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Special Report - Lighting Systems I

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PSDE GreenPower ENERGY EFFICIENCY

Shine a Light!

After just seeing the Rolling Stones new film recently at the Cinema, I thought I'd use the theme above. This issue, as you may have guessed is themed on Lighting, but also contains an insight to the power technology that will undoubtedly be demonstrated at the most important European power show, PCIM in Nuremberg, Germany from May 27 – 29. Power Systems Design Europe will be exhibiting in Hall 12, stand No. 245. Come along and meet us if you have a chance.

As last year, I will be running a forum on Wednesday starting at 4:00 with the theme 'Designing for Power Efficiency' where experts from Fairchild, International Rectifier, Infineon, National Semiconductor, Texas Instruments and Zetex will present their own material. Also, we will be presenting the GreenPower Leadership Awards. It promises to be a fun and informative event. Join the PSDE team there.

The advances being made in lighting now will undoubtedly form a significant portion of the future global energy saving cake. It' s therefore no big surprise that many of the power industry manufacturing companies are making heavy investment and therefore making great strides forward in technologies to make the current lighting forms seem almost pre-historic by comparison.

It will be interesting to see how all this gets implemented though. It's great to have technology to brighten our lives more efficiently in terms of energy consumption and I would expect to see the 'total cost of ownership' argument used at full throttle, but I wonder how long it will take to see a significant uptake and furthermore, replacement of existing inefficient installations. What is the driving incentive? Will we see initiatives such as in Australia where the government have set a phase-out date?

The energy savings achievable through the use of more efficient lighting are phenomenal in European terms. But this is just a part of the story. When we can also derive the power required to drive all this technology generated by a clean and green system such as the Photovoltaic systems mentioned in my On the Road Column, reported from a meeting with Genesis - a great company committed to driving the power grid from solar energy, it really begins to make sense. Power Utility companies as well as governments are now waking up to the fact that it can work - and work extremely well. If it hadn't passed the financial business model test with these guys, it would never have taken off as it now has.

I shall soon be featuring some key interviews with industry leaders in the power industry to get their views on the future of our industry and just what they are planning, in tangible terms, to take the industry forward now that it has become a pivotal force in the 'greening' of our world. CEOs bear a great responsibility, not just for their respective workforces, investors and profits, but also for the future environment our children and grandchildren will inherit.

Apart from the lighting theme, we have a wealth of material for you enjoy. We cover the whole power spectrum and sometimes go even further if relevant to our readers. I am getting a great interest in what the design automation industry is doing for energy efficiency at chip level and it turns out that it is in fact a great deal. And what's more, they have been doing it for some considerable time. Watch out for this in future issues of PSDE.

I hope you enjoy this issue, please check out the GreenPage at the back of the magazine and of course, Dilbert.

All the best!

Cliff Keys.

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

Tony Denayer New CEO at CISSOID

CISSOID, a leader of high temperature semiconductor solutions and the pioneer of Silicon-on-Insulator (SOI) products, announced today the appointment of Tony Denayer as CEO and Director.

Tony Denayer brings to CISSOID more than 20 years of experience in the semiconductor industry. Previously with AMI Semiconductor as Senior Vice-President & General Manager of the Telecom and ASSP Business Unit, after several years as Sr VP of Product Development. He joined AMI Semiconductor from Alcatel Microelectronics where he held a variety of management positions, including Director of DSL development and General Manager of the Automotive, Industrial and Peripherals Business Unit.

"CISSOID developed with the founder group tremendous skills on analog design and specific electronic markets based on SOI. With Tony Denayer experience, CISSOID is well positioned to achieve a new level of success and growth", said André-Jacques Auberton, Director at CISSOID and CEO of SOITEC.

"CISSOID is a company with great talents and leadership in High Temperature Semiconductor Solutions and Silicon-on-Insulator (SOI) products. I am very excited to join CISSOID while the company is at an inflexion point of its growth. SOI products bring solutions in high temperature systems, make possible environmentally friendly solutions, sustain high levels of radiations (Rad-Hard products) and open up new integration opportunities in Radio-Frequency (RF) applications. Thanks to its strong links with research activities at the "Université Catholique de Louvain", CISSOID is a pioneer in SOI and capitalizes on more than 20 years research and development background. CISSOID will undoubtedly reinforce its leadership in this rapidly growing market", said Denayer.

www.cissoid.com

Cree LED Lighting Increases Light Quality and Energy Efficiency in IHOP Restaurants

Cree has announced that the International House of Pancakes (IHOP) franchise in Northern Virginia, owned and operated by Wilhelm Restaurant Group, Inc., has chosen Cree LED lighting products as the preferred lighting for all existing and future restaurants.

Since testing began in January, 2008 more than 100 retrofit LR6 six-inch LED downlights have been installed in two locations, six additional locations have retrofit plans in progress, and construction plans for a new IHOP have been modified to specify Cree LR6 LED downlights.

Paul Belle, Vice President Wilhelm Restaurant Group wanted to move away from conventional, incandescent lighting toward a more sustainable, energy-efficient light. He was considering compact fluorescent lights (CFLs) but changed his mind after seeing Cree's LED products.

"Cree's LED lights were much more impressive than CFLs," said Belle. "LED light is more energy-efficient, generates less heat, has a longer life, and it's just a better quality light, in my opinion."

According to Belle, the IHOP employees prefer the LED lighting as it is very bright, easy on their eyes and enhances the general appearance of the food. "The light is not offensive like CFLs can be; the LEDs give off a warm, white light. The best way I can describe it is to compare the light to a high-definition television. Everything under the LED lighting appears to have a better clarity, like HDTV versus standard definition. I would really like to serve as a leader within the IHOP community by demonstrating success within our restaurants and expand the LED program nationally. It is normal to invest a little more in a new technology, but it's worth it. Somebody has to be first and I'm glad to be on the cutting edge."

Cree's LED lighting products use approximately 85 percent less energy and last up to 50 times longer than incandescent lights, they use 50 percent less energy and last up to five times longer than CFLs. Previously lighting products in the industry fell short in colour quality, efficiency or longevity. Cree has created a dimmable LED lighting solution that leads the industry in a combination of all three critical elements.

www.creeLLS.com

www.ihop.com

Alliance Extends UR Group's Product Range

Joe Matano, Managing Director of UR Group pictured with Novica Mrdovic, director of sales EMEA NeoPhotonics

UR Group has signed a distribution agreement with NeoPhotonics, the second-ranked firm in Deloitte's 'Technology Fast 50' listing for Silicon Valley. The new agreement considerably expands UR Group's portfolio to include a complete line of both active and passive optical components for every network market segment: FTTH/Access, datacom, storage area networks, metro and long haul networks.

UR Group's expanded product portfolio now includes: planar lightwave, MEMS Passive, FTTH and optical modules, as well as a complete range of complementary optical subassemblies.

Novica Mrdovic, Director of Sales EMEA NeoPhotonics, commented: "Although we have been using distribution partners in Europe for some time these arrangements have never worked out satisfactorily. UR Group's expertise in the optical market and the fact that they were actively searching for an optical partner, makes them an ideal partner for us."

Joe Matano, Managing Director of UR Group, added: "Although we had a strong range of optical transponders and transceivers in our portfolio we were missing discrete optical components. NeoPhotonics more than fills the gap adding a whole new range of active and passive optical components."

www.ur-group.co.uk

www.neophotonics.com

NEC Electronics Europe Signs Future Electronics to Distribute Products in Europe

Texas-based Lineage Power, formerly known as Tyco Electronics Power Systems, a leading provider of power-supply and power-conversion products and services to telecoms companies and enterprise customers, has signed a letter of intent with Germany's b+w Electronic Systems GmbH & Co. KG, global supplier of telecoms systems and services, in which b+w Electronic Systems will become the exclusive reseller, system designer and manufacturer of Lineage Power based systems in European, Middle Eastern and African markets.

The planned agreement will create a strategic partnership between the US-headquartered designer and manufacturer of world-class power systems components and Europe's leading systems integrator and service provider.

A formal agreement is expected to be finalized soon, with implementation to follow shortly thereafter in this fertile market for telecommunications equipment and services.

www.futureelectronics.com

www.eu-necel.com

TTI Appoints Thomas Rolle as VP Operations Europe

TTI, Inc. has announced the appointment of Thomas Rolle to the new position of Vice President Operations – TTI Europe, a role which encompasses European Logistics, Warehouse and Distribution Capacity and Capabilities, Information and Quality Systems Management. Thomas Rolle will also take responsibility for Supply Chain Management and Business Solutions.

"Our European objectives for growth demand that we continue to differentiate our levels of service and support to our customers as a critical success factor. We have to look for innovation solutions and must continuously improve the capability, capacity, flexibility and services that we deliver to our customers and our suppliers", explains Thomas Rolle.

Glyn Dennehy, Senior VP and General Manager Europe adds: "To leverage our capabilities manage and improve the productivity and effectiveness, our operations and procedures must be more integrated and activities along the Supply Chain better coordinated, and I am sure that Thomas Rolle and his team will achieve great success in this respect."

www.ttieurope.com

IR Names Michael Barrow Executive Vice President and Chief Operations Officer

International Rectifier

International Rectifier has announced the appointment of Michael Barrow as Executive Vice President and Chief Operations Officer, effective April 14, 2008. Barrow, 53, will report directly to Oleg Khaykin, President and Chief Executive Officer, and will be responsible for implementing strategies to build a world-class manufacturing organization.

Barrow brings 30 years of semiconductor and operational leadership experience to International Rectifier, having served at both Amkor Technology and Intel. At Amkor, Barrow most recently served as Senior Vice President and General Manager of the Flip Chip and Wafer Level Packaging Business Unit, where he was responsible for the strategic direction and business growth. Prior to Amkor, Barrow worked 12 years at Intel, most recently as Technology General Manager of Intel's Communications Group and also as Technology Manager of Intel's Chip Set Group. Prior to Intel, Barrow spent 11 years at Unisys in increasing levels of responsibility and started his career as a power design engineer at Electro Pacific Inc.

"We are very pleased to have Michael Barrow join the management team here at International Rectifier," said Oleg Khaykin, International Rectifier's President and Chief Executive Officer. "I feel confident that his vast experience in engineering and manufacturing will provide significant strength to the management team as we implement strategies to drive operational excellence in our manufacturing facilities worldwide. Michael has an outstanding track record of success in lean manufacturing, improving operational metrics, reducing costs and building successful teams."

"I am excited about the opportunity to join International Rectifier and help build upon the strong foundation that is already in place," said Michael Barrow. "I look forward to working with this talented team of individuals to help drive manufacturing process efficiency while meeting and exceeding the demands of our valued customers."

Mr. Barrow holds a BSEE/BSME degree from Natal Technikon (Institute of Technology) in Durban, South Africa.

www.irf.com

Fairchild Semiconductor Joins Alliance to Save Energy

Fairchild Semiconductor, a leading global supplier of high performance products that drive energy-efficiency, recently became a member of the Alliance to Save Energy. The Alliance promotes energy efficiency worldwide to achieve a healthier economy, a cleaner environment and greater energy security.

"Energy efficiency initiatives and regulations are key drivers to address the need for conservation of energy and the development of alternative energy," said Mark Thompson, Fairchild's president and CEO. "By nature, our products optimize system power thereby helping our customers and end-product consumers reduce energy consumption and reduce their global environmental footprint. As a member of the Alliance, Fairchild will work together with other member companies and nonprofit organizations to promote and invest in energy efficiency as a primary means of achieving environmental goals."

Electronic component manufacturers play an important role in making the electronic devices used every day, more energy efficient. Fairchild designs and develops products that reduce power consumption, extend battery life, prolong product use time and increase power performance without increasing power usage in applications such as cell phones, DVD players, flat panel displays, notebook computers, printers, cameras, TVs, home appliances, power adaptors, power supplies, lighting, motor control and automotive electronics.

"Today more than 150 corporations, trade associations, public interest groups, research organizations and others work together in strategic partnership with the Alliance to assure that energy efficiency is used effectively in the U.S. and abroad to help meet the anticipated, phenomenal growth in demand for energy," said Alliance president Kateri Callahan.

www.fairchildsemi.com

www.ase.org

Record UPS Market for Three-Phase Growth

According to the latest analysis by IMS Research, the global UPS market at year end is estimated to have grown by almost 20% from 2006 to 2007. Global growth continues to be driven primarily by large three-phase installations into new and refurbished data centers; as well as into developing segments for UPS systems, such as transport and security.

The single-phase segment of UPS showed signs of slowing towards the tail end of 2007 with increased economic concern in the US. According to analyst Michael Markides, "Although the three-phase sector continues to push the market to record levels, the concern over the US economy can be seen in the lower power segments, which are governed by small to medium sized businesses and their related IT investment. The three-phase market will continue to surge. It is too early to say whether the recent slowdown in the single-phase market will persist"

2007 as a whole was a banner year for UPS suppliers worldwide, with IMS Research estimating the global market to be worth $7.4 billion, with APC-MGE the largest supplier with a market share of more than 30%. Adds Markides, "As we see the financial sector globally suffering from uncertainty, it will be interesting to see if this affects large UPS installations in data centers, the main driver of double-digit growth for the market over the past few years."

www.imsresearch-usa.com

Tyco Electronics Announces IS-Rayfast as Specialist Distributor of the Year

From left to right: Michael Finch, Tyco Electronics Distribution Manager UK & Ireland; Karen French, IS Rayfast Managing Director; Paul Godden, Tyco Electronics Account Manager

Tyco Electronics selected IS-Rayfast as its UK & Ireland Specialist Distributor of the Year 2007. The award honours the distributor's class-leading increase in the value of sales of Tyco Electronics products over the last year. Tyco Electronics Account Manager Paul Godden commented: "We are very glad to be able to reward IS-Rayfast for their continued excellence in promoting Tyco Electronics." He added: "IS-Rayfast offers outstanding technical solutions, quick turnaround times thanks to good inventory holding and provide very good design-in work to support the Tyco Electronics Raychem brand."

James Leonard, Sales Director of IS-Rayfast, commented: "We are very happy to have won this award for the second year running. The award recognises our continued commitment to providing superior technical support to our customers and our excellent stock of products. I want to congratulate my superb team of people without whom this success wouldn't have been possible." "I also want to thank our good contacts at Tyco Electronics for supporting us throughout the year", Leonard added.

www.tycoelectronics.com

www.israyfast.com

Power Events

- ***PCIM Europe 2008,***
  May 27-29, Nuremberg, Germany, www.mesago.de/en/PCIM/main.htm
- ***euroLED 2008,***
  June 3-5, Birmingham, United Kingdom, www.euroled.org/2008/index.php
- ***European Fuel Cell Forum 2008,***
  June 30-July 4, Lucerne, Switzerland, www.efcf.com/exhibition/
- ***EPE-PEMC 2008,***
  September 1-3, Poznań, Poland, www.epe-pemc2008.put.poznan.pl
- ***23rd European Photovoltaic Solar Energy Conference,***
  September 1-5, Valencia,Spain, www.photovoltaic-conference.com
- ***electronicIndia 2008,***
  September 2-5, Bangalore, India, www.electronicindia.net
- ***Husum WindEnergy,***
  September 9-13, Husum, Germany, www.husumwind.com
- ***electronicAsia 2008,***
  October 13-16, Hong Kong, China, www.electronicasia.net
- ***electronica 2008,***
  November 11-14, Munich, Germany, www.electronica.de
- ***SPS/IPC/Drives 2008,***
  November 25-27, Nürnberg, Germany, www.mesago.de/en/SPS/main.htm

Tyco's Interconnection Systems for Lighting Components

With the explosion in the development of high reliability equipment in the construction, industrial and consumer industries, the cost of manufacture and implementation of associated lighting systems play a vital role. Competition, as ever, is tough and competitive superiority together with high quality and reliability can mean the difference between success and failure. Manufacturing, an often neglected part of the power and lighting story, is an area that deserves due credit in our industry.

Tyco Electronics has developed interconnection systems for the fast growing market in small lighting devices such as LEDs, mini CFLs, OLEDs and mini halogen lamps. A small footprint makes new 7.5mm Mini HVL connectors ideal for lighting applications where small size and easy interconnection are prime requirements, for example in shop and household furniture, display cabinets and mountable lighting.

Designed for power connection and coupling between lamps, 7.5mm Mini HVL connectors are rated at 250VAC, 125VAC as well as 42VAC and VDC. The devices meet IEC 60320 standards for installation in furniture, building ceilings, walls and floors.

Plug and outlet assembly kits featuring several different keying patterns and a 6 way distributor (including an additional switch feature) are available for 7.5mm Mini HVL connectors, enabling quick and easy assembly of lighting systems. Further accessories for the new interconnection include cable assemblies, panel mount outlets, splitters, outlet bridges and busbars.

LED wire connections for quick installation

A 'poke-in' connector for the LED lighting market. This connector is a low profile, surface mount (SMT), two-position connector ideally suited for use in PCB-based LED strings, lighting controls, and other applications that can benefit from an easy poke-in wire termination to the PCB.

The poke-in LED connector offers quick and reliable wire termination as a low-labour alternative to hand-soldering wires particularly when used with single-sided aluminium clad circuit boards. The new device is available in tape & reel packages for high speed SMT processing equipment and the high temperature plastic housing is reflow solder process compatible.

The RoHS compliant connector incorporates tin over nickel plated copper alloy contacts with a UL94-V0 rated high temperature thermoplastic housing. Packaged in reels of 800, the tape & reel packaging conforms to ANSI/EIA Standard 481-C

Although optimized for use with 18AWG 6 through 16 strand wire, the poke-in LED connector also accepts 18 through 22AWG solid wire as well as 18 through 20AWG pre-bond stranded wire. The connector is UL c/UL recognized for 4A at 48VDC and 4A at 250VAC. Mechanical wire retention is rated for 2.2kg minimum.

www.tycoelectronics.com

Figure 1: Mini HVL connector.

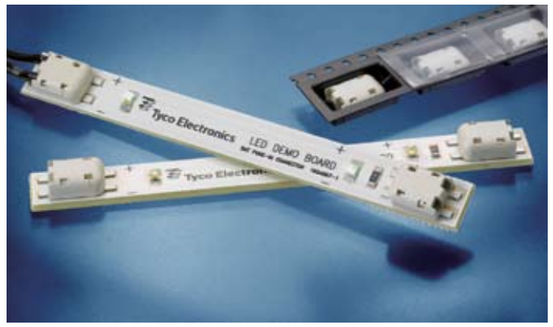


Figure 2: Poke-in LED connector.

An Industry Legend Takes a Break

IR Announces Retirement of Founder and Chairman Eric Lidow

I had the great honour of meeting with Eric Lidow when I first joined PSDE. I have never met such a courteous but truly powerful individual. He asked me several highly informed and articulate questions about the magazine and had obviously studied my work closely. To say I was impressed and more than a little nervous would be a complete understatement. The power industry salutes a truly great man. The entire staff of Power Systems Design wishes Mr. Eric Lidow a well-earned retirement.

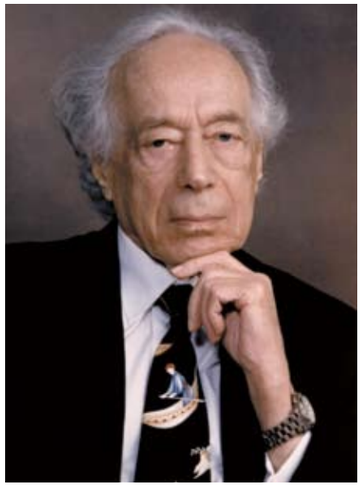
Reported by Cliff Keys, Editor-in-Chief, PSDE

The recently announced retirement of Eric Lidow, founder, chairman and member of the board of directors of IR has created a tidal-wave of admiration for a truly great man. Eric served as the company's chief executive officer from the time he founded IR in 1947, until 1995, after which time he assumed the position of chairman.

But even before the formation of International Rectifier, Eric was co-founder and general manager of Selenium Corporation of America, established in 1940. In 1944, Selenium Corp. was acquired by Sperry Corporation and Eric continued as Vice President of Engineering until 1947 when he founded IR.

Eric, born in Vilnius, Lithuania, graduated in 1937 from the Technical University of Berlin with a degree in Electrical Engineering. He emigrated to the US from Germany in 1937. Among his many accolades and achievements, he is a Life Associate of Caltech, a Life Member of IEEE, and a Life Trustee of the Los Angeles County Museum of Art. He also holds an Honorary Doctorate from Technion, the Israel institute of higher education.

Over the course of more than six decades at IR, he transformed what was then a start-up company developing selenium photoelectric cells and selenium rectifiers, into the company that is now a world leader in power management technology producing industry-beating, advanced analog, digital and mixed signal technologies and products.



When Eric founded International Rectifier, he was a very early pioneer of a then rare global enterprise business model. Under his leadership, IR developed a number of key power management technologies now pervasive in the industry; among them the HEXFET®, power MOSFET.

Speaking on behalf of IR's Board of Directors, President and Chief Executive Officer Oleg Khaykin stated, "Eric is one of the most respected pioneers in the power semiconductor industry. His long-standing commitment to the employees and customers of International Rectifier has been crucial to our progress over the decades. As we continue to grow as a Company, the legacy of Eric's leadership during his 60 years at IR will remain."

Eric added, "The development and growth of International Rectifier has been a great source of pride to me. While I am passionate about the technology, people are the vital ingredient. As the power management industry continues to evolve, I have great confidence in the Company's technology roadmap and in the management team's ability to execute the strategy established to take the Company forward."

I am certain, that the spirit Eric has endowed in International Rectifier will live on through the people he has led and developed over these decades. He has uniquely crafted a winning culture through his innovation, leadership and great wisdom.

www.irf.com

The Big Get Smaller

Top-10 power-management semiconductor suppliers face rising competition from smaller competitors

By Marijana Vukicevic, iSuppli Corporation

Facing slowing growth, intense price pressure and rising competition from smaller suppliers, most of the Top-10 power-management semiconductor suppliers under performed the overall market in 2007, according to iSuppli Corp.

Global power-management semiconductor revenue rose by 5.4 percent in 2007, down sharply from the 12.6 percent rise in 2006. Four of the Top-10 suppliers increased their revenue at a rate lower than the market average, while three suffered negative growth for the year. Collectively, the Top-10 suppliers saw a 3 percent decline in revenue, while all the smaller players together experienced a 7.7 percent rise.

OEMs have been sourcing increasing numbers of power-management parts from smaller suppliers because the more diminutive players are extremely price competitive. Because they are under less Wall Street scrutiny than the major players, the smaller competitors are willing to forgo some of their margins to win business and to gain market share. Partly due to this phenomenon, all major power-management semiconductor segments experienced Average Selling Price (ASP) declines in 2007—except for IGBT modules.

Some of the Top-10 suppliers reported shifts in revenue due to unique factors. For example, International Rectifier Corp's 10.1 percent revenue drop was due to the sale of its high-voltage discrete business to Vishay Intertechnology Inc. Meanwhile, Vishay achieved the highest growth rate of the Top-10 suppliers, at 38 percent, also due to the acquisition of the International Rectifier business.

Infineon Technologies AG achieved 11.5 percent revenue growth in 2007, the second highest rate among the Top-10 power-management semiconductor suppliers. The company benefited from strong sales of its Application Specific Standard Products (ASSPs) for wireless, automotive and industrial power-management applications.

iSuppli anticipate tough market conditions will persist through 2008. Growth will accelerate slightly compared to 2007, rising by 5.5 percent.

www.isuppli.com

Worldwide Top-10 Power-Management Semiconductor Supplier Revenue Ranking in 2007
(Ranking by Revenue in Millions of U.S. Dollars)

2006 Rank	2007 Rank	Company	2007 Revenue	2007 Market Share	2006 Revenue	2006 Market Share	2006-2007 Change
1	1	STMicroelectronics	2246	8.6%	2244	9.0%	0.1%
2	2	Texas Instruments	1899	7.2%	1858	7.5%	2.2%
3	3	Infineon Technologies	1443	5.5%	1294	5.2%	11.5%
4	4	Fairchild Semiconductor	1307	5.0%	1280	5.1%	2.1%
5	5	International Rectifier	1148	4.4%	1276	5.1%	-10.1%
11	6	Vishay Intertechnology	1080	4.1%	783	3.1%	38.0%
6	7	National Semiconductor	970	3.7%	1039	4.2%	-6.6%
8	8	Toshiba	895	3.4%	879	3.5%	1.8%
10	9	Maxim Integrated Products	886	3.4%	819	3.3%	8.2%
7	10	NXP	880	3.4%	900	3.6%	-2.2%
		Others	13464	51%	12499	50.3%	7.7%
		Total	26217	100%	24870	100%	5.4%

Source: iSuppli Corp. April 2008

Power Supply Control Design Tools – Part 2

Buck converter with current-mode control

In this article, Dr. Ridley presents a summary of current-mode control for the buck converter. A free piece of analysis software, the second in a series of six, is provided to readers of this column to aid with the analysis of their current-mode buck converters.

By Dr. Ray Ridley, Ridley Engineering

Modeling Power Supplies with Current-Mode Control

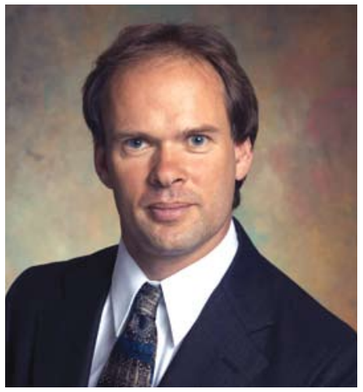
In the last article, (April 2008 Power Systems Design Europe, page 18) the complications of modeling power circuits were discussed in some detail for a buck converter with voltage-mode control. Even for that simple configuration, the analysis can have different levels of complexity. This will depend on how many parasitic components are included in the analysis, and any assumptions made about their relative values.

We don't usually use voltage-mode control for rugged converter design. Current-mode control is the preferred approach, implemented as shown in Figure 1.

A whole new world of mathematical complexity arises when current-mode control is used for a power supply. Fortunately, the full analysis of current-mode control is completed, and you can download the complete book on the topic from www.ridleyengineering.com.

The dynamic analysis of current mode involves advanced techniques, including discrete-time and sampled-data modeling. This is essential to arrive at a model which explains all of the phenomena seen with your converter, and which accurately predicts the measured control-to-output response and loop gain of the current-mode converter.

There are several important points to learn from the full analysis of the



current-mode converter:

1. The power stage has a dominant-pole response at low frequencies, determined mainly by the time constant of the output capacitor and load resistor values.

2. The power stage has an additional pair of complex poles at half the switching frequency which, under certain conditions, will create instability in the current feedback loop.

3. The resulting transfer function of the power stage is third-order, even though there are only two state variables in the converter. (This apparent anomaly, for control theorists, is caused by the fact that the switching power converter is a nonlinear, time-varying system.)

4. The second-order double poles at half the switching frequency cannot be ignored, even though they may be well beyond the predicted loop crossover frequency.

5. The capacitor ESR zero is unchanged by the presence of the current loop feedback.

As explained in reference [1], current-mode control has many advantages. These include elimination of the resonant filter frequency, the ability to current share with multiple power stages, simplified compensation design, and inherent peak current limiting.

Designing with Current-Mode Control

While the analysis of current-mode control is quite complex to read and understand, the design process is quite simple. Much simpler, in fact, than voltage-mode control, and this is one of the reasons that current-mode control is so popular today.

Figure 1 shows the current-mode feedback system. The inductor current, or switch current, is sensed and compared to a voltage reference to set the duty cycle of the converter. A sawtooth ramp may also be added to the signal to stabilize the current loop.

Closing the current loop is straightforward. A current transformer, or sense resistor, is used to generate a voltage signal proportional to the actual current in the switch. The only requirement on the design of this network is that the resulting signal should not exceed the

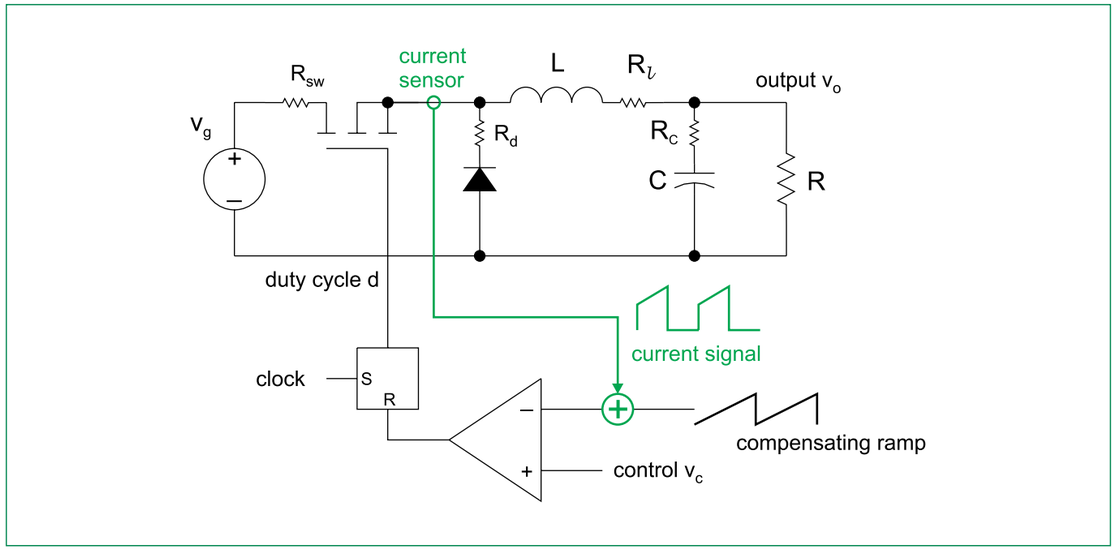


Figure 1: Buck converter with current-mode control. The green components show the current feedback; without these, the control is voltage-mode.

voltage headroom available in the PWM comparator. You do not have to think about the gain of the current loop, or resulting transfer functions at all during this phase of the design.

It is an interesting feature of the current loop that, regardless of how large you make the gain of the current sensing network, the current loop gain remains constant. This is because the PWM modulator gain, which is part of the current loop, is determined by the reciprocal of the slope of the sensed current. The higher the current gain, the lower the gain of the modulator. The two effects exactly cancel each other.

Once the current sense network is selected, you must decide whether you need to add a compensating ramp to the system. This is usually done for converters which will operate at duty cycles above 40%. Further details are given in[1]. Addition of the compensating ramp provides independent control of the PWM modulator gain. This stabilizes the tendency of the current feedback to oscillate at duty cycles approaching 50%.

Buck Converter Current-Mode Software

Software is now available for download that allows you to predict the small-signal response of your buck converter with current-mode control. After entering your power stage values and switching frequency, you can design the current loop parameters of current gain, and compensating ramp value. The software will help you choose the proper values. Once this is done, the transfer function gain and phase of the power stage is plotted for you, and the resulting poles and zeros given.

The software is designed to run under either Excel 2007 or Excel 2003. Make sure when you open the software that the macro features are enabled in order to use the program properly. Please go to www.ridleyengineering.com to download the software.

Summary

As mentioned at the end of the Design Tips in last month's magazine, you have your hands full trying to get a power supply into production. Trying to understand the intricacies of analysis of current-mode control is a useful thing to do, but most engineers simply don't have the time with their aggressive development schedules.

The software tool made available with this article will help you design the current loop properly, and give you the analysis of the converter. Remember, however, the results of any power supply transfer functions should always be verified by measurement. Our power systems are frequently dependent on circuit component parasitics that can be unpredictable, and can also be impacted by noise and improper board layout. Experimental verification[2] is an essential step for a rugged design, and should never be omitted.

References

1. "A New Small-signal Model for Current-Mode Control", Raymond B. Ridley,1990 PhD dissertation, free download is available at www.ridleyengineering.com/cmode.htm

2. "Measuring Frequency Response, Tips and Methods" http://www.ridleyengineering.com/downloads/Spring 2002 feature.pdf

www.ridleyengineering.com

TechTalk

New Packaging from Power Integrations

Saves costs in manufacturing and assembly

I talked recently with Andrew Smith of Power Integrations about the often neglected area of manufacturing and asked just what power semiconductor companies are doing in this brutally competitive area of our industry. He countered my probing question by telling me that this was indeed a priority for PI and explained the latest innovation from his company.

Reported by Cliff Keys, Editor-in-Chief PSDE

PI has introduced a new packaging format called eSIPTM: Eco-Single-Inline-Package. The eSIP-7C Package couples TO-220 Thermal Efficiency with DIP-7 Simplicity into a low profile, high thermal efficiency package which is optimized for high power density applications.

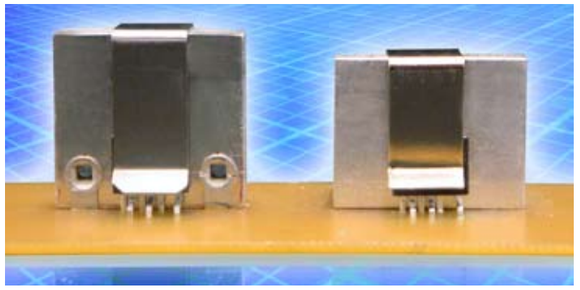


Figure 1: New eSIP package.

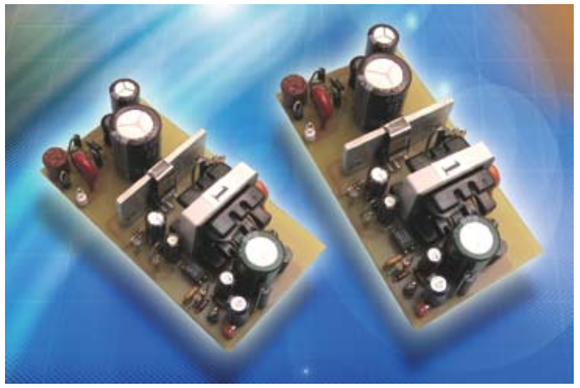


Figure 2: Simple push fit clip for low cost aeembly.

The package features a very simple heatsink attachment for low cost manufacture in applications which include LCD monitor, STB, PVR, Printers, Notebook power supplies and wall-mount power adapters.

The innovative lead bend of this format makes eSIP Safer, More Reliable and increases isolation. The Drain (HV) pin is moved away from the Heatsink providing a separation of 3.4mm and is further from other pins (separation is 2.0mm). The separation between low voltage pins also increased (0.8mm).

A great manufacturing advantage is the simple push-fit clip for low cost assembly which reduces time and materials – no screws. With the tab at source potential, no isolation washer is needed. The clip saves 1-2 cents in high volume manufacture with the Thermalloy (CLP212SG) and other clip designs are available upon request. The whole assembly has passed rigorous vibration tests.

eSIP-7C for TOPSwitch-HX

There is also now a new package option for PI's TOPSwitch-HX family featuring a power capability is similar to a Y package part of the same size. This adds dual frequency capability for large devices (TOP259E-261E)

www.powerint.com

Eltek Valere Launches Green Power Solution for 3G/4G and WiMAX Networks

New Flatpack2 Power System combines high efficiency rectifier with unique power distribution and management capabilities

I talked recently with Greg Fasullo, Chief Marketing Officer of Eltek Valere, on a topic which has become close to my own heart: The obscene power consumption of telecom providers and data centres that can, these days, be significantly reduced by utilizing the technology developed through the advances and consistent investments made by many leading power semiconductor companies such as Eltek Valere.

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

Eltek Valere has recently announced a new family of high-efficiency (HE) AC-to-DC power systems for cellular and WiMAX telecom networks that can significantly reduce power consumption, greenhouse gas emissions and electricity-related operating expenses.

Available in 150, 300, 600 and 1200 Amp versions, the new Flatpack2 power systems are available for all size wireless implementations from base stations to central wireless switching offices. The products were launched at CTIA Wireless 2008, April 1-3 in Las Vegas. Also at the show, the company leveraged a unique count up timer to demonstrate how much energy the wireless industry could have saved during the show through the use of its HE power systems.

The company is truly global in its operations with more than 2,000 staff, offices in 25 countries and sales to more than 100 countries. A substantial proportion of its business comes from Europe, but just taking the US wireless industry alone as an example, consumption there runs at more than 5 billion kWh annually, resulting in the release of nearly 4 million tons of CO_2 greenhouse gasses into the atmosphere.

Up to 70% of a carrier's power bill goes to supply power to the network equipment and an all-too-often overlooked contributor to wasted energy is the AC-to-DC power system.

Typical DC power systems waste between 8% and 15% of the total energy in the network due to low conversion efficiency, contributing to more than 750 million kWh and 600 thousand tons of unnecessary waste each year. Flatpack2 Power Systems are based on Eltek Valere's new Flatpack2 HE rectifier, a 2,000-watt, -48 volt rectifier that offers 96% power conversion efficiency.

Continuing with the US example, at this level the rectifier has the potential to reduce power loss from 1,500 kWh per year to 750 kWh. Given that a typical base station requires 5,000 kWh to operate and that there are roughly 200,000 base stations in the US, the power savings achievable, are substantial.

"The Flatpack2 is a great piece of power engineering – giving wireless carriers everything they need in a system from economical operation to fast and flexible load connections," said Greg Fasullo, Eltek Valere Chief Marketing Officer. "At 96% efficiency, this system sets a new industry standard - one that I hope the industry will follow so that the true environmental benefits can be spread to benefit all."

Figure 1: New high-efficiency Flatpack2HE power system.

Eltek Valere's systems include an innovative distribution bus that allows flexible distribution of power out to networking equipment (load). The system also has multiple power buses that can be used for priority and non-priority equipment, allowing the carrier to shed the load of non-priority equipment to extend the battery life in the event of a power outage. The systems are available with 24V and 48V outputs to support the widest range of wireless equipment.

The Smartpack controller built into the Flatpack2 Power Systems delivers local and remote system and battery string management along with fault detection and full system configuration all through a Web browser-based management system.

Flatpack2 Power Systems are now available in both 24V and 48V voltage levels through Eltek Valere's direct sales and value added resellers in 100 countries worldwide. All systems are both UL and NEBS certified. The new system is compatible with both Eltek Valere's legacy Flatpack2 rectifiers and its new Flatpack2 HE rectifiers.

www.eltekvalere.com

On the Road

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

Genesis Energy Investment Company

Provides Green Energy for the Future - Photovoltaics Lead the Way

With the rising interest throughout the world in 'alternative and green' energy sources, I have been hearing much from the power industry about Photovoltaics. I was particularly interested when I had the opportunity to meet with Dr. Eckardt Bihler, VP and Chief Operations Officer of Genesis Energy Investment Company Ltd. Based in Budapest, Hungary, the company has established for its goal the objective to become the leading manufacturer of thin film large solar panels. To achieve this, the company aims to reach 1 GWp production per year and achieve 10% world market share within just five years. A very ambitious plan and one I believe, after my meeting with Dr. Eckardt Bihler, which will bear rich fruits for the future.

The company's business model is very similar to that of a semiconductor foundry and the ambitious plan of Genesis is well underway with manufacturing plants for amorphous silicon thin film solar modules to be set-up in Spain and Hungary by 2009. By 2010, the company will also build a production plant for micro morph thin film solar cells in Singapore. Project support is already committed by the governments of these respective countries. It became clear to me that a lot of work and much progress had already been made.

The innovative elegance of cost-effectively manufacturing these seemingly huge panels lies in the fact that the sophisticated equipment necessary, has already been developed and much refined in the LCD industry for flat panel displays. Dr. Eckardt Bihler and his experienced team are taking this process several steps forward and 'tuning' it to today's clean-energy needs.

As a strategic supplier of thin-film manufacturing equipment, Genesis Energy has partnered with Applied Materials, the global leader in nano-manufacturing technology solutions.

Basically, Dr Bihler explained, the benefits of thin film photovoltaic are:

- Reduced silicon consumption:
  - Only few grams per m^2 (wafers > 1000 g/m^2)
- Cost effective:
  - Large area (5.7 m^2)
  - Simple processing from silane gas into complete module
  - 40 percent less production cost compared to wafer based photo voltaic
- Ready for mass production:
  - Proven tools used for LCD pro duction
  - High productivity
- Improved energy efficiency:
  - 25 percent more energy produced than wafer based photovoltaic

Thin film technology based on silicon is widely expected to gain a dominant share of the PV market. With the advantages outlined above such as low material consumption, low weight and a smooth visual appearance which can, in one application, be used to dramatic visual effect in the building architect's creative plans for energy efficient structures of the not-so-distant future.

But this is only a small part of the story for Genesis. Utility companies are beginning to see this as a huge potential for the grid, and rightly so. Apart from being the right choice for the planet, it will easily be seen to be an extremely viable business proposition which, of course, is good news for Genesis. This could and really should be the green alternative to what we have already. We have wind energy developing, which is clean but requires machinery and maintenance. PV generation requires good location and space. The power technology for inverting the power to the grid is available now and will no doubt be fine tuned by the industry as this medium takes off. The Genesis team has done its homework thoroughly and the numbers look very convincing, the power utility industry is taking notice.

The company is committed to its goals and will use its expertise from the seasoned industry professionals who have come together to form Genesis. They will continuously enhance the efficiency and manufacturing technology as well as the hard business side of managing economies of scale in joint purchasing raw materials and utilizing the benefits of centralized accounting, financing and IT. This is not merely another 'corporate sound-byte' that we normally get, but a real, heart-felt set of core values from the Genesis team.

www.genesisenergy.eu

Tyco Electronics, Raychem Circuit Protection Division

I had the pleasure to meet with Huw Muncer, Sales Manager, UK, Ireland, Israel and South Africa for Tyco Electronics UK Limited - Raychem Circuit Protection Division, while on my recent editorial visit to the UK. He gave me his lively view of the importance of circuit protection in these days of portable products both in the business and consumer areas. Huw gave me the following interesting perspective

Insist on the Right Power Source

"We've all seen stories in the press about overheating laptop batteries but I, like most of us probably never thought beyond an 'oh dear'. Until two years ago, when I joined Tyco Electronics as Sales Manager for their Circuit Protection Division, I thought a battery was just, well, a battery. Since then I have realised that it is not quite that simple and that protection is absolutely necessary for battery packs that provide the power for portable electronics equipment such as mobile phones, laptops and power tools. Pack protection is essential for continuing reliability, performance and safety against misuse.

In the last few years different battery cell technologies have evolved, each requiring its own specific protection solution. However, in the main, battery packs have two ways that failure may occur - the shorting of a terminal during discharge or an overcharge due to a faulty or incorrect charger. Either failure mode can result in significant overheating either inside or outside the pack.

The first problem to avoid is short-circuit during discharge; an unprotected battery pack can typically deliver up to 100A of short-circuit current when 'hard' shorted by a low resistance element.

Power dissipated in the battery cell's internal impedance leads to a rise in cell temperature, the severity of which will depend on the pack's thermal characteristics and the battery cell chemistry. At a minimum, the pack's performance will deteriorate and will have to be replaced, which is annoying, but with some packs, thermal runaway may take place resulting in venting, smoke or, in the worst case scenario, flames.

If an unprotected pack is 'soft' shorted by an element with some resistance, for example a stray piece of metal or solder of a few hundred milliohms, then the hazard changes from being power dissipated in the cell to power dissipated in the shorting element. Tests have shown that the resistive shorting element can reach temperatures in excess of 600°C, which could ignite materials in its vicinity.

The second failure mode is due to battery pack overcharge; each type of cell chemistry requires a specific charging profile to maximise performance and minimise hazards. If this charging profile is not adhered to, then overcharge can occur. This can be caused by either a runaway charging condition where the charger fails to stop supplying current to the pack once it is fully charged - typically caused by a charger fault - or by 'abusive' charging. This occurs when the pack is charged under the wrong conditions by an incorrect or faulty charger and is especially likely to happen when a 'cheap and cheerful' aftermarket charger is used.

To cope with the proliferation of battery chemistries, capacities and end-user products, a wide range of charger products has become available with limited standardisation. Product reliability and/or safety issues can arise in aftermarket products due to the proprietary nature of cell chemistry and charger designs.

Battery cell overcharge can result from either an over current or over voltage condition or a combination of both. Nickel chemistries (NiCd, NiMH) tend to use a constant current charge profile with charge termination determined by voltage, temperature or time detection,

Power source protection is vital in portable equipment.

whereas Li-ion cells are charged with a constant current followed by charge completion with constant voltage. In both cases if current or voltage is allowed to exceed the prescribed values then a significant rise in cell temperature may result, potentially resulting in venting, smoke or flames.

However, both UL (Underwriter's Laboratories) and IEC (International Electrotechnical Commission) have now set tests for battery pack resilience to both short-circuit and overcharge events (UL1950/IEC 6950) which should go some way towards making things safer. This is where devices such as the Tyco Polyswitch steps in to interrupt charging or discharging current during an unexpected short circuit or over temperature event in order to save the battery and stop what could be a disaster.

If there is one thing that I have learnt from this, it is never to use cheap batteries because you never know when your mobile phone might set your trousers on fire!

www.circuitprotection.com

Optimal LED Driver Solutions for Automotive & HDTV Applications

Huge demand needs competitive and comprehensive designs

There is a wide variance of high brightness LED market analysis statistics. One trend however, is clear: the high brightness (HB) LED market is growing at a staggering rate. According to Yole Development in France, the market size for all LEDs will reach $10.3 billion by 2012. High and ultrahigh-brightness LEDs combined will be responsible for approximately $4.45 billion of this total; almost 5.5 times the $783 million market size in 2007 (based on packaged LEDs).

By Jeff Gruetter, Product Marketing Engineer, Linear Technology Corporation

What supports such an impressive growth potential? First, LEDs are ten times more efficient at producing light than incandescent bulbs and almost twice as efficient as fluorescent lamps, thus reducing the required electrical power to deliver a given amount of light output (measured in lumens) dramatically as well as the dissipated heat. As LEDs are further developed, their efficiency at producing lumens from electrical power will continue to increase. Secondly, in a very environmentally conscience world, LED lighting does not require the handling, exposure and disposal of the toxic mercury vapor found in fluorescent bulbs. Thirdly, incandescent bulbs need to be replaced every 1,000 hours, while fluorescent bulbs last 10,000 hours compared to a 100,000+ hour lifetime for LEDs. In most applications, this allows the LEDs to be permanently embedded into the final application without the need for a fixture. Examples include body panels in automobiles or LCD screens in HDTVs as they will never require replacement during the life of the car or HDTV. Additionally, LEDs are orders of magnitude smaller and flatter then their counterparts and can be manufactured in very low profile form factor so they can be permanently embedded in both interior and exterior applications in cars as well as low profile consumer electronics. Furthermore, by using a configuration of Red, Green and Blue LEDs, an infinite number of colors can be delivered. LEDs have the ability to dim and turn on/off much faster than the human eye can detect, enabling dramatic improvements in backlighting of HDTVs and other types of displays. Without LEDs, dramatic contrast ratios and high resolution unblurred LCD HDTVs would not be possible.

Nevertheless, one of the lighting systems designers' biggest challenges is how to optimize all the benefits of the latest generation of LEDs. As LEDs generally require an accurate and efficient DC current source and a means for dimming, the LED driver ICs must be designed to address these requirements in a wide variety of applications. Power solutions must be highly efficient, robust in features and very compact and cost effective. Arguably, two of the most demanding applications for driving LEDs will be found in automotive

Figure 1: HB LED Lexus LS600h Headlights/Turn Signals/ Running Lights.

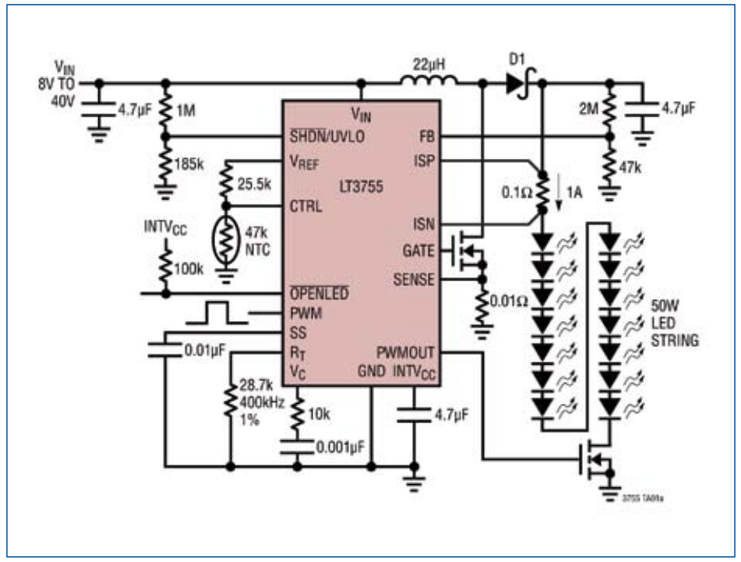


Figure 2: 50 Watt Headlamp Circuit Using the LT3755.

applications and in backlighting applications for large HDTV LCD displays. Because of the collective advantages of LEDs in automotive applications, they have found their way into every form of automotive lighting from headlights to instrument panel/navigation backlighting as well general interior/exterior lighting. LCD HDTV backlighting applications which have traditionally been serviced by CCFL (Cold Cathode Fluorescent Lamps) are being replaced by relatively large arrays of high brightness LEDs that can be dimmed in individual clusters, thus offering very precise local dimming. This enables contrast ratios an order of magnitude higher than convention CCFL backlight HDTVs. As previously mentioned, through local dimming and their ultra fast response time, they enable the LED brightness to be instantly adjusted to eliminate the historic motion blur inherent on CCFL backlight HDTVs.

Automotive LED Lighting

Benefits such as small size, low power consumption and fast turn-on time have initiated the wide spread adoption of high-brightness LEDs in Today's automobiles. The initial LED applications were in center high-mounted stoplights (CHMSLs); these applications used red LEDs to provide a very thin lighting array which was easily mounted and never needed replacement.

Traditionally, incandescent bulbs were the most economical light source and are still used in many cars. However, the decreasing available space for lighting and increasing requirements for long service life, light colorations and streamlined designs offered by LEDs are quickly replacing incandescent bulbs in many applications. It is becoming more common for traditional CCFL-LCD backlighting in Infotainment systems to be replaced by arrays of white LEDs which provide more precise and adjustable backlighting as well as a service life that will easily out live the vehicle. Even headlights, primarily the domain of Halogen/Xenon filament designs, are being developed with an electronically "steerable" array of high current LEDs (see figure 1). Almost all automotive lighting applications including interior/exterior and backlighting applications are transitioning over to LEDs. The benefits of using LEDs in this environment have several positive implications. First, they never need to be replaced, since their solid state longetivity of up to 100K+ hours (11.5 service years) surpasses the life of the car. This allows auto manufactures to permanently embed them into "in cabin" lighting, without requiring accessibility for replacement. Styling can also be dramatically changed as LED lighting systems don't require the depth or area that incandescent bulbs require.

Figure 1 shows Lexus's LS600h LED headlights, which have recently been offered in production. Audi's R8 and GM's Escalade have similar options. The overall lighting configuration is similar for all of these vehicles. Each headlight assembly contains 5 LED powered beams optimized for all lighting requirements, these include: a low beam, a high beam, a corner beam, a daytime running light and a turn signal—all serviced by LEDs. The standard beams will generally require between 35 and 50 watts of power. It doesn't sound like much, but remember LEDs deliver 10x the lumens compared to halogen, so the LED's light output is the equivalent of 500 watts of halogen. The high beams generally require the same or slightly higher power, whereas the cornering, daytime running lights, and turn signals will require less power. Each of these beams can be driven by a single HB LED driver, Linear Technology's LT3755. With the potential of over 200 watts of electrical power, one can see how having high efficiency LED drivers which minimize generated heat is of paramount importance.

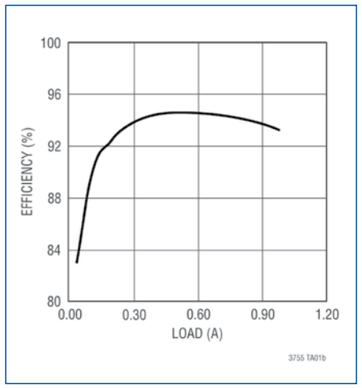


Figure 3: Efficiency of LT3755 Circuit in Figure 2.

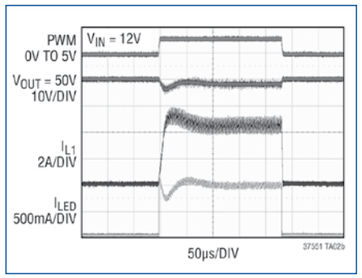


Figure 4: True Color PWMTM Dimming in Figure 2.

Design Parameters for Automotive LED Lighting

In order to ensure optimal performance and long operating life, LEDs require an effective drive circuit. These drive circuits must be capable of operating from the caustic automotive power bus, and also be both cost and space effective. In order to maintain their long operating life, it is imperative that the LEDs current and temperature limits are not exceeded.

Most headlamp applications require approximately 50W of LED current. Linear Technology's LT3755 has been designed to service this type of application. It can boost the automotive bus voltage (nominal 12V) to as high as 60V to drive up to fourteen 1A LEDs connected in series as seen in figure 2.

Figure 3 illustrates the LT3755's efficiency which can be as high as high as 93%. This is of great importance as it eliminates any requirement for heat sinking any of the power components, enabling a very compact footprint. Although the circuit in figure 2 is a boost mode topology, the LT3755's unique high side current sense design enables it to also be configured in a boost, buck mode, buck-boost mode or flyback topology depending on the application's specific requirements.

The LT3755 drives a low side external N-channel MOSFET from an internally regulated 7V supply. The fixed frequency, current-mode architecture provides

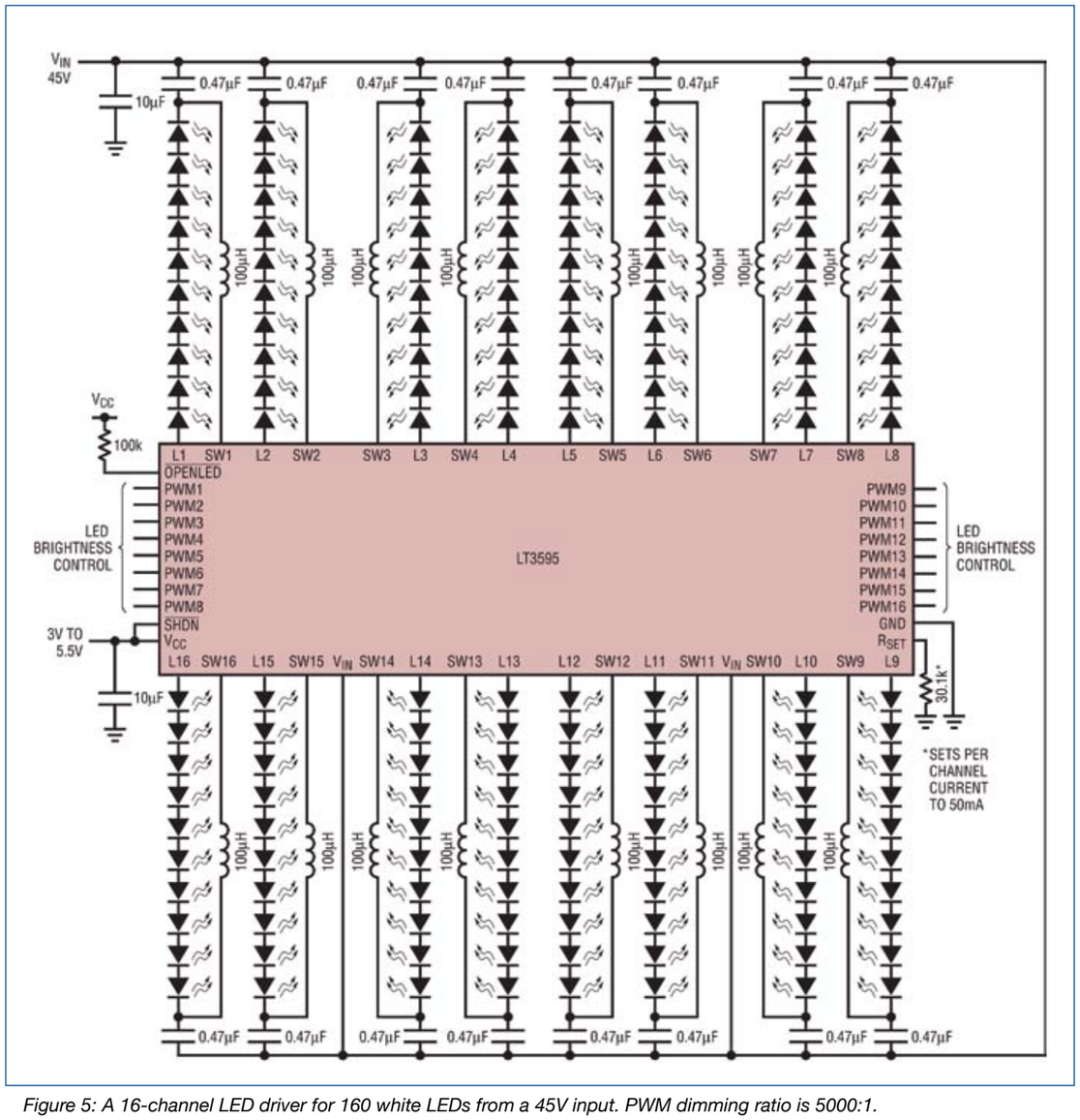


Figure 5: A 16-channel LED driver for 160 white LEDs from a 45V input. PWM dimming ratio is 5000:1.

stable and precise operation over a wide range of supply and output voltages. The LT3755 offers a constant current source which is imperative for LED driver ICs to enable constant brightness of the LEDs despite the irregularities of the input voltage. This is of particular importance in automotive applications, as the input voltage can swing dramatically due to transients encountered during scenarios such as cold crank and load dump. The LT3755's maximum input voltage of 40V enables it to regulate LED current and voltage even when the primary automotive bus is subjected to 40V transients commonly seen in a load dump condition.

A ground referenced voltage feedback pin serves as the input for many LED protection features, such as open LED protection and also makes it possible for the converter to act as a constant voltage source. A frequency adjust pin allows the user to program the efficiency between 100kHz to 1MHz to optimize efficiency and performance while minimizing external component size. If external synchronization is required, the LT3755-1 version can be synchronized to an external clock throughout its 100kHz to 1MHz frequency range.

The LT3755's True ColorTM PWM dimming enables dimming ratios as high as 3,000:1 with no change in color (see figure 4) of the emitted light enabling the LED headlamps to be constantly adjusted via the duty cycle of the PWM for a wide variety of ambient conditions. Because Linear Technology's high current LED drivers are current mode regulators they do not directly modulate the duty cycle of the power switch, instead the feedback loop controls the peak current in the switch during each cycle. Compared to voltage mode control, current mode control improves loop dynamics and provides cycle-by-cycle current limit.

HDTV Backlighting

Although seemingly unrelated, the LED backlighting of infotainment and navigations displays in cars, spurred the use of HB LED backlighting with high dimming ratios, the wide array of ambient lighting conditions in the interior of the vehicle drove the necessity for very wide dimming ratios which are also required in HDTV applications to produce the most dynamic range of colors.

One of the highest growth consumer electronics markets is flat panel HDTVs. As consumers demand larger panel HDTVs and higher resolution, the demand has rapidly shifted from plasma HDTVs to LED HDTVs. According to DisplaySearch, sales of plasma HDTVs will peak in 2008 at $24 billion whereas LCD HDTVs will enjoy a $75 billion market in 2008 and grow to $93 billion by 2010. However, LCD HDTVs have a variety of shortcomings ranging from motion blur to color reproduction. Namely, with the current generation of LCD HDTVs, true blacks can not be attained, and offer a lower dynamic range of all colors. Conventional HDTVs are backlight with CCFL tubes and can only offer contrast ratios between 450 and 650 cd/m^2. The primary problem of these HDTVs, is the inability to completely turn off or locally dim the CCFL backlighting.

Conversely, with HB LED backlighting, an array of LEDs (up to 1,600 for a 46" display) that can be dimmed or turned off locally in backlighting "clusters", offers contrast ratios almost an order of magnitude higher(>4,000 cd/m^2) than CCFL designs. Additionally, by adjusting the brightness of the backlighting LED clusters, more midtones of colors can be replicated adding a more vivid picture.

Another benefit of being able to completely, turn off the LEDs locally, is the reduction of motion blur. By turning the LEDs completely off between frames, the blur associated with fast moving objects in virtually eliminated. The LEDs very fast response rate is critical in resolving this fast motion blur issue encountered by CCFL backlit LCD TVs.

One of the key factors in making LED backlit HDTVs feasible are the LED driver ICs. Because there are so many LEDs per panel, the LED driver circuits must be very efficient or the display will have severe thermal issues and require very large heat sinks, which is not consistent with consumers desires for flatter and lighter flat panel HDTVs. Additionally, these driver ICs must have the capability to deliver very wide dimming ratios, as high as 5,000:1 to offer the desired wide contrast ratios. Finally, the entire LED driver solution must be very compact to enable the very thin format that most HDTV consumers require.

Linear Technology's LT3595 buck mode LED driver has 16 individual channels—each can drive a string of up to ten 50mA of LEDs from inputs up to 45V. Each channel can be used to drive a cluster of 10 LEDs to provide local dimming. Each LT3595 can drive up to 160 50mA white LEDs. A 46" LCD TV would require approximately 10 LT3595's per HDTV. Each of its 16 channels can be independently controlled and has a separate PWM input that is capable of up to a 5,000:1 PWM dimming ratio

Each channel requires only a tiny chip inductor and an even tinier ceramic output capacitor. The only other required components are a single input capacitor and current-determining set resistor (Figure 5). All sixteen channels of catch diodes, power switches, and control logic with compensation are squeezed inside the LT3595's relatively small 56-pin, 5mm — 9mm QFN package.

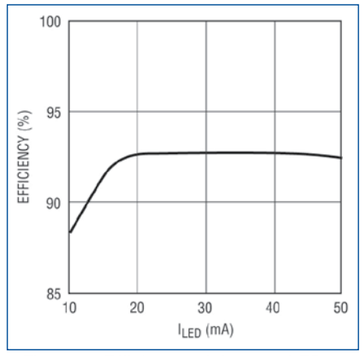


Figure 6: Efficiency of the 160-LED driver shown in Figure 5 is over 92%.

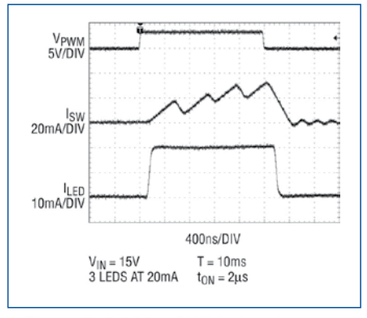


Figure 7: 5,000:1 PWM dimming waveforms for the circuit in Figure 5.

The LT3595 boasts 92% peak efficiency at a 2MHz switching frequency eliminating and requirements for external heat sinking.

The PWM dimming capability of the LT3595 is as high as 5,000:1. Figure 7 shows the 5000:1 PWM dimming waveform and a very square looking LED current waveform. Even at a mere 2µs on-time, a 20mA LED current turns on and off in sync with the 100Hz PWM signal. Higher PWM dimming ratios are achievable with lower PWM frequencies, but 100Hz guarantees that there is no visible flicker.

Full LED brightness is set via a single external resistor for all 16 channels. Each channel has the same programmed LED current—set between 10mA and 50mA. LED current accuracy is within 8% from channel to-channel. True Color PWM dimming uses a reduced duty cycle to offer accurate dimming without any shift in emitted light color. The fixed frequency, current mode control scheme provides stable operation over a wide range of input and output voltages and currents. Direct control of the LED current through internal sense resistors for each channel and internal switches and control circuitry for each channel provide excellent constant current source regulation for LED driving. The internal 100mA power switches and exposed thermal pad of the 56-pin QFN provide enough power and thermal management to handle the power and heat of 16 channels at 50mA.

Conclusion

The unprecedented acceleration of LED lighting applications in automobiles and LCD HDTVs has created many specific performance requirements for LED driver ICs in high current LED applications. In cars, these applications range from head lamps to interior lighting. In HDTVs, LEDs offer a much more sophisticated means of local dimming greatly enhancing picture quality. Additionally, many LED applications outside of the automotive and HDTV market can be found in a myriad of commercial and industrial environments also require most of these high performance requirements. These LED drivers must also provide constant current in order to maintain uniform brightness, regardless of input voltage or LED forward voltage variations, must operate with high efficiency and offer wide dimming ratios. These applications also require very compact, thermally efficient solution footprints. Linear Technology has taken the automotive, HDTV and a myriad of other LED design requirements "head-on" and has developed a family of high current LED driver products. Lighting system designers now have an easy and available LED driver source for their challenging lighting designs.

www.linear.com

Power Semiconductors Key to Improving MIPS/m²

Advanced power stages and dynamic power monitoring deliver data centre efficiency improvements

IR looks at the role that advanced power semiconductor technologies have to play in providing the energy-efficient infrastructures needed to support our insatiable appetite for processing, data storage and communication.

By Tim Phillips, Vice President, Enterprise Power Business Unit, International Rectifier

From e-mail to online buying and selling, social networking to gaming and VoiP telephony to video on demand, recent years have seen exponential growth in e-commerce, internet communication, and online or downloadable entertainment. This growth has fuelled ever-increasing demand for the electronic systems – many of them in secure data centres - that are needed to store, process and transfer the underlying electronic data 24 hours a day, 365 days a year. And there are very real economic, legislative and environmental pressures to make these systems as efficient as possible.

A 'typical' data centre will include servers, storage area networks, routers and switches. In the past, these centres have often been measured on their performance density (MIPS/m²). However, this is changing for a number of reasons.

Firstly, lifetime operation costs for the equipment in the data centre are now estimated at about three times initial capital outlay. Secondly, an increased concern on the environmental impact of electricity usage is driving legislation to maximise efficiency. And, thirdly, there is genuine concern that, without efficiency improvements, many data centres are going to be unable to handle the growth in processing power and supporting infrastructure needed to meet demand. Recent research from ARI, for example, found that 38% of data centres are already running at dangerous levels of power consumption and are at risk of failing due to a power shortfall.

As a result, the key Figure of Merit (FOM) metric as we move forward is performance efficiency, or MIPS/W. And, by improving both equipment efficiency and the efficiency of the supporting infrastructure, the latest power semiconductor technologies are playing a significant role in driving up this Figure of Merit.

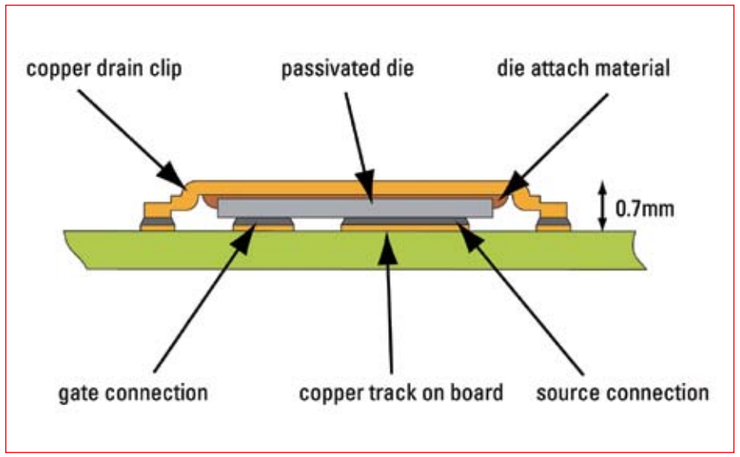


Figure 1: Latest products take advantage of industry-leading MOSFET technology.

Power consumption in the data centre

We can identify two general sources of power consumption in the data centre. The first is the processing, storage, switching and routing equipment itself. The second is the infrastructure required to cool and protect these servers, storage networks, switchers and routers. The energy usage from each is about equal and they are directly related.

Equipment energy consumption consists of three main elements. The electronic loads such as microprocessors and memory banks consume 60 to 70 percent of energy, while power supplies consume 25 to 30 percent, and fans use five percent.

While there have been significant advances in reducing the load's power profile (for example, the introduction of multi-core efficient processors and virtualization technology), there are other opportunities for engineers to significantly reduce the consumption of all three of these major energy consumers. New 'smart power' management systems, for example, include the co-design of several critical components of the power supplies that are integrated into the platform. Based on advanced power semiconductor technologies, the key elements of these power systems are highly-efficient and dense power stages, advanced highly responsive power controllers, digital interfaces for programmability and diagnostics, accurate power monitors, system controllers, and sequencing.

Advanced Power Stages

Advanced power stages can reduce power loss in power supplies by up to one third compared to traditional designs. The latest products take advantage of industry-leading MOSFET technology such as that shown in Figure 1. Here, semiconductor technology with significantly higher power density than was previously possible is combined with advanced packaging that exhibits nearly zero package resistance and inductance and delivers the industry's lowest industry thermal impedance.

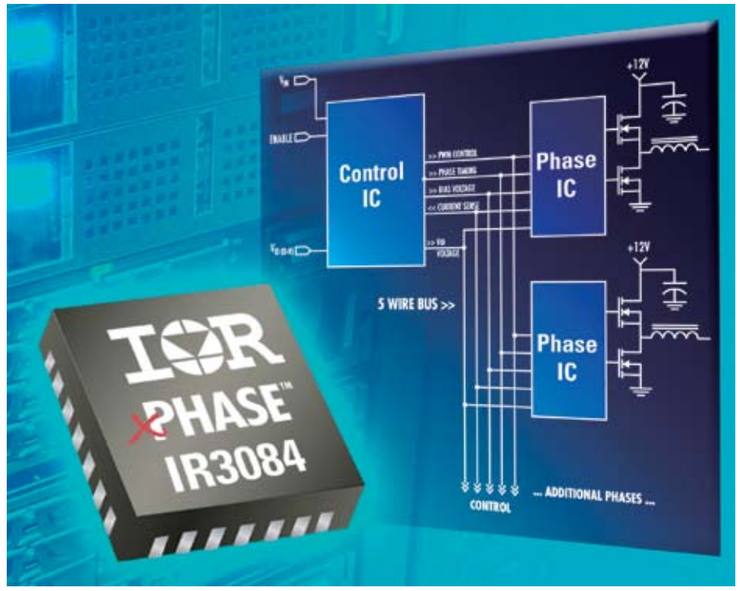


Figure 2: XPhase™ scalable multi-phase architecture.

Compared to standard plastic discrete packages, the metal can construction of these benchmark MOSFETs enables dual-sided cooling to effectively double the current handling capacity of high frequency DC-DC buck converters. This dramatically cuts energy losses while shrinking the design footprint of the circuit board. By using driver ICs with innovative control schemes that have been co-designed with (and optimised for) these efficient MOSFET power devices, engineers can obtain the best possible combination of efficiency and electrical performance. In the case of servers, for example, using this technology has been shown to improve efficiency by five to six percent over time.

Advanced Power Systems

Advanced power systems can have an even larger impact on the load's power dissipation. High power loads such as microprocessors and memory banks have a very unpredictable power profile due to rapid changes in their required performance and function. Under severe requirements these loads can exceed their thermal limits and, therefore, require a stepping back in performance to allow the silicon and the package to cool. Once sufficiently cooled, the load must increase once more. This creates highly inefficient "stop; start" thermal and power cycles.

Permitting high performance silicon to thermal and power cycle wastes both energy and performance. However, by dynamically monitoring instantaneous power, recording its trends over time, and understanding the thermal impedance of the load, it is possible for the power system to accurately predict thermals in the system at any point. With this information, the system can then alter the load's electrical characteristics (e.g. dynamically change core voltage or reduce clock speed) to limit its power and establish the correct cooling conditions in advance. Energy-efficient advanced variable speed motion control, for example, can be used to guarantee that the load never leaves its required thermal envelope, optimizing its throughput, and hence its performance. This can eliminate up to 15 to 20 percent of total power dissipation.

Application Example

The impact on efficiencies of applying the latest integrated power management semiconductor technologies can be illustrated by considering the server technologies employed in the modern data centre. Thanks to their modularity, low cost and small size, these will typically be rack-mounted 'blade servers'.

By adding racks containing high density blades data centre capacity can be increased in line with processing requirements. However, with the latest blades having up to four processors per boards (plus other high performance semiconductors including memory) their power requirements and heat dissipation are both significant. In practice, therefore, data centres often leave slots empty to provide more cooling and keep systems within thermal specifications.

Fortunately, the availability of the latest generation of power semiconductor technologies is helping engineers to address this problem. The two methods discussed in this article, for example, can help reduce the total power consumed in the blade. This reduces the cooling requirements, and thus allows greater blade density in the rack.

The first method allows engineers to develop highly-efficient on-board power supplies. Approximately 80 percent of the power drawn by the blade is consumed through the on-board power supplies, so the efficiency of the power supplies has a large impact on system efficiency. Much of this power is consumed through the microprocessors and memory. For example, a typical high-performance microprocessor will consume 130A at 1.1V, or 146W. Today it is typical for on-board power supplies to have about 80 percent efficiency, or 20% losses.

With advanced power control and conversion technology, such as International Rectifier's XPhase™ scalable multi-phase architecture (Figure 2) and DirectFET® MOSFETs, it is possible to increase system efficiency to over 88 percent. This reduces the power supply's power loss by 40 percent (from 20 percent to 12 percent). International Rectifier has also developed a family of accurate real-time power monitoring ICs. These facilitate further efficiency improvements by allowing engineers to develop advanced power systems that reduce dynamic power loss in the blade

Conclusion

The cost of employing the advanced power management technologies such as those described above is significantly less than the savings generated. Furthermore, these approaches offer secondary benefits. For instance, with less heat to distribute board level fans can run slower, thus saving more energy and reducing acoustic noise. Indeed, it is estimated that the adoption of optimized power management systems that incorporate advanced power stages, accurate and dynamic power monitoring, and high-performance power controllers will contribute to reductions of up to 25 percent of data centre power dissipation in as little as three years.

Fast Switching for Welding Equipment

Satisfying demands in power, size and price

In recent years, welding equipment has become increasingly lighter and physically smaller. In the case of welders of higher power, size is becoming increasingly important as a cost factor, e.g. in determining the total surface of a production line. For handheld equipment, size and weight are critical. In both cases, the price pressure is high.

By Simon Sidiropoulos, Product Marketing Manager, Vincotech

The fastPACK 0 H 2nd gen and fastPHASE 0 families of power modules are Vincotech's answer to these requirements. The portfolio of CoolMOS and fast IGBT full-bridges and half-bridges, along with optional AlN substrate and/or integrated capacitors, enable the fast switching required to reduce the size of the transformer. Featuring chips of various sizes, these modules cater for almost every need in welding for up to approximately 30kW as single modules. The compact flow0 housing and efficient layout design, lead to a high power per area rating, thus satisfying the demands for both small size and low price.

Overview of fastPACK 0 H 2nd gen and fastPHASE 0 modules

An overview of the modules in question can be seen in Table 1.

The technologies used are

- 600 V: CoolMOS and High Speed IGBT2
- 1200 V: Fast IGBT2
- Optionally available is an AlN substrate instead of the standard Al_2O_3 substrate for better thermal performance. The P72x modules feature the same layout and components as the P62x family and additionally feature internal DC link capacitors for reduction of E_{off} losses.

The simulation results shown throughout this document were generated using a linear interpolation model, based on actual measurements. This tool allows the comparison of two modules under the same conditions.

600V	1200V
$U_{out} = U_{dc} = 320V$ $R_{gon} = 4$ Ohm $R_{goff} = 2$ Ohm	$U_{out} = U_{dc} = 600V$ $R_{gon} = 6$ Ohm $R_{goff} = 6$ Ohm
$T_j = 125$ °C Ioutpeak/Iout = 1,3 $T_{sink} = 60$ °C to 100 °C in steps of 10 °C ZVS DC output	

Table 2: Parameters for application examples.

Part	Configuration	Voltage	Current	Technology	Substrate
P622-F64*	H	600 V	30 A	CoolMOS	Al_2O_3
P622-F74*	H	600 V	30 A	CoolMOS	AlN
P623-F04*	H	600 V	60 A	High Speed IGBT2	Al_2O_3
P623-F14*	H	600 V	60 A	High Speed IGBT2	AlN
P569-F40	Half bridge	1200 V	100 A	Fast IGBT2	Al_2O_3
P569-F50	Half bridge	1200 V	100 A	Fast IGBT2	AlN

*optionally available with internal DC link capacitors (P72x family)

Table 1: Overview of fastPACK 0 H 2nd gen & fastPHASE 0 modules for welding.

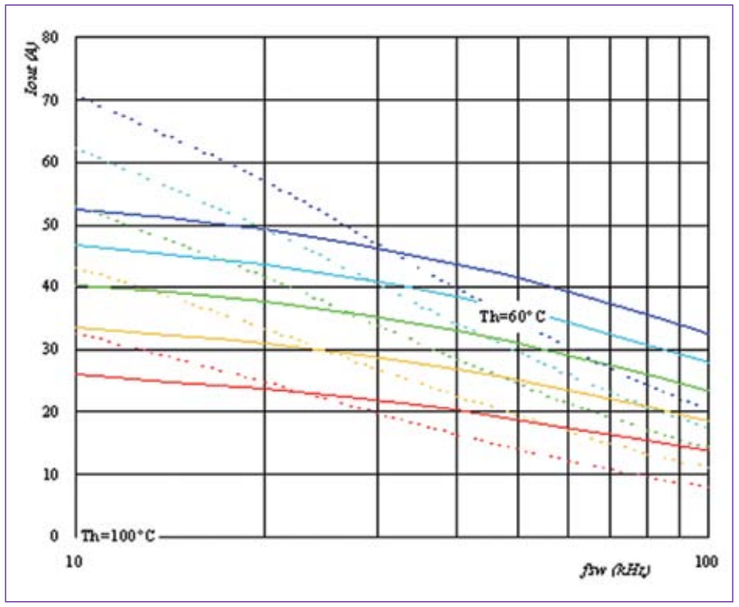


Figure 1: 600V High Speed IGBT2 vs std IGBT3
Typical available current at Tj = 125 °C as function of frequency (parameter: heatsink temperature)
- *continuous lines: P623-F04 (60 A rating, High Speed IGBT2)*
- *dashed lines: P625-F24 (75A rating, std IGBT3)*

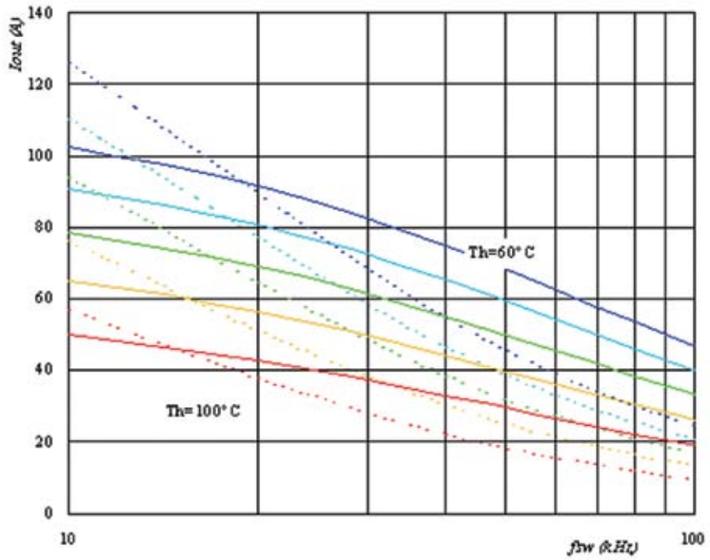


Figure 2: 1200V fast IGBT2 vs std IGBT3
Typical available current at Tj = 125 °C as function of frequency (parameter: heatsink temperature)
- *continuous lines: P569-F50 (100A rating, Fast IGBT2)*
- *dashed lines: P569-F30 (100 rating, std IGBT3)*

The cases simulated are for DC to DC conversion using Zero Voltage Switching, which is typical for welding. A more detailed simulation tool is flowSIM, the power module simulation tool by Vincotech.

Component Technology

At 600V, CoolMOS is used for the P622 and P722 modules. It is ideal for applications requiring extremely fast switching without short circuit capability. High Speed IGBT2 at 600V and Fast IGBT2 at 1200V are IGBT platforms designed for extremely fast switching. A comparison between the different technologies based on an application example can be seen in Figure 1 (600 V) and Figure 2 (1200 V). The conditions chosen are typical for welding and can be found in Table 2 below.

As can be seen in Figure 1, for any frequency above 13 kHz to 18 kHz (depending on the heatsink temperature), the High Speed IGBT2 module P623-F04 provides a clear advantage over the even higher rated IGBT3 module P624-F24. At 1200V, the Fast IGBT2 module P569-F50 performs better than the equally rated standard IGBT3 module P569-F10 for any switching frequency above 10 kHz (Figure 2).

DC link capacitors

The internal DC link capacitors of the P72x family aim at reducing the parasitic inductance and the E_{off} losses during switching. The great advantage of capacitors inside the package is the extremely short current path. As can be seen in Figure 3, the switch-off overvoltage peak in a module with capacitors reaches 120% of the nominal DC voltage, as opposed to 138% in a module without capacitors. This 15% reduction in the turn-off voltage peak extends the lifetime of the module and increases its reliability. In some cases, it even makes the use of lower rated components possible.

The conditions used for the example above were:

U_{ce} (100%) = 400 V
U_{ge} (100%) = 15 V
I_c (100%) = 60 A
R_{gon} = 4 Ohm
R_{goff} = 2 Ohm

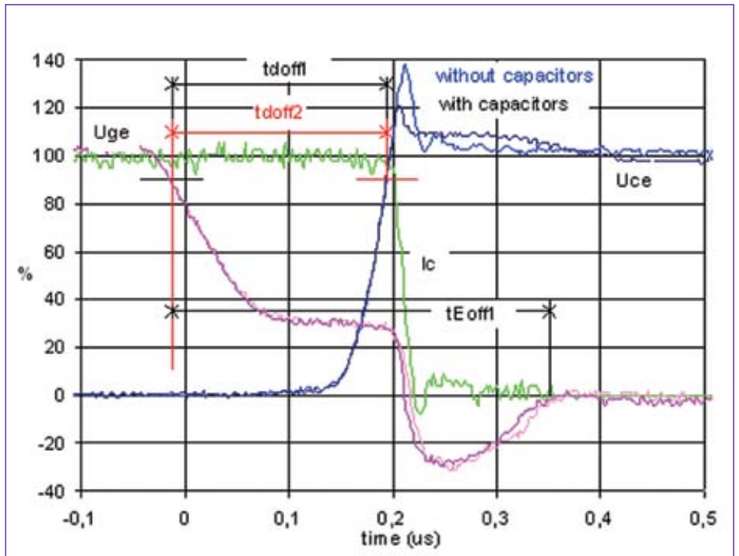


Figure 3: Turn-off characteristics w/o internal capacitors
- *light coloured lines: P623-F10 (no capacitors)*
- *dark coloured lines: P723-F10 (with internal capacitors)*

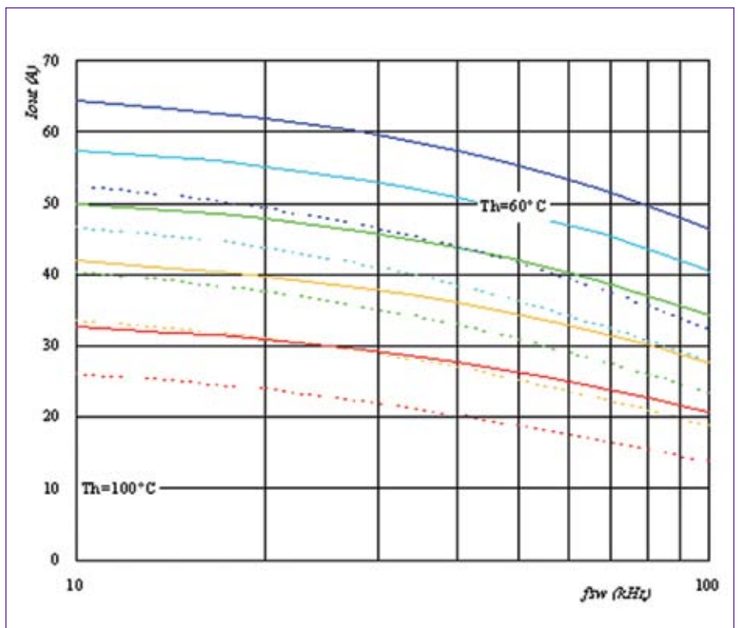


Figure 4: AlN vs Al_2O_3 substrate
Typical available current at Tj = 125°C as function of frequency (parameter: heatsink temperature)
- *continuous lines: P623-F10 (AlN substrate)*
- *dashed lines: P623-F04 (Al_2O_3 substrate)*

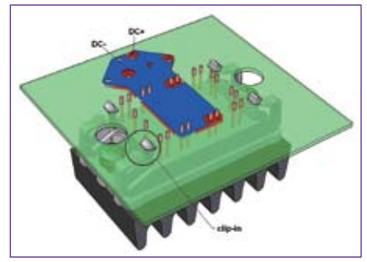


Figure 5: P62x family with DC+ & DC- side by side in flow0 housing with easy clip-in mechanism.

AlN substrate

The AlN substrate reduces the thermal resistance of the module by approximately 30% compared to a module with an Al_2O_3 substrate. The lower temperature rise means that smaller chips and potentially smaller modules can be used, or that a higher switching frequency can be used, leading to an advantage in size and price. Figure 4 illustrates the advantage of a module with AlN (conditions in Table 2). The two modules used are identical, apart from the substrate.

flow0 housing

The flow0 housing features a number of advantages: it is compact (66 mm x 13 mm x 17 mm), flexible in pin position and therefore with optimized DCB layout and pinout (DC+ and DC- side by side for low inductive supply) and easy to mount onto the PCB (via clip-in mechanism). For details see Figure 5.

Conclusion

The fastPACK 0 H 2nd gen and fastPHASE 0 families are designed to meet the requirements of today's welding manufacturers: fast switching in a compact design. Single modules cover up to 30 kW; due to the positive thermal coefficient of the IGBTs, chips can also be paralleled in order to achieve higher power. Vincotech also offers the corresponding input rectifier stages in the flowCON 0 family (P590 and P600), as well as PFC stages (P80x family).

For more information please visit: www.flowpim.com, or contact Vincotech directly.

www.vincotech.com

The Greening of PoE

Power over Ethernet (PoE) has emerged as an important deployment tool for IP telephony and wireless networking

There are few issues more prominent than the growing energy crisis in today's enterprise computing and IP-telephony infrastructure. The topic continues to draw attention, especially in the wake of the 2007 EPA study reporting that energy usage in the data center doubled between 2000 and 2005 and will grow to 3 percent of all U.S. energy consumption by 2010. The EPA report did not include the power consumed in the telecommunications and LAN closets.

By Daniel Feldman, Senior Product Line Manager, Analog and Mixed Signal Group, Microsemi

Power over Ethernet (PoE) has emerged as an important deployment tool for IP telephony and wireless networking thanks to its ability to provide a new, universal power/data jack. And now, thanks to new advances, PoE is also becoming a weapon in the war against energy inefficiency throughout the enterprise and even in the data center – from small server closets to large enterprise-class data centers -- where the energy efficiency of large switches is of particular concern.

PoE is very rapidly evolving in support of ever-more-rigorous power mandates including those imposed by the Energy Efficient Ethernet (EEE) standard and other "green" initiatives. Several PoE technologies are addressing this challenge and turning PoE from a liability to a solution in the quest for improved energy efficiency. Increasingly, PoE energy-delivery efficiency is surpassing that of traditional wall-adapter solutions in a wide variety of applications, and new techniques and technologies such as dynamic power management and emergency power management are poised to make new "smart" PoE solutions even more power-efficient than prior PoE solutions and traditional wall adapters.

PoE's Cost and Deployment Benefits

Beginning with the first Bell telephone installations in the late 19th century, power and data co-existed on the same electrical cable. In contrast, the first IEEE802.3 and other data communications systems in the 1970s did not deliver power. By the late 20th century, data transmission rates were high enough to ensure the transmission of data packets. With the evolution of VoIP Protocols, it was necessary for Ethernet to evolve such that VoIP could become as simple and reliable as traditional and digital telephony. At the same time, sophisticated new high-bandwidth wireless LAN protocols were enabling wireless LAN access points to replace wired Ethernet in many applications, which made it even more important that Ethernet provide power-delivery capabilities where A/C power outlets were not available. The twin developments of VoIP and WLAN led the IEEE802.3 work group to create the IEEE802.3af task force in 1999. The task force's mission was to enable the transmission of data and packets on the same CAT3 (or above) Ethernet cable. Four years later, the IEEE802.3af task force created the first PoE standard, which supported the delivery of 12.95W to powered devices.

The Goal: More Power, More Efficiently

IEEE802.3af provided enough power for the majority of intended VoIP and WLAN applications, as well as network cameras, embedded thin clients, barcode RFID readers, access control applications and others. More power was required, however, if the RJ45 connector were to truly become a universal power socket for virtually any terminal, including video phones, multi-channel Access Points, outdoor applications such as Fiber to the Home Optical Network Terminators, IEEE802.16 subscriber stations and notebook computers. In 2004, the IEEE802.3 working group created the PoEPlus study group, which in 2005 became the IEEE802.3at, with the goal of delivering at least 30W for devices powered over Ethernet cables.

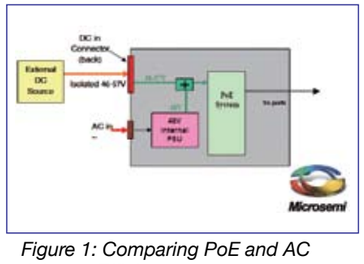


Figure 1: Comparing PoE and AC Adapter Efficiency.

Today, IEEE802.3at is poised to usher in a new generation of easy-to-deploy, easy-to-power wireless applications. In addition to delivering more power, the technology is also capable of more carefully managing power delivery and ensuring it's most efficient use.

Comparing PoE and AC Adapter Efficiency

The most important gauge of energy efficiency is overall PoE system efficiency at maximum load. Power is converted from 100-240VAC to 44-57VDC at the output of the PoE power sourcing equipment (PSE), than delivered over an up-to-300-foot cable to the powered device at a voltage of 37-57VDC, after which it is again converted to the several voltages at which the different circuits work (5V, 3.3V, 2.5V, 1.2V, 0.9V, etc…). See Figure 1.

To calculate the overall efficiency of a PoE system, the following formula is used:

PoE System Efficiency = PSE (Power supply efficiency) x PoE PSE circuit efficiency x channel (cable, patch panel and connectors) efficiency x PoE PD circuit efficiency x PD DC/DC efficiency

Clearly, system losses occur, and one initially might believe there is little that can be done about it. However, there is a major difference between the PSE and the PD. In the case of the PD, designers must assume a worst case power conversion of 57VDC down to its lowest voltage (e.g.3.3V) for power dissipation purposes. But the PSE designer has the freedom to determine the voltage it outputs. As an example, consider an IEEE802.3at-powered device that requires exactly 29.52W to operate and is placed at the end of a 300ft CAT5 channel (resistance is 12.5Ω). In this scenario, the PSE circuit resistance is 0.65Ω, and the PD circuit resistance is 0.58Ω plus a diode bridge and the source is 110VAC. The PSE designer can either use a power supply with a 56V minimum voltage or a power supply with an output voltage of 51V. In the 56V system, current will be 616mA, while in the 51V system, current will be 720mA. The following formulae apply:

56V System Efficiency = Eff 110→56V x 99.3% x 86.1% x 97.2% x Eff 46.54→3.3V = 83.1% x DC/DC efficiency

51V System Efficiency = Eff 110→51V x 99.1% x 82% x 96.5% x Eff 39.58→3.3V = 78.4% x DC/DC efficiency

The choice of a 56V minimum voltage yields 5% higher system efficiency than the choice of a 51V minimum voltage. Additionally, this choice results in a low overall resistance of only 0.65Ω inside the PSE circuitry.

In this example, the assumed efficiency of the DC/DC stage in the PD and the AC/DC stage in the PSE power supply is 90%, making the overall efficiency of this PoE system, at full IEEE802.3at load, 90% x 90% x 83.1%= 67.3%. This compares with a typical standalone AC adapter, such as that used in a laptop, which normally has an efficiency of approximately 50% to 70% at maximum load.

Additional Power-Saving Opportunities

Besides improving overall system efficiency as compared to traditional A/C wall adapters, PoE has the opportunity to squeeze even more power efficiency out of today's multi-user systems through smart power deployment and management.

Clearly, a very significant energy factor is how much power is being dissipated by large PoE power supplies when those are not being used. For instance, an IT manager might purchase a 48-port switch with full power per port (800W), but only use it to power 20 ports. In this scenario, the power supply may be operating well below its optimal efficiency state, wasting as much as 80W of quiescent power. At below maximum power loads, the quiescent power can be typically 10% of the power supply level. By choosing a non-full power supply, the IT manager may be reducing wasted power by half.

The utilization of available power will be maximized only when there is an accurate measurement of power consumption and the proper algorithm is used to dynamically allocate power to many diverse ports, according to priority. Additionally, smaller power supplies are also more economical and, in situations where users do want to have full power per port, the switch vendor can offer incremental additional power via an external power supply. This requires a smart management of the power supplies available on the system.

Cost implications

Having established that system efficiency is optimized when voltage is as high as possible at the PSE power supply, the next consideration is cost. In general, the cost of a PSE power supply is typically directly proportional to the difference between the input and output voltages. In other words, a PSE power supply supporting 110→56V will be less expensive than a power supply supporting 110→51V. On the PD side, the power supply needs to be designed for the worst case (57V), which means the voltage on the PSE will not affect its cost.

Additionally, because overall system efficiency is improved at higher voltages, it is possible to support a given PD load with a smaller power supply. And, because of the resulting lower heat dissipation of the system, smaller and/or lower-speed fans can be used, further reducing costs.

From both a system efficiency and cost perspective, PoE is emerging as a highly viable solution for significantly improving energy efficiency in the enterprise.

www.microsemi.com

ATCA and MicroTCA Standards Invite Integration

Solutions leveraged to simplify designs and improve performance

To keep pace with rapid technology advancements in computing, communications and industrial markets, Advanced Telecom Computing Architecture (ATCA) and MicroTCA (µTCA, uTCA, MTCA, or mTCA) open standards were developed by the PCI Industrial Computer Manufacturers Group (PICMG®) and are now becoming widely adopted. The standard was adopted by PICMG® in 2005 and specifies mechanical, shelf management, power distribution, thermal and connector requirements.

By Jack Olson and John Cummings, Texas Instruments

The driving force behind this standard was to reduce development and cost in legacy systems, where implementations and requirements were sufficiently different from application-to-application and manufacturer-to-manufacturer. With wider adoption of these new open standards, opportunities are created for system developers and telecommunications equipment manufacturers (TEM). A standard approach lends itself to the development of highly-integrated silicon solutions that can be leveraged to simplify designs and improve performance while reducing board space requirements, cost and time-to-market. ATCA and MicroTCA standards are rising in popularity with TEMS, networking equipment providers, communications system integrators and sub-system manufacturers.

AdvancedMCs, also specified by PICMG®, are mezzanine daughter card modules that provide extended, new or upgraded functionality to an ATCA carrier card. These AdvancedMC modules can contain digital signal processors (DSP), microprocessors, programmable hard-disk drives, communications or any foreseeable connectivity components for use in the system. In fact, they can contain any functionality desired by the user. They are especially useful for systems requiring high reliability and scalability. The modules can be used to provide expanded capability or redundancy. As the standard is defined, up to eight AdvancedMCs can be supported by an ATCA carrier card (Figure 1).

MicroTCA is a complementary PICMG® standard that allows for use of AdvancedMC daughter card modules in distributed system. MicroTCA is optimized for use in systems requiring smaller form factors and lower costs. In MicroTCA, up to 16 modules can be inserted directly into the backplane. The architecture accommodates the 16 modules as follows: 12 AdvancedMCs with the desired functionality, two MicroTCA Carrier Hubs (MCH), and two cooling units. An example eight-module unit is shown below in Figure 2.

Hot Swap Functions

Hot-swap power management requirements for the –48V, 12V main payload power, and 3.3V management power rails for each AdvancedMC module are defined in the PICMG® standards collectively and include inrush limiting, current limit protection and ORing control. The PICMG® standard defines the 12V rail as the payload power (PWR) channel with a maximum power delivery capability of 80W. The actual limit is determined by the individual module design. The 3.3V rail is defined as the management power (MP) channel with a maximum current limit of 150mA. Current limiting is required on a per module basis to prevent a defective AdvancedMC card from causing the rest of the system to fail.

In proprietary systems and prior to widespread adoption of ATCA and MicroTCA, these requirements were system-specific and typically used discrete hot-swap controllers and ORing FET controllers for each rail. As each solution was unique, it was challenging to create a common, hot-swap control architecture to simplify the overall solution. Following is an example of how the standard has helped to simplify the hot-swap and ORing control. A MicroTCA system designed for accepting 12 AdvancedMCs, two MCHs, and two cooling units, would need a total of 32 individual hot-swap controllers or 16 channels of 12V hot-swap and 16 channels of 3.3V hot-swap with current limiting. In redundant systems, ORing MOSFET control systems are used in place of ORing diodes to reduce power dissipation on high current 12V payload power channels. For these systems, an additional 16 ORing FET controllers would be needed, resulting in a total of 64 integrated circuits required to implement the desired functionality. When including external hot-swap MOSFETs, ORing diodes and passive components used to set current limits, timers, undervoltage lockouts and other parameters on the hot-swap controllers, in excess of 465 components were required for the implementation. Component space required to support these 16 slots requires more than 3000 mm^2 of board space.

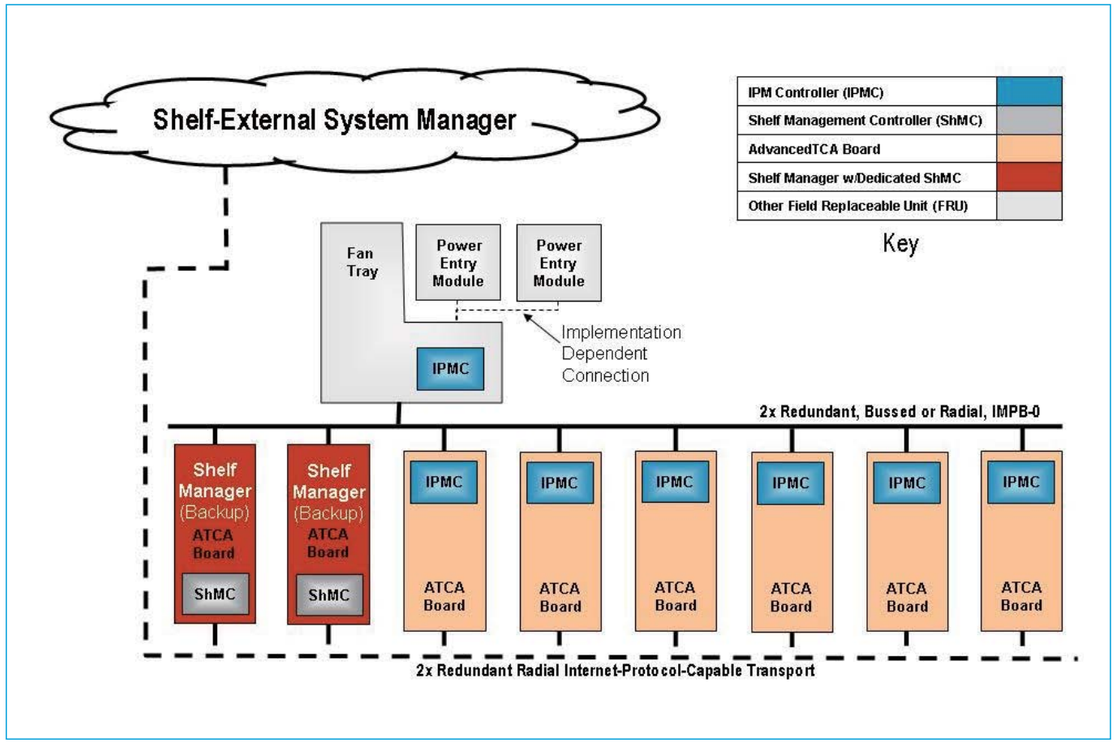


Figure 1: Typical ATCA Carrier Card.

Standardization allows simplified solutions to be developed to control the hot-swap, ORing control and current limiting. Prior to the ATCA/MicroTCA standards, the varying requirements and operating conditions made designing integrated hot-swap power managers inefficient and impractical. In order to meet broad, widely varying operating requirements, performance and cost were sacrificed by adapting generalized solutions to meet the system needs. Designing these discrete hot-swap systems was a significant challenge and burden on the system designer.

With rapid and widespread adoption of ATCA and MicroTCA, there were challenges to meet the strict requirements and opportunities for intelligent integration. The TPS2359, a dual-slot AdvancedMC hot-swap controller shown in Figure 3, is an example of such a device where control and hot-swap functions for multiple channels are achieved on a single integrated circuit. The TPS2359 has full power control for two AdvancedMC slots and is fully compliant with the AdvancedMC standards. The device controls two channels of 12V PWR and MP with hot-swap and ORing FET control. Low-current MP channels are handled internally with integrated MOSFETs and current shunts. The PWR channels use external MOSFETs to allow for the best overall system solution.

The TPS2359 takes advantage of the I^2C interface required for the intelligent platform management bus (IPMB) by allowing direct control over the individual PWR and MP channels and can be programmed for current limit, fault time, and power good threshold adjustment. Each channel has six bits of status which can be read over the I^2C. The bits indicate power good, momentary over-current, fault, fast trip, hot-swap FET status, and ORing FET status. The power good, hot-swap, and ORing FET status let the system know that the channel is operating normally. The I^2C interface adds system flexibility to build histories that can be instrumental in predicting system behavior and predicting failures. This programmability eliminates

Figure 2: MicroTCA Modules.

the need for external components, further simplifying the design process, and reducing solution size and cost. The 6x6mm, 36-pin QFN packaging greatly minimizes board space.

In contrast to the discrete 16-slot MicroTCA system implementation previously discussed, a TPS2359-based implementation reduces the number of hot-swap / ORing ICs from 48 down to a manageable eight addressable controllers. Integrating of hot-swap MOSFETs for the 3.3V channel and using I^2C to set key parameters helps to reduce the total number of components by more than half from the required >465 to less than 200 total components. With respect to physical area required, the solution size drops from the 2200mm^2 to just under 1300mm^2 with increased functionality. This high level of integration has the added benefit of being fully compliant with the narrow and specific Advanced-MC power interface requirements. To help quantify this further, the accuracy of the TPS2359 current limit circuitry requires only one percent current tolerant external resistors to be used while still meeting the ±10 percent current limit requirements of the 12V channel. Other compliant solutions do not have this high level of accuracy.

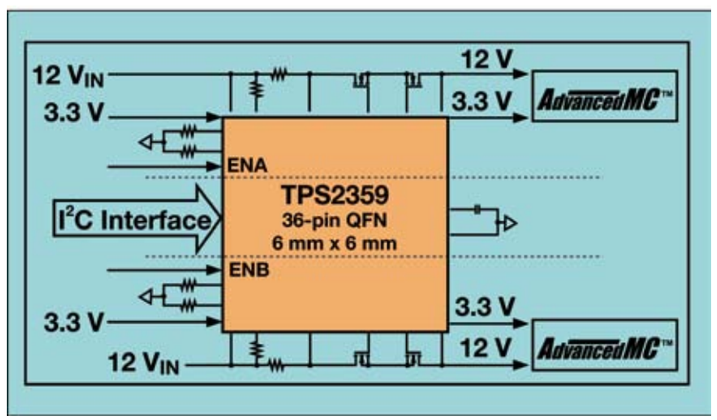


Figure 3: TPS2359 Dual-Slot Controller.

Summary

Adopting ATCA and MicroTCA standards has enabled the simplified power interface solutions to be developed. Without the benefit of ATCA/MicroTCA, new technology developments were inhibited by the need to devise proprietary solutions for each given infrastructure. This meant that a new technology would develop multiple proprietary solutions in order to be deployed. With ATCA/MicroTCA standardization in place, this barrier to rapidly deploy new technologies is eliminated. To this end, the TPS2359 was developed as a fully ATCA/MicroTCA AdvancedMC compliant dual hot-swap controller. This controller helps to save precious board space by reducing component count and size while adding the precise control limits set forth by the ATCA/MicroTCA standards. The I^2C interface allows for a minimal number of external components while adding the flexibility and advanced system management features.

To download a datasheet on the TPS2359, visit: www.ti.com/sc/device/tps2369.

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Floating Inserted Pins (FIP) Concept

Evolution opens door to high current surface mount applications

The latest sixteenth-brick surface mount DC/DC converter from Ericsson Power Modules is more than a new product; it introduces a new assembly concept that opens the door to higher current, surface mount units.

By Patrick Le Fèvre, Marketing Director, Ericsson Power Modules

If at glance, due to its simplicity, the Floating Inserted Pins (FIP) concept seems not to be unique, that apparent simplicity is the result of much research conducted throughout the years, and it is important to recap from where this project emerged, resulting in a the state of the art technology that brings solutions for higher current, surface mount units.

In 1993, when most DC/DC converters were packaged in the famous 2x2 inch packages, Ericsson Power Modules introduced a highly integrated DC/DC power module named The MacroDens™ (figure 2). Based on a ceramic substrate, thick-film technology, and a combination of early surface mount components, the MacroDens product was the first module fully optimized for surface-mount assembly, and was considered a breakthrough technology.

From the first MacroDens shipped in October 1993 through to the end of 2007, more than 40 million units were shipped to market, with 80 percent of that volume being surface-mount.

Figure 1: Sixteenth-brick surface mount DC/DC converter.

Ericsson has a long standing experience in the development of low and mid-power surface mount units, but the growing demand for higher current isolated, also non-isolated surface mount modules such as POL (Point of Load) or VRM (Voltage Regulator Modules), coupled with more stringent assembly requirements related to the usage of lead-free soldering, created a need to develop a sustainable interconnection between the board-mounted-modules to motherboards.

Taking into consideration the entire process from original manufacturing to final assembly by the customer, Ericsson Power Modules' PKU-SI is the first product to adopt the FIP concept (Floating Inserted Pins).

To make it possible to simply convert pinned modules to surface mount, in the mid nineties the power industry developed a concept based on a folded or tooled box of copper named Boxpin. This technique, based on a very simple process, has been successfully implemented on various products. For example, Power Modules' DOSA compatible Point-of-Load products use this technology (figure 3).

At the same time that the original

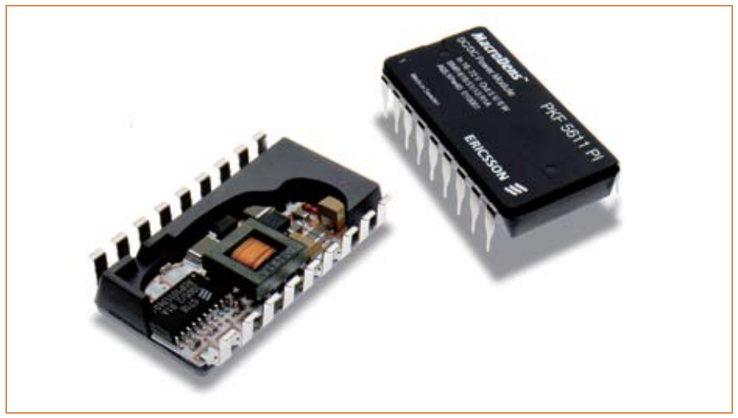

Figure 2: DC/DC power module - MacroDens™.

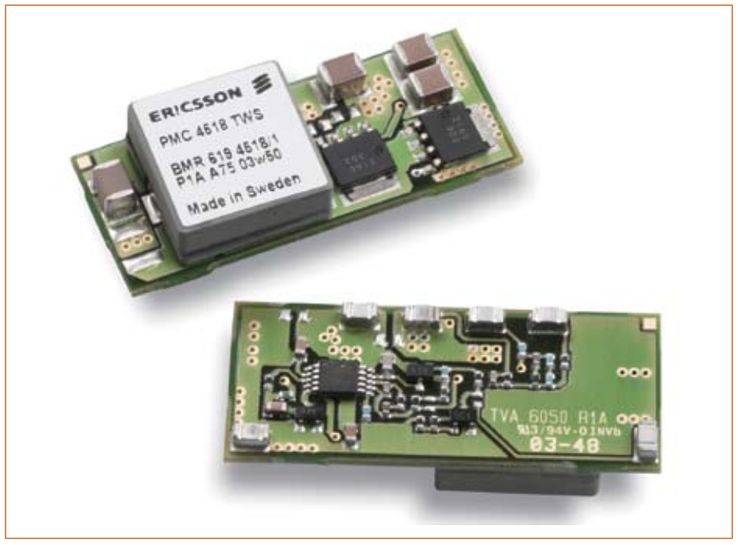

Figure 3: DOSA compatible Point-of-Load products.

Box-pins became a de facto standard, some companies developed a cylinder approach, replacing the box with a cylinder. Although the basic principal remained the same, due to the interface not being mechanically attached to the power module, this technology was limited to low mass assemblies (e.g. low current POL).

In parallel to the Box-pin, driven by the growing need to efficiently interconnect multi grid-array modules, semiconductors' manufacturers developed a new concept based on combining solder balls and cylinder-pins underneath the substrate, resulting in a number of patents such the one filed by Fairchild in October 2000 (6391687).

Considering the evolution of on board power modules integrating more functionalities, requiring parallel or serial bus communication, BMP power manufacturers considered to use this type of interface (columns + balls) when migrating to higher power, and more intelligent power modules. Unfortunately the cost related to this concept, and difficulties experienced in implementing it to sub-assemblies such as BMP made this technology unsuitable for commercial products.

If Fairchild's combined columns + balls concept was not appropriated to board mounted products, in 2001 another technology developed by the company Autosplice, the so called Solderball Pin Technology emerged, offering an alternative interconnection to the ten year old Box-pin.

Solderball Pin Technology has a certain number of benefits, and Ericsson Power Modules uses such an interconnection on its POLA interoperable products (figure 4).

Challenges

One would think that Box-pins, Cylinder-pins and Solderball Pins should be enough to satisfy most of the needs of the industry. Although increasing power densities, the migration from leaded soldering processes to un-leaded processes, mechanical constraints and vibrations added during possible second-reflow when customers assemble their boards, have combined to force Ericsson Power Modules to re-consider how to guarantee the most suitable interface between the sub-assembly (e.g. DC/DC or VRM) and motherboard.

The migration from leaded solder to unleaded solder revealed that if in most of the cases low mass components were not mechanically affected too much during second or third reflow during the end-customers' final assembly process, then more massive components such as eighth and sixteenth bricks were subject to multiple problems.

From investigations conducted by Ericsson Power Modules in close collaboration with its customers and their contract manufacturers, Box-pins and others interfacing technologies commonly used for low mass modules appeared NOT to be the most optimized solution to guarantee high yield when higher mass modules were assembled on motherboard.

Considering the complexity to develop such an interface without adding extra costs, the challenges placed on our R&D were multiple:

- Guaranteed excellent co-planarity
- Ability to transfer high current with low losses
- Good thermal conduction
- Cost close to or lower than other technologies (e.g. tooled box-pin)

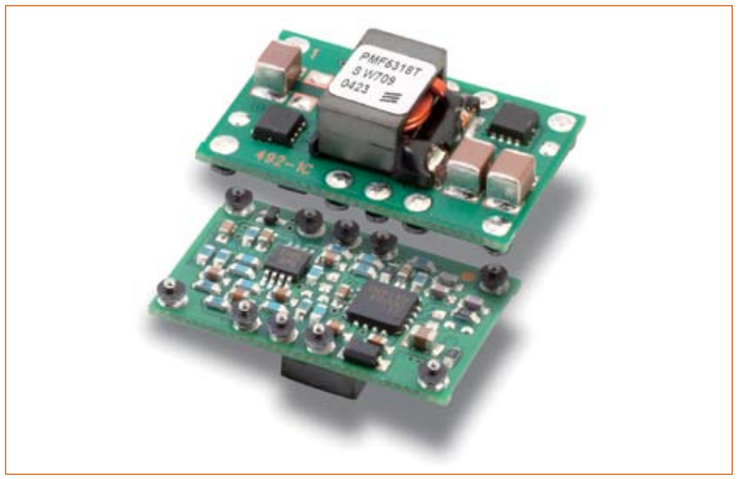

Figure 4: Solderball Pin Technology used by Ericsson Power Modules.

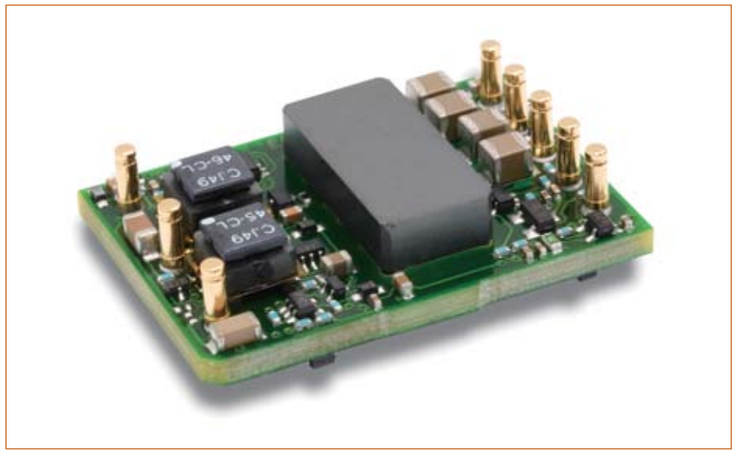

Figure 5: Solution based on a floating inserted pin.

- Easy to assemble with automatic insertion equipment
- Permanent 'in-place' condition whatever the surrounding conditions

Considering all those parameters, the project manager developed a concept based on a combination of different techniques that Ericsson had developed for other surface mount sub assemblies, combining learning from pinned products and experimental research started in 2000 when considering BGA (Ball Grid Array) DC/DC converters.

From concept to solution

Knowing the strategic importance to guarantee physical integrity when a module is exposed to additional reflow while keeping the co-planarity intact, a concept based on a floating inserted pin emerged (figure 5).

The FIP concept is based on several principles:

The pins are manufactured with very tight tolerances, guaranteeing co-planarity, mechanical accuracy, and high yield when inserted to the board.

The pin-tail is thoroughly designed to guarantee that pins remain in place and are aligned during second or third reflow soldering.

The amount of solder added to the pin-tail is controlled to make it possible for the pin to float during final assembling, and to self-adjust to potential co-planarity variations resulting from motherboard inaccuracies.

The assembly advantage of FIP for the final user is significant, as it guarantees high stability and reliability when assembling heavier surface-mount modules, while opening room for future applications requiring higher current or better thermal conduction when modules are inserted in a seal-box (e.g. Radio Power Amplifiers).

First Product to use FIP

The first commercial products to use Floating Inserted Pins are three models of Ericsson Power Modules' sixteenth brick PKU-SI:

- PKU4510 SI 48Vin/ 3.3V/15A 50Wout.
- PKU4511 SI 48Vin/ 5V/10A 50W.
- PKU4515 SI 48Vin/ 15V/3.3A 50Wout.
- Other voltages will soon follow.

The modules feature a wide output adjustment range of, for example, 3.3V +10/-40 percent. For safety, the modules have a 1500V input-to-output isolation rating and feature comprehensive protection against over-temperature, output short circuit, and output overvoltage.

The PKU-SI is DOSA (Distributed-power Open Standards Alliance) compatible, ensuring footprint compatibility across a wide range of manufacturers and compatibility with all aspects of DOSA. The same board is used for PI and SI versions of PKU, which increases the flexibility and speed of manufacturing and contributes to reduced lead-times.

PKU-SI is available in molded trays (JEDEC design guide 4.10D standard) and in tape and reel formats. Complying with the IPC/JEDEC standard J-STD-033 (handling, packing, shipping and use of moisture/reflow sensitivity surface-mount devices) inner shipment containers are dry packed in standard moisture-barrier bags.

www.ericsson.com/powermodules

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Lighting Systems Part II

Using Light Sensors to Extend Battery Life

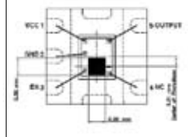
ISL29000 family extends usefulness of typical ambient light sensors

Ambient light sensor technology plays a key role in power management strategies for display products. This article compares various ambient light sensor technologies and explains by properly applying the ambient light sensing in conjunction with LED backlight driving, one can significantly reduce power consumption and increase battery life in a portable/cell phone system.

By Mike Wong, VP Applications Engineering and Tamara Schmitz, Principal Aplications Egineer, Intersil Corporation

In this article, advances in optical sensors are discussed with respect to two application examples: an ambient light sensor for a laptop and cell phone display. A selection of optical sensors is shown in Table 1. They are arranged from left to right in order of complexity. Considering reasonable order quantities, they are also ordered by cost. A discussion of the trade-offs will uncover what advantages can be bought with a few extra pence/ cents per unit.

Table 1: Summary of optical sensor options.

Device	Photo Resistor	Photo Diode	Photo Transistor	Photo Diode and Current Amplifier
Referenced Part #	PDV-P500X	Everlight DTD-15	Everlight DPT-092	ISL29000
				
Accuracy	Not Guaranteed	Not Guaranteed	+-75%	+-33%
Current (1000 Lux)	Varies	3uA	2.6mA (@70K Lux)	900uA
Range	1 to 100 Lux	7 to 50K Lux	1K to 100K Lux	1 to 100K Lux
Response Time	55ms	6ns	15us	500us
Enable Function	No	No	No	Yes

The simplest optical sensor is a photo resistor and can be identified by the meandering channel between two terminals. The low-end versions are made with cadmium sulfide, while the more expensive counterparts are gallium arsenide. GaAs allows the inclusion of a photo resistor in an IC and its small bandgap (1.4V at 300K) allows the low energy photons in infrared light to free electrons into the conduction band. The data from the reference part is only reported from 1 to 100 Lux, yet a variety of resistance values are available.

Photo diodes are the next step in complexity. Photons bombarding the junction produce current. For optimal use, the diode should be reverse-biased. The amount of bias translates into quality of operation—larger reverse bias enhances speed and linearity while also increasing dark current and shot noise. Light creates forward current which subtracts from the reverse bias current.

Special Report – Lighting Systems Part II

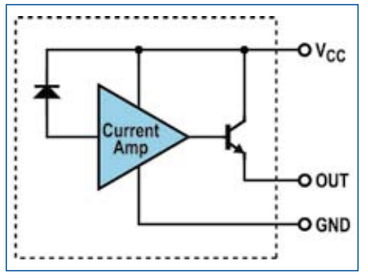


Figure 1: Block diagram of ISL29000, ambient light sensor with integrated current amp.

External circuitry can be added to linearize the diode's I-V curve, to amplify the signal, and to allow a disable function.

A photodiode driving the base of the transistor is a photo transistor. It requires more bias current and the noise associated with the current forces a shift in the sensitivity of the sensor to a higher lux range (1K to 100K instead of 7 to 50K). Response time is similar, and can be varied with bias. Current will also vary with detected signal level, of course. A photo transistor is capable of determining coarse environmental levels like indoor/outdoor, day/night, and bright light/shade. External circuitry is still needed to calibrate the output signal and include a disable function.

The latest process technology has integrated photodiode cell in the standard CMOS process, thus allowing the creation of a single die device like the ISL29000. It places a photo diode and transimpedance amplifier in one die, as shown in Figure 1. This combination allows for lead length reduction and minimum parasitic capacitance on the amplifier inputs. This, of course, is the optimal condition for minimum noise, high frequency and convenience. The low noise characteristics extend the sensitivity of the sensor down to 1 Lux while keeping the upper limit of 100K Lux. The power drawn is still dependent on the amount of light sensed, reaching 0.9mA for 1000 Lux. To conserve power, a power-down pin is included. This device is suitable for many situations, such as digital cameras and automotive navigation systems.

Applications for Ambient Light Sensors

Light sensors are ubiquitous in modern society. Some of these applications use reflected light with optical detection for position sensing, like bar code readers, laser printers and auto-focusing microscopes. Other applications use optical sensors to gauge the amount of ambient light, such as digital cameras, cell phones, and laptops. It is this second group that we'll investigate further.

Ambient light sensors are included in laptops to sense the ambient light, allowing for adjustment of the screen's backlight to comfortable levels for the viewer. The range of "comfortable levels" is dependent on the room's light and the sensitivity of the human eye. The relationship is shown in Figure 2. Understandably, a screen's brightness needs to increase as the ambient light increases. What is less obvious is the need to decrease the brightness in lower light conditions for comfortable viewing and to save battery life. The human eye's response breaks the received light into one of three regions as shown in Figure 2: low-light (as in the car or home), medium-light (as in an office setting) and full daylight. The best ambient light sensors will incorporate the brightness versus illumination information to maximize resolution and save power.

In laptop design, ambient light sensors

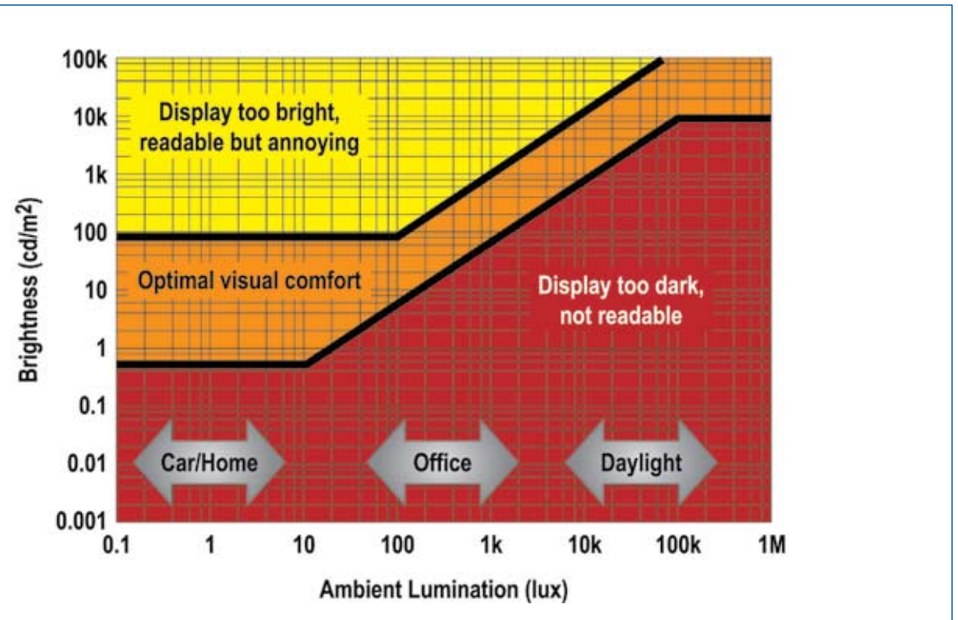


Figure 2: Graph of desired brightness with respect to ambient illumination.

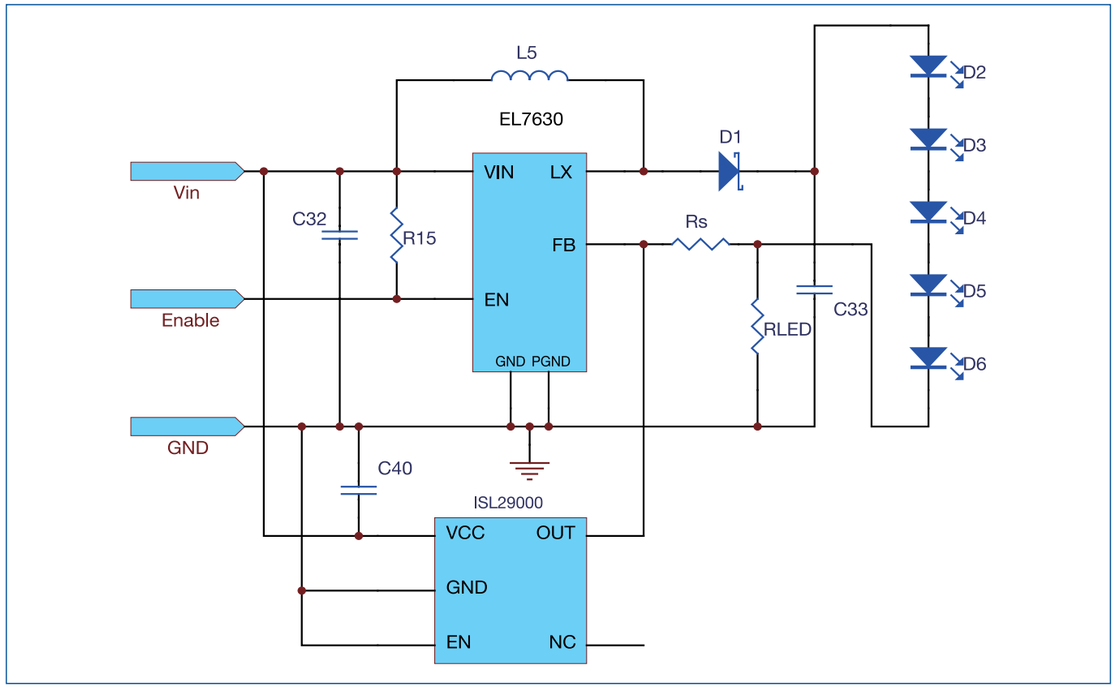


Figure 3: Automatic white LED backlight intensity control circuit.

are typically placed next to the speakers where the case has an opening for light. These portals are commonly covered by a cross-hatch pattern to protect the speakers. Because of this protection (and the fact that the light sensor is next to the speaker instead of on top of it), the light is obstructed. The obstruction reduces the amount of light to be measured, requiring a solution with low-light accuracy.

A second common example is an ambient light sensor used in a cell phone where every mA-hour saved translates into longer battery life and happier customers. The enable/disable function is equally important for the battery-saving, power-down feature. The extension of battery life is remarkable. With the light sensor to adjust the back-light illumination, battery life is increased by a factor of 4! (Assuming the backlight would remain on full-power without any feedback from a light sensor).

Figure 3 shows the complete automatic back light control circuit for cell phones. The ISL29000 senses ambient light intensity and outputs a proportional current. Equation (1) shows the relationship between light intensity (E) and output current (Iout)

$$Iout = E \cdot \frac{60uA}{100lux} \quad (1)$$

The light sensor output current injects into the feedback input of the White LED driver. In a bright environment, the light sensor source more current into the feedback node; as a result, it reduces the White LED output current and reduces the White LED output light intensity. The relationship between ambient light intensity (E) and White LED output current is shown in equation (2)

$$I_{LED} = \frac{V_{FB}}{R_{LED}} - E \cdot \left(\frac{6uA}{10lux}\right) \cdot \frac{R_S}{R_{LED}} \quad (2)$$

Table 2: Comparison of power used in a device with and without an ambient light sensor.

	Always ON	Ambient Light Sensor Incorporated	
Mobile Phone LED power	100	100	mA
Average use per day	120	120	minutes
Portion used in bright light	75	75	%
Total LED on-time	120	30	minutes
Total LED off-time	0	90	minutes
Impact on Battery	**200**	**50**	**mAh**

Conclusion

A wide variety of optical sensors are available in small packages at reasonable prices. Passive solutions have been serving consumers for decades in nightlights and still digital cameras. Active solutions have increased the range and usefulness of ambient light sensors. Typical active solutions integrate a photo transistor or a photo diode with a current amplifier. When greater resolution, low-light capability, power supply rejection or a disabling function would be useful, the ISL29000 family extends the usefulness of typical ambient light sensors.

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Lighting Systems Upgrade to LEDs

Driving high brightness LEDs for illumination

Few technologies in lighting have the potential to revolutionize the entire industry like the recent advent of high brightness LEDs. This article discusses methods for driving these LEDs from the AC mains voltage. Power Factor Correction, trends in Power MOSFET design and protection features needed for low cost, high volume lighting are discussed.

By Jinho Choi, Field Applications Engineering, Fairchild Semiconductor

About 22% of the total energy generated in America today is consumed by lighting and today's high cost of energy has given fresh impetus into newer, more efficient forms. Recent increases in the Lumens/Watt ratio of today's high brightness and ultra-high brightness Light Emitting Diodes (LEDs) have contributed to the promise of significantly reducing the energy consumed in lighting. LEDs are now emerging as a viable alternative to incandescent or fluorescent lamps in lower brightness applications.

Since the light output of high brightness LEDs depends on the DC current through them, constant current output PWM schemes to control long strings of LEDs in series are widely used. Here, we explore the use of a very inexpensive and popular SO-8 packaged Power Factor Corrector (PFC) IC, the FAN7529, for implementing this PWM scheme.

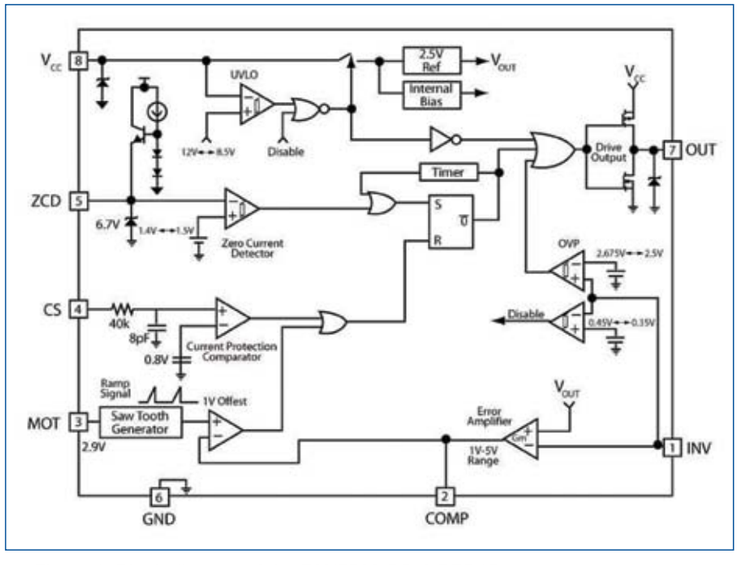


Figure 1: Block diagram of the FAN7529 SO-8 PFC IC.

By law, all lighting sockets above a certain wattage must implement a power factor correction scheme. For example, in Europe, the EN61000-3-2 requires all lighting circuits over 25W to implement a PFC scheme. The most popular method is an active Power Factor Correction scheme with a simple transition mode (boundary of discontinuity of the inductor current) scheme.

Due to the requirements spelled out in EN61000-3-2 etc., the lighting industry has long been a pioneer in the use of active power factor control.

The operation of the FAN7529 is relatively simple. An error amplifier measures the divided output voltage on IN and compares it to the desired set-point. EA-OUT is used for compensating this amplifier. The input voltage sinusoid is measured on MULT. The FAN7529 multiplies the input voltage and the output voltage error.

CS is the current sense input from the MOSFET. When the multiplier output exceeds the current reference, the flip-flop is toggled, driving OUT high, turning the MOSFET on. When there is a zero crossing detected by I_{det}, OUT is driven low, turning the MOSFET off.

Since the FAN7529 and similar, inexpensive SO-8 ICs have been available

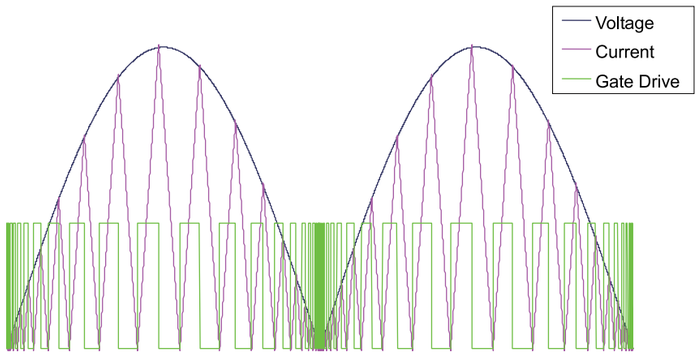


Figure 2: PFC with FAN7529. Typical gate drive, input voltage and inductor current waveforms.

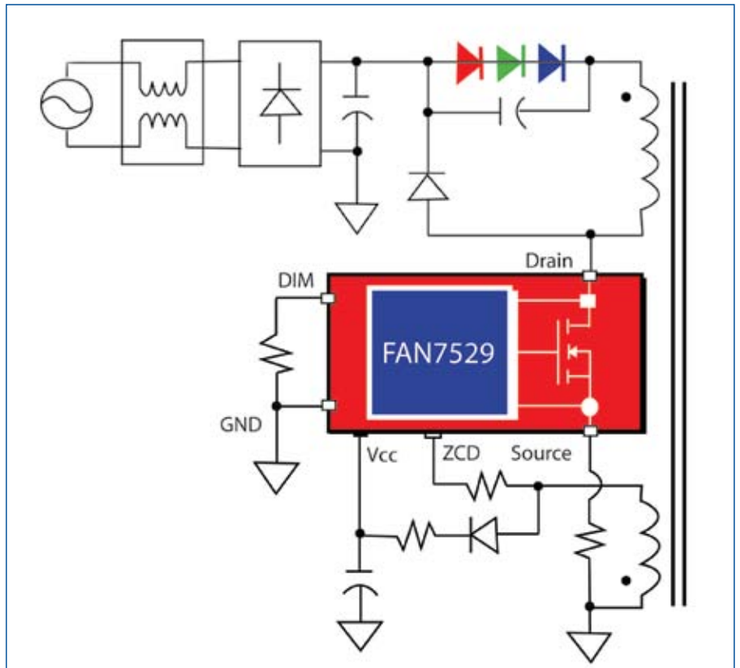


Figure 3: A simplified block diagram of the use of the FAN7529 in a non-isolated buck converter application.

for over a decade and are well known to the designers of lighting ballasts, it comes as no surprise that the control circuits for new forms of lighting such as LEDs shall also be implemented using the same IC.

If we look at LED circuits driven from the AC mains voltage, it becomes clear that both isolated or transformer-based control circuits and non-isolated Buck type circuits are popular. The circuit chosen depends on the number of LEDs and the size of the mechanical fixtures. In most lighting applications, isolation from the AC mains is not an absolute necessity.

The holy grail of AC-DC power electronics has been the search for a single PFC+PWM stage where due to cost and efficiency reasons, it is better to implement a single power stage implement with both a PFC and a PWM function. Normally, in most power supply applications, it is the load and temperature variations that have prevented any of the variety of proposed solutions from being in widespread use today. Since the illumination of the LED socket has a relatively fixed load, this provides the impetus to attempt to simply use the FAN7529 PFC IC for implementing the PFC and PWM functions.

For this application, input voltage of VIN should be higher than output LED voltage. This means we need a bigger bulk capacitor than general PFC application. The turn on time is given in the equation below.

$$t_{on} = \Delta t = L\frac{\Delta i}{V_{in(peak)}} = L\frac{I_P}{V_{in}}$$

$$t_{off} = L\frac{\Delta i}{V_L} = L\frac{I_P}{V_{LED}}$$

ton : Turn-on time
toff : Turn-off time

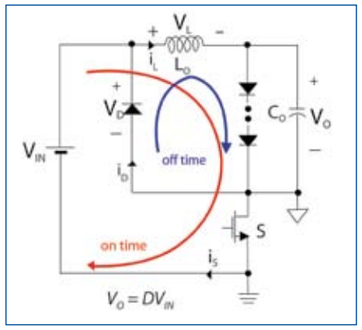


Figure 4: Principle of operation of the high voltage non-isolation buck converter.

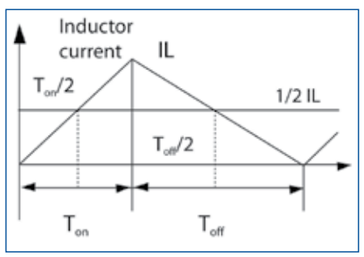


Figure 5: Input current and inductor current waveform during a switching cycle.

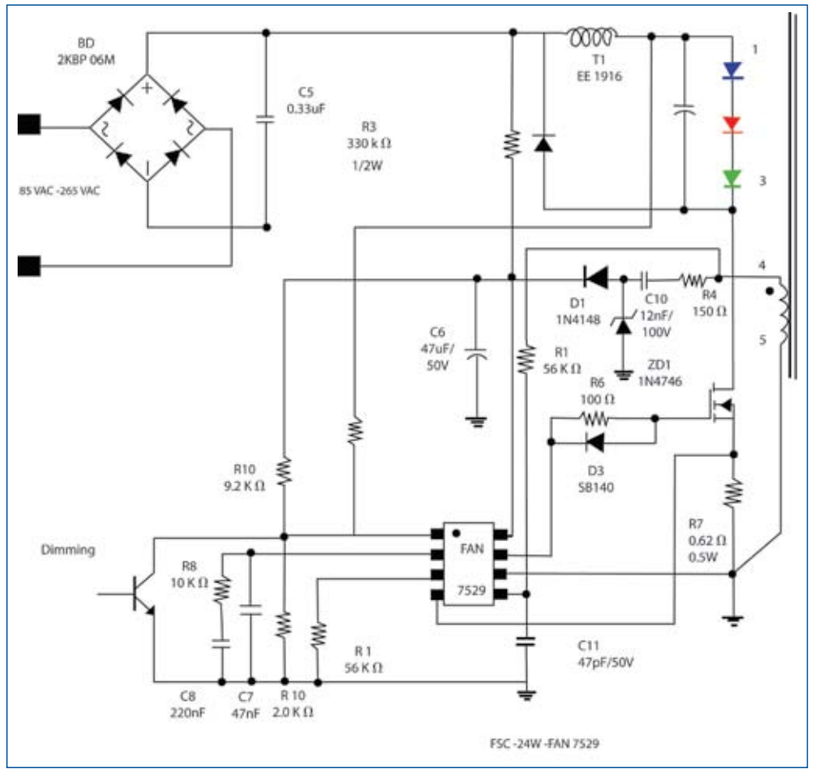


Figure 6: Non-isolation buck converter - detailed schematic.

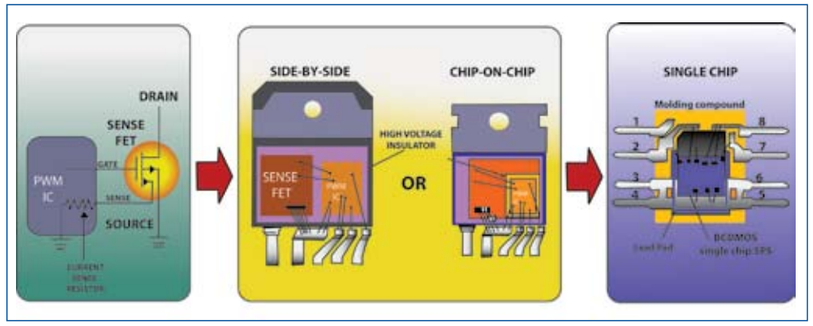


Figure 7: Placing a MOSFET and a controller in the same package reduces size and increases reliability. Two types of multi-die packaging are compared to monolithic construction.

The inductor value is determined by the output power and the minimum switching frequency. The minimum switching frequency must be above the audio frequency (20KHz) to prevent audible noise. The maximum switching period, Ts(max), is a function of VIN(peak) and Vo, the output voltage. It can have a maximum value at the highest input voltage or at the lowest input voltage according to Vo.

$$L = \frac{\eta \cdot V_{in(peak)}^2}{4 \cdot f_{sw(\min)} \cdot V_o \cdot I_{o(\max)} \left[1 + \frac{V_{in(peak)}}{V_o - V_{in(peak)}}\right]}$$

The voltage ripple of the input capacitor is maximum when the line is lowest and the load is heaviest. If fsw(min)>>fac, the input current can be assumed to be constant during a switching period.

$$C_{in} \geq \frac{L \cdot I_{o(\max)}^2 \cdot V_o^2}{\Delta V_{in(\max)} \cdot V_{in(peak\_\min)}^3}$$

Vin(peak_min) > = V_led

Similarly, the FAN7529 may also be used to make an isolated flyback converter if the application warrants it. Using only a few additional circuit components, dimming can also be introduced to control the intensity of the light output.

As LEDs evolve, it is reasonable to expect that this promising market will yield several innovative solutions for LED controllers that handle rectified AC mains voltages. Using popular and relatively inexpensive 600V Bipolar-CMOS-DMOS processes, a number of integrated circuits designed solely for LED control can be implemented. The small size of these controllers will evoke interest in packages that can combine a controller built with a 600V IC process along with a 600V power MOSFET (either conventional or of the charge –balance variety) in the same package. Various chip-on-chip and chip-by-chip styles are already popular in high volume applications worldwide.

Reducing EMI will also be a key challenge to the development of LED controllers for the illumination market. Quasi-Resonant, variable frequency, zero voltage switching circuits hold great promise to make better illumination LED controllers.

www.fairchildsemi.com

Microchip Offers Free Field Oriented Control Algorithm for New Low-Cost Motor Control Digital Signal Controllers

Microchip announces 10 new 28- and 44-pin 16-bit Digital Signal Controllers (DSCs) for motor control designs requiring increased memory, performance, or enhanced peripherals, while obtaining cost and size savings by using lower pin-count devices.

The company also has a new motor control development platform based on the popular Explorer 16 development board. Additionally, Microchip announced five motor control software solutions for: Power Factor Correction (PFC), sensorless Field Oriented Control (FOC) of a PMSM motor, sensorless FOC of an ACIM motor, sensorless control of a BLDC motor using Back EMF filtering and sensorless BLDC control with Back-EMF Filtering Using a Majority Function.

The 10 new devices bring Microchip's total count of motor control DSCs featuring 3-phase motor control PWMs up to 36 devices. The newly announced devices come in packages as small as 6x6mm, and offer up to 128 Kbytes of Flash memory for large proprietary algorithms such as observer motor control models; integration of motor control algorithms with system-level control; communication stacks such as CAN; and graphic libraries for displays.

The new devices are sampling now and are expected to be available in volume during Q2 2008. The application notes and related software are all available today as free downloads from the Microchip Web site. The new PICtail Plus Motor Control daughter card is available now and includes a dsPIC33FJ256MC710 plug-in module for the Explorer 16.

www.microchip.com/DSCMOTOR

New Colors Added to Broad Line-up of LEDs

Lumex has announced three new color choices to its wide range of visible LED offerings: Pink, purple, and turquoise. Available in Lumex's new InspirationLEDs™, these new colors are ideal for adding impact, excitement, and product differentiation to all types of electronics equipment ranging from consumer products through even the most specialized electronic instrumentation. Potential applications include home electronics, automotive and appliance displays, medical equipment, or anywhere soft pastel colors are desired – with the reliability and low power consumption of LEDs.

According to Richard Halliday, Lumex's Director of Sales and Marketing, "Our new InspirationLEDs will provide design engineers the opportunity to introduce innovative and non-traditional color choices into competitive market designs, without sacrificing product quality and speed-to-market."

These new devices come in a standard T-5mm packages with radial leads and epoxy lenses. The pink LED is Lumex part number SSL-LX5093PC, and its color is defined via the chromaticity coordinates of 0.33 (x) and 0.20 (y), according to the ICI Standard Colorimetric System purple device carries part number SSL-LX-5093VC, and has x and y color coordinates of 0.22 and 0.10 respectively. The turquoise InspirationLED is part number SSL-LX5093TC with color coordinates of 0.19 and 0.41.

These devices achieve their distinctive colors by starting with state-of-the-art, high-brightness InGaN-on-silicon chip technology that provides light output at 470nm. Then, unique phosphor coatings are applied to shift the color to the desired pink, purple or turquoise. Lumex's InspirationLEDs have an axial intensity of 2200mcd (typical) at an I_f of 20mA, and a viewing angle of 20°. The angle is defined by the points where light output is 50% of the on-axis light intensity.

All devices are lead-free and RoHS complaint, and are available in bulk or on tape for automatic insertion equipment.

www.lumex-europe.com

Boost Controller Drives Industrial Lighting Innovation

Texas Instruments has introduced a 4.5 V to 52 V wide-input voltage, non-synchronous boost controller, intended for applications where the output is a regulated current instead of a regulated voltage. The new TPS40211 allows designers to efficiently manage LED lighting, industrial control and battery-powered systems.

The TPS40211 efficiently drives high-power LEDs when the input voltage is less than the voltage to turn on the LEDs. The LED driver is designed to power multiple 1-5 W high-brightness LEDs in series, and features a programmable closed soft start, over current protection with automatic retry and a programmable oscillator frequency. The device's fixed frequency current mode control provides improved transient response and simplified loop compensation. Designers have the flexibility to use the TPS40211 for boost, flyback, SEPIC and various LED driver topologies.

The TPS40211 is available in volume from TI and its authorized distributors. The device is offered in a 10-pin PowerPAD™ and a 10-pin SON package.

www.ti.com

High-Current Flash LED Driver with Adjustable Over-Voltage Protection

National Semiconductor has introduced the industry's first high-current LED driver that enables dual LED operation for the camera flash function in portable multimedia devices. The LM3553, a member of National's PowerWise® energy-efficient product family, drives one or two high-current LEDs in series in handheld devices such as mobile phones, personal digital assistants (PDAs), smartphones, portable scanners and medical strobe lights.

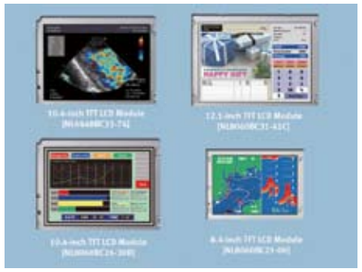
National's LM3553 flash LED driver is a fixed-frequency, step-up DC-DC converter with two regulated current sinks, driving loads up to 1.2A from a single-cell Li-Ion battery. Using the driver's adjustable over-voltage protection circuitry allows designers to drive two high-current LEDs in a series configuration, which maximizes the illumination-to-power ratio. The LM3553 can drive the camera in a high-power flash mode for still photography or a low-power torch mode for video recording. To configure the driver to fit their application, designers can

use the adjustable 128-flash current levels and 16-flash timer durations via an I^2C compatible interface. The LM3553 also features built-in time-out protection to protect the flash LEDs in case of an error condition.

National's LM3553 flash LED driver maximizes the light output for low-power systems with peak efficiency equal to or greater than 90 percent, positioning it among National's PowerWise® family of energy-efficient products.

www.national.com/power

New 10.4-inch LCD Module with Superior Viewing Performance



NEC LCD Technologies has introduced a new 10.4-inch (26 cm diagonal) amorphous-silicon TFT liquid crystal display module, NL6448BC33-74, with VGA resolution for industrial equipment, including factory automation controllers and measuring devices. The new module incorporates NEC LCD Technologies' proprietary super-advanced, super-fine technology (SA-SFT) to achieve superior viewing angles without compromising brightness or color gamut.

An ultra-wide viewing angle of 176° (horizontally and vertically), high luminance of 400cd/m^2 and high contrast ratio of 700:1 are realized through NEC's own unique SA-SFT technology, which delivers high transmissivity and wide viewing angle properties. In addition, SA-SFT technology reduces color shift problems that occur due to a change in viewing angle. These features enable information to be viewed from any angle easily and accurately, thus allowing usage of the display in portrait and landscape orientation.

A wide operating temperature range, from –20 to +70°C, guarantees operation even in extreme conditions.

The new product is compatible with NEC's 10.4-inch standard products in relation to outer dimensions, position of mounting holes, and screen center. In addition, the new module maintains signal compatibility with conventional products supporting a VGA-type digital interface. Thus, it can be replaced easily without the need to change any of the peripheral appliances.

In addition to the new 10.4-inch LCD module, NEC LCD Technologies also offers three other modules with improved visibility:

12.1-inch, NL8060BC31-41C, SVGA resolution
10.4-inch, NL8060BC26-30D, SVGA resolution
8.4-inch, NL8060BC21-06, SVGA resolution

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Power Systems Design Europe

Green Page

PSDE Green Power ENERGY EFFICIENCY

The Green Power Grid is Coming

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

With the power industry on a worldwide basis concentrating its efforts into more efficient systems and cleaner and greener methods of generation, there is a flood of news coming in. It shows no sign of relenting, in fact, quite the reverse. I have a selection of reports for you here, indicating the scale of the 'green era' and what is likely to come.

There were fears that Germany's electricity transmission network may not cope with extreme weather scenarios, according to the network regulator who asked operators to undertake a rapid overhaul. And the fact that Germany exported more power into other countries than it imported, should not create a false sense of security. There was a call for the need of 'a significant expansion of the grids,' it said, drawing conclusions from the quarterly status reports submitted by network operators in Europe's biggest electricity market since 2006.

The regulator said that if there were a sustained period of little wind and if a hot summer limited cooling water supplies to thermal power plants, Europe could face a critical situation.

According to revised government figures, as many as 400,000 people could be employed in the renewable energy industry in Germany by 2020. This is due to the boost that the country's economy

and exports has received as a result of massive investment in the renewable sector.

"The systematic expansion of renewable energy is not only good from the environmental and climate policy point of view but also for innovation, growth and employment in Germany" said Sigmar Gabriel, the German Minister for Environment.

The US power provider, Southern California Edison, is waiting for approval from the California Public Utilities Commission to begin work on a 250 million-megawatt solar power plan that would install 6.5 million m^2 of solar panels on commercial facilities over the next five years. The power company hopes to negotiate partnerships to put the solar panels on commercial structures with the largest amounts of roof space, to keep costs of the panels for the $875 million project as low as possible.

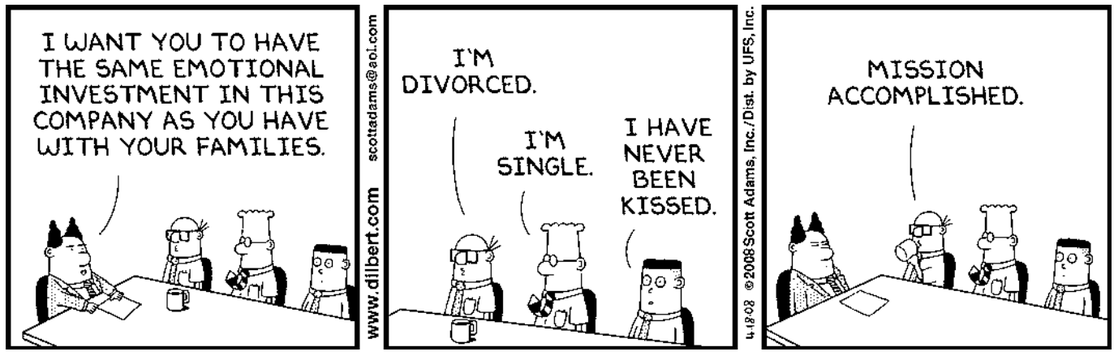
India's renewable energy ministry has announced a new program to expand solar power generating projects up to a maximum capacity of 50 megawatts.

Solar developers who build, own and operate projects will be supported with financial incentives of about 30 cents for each kilowatt of solar power generated per hour. Incentives for thermal power fed to power grids would be slightly less, according to a government statement.

Faced with inadequate power generation and large transmission and distribution losses, the Indian government wants to generate at least 10 percent of its electricity through solar power by 2012.

A total of 33 solar photovoltaic power plants connected to the Indian power grid have already been built with government support. The plants are expected to generate 2.55 million units of electricity annually. India now has 19 manufacturers of solar photovoltaic modules. Several more large investments are under consideration.

www.powersystemsdesign.com/greenpage.htm



1947: IR opens for business, launching selenium rectifiers

1954: Commercializes germanium rectifiers

1959: A pioneer in silicon controlled rectifier (SCR)

1962: Introduces new epitaxial process for producing industry's most stable high voltage SCRs

1979: Patents first commercially viable Power MOSFET (HEXFET®)

1980: Introduces high reliability power semiconductor devices for space programs

1983: Launches first commercially viable high voltage power ICs

1996: Introduces MOSFET and Schottky in a single package

1950 | 1960 | 1970 | 1980 | 1990

2000

Introduces wafer level package (FlipFET™)

2001: Invents integrated building blocks for DC-DC converters (iPOWIR™)

2002: Introduces integrated design platform for motion control (iMOTION™)

Invents first dual-sided surface mount package (DirectFET®)

Invents scalable multi-phase architecture for DC-DC buck conversion (xPHASE®)

2003: Introduces iMOTION™ Digital control ICs

2004: Sets new standard In lighting ICs

2005: Introduces µPFC™, One-cycle controller for PFC

2006: Introduces high reliability motor drive module; AC-DC Smart Rectifier IC

2007: Adds N+1 redundancy and HotSwap capability to xPHASE ICs

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