Power Systems Design EUROPE

Empowering Global Innovation

May 2007

PSDE PowerLine

PSDE PowerPlayer

MarketWatch

Design Tips

Lighting Systems

PSDE Green Power ENERGY EFFICIENCY

PCIM Europe 2007

ISSN: 1613-6365

Power Systems Design EUROPE

Power Systems Design EUROPE

AGS Media Group
146 Charles Street
Annapolis, Maryland 21401 USA
Tel: +410-295-0177
Fax: +510-217-3608
www.powersystemsdesign.com

Editor-in-Chief
Cliff Keys
cliff.keys@powersystemsdesign.com

Contributing Editors
Liu Hong
Editor-in-Chief, Power Systems Design China
powersdc@126.com

Marijana Vukicevic, isuppli Corporation
mvukicevic@isuppli.com

Dr. Ray Ridley, Ridley Engineering
RRidley@ridleyengineering.com

Publishing Director
Jim Graham
jim.graham@powersystemsdesign.com

Publisher
Julia Stocks
julia.stocks@powersystemsdesign.com

Business Manager
Cathy Schmidt
cathy.schmidt@powersystemsdesign.com

Circulation Management
Kathryn Ferris
kathryn.ferris@powersystemsdesign.com

Research Director
Meghan Corneal
meghan.corneal@powersystemsdesign.com

Magazine Design
Beata Rasmus, Eyemotive
beata@eyemotive.com

Production Manager
Abby Wang
abbyw@action-new.net

Registration of copyright: January 2004
ISSN number: 1613-6365

Send address changes to:
circulation@powersystemsdesign.com

Volume 4, Issue 4

Where Do We Go Now, After Analog?

So, we successfully exited the orbit of linear…or have we? Although there are a whole catalog of parts for the 'supposedly' analog power converters..there is now on the scene a whole raft of proposals for converting us again into the 'new' digital power technology. And really this is not without some good reasoning. When I designed power supplies, decades ago, so don't give me more of you're difficult questions, it was a simple rectification circuit followed by an equally simple linear regulator system…now it's a little different. No longer do we have the luxury of, almost infinite, heat-sinking… but we now do not have the luxury of a single heavy and hot, the way we would maybe sometimes like to think of ourselves, PSU, the space, time, flexibility to execute the design. There was in those days no worries about lead, its poor 'contribution' to the environment…and so on…the smarter of the politicians will tell us 'engineering types' all we already know, when they have figured it out..!

The fact is, that we all have to get so much smarter about energy. Have a look at the GreenPage at the back of the book. It's both simple and complex. Whizzing phased supplies around to save burning out your design, just because you're the last guy in the design line that's told.."ok you have two weeks to get these 10 voltage rails at these available currents, in this area, that must be efficient, Oh, and by the way, you are aware of the EMC regulations, aren't you?"

It is very unfortunate that the power guy is normally at the 'back-end' at the moment, but I can assure you that this will change very soon. Listen to where the the 'new' wisdom of guys like Al Gore and Richard Brandson is going..

This month we have the PCIM show. I last reported on the APEC, when I was out in California, and will do the same for those who cannot attend this great power design show in Nuernberg, Germany. For Europe, this is always the prime event to bring real power people together. Just FYI, get your boss to pay to send you. It's an investment for you both. It runs from 22-24th May, there are tutorials, exhibits as well as our team with tons of coffee.

I shall run a podium discussion with all the tip-top players..it will be fairly short, based on the latest technologies and hopefully sweet, it only lasts one hour, but should be an action packed and fun event. You can see the detail on our website at www.powersystemsdesign.com. Do come along and see us, get a very warm welcome, great presentations and maybe a gift-pack…

I just came back from a great conference from Texas Instruments. With even their DSP technology being designed into white goods and utility systems, they have, of course, thought very creatively and carefully about how they need to power all this stuff up (and down!) and to get the top efficiency ratings. On top of this, you will see a later report, next issue, on their comprehensive and practical solutions to digital power needs. I can promise a great read, it's really great stuff!

May should be a fun month, it normally is!

Cliff Keys.

PSDE Green Power ENERGY EFFICIENCY

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

Lighting Leads the Way

Tuesday, May 22 at 14:30 in the PCIM Europe Exhibit Hall

Moderator: Cliff Keys, Editor-in-Chief Power Systems Design Europe

Indium Corporation Promotes New Sales Manager in Europe

Indium Corporation announced that Guido Lanoye has been promoted to Sales Manager for Indium Corporation in Europe.

Guido is responsible for driving and managing Indium's sales activities for soldering products across the European, African, and the Middle Eastern markets. He previously served as Regional Sales Manger in Europe.

Guido is an Electronics Engineer with a degree in Digital Techniques. He has 20 years of experience in the Printed Circuit Board industry in both quality and production. In addition, he worked in sales for capital equipment for PCB manufacturing and assembly.

Indium Corporation is a four-time Frost & Sullivan Award-winning supplier of electronics assembly and semiconductor packaging materials, including solder pastes, solder preforms, fluxes, Pb-Free solder alloys, underfill materials, die-attach materials, and more. The company is also the world's premiere supplier of commercial grade and high-purity indium. Factories are located in the USA, the United Kingdom, Singapore, and China. Founded in 1934, the company is ISO 9001 registered.

www.indium.com

Maxwell Technologies Opens Up Asia for Ultracapacitors

Maxwell Technologies has announced that it has opened a sales office in Shanghai, China to market its BOOSTCAP® ultracapacitor products, service customers and support its distribution channel partners throughout Asia.

Maxwell senior vice president Alain Riedo said, "We see virtually unlimited opportunities for our BOOSTCAP products in the Asian transportation, industrial and consumer electronics markets, and Shanghai's central location makes it ideal for servicing the rapidly growing Chinese market and the entire South Eastern Asia region."

The office, which is located at the Swiss Center in Xinzhuang Industrial Park, is staffed by sales and application specialists as well as support personnel, all of whom are fluent in both Chinese and English.

BOOSTCAP ultracapacitors are based on an innovative energy storage technology ideally suited for applications needing repeated bursts of power for fractions of a second to several minutes. Ultracapacitors have muchhigher energy density than electrolytic capacitors and many times the power density of batteries. They require no maintenance, and operate reliably in extreme temperatures.

Ultracapacitors' burst power capabilities and life-of-the application longevity make them a preferred energy storage and power delivery solution for transportation, renewable energy, industrial and consumer electronic-sand other applications. BOOSTCAP ultracapacitor products are available in a range of form factors with capacitances of up to 3,000 farads as well as packs and modules that provide easy-to-integrate energy storage and power delivery solutions for a wide range of applications.

Maxwell also has established a contract manufacturing alliance in China for assembly of its BOOSTCAP products and is supplying its proprietary ultracapacitor electrode material to other manufacturers in Asia.

www.maxwell.com

OSRAM Halves Emissions from Glass Production for Energy-Saving Lamps

In normal everyday use, energy-saving lamps from OSRAM consume 80 percent less electricity than ordinary light bulbs. But OSRAM's contribution to environmental protection starts much earlier – with the processes for manufacturing energy-saving lamps. For the first time in the world, a flameless oxidation process is being used at the Augsburg plant for producing glass. This process reduces the emission of harmful substances by almost 50%.

The innovative glass FLOX furnaces have been developed as part of a project sponsored by the German Federal Ministry of Economics in cooperation with the Essen based Gaswärme-Institut (Gas and Heating Institute). The new furnaces have now been put into operation in Augsburg after extensive laboratory testing. OSRAM produces a wide range of energy-saving lamps for domestic and commercial customers at the plant. In future, emissions will be even lower thanks to flameless oxidation.

"The new technology is a major step forward in achieving lower emissions in the production of energy-saving lamps. As a company we are providing a clear signal. And by buying energy-saving lamps, consumers are making a double contribution to climate protection", said Dr. Ralf Criens, Sustainability Officer at OSRAM.

www.osram.com

TTI Announces the Closing of its Acquisition by Berkshire Hathaway

TTI, Inc., the world's leading passive and connector specialist, announced today the closing of its acquisition by Berkshire Hathaway Inc. making TTI and its affiliate Mouser Electronics part of the Berkshire Hathaway Group, whose Chairman and CEO is Warren Buffett.

Paul Andrews, TTI Chairman and CEO, commented, "The deal is complete and TTI and Mouser are honored to be part of the distinguished Berkshire Hathaway family. We anticipate a smooth and seamless transition internally as well as for our customers and suppliers." He emphasized that the acquisition positions TTI and Mouser for the long-term. "This is a perfect union of one great company becoming part of another. Berkshire's management style melds perfectly with the way TTI has conducted its business for the past 36 years. Berkshire has an entrance strategy, but no exit strategy and that suits my business philosophy for TTI," Andrews said.

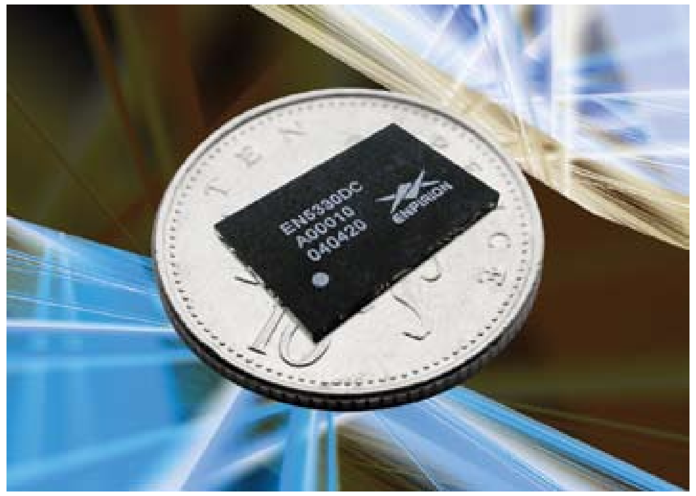
TTI's and Mouser's management will remain in place and will continue to run TTI's day-to-day activities. This ownership change should be invisible to customers and suppliers.

TTI finds itself among a distinguished list of some of the most solid businesses and recognizable brand names in North America including GEICO Insurance, See's Candies, Business Wire, Fruit of the Loom and NetJets, just to name a few. TTI becomes the third Fort Worth-based company to be purchased by Berkshire Hathaway. Acme Building Brands and Justin Brands also are owned by Berkshire Hathaway.

www.mouser.com

www.ttieurope.com

Enpirion Appoints UR as UK Sales Partner for World's Smallest Silicon-Based Power Systems



UR Group has been appointed by US-based Enpirion as its UK sales partner. Enpirion produces the world's smallest Power System on Silicon (PSoS) – the first and only all-silicon, switch-mode DC-DC converter with an integrated inductor. The company's patented technology provides a powerful Point of Load (PoL) solution that incorporates a Pulse-Width Modulation (PWM) controller, power FETs, compensation circuitry and magnetic components in a single, turnkey IC package.

The layout and placement of the inductor is one of the most common reasons for power IC-related failures. Enpirion products not only solve this problem but also reduce board footprint by up to 70% and component count by up to 60% as well as reducing noise and ripple associated with switch-mode power conversion. At the same time, they achieve up to 92% peak efficiency, deliver best-in-class transient response and enable a tenfold switching-frequency improvement over solutions that were until now considered state of the art – output supply voltage can be scaled in a blistering 10 microseconds. In terms of output current, the product line currently ranges from 500mA to 9A and is continuing to expand.

Enpirion's revolutionary technology provides the ideal solution when board space is at a premium and power consumption must be kept to a minimum. It is also ideal for applications where one or more PoL supplies are required to power key circuitry and there is a need to simplify design and manufacturing, reduce development costs and accelerate time-to-market.

Applications include a wide range of high-volume consumer products such as mobile phones, portable game players, set-top boxes, MP3 and personal media players, PDAs, notebooks and PCs. Business and industrial applications include servers, point-of-sale equipment, telecoms and data communications systems, medical equipment and military and aerospace systems.

Joe Matano, Managing Director of UR Group (UK), commented: "Enpirion technology represents the first major innovation in integrated power technology for over a decade. With the need to pack more and more functionality into ever shrinking space, chip-level integration frees up vast amounts of precious real estate. Enpirion solves a multitude of power design problems. The technology is stunning and the benefits are enormous."

www.ur-group.co.uk

www.enpirion.com

National Semiconductor to Showcase Power Management Innovations at PCIM 2007

National Semiconductor will showcase its latest power management technology at the Power Conversion and Intelligent Motion (PCIM) Conference in Nuremberg, Germany, from May 22-24. PCIM is one of the industry's leading forums for presenting and discussing power electronics and its applications in intelligent motion.

In Hall 12, Booth 329 of the Nuremberg Exhibition Center, National will demonstrate a new Power-over-Ethernet controller with an adjustable output power level that is compatible with any DC-DC converter topology. The company will also demonstrate the LM5116, the industry's first 100V current-mode buck controller. The LM5116 is ideally suited for step-down regulator applications from a high voltage or from a widely varying input supply. Designed with National's patented Emulated Current Mode (ECM) technology, this synchronous buck controller offers a unique combination of high performance, flexibility and ease-of-use for DC-DC power supply designs.

A third highlight at the show is National's latest generation of SIMPLE SWITCHER® regulators. The six new high-frequency buck regulators operate with an input voltage range up to 75V and deliver up to 3A of continuous output current. Their designed-in ECM technology provides superior load transient response in low duty cycle applications that are not addressable by traditional current mode control. Combined with the recent "dial-in" performance enhancements to National's WEBENCH online design environment, SIMPLE SWITCHER regulators offer design engineers high performance, ease-of-use and flexibility to provide faster time-to-market for their DC-DC power supply designs.

In addition to the product demos, National's technical experts will take a huge presence at the show's conference program.

www.national.com

Microsemi Appoints VP Sales for New Analog Mixed Signal Group

Microsemi

Microsemi Corporation has announced the appointment of Fabian Battaglia as Vice President of Sales for its recently formed Analog Mixed Signal Group.

Battaglia comes to Microsemi from Maxim Corporation where he most recently managed field applications engineering. At Microsemi he will be responsible for sales of all products of the new Analog Mixed Signal Group, including the Power over Ethernet products added with Microsemi's acquisition of PowerDsine Ltd.

"We are delighted to add Fabian's experience to our sales management team," said Jim Gentile, Microsemi's Senior Vice President of Worldwide Sales. "He will be able to focus on driving sales for the Analog Mixed Signal Group and allow me to resume full time sales management in my broader Corporate responsibilities," he said. Gentile had been fulfilling this position on an acting basis prior to the Battaglia appointment.

"Fabian's extensive expertise in mixed signal analog product sales and application engineering is a great addition for our new organization," said Steven G. Litchfield, Microsemi's Executive Vice President and President of the Analog Mixed Signal Group. "Our systems engineering vision fits perfectly with his experience."

www.microsemi.com

Power Events

- ***PCIM Europe,*** *May 22-24, Nuremberg, Germany, <www.mesago.de/de/PCIM/main.htm>*
- ***Sensor+Test 2007,*** *May 22-24, Nuremberg, Germany, www.sensor-test.de <http://www.sensor-test.de/>*
- ***euroLED 2007,*** *June 5-7, Birmingham, United Kingdom, <http://www.euroled.org/2007/index.php>*
- ***The China International Power Supply (CPS EXPO),*** *June 13-15, Shenzhen, China, <www.cpsexpo.cn/en/index.html>*
- ***The China International Power Supply (CPS EXPO),*** *November 6-8,Shanghai, China, <http://www.cpsexpo.cn/en/index.html>*
- ***APEC 2008,*** *February 28-28, Austin, Texas, USA, www.apec-conf.com <http://www.apec-conf.com/>*
- ***PCIM China 2008,*** *March 18 – 20, Shanghai, China, <www.mesago.de/en/PCChina/main.htm>*

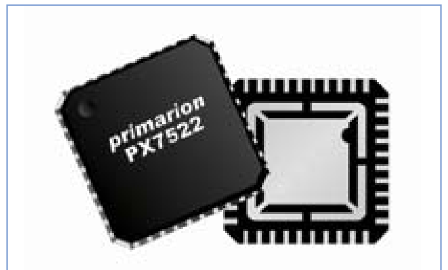
Primarion Gives the Industry's First Dual Output Digital Synchronous DC/DC Controller

Primarion, a mixed-signal semiconductor company that designs, manufactures and markets digital power ICs, has announced the addition of the dua-output, dual-phase PX7522 to the Primarion Di POL™ product family of fully programmable digital power conversion and power management ICs.

The PX7522 is a power conversion and power management IC for synchronous DC/DC converters in the telecom, datacom, computing and storage markets. The PX7522 is configured to regulate two independent outputs, or two phases in a single output mode. It supports both DCR and RDSon current sense topologies and a wide output range of 0.5V to 8V. This highly configurable control IC utilizes PMBus™ and onchip non volatile memory (NVM) for extensive userfriendly control and real-time system monitoring.

"With the introduction of PX7522, Primarion has taken another major step forward towards increasing system level integration," said Mohan Mankikar, president of MicroTech Consultants, a research and consulting firm specializing in the power electronics market. "The PX7522's higher level of flexibility, with its dual output feature and PMBus compatibility for system communication, will enable OEMs to use this IC in a very cost-effective manner. This is precisely the type of product progression that will accelerate market adoption of digital ICs."

Deepak Savadatti, Vice President Marketing.



The PX7522's control functions utilize digital technology, providing the ultimate in adaptable, stable and flexible solutions at an increased output load. By incorporating an industry standard I2C PMBus serial interface for control and monitoring, Primarion enables the power supply designer to quickly optimize designs and monitor real-time system performance.

"The PX7522 and the Di-POL product family address two aspects that are becoming increasingly important to OEMs; the first is time to market and the second is simple system level communications," said Deepak Savadatti, vice president of marketing for Primarion. "A complete system can quickly and easily be built around the PX7522 and other members of the Di-POL product family with a simple graphical user interface (GUI). The GUI enables designers to perform design, analysis and optimization without having to devote time to software programming. We are excited to be able to bring such a complete solution to the market."

Configurations for the PX7522 are easily loaded, edited and saved to NVM over the device's I2C serial interface using Primarion's GUI. With configurations stored on the IC, the controller can perform real-time adjustments to the designer's previously configured settings and thereby optimize performance accuracy, without the delay of accessing outside memory storage.

With other technologies, many of these configurable functions would typically require an external microcontroller. The extensive flexibility offered by the fully digital control, PMBus interface and user friendly GUI allows optimization of the PX7522's power management performance within an already existing system.

The PX7522 operates on a single +5V supply and has a switching frequency range of 150KHz to 1MHz. Accurate sharing between phases (in a single mode operation) enables the flexibility to support multiphase operation for increased power requirements. The PX7522 provides superior accuracy through internal calibration that measures and corrects system level current sense error sources upon startup. The programmable current sense temperature compensation allows the designer to tailor the response for the best accuracy over temperature.

www.primarion.com

PSDE Power Player

Flexibility Reduces Development Costs

By Davin Lee, VP/GM – Industrial & Communications Power, Intersil Corporation

Developing and qualifying a power solution can be an arduous and lengthy process. This is particularly true in the industrial and communications infrastructure markets where the product qualification cycles can take upwards of eighteen months due to the stringent set of requirements. These long qualification cycles can lead to extended development times.

However, the life cycles of these systems can last several years, allowing a supplier to build a revenue annuity stream over time. Suppliers are mitigating the “time to money” challenge posed by this lengthy qualification process while increasing the value to the end customer by developing products that possess high flexibility. The versatility of these products allows customers to qualify a smaller number of components that can be used across multiple platforms. These adaptable products span across several functions in the power management chain.

In the area of voltage monitors, the ISL88016 and ISL88017 offer pin-selectable voltage trip points along with popular functions such as power-on reset (POR) control, supply voltage supervision and manual reset assertion in a small 6-pin TSOT package. These supervisors have the unique feature of allowing users to program the voltage trip point from 1.60V to 2.85V in 50mV increments on the ISL88016 and from 2.15V to 4.65V in 100mV increments on the ISL88017. Trip point selection is made by connecting the three VSET pins to VDD, GND or floating. By allowing users to select from 26 different VTRIP voltages on each device, the same supervisor part can be used on different platforms and projects without the need to qualify a different part when

a custom voltage trip point is needed.

In the area of PWM controllers, the ISL8120 is a dual voltage-mode PWM controller with voltage feed forward compensation to maintain a constant loop gain for optimal transient response for wide Vin applications. It has an input range of 3V to 22V and has integrated 4A gate drivers. The ISL8120 offers unmatched flexibility that allows designers to configure it as a dual single-phase output or a single two-phase output. In addition, the ISL8120 can scale for 1, 2, 3, 4, 6, or up to 12-phase single output or up to 7 independent outputs. This flexibility allows designers to qualify one part and utilize the scaling feature according to the number of outputs and load requirements.

In the area of integrated FET regulators, the ISL65426 is a dual-channel synchronous buck regulator that is capable of providing up to 6A of total load current with up to 95% efficiency. The two output voltages are logic-programmable or resistor adjustable, with the load current for each output channel being user-configurable. So, if the power needs change during the course of the design, the new requirements can be met by simply reallocating the load current for each channel.

In the area of digital power, the ISL8601 is a PMBus compliant single-phase PWM controller with integrated MOSFET drivers utilizing analog voltage mode control that enables rapid and flexible power supply design and comprehensive product evaluation and testing. The extensive PMBus command set offers exceptional flexibility in the customization of the operating parameters and system monitoring functions. The ISL8601 supports both low-side MOSFET Rds(ON) and Inductor DCR sensing schemes. Programmable temperature compensation for sensed current values is provided to ensure maximum accuracy. In addition, the ISL8601 can utilize select PMBus commands without using the I2C interface, but rather through the use of external resistors, thereby bringing the power and flexibility of PMBus into low-cost power supply systems.

In certain markets, the qualification process can be extensive and onerous. As a result, many companies try to reduce the number of components that need to undergo this process. One method in achieving this is to utilize flexible products that can be used across multiple platforms by changing a few external components. The products mentioned above allow customers to save on qualification costs and to simplify the design effort, thereby reducing the overall development expenses.

www.intersil.com

Automotive Lighting Drives Toward LEDs

Endless opportunities for power-management firms

By Marijana Vukicevic, iSuppli Corporation

The automotive industry over the past 10 years has generated a number of new lighting applications for LEDs, according to iSuppli Corp.

Exterior rear lighting

One of the first uses for LEDs in the automotive industry was in the exterior rear lighting systems of cars. Since the 1990s, LEDs have gradually replaced incandescent bulbs in brake lights, tail stop lamps and Center High Mounted Stop Lamps (CHMSLs).

For external rear lighting, LEDs' high brightness, long life spans, low power consumption and good resistance to shock and vibration make them extremely attractive to automotive manufacturers. LED lights last nearly as long as the vehicles themselves. They also offer better visibility and illuminate 0.2 seconds faster than conventional incandescent lamps. This improves driver response and provides extra braking distance.

Furthermore, LED technology enables compact packing, styling benefits and flexible optical designs. Consequently, although LEDs cost more than comparable incandescent lamps, they increasingly are being used in rear-lighting applications in cars.

The European market adopted LED rear-lighting systems before the United States mainly because of the stringent safety standards in force in the region—combined with the fact that consumers there were more interested in this technology and thus were willing to pay extra to get it. However, LEDs increasingly are being deployed in the rear-lighting systems of U.S. and Japanese cars.

Despite the high cost, LED lighting systems gradually will permeate through various car segments, just as anti-lock-brake systems did in the past. LEDs in the future will be offered in increasingly diverse models of cars, minivans, SUVs, trucks and buses. Approximately 30 percent of the cars manufactured in 2005 used LEDs in the external rear-lighting systems, according to iSuppli Corp.

Dashboard and rear lighting

The availability of High-Brightness (HB) and high-power LEDs in a rich palette of colors—i.e. red, blue, amber and green—is allowing the technology to expand from rear-lighting applications to the illumination of interior features in cars. As the efficiency and brightness of LEDs have improved, the lumens-per-dollar ratio has dropped, making it affordable for LEDs now to be used to provide rich, monochromatic lighting in cars for dashboards, switches, radios and for general aesthetic appeal. HB white LEDs also are being used for dome lights in cars and for the illumination of door and window controls in high-end autos.

As with the rear lighting, European cars were the first to use blue, green, white and amber HB LEDs for instrument panel illumination. Many Japanese and American luxury car manufacturers now are beginning to follow suit.

Automotive headlamps

The increasing brightness delivered by new Ultra-High Brightness (UHB) LEDs also has made them an attractive solution for headlamps in cars, which is one of the most high-value lighting systems in automobiles. Although still in the early stages, almost all of the major automotive companies are investigating the use of UHB LEDs in headlamps of various luxury vehicles and new concept cars.

UHB LED headlamps now meet all Society of Automobile Engineers (SAE) specifications. Furthermore, the capability to dynamically and independently control the intensity and the directional output of multiple discrete UHB LEDs allows car manufacturers and OEMs to design headlamps with output intensities that can be adjusted based on the ambient lighting conditions.

With discrete light sources, the headlamp beams also can be focused into tight spots, or defocused for broader illumination. The beams can even be bent around corners. These features will help to enhance the safety of automobiles and their occupants.

However, LED headlamps face a significant hurdle that must be overcome: the development of new drive circuitry. Powering several high-flux LEDs with conventional LED drive circuitry can result in large amounts of Electromagnetic Interference (EMI) with other vehicular systems.

www.isuppli.com

Capacitors for Switching Power Supplies

By Dr. Ray Ridley, Ridley Engineering

In several past articles, we have examined some of the complex characteristics of the power magnetics of a switching power supply. In this article, we examine another major passive component of the power supply—the capacitor. This is often a component that is viewed as a simple part that doesn't require too much attention.

Power Supply Capacitors

Figure 1 shows the simple buck converter. Given modern integrated controllers, the design task of the engineer is apparently very simple—all we have to do is select an inductor and two capacitors, and the job is done. Choosing inductors can become very complex, and now we'll see how capacitors can become troublesome, too.

I'm often asked to perform worst-case analysis of switching power supply designs for companies. Step one of this process usually consists of the company sending me schematics, parts lists, and component data sheets. Before proceeding further, I always ask for working physical samples of the power supplies to test on the bench. To the alarm of people not familiar with power supplies, much of the worst-case analysis depends on measurements of existing designs, combined with documented datasheet variations.

Component data sheets are rarely adequate for properly characterizing parts, and a comprehensive analysis requires information not readily available from manufacturers. Additional measurements are needed for magnetics, and additional measurements are needed for capacitors, too.

Low-Impedance Capacitor Measurement

A simple fixed RLC tester with a single measurement frequency is not adequate for characterizing capacitors for use in a modern switching power supply. The capacitors must be measured over a wide range of frequency to fully characterize their behavior.

Figure 2 shows how to make measurements of low-impedance capacitors with a frequency response analyzer [1]. Proper choice of the sensing resistor, and proper RF layout of the test circuits will allow you to measure impedances as low as 1 mOhm. Many component testers will only look at a single frequency, or a narrow range of frequencies. It is recommended that you sweep the frequency to see the impedance of the component under test from 10 Hz to at least 10 MHz.

Electrolytic Capacitor Measurement

Electrolytic capacitors are still the component of choice for most commercial, low-cost power supplies. They are also used extensively in automotive applications, where temperatures can be extreme.

Electrolytics are easy to measure since they have relatively high equivalent series resistances. But it is important to vary the temperature of the capacitor to see its effect on the characteristics.

Figure 3 shows the variation in capacitor impedance for a 10µF electrolytic. Two curves are shown—the red plot is for the capacitor at 25 degrees, and the blue curve for -55 degrees Celcius. Notice the large separation in the curves.

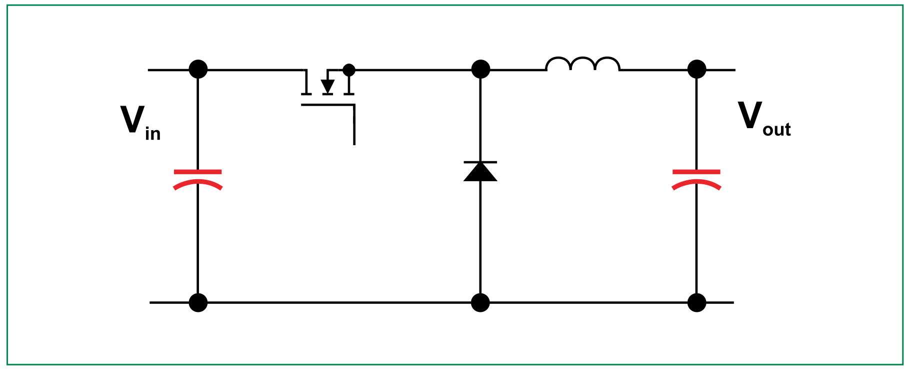


Figure 1: Buck converter with critical capacitor components. The output capacitor impedance determines the mid- and high-frequency response of the converter using either voltage-mode, current-mode, or any other form of control, including digital.

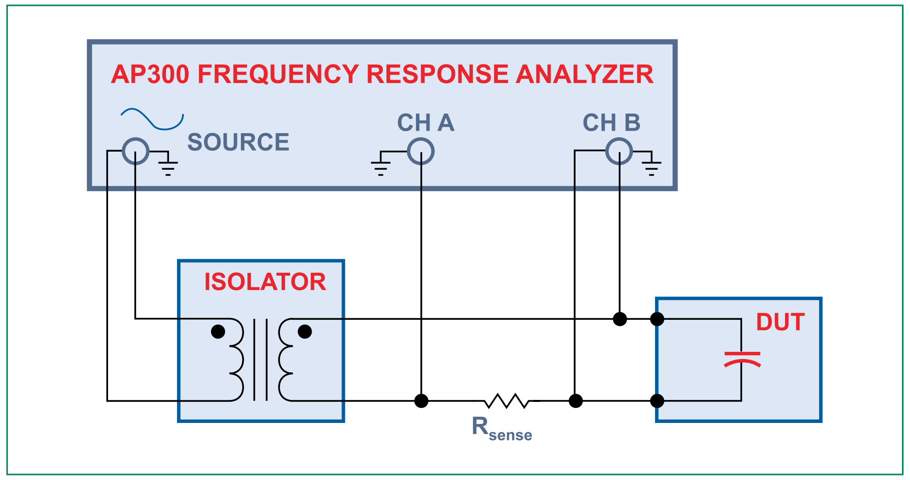


Figure 2: Measurement setup for low-impedance capacitors.

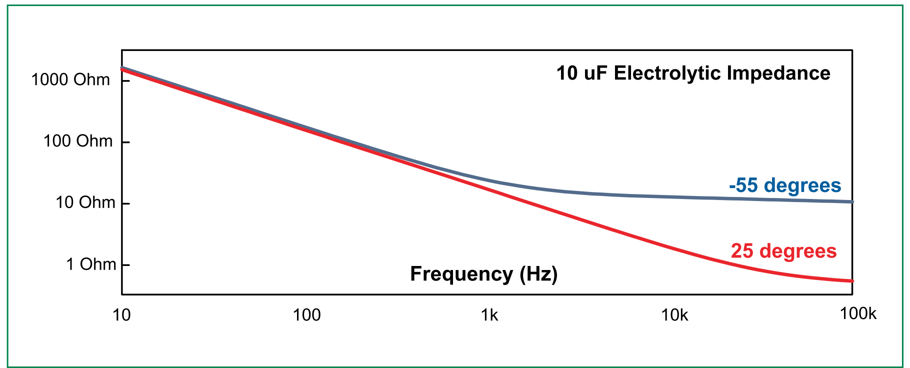


Figure 3: Impedance measurement of a 10 μF electrolytic capacitor at two different temperatures.

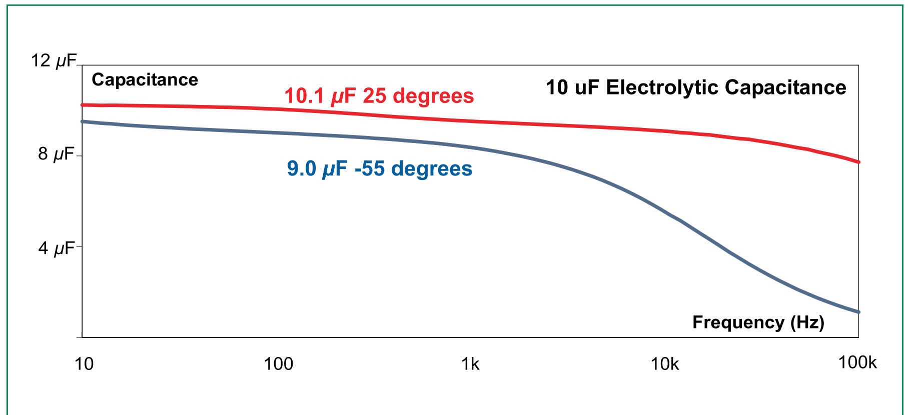


Figure 4: Capacitance of a 10 μF electrolytic capacitor at two different temperatures.

This is due to the well-known effect of electrolyte freezing in the capacitor. You will find in doing this measurement yourself that the ESR continues to rise as the temperature drops further and further below zero degrees. It is unlikely you will find the full set of data that you need for your particular part in the data books.

Figure 4 shows the imaginary component of the impedance extracted to show the equivalent capacitor value. Two variations in capacitance are apparent—one is a weak dependence on frequency, and secondly, a dependence on temperature. For the cold capacitor of the blue curve, the apparent substantial drop in capacitance beyond a few kHz is not really significant since the impedance of the device is dominated by the equivalent series resistance (ESR) at those frequencies.

The ESR is found by taking the real part of the impedance measurement of Figure 3, and this is plotted in Figure 5. At low frequencies, both resistances measure high, but this is always a questionable measurement—we are trying to extract a very small real component from an impedance vector which is mostly reactive.

Beyond a few kHz, the ESR that we are concerned with is both frequency and temperature dependent. Notice that the cold capacitor has an ESR of about 12 ohms, while the warm capacitor is about 0.5 ohms. This is more than a 20:1 difference!

Many designers who operate over wide temperature ranges will stay away from electrolytics for this, and other reasons. However, in some cases, they are economically necessary, and the control loop must accommodate the variations that will occur with temperature. This can present a significant challenge when designing the control loop. It can certainly be done, especially when using current-mode control, but the loop bandwidth is often severely compromised.

Electrolytics will also vary substantially with aging, especially at elevated temperature. This is another involved topic which is beyond the scope of this article, but you must check the lifetime and temperature of operation in your power supply to ensure that the electrolytics are not going to fail.

Multilayer Ceramic Capacitor Measurement

Point-of-load power supplies, and motherboard supplies, have widely adopted multilayer ceramic capacitors as an alternate to electrolytics. Advances in construction techniques have made available very large value capacitors with extremely low ESRs, in very small packages. This is essential for point-of-load converters where board space is at a premium.

Rarely do I see due diligence done in

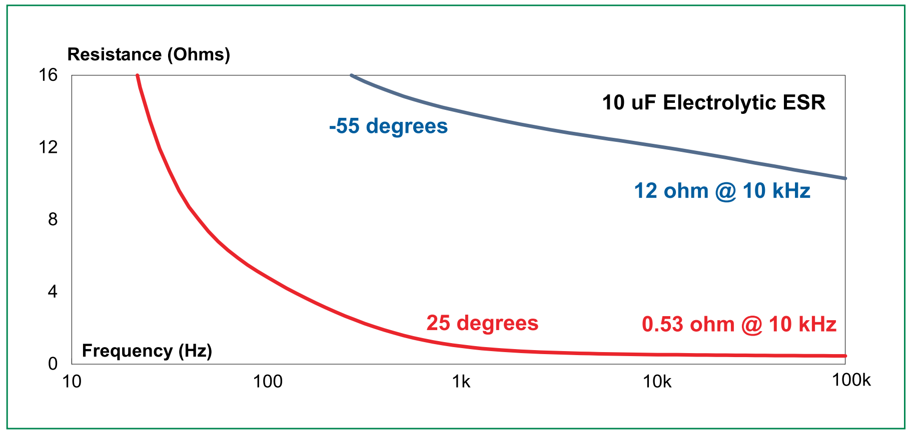


Figure 5: Equivalent series resistance of a 10 μF electrolytic capacitor at two different temperatures.

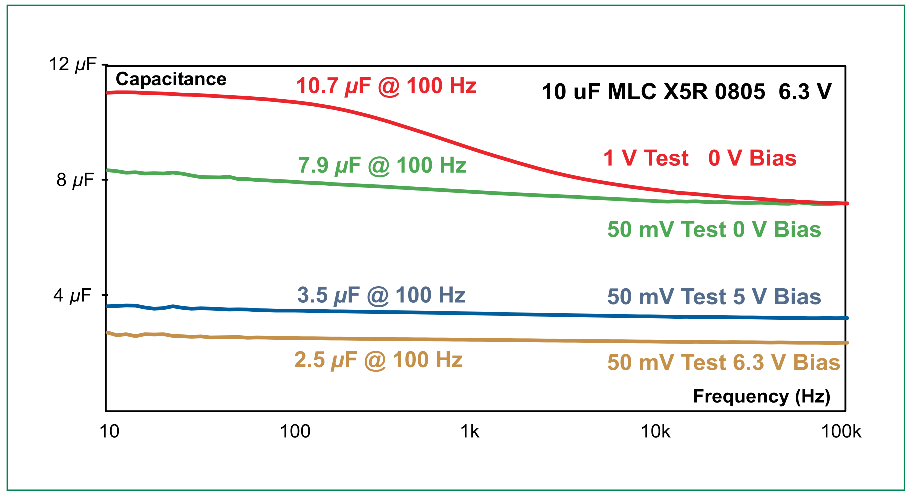


Figure 6: Measurement of a 10 μF multilayer ceramic capacitor at different test signal levels, and with varying DC bias.

considering the characteristics of MLC output capacitors. Even though they don't suffer from the drastic temperature shifts of the ESR of electrolytics, MLCs are equally complex in their characteristics.

Figure 6 shows the capacitance value of a small 0805 MLC with a voltage rating of 6.3 V, and a nominal value of 10 μF. The red curve shows that the capacitor has a value of 10.7 μF at 100 Hz. Notice the significant frequency dependence from 10 Hz to 10 kHz.

This change with frequency is due to the fact that the capacitance of an MLC is a function of the applied AC voltage [2]. In the test setup of Figure 2, a constant 1 V source is applied from the frequency response analyzer. At low frequencies, the voltage all appears across the capacitor, but as the frequency increases, the drive to the capacitor is reduced. MLCs show an increase in capacitance with drive level.

The green curve shows how this frequency dependence is eliminated with a small drive signal of just 50 mV. Notice that the value of the nominal 10 μF capacitor is reduced to 7.9 μF.

MLCs are also strongly dependent on the DC voltage which is applied. The blue curve of Figure 6 shows how the value of the capacitance drops to 3.5 μF with a 5 V DC bias, and to 2.5 μF with a 6.3 V DC bias. If you push the capacitor close to its voltage rating, you don't have much capacitance left in this particular example. My experience with MLCs is that it's not good to push them close to their rating anyway, for reliability reasons.

All of the different dielectrics used for MLCs will exhibit different characteristics. There is a lot of useful information on the AVX website, and you are encouraged to read as much as possible to understand this topic in depth. MLCs have additional dependence on temperature and lifetime which we won't cover here.

If data is either hard to find or inaccurate, it is always a good idea to make your own measurements on the bench. Also, most curves presented are typical characteristics. Many worst-case characteristics are so extreme that you cannot possibly accommodate all of them in a practical design.

Summary

Capacitors are often overlooked as a source of variation in power supplies. All types of power supply capacitors have their own special sets of issues that you must thoroughly understand if you are going to build rugged converters.

Always make measurements of your power capacitors during the development phase. And, like inductors and cores for the magnetics, do not blindly make substitutions from one vendor or dielectric to another without proper characterization of the new part. Not all vendors present full data—be prepared to do this yourself.

Additional Reading

[1] "Frequency Response Measurements", http://www.ridleyengineering.com/downloads/Spring 2002 feature.pdf

[2] "High Voltage MLC Chips", http://www.avx.com/docs/techinfo

[3] "Comparison of Multilayer Ceramic and Tantalum Capacitors", http://www.avx.com/docs/techinfo

www.ridleyengineering.com

How Do You Design a 100W + 100W Class-D Amplifier

High quality Class-D comes of age

The traditional Class-AB has been the stalwart for many years now. With power efficiency becoming also of age, there is now the technology to deliver great quality with power efficiency.

By Jun Honda, International Rectifier

The efficiency advantage Class-D amplifiers hold over Class-AB designs is irrefutable and, through this trait, switching-amplifier topologies have earned much of their market share. Less intuitive is that a reasonably well crafted switching amplifier can outperform a Class-AB audio power amplifier by providing both better linearity and lower output impedance.

As with any high high-fidelity amplifier topology, competitive linearity figures result from careful attention to details of the circuit's behavior: A PWM-drive and a couple of MOSFET switches banging between the rails doesn't quite get you there. However, with today's class-D IC controllers, the topology has come of age, and excellent results are attainable without heroic efforts during the design cycle.

Better linearity is, of course, only a part of the class-D amplifier's story. In many applications, such as flat-screen television, the topology's efficiency advantages drive the growing adoption rate: A 100W class-D power amplifier at full power delivers about 95% of its input energy to its load, as compared to 65 to 75% for class AB. At 1/8 output power—an operating point more typical of average use—the efficiency of class-D falls to about 85%. Under the same output conditions, however, class AB delivers load energy with only 25 to 30% efficiency. Flat-screen monitors suffer temperature-induced color shifts and poorly tolerate class-AB-amplifier dissipation.

Class-D's efficiency gains come at the cost of greater signal processing bandwidth: Class AB amplifiers for many applications need only provide a signal bandwidth of 10 to 20 kHz. High-end linear amplifiers may extend their signal-processing spectrum to 100 kHz or so. Class-D stages, on the other hand,

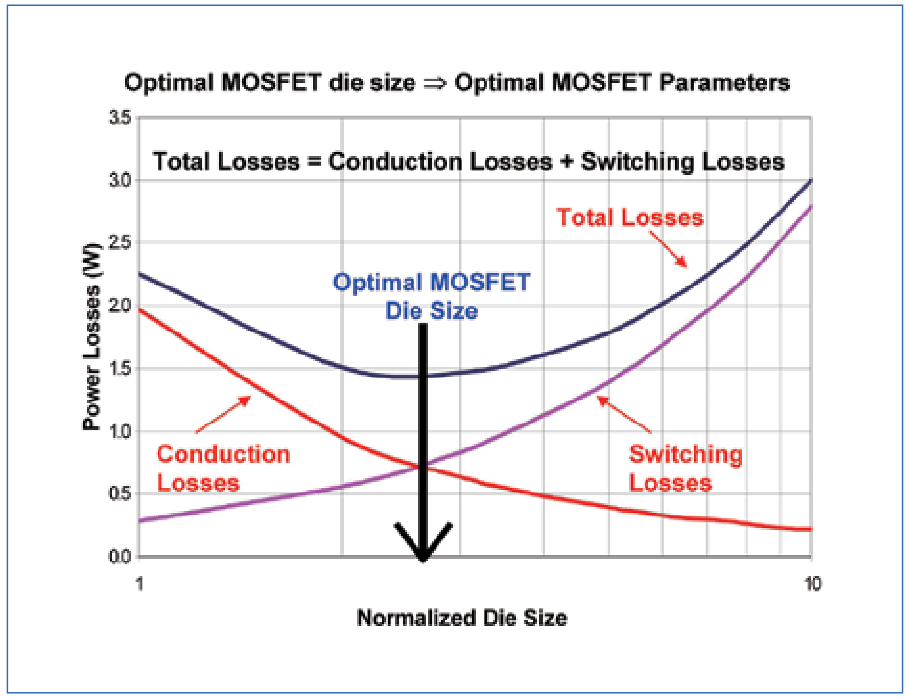


Figure 1: Select the MOSFET die size for equal conduction and switching losses.

must provide accurate signal processing into the MHz, which makes component selection and layout a more critical part of the design.

The successful completion of three tasks helps assure a successful class-D amplifier design:

- Optimizing the power-device choice
- Managing spikes from hard switching to ensure low THD and EMI
- Adhering to good high-frequency PCB-design rules
- A 100 W/ch design illustrates these three design challenges

The Bigger the Better?

Choosing the right MOSFET is essential to class-D amplifier design. A large MOSFET die does not always deliver the best efficiency. There is an optimum die size for a given design and choosing a device that is as close as possible to the optimal size is crucial to high efficiency.

A class-D amplifier's dissipation consists of switching- and conduction-loss terms:

$$P_{CONDUCTION} = \left(I_{D(RMS)}\right)^2 R_{DS(on)}$$

$$P_{SWITCHING} = I_D V_{BUS}\left(t_r + t_f\right) f_{SW} + C_{OSS} V_{BUS}^2 f_{SW} + 0.5 K Q_{RR} V_{BUS} f_{SW}$$

The tradeoff between switching and conduction losses is a function of the silicon process. However the terms follow characteristic curves independent of process node (Figure 1): Increasing the die size to minimize $R_{DS(on)}$ slows the switching speed due to the increased gate charge, which leads to longer switching transition times and greater switching losses.

Though the characteristic shape of the loss curves are independent of process technology, the absolute loss magnitudes do scale. Advanced silicon technologies provide better optimization points, which is important to class-D. This indicates that efficiency is still subject to improvement, unlike topologies that operate the output devices in linear mode. One way to assess the relative merits of competing MOSFET technologies is to compare products of $R_{DS(on)}$ and gate charge, Qg.

For a given rated power, the conduction loss is inversely proportional to the load impedance. The switching-loss components increase with PWM frequency. Therefore, the optimal die size is a function of rated power, load impedance, and PWM frequency.

For example, International Rectifier's IRF6645 trench MOSFET has a 14-nC gate charge and 28 milliohm $R_{DS(on)}$. At a 400-kHz PWM frequency, the loss distribution is 60% and 40% to switching and conduction, respectively.

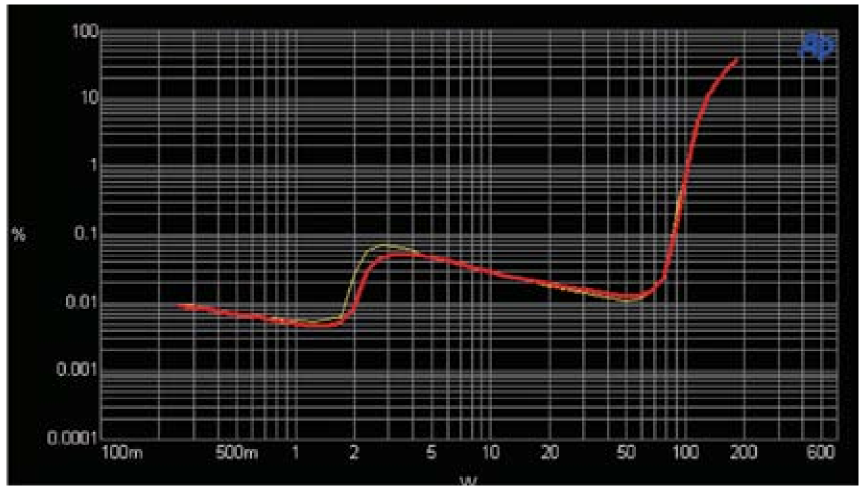


Figure 2: Use THD+N plots to diagnose performance anomalies such as noise from hard switching coupling into sensitive nodes.

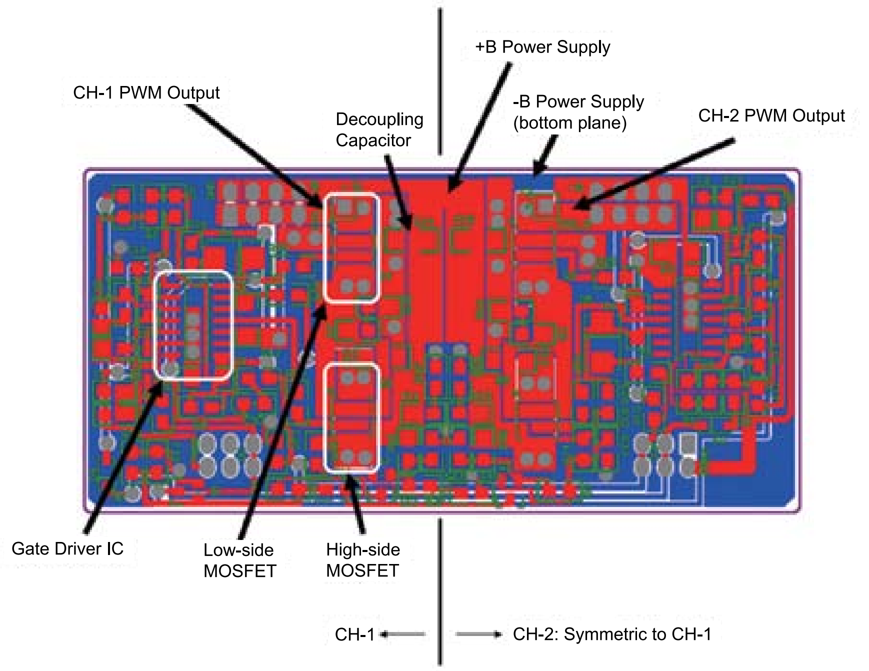


Figure 3: Route the two channels of a stereo amplifier separately to minimize common impedances but provide high-frequency coupling between the ground systems to reduce EMI.

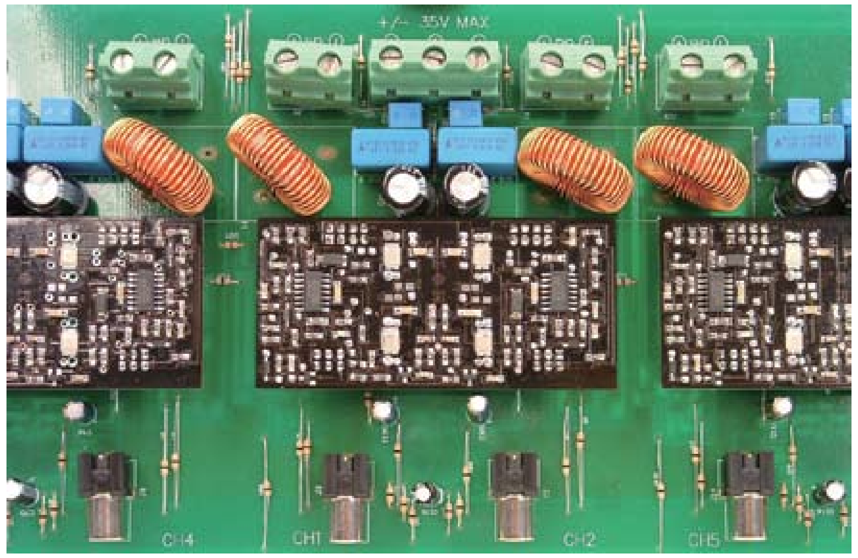


Figure 4: The resulting compact and lightweight 100W+100W amplifier demonstrates the advantages of class-D amplifiers over class-AB.

Eliminating Unwanted Spikes

The amplifier's output current determines its switching mode. In ZVS (zero-voltage switching), the output current is always smaller than the inductor ripple current. In hard switching, the output current is greater than the inductor ripple current.

In ZVS, inductive kick back—not the opposite-side MOSFET—drives commutation. The switching-current waveform looks much cleaner and does not contain shoot-through current during the body diode's reverse-recovery interval.

In hard switching, turning on the MOSFET starts with the reverse recovery interval during which the circuit removes minority carriers that accumulated in the body diode during dead time. There is no large inductance in the reverse-recovery current path to reduce the peak current, resulting in large spikes in the current waveform.

THD+N as diagnostic

The amplifier's THD+N curves are good indicators of circuit performance anomalies. For example, the circuit that Figure 2 characterizes operates with ZVS with outputs to 2 watts. THD degradation evident beyond the 2-watt level indicates a performance anomaly due to hard switching.

Poor THD+N performance at low power suggests a fundamental problem, such as bad grounding or PWM jitter. High THD+N at very low power indicates a high audible noise floor. In this region, operating with ZVS, the problem is likely in the PWM modulator or an earlier stage.

The THD+N bump at the transition between ZVS and hard switching suggests that noise from hard switching is disturbing the PWM signal. In this case, check the power stage's current path, particularly a current loop between the positive and negative busses through the two MOSFETs. Make sure that the current loop is as tight and narrow as possible. Then check if any sensitive blocks share a common impedance with switching elements particularly in the power stage. This type of noise-coupling mechanism is a particular concern in the source path of the low-side MOSFET and in the ground of the high-side gate driver's floating supply.

Clean Gate Drive

A clean switching waveform requires a clean gate drive. Remember that a MOSFET operates in its linear region during switching transitions. Remember also that the MOSFET—a gain element—shares a common impedance with the gate-drive loop and the output-current loop.

The common impedance in the MOSFET's source connection is inductive and provides negative feedback that decreases the switching speed by subtracting from the gate-drive voltage during the drain-source voltage transition. This can induce ringing with capacitive terms such as the MOSFET's gate and output capacitances. Minimize the common impedance in the MOSFET's source path by applying good high-frequency PCB design techniques. In this environment, small surface-mount FET packages are advantageous.

What to Share, What Not to Share

In a stereo amplifier design, common impedances among the audio channels are also problematic. Route the two channels separately to attain good audio performance (Figure 3). In a switching topology, it is always good practice to use separate closed-current paths for each switching leg in order to avoid coupling noise into an adjacent channel.

Unfortunately, simply separating the routings for each channel can weaken the design with respect to EMC due to switching-current waveforms' broad spectral components. This particularly applies to ground design. Those separated ground routes need high-frequency couplings to each other. A 1nF to 10nF ceramic surface-mount capacitor is a good choice for the switching artifacts, but does not couple audio-frequency signals, which would diminish the primary purpose of the separate grounds.

Combining these three fundamental facets of class-D design—device selection, noise reduction, and PCB design—a 100W+100W amplifier can fit in a sleek daughter-board module (Figure 4).

www.irf.com

High Power IGBT Modules with Improved Mechanical Performance

Higher reliability at lower cost

New power electronic designs commonly demand for increased power density, improved reliability and simple assembly. Enabling higher thermal and electrical chip utilization combined with higher robustness and reliability paired with compatibility to existing designs were the targets of the latest high power module development.

By Thomas Schütze, Jürgen Biermann, Reinhold Spanke, Manfred Pfaffenlehner; Infineon Technologies AG, Germany

Beginning in 1990 the IGBT high power module IHM with its base plate sizes of 130x140mm or 190x140mm has set a mechanical standard for its product class. Since that time, all major suppliers have developed blueprints based on its mechanical dimensions such as base plate sizes and attachment points. Present-day high power inverter design could not be imagined without these standardized components.

Housing technology

The basic prerequisite for the new design was complete compatibility of the electrical and mechanical access points with the existing IGBT High Power Module (IHM) such as screw and terminal positions. A simplification of the internal module design was reached by a re-arranged substrate layout and the omission of an internal PCB. Substrate interconnections are now solely realized by a bonding process.

Quality improvement and long term cost ratio are achieved by an increased automation level, reduction of components and manual handling steps. A one piece housing with slide-in lids simplifies mounting and allows for a new terminal design.

The materials used for the new IHM B housing are in compliance to the RoHS criteria (Restriction of the use of certain Hazardous Substances). Although high power products do not apply to the scope specified by the directive, Infineon has set up a green product standard which goes beyond the requirements of the RoHS guidelines by only allowing mercury-, cadmium- and hexavalent chromium-free materials without brominated flame retardants and lead free external soldering pins for new designs.

Terminal design

Due to the continuously increasing current density accomplished by new chip technologies, nominal currents of up to 3600A with 1200V and 1700V chips already need to be handled by present-day modules. A simple calculation delivers an astonishing number: The lead resistance of a 140x190mm IHM A is 0.12mW. Considering a rms phase current in the range of the nominal module current rating, the dissipated power in the leads add up to 770W!

The IHM A uses identical collector and emitter terminals which are rotated 180°. This enforces the need for elongated holes. The new terminals are already bent when mounted. Circular holes increase the contact surface to the busbar and assure proper terminal alignment. A larger soldering surface im-

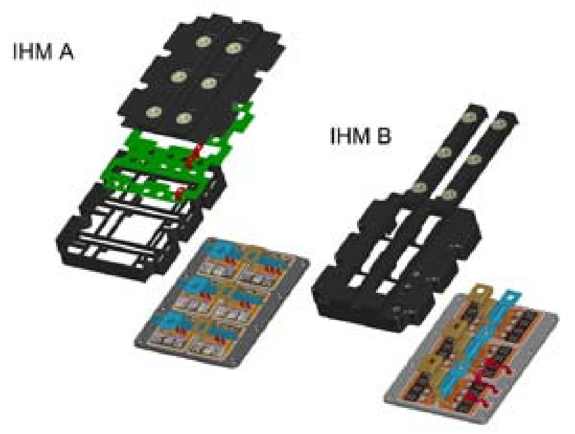


Figure1: comparison of IHM A and IHM B housing.

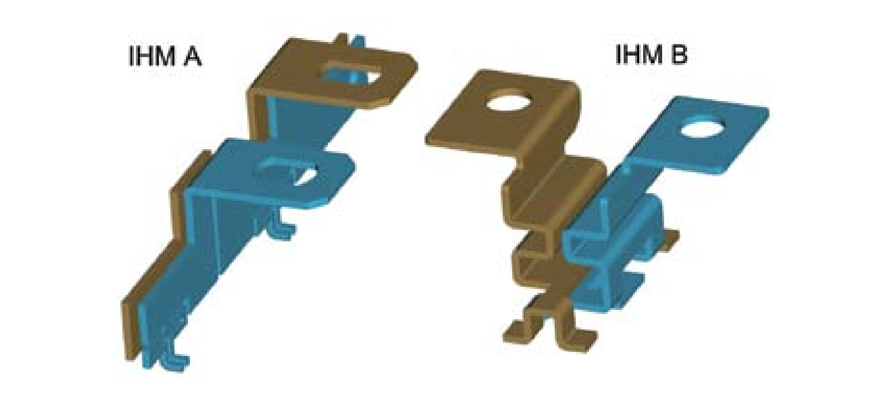


Figure 2: comparison of IHM A and IHM B terminal design.

proves the heat flow to the base plate. The required flexibility of the terminals for sufficient stress relief is obtained by the use of meanders, which do not limit the heat flow. To support a targeted low inductive inverter design, the current loop within the IHM B module was optimized. The internal module stray inductance is reduced by more than 40%.

Boosting the temperature limits

Lowering the admissible storage temperature of -40°C for state-of-the-art modules is a specific request for applications running in Russia, an emerging market for traction applications in the near future. A specifically ductile silicon gel will hoist the accessible temperature range for the IHM B down to -55°C. On the other side of the temperature scale, extending the maximum switching operation temperature from 125°C to higher values would lead to an enormous win of current carrying capability. New techniques for joining parts as well as soldering technologies in the IHM B allows to raise the maximum junction temperature to 150°C. Besides qualifying the silicon chips for continuous operation at this temperature level, power cycling tests have been performed, where cycles repetitively reach T_{jmax} in a time frame of a few seconds. The IHM B discloses the same power cycling capability at 150°C as already achieved with the IHM A modules at 125°C. Alternatively the reachable cycles for the IHM B double for a peak temperature of just 125°C.

Chip arrangement

As a consequence of the new terminal arrangement along the center of the module, the chips are rearranged as well.

Most obvious is the increase of diodes from two to four chips. While the electrically active area remains already the same as before, the thermally active area is enlarged by this. The number of IGBT chips remains the same but the chips are now placed closer together. The proximity and equity to the base plate screws provides a better thermal contact to the heat sink which compensates the reduced thermal spread by a more homogeneous temperature distribution among the single chips.

Since traction applications require a sufficiently dimensioned diode for regenerative operation, particular care was take to achieve a well-balanced utilization of IGBT and diode part. A close adjustment between switching and conduction losses and thermal resistances Rth_{jc} and Rth_{chs} lead to widely identical current utilization either at power factor 1 or -1.

Proper heat dissipation requires an effective heat flow from the base plate into the heat sink. A pressure contact is achieved by bending the base plate. During the mounting process this bow applies mechanical stress onto the module with the risk of breaking the ceramic substrates. With chips placed along the long edge of the IHM B module and closer to the screw holes, forces generated by the bow become of minor importance.

3.3kV IGBT3 chip technology

The new housing is launched with IGBT3 chips; a technology, which is already in production in the 600V, 1200V and 1700V voltage classes.

This technology uses a trench cell, which has been carefully optimized to meet the requirements of the 3300V rating concerning overcurrent turn off and short circuit ruggedness even at the raised operation junction temperature of 150°C. The trench cell design leads to an increase of the stored charge carriers at the front side of the device compared to a planar cell. This results in very low on state losses. The cell size and pitch were designed to get a well-tempered trade off between switching and conduction losses appropriate for the applications in focus. A too high carrier

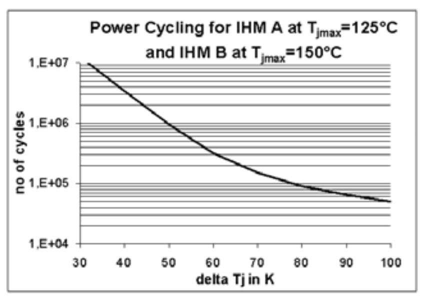


Figure 3: Power cycling capability for IHM A at T_{jmax}=125°C and IHM B at T_{jmax}=150°C.

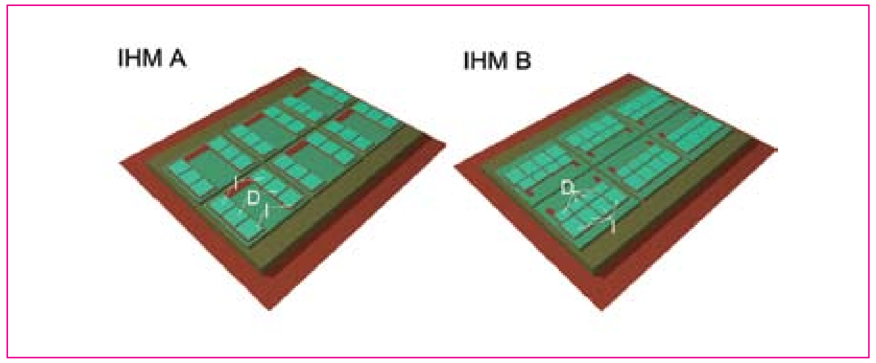


Figure 4: Comparison of IHM A with 2nd generation 3.3kV chips and the arrangement of 3.3kV IGBT3 chips in an IHM B.

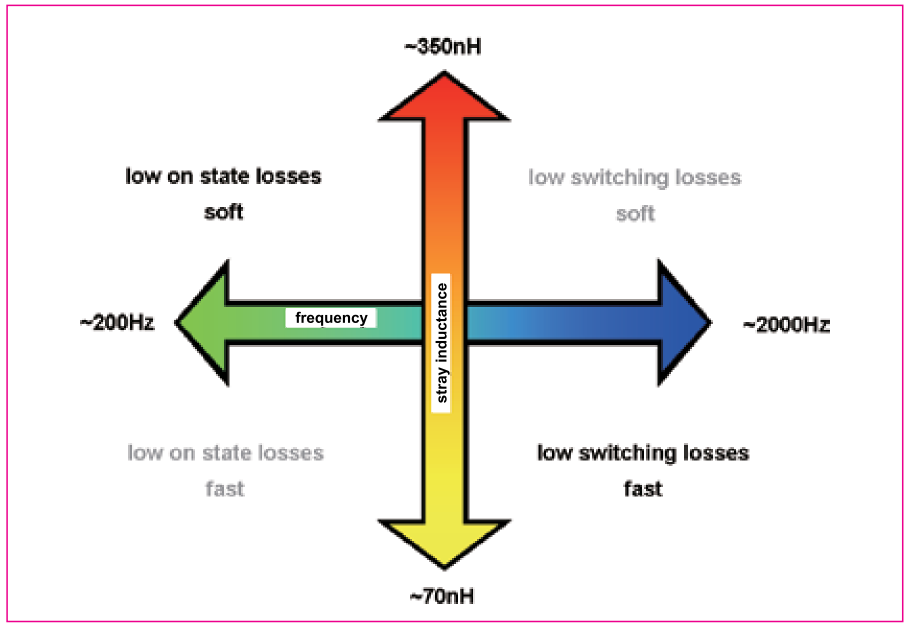


Figure 5: The diversity of requirements is reflected by two optimized versions of 3.3kV chips.

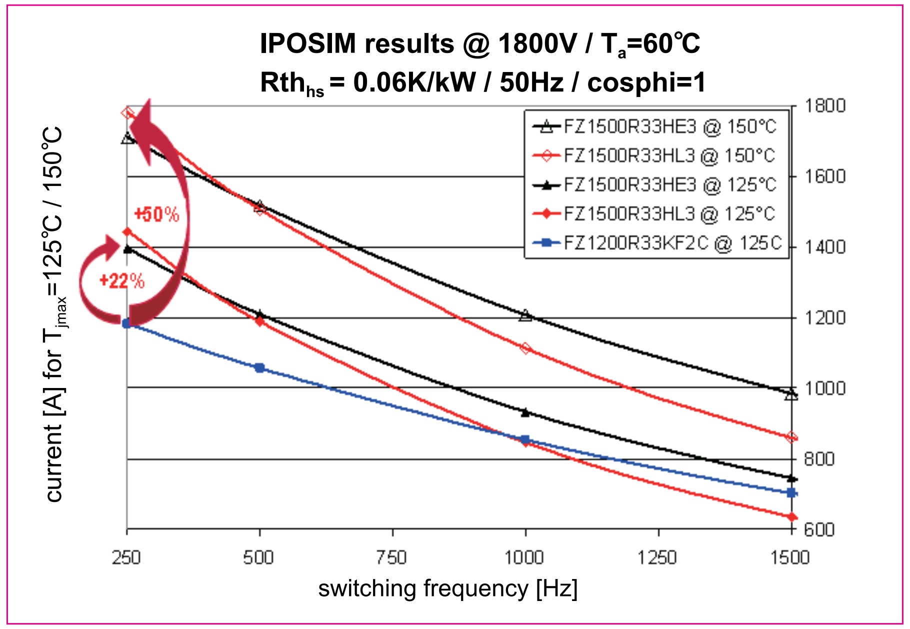


Figure 6: Comparison of both IGBT3 in IHM B housing; soft FZ1500R33HL3 and fast FZ1500R33HE3 version as well as the standard NPT device FZ-1200R33KF2C in IHM A housing.

concentration would prolong the turn off delay and lower the voltage slope during turn off resulting in high turn off losses and poor controllability of the voltage overshoot.

A key technology for the increase of the operation temperature is the field stop structure. Compared with a conventional NPT structure, the field stop leads to a drastically reduced reverse current especially at high temperature. This prevents thermal runaway not only in blocking operation, but also after short circuits and overcurrent turn offs.

The diode, which goes with the IGBT, is based on the Emcon concept. To get a good matching with the IGBT concerning losses, the vertical structure was also adapted. The Emcon concept has also positive effects on the reverse current, since there is no need for a local reduction of the carrier lifetime by irradiation, which tends to increase the reverse current.

Two versions of the chipset will be realized: A fast version is reaching for higher switching frequencies e.g. for permanent magnet motors while a soft version is optimized for high currents even at very high stray inductances.

Utilization of new chip plus new housing

Performing a comparative thermal calculation under the conditions of T_{jmax}=125°C and a water cooled heatsink with Rth_{hs}=6K/kW and T_a=60°C, one achieves a highly improved performance of the fast version across the whole frequency range if compared with today's standard device. The soft version shows its superiority in the targeted range of around 500Hz switching frequency. Its soft switching behavior even at high stray inductances makes it the device of choice for most inverters in the upper power range. A substantial enhancement of up to 22% of the output current capability for inverters built with the new IGBT3 technology against standard NPT devices can be deduced.

The full potential of the new development becomes obvious, when making use of the elevated operating temperature of 150°C for the IHM B. The output current can be raised up to 50% compared to present-day standard devices!

Summary

Drastic electrical and mechanical improvements can be reached by incorporating latest material, soldering and mounting technology into the IHM state-of-the-art high power module. While staying mechanically compatible, the combination of new IHM B housing and latest IGBT3 chip technology with an extended storage temperature down to -55°C and a maximum allowed junction temperature of up to 150°C will allow a far reaching increase in the thermal and electrical utilization of new devices.

www.infineon.com

High Current, Integrated DDR Memory Control in Portable Applications

Managing the power to devices with many varying power rails in a cost effective, efficient, and compact manner

Increasing features, while at the same time reducing form factor size and cost, and demanding longer run time is a tough call. This article discusses different techniques that may be employed to help achieve a highly integrated, flexible, efficient, and cost effective power supply design.

By Shadi Hawawini, Summit Microelectronics Inc.

Many modern portable electronics devices are proving to be difficult to design an efficient power management system, especially in the area of applications such as portable computing products. A block diagram of the final sample applications circuit is shown in Figure 1- with desired operations we wish to achieve, for a low power consuming, compact, computing application.

The difficulty in designing the power supply for a portable computing system is that the Central Processing Unit (CPU) of the computing system often requires very high current levels, at a low operating voltage, while the Random Access Memory (RAM), usually DDR, does not have high power requirements but because they are low voltage, high speed memory types, require extremely accurate voltages and many other parameters to be very accurate. Many designers, when they begin to embark on such a difficult task, often go to the simplest route, and design in a lot of discrete power supplies that handle different needs inside the system. One power device may be suited for high current applications, another for achieving DDR compatibility, another chip for controlling sequencing, etc. Although this methodology may work, it will be very space consuming as well as very expensive to implement. There are however, single, highly-integrated power manager chips that make achieving all of these desires possible. In the design examples shown below, a highly-integrated, flexible, switch mode power supply (SMPS) manger will be utilized.

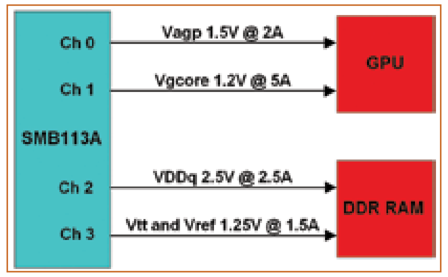


Figure1: Generic Computing System Application Block Diagram.

Achieving high efficiency for a high current CPU

The first step in designing the overall power system is to design the higher power portion of the system. This will most likely take up the largest amount of space on the PCB layout, because the components will have to naturally be larger to support such high levels of current. There are many things involved in designing a high current application that need to be understood to properly design the power supply. The easiest approach would be the utilization of a traditional power management solution and of larger MOSFETs with higher current ratings. This implementation would result in the desired current output, however, efficiency will surely take a significant hit. To truly understand how to obtain high efficiency the designer must understand the three major components in a switching regulator design, and familiarize them with how they must be analyzed to see how they could possibly affect overall system efficiency in a high current application. Those three components are the switching MOSFETs, output inductor, and output capacitor. This section analyzes the effects and implementations of these three components using a highly integrated power manager. For our application example

POWER SUPPLIES

we shall use a 4-channel device (Channels 0-3) to power our system. To power the CPU, we assigned Channel 0 of the power manger to output a voltage of 1.5V, and Channel 1 a voltage of 1.2V, which are programmable parameters.

Many older switch mode power supply (SMPS) designs used only a single transistor to control the switching in the SMPS, however, with the need for higher efficiency, we opt for the synchronous buck converter topology that requires two complimentary FETs. This runs the transistors complimentary to one another in a synchronous manner for a buck converter, replacing the freewheeling diode, and increasing efficiency due to the ability of the MOSFET to conduct in both directions while exhibiting lower I^2R losses, as compared to the diodes IV losses. To achieve synchronous rectification, programmable dead time is required, and should be available to program on most parts, to prevent shoot through (both transistors on at once) and to accommodate for a large range of FETs. Figure 2 shows the standard synchronous buck configuration to be used.

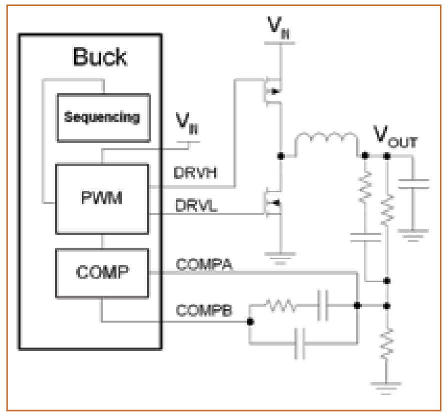


Figure 2: Simple Synchronous Buck Configuration.

MOSFETs

The first and most important step in designing a high efficiency buck (step-down), switching regulator, is deciding what FETs to use, because most losses in a switching regulator are through the switch itself. In order to achieve a high level of efficiency, FETs with a very low $r_{DS(on)}$ and a relatively low gate charge, need to be selected. The problem that inevitably arises is that for higher current applications, larger FETs must be selected, resulting in a higher gate charge.

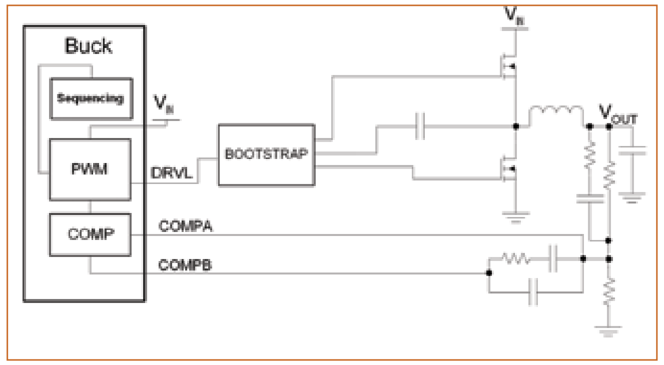


Figure 3: Buck Regulator with bootstrap implementation and two NFETs.

This problem is even more severe with the upper P-Channel FET as compared to the lower N-Channel FET, due to the fact that P-Channel FETs naturally have a higher gate charge and $r_{DS(on)}$ as compared to a comparable N-Channel FET. This gets worse as the FETs get larger, ultimately resulting in the upper P-Channel FET becoming a huge limiting factor in achieving a high efficiency design for a high current application. To alleviate this problem, the upper P-Channel FET is replaced with an N-Channel FET. As a general rule of thumb, if the $r_{DS(on)}$ of the P-Channel FET is starting to approach twice the value of the N-Channel FET, using a two N-Channel configuration is the best way to go.

The problem now becomes that the switch node is the source for the upper N-Channel FET, which should be switching between 0V and Vin. If the gate drive to the upper N-Channel FET is switching between 0V and Vin as well, then the FET could never turn on, because the gate to source threshold voltage is not being exceeded, or at least not enough to put the transistor into saturation. This problem is solved by using a bootstrap circuit to increase the drive of the upper N-Channel FET above Vdd, which is often achieved using an amplifier, bootstrap capacitor, and diode among other components. This, however, may not be too practical using discrete components, so available MOSFET drivers that have built in bootstrapping and will require only one input drive to be used is shown in Figure 3. Using the bootstrap technique can improve the efficiency from about 80% up to 90%, by replacing the upper P-Channel FET.

When selecting a FET, the sources of losses must be thoroughly analyzed. The sources of loss can be grouped into two main categories, switching losses and conduction losses. These two parameters can be simply quantified as seen below, and then summed, for the purpose of comparing FETs, to select the one that will yield the least amount of power loss.

$$P_{sw} = t_r V_{ds,\max} I_{Load} f_{sw} + \frac{C_{oss} V_{ds,\max}^2 f_{sw}}{2} + f_{sw} Q_g V_{drive}$$

(Equation 1. Switching Loss)

$$P_{Cond} = R_{DS(on)} I_{Load}^2 D_{\max}$$

(Equation 2. Conduction Loss)

t_r = Turn-On Rise Time
Q_g = Total Gate Charge
V_{drive} = Maximum Gate driver voltage
D_{max} = Maximum Duty Cycle
f_{sw} = switching frequency
C_{oss} = Output Capacitance
$V_{ds,max}$ = Maximum Vds, for PFET is |Vout-Vin|, for NFET is Vin

Another method of achieving a couple extra percents of efficiency is to connect a schottky diode across the lower N-Channel FET. This prevents the switch node from dropping below GND when switching the FETs and allowing the body diode to conduct, which will hurt efficiency. Once the switch node begins to drop below GND the schottky diode should clamp the voltage to ground. There are available N-Channel FETs designed specifically for this application that will have a schottky diode integrated into the package with the FET.

Inductor

The second component that must be accounted for in a high efficiency high current design is the inductor. The inductor forms the backbone of any SMPS; therefore it is very important to know how to properly choose an Inductor and to know what to stay away from. Below, the tradeoffs in selection of different inductor parameters, and how they affect efficiency will be discussed. The parameters to be discussed include inductance, DC resistance (DCR), and current rating.

The first consideration in choosing a proper inductor is the inductance value of the inductor, affecting the amount of energy to be stored. The inductance value has effects on many of the other parameters of the inductor as well as the SMPS. One thing to look for is where the inductance value is rated at in the datasheet. As the frequency of operation increases, the inductance decreases, and some datasheets may not spec their inductor for frequencies between 500kHz to 1000kHz. Also, look for how the inductance varies with DC bias current.

Another factor to consider when choosing a proper value inductor is that when the inductance value increases, your ripple current through the inductor decreases. This is good because it helps reduce the amount of ripple on your output, which can add to inefficiencies through the output inductor, as well as reduces the quiescent current. However, when inductance values go up, so to do the DCR values reducing the amount of current the inductor can handle. The DCR is very important, because this can greatly affect efficiency. The DCR has to do with the type of wire used, its properties, diameters, and lengths. So a larger inductor with more turns will have a higher DCR, but inductors that are physically larger to accommodate larger diameter wire will have a lower DCR. The ideal choice of inductor will have about equal amounts of core loss due to the ripple current and copper loss due to the DCR.

The temperature rise saturation current rated (at its most de-rated point) for your particular load application and operating frequency, is another very important characteristic of the inductor. If an inductor is chosen that is too small and without a high enough current rating, the inductor will saturate, causing core losses in overall switcher efficiency, by increasing I^2R losses due to large peak currents. In analyzing the areas for loss through an inductor, the sources can be grouped into three categories: Hysteresis loss, Eddy Current Loss, and copper loss. Hysteresis loss is essentially the loss incurred by switching the direction of the magnetic field each time the current through the inductor changes direction, and is dependent on the amount of turns in the inductor around the core, the core volume, and the switching frequency. Eddy Current loss occurs when current circulating the core induced by the magnetic field, begin to heat the inductor, forming heat losses. Copper losses, as alluded to above, are a type of resistive loss that is associated with the resistance of the windings and the DCR of the inductor, and will be the most significant source of losses through the inductor, assuming a proper core has been selected. Using a ferrite core, we may assume, as an estimate, that Hysteresis losses and Eddy Current losses may be neglected. These types of losses are generally very hard to quantify, and result in very little power loss as compared to copper losses, when using a ferrite core. DCR loss is best found by the following equations.

$$P_{D(DCR)} = I_{rms}^2 R_{DCR}$$

(Equation 3. Inductor Power Loss)

$$I_{rms} = \sqrt{I_{LOAD}^2 + \frac{\Delta I^2}{12}}$$

(Equation 4. RMS current through Inductor)

$$\Delta I = \frac{(V_{in} - V_{out})D}{L f_{SW}}$$

(Equation 5. Peak-Peak Current)

Output Capacitor

Finally, decreasing the inductor value to accommodate for larger currents, may affect the output ripple. The output capacitor has an equivalent series resistance or ESR associated with it, which adds an additional ripple component to the output. The two ripple components are actually out of phase with one another and the ESR component ripple is proportional to the inductor ramp current, which does not bode well in a high current design where the inductor ramp current can be very large. To limit this problem we increase the size of the output capacitor, which is inversely proportional to the ripple voltage but more importantly, we choose a capacitor, like a ceramic, with a low ESR to minimize the effects of large inductor ramp currents. Additionally, choosing a capacitor with low ESR will decrease your power loss as evident in Equation 6.

$$P_{D(ESR)} = I_{Ripple}^2 R_{ESR}$$

(Equation 6. Output Capacitor Loss)

$$I_{Ripple} \cong 0.3\Delta I$$

(Equation 7. Output Ripple)

Using the preceding equations and design philosophies, an efficient, high current power management solution can be designed by selecting appropriate components. To calculate the approximate efficiency for the designed system, the losses are summed together to get the total channel power loss and then plugged into Equation 8.

$$\eta = \frac{1}{1 + \frac{P_{loss}}{P_{out}}}$$

(Equation 8. Overall system Efficiency)

To further simplify the above process, there is software available to automatically perform all the above calculations. One such product is PowerTools™ , a free design tool offered by Summit Microelectronics. PowerTools™ aids in the selection of MOSFETs, Capacitors, and Inductors and aids in overall system design.

Of equal importance to the selection of components is properly laying out the board for a SMPS. When laying out a SMPS, the difficulty lies in the fact that switcher generates a lot of electromagnetic interference (EMI) noise due to high dv/dt switching, and this problem is exacerbated with higher currents. This EMI noise can be injected into very noise sensitive components of the SMPS, which can cause a system to become unstable. As a general rule of thumb, it is good practice to layout all of the power components, inductor, MOSFETs, and output capacitor on the

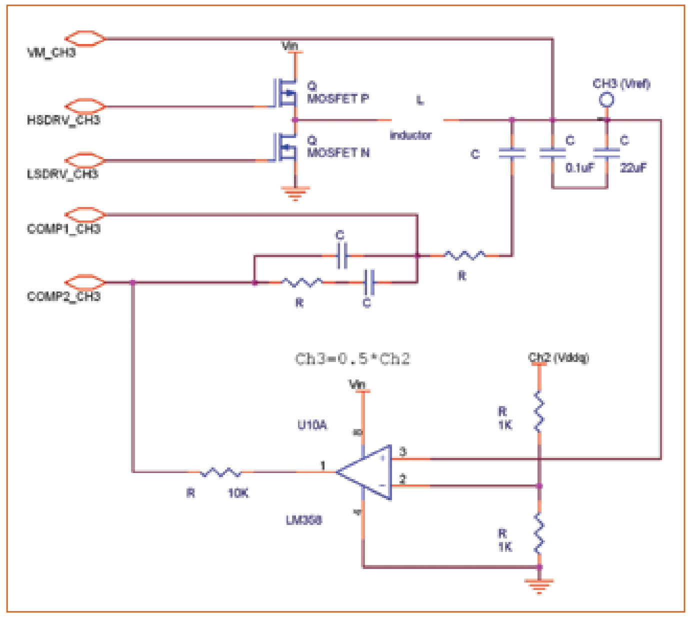


Figure 4: VDDQ Variation tracking circuit.

topside of the board, with a minimum amount of distance between the gate of the MOSFET and the part. Input capacitors for the MOSFETs should also be placed very close. Additionally, compensation components should be placed on the opposite side of the PCB from the power components and not directly underneath the switcher to prevent these noise sensitive components from picking up noise. Furthermore, the compensation components should be placed close the compensation pins on the part to further prevent noise pickup at the high-z input node to the comparator. There are a plethora of other layout considerations for a SMPS, but these are beyond the scope of this article.

The next step in the design of the system is integrating the stringent DDR specs for our power manager. The DDR tolerances must be very tight due to the fact that it has a low operating voltage among other issues. The tolerances and requirements, as well as the methods for achieving these are mentioned forthcoming.

Achieving DDR compatibility

Overview and Specifications

Currently there are two DDR SDRAM standards available on the market, DDR and DDR2, with a DDR3 standard currently in the works with a predicted mid 2007 release. All three run using the same basic power requirements for operation with a few notable exceptions, one of which being that DDR has an Output Supply Voltage, V_{DDQ} of 2.5V, DDR2 uses a V_{DDQ} of 1.8V and DDR3 is tentatively set to use 1.5V to help reduce power consumption. However, aside from that, all the DDR SDRAM's run using three Voltages, Output Supply Voltage, V_{DDQ}; Input Reference Voltage, V_{REF}; and Termination Voltage, V_{TT}. The rules that a DDR power converted must follow for proper operation are as follows.

1) $V_{REF} = 0.5*V_{DDQ}$
2) V_{REF} must be able to track any variations in V_{DDQ}
3) V_{TT} must equal V_{REF} +/- 40mV
4) Ripple Voltage on Vref must not exceed +/- 2%
5) For DDR2, $V_{DD}=V_{DDL}=V_{DDQ}$
6) Power up voltage ramp < 20ms
7) Must be able to source and sink current

Implementation

Many of these requirements can already be satisfied using the programmability specified above, without any modifications or additions. For the memory, using DDR SDRAM as an example, we use Channel 2 of the part to supply V_{DDQ} = 2.5V and Channel 3 to supply V_{TT} and V_{REF} = 1.25V, thus satisfying conditions one and three.

Using proper compensation values, as well as a 10uH inductor and a 22uF output ceramic capacitor in parallel with a 0.1uF bypass high frequency decoupling ceramic capacitor, or other low ESR capacitors, will reduce the ripple on the output of the channels to satisfy condition four. As a general rule, the larger the inductor, the less ripple current there will be. Additionally, the larger the output capacitor and the lower the ESR, the better the output ripple will be.

To satisfy condition six, we make use of the programmable Slew Rate control via the programmable protocol to adjust the rate at which each channel of the power manger turns on. To meet the requirements, the Slew Rate should be set to either 200V/s or greater to achieve the desired power up time. The Slew Rate is generally dependent on the resistor divider of R1 and R2, therefore, increasing R1 (decreasing R2) will also increase the slew rate.

Additionally, the ability to source and sink current is done intrinsically due to the nature of the synchronous buck topology used by our power manager.

The final requirement that must be satisfied is the condition that V_{REF} must be able to track any variations in V_{DDQ}. This is accomplished by the addition of a high-speed operational amplifier and three resistors; two tight tolerance, 1kW resistors and a 10kW current limiting resistor, as seen in the following circuit. Half of V_{DDQ} is created via voltage division across the series 1kW resistors, and is present at the non-inverting terminal of the Operational Amplifier. Any variations to V_{DDQ} are "sensed" by the non-inverting terminal of the operational amplifier, which is then being "compared" to V_{REF} at the inverting terminal. The output of the operational amplifier is then fed into the compensation pin for V_{REF} (COMP2_CH3) on the power manager part, which internally adjusts the duty cycle to enable V_{REF} to track V_{DDQ}, thereby actively adjusting the output voltage of channel 3 for V_{REF} by feeding back to change VREF when V_{DDQ} changes.

Conclusion

As can be seen using the above design techniques, a designer can now create a lower cost, highly integrated and flexible, switch power supply. Not all of the above information may apply in every instance, and should not be used as a "cookbook", instead the general methodology for creating the power supply should be used and custom tailored to the particular power manager in use.

www.summitmicro.com

Powering Up for the Future

When the chips are down…the industry brains move in

Great steps ahead have been made over the past years in process technology to enhance performance of power converters; novel topologies and innovative IC control logics that have renovated the standard power supply architectures. But what major trends and applications will lead the innovation of power supply technology?

By Michele Sclocchi, National Semiconductor, Senior Principal Applications Engineer, Power Management Europe

During the last decade, electronic equipment has taken a great step ahead offering smaller solutions and higher performances. These dramatic improvements have been mainly driven by microprocessors that quickly moved from the MHz clock speed range to GHz. and memory storage units that now contain several gigabytes. This has been made possible by the advances in silicon technology geometries which have moved from a few microns to sub micron today. While the 1.0 micron technology operated at 5V, the 0.1u technology operates now at only 1V. As the power remains almost the same, it takes just a quick look at Ohm's law to see that the voltages have come down and currents have gone up.

This new technology trend forced power supply solutions to follow the trend offering more efficient solutions and miniaturized systems that fulfill these requirements.

Furthermore, the high oil price and severe Co^2 emission concordats will emphasize the importance of more efficient sub-systems, pushing further to novel power supply architectures and applications. And Europe, been always more sensitive to these issues, will take the lead driving innovating solutions.

National Semiconductor, market leader in power management, has the technology and IP to lead these requirements.

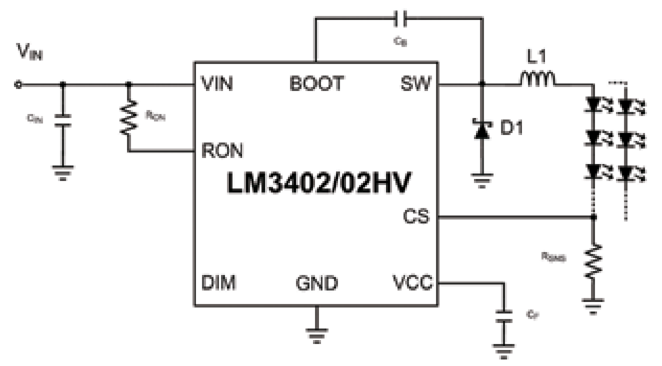
Lighting the future with LED technology

If "efficiency" is THE BIG key-word, then white light emitting diodes (LEDs) must be the tip for the top of the future. The high-brightness LED market will grow from $6.6 billion in 2006 to $10.6 billion by 2011, an average annual growth rate of 10.6 percent. High-brightness LEDs use a fraction of the power needed for bulb technology, have much longer operating lifetimes, and do not endanger the environment. LED technology is used already for automotive lighting systems, displays, mobile devices and many other applications.

Lumens-per-watt is the standard used by the lighting industry to measure the conversion of electrical energy to light. As a reference, conventional incandescent light bulbs are typically in the 10 to 20 lumens per watt range, while compact fluorescent lamps range from 50 to 60 lumens per watt.

LED semiconductor suppliers have been racing against each other to produce higher efficiency white LEDs with a target of 100 lumens per watt, seeking energy efficiency alternatives to conventional lighting.

One way to boost efficiency in a lighting apparatus is to use a configuration of multiple LEDs connected to a series



- V_{IN} Range: LM3402HV: 6V – 75V, Buck Topology
- constant current to LEDs with 200mV feedback voltage
- Low shutdown current when "RON" pin low
- Precise PWM dimming
- Switching Frequency up to 1MHz
- Hysteretic operation with constant on-time for F_{sw} control over V_{IN}

Figure 1:

of strings, which guarantees the closest matching color and brightness, driven by a high efficiency constant current source switching driver. A switching regulator offers the unique advantage of efficiency, reducing the dissipation that drives the LED as well as reducing the heat transferred to the LED itself.

A dedicated LED driver solution is shown in figure 1, where a high switching frequency regulator provides constant current to one or multiple strings of LEDs with precise dimming-brightness control, low power consumption and minimum external part count.

Precise dimming control is enabled trough a dedicated DIM pin that accepts linear as well as PWM input. Dimming with PWM is the generally accepted standard for reduction of light output in LED lighting systems. Light output from LEDs changes in a linear fashion as the forward LED current is varied; however, the dominant frequency of light emitted also shifts. Linear dimming is used in applications where this change in color is acceptable. Applications such as automotive brake lights, LCD backlighting, and direct view RGB, brightness and color requirements are too tight, a PWM dimming control is usually preferred.

LED semiconductor technology together with dedicated driver solutions will further boost the adoption of LED subsystems in large TFT displays, pendant lights, automotive front lights, and most of the other applications where efficiency and reliability are needed.

National Semiconductor developed a family of dedicated regulators that address these needs, combining better efficiency and accurate temperature/brightness control together with a high level of integration.

Enhanced power solutions for the automotive market

It is well known that the innovation in automotive electronic equipment is primarily driven by efficiency (fuel consumption) and reliability.

Efficiency and reliability can be addressed with a high quality process technology with wide voltage and temperature operating ranges, and innovative control techniques. National Semiconductor has addressed these needs, offering high voltage process capability up to 100 volts, that can withstand the most severe load-dump requirements, as well as innovative IC control techniques like the LM26001 family that offers world-class low consumption current in stand-by operation.

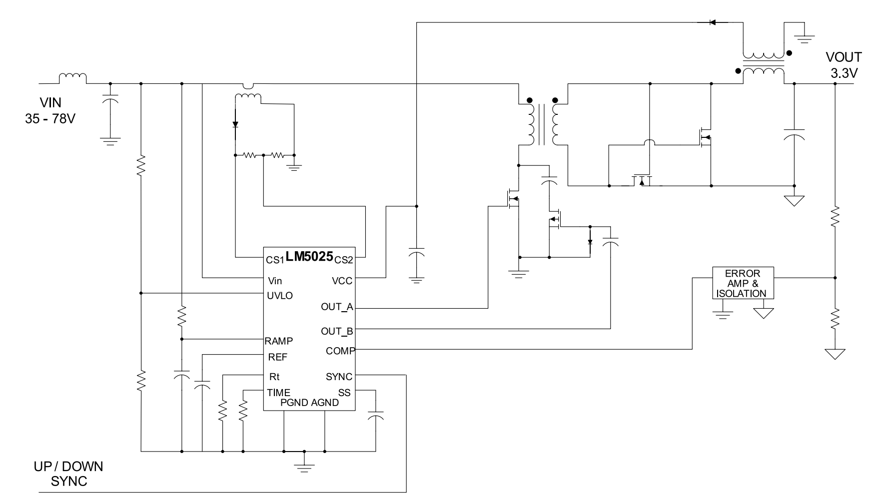
The LM26001 regulator meets the challenge of efficient regulation at light loads through a novel combination of PWM control techniques:

- Burst mode to achieve high efficiency at light load
- Reduced bias current when not switching to further improve efficiency at light load
- PWM mode for best EMC behavior at normal load
- Synchronizable and adjustable switching frequency for more design flexibility

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

The LM26001 uses a current-mode PWM control scheme for accurate regulation over a wide input voltage range. The part has a wide input voltage range of 4.0V to 38V and can operate with input voltages as low as 3V during line transients. The operating switching frequency can be adjusted from 150 kHz to 500 kHz with a single resistor and be synchronized to an external clock.

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



Forward active clamp advantages:

- Optimum reset of magnetic core
- Use of multiple magnetic quadrants
- Minimum stress to the primary MOSFET switch
- Leakage inductance energy re-circulated
- Ease of self driven sync rectifiers
- Zero voltage switching for main switch turn-off

Figure 2: forward active clamp topology advantages with National Semiconductor LM5025 - LM5026 high voltage controllers.

Active clamp topology leads isolated power supply architectures

The benchmark for high current isolated DC-DC application is the forward active clamp topology and its derivatives.

Demands for higher conversion efficiency, power density, and reduced cost have encouraged the use of the forward converter with active clamp reset.

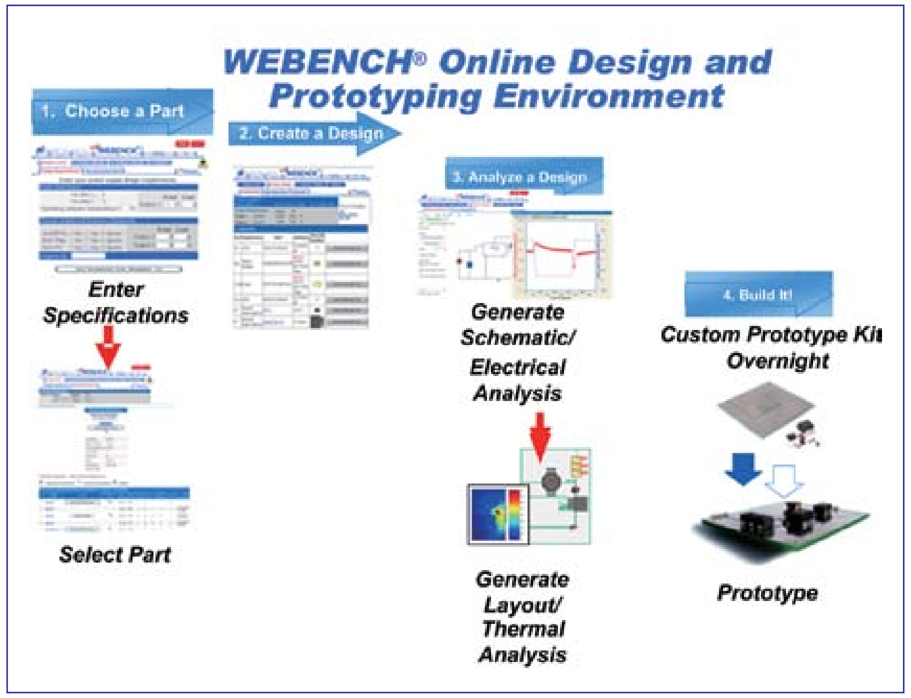


figure 3: Webench on line tool: power supply design in four simple steps.

Higher output current applications may benefit from a dual or single forward active clamp solution. Power supply manufacturers and telecom customers have widely adopted National Semiconductor's solution (LM5026/LM5034) which offers unique performance in terms of efficiency, reliability and cost-size The LM5000 family of active clamp controllers enable the forward topology to be more efficient and more flexible with regard to the possible voltage levels. A typical active clamp converter with a P-channel switch is illustrated in fig 2 with its advantages.

The active clamp capacitor recycles energy stored in the transformer, magnetizing and leakage inductance to improve overall efficiency. Utilizing active clamp techniques improves overall efficiency easily to as high as 92% with output currents up to 15-30Amps.

Higher output current applications may benefit from a dual forward active clamp solution.

Active clamp controllers enable the forward topology to be more efficient and more flexible in regards to the possible duty cycles. The dual interleaved version of an active clamp controller combines both of these topologies in a very clever way.

The advantages of dual interleaved operation are that the power is well distributed within two separate transformers, with much better efficiency and heat dissipation compared to one high power planar transformer.

National Semiconductor LM5034 forward active clamp interleaved controller aims efficiency up to 93% with output currents up to 30-60Amps.

How to keep pace with more complex electronic equipments with fast design cycles: time is money!

The new era of "consumer supply" introduces a fundamental main factor on the equation of economic growth: the "time factor".

Time is not only seen as an additional factor for engineering and production cost, but mainly by the quantities of innovative products that the company is able to launch in the market with fast adoption rate.

Consumers are persuaded to buy new electronic devices by the continuous introduction of new models with new features and better performance. This applies to any electronic goods, from a simple electric toothbrush to an expensive flat panel TV. The "magic formula" applies for every device: new models with an added value, and most important products that should be released faster than competitors. Here the factor of "time" plays a fundamental role.

Aggressive marketing teams sell to the market concept ideas that are not yet engineered, giving more and more pressure to the engineering department for fast design cycles.

How do these "fast designs" and "adding value" models translate to a design engineer?

If we can generalize a typical electronic board design, it can be split in four general blocks: digital processing core (microprocessor, DSP, FPGA, memory), display interface, signal path (DAC/ADC converters, amplifiers) and, most often last but certainly not least, the power supply system (switching power supply, linear regulator, voltage monitors); usually selected and designed in the same order.

The power supply is almost always the last part of the design, since it can be developed only when all the power requirements of the other main blocks are well defined.

Designing a switching power supply is not as simple as it seems, since it embraces all the aspects of engineering: EMI noise, close loop analysis, power losses, thermal analysis, layout issues, magnetic design.

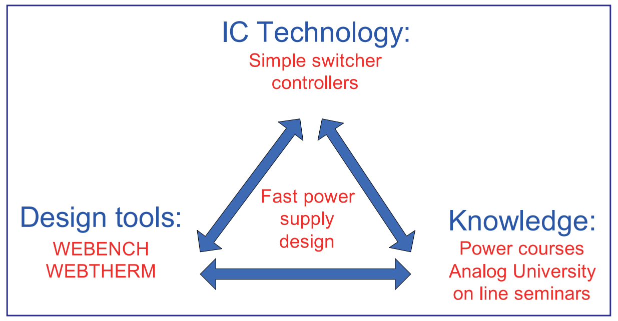


figure 4: National Semiconductor provides more than just silicon.

Power supply design is not longer the responsibility of experts, but can become a task for any system designer. Fortunately, a wide selection of integrated switching regulators and design tools are available to simplify and accelerate the design process of a power supply.

National Semiconductor, market leader in power management, has recognized these needs by providing easy-to-use regulators such as its Simple Switcher product family and easy to use software tools like WEBENCH.

WEBENCH is an online design tool that allows the design of a complete switching power supply in four simple steps, from design specification, selection of the most appropriate switching controller and discrete external components, electrical and thermal simulation and final prototype with custom evaluation boards for fast bench verification.

This free online tool is intended to be used by engineers of all levels of expertise. Of course, design simulation tools such as WEBENCH can support and facilitate the design process of a power supply. It can be used to discover design problems and correct them, as long as the engineer is capable to apply the most appropriate thinking. However, engineering know-how will never be completely replaced by simulation tools; appropriate thinking, personal experience and deep knowledge on the specific subject can expedite the optimization process of the design.

National Semiconductor and its power supply design expertise are continuing to develop training material, power courses and on-line training tools to stimulate the self-development of engineers and to raise the knowledge in the increasingly important power field.

The key of a fast engineering design process of any electronic device is the right combination of: suitable IC technology, design supporting tools and knowledge.

National Semiconductor provide the "key" of an optimized power supply design offering a wide selection of switching regulators, together with on-line simulation tools such as WEBENCH and WEBTHERM, together with a most comprehensive package of training and support material with specific power courses, analog-university and design application notes.

www.national.com

Prioritizing the Power Electronics Focus on Energy Efficiency

Its time to start attacking the major contributors to energy efficiency

By Kevin Parmenter, FAE Director – Americas, Fairchild Semiconductor

Legislative efforts and advertising dollars have recently been focused on an important aspect of energy use and where power electronics can make a positive impact – namely, standby power efficiency. Many regulatory efforts such as Blue Angel and Top Runner have required standby power consumption of many products to be below one Watt in the standby mode. Some standards globally are voluntary and others are mandatory. The power electronics industry has delivered solutions and many of the industry's best and brightest have been working away at reducing standby power consumption of products from copiers to consumer electronics and battery adapters and chargers.

One or two companies keep a running clock of how much power that they estimate consumers have saved by incorporating their solutions, which is admirable. However, let's step back and take a look at the real challenges facing us in the typical day in the life of an actual consumer and how power electronics could make a difference. Let's say the consumer wakes up takes a hot shower enabled by one of man's most inefficient inventions – the water heater. A tank of water kept hot 24-7 just in case you might need it. If someone tried to invent a more inefficient system it would be difficult to conceive of one. This average consumer unplugs their cell phone from the wall charger and leaves it in the wall where it thankfully only consumes under a watt of standby power until the owner and his phone to be charged return. Lets say this consumer's child (like most children) is distracted doesn't think to turn off their closet light and a 60 watt bulb needlessly burns all day long. While the consumer is gone, his refrigerator keeps the food cold and uses an outdated yet widely used induction motor in its compressor. Let's say the air conditioner for the home using the same outdated technology in its compressor kicks on a few times during

the day to keep the home cool (or if it' s a heat pump – warm). Our consumer goes to work and in his office are many computers and servers.

The computer and servers that power the internet are becoming a considerable drain on the electric power system. Internet use is growing rapidly and information technology is now consuming a significant portion of the electricity generated on our planet. Since electricity use associated with servers doubled from 2000 to 2005, representing an aggregate annual growth rate of 14% per year for the U.S. and 16% per year for the world, power electronics can contribute to the efficiency of this important segment of our energy bills by increasing efficiency. The amount of electricity used by servers and other Internet infrastructure has become an increasingly significant proportion of our electricity consumption as a society and it is never in standby – it's always operating. We can see that like the aluminum and manufacturing plants of the industrial age – the server farms of the information age are built next to large hydroelectric and other sources of renewable power. "In recent years as demands for new Internet services (like music downloads, video-on-demand, and Internet telephony)" Koomey (2007) have become more widespread this energy consumption keeps on growing and can never be off. According to Lawrence Berkeley labs "the Total power used by servers represented about 0.6% of total U.S. electricity consumption in 2005. When cooling and auxiliary infrastructure are included, that number grows to 1.2%, an amount comparable to that for all color televisions and this figure is growing. The total power demand in 2005 (including associated infrastructure) is equivalent (in capacity terms) to about five 1000 MW power plants for the U.S. and 14 such plants for the world. The total electricity bill for operating those servers and associated infrastructure in 2005 was about $2.7 B and $7.2 B for the U.S. and the world, respectively. If power per server remains constant, those trends would imply an increase in electricity used by servers worldwide of about 40% by 2010" which means it will be even more significant part of our energy bills as a society.

Back to our consumer for a moment, after work on the way home the consumer drives to the kids soccer game and leaves the car running to power the air conditioner in the SUV since it is so hot and humid outdoors.

What is the point of all of this? While standby power is an important part of energy consumption it might be important to paredo the contributors of inefficiency and what power electronics can do along the way. The standby power of that charger and likely everything else in the consumer's home which is in "standby" is a rounded off error compared to the overall energy "footprint" of the consumer and what could be saved through the proper application of power electronics in the larger and less efficient systems in the consumer's home.

What if we had "smart" water heaters sensing and providing hot water at the "point of load" instead of a giant hot water tank of always hot water? Electronics would certainly be used in the sensing and control of this application. Lighting is a considerable part of everyone's utility bills and CFL lamps are a step in the right direction. However, even with the reduced power consumption, the power factor of these replacement lamps is causing issues. LED lamp fixtures with built-in PFC and drivers could increase efficiency and provide a life long fixture with unity power factor – not only would efficiency be increased, but the maintenance costs over the life of the fixture would be reduced. Additionally, what if we had smart light switches that sensed activity in the room combined with a timer? We have these today yet the previously mentioned power factor issues of a fluorescent lamp of any type makes the triacs in these devices misfire and they will not work properly unless used on an incandescent load – woops back to the dark ages – what if we could invent one that worked well with any load? Could a payback period be demonstrated? Now if we incorporate our previously mentioned LED fixture with a smart light switch – we could really make a difference. Let's look at our consumer's appliance loads again! Standby power is important and while the electronics to control the appliances have improved the motors in the HVAC and refrigeration systems have been grounded in decades old technology – what if we were able to use electronic drives on refrigeration compressors routinely and cost effectively? Wind generators and solar panels are increasingly becoming viable options and in order to use the output of these systems to power our 85-265 VAC, 50-60 Hz devices power electronics will be required to enable interfacing and efficient conversion from DC to AC. In terms of our vehicles hybrid electrics are a reality today and pluggable hybrids are emerging. As far as running the AC and watching the soccer game – If the kids can play ball in the heat we should be able to stand around and watch them in the heat! Sometimes we just have to turn it off. We can make systems more energy efficient and add predictive and smart controls to anticipate need and turn off systems when not in use to contribute to energy savings however a smart consumer is a key element to conservation.

Customers make decisions based on economics we have to sell value in terms of payback period, reduced cost of replacement and maintenance over the life of the products. Legislative aspects can help – ostensibly a move is afoot to mandate the elimination of the incandescent lamp for example. Clearly we need to place our engineering, legislative and business resources in the areas with the largest ROI, set aggressive goals for efficiency and work towards achieving that end. – While standby power is important and significant its time to start attacking the major contributors to energy inefficiency which make standby power look like a noise level problem. As always power electronics will be the enabler to accomplishing the objective of increasing efficiency and functionality and reducing the total cost of ownership for the consumer and conserving our precious resources.

References:

Estimating Total Power Consumption by Servers in the US and the World

Jonathan G. Koomey, Ph.D. Staff Scientist, Lawrence Berkeley National Laboratory and Consulting Professor, Stanford University JGKoomey@stanford.edu.

www.koomey.com

www.fairchildsemi.com

Lighting Systems Part II

The Sun is Setting on the Incandescent Light Bulb

LED efficiency and lower cost will illuminate the future

With all the benefits of higher efficiency in a technology that has come on in leaps and bounds, LEDs are already a natural choice for many applications. Modern LEDs and their associated IC drivers have become more sophisticated than their early predecessors.

By Tony Armstrong, Product Marketing Manager, Power Products Group, Linear Technology Corp.

The sun is about to set on the use of the incandescent light bulb as a primary light source. This is being fueled by the proliferation of the light-emitting diode (LED) as a solid-state lighting source. A LED is a semiconductor device that emits incoherent narrow-spectrum light when electrically forward biased, resulting in a form of electroluminescence. In other words, the direct conversion of electric energy to light by a solid phosphor subjected to an electric field. The color of the emitted light depends on the chemical composition of the semiconductor material used, and can be near ultraviolet, visible or infrared.

LED technology has increased significantly over the past couple of years. Higher brightness levels, higher efficiencies, longer lifetimes and decreasing costs have spun out from the many advances made in terms of heat dissipation, packaging and processing. Unlike incandescent light bulbs, LEDs do not have a filament that will burn out and they tend to run cooler. Incandescent light bulbs waste 95 percent of the energy they consume as heat.

High-energy efficiency LEDs use only 10% of the electrical energy required to power traditional incandescent bulbs and give of less heat with similar light output levels. Furthermore, LEDs offer extremely long life – typically ten years or more, twenty times longer than the

best incandescent bulbs. In addition to solid-state reliability, the shape of the LED package allows light to be focused. Incandescent light sources often require an external reflector to collect light and direct it in a usable manner.

However, despite these significant advances, more can be done in terms of the efficiency of energy conversion, thermal management and production costs. For example, LED efficiency has made dramatic gains. These improvements resulted from better light generation within the chip and a better means of extracting the light from the chip and its package. Similarly, the selling price of 20mA white LEDs have dropped dramatically. When initially introduced, volume prices were a nominal $1. Today, it is possible to purchase these 20mA white LEDs for less than 25 cents in high volume.

LEDs are driven with a constant current where the DC current level is proportional to LED brightness. To vary the LED brightness, there are two methods of dimming the light by controlling the LED current. The first method is analog dimming, in which the LED DC current level is reduced proportionally to a maximum of 10:1 ratio by reducing the constant LED current level. Reducing the LED current further than this can result in a change in LED color or inaccurate control of the LED current. The second method is digital or pulse-width-modulation (PWM) dimming. PWM dimming switches the LED on and off at a frequency at, or above 100Hz, which is not perceivable to the human eye. The PWM dimming duty cycle is proportional to LED brightness, while the on-time LED current remains at the same level (as set by an LED driver IC), maintaining constant LED color during high dimming ratios. This method of PWM dimming can be used with ratios as high as 3000:1 in certain applications.

Of course, all of these advances have not only fueled the adoption of LEDs as a lighting source in different applications, but have also simultaneously driven the demand for LED driver ICs with which to power them. To understand the obstacles for the design and manufacture of these LED driver ICs, it is necessary to understand what a white LED requires in order to produce light. As already stated, a white LED must be driven by a constant current source so that the

white point of the light is uniform (that is, it does not shift). Furthermore, since the white LED is a diode, its internal forward voltage (Vf) drop has to be overcome. This Vf varies with the current rating of the white LED and will also change with temperature. A typical 20mA white LED has a Vf that varies between 2.5V and 3.9V over the entire operating temperature range. Most applications use more than one white LED and can also have these LEDs configured in parallel, in series, or a combination of both – for example parallel strings of LEDs in series. This means that white LED driver ICs must be capable of delivering sufficient current and voltage for the specific configuration of LEDs, and in a conversion topology which satisfies both the input voltage range and required output voltage and current requirements.

Applications for LEDs are commonly found in displays and indicators for automotive and aircraft dashboards, traffic signals, cell phones, police take-down bars, othoscopes, flat-panel-display backlighting, miner's lamps, architectural and outdoor stadium lighting. Nevertheless, the single largest market driver for LED growth now, and for the next couple of years, is the backlighting of flat-panel-displays. These displays come in the form of liquid crystal displays (LCDs) used for TVs, navigation systems, portable media players, digital signage and computer monitors. However, one of the challenging technical hurdles for LED adoption is the concern over thermal management. Although LEDs do not radiate as much heat as other light sources, depending on the output power, they may need appropriate heatsinks so that light output and lifespan do not decrease. For example, a high-brightness LED with 25-lumen output typically consumes more than 1W. This means that the white LED driver IC must have high efficiency conversion so that it is not a major contributor to this thermal issue. Also, as seen by the wide range of applications, in many instances there are space limitations. This means that the LED driver IC must be able to accommodate a compact solution footprint and also be low profile.

As an example, consider the cellular phone. Most of today's cellular phones have a built-in digital camera capable of high-resolution still and video images. Gains in camera performance have also created the need for a high power white light source for camera use in-doors or in dim ambient light. White LEDs have emerged as the primary light source in cellular phones equipped with cameras. Since they possess a desirable combination of features for the modern cell-phone designer: small size, high light output, and the ability to provide both "Flash" and continuous "Video" subject lighting. High output power LEDs have been developed specifically for use as integrated camera lights.

Just about any handheld battery-powered device uses a color active-matrix LCD to display the different types of information and data needed by the user. However, manufacturers are faced with the challenge of ensuring that a user can read the information from these displays in any type of environment. To achieve this, they must provide the color LCD with the correct amount of backlighting. This backlighting is normally provided by white LEDs. This created the demand for a compact, efficient and low noise methods to power these LEDs.

In this specific area of white LED driver ICs, Linear Technology has a number of solutions available. The use of either a low noise inductorless DC/DC converter (more commonly known as a charge pump) or a DC/DC converter – the main difference between these being the need for an inductor (magnetics). Inductorless DC/DC converters are an ideal choice for space-constrained applications where low to moderate load currents must be supplied. Furthermore, they come in small packages and require very few external components, typically as few as three ceramic capacitors. Most boost DC/DC converters are specifically designed to provide high efficiency and constant-current drive for white LED backlights.

High brightness (HB) and super HB LEDs can be found in LCD TFT backlighting in high-end TVs, industrial lighting, automotive navigation displays and projectors. One popular area is for instrument panel backlighting, interior lighting, and the brake lights of many automobiles and trucks. Luxury automobile manufacturers are increasingly taking advantage of the latest technologies in solid-state LED lighting to enhance the aesthetics of their future model vehicles by relying on these lighter, smaller, and more durable devices for interior and exterior illumination. It is clear that LEDs promise lower long-term cost and longer life which are among many advantages over incandescent light bulbs for interior lighting.

However, driving LEDs at high current requires the DC/DC converter to accurately regulate the current to ensure uniform light intensity and color integrity as well as to protect the LEDs. Furthermore, a significant challenge is to power one or several strings of LEDs from a battery voltage that can be less than, equal to, or higher than its load voltage. Yet another concern is to efficiently dim the LEDs over a large dimming ratio while preserving their chromatic characteristics at both low and high brightness levels. And lastly, efficient operation of the DC/DC driver is a crucial requirement, especially in driving HB (high brightness) LEDs, since all the power not emitted as light is dissipated as heat.

Driving LEDs from a car battery requires a DC/DC converter to accurately regulate the LED current to ensure uniform light intensity and color integrity as well as to protect the LEDs. Moreover, the DC/DC regulator should be optimized for specific power requirements depending on the intended use of the LEDs. Also, a difficult challenge is to power one or several strings of LEDs from a battery voltage that can be less than, equal to, or more than the load voltage. Another concern is to efficiently dim the LEDs over a large dimming ratio while preserving their chromatic characteristics at both low and high brightness levels. Efficient operation of the DC/DC driver is a crucial requirement, especially in driving HB LEDs, since the power not converted into emitted light is wasted through heat.

It is clear that the trend to utilize white LEDs as a primary lighting source will continue for many decades to come. Their long life, reliability and efficient energy conversion when compared to the incandescent bulb are too compelling to dismiss. At the same time, their continued adoption will fuel the demand for the LED driver IC that are necessary to power them.

www.linear.com

LIGHTING SYSTEMS

High Quality TFT Monitors Need Optimized Design

Liquid crystal characteristics and driving circuits

Today's consumers and a large proportion of the business world demand top quality displays for their TVs, Computers or the new Information displays we are seeing at airports. The control and driving circuits are a critical function and require close attention

By Oliver Nachbaur, System Engineering Manager, Display Power, Texas Instruments

Liquid crystal displays using active matrix thin film transistors (TFT) are used across many applications and often determine the success of the end product on the market. The main technology driver is the large screen LCD (liquid crystal display) TV panel, which requires superior picture quality to compete with CRTs (cathode ray tubes) and plasma panels. This article gives more insight into the latest TFT LCD characteristics and its control circuits. It focuses on the dot inversion driving method as used for notebook, monitor, TV and public information displays.

Construction of a Liquid Crystal pixel

Figure 1 shows a twisted nematic (TN) cell, which has a 90° crystal twist. Such a cell is commonly used in active matrix displays and contrasts with the super twisted nematic (STN) cell, which has a twist of 270° and is mainly used in passive matrix displays.

As a voltage is applied across the cell, the crystalline structure is aligned along electrical field. Since the polarized light is also oriented along the crystalline structure, the polarizer on the other side of the pixel blocks the light causing the pixel to appear black. If no voltage is applied, then the polarized light passes through the cell as it travels along the crystalline structure with a 90° twist.

When applying a voltage across the cell it is important to apply an AC (Alternating Current) signal instead of a constant DC (Direct Current) voltage. This is because any DC voltage applied for a longer period of time is destructive to the liquid crystal.

Active Matrix Displays allow high resolution and contrast ratios

In order to achieve high contrast ratios, active matrix displays are used.

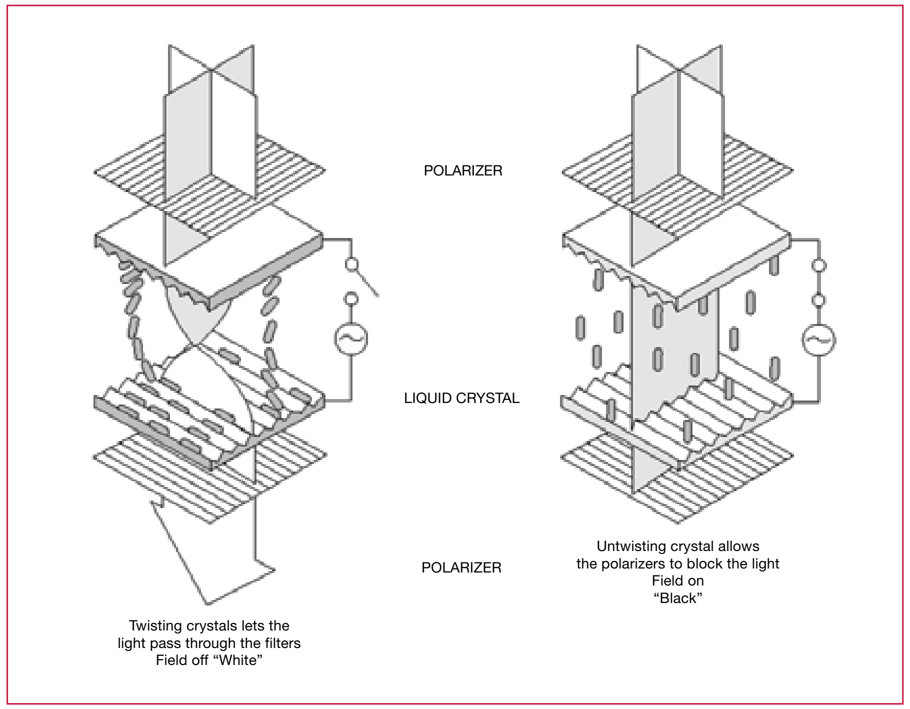


Figure 1: Basic construction of a liquid crystal cell.

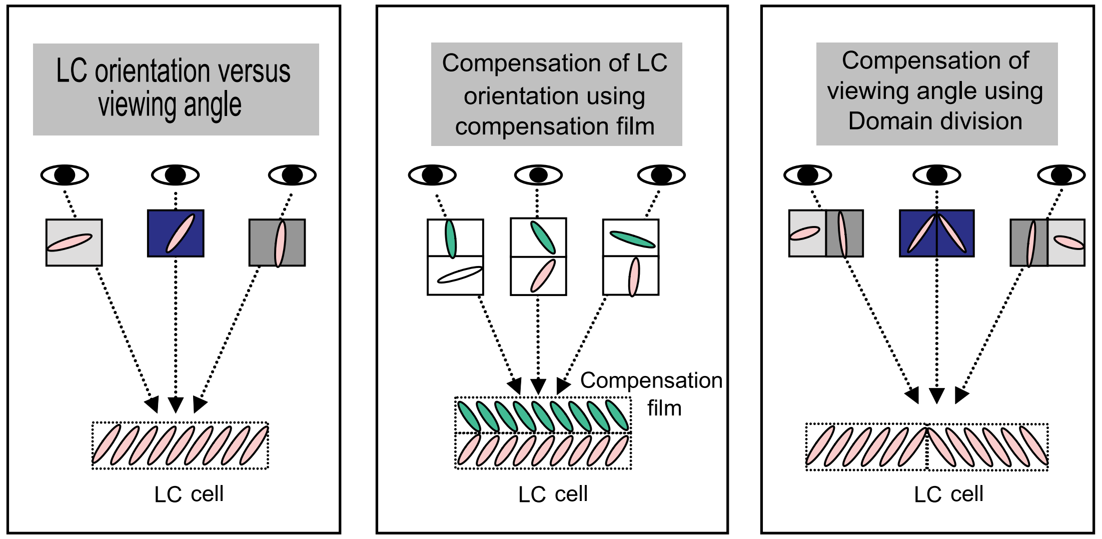


Figure 2: Crystalline orientation influences the reflection of light.

With such a matrix each pixel is controlled by its own TFT. For a colour display, each pixel consists of 3 subpixels using different colour filters to generate red, green and blue. Each sub pixel typically has 256 grey scale levels (8Bit) allowing all the different colours to be generated.

Crystalline structure influences the LCD viewing angle

One of the first challenges to be experienced when using LCDs was their limited viewing angle, but especially when used for TV panels, a wide viewing angle with no change in contrast or colour is required. The first picture in Figure 2 shows the dependency between viewing angle and reflected light. Due to this, the contrast and colour change depend on the viewing angle.

One of the first solutions to overcome this problem used an optical film to compensate for the LC orientation and this technique is still used, mainly for low cost monitor applications. More advanced solutions are used for TV panels utilising vertical alignment (VA, PVA) or Inplane Switching (IPS). The picture on the right in Figure 2 shows one example using vertical alignment. Other technologies such as IPS and FFS (Fringe Field Switching) use additional electrodes in the panel to align the crystalline structure horizontally. Use of these technologies allows viewing angles up to 180° with minimum degradation of contrast ratio and colour gamut. Each technology (TN+Film, VA, PVA, IPS, S-IPS, FFS) has its specific advantages and characteristics that should be chosen depending on the end application. Some offer faster response times, while others offer wider viewing angles, or higher immunity against image sticking.

The backlight sets the possible colour gamut

Colour saturation and colour gamut depend mainly on the LCD backlight. The colour gamut of the screen is referenced to the colour gamut possible with the NTSC standard set as 100%. A standard CCFL (Cold Cathode Fluorescent Light) typically used for LCD backlight has a colour gamut of only 31%. Consequently, panels using RGB LED backlights are of interest because they give a much higher colour gamut. Unfortunately, this is at a higher cost compared to CCFL lamps, although that might change in the near future as RGB backlight becomes more commoditized. However, new CCFL lamps were recently introduced offering a colour gamut of 90%, which is a big step forward and closes the gap with RGB LED backlight systems.

Using these technologies allows good picture quality. Another important parameter is the response time of the liquid crystal pixel to avoid motion blur.

Fast response time avoids motion blur

At the beginning of the LCD era, the response time was specified as black to white response time. While most of the displays have very fast black to white response times, the more important

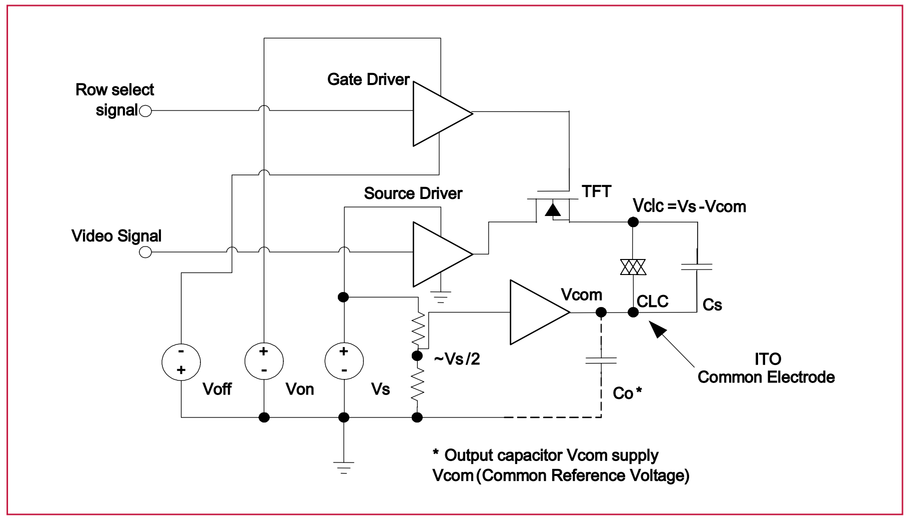


Figure 3: Implementation of the TFT, LC pixel and its driving supplies.

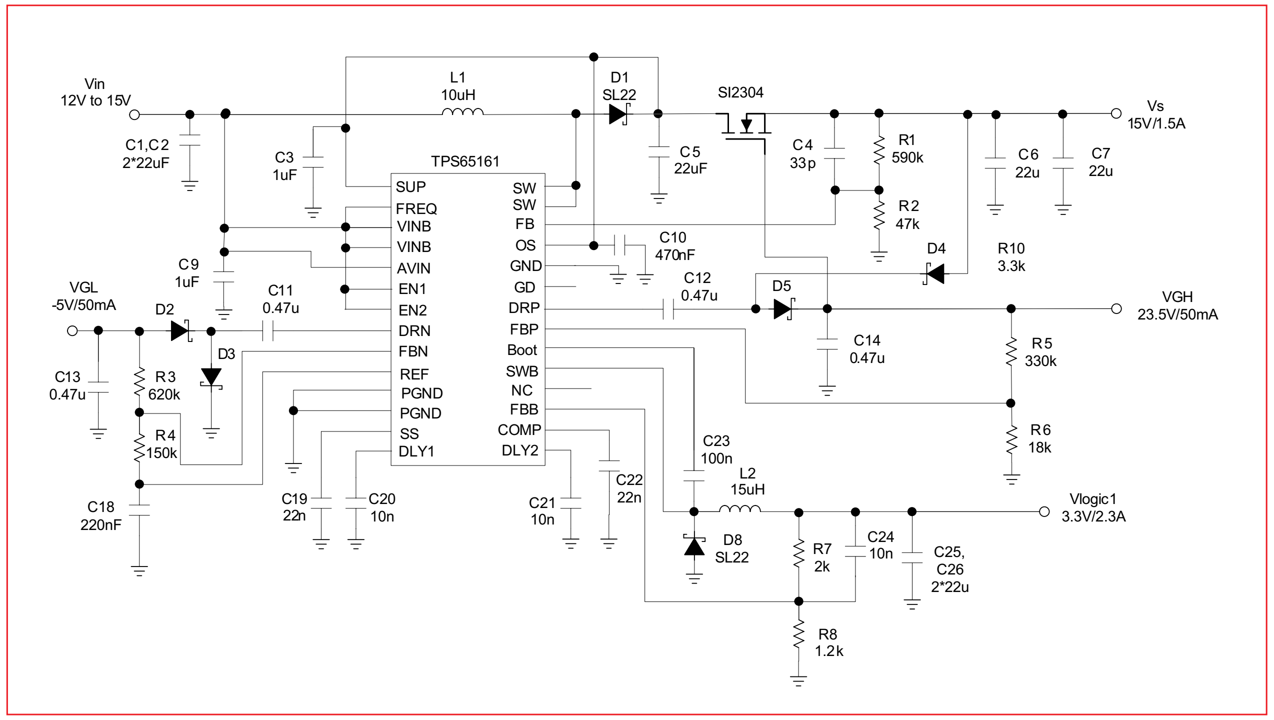


Figure 4: Compact LCD bias supply circuit.

parameter is the grey to grey level response time that is usually much slower. To improve the grey to grey level response time, liquid crystal materials with faster response times are being used. In addition to that, voltage overdrive of the TFT is applied and response times of 4ms and faster are currently achievable. (Some vendors already claim 2ms).

To support all the features discussed, specific power management and control ICs have been developed by semiconductor IC suppliers. The next section outlines the principal circuit to drive a LC pixel and an appropriate power supply and control solution.

Implementation and structure of TFT LC Displays

The implementation and principal structure of an active matrix display using the dot inversion driving method is shown in Figure 3.

Figure 3 shows the principal implementation of a LC pixel and the TFT. To drive the pixel and TFT, the following voltage rails are required:

a) Turn on voltage (Von or VGH) for the TFT in the range of 20V to 30V
b) Turn off voltage (Voff or VGL) for the TFT in the range of -5V to -7V
c) Source driver voltage (VS or AVDD) for the video signal and gamma reference voltages in the range of 7V to 18V
d) Common reference voltage Vcom. Vcom≈Vs/2

The common reference voltage Vcom is used to implement an AC signal across the LC cell. To implement a positive and negative swing across the LC cell, the video signal Vs is an AC signal with a swing between 0V and its nominal voltage e.g. 15V. The Vcom reference voltage is selected to be half of the source voltage (Vs). This implements a virtual ground and forces a positive and negative voltage across the cell. The Vcom reference voltage is implemented with a buffer (Operational Amplifier) to be able to source and sink current. To implement these different voltage rails, dedicated power supply ICs are used.

TPS65161 Compact LCD Bias IC

To simplify the LCD bias and control circuit and to minimize total solution costs, Texas Instruments provides several Compact LCD Bias ICs dedicated to specific end applications. TPS65161 is one example from a fast growing portfolio of Compact LCD Bias Supplies. The device runs from a 12V input voltage rail and provides all voltage rails as outlined in Figure 3. In addition a step down converter is integrated providing a 3.3V supply rail to power the timing controller (TCON) of the panel. Special care is needed in respect of power on sequencing of the different supply rails as well as high power supply efficiency in order to allow such high levels of integration for power supply circuits. The boost converter itself delivers 15V@1.5A. As an example, Figure 4 shows the TPS65161 optimized for high resolution large size LCD TV panels.

Conclusions

This article outlined the key requirements and display characteristics for modern LC panels as used in Notebook, Monitor and TV applications. However, to achieve an excellent picture quality the entire monitor or TV set has to be optimized. The power supply and control circuit discussed usually comes with the panel. For a complete system the graphic controller with its video scaler has a major impact on the overall picture quality as well. Therefore panel technology and driving circuits, as well as the graphic controller provided by the set maker, have to be optimized to achieve superior picture quality.

www.ti.com

Building Backlighting Solutions for LCD Displays

The proper choice of light source

Designers face three key choices when building backlighting solutions for today's wide variety of LCD displays: which light sources to use for the lamps, how to drive them, and how to improve quality and power efficiency using visible light sensors for automatic brightness control.

By Roger Holliday, Vice President, Strategic Business Development and Dr. Xiaoping Jin, Senior Systems Engineer, Microsemi Analog Mixed Signal Group

Designers face three key choices when building backlighting solutions for today's wide variety of LCD displays: which light sources to use for the lamps, how to drive them, and how to improve quality and power efficiency using visible light sensors for automatic brightness control.

Since the backlight unit consumes the most power within the display subsystem, these choices are not trivial. The right decisions can significantly improve battery life in portable products, while in the wide variety of other display applications the backlight design is critical for optimizing display brightness, contrast and viewer ergonomics.

Picking a Light Source

Most large LCD display backlight systems use either cold cathode fluorescent lamps (CCFL) or external electrode fluorescent lamps (EEFL) to provide the high-intensity illumination required for displaying full-motion video. Also in mass production are U-shaped CCFL and EEFL backlight configurations; however, since both require higher driving voltage than CCFL, their application is currently limited to screens below 32 inches.

Light-emitting diodes which produce a specific light within a narrow spectrum are providing another promising lamp source for backlight units. LEDs offer greater mechanical stability than CCFLs or EEFLs. Their short switching time and, by using a pulsed light source, can eliminate "smearing" effects of fast-moving images in LCD displays.

LED backlights can utilize single-color, multi-color or white LEDs. (Monochrome white LEDs actually mix blue and yellow light to create their white light.) Multi-color red/green/blue solutions, when available, promise to leverage advanced packaging techniques to significantly increase color options and color mixing.

Powering the Lamps

After selecting a light source, the next step is to power the lamps. To do this, backlight inverters must be able to drive backlight systems with high efficiency, low interference, reliable start-up and protection, and tight control of lamp current distribution under multi-lamp environments.

Most LCD backlights use straight lamps which, in low-cost screens below 20 inches, are generally mounted at the top and bottom edges of the panel. In larger panels, this approach risks problems with intra-lamp cross-coupling, uniformity of illumination, and heat concentration, so the preferred approach is to space the lamps evenly behind the panel.

In general, a lower-cost, single-ended wiring scheme is the most popular for screens below 32 inches. The drive voltage is applied only to the hot end of the lamps, with the other end grounded to the chassis. The voltage on the hot end can be a common single phase, or multiple phases. Better picture quality is possible by using an interleaved two-phase design, in which voltages between adjacent lamps are alternated by 180 degrees. The high voltage field is largely localized between two adjacent lamps, significantly reducing interference to the LCD display. Fig.1 shows a typical configuration using CCFLs.

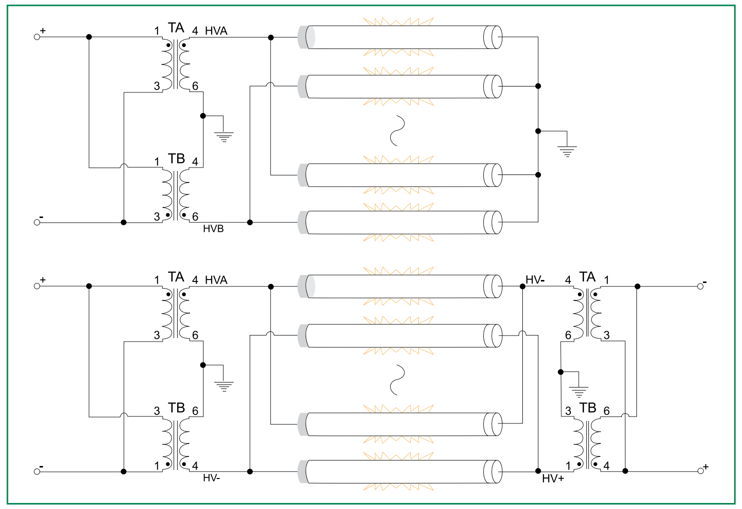


Figure 1: Typical Multi-CCFL Architecture.

In larger screens, the simplified, single-phase approach is often inadequate. A better solution is a floating lamp structure in which the high voltages are applied to both ends of the lamp, with a 180-degree phase difference of their fundamental frequency.

Regardless of whether a single-phase or floating lamp structure is used, inverter designers also must solve technical challenges related to lamp current balancing, striking, fault detection and synchronization.

Proper lamp current balancing ensures even brightness over the screen. This is difficult because the lamp's negative operating impedance and positive current-temperature characteristics accelerate current imbalance. Additionally, the lamps can exhibit unmatched parasitic parameters, especially the parasitic capacitance, which also can lead to lamp-current imbalance.

Striking is equally important and challenging, especially when multiple lamps are powered from a common output. When multiple lamps are paralleled, the voltage can be clamped to the lamp operating voltage of the struck lamps, thus preventing other lamps from successful striking. It takes careful design to guarantee reliable striking.

The third challenge is reliable fault detection. To ensure safety, each lamp' s open condition must be detected. In multi-lamp systems where lamps are powered from the same source, the transformer voltage may not rise when a single lamp is open.

Finally, the operating frequencies of multiple inverters must be synchronized in order to eliminate cross frequency interferences. Also, the phase relationship of inverter outputs must be controlled to ensure the desired driving voltage polarity. For high picture quality, inverter frequencies also must synchronize with video scanning frequencies to avoid an optical beating effect that appears as a moving bar on the screen.

There are several ways to meet these challenges with available circuit topologies while optimizing both performance and cost efficiency. The three basic topologies for LCD TVs are push-pull, half- bridge, and full-bridge.

The high total impedance of both push-pull and half-bridge circuits makes it difficult to get satisfactory lamp current waveforms over a wide input range. Full-bridge topologies perform better by using soft switching to minimize the interruption to circuit resonance characteristics. If a floating lamp architecture is used with a full bridge topology, system costs are increased since, as mentioned earlier, separate inverters are usually needed at both ends of the lamps. A patent-pending Microsemi soft-switching architecture illustrated in Fig. 2 achieves excellent performance with only half the power components by using two-switch inverter stages at each side of the panel to provide opposite phase voltages with separate transformers.

Microsemi also has a patent-pending soft-switching strategy for split-bridge architectures. Its advantage is that the waveforms on the two ends of the lamps always remain in 180-degree phase difference, compared with the varying phase angles of the phase-shifted method, resulting in improved current balancing in the presence of parasitic capacitances.

Once the topology has been selected, the designer must choose either an active or passive balancing scheme. Passive schemes rely on impedance-matching of the lamp circuit by purposely introducing more impedances into the system. This can be achieved with a ballast capacitor, shunt capacitor, inductor, or high leakage inductance of the transformer. While less costly, these solutions may be inadequate when imbalance is severe. Active balancing schemes work better because of their active self-correction mechanism. Balun is one example – when balanced, the flux generated by the two branch current cancels each other and the balun behaves like a pure DC resistance. When an unbalanced condition occurs, an error flux is generated to resist the unbalance condition. The inductance of each winding works like the open loop gain of a control system, and more turns are needed to minimize the balancing error.

Microsemi has developed a more versatile and cost-effective method called Jin balancing. As illustrated in Fig. 3, each balancer has two windings. During operation the circulation current in the secondary winding loop maintains the balance of the lamp current. Under balanced conditions, the magnetizing force from primary and secondary current cancel each other out. The effective magnetizing current is essentially zero. Flux is only generated under unbalanced conditions where the difference of the primary and secondary magnetizing force will induce a correction voltage in the balancer winding, thus forcing the current to balance.

This concept succeeds because of its active electro-magnetic coupling mechanism. Also, because the secondary winding is free from the lamp circuit, the signals from the secondary winding

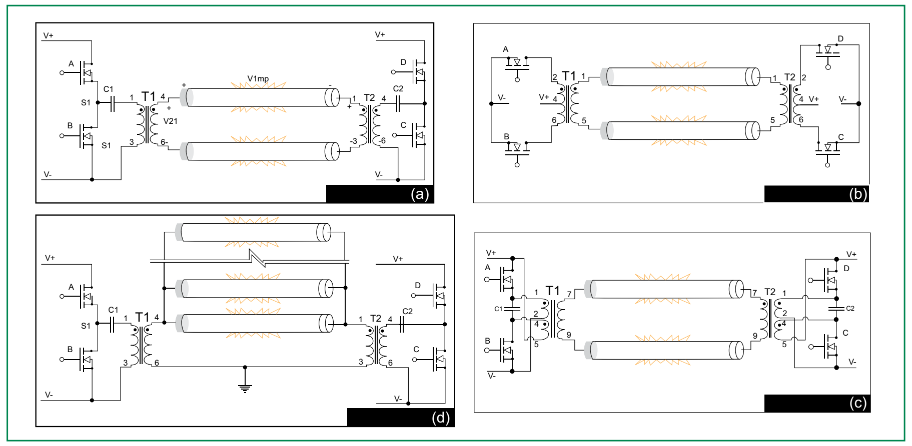


Figure 2: Split Phase Inverter Configurations For Floating lamp Structure.

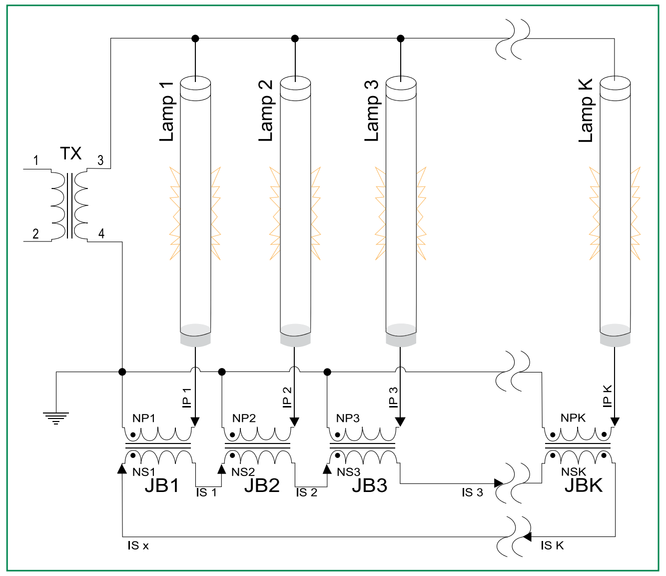


Figure 3: Jin Balancer Concept.

can be used anywhere in the system without restriction on the placement of primary winding. Jin balancing offers significant cost savings and design flexibility in multiple-lamp systems.

Automatic backlighting

In addition to selecting a light source and choosing an inverter design, it is important to consider automatic backlighting technology. Portable devices roam between vastly different ambient lighting conditions. Without automatic backlight control, users either tolerate poor-quality displays or must manually adjust the brightness setting. Automatic backlighting improves ergonomics and also drives substantial incremental power savings. For example, backlight power required for optimum display readability in a typical office environment is 0.73 watts less than in sunlight conditions.

Integrated circuit visible light detectors enable these automatic backlight control applications. These devices consist of an array of PIN diodes on a single substrate. The overall spectral response of the diodes within the array closely approximate that of the human eye. Their benefits can be realized whether the systems are backlit by CCFL or LED lamps.

One of the most challenging applications for automatic backlight control is the automobile, where CCFLs are the preferred choice because of their superior brightness capability. Automotive displays are used in both bright, sunlit ambient environments and at night. This requires outputs in excess of 600 candelas/m^2 (nits) during the day, or about four times the brightness of a typical laptop computer, and three to five nits at night. Dimming ranges must be in the ranges of 225:1, or more than 10 times those of the best typical computer displays.

There are two basic automatic backlighting control approaches. The first is simply to reverse the display contrast under software control, as ambient light changes to preset levels, but this is of only limited effectiveness and will not work with the increasing number of video-based applications. A better approach is based on integrated circuit control. In the case of automotive applications, this is done using a wide-range CCFL dimming control technique. It allows night-time display brightness to be reduced to less than one percent of its maximum daytime levels, and provides true, flicker-free uniform lamp-dimming across the extreme range of ambient light. In addition, integrated circuit control operates at much lower power levels and can be achieved with no incremental cost penalty.

Today's automatic backlight control systems can extend the battery life more than one-half hour in a typical laptop, and provide up to 20 more minutes of talk time for a cellular handset. Additionally, this approach reduces stress on the LEDs or CCFL lamps that illuminate the displays and can often improve lamp life by as much as three times.

Conclusion

The LCD display market is continuing in rapid growth, powered by increasing affordability and superior performance in a variety of applications, from the harsh, demanding environment of the automobile, to the complex demands of big-screen LCD TVs. The proper choice of light source, inverter technology and automatic brightness control solutions will result in the optimal implementation for the given application.

www.microsemi.com

Acriche LED - New Design and Improved Brightness by 20%

Seoul Semiconductor, no.1 LED manufacturer in Korea, released the Acriche 2W single emitter of octagon type, a new type of package with brightness improved by 20% than previous LEDs. Acriche is an innovative semiconductor lighting source, which can run directly from AC supplies without converters. Seoul Semiconductor has devoted its strength to improve the brightness and package design so that customers can conveniently use more improved products, since last November's announcement of Acrich's mass production, economical and environment-friendly semiconductor lighting. As a result, in only 3 months, the maximum brightness of Acriche reached 96 lumens for two watts, and the luminous efficacy became 48 lumens per watt, an improvement of 20%. The new package of "the Acriche 2W octagon type" is a single emitter and its diameter is 25 mm. It was designed to make it easier for customers to apply to various kinds of applications.

It is easy to apply secondary optics (collimators) to these devices, to adjust the viewing angle of Acriche so that customers can create various moods by applications. For instance, the lens with narrow viewing angles can be used for the lighting fixtures focusing on a certain areas such as reading lamps, while the lens with wide viewing angles for those shining on wider spaces like living rooms at home or offices.

Acriche can be applied to architectural lighting, scenery lighting (such as park lighting), stand lighting, exit lighting, street lamps, industrial lighting, and many others.

The device offers improved power efficiency, brightness, and lifespan compared to incandescent and halogen lamps, and outpaces fluorescent lamps in terms of lifespan, power consumption, convenience, and actual lighting fixture efficacy. It is the efficacy when applied to actual lighting fixtures: fluorescent and incandescent lamps loose lots of light from the back, since they emit light through 360 degrees, while Acriche emits only downwards losing less light than other sources. Acriche lasts 35,000 hours compared to 1,000 hours for incandescent lamps, 3,000 hours for halogen lamps, and 8,000 hours for fluorescent lamps. Using Acriche, a consumer will pay approximately 85% less in electricity costs compared to incandescent lamps; and 50% less compared to general fluorescent lamps.

www.acriche.com

Industry's First Pre-Standard IEEE802.3at Power-over-Ethernet Integrated Solution

Microsemi Corporation has announced the industry's first pre-standard IEEE802.3at power over Ethernet integrated solution family, delivering 36 watts of power for devices ranging from video screen phones and WiMAX transmitters to pan-tilt-zoom cameras, thin-clients and laptop computers.

The new product family includes the PD64012GH 12-port PSE PoE Manager and the PD64004AH 4-port PSE PoE Manager. Both feature integrated power FETs, enabling switch manufacturers to build switches that can drive 36W for every 2-pairs and interface to devices consuming up to 30 watts. Customers requiring up to 60 watts can use the same Microsemi integrated circuits in a 4-pair configuration. The ICs support Layer-2 Classification.

Both the PD64012GH and PD64004AH include all of the features found in lower power PD64012G and PD64004A circuits, including detection of pre-standard devices, dynamic power management and emergency power management. In addition, the new devices also add support for power management based on Layer-2 classification.

With increases in the maximum theoretical power per port, advanced power management features become critical for the design of PoE switches, saving integrators an average of 50% of the cost of adding PoE to a switch.

The PD64012GH and PD64004AH not only operate in pre-standard IEEE802.3at mode, but also are 100% IEEE802.3af compliant when detecting IEEE802.3af PD's. The PD64012GH and PD64004AH are managed by the PD63000G PoE MCU using Firmware Release 6 or above.

"The upcoming IEEE802.3at standard transforms the RJ45 connector into a truly universal power socket, capable of delivering power to applications in the enterprise, SME, SOHO and residential markets," said Derek Brown, VP Marketing of Microsemi's Analog Mixed-Signal Group. "The PD64012GH and PD64004AH were designed having in mind that customers will need a solution that is flexible enough to deliver 720mA on 2-pairs, but at the same time can be implemented in a cost effective manner to support up to 571mA in the period before the IEEE802.3at standard is ratified."

www.microsemi.com

New Daylight-Readable LED – Display Digital Panel Meters with Auto-Dimming Function

With the launch of its DATEL branded 3½ digit DMS-30DR series, C&D Technologies is first-to-market with an auto-dimming, daylight readable, LED-display digital panel meter. The large, 14.2mm high, super-bright red LED is readable in direct sunlight without the need for special filters or shading devices.

The DMS-30DR series satisfies the growing market requirement for displays that can be used in very high ambient light conditions, but can also dim themselves in poorer light. Previously, applications that required daylight visibility necessitated the use of less reliable liquid crystal display (LCD) technology that incorporates complex, high power consumption, backlighting circuitry. A further drawback of LCD versus LED displays is the LCD's poor viewing angle; characters on the DMS-30DR series can be read at viewing angles of up to 180 degrees, in both vertical and horizontal planes.

Housed in a small, encapsulated, 12-pin DIP package with overall dimensions of 55mm x 23mm x 14mm, the DMS-30DR series is suitable for either panel or PCB mounting. The rugged, moisture and vibration resistant assembly integrates the display, autodim display drivers, a light sensor, reference circuitry and A/D converter. Each package also incorporates a built-in colour filter and bezel. A user-accessible external brightness adjustment pin enables custom intensity settings or brightness matching in multi-display applications.

The DMS-30DR series comprises four panel meters offering a choice of four high-impedance differential input voltage ranges: ±200mV, ±2V, ±20V and ±200V. Typical display accuracy is ±1 count. All models operate from a single +5V supply and draw as little as 7mA when operated in total darkness, and typically less than 200mA when operated at maximum brightness. CMRR for all devices is 86dB, and inputs are over-voltage protected to ±250V. Operating temperature range for all models is 0ºC to +60ºC.

www.cd4power.com

Total Power Device Solutions for Highly Efficient, Reliable and Low-Noise LCD TV Power Designs

Fairchild Semiconductor announces new Stealth™ II and Hyperfast II diode technology as part of a total power device solution specifically designed to optimize LCD TV switch-mode power supply (SMPS) applications. The new FFP08S60S and FFPF08S60S Stealth II diodes exhibit excellent soft recovery (tb/ta > 1.3) and very fast reverse-recovery time (trr < 25nS @ 600V breakdown voltage). These characteristics are ideal for reducing problematic EMI and MOSFET switching losses in CCM (continuous-current-mode) power factor correction (PFC) designs. Also being introduced is the FFPF08H60S Hyperfast II diode. Featuring fast reverse-recovery time (trr < 35nS @ 600V breakdown voltage) and low forward-voltage drop (Vf < 2.1V), this diode helps reduce conduction losses to increase energy efficiency in DCM (discontinuous-current-mode) PFC designs. The new Stealth II and Hyperfast II technology was developed to combine with, and complement, an array of Fairchild's existing UniFET™ and SuperFET™ MOSFET technologies. This vast product offering presents a comprehensive solution for increasing system efficiency and reliability while lowering EMI in LCD TV power designs.

Stealth™ II / Hyperfast II + UniFET™ combination optimizes PFC designs in LCD TV's SMPS operates in two types of PFC current modes: CCM and DCM. For optimizing CCM designs, Fairchild's new FFP/PF08S60S Stealth II fast-recovery diodes can be combined with Fairchild's previously introduced UniFET MOSFETs. For example, the 19A 500V FDA18N50 UniFET utilizes proprietary planar stripe DMOS technology for low RDS(on) (0.265 Ohm @ VGS = 10V) and high unclamped inductive switching (UIS) capability. Combining a new Stealth II diode with this UniFET device reduces switching loss by 10 percent compared to previous-generation devices, which results in excellent system efficiency. Similarly, Fairchild's new FFPF08H60S Hyperfast II diode can be combined with the same UniFET device to improve efficiency and avalanche protection during DCM PFC operation.

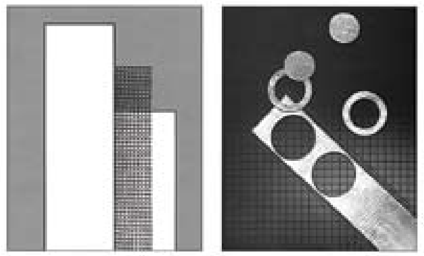
Today's LCD TV SMPS must reduce power consumption while maintaining system performance and reliability in switching-mode operation. Fairchild's existing SuperFET Fast Recovery MOSFET (FRFET) products are optimized to meet this design challenge. Uniting SuperFET technology with a lifetime killing process, SuperFET FRFETs offer improved body-diode characteristics, turn-off dv/dt immunity and low EMI. The latest-generation FCPF11N60F device, for example, offers trr = 120ns & Qrr= 0.8µC and up to 50V/ns dv/dt capability. These advanced MOSFETs increase efficiency and reliability in even the most cutting-edge LLC half-bridge converters.

New Stealth II and Hyperfast II products are available in lead (Pb)-free packages that meet or exceed the requirements of the joint IPC/JEDEC standard J-STD-020C and are compliant with European Union regulations now in effect.

www.fairchildsemi.com

NEW PRODUCTS

InFORMS – Reinforced Indium and Solder Alloy Fabrications – at PCIM



Indium Corporation will feature InFORMS at PCIM Europe. InFORMS are patented fabrications that increase the tensile and compressive strength and add handling capability to soft and ductile indium and solder alloys. InFORMS can also dramatically improve handling when compared to conventional solder alloys.

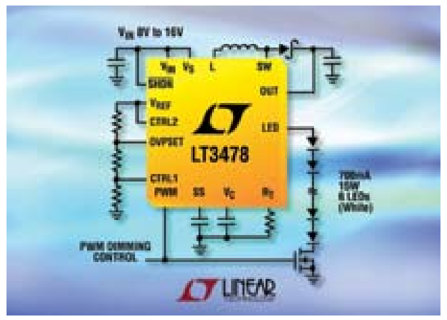
InFORMS are used as compressible thermal interfaces, accommodating mismatch while maintaining the benefits of the high conductivity and low contact resistance. Other applications of this unique product include cryogenic and vacuum seals, EMI and RFI shielding, ground straps, stand-offs, or backplane assembly washers.

InFORMS are fabricated by sand-wiching braided, woven, or random-fiber metal or non-metal substrate materials between pure indium or solder alloy. This patented process adds strength while retaining the unique attributes of the metals selected for the outer layers. In addition, layers can be adhered to the substrate so that the substrate can flex to accommodate shear or thermally-induced forces. For solder applications, flux may be incorporated within the matrix or applied as a coating.

InFORMS can be produced from a wide range of metal and non-metal substrates, such as plated copper shielding mesh, stainless steel mesh, and even woven and random-fiber fiberglass cloth. InFORMS can offer countless opportunities for solving difficult application problems. Contact Indium's Technical Support Engineers to help you to develop samples for experimentation, including special substrate materials, layer thicknesses, or outer layer metallizations.

www.indium.com

Multi-Topology 40V, 4.5A LED Driver for High Current LED Applications



Linear Technology announces the LT3478 and LT3478-1, two 40V, 4.5A DC/DC converters designed to drive high current LEDs at constant current. Their 2.8V to 36V input range is ideal for a wide variety of applications, including automotive, industrial and architectural lighting. In boost mode, the LT3478/-1 can drive up to six 700mA LEDs in series from a 12V input, making the device ideal for applications such as automotive display backlighting. The LT3478-1 uses an internal current sense resistor, limiting output current to 1A, whereas the LT3478 uses an external sense resistor to extend the maximum LED current up to 4.5A. Both parts deliver efficiencies up to 90% in boost mode from a thermally enhanced TSSOP-16E package. The devices use True Color PWM™ dimming, which delivers constant LED color with dimming ranges up to 3,000:1, and a fixed frequency, current mode architecture offers stable operation over a wide range of supply and output voltages. A frequency adjust pin enables the user to program the frequency between 200 kHz and 2.25 MHz, optimizing efficiency while minimizing external component size.

The LT3478/-1 senses output current at the high side of the LED, enabling buck, buck-boost or boost configurations. One of the two CNTRL pins can be used to program maximum LED current and the other can be used to program a reduction in maximum LED current with increases in temperature, thereby maximizing LED usage and improving overall reliability. Other features include inrush current protection, open LED protection and programmable soft-start.

The LT3478EFE and LT3478EFE-1 are available from stock in a thermally enhanced 16-Lead TSSOP-16E package. Extended temperature versions, "I" Grades, the LT3478IFE and LT3478IFE-1, are also available from stock.

www.linear.com

NEC to Further Enhances ST-NLT Lineup with Launch of Four New TFT LCD Modules

NEC LCD Technologies, Ltd. has announced that it will begin successive shipment of four new amorphous silicon thin-film-transistor (TFT) liquid crystal display (LCD) samples. The new products comprise a 15.0-inch (38cm-diagonal) extended graphics array (XGA) TFT LCD module, NL10276BC30-18C, a 12.1-inch (31cm-diagonal) extended graphics array (XGA) TFT LCD module, NL10276BC24-13C, and two 10.4-inch (26cm-diagonal) video graphics array (VGA) TFT LCD modules, NL6448BC33-63C and NL6448BC33-64C.

All four new LCD modules feature NEC LCD Technologies' proprietary super-transmissive natural light TFT (ST-NLT) technology that achieves display of vivid colors in environments with high ambient light. In addition, the models support wide operating temperature ranges of either -10 degrees Celsius to +70 degrees or -20 degrees Celsius to +70 degrees. These enhanced features make the new models ideal for installation in automated teller machines, automated ticket machines, automatic vending machines, and point-of-sales systems for gas stations.

Since the launch of the 5.5-inch TFT LCD module, NL3234BC35-22, featuring ST-NLT technology in April 2005, NEC has worked to expand its ST-NLT product lineup. Accordingly, four new products have been launched since 2005 to meet market demand for display of vivid colors even under extremely bright outside light, an ongoing issue with conventional electronic display devices. However, market demand for diversified ST-NLT-based products continues to increase along with market expansion.

"The addition of these four new sophisticated models will boost NEC LCD Technologies' competitive edge in a market of ever-increasing and diversified needs," said Masaaki Hiroshima, Product Planning Department Manager at NEC LCD Technologies. "Our unmatched product lineup is now 9-models strong, ranging in size from 5.5 to 15.0 inches in six different sizes from QVGA up to XGA resolutions, enabling us to provide a premium range of products to an even broader range of customers worldwide."

NEC LCD Technologies remains committed to the enhancement of its lineup of LCDs adopting ST-NLT technology responding to a broader range of industrial applications and environmental conditions.

www.eu.necel.com

ST's First Column-Driver IC for Fast-Growing Large-Size LCD Market

STMicroelectronics has announced successful development of its first column-driver ICs for the fast-growing large-size LCD TV market. Developed in the company's Asia-Pacific Design Center (APDC) in Singapore, the STD8420C and STD8420A are the first chips in ST's new LCD driver family being sampled to key customers.

Demand for large-size LCD TVs is growing rapidly, especially in countries such as Korea, China, Taiwan and Japan, with the establishment of HDTV (high-definition TV) services. Many consumers are upgrading from CRT (Cathode Ray Tube) television sets. Analyst iSuppli predicts that sales of large-size LCD panels will continue to rise in the first half of 2007, compared to the end of 2006, in contrast to normal seasonal patterns.

The device uses PPDS® (Point-to-Point Differential Signaling) display technology licensed from National Semiconductor to dramatically simplify the LCD intra-panel interconnect and to reduce the total number of column-driver signals required, aiding manufacturers by enabling a physically smaller bezel around the TV screen while providing cinema-quality display performance. The use of this technology in the new LCD driver complements ST's long experience and expertise in display systems and technologies, including computer monitors, TV applications, mobile displays, plasma screens, small-size LCD and OLED (Organic LED) displays.

The STD8420x is being produced in a leading-edge process technology, developed by ST specifically for this application. Other products in the new family will also be designed in ST's APDC in Singapore. Key features of the STD8420C include: 414/420 outputs, PPDS interface compatible, support for independent digital gamma control of each RGB color, support for Dot and N-line inversion drive schemes, operation over a wide output voltage range, and 1024 gray levels per output built from internal 12-bit linear digital-to-analog converters. The STD8420A incorporates all the features of the STD8420C with the exception of output gray levels, which are limited to 256 steps.

Engineering samples of the STD8420C and STD8420A are now shipping to key customers.

www.st.com

New Series of High-Brightness LEDs for Portable Outdoor Electronic Signs and Signal Applications

Avago Technologies today announces a new series of low-power high-performance extra-bright round through-hole light emitting diodes for portable and solar-powered outdoor electronic signs and signal applications. Available in Red, Amber and Red-Orange colors, Avago's new HLMP-Exxx series of 5mm aluminum indium gallium phosphide (AlInGaP) LEDs are highly reliable and provide high luminous intensity with low forward voltage to meet the needs of designers who need a low-power lighting solution.

Typical applications for these devices include outdoor portable commercial full color or monochrome signs and marquees, scoreboards, and traffic management signals such as pedestrian signals, and construction zone warning lights. These new LEDs are also ideal for use in signs that are solar powered, provide variable messages or use channel lettering.

Avago's new family of LEDs are competitively priced and available in un-tinted, non-diffused, T 1-3/4 packages to provide well defined spatial radiation patterns at specific viewing cone angles for excellent readability in sunlight. Moreover, these precision optical performance LEDs provide superior light output and are extremely reliable.

Samples and production quantities are available now through Avago's direct sales channel and worldwide distribution partners.

www.avagotech.com

Comprehensive Line of V·I Chip Evaluation and Validation Boards

Vicor Corporation announces at PCIM – Hall 12.431 (on the Hy-Line stand) the availability of a comprehensive line-up of 52 Factorized Power Architecture (FPA) Customer Evaluation and Validation Boards, featuring BCM™, PRM™ and VTM™ V•I Chip™ power components. In addition, the company has created an expanding library of V•I Chip™ application notes to support the implementation of power system designs. The introduction of the evaluation boards and application note library provides a quick and easy way to get an appreciation of the advantages of V•I Chip technology.

FPA technology and the families of V•I Chip power components offer a fundamentally new and improved approach to distributed power. Factorizing DC-DC power conversion into its basic functions – isolation and transformation in the VTM units and regulation in the PRM module – maximizes power system performance and cost effectiveness. Unregulated BCM converters complete the line-up.

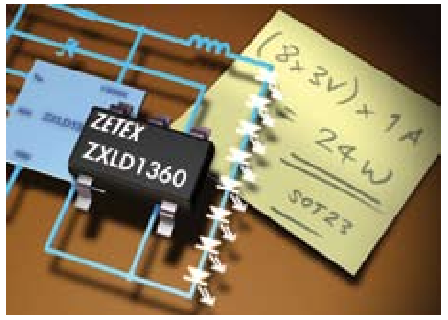
Four PRM non-isolated regulator boards and 13VTM current multiplier boards are available now. A PRM board is selected to match the desired input voltage, and a VTM board is selected to provide the desired output voltage and current. Plugged together, they allow the user to explore FPA's regulated DC-DC capabilities and develop an understanding of the technology.

Fourteen 48V BCM converter evaluation boards with fixed ratio outputs from 1.5V to 48Vdc are also available, along with high voltage (352Vin and 384Vin) versions. In addition, 21BCM validation boards with standard 1/4 brick pinning are designed for engineers to test the performance of the BCM intermediate bus converter in their existing application and enable 300W or 600W solutions.

Vicor presents a conference paper on Tuesday 22 May at 11.30 hrs-Direct, high efficiency, high power density 48V – 1.xV, 100A solution for microprocessor applications.

www.vicoreurope.com

LED Lighting Driver Increases Power Density



Providing an adjustable output current of 1A from a SOT23 package, the ZXLD1360 LED driver from Zetex Semiconductors offers higher power density than alternative and much larger SO8 devices. A buck regulator device, it operates over a supply range of 7V to 30V and is capable of handling up to 24W of output power in a wide range of high power LED illumination applications.

Achieving up to 95% efficiency, this LED driver's thermally enhanced construction combines with a high level of component integration to create compact LED lighting solutions which are low in part count and simple to configure. The ZXLD1360 integrates a 30V NDMOS switch and a high-side current sensing circuit, which sets the average output current in relation to an external sense resistor.

Where LED brightness control is required, the output current can be adjusted above or below the set value by applying an external DC voltage or PWM control signal to the ADJ pin. The driver's in-built PWM filter also provides a soft-start capability by controlling the rise of input/output current. Soft start time can be further increased using an external capacitor. Applying a low voltage to the ADJ pin turns the output off and puts the device into a low current standby mode.

Designed to be used in LED-based automotive, industrial, emergency and architectural lighting circuits and in general illumination applications, the ZXLD1360 is temperature rated over the range –40ºC to +125ºC and will handle transient voltage incursions of up to 40V. In the event of LEDs going open circuit, coil current flows via an external clamp diode to ensure the driver is protected from harm.

Pin-compatible with the well-established 350mA ZXLD1350 LED driver, the ZXLD1360 is to be followed later in the year by the introduction of a 60V, 1A driver (ZXLD1362) and a configurable driver, supporting buck, boost and buck/boost operating modes (ZXLD1380). For very simple low voltage LED indication applications, a single cell boost regulator is soon due for release (ZXSC380).

www.zetex.com

VACUUMSCHMELZE Presents Evaluation Kits for Current Sensing Systems with DRV401

VACUUMSCHMELZE GmbH & Co. KG (Hanau) will present new products, including evaluation kits for the installation of current sensing systems with the company's DRV401, at this year's PCIM held from 22 to 24 May in Nuremberg. VACUUMSCHMELZE are in Hall 12, Stand 130. At the conference on 24 May, Klaus Reichert gives a talk on applications for compensation-based current sensing systems, entitled "Closedloop current sensing systems with magnetic field probe incorporating a new sensor signal conditioning IC".

VAC's patented closed-loop current sensors with magnetic field probe feature outstanding sensor precision. The system electronics are almost wholly integrated in the DRV401, designed in collaboration with a leading IC manufacturer. However, the IC is also available as a separate unit for operation with passive VAC sensor modules; in this case the system electronics are external to the sensor module. VAC supplies evaluation kits for developers designing current sensing systems with IC DRV401. A variety of kits are available for passive VAC current sensors.

www.vacuumschmelze.com

Companies in this Issue

Please note: **Bold**—companies advertising in this issue

Power Modules, Lighting & Surface Mount Technology

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

I get a lot of 'green' stuff these days …it is the fashionable word for the authorities to use and identify with. But if you dive below the general hype, and take an 'engineering-approach' you get the real story, just as always.

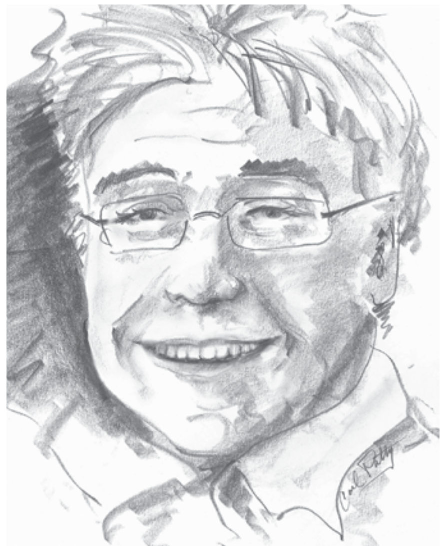
I talked with Patrick Le Fevre, briefly, from Ericsson Power Modules, one of the electronics giants, for the real story, from his perspective. We had a little dialog on the issue.

From the night satellite-pictures of earth throughout the last decades, it is clearly evident that the energy consumed by lighting has grown dramatically, becoming a major concern for communities, industries and their governments.

From Thomas Edison's seemingly perfect contribution in 1880 to modern lighting and now with the recent development of highly efficient white LEDs, many power technical improvements have contributed significantly to improve overall efficiency of such systems, though as for many others, they have reached a point where other technologies are needed to 'walk the extra mile'.

The recent research and development in the board-mounted power supply industry, which usually is not normally thought of in terms of lighting, have proven that digital power and power management can significantly improve performance and lower the power consumption of such modern lighting systems.

By introducing digital control in systems powering lighting, it has become possible to tightly control the different parameters during the life-cycle, adjusting power to the actual lighting demand, depending upon circumstances whether environmental or local requirements.



Among several benefits, digital power makes it possible and easier for any Energy Management Supervisor to monitor through a communication interface, the status of lighting at any time and point of operation, resulting in an optimization of the energy consumed.

There is no doubt that, as for other industries, digital power and power management will make lighting, as well as other power consumers, more efficient, reducing the overall energy consumed and preserving global energy resources.

But this, in lighting, is the tip of the iceberg. At the SMT show this week in Nuernberg..at the heart of the whole production side of our industry in Europe, I had the great opportunity to meet with Ross Berntson, the Vice president of Indium's Solder Products Business Unit where he told me how important the expertise of his guys was with in helping to keep the emissions and pollution down and also to advise and consult companies on how they can help themselves to be more competitive and develop themselves in this new 'green' world which is fast becoming a competitive plus factor. I had never realized what a great importance there was in sticking the high tech, multi-pin converters, POLs and other power products onto PCBs that would not flip-off at the critical thermal cycle or vibration….for instance in an aeroplane!

These guys are not only highly qualified and brilliant physics engineers, they are the consultants of the whole world of production design. There was much of this at the show, which made the trip an extremely worthwhile visit.

It was, I must admit, strange to see a true production show with a really 'Green' focus. Since my early 'NEPCON' days, way back in the UK, the focus was all about throughput and productivity, now it's a completely different story.

Also, with the NEPCON China show in April, the largest SMT trade event in Asia, - where it all happens these days, it featured the widest range of innovative SMT products and technology available. The entire range of SMT technology was there for every customer, providing a platform to source new suppliers, gather new market information and learn the latest technologies.

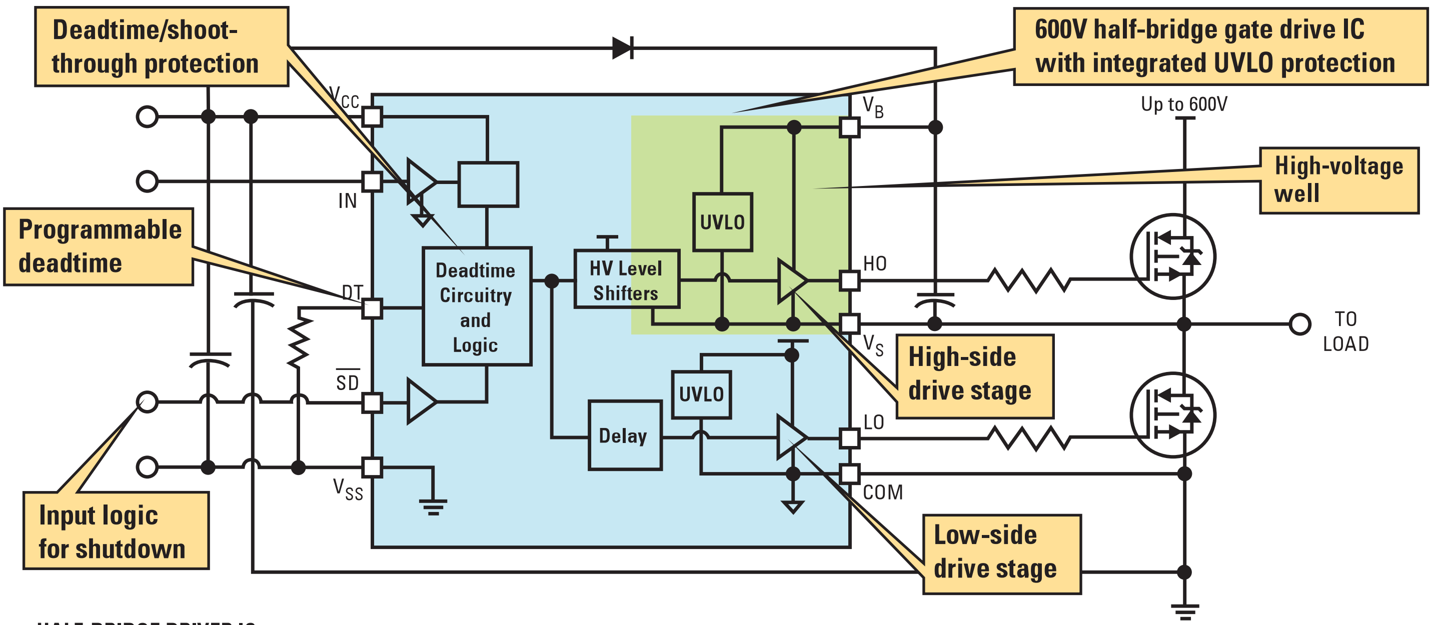
Just for the record, we had over 650 exhibiting companies from 22 countries, occupying 32,000 square meters of exhibit area filled with 18,000 high quality visitors.

I see our GreenPage featuring in the future, a lot more of what's coming from our power industry's, almost hidden, production technology in their pioneering approach to a new set of criteria, crucially important to the 'almost new' Green processes. Stay clean, get green.

www.powersystemsdesign.com/greenpage.htm

IR SETS THE STANDARD FOR 600V ICs

Rugged, Reliable, Highly Integrated



HALF-BRIDGE DRIVER ICs

Part Number	Pin Count	Sink/Source Current (mA)	Comments
IRS2103(S)PBF	8	290/600	UVLO V_{CC}
IRS2104(S)PBF	8	290/600	Input logic for shutdown; UVLO V_{CC}
IRS2108(S)PBF	8	290/600	UVLO V_{CC} & V_{BS}
IRS21084(S)PBF	14	290/600	Programmable deadtime; UVLO V_{CC} & V_{BS}
IRS2109(S)PBF	8	290/600	Input logic for shutdown; UVLO V_{CC} & V_{BS}
IRS21094(S)PBF	14	290/600	Input logic for shutdown; programmable deadtime; UVLO V_{CC} & V_{BS}
IRS2183(S)PBF	8	1900/2300	UVLO V_{CC} & V_{BS}
IRS21834(S)PBF	14	1900/2300	Programmable deadtime; UVLO V_{CC} & V_{BS}
IRS2184(S)PBF	8	1900/2300	Programmable deadtime; UVLO V_{CC} & V_{BS}
IRS21844(S)PBF	14	1900/2300	Input logic for shutdown; programmable deadtime; UVLO V_{CC} & V_{BS}

INDEPENDENT HIGH- AND LOW-SIDE DRIVER ICs

Part Number	Pin Count	Sink/Source Current (mA)	Comments
IRS2101(S)PBF	8	290/600	UVLO V_{CC}
IRS2106/IRS21064(S)PBF	8 / 14	290/600	UVLO V_{CC} & V_{BS}
IRS2181/IRS21814(S)PBF	8 / 14	1900/2300	UVLO V_{CC} & V_{BS}

IR's 600V ICs for motor control, lighting, switch-mode power supplies, audio, and flat-panel display applications deliver more features and greater functionality to simplify your circuit design and reduce risk.

IR's latest-generation high-voltage IC technology delivers superior protection and higher field reliability in an intelligent, monolithic driver IC.

Our new ICs are offered with single or dual inputs, under-voltage lockout protection, and fixed or programmable deadtime for half-bridge drivers.

Features:

- 3.3V logic compatible input
- Drive current up to 2.5A
- SO-8 package available*
- Separate COM and logic ground*
- UVLO protects V_{BS}*

**select models*

PCIM Europe 2007
Hall 12, Stand 202

For more information call +44 (0)1737 227215 or +49 (0) 6102 884 311 or visit us at **www.irf.com/product-info/hvic**

International IOR Rectifier
THE POWER MANAGEMENT LEADER