1.50 V Injection Signal. Noise is Distorted Further, Higher Gain Can Be Resolved, but Measurement is Distorted Approaching Crossover Due to Overdrive.

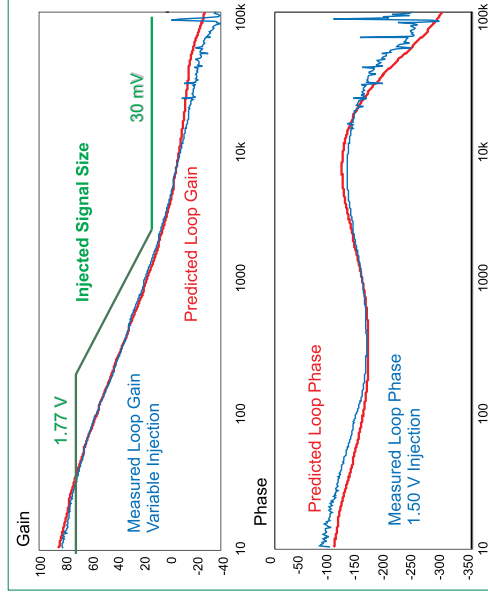


Figure 5: Measurement with Variable Injection Signal. High Signal Levels are Used at Low Frequency, and Reduced Approaching Crossover Frequency to Optimize Measurement.

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 er-

ror. 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

1. "Frequency Response of Switching Power Supplies, Parts 1-3", Power Systems Design Magazine, Design Tips Archive. <http://www.powersystemsdesign.com>

2. "AP Instruments AP300 User Manual", <http://www.apinstruments.com/files/Model300.pdf>

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, notebooks 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

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.

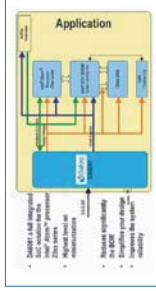
The DA6001 includes a clock synthesizer/driver according to Intel's CK610 specification providing all the necessary



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



DA6001 Application example

complete system start-up and shutdown procedures as well as the state transitions of the Intel Atom processor during all operational modes.

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 less 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

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 XLP™ 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."

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.

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-

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

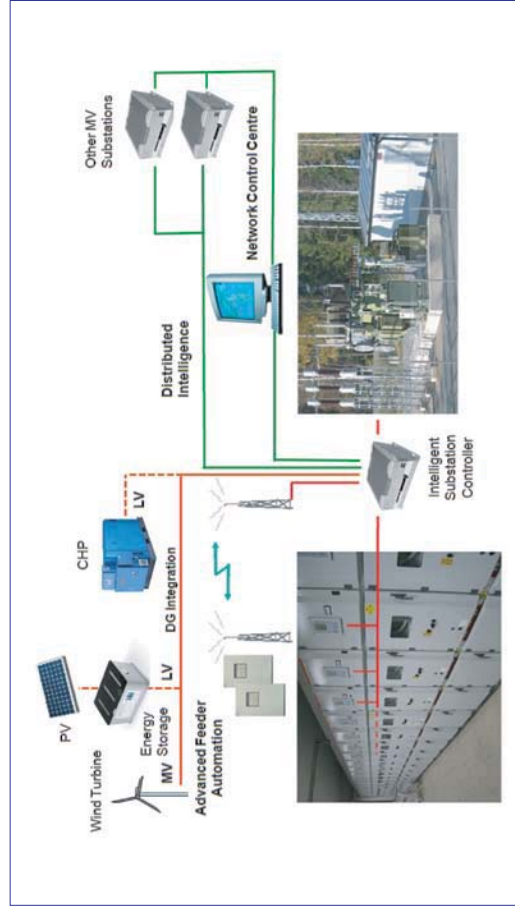


ABB Decentralized control schematic.

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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 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

tion, 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) power sharing between the 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, SharVard 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.

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Power Systems Design Europe June 2009

Recently, austrianmicrosystems, 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

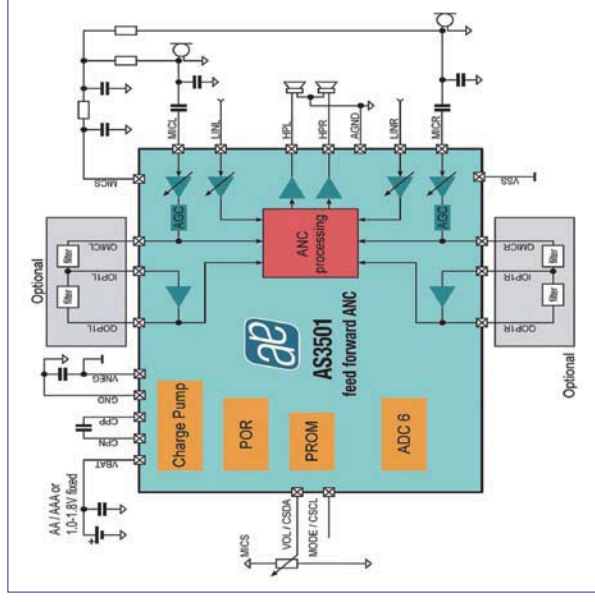
I asked Oliver to tell me what this technology is and what these two new devices would bring the consumer in terms of power savings and audio quality.

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

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



AS3501 block diagram.

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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 be-

haviour, 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 Hessemer.

The four finalists (in alphabetical order by company) are: Company: Colcraft, 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. Zilk & Bruce Olschick • Company: Philips Lumileds, Article: "Welding 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 submit editorials on "energy efficiency" to be judged for next year's 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

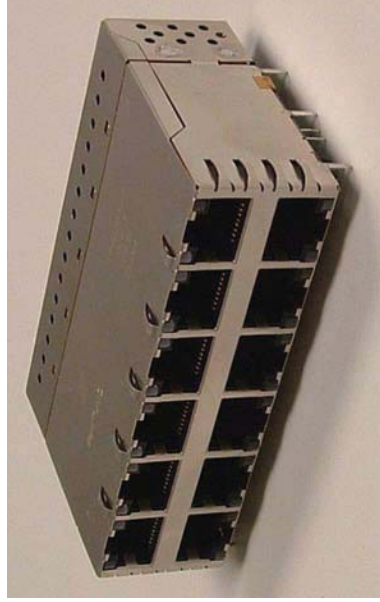


Figure 1: 12-Port PSE-ICM, COURTESY OF Tyco Electronics.

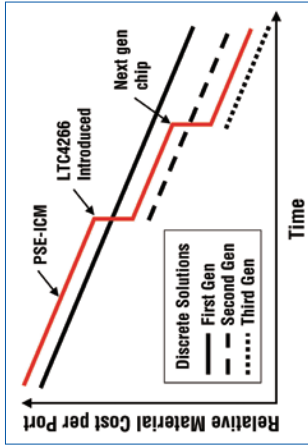


Figure 2: Block Diagram.

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: 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.

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-

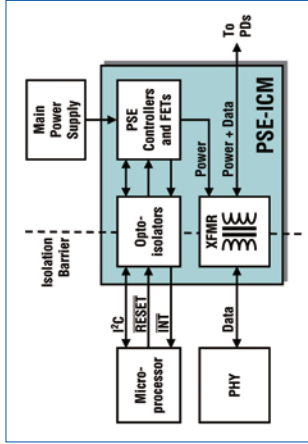


Figure 3: PSE Cost vs. Time.

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 I²C 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 I²C 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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Intersil's Broad Portfolio

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Automotive ICs	Power Management
Battery Management	Power MOSFET Drivers
Communications ICs	Power Supply Support
D2Audio® (Audio ICs)	pinPOINT™ Precision Analog
Data Converters	Space/Defense
Digital Potentiometers (DCPs)	Special Analog
Display ICs	Switches/MUXes/Crosspoints
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2009 GreenPower Leadership Awards



2009 GreenPower Leadership Awards Announced 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, Slovenia

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

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

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



Paul Liebman & Len Crane, Colcraft 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 Odekkirk



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

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Adam Latham, Intersil Corporation accepts Gold Sponsor award

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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 submit editorial content dealing with energy efficiency to be judged for next years program, contact Cliff Keys, Editor-in-Chief: cliff.keys@powersystemdesign.com
For sponsorship opportunities: Julia Stocks, Publisher: julia.stocks@powersystemdesign.com

www.powersystemdesign.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



Dave Bell, CEO, Intersil Corporation

for semiconductor companies.

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

We have created new departments 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 server 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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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 Hessemer.

The four finalists (in alphabetical order by company) are: Company: Colcraft, Article: "Designing for Efficiency at the Component Level", Author: Len Crane • Company: Linear Technology, Article: "Solving Current Source Design Challenges", Author: Robert Dookin • Company: Microsemi, Article: "SiC Impacts 'Greening' of Power", Authors: Philip C. Zuk & Bruce Odekrick • 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 submit editorial content on "energy efficiency" to be judged for next year's 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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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 reaped 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

analogy. Anyone can solve a problem by throwing millions of transistors at it, but doing 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 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 base stations 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.

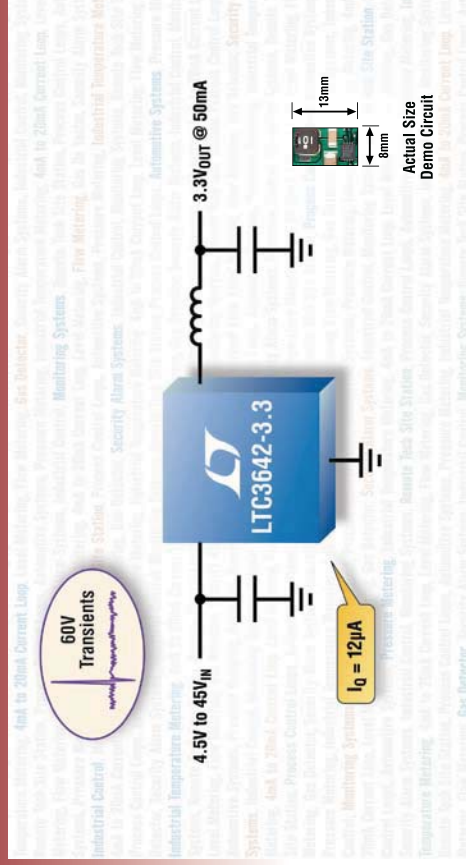
Green power is just another color added to an engineer's palette of design and product opportunities. The goal of green power is to improve our life experience, not to make us learn how to pedal on bikes to work or to live by one 50 watt light bulb. The move to hybrid and electric vehicles presents engineers 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-

Power Systems Design June 2009

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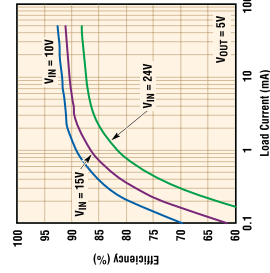
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The Mantle of Energy Efficiency

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 Hesenar, 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



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 MicroET™ 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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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, supercapacitors 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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2009 GreenPower Leadership Awards Winners and Finalists Announced at PCIM Europe

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

The four finalists (in alphabetical order by company) are: Company: Colcraft, 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 Odekrick • 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 submit editorial content on "energy efficiency", to be judged for next year's 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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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 designers 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.

As Set Top Boxes used for watching and 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 led 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 1.2W 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

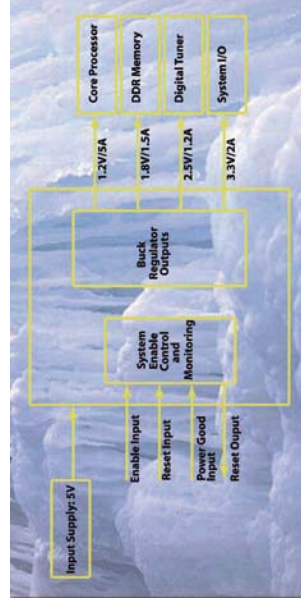


Figure 1: Typical power consumption of a Set Top Box.

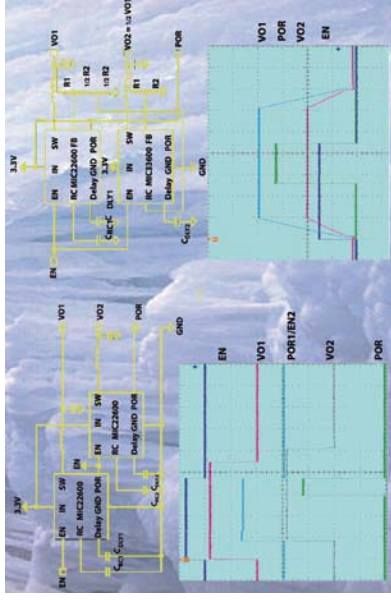


Figure 2: Two example sequences accomplished through different applications of the control pins.

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 $R_{DS(on)}$ 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.

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.

adequate power while still not taking up any unnecessary valuable board space. The MIC22700 has a power density rating of 0.4375 Amperes/mm², while most others in the industry are still under 0.23A/mm². The closest competitive synchronous buck regulator in the market offers only 0.375A/mm².

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 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



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

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.

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 den-

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

sity 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.

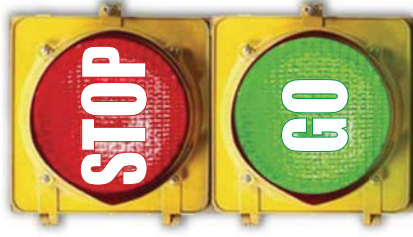
Himag Solutions have found there are a few common misconceptions about planar transformers in general:

"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 4kW@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-

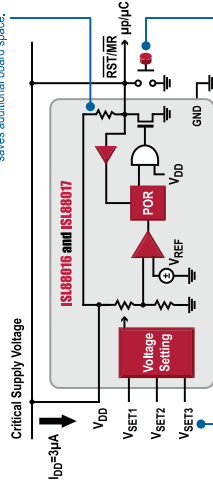


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Himag Solutions E102 7kW-30kW Planar Transformer.
(Possible minimum dimensions 194mm x 102mm x 22.5mm if no heatsink is required)

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

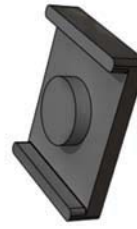
“Planar transformer technology is patented”;

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 perfor-



Planar E Core



Planar ER Core



Planar EL 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.

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.

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.

mance 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 heat-sink 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.

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 retrofit 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 interleaving 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

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.

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.

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!

Integrated Circuit Transistor Counts 1971-2008 & Moore's Law

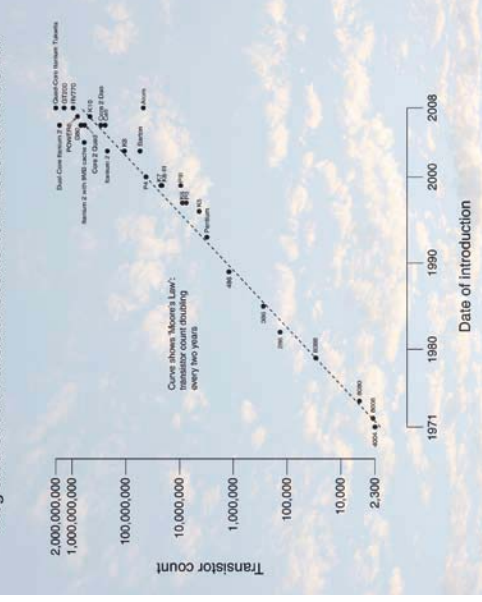


Figure 1: Gordon Moore's forecast (Moore's Law).

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 reduction

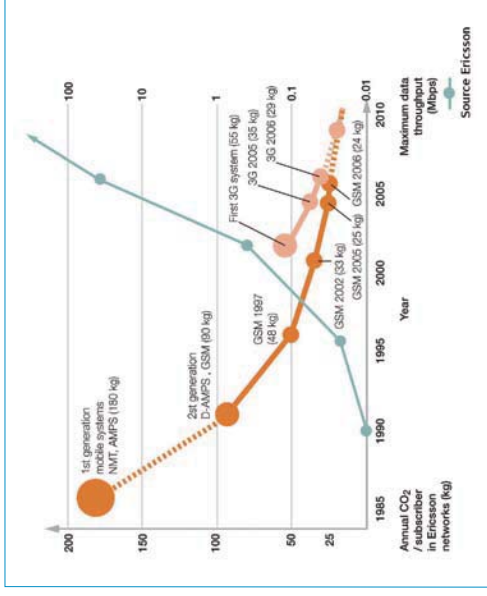


Figure 2: Ericsson Life Cycle Assessment curve.

consumption at both cores level and 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.

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.



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



Figure 4: Ericsson power blocks ROA 128 3003.

tion in CO₂ 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 VPM 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.

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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?

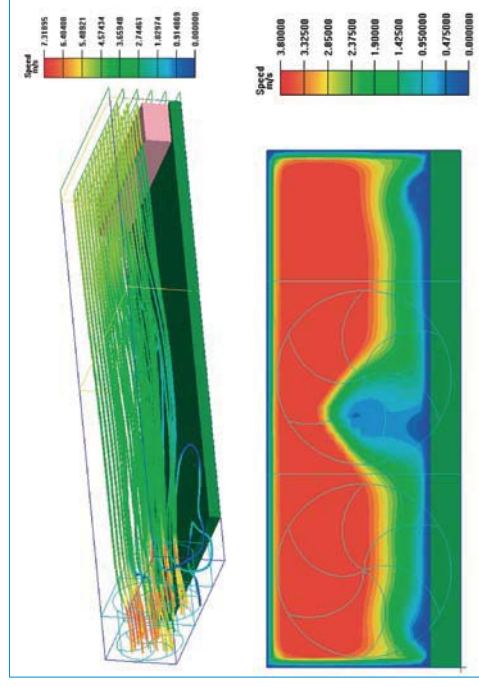
System cooling is one of the biggest challenges facing server architectures today. For every 100 watts generated to power the system, another 50 watts is consumed just to cool it. In the average high-capacity server, microprocessors, chassis fans, and power supply losses combine to account for 50%-80% 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 (CO₂) 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

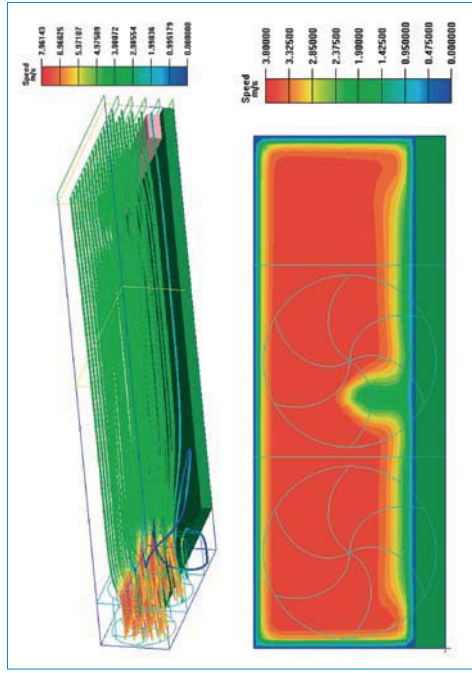
and the connector itself.

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.

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 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:

$$Q = 1.76 \text{ W / Tc}$$

Where:

Q = Airflow required (in CFM)

W = Heat to be dissipated (in watts)

Tc = Temperature rise above ambient

$$1.76 = \text{slope}$$

So in our example above, the required airflow should be 23.67 CFM to meet

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 to 1200 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

Our second example is of the Molex EXtreme LPHPower™ connector used in the same environment. The LPH connector, being half the height of the

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.

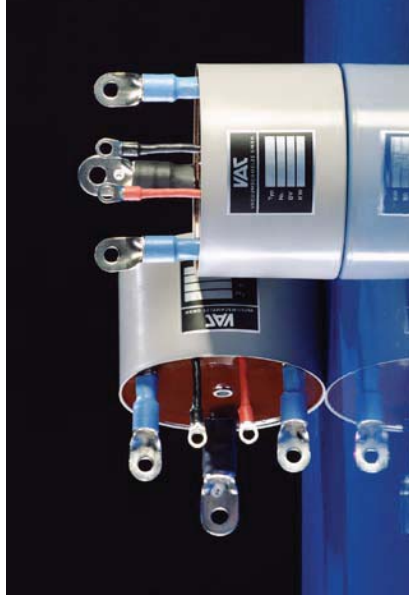


Figure 1: Examples of inductive components and cores made of VAC VITROPERM® material.

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-

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 supply

plies, 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.

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 semiconductor. 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

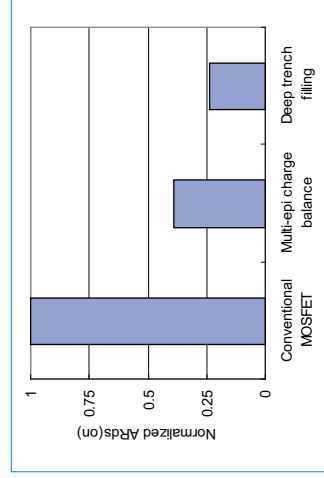


Figure 1: Specific RDS(on) trend in high voltage power MOSFET.

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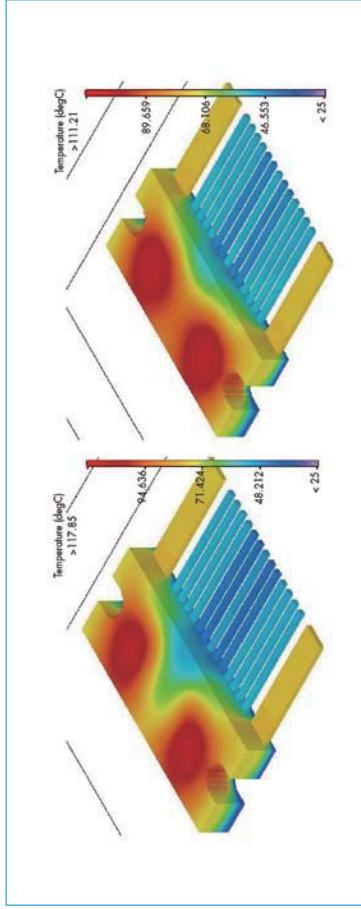


Figure 2: Thermal characteristic analysis with various designs.

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 endfills, 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 Zar, 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.

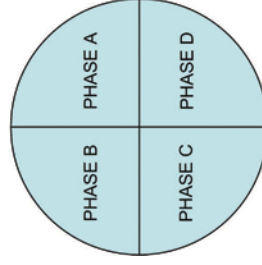
The Impact of Web 2.0

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

4 PHASES RUNNING (FULL LOAD)



3 PHASES RUNNING (51% - 75% LOAD)

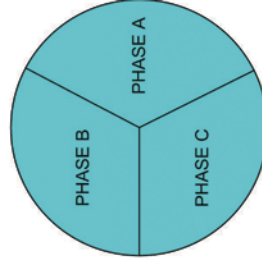


Figure 1: Phase shedding with varying loads.

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 every-one 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 are 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 motherboards 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 (see figure 1).

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 pro-

ducing and sharing documentation or presentations will be server side.

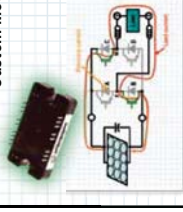
Also, virtual gaming is coming. Most gaming computers require extremely high performance computing to render the life-like scenes depicted in these games. That may move to the server side and only a stream of real-time video will be sent to the client PC. This would enable low performance Networks and 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.

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Solar and Wind Power Advances

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

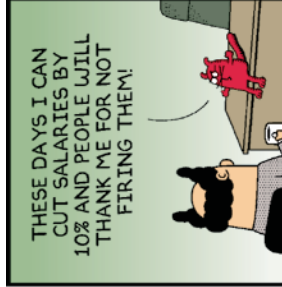


As I talked with companies at the recent PCIM show in Nuremberg, and since, in the US, I have been fascinated by the heavy, high power sector of our industry; Companies that are driving forward and managing power in the kilowatt and megawatt ranges for wind and solar power generation. I shall explore 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.

Riso, 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 Riso DTU.

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IRFS3004PBF	40	1.75	195*	160	D2PAK
IRFS3006-7PPBF	60	2.1	240*	200	D ² PAK-7
IRFB3006PBF	60	2.5	195*	200	TO-220
IRFS3006PBF	60	2.5	195*	200	D ² PAK
IRFS3107-7PPBF	75	1.85	195*	380	TO-247AC
IRFS3107PBF	75	2.6	240*	160	D ² PAK-7
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