Power Systems Design EUROPE

Empowering Global Innovation

June 2007

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PSDE Green Power
ENERGY EFFICIENCY

Special Report - PCIM Europe 2007 Roundup

ISSN: 1613-6365

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

Send address changes to:
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Volume 4, Issue 5

An Industry of Vision, Leadership and Change

Last month we had the pleasure of participating at the PCIM conference and exhibition in Nuremberg, Germany. What a great show this was! Just as at APEC at the end of February in California, all the power guys came together, but here in Europe I got a better feel for what's happening here on our doorstep, so to speak. The atmosphere was, for me, electric (no pun intended!). I had the pleasure of several interviews and product pitches, much of which I have written up in this issue for the benefit of those who could not attend.

What was particularly interesting for me was the fact that top executives from the major power companies, are really taking the environmental issues seriously. In particular Alex Lidow of International Rectifier and Arunjal Mittal of Infineon were outstandingly insightful and vocal in their energy philosophies that, for sure, will become embedded in their respective company cultures. With the minds of these deep, creative thinkers I believe we will see, in time, real progress in terms of real products that are truly green and not just timely philosophies.

Power Systems Design Europe ran a very well attended forum, reported later in this issue. I would like to thank the presenters for their excellent material meticulously prepared and presented to a full house. I can recommend you look up the presentation compendium available on our website, again you will find this in the PCIM roundup section in this issue.

The issue of lighting really doesn't want to go away, and, thankfully, it never will. I gave a call for articles at the beginning of the year which resulted in a 'tidal wave' of material. There is so much innovation in this broad area, this is why we used it as the theme for our PCIM forum. We ran the special feature in two parts to cope with the number of submissions, but could easily have run to three. I have to keep a balance editorially so will report on developments in real time as the news comes in.

News just in time says that Philips Electronics India, is installing energy efficient lighting in India to help save the energy crisis there. Philips has outlined ambitious plans to sell 20 million CFLs in India by Dec 2007.

There are many more hot news items in this issue. Our news section leads with National Semiconductor's appointment of a new Vice President and General Manager for Europe, Robert Hinke. He brings a vast resource of marketing, sales and product experience to the role and will, I am sure, use this solid base to motivate and steer the rich and talented resources available within the company.

In my GreenPage report I mention the spiraling datacentre power demand. Just browsing the news-feeds, I see this is now being addressed as a matter of some urgency. Not altogether surprising, considering the huge wastage of energy here together with the accelerating demand for more computing power. I will investigate this further and report in a near-future issue.

So, before moving into this issue of PSDE, I must say that I have been greatly impressed by the volume of newly-launched, energy-efficient power design techniques and products that will certainly affect the lives of us all for the better. But in addition to all this, it has been refreshing to hear the views of the guys that are wielding great power and influence in our industry in that they have a very clear vision of what is needed in terms of tangible plans and actions to really help improve our environment. I absolutely believe that the environment will be fixed by the kind of engineers and visionaries I talked with recently at PCIM and APEC, rather than by any political committee directive.

All the best!

Cliff Keys

Editor-in-Chief, PSDE
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National Appoints Robert Hinke as Regional Vice President and General Manager for Europe

National Semiconductor Corporation has announced that Robert Hinke has been appointed Vice President and General Manager, Europe. Previously, Robert served as National's European Marketing Director.

Robert joined National Semiconductor in 1983 and now brings a wealth of sales, marketing and communications experience to his new position. Through his participation in National's marketing council, he has been instrumental in shaping the company's global marketing strategy.

The broad experience Robert has gained in his key positions within the company's sales organisation, including worldwide account manager and regional sales manager for National's Central and Southern European Communication Segment, forms a very strong foundation for this key leadership role.

Robert studied in Munich/Germany and holds a Master's Degree in Electrical Engineering. In his new role, he reports to Mike Noonen, National's Senior Vice President, Worldwide Marketing and Sales.

www.national.com

Digi-Key and Linear Technology Announce Expansion of Distribution Agreement

Digi-Key Corporation and Linear Technology Corporation have announced the expansion of the companies' distribution contract from a North American contract to a global contract.

Linear Technology Corporation designs, manufactures and markets a broad line of standard high performance integrated circuits. Principal product categories include amplifiers, battery management, data converters, high frequency, interface, voltage regulators and voltage references. Applications for Linear Technology's products include telecommunications, cellular telephones, networking products, notebook and desktop computers, video/multimedia, industrial instrumentation, automotive electronics, factory automation, process control and military and space systems.

Digi-Key Corporation is a broad-line distributor specializing in board level electronic components. The company's focus on product selection, coupled with its commitment to stock 90 to 95 percent of the products featured in its print catalog, facilitate Digi-Key to supply a broad range of customers from numerous areas of commerce and industry around the globe.

Linear Technology products stocked by Digi-Key include a wide range of integrated circuits. These products are featured in both its print and online catalogs and are available for purchase directly from Digi-Key. The distribution agreement between Linear Technology and Digi-Key enables the distributor to fulfill the needs of its diverse customer base.

"With Digi-Key's rapid growth in the overseas markets, we are very pleased to expand our agreement with Linear Technology," said Mark Larson, Digi-Key president and COO. "Linear Technology's commitment to quality and customer satisfaction makes for a valued partner, with Digi-Key passing its own brand of superior customer service on to the thousands of customers it comes in contact with every day."

www.digikey.com

www.linear.com

2 Million Barrels of Oil Saved by Energy-Saving Devices from STMicroelectronics

STMicroelectronics a leading proponent of sustainable development, announced that it had shipped over 250 million units of energy-saving products in 2006. Designed to reduce power consumption in end equipment from lighting to white-goods appliances and entertainment electronics, these ST chips allow to save over 1200 GWh of electricity at the point of use, which is equivalent to saving the more than 2 million barrels of oil needed to generate this energy.

ST's long-term focus on power-conscious design incorporates both reduction of energy consumption in the chip itself and contribution to energy savings in the end application. For example:

In lighting, their microcontroller-based solution for compact fluorescent lamps significantly reduces the energy consumption of the lamp by using high-performing switching components that minimize power losses. The microcontroller also makes the lamp's light intensity almost constant throughout the life cycle and extends the lamp's life, reducing waste. Intelligent dimming solutions from ST reduce power consumption in traditional bulb lamps while ST's phase-control dimmers also extend bulb life and enhance the consumer experience, providing smooth up-and-down light adjustments and memory presets.

Advanced motor-control and thermo-regulation technologies contribute to energy efficiency and higher reliability in a variety of home appliances from heating and air-conditioning systems to refrigerators and washing machines.

ST's patented sensorless motor controller adjusts the frequency and voltage of the power supplied to the motor and optimizes the motor speed to the load needs, thus reducing the energy consumed by white-goods appliances and air-conditioning systems.

The company's dedicated solution for refrigerators uses digital temperature regulation to maintain the internal temperature more accurately for better food preservation while saving power.

Remote control systems are yet another significant consumer of energy. ST's power-supply units for stand-by systems use innovative technologies to reduce energy consumption in TV sets, set-top-boxes and PCs, which remain in stand-by mode 24 hours a day.

According to iSuppli, STMicroelectronics is the world's number one supplier of semiconductors for power management.

www.st.com

50 Years of Pioneering Mobile Comms

In 1956, after nearly five years development, Deputy Director of Swedish Telecom Administration, Sven Thornander, made a 600 Kilometers mobile phone call from a bus in the town of Trelleborg throughout the Swedish archipelago. The mobile phone industry was born.

Powering such equipment was then very challenging and throughout fifty years of improvement, power supplies have played a vital role in the mobile industry.

Late 1977, in parallel with the development of pure telecom core-systems, Ericsson developed high efficiency, high reliability dc/dc converters to power its new generation of fixed and mobile systems.

"It was challenging for the power industry to develop military type dc/dc converters at a price for industrial, and to make them optimized for mass manufacturing, while permanently improving power efficiency", said Ericsson's Patrick Le Fèvre. "With more than 60 million dc/dc converters shipped to the Telecom and Datacom industry powering worldwide fixed and mobile telecom systems, the celebration of the millionth radio-base-station shipped to our Nigerian customer is the proven evidence that what was a huge challenge became a wonderful success story. More will come with next generation of intelligent power supplies drastically reducing power consumption and resulting in less energy consumed and CO_2 released during telecom systems' operation."

Ericsson has now delivered its millionth GSM base station. The shipment marks a milestone for the GSM technology that, since its introduction in 1991, has connected more than 2.3 billion users. Today, Ericsson has deployed GSM networks in more than 100 countries. The millionth GSM base station was delivered to the mobile operator MTN Nigeria.

Since delivering its first base station in 1991 to Mannesmann in Germany, Ericsson rapidly emerged as the market leader in GSM technology. The growth in demand for GSM services has resulted in Ericsson delivering the same number of GSM Base Stations during 2004-2007 as during the period 1991-2003.

Strong growth is expected to continue. The number of GSM subscribers around the world is set to increase by 40 million per month during 2007 according to the global trade association GSM Association, GSMA. More than 10 million are currently being added every month across India and China. In India alone, Ericsson is currently installing a new GSM base station every 15 minutes.

Kurt Jofs, Executive Vice President and head of Business Unit Networks at Ericsson, says: "After 16 years, the pace of GSM deployments shows no sign of slowing down. In fact, we expect 2007 to be the fifth consecutive record year for deliveries. Ericsson is committed to delivering quality communications for all. We will continue to leverage on our expertise in evolving mobile infrastructure to provide future-proof investment in Ericsson GSM networks."

GSM, first introduced in 1991, is the world's leading digital cellular system. It provides voice, packet switched data (GPRS/EDGE) and Short Message Service (SMS). GSM has become the world's most widely used mobile system and is now deployed in more than 100 countries on all continents.

www.ericsson.com

OSRAM Expansion in Opto Semiconductors with New Chip Factory in Malaysia

OSRAM is significantly expanding production capacity at its plant in Penang, Malaysia. At the same time, a further construction phase will be completed by the end of 2007 at its plant in Regensburg, Germany. OSRAM, Europe's leading manufacturer of light emitting diodes (LEDs) and number two on the world LED market, will be equipped to meet growing demand for LEDs far into the future. In Malaysia, in addition to the existing facilities for assembling Regensburg chips a wafer production line will be put into operation in 2008 for the upcoming volume applications for lighting and consumer.

The construction of a chip factory in Penang will mean that OSRAM will have a second production site for chips in addition to the plant in Regensburg. From 2008 the Penang site will manufacture LED chips. Total investment in the new plant will ultimately be in high double figures of millions of euros. The lighting manufacturer is also starting to expand the existing LED assembly facilities in Penang. When work is completed, capacity will be 50 percent higher.

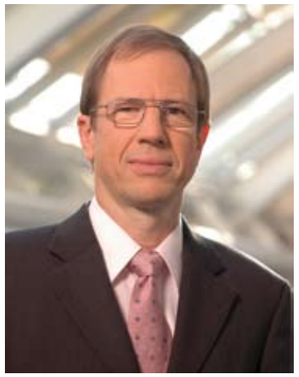
Expansion work will also continue in Regensburg at the same time as capacity is expanded in Malaysia. Regensburg will continue to manufacture semiconductor materials and produce wafers for highly innovative semiconductors for lighting, display and sensor applications. The new construction phase in Regensburg is approaching completion, with investment in high double figures of millions of euros. In addition to production, Regensburg also accommodates the central research and development of OSRAM Opto Semiconductors.

OSRAM CEO Martin Goetzeler said "OSRAM's life-blood is its innovations – and opto semiconductor products are central to our growth strategy. LEDs are the light sources of the future as they offer so many benefits including compact dimensions and enormous potential for energy savings. The expansion of our production capacity in Penang and Regensburg is a clear sign that we are on course for sustained growth."

Ruediger Müller, CEO at OSRAM Opto Semiconductors, commented: "The expansion of our production sites is our response to increased demand for LEDs throughout the world. At OSRAM Opto Semiconductors we now have the broadest portfolio of patents on the market. Our successful bases in Regensburg and Penang will enable us to strengthen our market position still further with technologically and economically impressive products."

www.osram.com

Infineon Appoints Dr. Reinhard Ploss to Management Board



The Supervisory Board of Infineon Technologies AG has appointed Dr. Reinhard Ploss to the management board. He will be responsible for operations, comprising advanced logic and power logic front-end manufacturing, back-end manufacturing, logistics and quality management units previously assigned to different responsibilities. "Our 'fab-light' strategy has caused us to shift the focus of our in-house manufacturing toward power logic products and to farm out manufacturing of advanced logic products to foundries. We are reorganizing to reflect this change," said Dr. Wolfgang Ziebart, President and CEO of Infineon Technologies AG. "Reinhard Ploss has not only been with the company and involved in the semiconductor market for many years, he also has exceptional knowledge and experience in these areas. This will help us to further improve productivity in our manufacturing operations." After receiving undergraduate and doctoral degrees from Munich University of Technology, Dr.Reinhard Ploss began his career at Siemens AG in Munich, where he held a number of managerial posts in the field of single process technology. He then moved to Siemens' semiconductor plant in Villach, Austria, where he was latterly responsible for the entire process technology. From 1996 to 1999, Ploss headed Siemens' Power Semiconductors division in Munich, and when Siemens spun off its Semiconductor Group to form Infineon Technologies AG in 1999, Ploss was additionally appointed to manage EUPEC, a wholly owned subsidiary of Infineon Technologies AG in Warstein, Germany.

www.infineon.com

Indium Roundup

New Sales Director for Asia Pacific Region

William (Bill) Brunstedt has been appointed Associate Director of Sales and Marketing for the Asia Pacific region. Bill is responsible for integrating sales activities in China and the Asia Pacific regions. In addition, he will work on developing and expanding the region-specific sales force throughout Asia. Bill has over 20 years of experience in the electronics industry and joined Indium Corporation in 2005 as a Market Development Manger for Asia. Bill is based at Indium Corporation's Asia Pacific office in Singapore.

New Business Development Director

Terry Guckes has been hired as Business Development Director for the Metals & Chemicals Business Unit. Terry is responsible for extending existing relationships and creating new customer opportunities for Indium's gallium and germanium products. He has extensive industry experience in specialty chemicals, batteries, solar, and gallium, as well as in production and reclaim and refinement of raw materials. Terry will be based at Indium Corporation's global headquarters in Clinton, NY, USA.

New Technical Manager

Richard Brooks is promoted to Manager of Technical Services for the Asia Pacific Region. Rich's primary responsibility is to train and manage the teams of technical support engineers that serve China and the Asia Pacific region. With 19 years of electronics industry experience, Rich provides the resources and experience necessary to lead a world-class support team. Rich is based in Texas, USA.

2007 Innovation Award

Indium5.1AT Pb-Free Solder Paste was awarded the Innovation Award at NEPCON China in Shanghai, China. Sponsored by

EM Asia magazine, the Innovation Award recognizes excellence in the Asian electronics industry.

Indium5.1AT is an air-reflow, no-clean solder paste that provides increased finished goods reliability when compared to competitive solder pastes. It features ultra low voiding (in the 5% range) when soldering BGAs with micro via-in-pad designs. No other solder paste is known to exceed this level of performance.

www.indium.com

Power Events

- ***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>*
- ***PCIM Europe 2008,*** *May 27-29, Nuremberg, Germany, www.pcim.de <http://www.pcim.de/>*

Efficient Full-Brick DC/DC Converter is 'Drop-In' Replacement for New and Old Designs

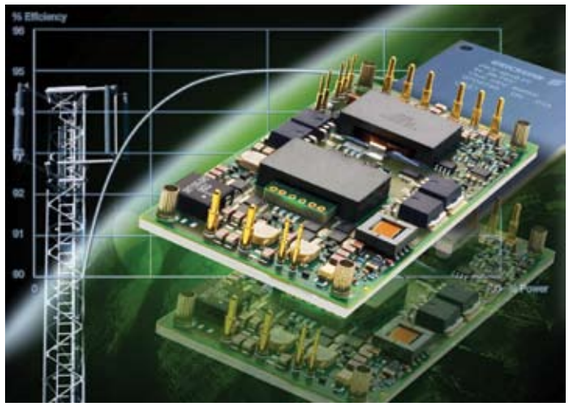
Ericsson Power Modules' latest DC/DC converter platform, the PKY4716PI, utilizes industry standard full-brick format and footprint, an excellent drop-in replacement for enhanced performance.

Predominantly aimed at the telecoms market with customers developing base transceiver stations in cellular radio networks where high efficiency and reliability are premium, the PKY4716PI is also suitable for many industrial applications.

Delivering 700W output power and typically exceeding 94 % efficiency, the efficiency curve is virtually flat from 30 % to 100 % load. This impressive level of performance is achieved by using a specially optimized topology and advanced rectification techniques.

The device will handle both 48V and 60V system voltages and has an input voltage range of 36-75V. For safety and availability, it can withstand up to 100V input continuously and features an ultra-wide output voltage trimming range that can be adjusted down to 10V to provide flexibility, desirable for different RF power amplifier technologies and applications.

Load and line regulation is typically 20mV with ±1% set voltage over a base-plate temperature range of -40 to 100°C. The device delivers full power at 100°C base-plate temperature. Fully current-limit-protected, the device has over-voltage protection on input and output connections. This new product fully meets ROHS requirements and, with its low component count, offers high reliability.



Offering superior efficiency in this market category, the PKY4716PI can handle dual system voltages. The very high control-loop bandwidth in the converter means that a minimum of external filter components are needed, giving greater economy and real estate savings for new RF power amplifier designs. In use, normally an input filter is not necessary if the input feeding impedance is low enough.

The unique use of magnetics, planar technology, switching and new advanced synchronous rectification, differentiate this new product. Mechanical design has been refined and offers very efficient thermal management able to handle the extreme power levels of high-performance DC/DC converters.

Demand drivers for this device include applications such as WCDMA base transceiver stations. Higher output power means increased demands on efficiency to reduce power losses and energy usage. It is estimated that 1 watt of power loss at board level is worth about $10 over a five-year period.

In addition, investments in central power equipment, standby batteries, cooling, floor space, and other areas are directly proportional to the power and energy consumption. Comparing the efficiency of the PKY4716PI with the market today, the energy cost savings alone would account for about $150 over a five-year period, assuming 70 percent average output power and $0.1/kWh. This is for one single converter. A base transceiver station, or radio base station, contains several RF power amplifiers and converters, so nationwide deployment would result in huge annual savings. This makes it a great investment, both for the bottom line and, importantly, for the environment.

www.ericsson.com/powermodules

Pioneering a Greener Electrical Environment

By Christophe Basso, Application Manager – Automotive and Power Regulation Group, ON Semiconductor

Since the days when Thomas Edison powered the first light bulb in 1879, electricity was considered a gift and our modern consumer life-style shows this to be true. Unfortunately, freedom always comes at a price. International agencies have now been set up to regulate energy production amidst concerns that atmospheric emissions from power stations contribute to the cause of many climate-related problems. Solutions need to found to reduce energy bills while protecting the environment. Capitalizing on long term experience in the energy conversion domain, ON Semiconductor plays an active role in the race toward lower and smarter power consumption. In the 80's the UC384X family entered the market as the only reliable Switch-Mode Power Supply (SMPS) controller. At this time, power greed was not of real concern and a generic UC384X-based power supply could easily draw 10W when left connected idle to the mains. Ahead of their time, ON Semiconductor successfully introduced the MC4460X family with the intention of drastically reducing power consumption in consumer applications left in standby mode. Today, ON Semiconductor's components power LCD/ plasma TVs and set-top boxes via hard switching or resonant solutions, offering cost effective and flexible semiconductor solutions to achieve standby power levels below 300 mW.

ON Semiconductor's new integrated circuits provide the designer with ready-to-use solutions aimed to address and exceed the next International Energy Agency (IEA) recommendations, Blue Angel and U.S. Energy Star regulations. Techniques range from skip-cycle to frequency foldback, depending on output ripple requirements. Measurements carried out on 65 W adapters built with the NCP1230 or the NCP1271 have shown the ability of these new controllers to lower the no-load standby power below 100 mW in high-line conditions.

When a power supply engineer designs a converter, the component choice and arrangement are mainly dictated by the wish to maximize the efficiency at nominal load. This is the case for a personal computer (PC) where the efficiency of a standard 250 W silver box peaks around 75% at full power. Experience shows however that a computer will rarely consume its full power during a normal operating time. Given its internal structure, the system is more likely to draw energy in a range of 20% to 60% of the power supply capability, with surges up to 80% sometimes. Therefore, as the power supply operates a long way from its nominal design point, efficiency suffers drastically. In an attempt to improve the situation, a new program called 80 PLUS, funded by US electricity suppliers, has been implemented. This program imposes efficiency above 80% for a power supply operated between 20% and 100% of its capacity. ON Semiconductor is one of the first vendors to obtain 80 PLUS certification for a power supply built with an active-clamp controller, the NCP1562.

If energy efficiency poses a challenge to power supply designers, electricity suppliers face another concern brought about by the multiplication of ac-dc front-end sections: the full-wave rectifier drawing discontinuous current pulses. Given the operating principle which consists of recharging the bulk capacitor at the sinewave peak, the input current and voltage suffer distortion and sag. Among the many troubles it brings, distorted line signals induce higher rms currents and force the use of heavy and expensive copper wire. ON Semiconductor was one of the first companies to introduce Power Factor Correction (PFC) circuits designed to shape the current and make it look more 'friendly' to the electricity plant. The MC33261 and MC33262 actually pioneered this effort 20 years ago when no official coercive standard ruled this domain. In January 2001, the European Community firmly adopted the IEC1000-3-2, banning non PFC-equipped products if the power drawn exceeds 75W. ON Semiconductor, in its efforts toward better and smarter worldwide power consumption, has recently introduced several new PFC controllers among which the NCP1653 sets new performance standards. Single-stage PFCs are also highly regarded given the benefit they bring in terms of compactness and cost reduction. The NCP1651 operates a single-switch flyback in a continuous conduction mode and brings excellent power factor performance together with a reduced bill of materials.

Years ago, consumer devices such as TVs or VCRs were lacking technical solutions to reduce their own consumption bill, making the design of efficient power supplies a perilous exercise. Fortunately, the situation has now evolved favorably and the semiconductor industry now offers design solutions to meet even the most stringent laws and regulation limits, which in addition, are environmentally far superior to their predecessors.

www.onsemi.com

Communications Systems Driving Innovation

Networking systems spurring improvements in the power supply industry

By Marijana Vukicevic, iSuppli Corporation

The communication equipment market has grown tremendously in the past decade due to the widespread adoption of the Internet and the upgrade of obsolete telecommunications equipment, both wired and wireless.

The telecom/datacom network equipment market comprises infrastructure equipment used to handle the transfer of voice and data around the world's communication networks. It is a large and well established market whose major players include manufacturers of high-end servers and switching and routing equipment.

The performance level, power throughput and system costs typically are higher for such systems than in most other kinds of equipment. The power conversion takes place throughout a full network equipment power system, spanning the entire range, from the AC mains to the final point of power consumption.

Networking equipment—i.e. switches, routers, servers—by definition need to work in concert with other such devices—anywhere from one to thousands—in a system. Furthermore, such systems

often employ redundancy techniques to ensure adequate system reliability and performance. The size of those systems is large, and for that reason, coordination between power subsystems will become crucial in the coming years as companies redefine the components in such systems in order to drive out cost or to increase performance.

Complex systems as networking equipment often serve as an early-adoption opportunity for innovations in the power supply industry, innovations that ultimately may have wider applicability throughout the industry.

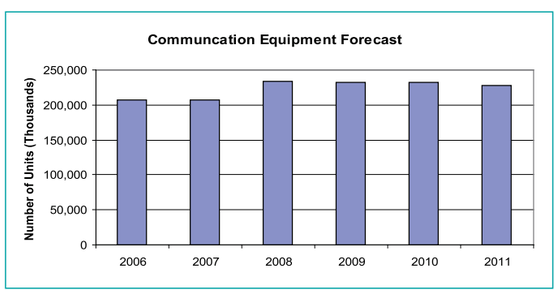


Figure1: iSuppli's forecast for communication equipment units for the period of 2006 through 2011.

In 1980s and 1990s, telecom switching systems drove the trend toward distributed power and innovations in higher-density DC/DC conversion. Principles including lower profiles, higher frequencies, new technologies, new component form factors, innovations in magnetic devices and distributed power since have been employed throughout the power conversion industry in non-network applications. Voice and data network power developments therefore can be viewed as a bellwether for future trends in the power supply industry in general.

As such, communications systems are driving deployment of high-performance AC/DC and DC/DC power supplies. The system design is becoming more complicated as the number of supply voltages is increasing and power requirement levels are rising. An example of this trend is a mid-level server power system design that accommodates more than 10 point-of-load supplies, and is likely to rise to support more than 20 in the near future.

The requirement for more sophisticated power supply designs is unavoidable—and the way to implement them is through the use of digital power. As of today, some communication equipment uses digital power managers (DPM) that administer power supplies and connect them to other parts of systems. Some use digital control of power (DCP) that combine voltage loop controls and digital power managers into a single unit.

The communication market is a major technology driver, and in the case of digital power will be a market driver too. The market for digital power in the communications equipment market is predicted to grow by a factor of four from 2007 to 2012.

Figure1 presents iSuppli's forecast for communication equipment units for the period of 2006 through 2011.

www.isuppli.com

Using the TL431 in a Power Supply

I've devoted several articles so far to the complexities of allegedly simple passive components. In this article, we'll look at one of the active semiconductors of the power system—the popular TL431. This three-terminal part includes a precise voltage reference and an amplifier. It consumes very little board space and is widely used in the industry to achieve reasonable performance at low cost. However, its analysis is very complex when used with an optocoupler for feedback isolation.

By Dr. Ray Ridley, Ridley Engineering

Operational Amplifier Feedback

For the best performance, the preferred circuit for feedback control compensation uses an error amplifier and a precision reference—part of the control chip for non-isolated supplies. Current-mode control is the best way to control converters, and is used by most power supply designers. For this type of control, the optimal compensation network is a Type II amplifier, an

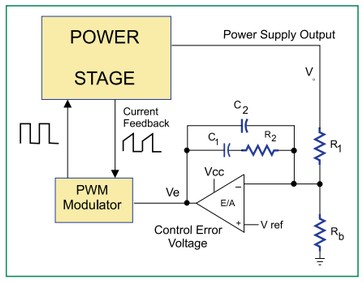


Figure 1a: Type II Compensation Feedback.

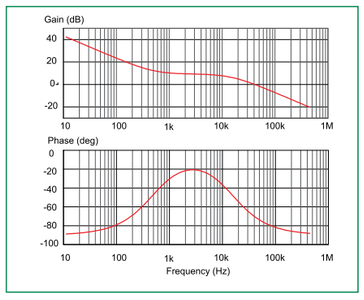


Figure 1b: Type II Compensation Bode Plot.

example of which is shown in Figure 1. In this configuration, a conventional operational amplifier is used to amplify the difference between the output voltage of the power supply and a fixed reference voltage.

Figure 1b shows the typical compensation curve for a Type II amplifier. At low frequencies, the circuit acts like an integrator, utilizing components C_1 and R_1 to provide high gain. Resistor R_b provides the correct dc regulation level, but due to the virtual ground at the input of the error amplifier, it does not appear in any of the gain equations.

At a frequency typically several times less than the loop gain crossover, a zero is introduced in the transfer function and the midband gain of the compensator is given by the ratio of R_2 and R_1.

At a higher frequency, selected according to the power stage characteristics, the circuit again forms an integrator, the gain determined by R1 and C_2. Exact choice of these parameters are outside the scope of this article [1,2].

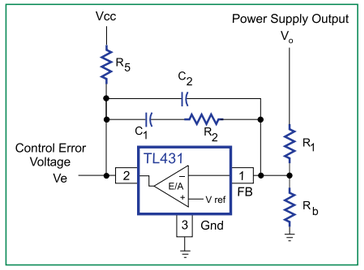


Figure 2: TL431 Used as a Type II Amplifier.

Figure 2 shows how the TL431 can be used as a standard error amplifier. There are three differences found when using this part versus a standard operational amplifier:

1. A pullup resistor must be used on the output. The value of this resistor must be chosen to provide sufficient bias current to the device under all circuit conditions. Furthermore, the output of the amplifier must be kept above a minimum value required to provide the bias;
2. A good voltage reference is included in the part; and
3. The open loop gain, and drive capability are less than that of a good op amp. However, if you keep the impedances around the amplifier high, it will work well.

If the TL431 is configured as shown in Figure 2, and these are obeyed, the design procedure is the same as for a standard Type II amplifier.

TL431 Feedback with Isolation

Most engineers using the TL431 don't use it as in Figure 2. They use the circuit that has become very widespread in the industry where the TL431 is used in conjunction with an optocoupler to provide feedback loop isolation, as shown in Figure 3.

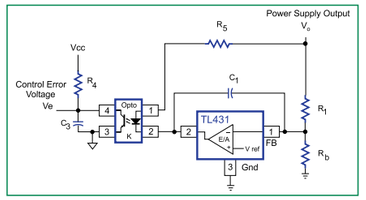


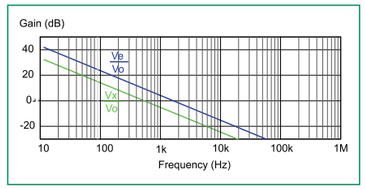
Figure 3: Typical TL431 Configuration with Output Bias and Optocoupler.

In this circuit, the output of the TL431 is powered through the resistor R_5, and the optocoupler diode, connected in series with the power supply output. This apparently subtle change has a big effect on the way the circuit works. The gain of the circuit is now driven by the current into the output of the TL431, not by its output voltage. This current is determined by three things: the voltage gain of the TL431, the supply voltage to the top of the resistor R_5, and the value of the resistor itself. While the circuit of Figure 2 is independent of the resistor value and the supply voltage, the circuit of Figure 3 is a strong function of both of these quantities.

Note that the feedback compensation consists of just a capacitor, C_1. A second capacitor, C_3, represents the output capacitance of the optocoupler, and its frequency response rolloff. However, the circuit of Figure 3 is still a type II compensator, although this is not immediately apparent.

TL431 Compensation – Low Frequency

At low frequencies, the gain of the TL431 amplifier, with capacitor C_1 and Resistor R_1 forming an integrator, is high, and this dominates the response. Figure 4a shows the low-frequency equivalent circuit.



The gain from the power supply output to the output of the error amplifier, Vx, is given by the classic integrator equation, and plotted in green in Figure 4b. Going across the isolation boundary through the optocoupler, this integrator gain is multiplied by the current gain of the optocoupler, and the ratio of the resistors R_4 and R_5. The resulting low frequency gain of the circuit, from power supply output, to control input, Ve, is shown in red in Figure 4b.

TL431 Compensation – Mid Frequency

At a higher frequency, the gain of the integrator around the TL431 amplifier reaches unity, and beyond this point, the voltage signal is attenuated. However, there is always gain from the output voltage to optocoupler diode current due to the connection of the resistor R_5 to the power supply output. In the midband frequencies, this is the dominant feedback path.

Figure 5 shows the equivalent circuit in the midband region. The gain is determined entirely by the choice of resistors on the primary and secondary side of the optocoupler, and the amplifier is not part of the circuit. The crossover of the loop will normally occur during this frequency range, and the resistors should designed first for the desired crossover frequency.

TL431 Compensation – High Frequency

At high frequencies, we encounter the pole of the optocoupler itself. This is represented by the capacitor C_3 in the circuit of Figure 6a.

Figure 6b shows the rolloff of the gain of the optocoupler. With a good opto-

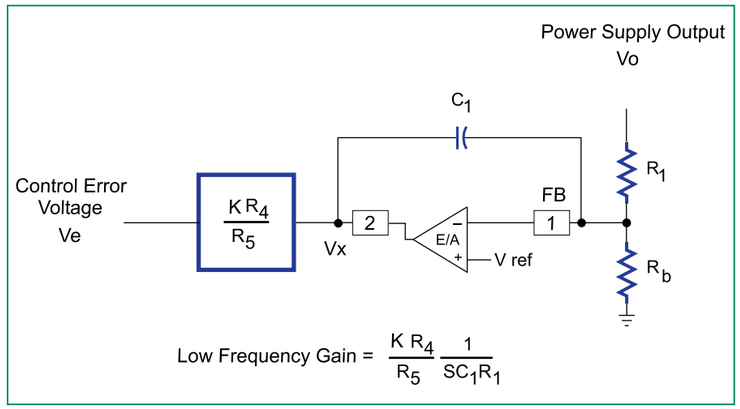


Figure 4a: Low Frequency Circuit for Typical TL431 Connection.

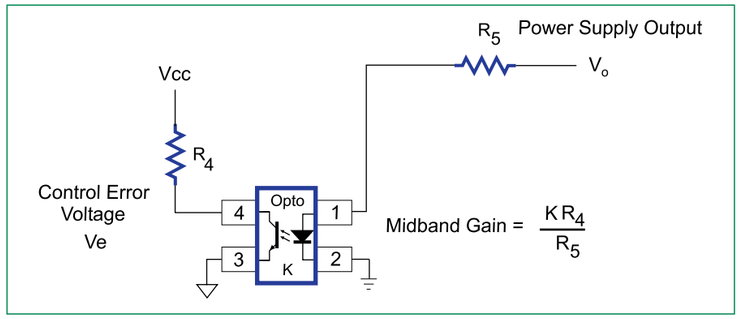


Figure 5: TL431 Circuit Midband Gain.

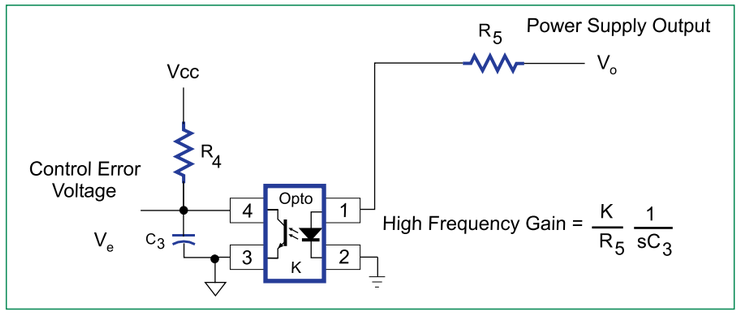


Figure 6a: TL431 High Frequency Gain Circuit.

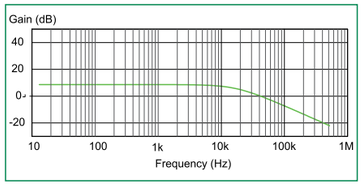


Figure 6b: Mid-Frequency and High-Frequency Gain Plot.

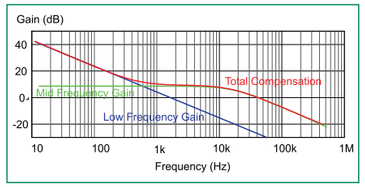


Figure 7: TL431 Final Compensation Gain.

coupler, this can be in excess of 10 kHz. However, the rolloff is a function of the current level at which the optocoupler is operated. The more current flowing in the device, the higher the bandwidth. It is advisable to bias the optocoupler with relatively low values of resistors to make sure it operates near the upper end of its rated current range.

Unfortunately, for integrated power supplies, the bias resistor is built into the controller, and cannot be easily changed. This often forces the optocoupler to operate in the low current region, and the loop design is compromised.

TL431 Complete Compensation

The two feedback paths of the TL431 configuration combine to give the total compensation shown in Figure 7. The integrator gain, shown in blue, dominates at low frequencies, and the second feedback path through the bias resistor dominates at mid and high frequencies.

The resulting total compensation is shown in red. This is still the desired Type II compensation, optimal for current-mode control. However, the design of the frequency break points is now more complex, and determined by components other than just the feedback parts around the error amplifier.

TL431 Loop Measurement

If you are going to use this circuit for compensation, you MUST measure the resulting loop gain to make sure you have a stable system. The entire stability of your power system using the TL431 circuit is dependent upon quantities that can be very variable. The gain and bandwidth of the optocoupler can change from part to part, and also vary significantly with time and temperature.

Care must be taken in measuring the loop. It is important that you break both of the feedback paths by injecting as shown in Figure 8. This will provide the proper loop gain of the system. If you attempt to measure the loop at either point A or B shown in this figure, the measurement results will not be particularly useful for the design of a well-compensated loop.

An additional valid point for injection and measurement is at point C, on the primary side of the isolation boundary, although this is sometimes more difficult to implement due to line-referenced voltages.

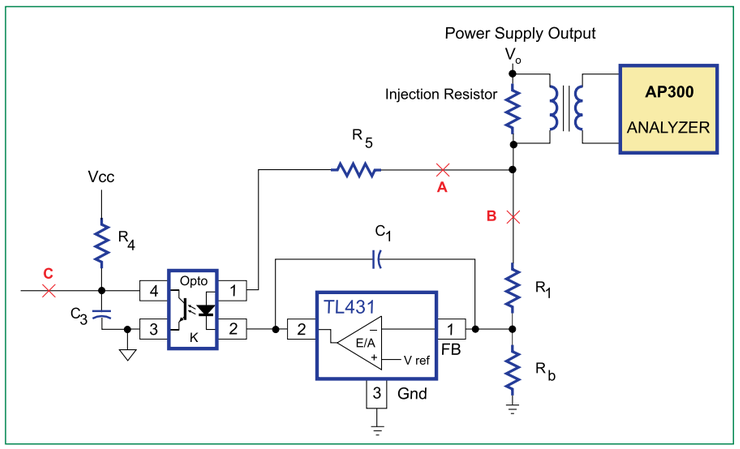


Figure 8: While measuring the loop, it is important to break both of the feedback paths by injecting.

Summary

Should you use the TL431 as your primary feedback amplifier? By all means, it has a good internal amplifier, and reference, and if your output voltage level is high enough, it can work well. (A low voltage version of the part, the TLV431, extends the range of operation to lower output voltages.) If you hook the TL431 up in its industry standard configuration with an optocoupler, be sure to follow the recommendations of this article, and you should be able to design a rugged control loop.

1. Design course notes, www.ridley-engineering.com/workshop.htm
2. “Switch Mode Power Supply SPICE Simulations and Practical Design”, Christophe Basso.

www.ridleyengineering.com

How Much Does Your System Really Cost?

I asked Alfred Hesener, the Marketing Director for Fairchild Semiconductor, responsible for the European market to enlighten us a little more about the multiplicity of advantages gained by today's popular use of modules in power electronics.

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

Thoroughly analyzing the cost components of a given system often reveals surprising insights – costs are higher than anticipated, the factors driving the cost may not be what you expect, and the impact on the end user of the system can again be quite different from what can normally be expected!

Taken at face value, the cost of a given system is the sum of the cost of its components – that's easy. However, moving from this simple summing operation to the cost of a finished design (and let's not forget the occasional redesign), to a readily assembled board, to a tested and mounted board, and then on to the energy the system is consuming for its given function, the failure rate it is showing, and the performance and / or cost improvements it can bring to the party, adds a lot of further variables to the equation – in return, all of these factors are influencing the selection of the original components on the BOM in the first place.

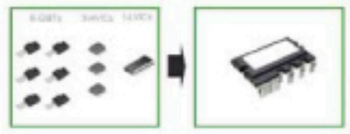


Figure1: Ten or more components can be integrated into one module.

In system design, there is an opportunity that is becoming more and more of a reality, as lower-cost, higher-reliability multichip packaging techniques move into the mainstream: power modules. Gone are the days when getting the module to not fall apart upon a few thermal cycles used to be a mystical art, and no flexibility in changing key parameters meant huge NRE cost and pretty much going down a one-way street with no alternatives.

Table 1: How the usage of modules drives different system cost components.

Impact of using modules on…	BOM cost	System cost	Time to market	0h failures	Failures in time
Reduced number of components	+	+	++	++	++
High performance	++	++	+	0	0
Increased reliability	0	0	+	++	+++
Less board space or application volume	++	+++	++	0	0
Easier and faster design	+	++	+++	+	++
Reproducible performance	++	+++	++	+	+

Integrating key components into a module offers many advantages, with the cost improvements possible driven mainly by the much improved fine-tuning between the different components – no extraordinary design margining required. This in turn helps first of all to improve the system cost, since a higher performance can be reached, the board space can be reduced, and the desired performance can more easily be reproduced, reducing the amount of effort required elsewhere in the system to compensate for component variations.

A standardized module with a gate drive circuit that's tried and tested, along with its standardized high-power routing and protection functions that are close to the components to be protected, can significantly reduce design time – especially in the case of changing a system to higher (or lower) power. With pin-compatible power modules available today, that task can literally be reduced to the few seconds it takes to change a part number in the EDA design system. And that in turn helps to improve time to market, a factor that has a large impact on the success of a given system!

As the module manufacturer performs the reliability engineering at module level, testing all the components involved together, the reliability of the system is strongly improved. This can be shown both in 0h failures as well as field failures, the latter being significantly more expensive to fix.

Energy efficiency is always welcome, since it brings cost savings in three different ways, namely, reduced effort for cooling the system, resulting in reduced system size; lower electricity cost over the lifetime of the system; and, reduced environmental impact. Especially in industrial applications, where the cost for operating equipment is part of the calculation of the total cost of ownership, improving the efficiency can be a significant competitive advantage.

Using modules in power electronics has many advantages. Above table shows the impact of using modules on the different cost factors of an application. For all the applications that do not simply have enough space or relaxed performance requirements, module-based solutions can significantly improve the cost end users are seeing.

www.fairchildsemi.com

Multi-Function Power Management Solution from Linear

Li-Ion/Polymer battery applications

Linear's switch mode USB power manager & triple buck regulator provides faster charge time with minimized thermals. I talked with Tony Armstrong, Linear's Power products Marketing Manager.

Reported by Cliff Keys, Editor-in-Chief PSDE

Linear Technology Corporation has just announced the LTC3555, the first in a family of next generation multi-function power management solutions for Li-Ion/Polymer battery applications. The LTC3555 integrates a switching PowerPath™ manager, a standalone battery charger, an ideal diode, I2C control, three high efficiency synchronous buck regulators plus an always-on LDO, all in a compact, low-profile 4mm x 5mm QFN package.

High-end portable electronic devices continue to be constrained for board space, while battery capacities are increasing due to increased power demands from today's demanded increased levels of functionality. USB charging is now becoming commonplace and the number of system rails continues to increase in order to power uP/FPGA/DSP cores, I/Os, memory circuits, media processors, radio/mobile broadcast receivers, HDDs, etc..

The LTC3555 is the first member of a new family of products that implement truly 'meaningful' integration to allow designers to deliver vital competitive advantage. This means simply that Linear have talked with their customers and found out what they actually need. Somewhat different to many manufacturers who simply pack as much as possible onto a chip, almost as a demonstration of technological achievement, a

Multi-Function Switching Power Manager+Battery Charger+Triple Sync Buck+LDO

practice that comes at a price, not just in dollars but also in terms of thermal issues, routing problems and the possible generation of spurious noise from unused regulators on the chip.

Performance needs for portable products major on high efficiency, low output voltage and medium to high output current from bucks, fast charge rates, small solution size and minimal external components.

Many designers in the portable electronics marketplace perceive that Power Management ICs (PMICs) are big, clunky, low-performance, but relatively cheap ICs. Linear's products clearly demonstrate to the design community that high-performance PMIC's now exist in the marketplace, i.e. all multi-function PMIC's are no longer alike.

The intelligence in the new LTC3555 from Linear is truly outstanding. With Linear's PowerPath system, the load is always powered first, no matter whether the battery is flat, faulty or even missing. This gets rid of the perennial and most annoying problem of a portable device not starting up due to the battery charging priority from the charger chip. But thankfully, to the hard-pressed designer, this intelligence poses no extra problems. Linear's customer research and dialog has been used effectively. They want all these extra differentiating features to be easy to implement. Linear, as a function of their well developed design culture, look beyond the requirements of today and project this well into the future so that once a family is agreed and put into silicon design, it will last. No 'knee-jerk' spins and fixes are generally necessary due to this meticulous and practical planning for their future customer needs. This is the reason they have the most envious business model in the industry with their innovations in power often 'adopted' by competitors. Perhaps this is the most sincere form of flattery.

Tony Armstrong, Linear's Power Products Marketing Manager at the company's HQ in Milpitas California, commented, "We take very great care when defining new analog ICs. This is based in part, upon our ongoing dialog with our customer base, and input from our huge engineering talent here to determine future requirements also. We are highly adept at anticipating future customer needs; therefore, it is common for our products to generally satisfy the needs of the majority of customers - and that is a great achievement and accolade for our engineers and field staff.

In this specific case, we anticipated the demand for higher power loads and higher capacity batteries. Thus, with this chip, for example, we demonstrate a very high efficiency energy transfer. When powered from a current limited source such as a USB port, you don't want to waste any available energy which will aggravate the thermal issues associated with small packages. Using a linear regulator taking 5.2 volts down to, say, 3.6V, you will get a power loss of about 32%. Using the switching regulator as we do, this loss is as little as 7%. Thus, the best use of a limited energy source and much less heat dissipation means no risk of thermal shutdown as with linear regs, it's win-win".

Linear's Bat-Track™ system which charges the battery at 300mV above the battery terminal voltage ensures that dissipation is minimized. This is a big deal for portable products where the battery will still receive a charge even when the device is in use. Even when the source current is limited to 100mA,

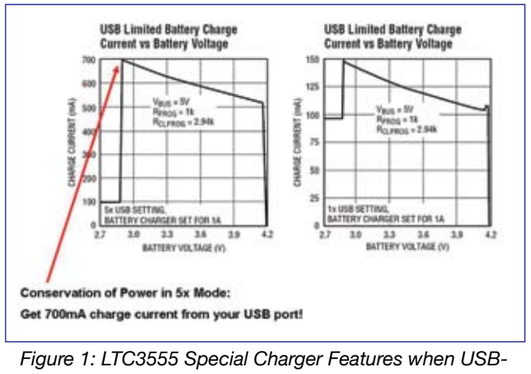


Figure 1: LTC3555 Special Charger Features when USB-powered.

the portable device, which in the case of an mp3, will need about 80mA leaving the remainder for the battery via a high efficiency charger.

The LTC3555's PowerPath control feature seamlessly manages power flow between an AC wall adapter or USB port, Li-Ion battery and system load while its "instant-ON" operation ensures system load power even with a dead or missing battery. For fast charging, the LTC3555's switching input stage converts nearly all of the 2.5W available from the USB port to charging current, enabling up to 700mA from a 500mA limited USB supply and up to 1.5A when wall powered. An internal 180milliOhm ideal diode plus optional external ideal diode controller provide a low loss power path, further minimizing heat generation and maximizing efficiency.

The chip's three integrated synchronous buck regulators feature 100% duty cycle operation and are capable of delivering output currents of 1A/400mA/400mA, respectively, with adjustable output voltages down to 0.8V. The internal low $R_{DS(ON)}$ switches enable efficiency as high as 94%, maximizing battery run time. In addition, Burst Mode® operation optimizes efficiency at light loads with a quiescent current of only 35uA per regulator (<1uA in shutdown). The high 2.25MHz switching frequency allows the use of tiny low cost capacitors and inductors less than 1mm in height. Furthermore, the regulators are stable with ceramic output capacitors, achieving very low output voltage ripple.

The device features USB-compatible programmable current limiting to 100mA/500mA/1A, while its Bat-Track adaptive output control enables high efficiency charging and reduces power dissipation. Standalone autonomous operation simplifies design, eliminating the need for an external microprocessor for charge termination. To preserve battery energy, the LTC3555 draws <23uA from the battery in suspend mode. The charger is compatible with inputs up to 5.5V (7V absolute maximum transient for added robustness).

Here follows a summary of features for the LTC3555:

- Complete Multi-Function PMIC: Switching Power Manager, Li-Ion/Polymer Battery Charger, Three Buck Regulators & LDO
- Thermally Enhanced, Low Profile (0.75mm) 28-Lead 4mm x 5mm QFN Package

Power Manager & Battery Charger:

- High Efficiency Switching PowerPath Controller with Bat-Track Adaptive Output Control
- Programmable Input Current Limit (100mA/500mA/1A)
- Maximum Charge Current Programmable up to 1.5A from Wall Adapter
- 180mOhm Internal Ideal Diode Plus Optional External Ideal Diode Controller Provides Low Loss Power Path from Battery to Load

DC/DC

- Three, High Efficiency 2.25 MHz Synchronous Buck Regulators: 1A, 400mA, 400mA I_{OUT}
- Adjustable Output Voltage Range: 0.8V to V_{BAT}
- Burst Mode Operation with Low I_Q: 35uA per Regulator
- Always-On 25mA/3.3V LDO

This will undoubtedly be a real hot product for the portable electronics market. Linear have accumulated a great deal of experience here, already working with major players in this booming industry.

The LTC3555 is available from stock in a compact, low-profile (0.75mm) 4mm x 5mm QFN-28 package.

www.linear.com

System on Chip for Brushless DC Motors

Silicon integration enables next-generation motor designs

The latest levels of silicon integration are helping designers of brushless DC (BLDC) motor designs to simplify development and drive down component count and cost without sacrificing functionality or performance.

By Dr Georges Tchouangue, Principal Engineer and Wolf Jetschin, Senior Marketing Engineer, Toshiba Electronics Europe (TEE) Dusseldorf, Germany

From industrial pumps to white goods and from fans to air conditioning systems, the demand for brushless DC (BLDC) motors is growing year-on-year in line with requirements (both commercial and legislative) to improve efficiencies and deliver quieter, cleaner operation.

BLDC drives offer a number of advantages over brushed DC and induction motors – but to make the most of these benefits while ensuring accurate and effective motor control has typically required very complex solutions. Now, however, the latest integrated application specific standard product (ASSP) semiconductor technologies are helping engineers to simplify and reduce the costs of BLDC motor-based applications while allowing them to improve performance, functionality, reliability and efficiency.

The advantages of going BLDC

There are a number of advantages in choosing BLDC motors for modern motion control applications. The elimination of mechanical commutation, for example, leads to quieter operation with less vibration and helps to increase reliability and reduce maintenance even under non-fault conditions. What's more, BLDC motors can also win on pure performance considerations: their dynamic response is superior to many alternatives and they can reach higher speeds. In certain cases choosing a BLDC approach may allow smaller and more cost effective motors to be chosen, making them suitable for space-constrained applications, which then also benefit from their easier cooling and inherently increased torque density. Cost considerations are further aided by the fact that falling prices have made BLDC motors much more affordable in recent years.

Driving BLDC Motors

BLDC drivers use electronic, rather than mechanical, commutation and hence require inherently more complex circuits to drive them. The main component of the drive is an inverter based on power MOSFETs or IGBTs, which direct current to the wound components (Figure 1).

The power MOSFETs in the power stages require gate drivers and the overall system needs high-level control – for instance for start-up sequencing and fault-state handling. Designs will also need some form of feedback mechanism to sense the rotor position and allow the controller to calculate the necessary PWM stator waveform; only then can the electronics commutate the outputs at the correct time to produce the desired speed of motion. Indeed, position sensing constitutes a fundamental design decision for the drive designer and will guide the choice of controller device.

Absolute rotor position detection, which requires a resolver and sophisticated vector control techniques, is the domain of very high-end systems. For most other applications the choice is typically between Hall-effect sensing or sensorless architectures.

Hall-effect sensing is an established technique with well-understood advantages: primarily, it allows higher torque to be applied at zero speed than sensorless designs; and the controller circuitry allows enough 'detectable incidents' per revolution to minimise jitter and to provide the necessary accuracy of position detection. This allows the production of drives that are versatile and resistant to stalling. For some applications however, the addition of the sensor element may be too costly, or it may be impractical to mount the sensor in close enough proximity to the rotor. Furthermore, adding Hall sensors clearly has an impact on overall reliability, an issue that is compounded by the fact that the sensors themselves can be prone to damage and to demagnetisation of the small rotor magnets used to trigger them. Use of sensors also necessitates additional interconnections, increasing vulnerability to electrical noise. This has led many designers to employ a "sensorless" architecture. In this case the drive circuit measures the back-EMF from the stator coils and employs the necessary algorithms to determine the rotor position.

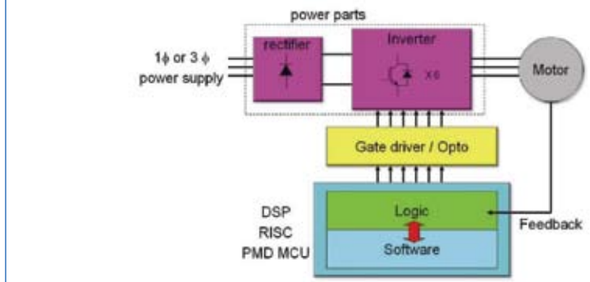


Figure 1: Block Diagram of Inverter.

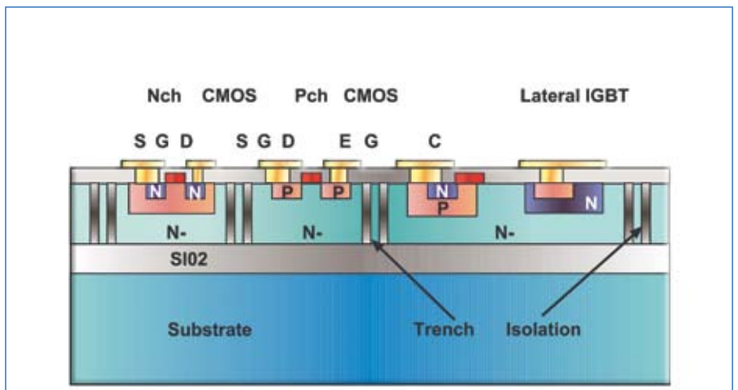


Figure 2: Toshiba SOI Power Structure.

SOI (Silicon on Insulator) for BLDC applications

Developing integrated semiconductors that can simplify drive implementation is not a trivial task, not least because such ICs must combine high-voltage switching with digital control circuitry. Chip designers have therefore been obliged to use new fabrication techniques for BLDC driver components. For the AC 110V and the AC 220V main voltages, for example, Toshiba has developed its own high-voltage SOI manufacturing process that allows the integration of power transistors with almost any type of active device in a monolithic circuit.

Conventional bulk silicon fabrication technology forces designers to use junction isolation to isolate individual circuit elements. But devices such as forward biased diodes and minority carrier injection devices cannot then be integrated on the same substrate as a high voltage power transistor such as an IGBT or power MOSFET.

By contrast, Toshiba's high voltage SOI fabrication allows the various circuit elements to be isolated by a thin layer of silicon dioxide, which is a perfect insulator. Not only does this allow almost any type of active device to be integrated alongside power transistors rated up to 500V or higher, but it also allows all devices to be packed together very densely on the substrate. Leakage currents are

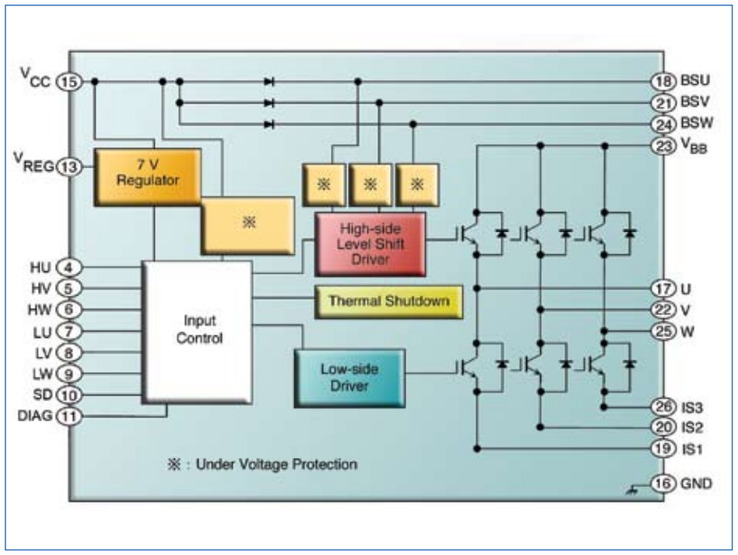


Figure 3: Block Diagram of TPD4120.

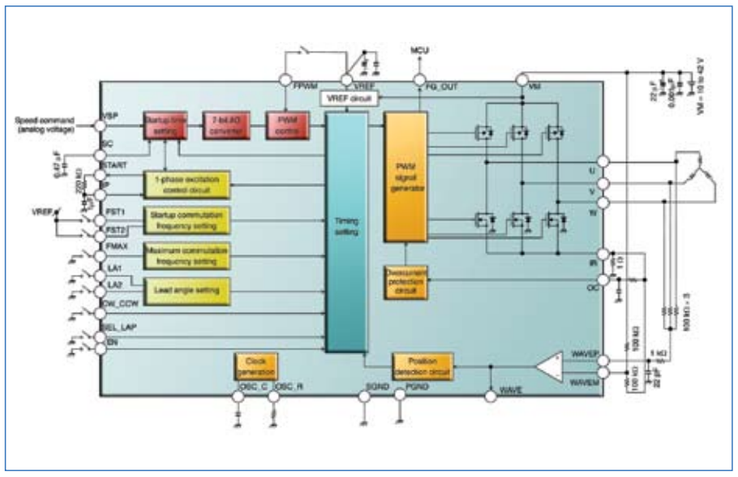


Figure 4: Block diagram of Toshiba's TB6588FG PWM sensorless driver ASSP.

also greatly reduced, as are parasitic effects. By comparison, junction isolation techniques introduce parasitic capacitances and do not prevent leakage currents from flowing.

Toshiba's SOI power ICs incorporate silicon dioxide trenches that isolate the IGBTs from low-voltage CMOS circuitry. These trenches can be made very thin, enabling compact and highly integrated power devices. In fact, the separation area between high voltage devices is reduced to around 0.7% of that required for a bulk silicon device of comparable current rating. This allows an equivalent current density of approximately 100A/cm^2. The active circuit elements are also isolated from the silicon substrate by a thick layer of silicon dioxide. Figure 2 shows a cross section of the Toshiba SOI power IC structure.

SOI-based ICs can interface directly with logic-level devices and microprocessors, while the technology permits increased device density, by reducing leakage currents and parasitics. Developments like these support the development of ready-integrated solutions for BLDC applications.

Single-chip inverters

Launched at last month's PCIM exhibition in Nuremberg, the latest SOI-based devices from Toshiba are single-chip inverters for BLDC motor applications operating with voltages up to 500V. Toshiba has combined its SOI technology with a trench isolation structure as shown in Figure 2 to bring together low and high voltage circuits in a reliable monolithic device measuring just 32 x 13mm. At 3.8mm (max), package thickness is 27% lower than existing HZIP23 packages, while improved thermal resistance reduces requirements for external cooling.

Devices in the new TPD412x family integrate into a single part full three-phase inverter bridge operation and other key features including protection and integrated bootstrap diodes. Supplied in the latest, compact DIP26 packaging, these single-chip inverters are ideal for industrial motion control applications including pumps and fans, as well as home appliances such as dishwashers.

Figure 3 shows a block diagram of the TPD4120AK, one of the devices in the new family. As the diagram shows, the new chips combine high- and low-side drivers with six IGBTs to supply current to the motor stator coils. Integrated fast recovery bootstrap diodes reduce component count and cost, while additional on-board functions include protection against overtemperature, overcurrent and undervoltage conditions.

Toshiba's new single-chip inverter line-up features devices with output voltages of 250V and 500V. The 250V inverters offer a 1A output current, while the 500V versions are available with output currents of 1A, 2A or 3A. All of the inverters can interface directly with a host microprocessor.

Whether sensor-based or sensorless, pulse width modulation (PWM) is the underlying technology for the motor drive circuit. However, the designer has decisions to make with regard to the complexity of the PWM circuit to be used. In many sensorless applications, for example, the basic rectangular PWM waveform is often perfectly acceptable, and has the advantage that it is simple, requires few components, and achieves high efficiency. In such designs the PWM signals are integrated out by the inductance of the motor, resulting in a rectangular current wave that is several magnitudes lower than the PWM frequency. To help engineers address the requirements for PWM functionality with the minimum number of external components, the Toshiba TPD421x family includes devices that offer built-in PWM functionality.

Sine of the times – beyond PWM

There are applications where the electrical and acoustic noise that is created prevent a straight PWM solution being employed. In these cases it can be better to use a sensor-based design in conjunction with circuitry designed to create a sinusoidal motor current from the underlying PWM signal. This sine wave current can help to ensure smoother operation, minimising both vibration and noise.

In general, there are two ways to create the requisite sinusoidal current from the PWM signal. The first is to develop software to run on a microcontroller or other programmable device, and the second is to choose an ASSP (application specific standard product) solution such as Toshiba's TB6551F, which contains all the circuitry necessary to generate three-phase sinusoidally modulated PWM signals with programmable dead time and lead angle. The route chosen will depend on a number of factors, not least the trade off between the suitability of a standard solution and the time and cost required to develop software and implement a fully custom design. For designers looking to an ASSP solution, the TB6551F can be combined with an inverter with dead-time specification appropriate to the desired operation. For instance, in the case of Toshiba's TPD4113K and TPD4113AK 500V/1A single-chip inverter ICs in HZIP23 packages (and, in the near future DIP26 options), the adjustable minimum dead time is 1.4µs. This allows the creation of 'silent' brushless DC motor drives with all the high efficiency and low power dissipation benefits of PWM.

Simplifying sensorless control

In addition to highly integrated inverter products, semiconductor manufacturers such as Toshiba can also offer ASSP driver ICs that will help to simplify BLDC motor designs. Earlier this year, for example, Toshiba launched a single chip ASSP that brings together driver and controller to provide a single-chip solution for three-phase BLDC motor applications requiring sensorless control. The TB6588FG PWM sensorless driver ASSP integrates PWM sensorless motor control, protection functionality, an output power stage and an operational amplifier in a single 36-pin HSOP package.

Figure 4 shows a block diagram of the TB6588FG in a typical application circuit. By combining sensorless operation with high levels of on-board functionality, the new ASSP can significantly reduce the component count, design complexity and development time of three-phase, full wave BLDC motor applications with power levels up to 60W. In particular the device is ideal for home appliance, pump, industrial motion, automotive motor and other motion control applications requiring an operating power supply voltage ranging from around 10V to 42V.

Toshiba's TB6588FG is a complete motor driver solution that controls forward or reverse rotation speed by changing the PWM duty cycle based on an analogue control signal input. Full wave PWM operation provides for high-efficiency and low-power operation while minimising electrical and acoustic noise. Lead angle control options of 0°, 7.5°, 15° and 30° allow designers to tune their application for optimum efficiency.

The IC can deliver a maximum current output of 2.5A through its integrated power stage and offers configurable modes for improving the motor start-up characteristic. Built in protection against overcurrent conditions and the ability to enable detection of excessive commutation frequency and low rotation speed further improve design flexibility while minimising the need for external components.

Future developments

Toshiba's six-input 500V/2A and 500V/3A single-chip inverters are in mass production now and additional devices – including versions with integrated functions for Hall sensor-based designs and devices targeted at sensorless motor control – will join the line-up during the course of the year. In addition to the devices themselves, Toshiba is also developing evaluation boards that will allow designers to quickly and easily assess inverter performance in target applications.

The next stage in the evolution of single-chip controllers and drivers will be an IC that not only integrates sensorless motor control, op-amp and power stage, but also incorporates all of the circuitry needed to deliver full-wave sine wave PWM motor drive output.

By continually investing in new technologies, processes and packaging, semiconductor manufacturers such as Toshiba are driving up the levels of integration available to designers of BLDC motor applications. And by choosing products with high levels of integration, these designers can dramatically reduce the component count, board space, complexity and cost of their designs without sacrificing – and, indeed, in many cases further enhancing – the functionality and performance of their target application.

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Power-Off Protection in Analog Switches for More Robust System Design

Hot plug insertion, transient signal blocking, and system fault protection

Without off isolation there is a risk of data acquisition or processing problems resulting from unintended signals bleeding through the switch, or current leakage resulting in device failures. This article outlines how the designer can avoid these problems.

By Travis Williams, Senior Applications Engineer, Fairchild Semiconductor

Analog switches can be used in many different applications including portable handheld devices from cell phones and PDAs to consumer devices such as computers and video displays. Regardless of the application, whether it be audio, video, USB, or control signal routing, system designers often find cases where non zero signals could be present on the switch inputs when no power is supplied to the switch. When subjected to input signal over voltage conditions, analog switches using standard design techniques are susceptible to unintended signal glitches (lack of signal off isolation) and excessive current leakage. Lack of off isolation can lead to system data acquisition or processing problems resulting from unintended signals bleeding through the switch. The second problem, current leakage, is far more serious in that it can result in device failures and potential product returns. Fairchild Semiconductor has developed specialized power-off protection circuitry used in their newest analog switch products, which allows the switches to not only withstand over voltage conditions but to also guarantee signal off isolation will be maintained. The following article outlines common application situations where such an over voltage condition could occur and provides a detailed discussion of how standard analog switches will respond to such an event. Finally, it discusses from both the data path and reliability viewpoints how the power-off protection feature overcomes these design challenges and protects the system.

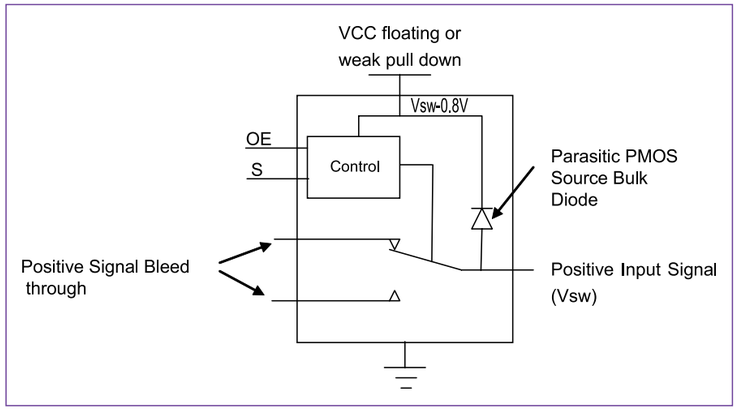

Figure 1: A Typical Analog Switch Application with Signal Bleed Through.

A Case for Power-Off Protection

There are several common situations where it is desirable for an analog switch to ensure signal isolation when the switch is not powered. One need arises during system power up sequencing. In addition to power up sequencing other application examples where power-off protection is desirable are, hot plug insertion, transient signal blocking, and system fault conditions. In the power up sequence case, some functional systems become powered on before others. Often this is a result of different voltage requirements necessitating multiple internal power rails. Generally it is advised to power the analog switch with the highest supply rail available to achieve the best switch operating performance. This can mean that components which use the lower V_{CC} rail, such as the system processors, are fully powered on before the neighboring higher voltage analog chipset. For example, if the analog switch is being used to route control data and the general purpose input output (GPIO) controller becomes fully powered before the analog switch it can result in the controller sending a signal to the input of the switch before it has fully turned on. For the analog switch to fully guarantee correct functional state based on its own control inputs it must be powered on. For a standard analog switch when a positive data signal appears on the switch input before the switch has fully turned on there is a no guarantee that the signal will be handled correctly. Often the system designer is aware of the power up timing mismatch and relies on the analog switch to isolate input from output. Unless the analog switch has specifically designed circuitry to guarantee off isolation in the power-off case, the signal can bleed through. Signal bleed through can result in false logic states which could derail system startup. Signal bleed through can even occur on both output pins simultaneously of a single pole double throw switch regardless of the OE and S pin states. When the V_{CC} pin is floating or very weakly pulled down it is possible for the switch input signal Vsw to power up the switch internal circuitry thus allowing the signal to bleed through the switch. This can be seen in Figure 1 where the switch internal V_{CC} node is indicated as Vsw-0.8V. With the internal node now powered up the switch will turn on and pass the input signal. In this case it is even possible for a positive voltage to appear on the unselected output.

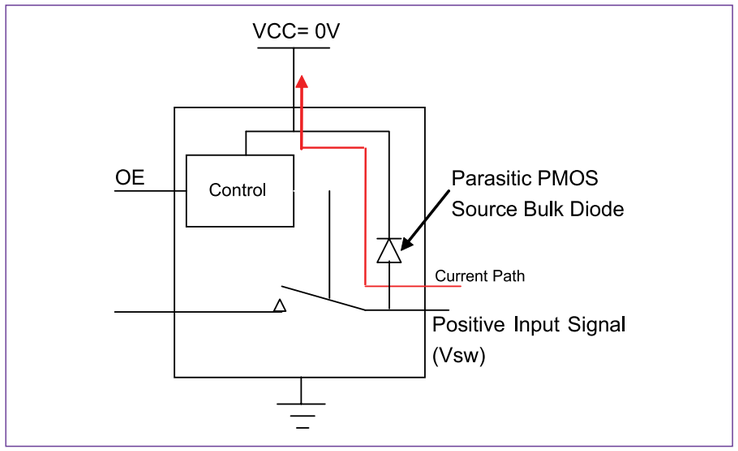

Figure 2: Typical Analog Switch Current Leakage Path when in an Over-Voltage Condition.

In applications where the analog switch is used to protect against transient noise or against a fault condition, often the switch is placed on the system periphery and is used to separate internal components from the outside world. In a fault protection application the switch is also expected to withstand such a condition for long periods of time (milliseconds). When the positive input voltage is sustained, as in a fault condition or power up sequence, it can also lead to irreversible damage of the analog switch. This damage results from excessive current flowing from the switch input ports to a grounded switch V_{CC} pin. This current path is a result of the inherent switch parasitic PMOS bulk diode which acts like a forward biased diode when the input voltages are greater than V_{CC} + 0.5V. The diode does require a minimum forward voltage to conduct which is typically assumed to be approximately 0.5V. This effective diode allows excessive current to flow through the chip into the V_{CC} pin. The greater the voltage on the input pin the greater the current will be. This voltage current relationship is exponential and can easily be represented with an ideal diode curve. As a result the maximum current rating of the chip can quickly be exceeded. Once a part has been damaged from an over voltage event the part will often continue to exhibit excessive leakage and may no longer function even when inputs are returned to normal operating conditions. Figure 2 illustrates the current path formed between the data input pin and V_{CC} just described.

Power-Off Protected Switches for Robust System Design

Switches with power-off protection have specially designed circuitry that prevents unintended signal bleed through as well as guaranteed system reliability during an over-voltage condition. When V_{CC} =0V the switches will isolate the input signal from the outputs regardless of the state of the enable pins or the select pins thus preventing unintended signal bleed through. It will also protect against current leakage from the signal pin into the supply pin. The input signal will effectively see a high impedance input when the switch is powered down thus preventing any parasitic PMOS bulk diodes from being forward biased. It is important to note that unless specified power-off protection is typically only on one port and not necessarily on both sides of the switch. On the first generation of power-off Protected switches the protection has been added to the common pin because this port is most likely to see an over voltage event. This means that the system designer must carefully read the datasheet to ensure that the switch is properly configured to protect against the anticipated threat. A system designer will likely also want to know how the power-

off protected switches behave in a system which is powered up an in which the input signal still greater than V_{CC}? For example, if the switch were powered by V_{CC} =2.8V and Vsw = 3.6V. In this case, the power-off protected switch will not protect against excessive current leakage to V_{CC} and thus datasheet absolute max ratings must be observed. In a typical switch it is acceptable for Vsw to exceed V_{CC} by 0.5V however any voltage in excess of this can lead to reliability failures and should be avoided. In the above mentioned example the V_{CC} supply should be increased to equal the max value of the switch input signal, if this is not possible it should be within 0.5V of Vsw. The SPDT switch will ensure that the unselected output will not have any signal bleed through as illustrated in Figure 1. The selected output on the other hand will still pass the full value of the input signal. Thus referring to the case just described if V_{CC} were increased to 3.3V the Vsw input of 3.6V would pass through to the selected output. Future power-off protected switches will further increase this range allowing the switch input swing to exceed V_{CC} up to a maximum level regardless of the V_{CC} supply. In the mean time though there is a simple schematic work around which solves this problem. By inserting a 100 Ohm series resister between the switch V_{CC} pin and supply rail you can protect the switch against damage during a powered up over-voltage condition. By so doing the 100 Ohm resistor limits current flow back in to the V_{CC} rail during the over voltage event to within a safe operating range. Finally, it should be noted that datasheet limits always apply with regard to maximum over voltage conditions in both cases whether the parts are powered up or down.

Conclusion

System designers frequently have application conditions such as, power up sequencing, hot plug insertion, or fault conditions that can compromise system data flow. The need to ensure robust system performance has resulted in power-off protection being added to many of Fairchild's newest analog switch products. The FSUSB30 and FSA2156 both incorporate power-off protection which helps protect against the powered off Vbus fault condition described in the USB specification or other system power off fault conditions. Continue to look for new Fairchild analog switches including USB switches and high performance audio switches which will also have this feature. By choosing analog switches with this feature, designers can feel confident that their system will be protected during a power-off over voltage condition.

www.fairchildsemi.com

Powering Portable Media Players

Innovative solutions provide peak performance

Fully understanding Portable Media Player system and power requirements is crucial for a successful design. Space-saving solutions with reduced number of regulators and the ability to handle multiple tasks are now a must for today's designs.

By Dipak Patel, Applications Manager, National Semiconductor

In the past, when system designers were handed a project, they basically purchased off-the-shelf discrete power solutions from various vendors. The list of issues the power designer must now consider has greatly increased as power systems have become more complicated. Some of the key areas where these new design challenges exist are:

- Multiple outputs due to feature-rich devices, LDOs, Bucks, battery chargers; overall more control of the system is required to obtain better efficiencies during battery operation.
- To ensure stable multiple voltage supplies to the host processor, IC systems now require increased flexibility, programmability, and power sequencing to allow for powering down unused power functions when left unused.
- Finding an easy to implement, correct and easy-to-use power management solution can become a critical part of rapid system development and improved cycle time-to-market.
- By having a high level of integration in such a PMIC reduces overall system cost and size constraint significantly when compared to equivalent discrete solutions.
- Extending battery life now requires higher efficiencies and DVS (Dynamic Voltage Scaling) to reduce overall power consumption.

The system diagram in Figure 1 details the many power requirements of a typical personal media player (PMP). Using smart power control in your design can yield improved performance in many areas including:

- Digital signal processor
- Hard drive for storage of the downloaded media
- Touch pad to select software driven functions of the media player
- LCD display

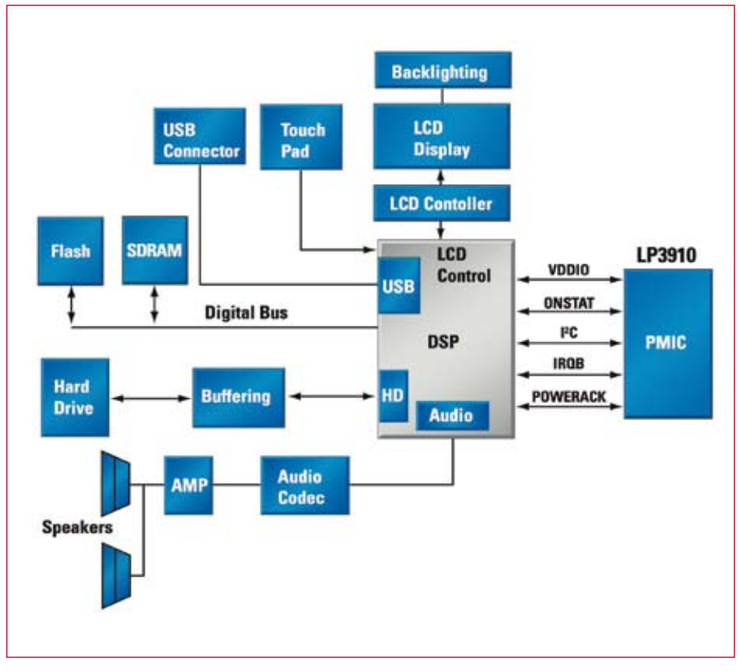

Figure 1: Portable media system level diagram.

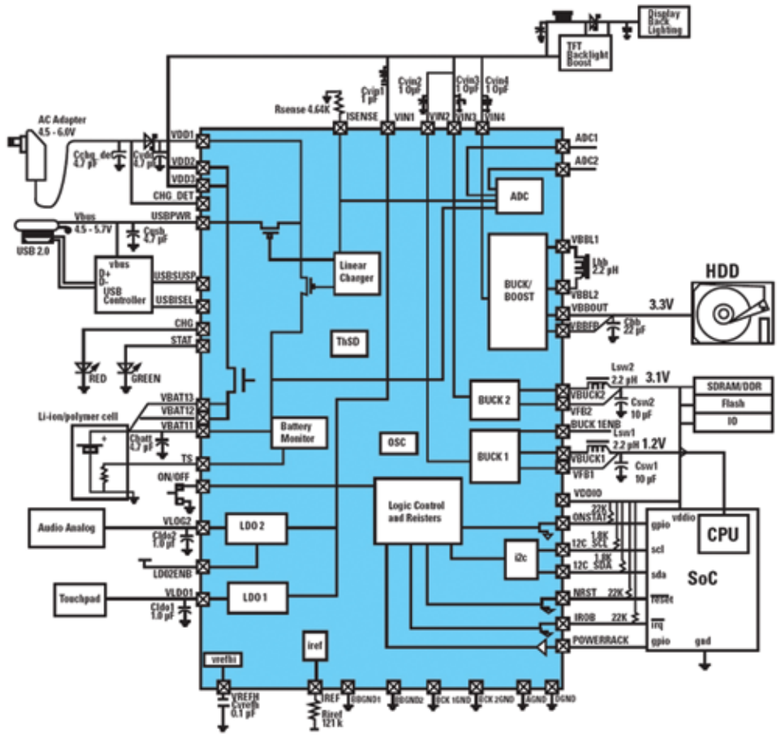

Figure 2: Detailed power requirements for a Portable Media Player system.

- Audio amplifier
- Audio Codec
- Flash memory used to store the operating system; upon system boot up of the DSP, the bootloader instructs the DSP to download the OS image from Flash to the SDRAM
- SDRAM storage of the OS image, SDRAM has faster access time than flash so the DSP can access information quickly
- USB interface to download music content from a computer

Many of these challenges can be seen when designing in power requirements for PMPs. These devices have a multitude of constraints and unique needs that can be better handled when using smart, programmable power controllers. This article includes details of the design specifics on powering the main subsystems. We'll also review how the integration of various power and control functions into a common IC can solve system issues such as: powering subsystems, digital application/peripheral, audio amplifier block, DSP (I/O, Core), and memory, hard disk drive, and LCD backlight display.

Later, we'll review more key features that affect design and power management such as: battery charging and monitoring, battery charger linear charger, smart control parameters, power prioritisation routing, power sequencing, soft-start, and communication between the PMIC and the DSP.

Powering the digital application / peripheral

Typically Low Drop Out (LDO) regulators are used to power digital peripherals. Voltages are usually 1.2V to 3.3V with a current requirement of 150mA. Good external output filtering is also required. Digital loads require LDOs to have good load transient response to keep the output voltage in regulation.

Powering the audio amplifier block

An LDO is required in this application as the noise generated from a switch mode supply will introduce excessive noise into sensitive analogue circuits. Here, the important parameter to consider is the Power Supply Rejection Ratio (PSRR). If transients on the power supply line are not suppressed, harmonics will appear at the speaker output. Attention to good output filtering and PCB layout is important.

Powering the DSP (I/O, core), and memory

Typically, magnetic buck switching regulators are used to power the DSP and memory due to the high load demand and high efficiency requirement.

Buck 1 and 2 are high efficiency synchronous FET (low rds) switching regulators. A multiphase switching scheme has been implemented such that NFET,

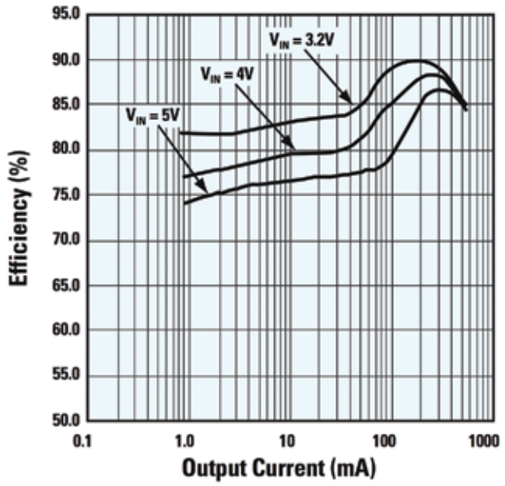

Figure 3: Typical efficiency vs I_{OUT} for a 2 MHz magnetic buck switching regulator.

and PFET of buck 1 are turned on/off at fixed phase intervals in time which are different to that of buck 2 using counter logic. This reduces the overall demand from the main DC source or battery.

The output voltages can be changed via I^2C if dynamic voltage scaling is required. The concept is to dynamically scale the output voltage up or down based on the load demand at that moment in order to maximise the overall system power saving. For example, when the DSP is running in a mode where it is reading or writing large amounts of data to memory or doing intensive numerical calculations where the power needs to change dramatically. By using the I^2C the voltages can be changed. Once the function is completed the DSP informs the PMIC to go back to the lower voltage setting. This type of power management technique increases the longevity of the battery.

The bucks operate at 2 MHz which means the physical dimensions of the external inductor are considerably reduced. Below is a typical efficiency plot for a magnetic switching buck regulator.

Powering the hard disk drive

The Buck-Boost is required when extending the device runtime 3.3V for the hard drive during battery operation. This voltage is lower than the maximum battery of 4.2V and higher that the minimum battery of 2.8V. In addition it needs to supply a peak current initially of about 500mA for the motor on the hard drive spindle to turn. During read write cycles to the hard drive the current averages about 200mA.

Powering the LCD backlight Display

A Boost circuit is required to power the LCD backlight display. This is required to produce a large voltage which tends to be greater than the supply voltage for the lighting supply to the LCD display. A magnetic or switched capacitor boost regulator can be used as an LED backlight driver.

Battery charging and monitoring

The A/D converter multiplexes the battery voltage and the battery charger current. Battery voltage measurement is then scaled and can be used to monitor the battery voltage during (constant current, constant voltage) charging, or when the battery is being used in the system.

If the Li-Ion battery voltage drops below the battery low threshold voltage, the battery low alarm interrupt is pre-triggered prior to event occurring, by setting a "voltage low-value threshold" higher than the battery-low alarm. The DSP is informed earlier so that it can take precautions before the battery voltage drops and causes a system failure. This informs the user that the battery needs to be charged via the DC source, otherwise the system will gracefully shutdown without the loss of media content.

A dual voltage comparator with hysteresis prevents battery chattering. Once the battery trips the low threshold, it is disengaged from the system. However, the battery voltage can float back up. By setting the hysteresis window with a high enough upper threshold, the battery cannot re-power the system.

Battery charger linear charger

Prequalification mode is the mode when the battery is charged, at a lower current rate initially about 10% of the full rate if a DC source is connected. The reason for this is, if the battery is damaged and full charging is initiated, this could create a potentially hazardous condition. In addition, the battery has a low effective standard resistance by charging the battery at full rate could create a voltage spike on the battery, creating a false condition that the battery is fully charged. This mode terminates once the full rate charging voltage is reached, typically 2.85V.

The module provides CC (Constant Current) charging and CV (Constant Voltage) charging to charge the battery. Full charging mode occurs once the prequalification charging is completed. In Constant Current mode, the appropriate battery charging current is supplied.

In CV mode, the voltage on the battery increases rapidly during the full charging mode. Once it reaches the programmable termination voltage, which is typically 4.1V, it is complete — known as End of Charge (EOC). Top off mode enables once the battery is in the EOC cycle which is about 5% to 10% of the full rate charge. CV charging continues a little longer to squeeze more capacity into the battery.

The beauty of the integrated charger

Figure 4: Hard drive load demand during start up and normal read write operation.

in the PMIC is that status of the battery charger can be accessed via internal registers. There is no need to write firmware (Microcontroller or DSP) to control the battery charger, as its intelligence is self contained where the DSP acts upon the messages and takes the appropriate action.

Power prioritisation routing

Power routing allows system usage immediately after an external power source has been detected. System power takes precedence over the battery charging, so when the user has the DC source connected and wants to use the device, power from the DC is allocated to the normal operation of the media player, whatever power is leftover is used for charging the battery.

Battery disconnect is a feature that allows longer battery shelf life in products. When the system is being shipped, the unit uses the "disconnect circuit" which prevents discharging of the battery. The user "opens" the circuit by simply connecting DC source to the media player, where the DSP wakes up and connects the battery as necessary.

PMIC enables power sequencing

Power sequencing of the supplies occurs when there are multiple voltage domains where the highest voltage needs to come on first (typically the I/O pins) followed by all the other voltage rails in a high to low order sequence. With the DSP core being last. In addition one supply rail is not to exceed another by more than a diode drop; otherwise, excessive current flow backward from the I/O voltage through the IC, into the lower voltage DSP core. From a system standpoint, the power supplies need to be present in a particular sequence and handshaking and acknowledgement signals between the DSP and the PMIC need to occur for this to happen.

Soft-start

Soft start provides a smooth linear ramping of the buck regulator's output voltage. By actively limiting the inrush current to the active devices gives the system added reliability.

Communication between the PMIC and the DSP

I2C interface bus permits communication between the DSP master to the PMIC slave via a clock and data line. Registers can be read over this communication link and information on the status of the overall system can be proactive with this data.

The PMIC has the ability to interrupt the DSP through the IRQB open drain pin, which transitions to a logic low level upon the following events: removal and insertion of the DC source, USB power detected and disconnected, battery low alarm, thermal alarm, ADC conversion completed, charger safety timeout (after 10 hours of charging.)

Once an event occurs, the DSP can then read the interrupt register bits via I^2C and then service them appropriately. This interrupt message can be relayed to the application software layer informing the user an event has occurred.

Final thoughts on power management

Understanding Portable Media Players system and power requirements are keys to selecting power designs for fast time-to-market constraints. PMICs such as the LP3910 address both the needs and the challenges implementing power solutions.

This complete device features buck-boost for HDD, DVS for system power savings, power sequencing for multiple rails, Li-Ion battery charger and battery monitoring. This integrated solution not only powers PMPs effectively, it is also an ideal space-saving solution by reducing the number of regulators with the ability to handle multiple tasks for advanced designs with many requirements. Using the new PMIC's, power designers can meet the challenges required in a wide variety of portable devices, while increasing performance.

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Integrated Platform Improves Motor Control Performance in Commercial Aviation

Control for new higher efficiency, lower weight aircraft motors

The vast array of pumps, fans compressors and actuation motors on modern aircraft has transitioned to higher performance variable speed permanent magnet motors. Driving these motors presents some design challenges.

By Michael Toland, Product Marketing Manager, International Rectifier

In order to lower major operating costs such as fuel and maintenance, airlines are driving airframe manufacturers to produce more efficient planes. A key area of focus is the many motors utilized within an aircraft for fuel, environmental and hydraulic control.

Traditionally, the aircraft industry has used fixed speed induction motors with mechanical gearboxes. New system architectures are moving to variable speed permanent magnet (PM) motors because of their smaller size and lighter weight, in addition to their high torque to current ratio, efficiency and power factor. These new motors are designed to drive fuel and liquid cooling pumps, environmental control fans, compressors, and actuation of flight surfaces more efficiently. These new motors, like any new technology, come with design challenges.

First, the development of the motor control so ftware algorithm using a DSP or FPGA requires significant investment in resources and rigorous certification process. Secondly, the motors require electro-mechanical use of Hall sensors for rotor position, which can lead to cable complexity and added reliability concerns.

A high reliability control platform for sensorless vector control of variable speed PM motors (Figure 1) has been introduced to facilitate the transition from geared motors. Utilizing an innovative Motion Control Engine (MCE) with an embedded pre-configured sinusoidal field oriented control (FOC) algorithm IC;

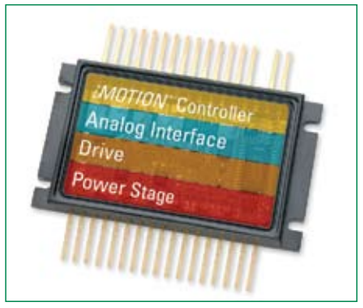

Figure 1: IRMCT3UF1integrated motor module.

benchmark gate drivers; MOSFETs and feedback electronics, the new approach provides complete drive control in a robust, small footprint and lightweight plastic package.

The new integrated motor module, which is MIL-STD-883 certified is supported by design tools that enable the user to quickly configure the motor drive in a variety of configurations to a specific application. Since the control algorithm is a hardware-based IC dedicated to motor control, certification requirements are simpler than those designed for a software-based algorithm programmed into a microcontroller or FPGA, resulting in a rapid, cost effective time-to-market solution for electric aircraft system integrators.

An Integrated Approach

In existing solutions, digital motor control is typically designed using a DSP, microcontroller or FPGA-based software program, requiring a team of software design engineers to write and debug the code.

However, a new approach using an integrated motor control module, International Rectifier's iMOTION™ IRMCT3UF1, incorporates a unique hardware-based Motion Control Engine™ (MCE) IC (Figure 2) to perform the same function previously delivered using a resource-and time-consuming DSP or FPGA alternative.

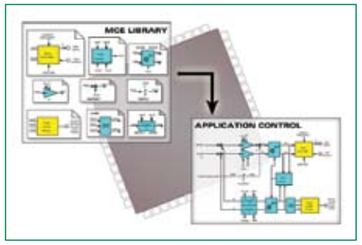

Figure 2: Motion Control Engine.

A companion development tool, ServoDesigner™, expedites software development by providing a simple menu-based selection process where motor design and user defined parameters such as ramp time or maximum speed are organized a drive parameter spreadsheet. Upon completion of the motor design, the final design parameters and the user defined parameters are entered into the development spreadsheet. ServoDesigner™ translates the motor parameters and stores them within the module, enabling the motor designer to quickly evaluate the performance of the motor. Diagnostic tools are also available to aid this process.

This hardware-based control scheme dramatically reduces the number of man hours required from months to days to obtain mandatory certification and can be easily duplicated for each motor drive.

Sensorless Digital Brushless DC Motor Control

The Motion Control Engine (MCE) IC allows the designer to control motors up to 500 VA without software development or the use of Hall sensors to determine the rotor position. Without Hall sensors for position sensing, the rotor must start in a known location. In order to gain control of the motor the rotor windings must be spun and parked to the known position. The goal is to maintain an orthogonal relationship of the stator and rotor windings. The stator winding back EMF is a function of the motor speed, and the stator currents are a function of the back EMF and applied voltage. The rotor position can be calculated and the signal fed to the space vector PWM modulator and the appropriate gate signals applied to switch the MOSFET. In addition, inverter leg shunt current sensors are used to feed back phase current to the digital controller in order to provide the maximum torque and maintain speed. The rotor angle with respect to the stator is estimated every 11 microseconds to provide a smooth operating drive with minimal torque ripple.

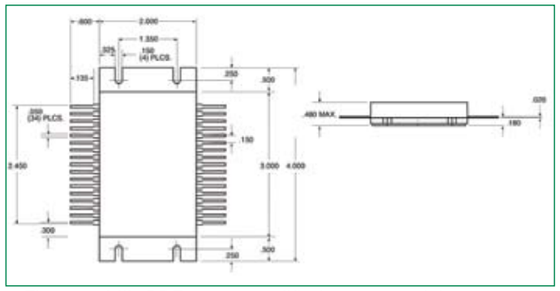

Figure 3: MIL-PRF-38534 qualified power module.

The sensorless algorithm operates over a continuous speed range of 10 percent to 100 percent of full speed without overload for greater performance. Removal of the Hall sensors reduces the motor cost while significantly improving reliability.

The module is designed to shut down during an over-current, over-temperature, or an over- and under-voltage event. Phase currents are monitored. If the safe condition is exceeded a gate kill signal is applied and a fault occurrence is indicated. At this point, a restart sequence can be initiated which includes clearing the fault.

A thermistor is mounted on the IMS substrate board in close proximity to the power silicon. If the substrate temperature exceeds the safe limit of 105 degrees C a gate-kill signal is asserted. The DC bus is also monitored for under-voltage and over-voltage conditions and minimum and maximum speed conditions. Operation outside these preset limits will also produce a fault to protect the load. To clear the fault condition a fault clear pin is provided to initiate restart sequence. Communication to the device is done via an RS-232 serial interface and can be used for longer cable lengths or noisy environments. Additionally the module uses an error detecting protocol to maintain the integrity of the host registers.

Gate Drive Circuitry

Based on selected parameters, the proprietary algorithm within the digital controller ultimately controls the gate driver integrated in the motor control module and the switching of the power semiconductors during commutation.

The optimized chipset including the control, gate drive and power MOSFETs and intellectual property have been combined with rugged packaging to meet vibration profiles in a small lightweight footprint ready to mount on a cold plate or heatsink.

This integrated package (fig 3) approach also incorporates a fully qualified power MOSFET mounted on an insulated metal substrate (IMS) close to the gate drivers for the lowest possible inductance. Each lot is screened to military specification MIL-PRF-38534 to ensure the highest level of reliability and rated at the full operating temperature range of minus 40 to plus 85 degrees Celsius.

Conclusion

The trend in aircraft design is towards more efficient brushless DC motors. A new approach using an integrated motor drive module for brushless DC motors dramatically reduces the effort of programming the motor control and simplifies the certification process. Because the device is configured for sensorless field oriented control the elimination of Hall sensors improves reliability while reducing component count to simplify design and increase performance in variable speed motors used in electronic aircraft to achieve greater fuel economy and lower maintenance costs.

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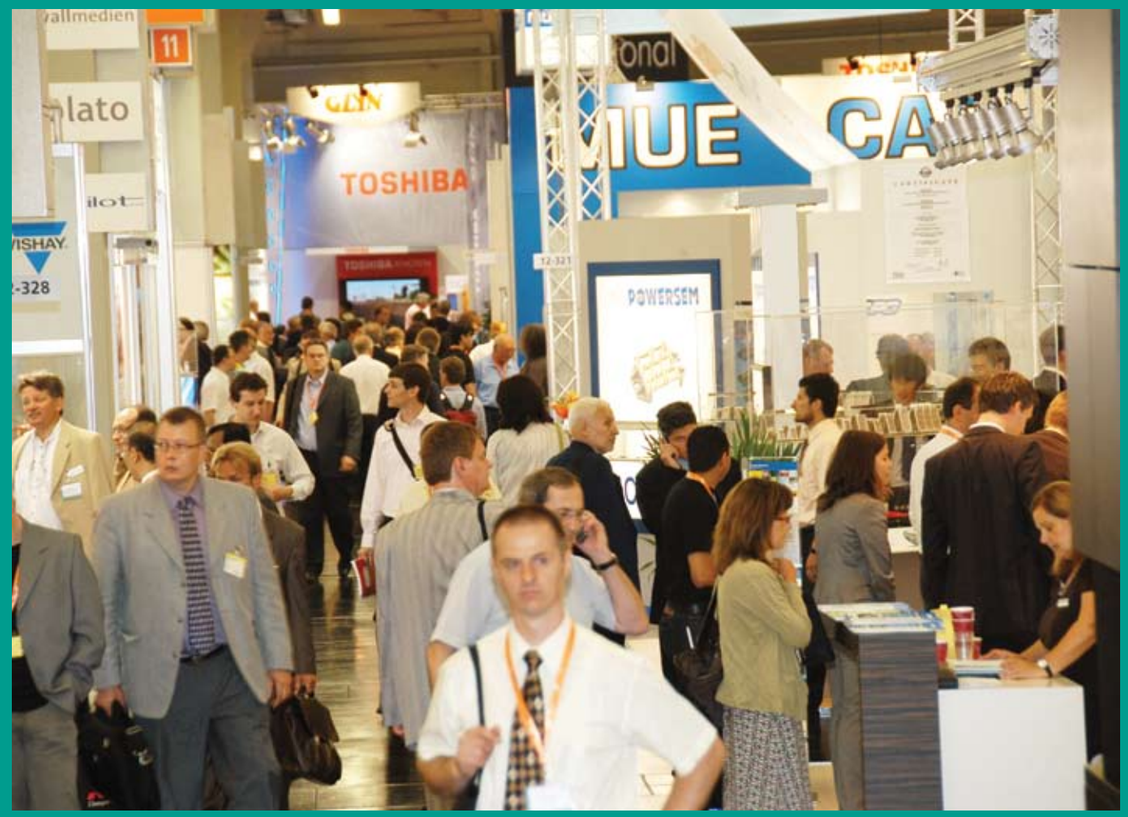
Special Report PCIM Europe 2007 Roundup



Special Report

PCIM Europe 2007 - The Energy Custodian

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

The PCIM International Exhibition and Conference for Power Electronics, Intelligent Motion and Power Quality convened in Nuremberg, Germany, May 22-24, was the finest example of a focused and dedicated platform for the power industry. To describe it as a success is a complete understatement. The quality of speakers and exhibitors alike was higher than I could have ever imagined. I met with engineers and senior executives from many world-class companies there, large and small, limited only by the time available to get around them all.

The key messages, products and future plans I was privileged to be part of, truly inspired me and underscored my belief in the future of this great industry. We, at Power Systems Design Europe, ran a high level forum that was packed to full capacity. There was great enthusiasm from delegates to hear our premium-class speaker panel supported by Fairchild, Infineon, International Rectifier, National Semiconductor, ST and Texas Instruments, giving their insightful presentations and predictions on the highly topical theme of "Lighting Technology". We actually had to print more handouts and place the presentations on our website due to the huge demand. Check it out at:

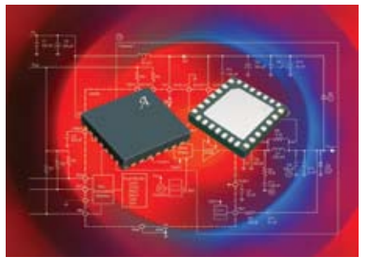
www.powersystemsdesign.com/PCIM_Lighting.pdf

With well over 6,000 trade visitors from 50 countries, everyone was kept on high alert throughout the whole event. The 300 or so exhibitors have given a resoundingly positive response to the event and many, including us at PSDE, have already signed up to be part of next year's PCIM. Several of the companies I interviewed told me spontaneously that this show and conference is a 'must do' in their yearly planning cycle. It doesn't get any better than this!

This industry is defining the future in a multitude of diverse areas and is probably the nearest thing we have as a saviour of the environment. It captures the attention and imagination of the world. The profile of the technologies and products we are working with today has never been higher... and it's growing fast. Join us next year at PCIM and grow with it…and with us!

Allegro Pushes Ahead

Developments in linear Hall effect sensors



At the Sensor & Test Conference, Nürnberg, Germany engineers from Allegro MicroSystems presented a paper covering major new developments in linear Hall-effect sensor technology.

The paper focused on a new low-noise, high-bandwidth linear Hall-effect sensor for applications in current and position sensing.

The new device includes improved amplification and a new filter option that allows the user to reduce noise and bandwidth by changing a filter capacitor.

The new sensor also includes a shield to prevent noise being transmitted from the current loop to the sensor circuitry in current-sensor applications. For a flip-chip sensor, the noise has been reduced by more than 60% compared to earlier devices.

New sensor products from Allegro MicroSystems were featured on the company's booth including the ACS712 and ACS713 families of high-performance low-noise current sensors with 2100V RMS isolation, the A138X family of programmable, analog-output devices in low-profile surface-mount packages, and the ATS651LSH gear-tooth sensor module that is optimized to meet the requirements for speed and direction sensing in automotive transmission applications.

LNB voltage regulator ICs for satellite receivers

Allegro also introduced four new voltage regulator ICs for use in the LNB (low noise block) sections of analog and digital satellite receivers.

The A8290 and A8291 are single LNB supply control voltage regulators, while the A8286 and A8292 are dual LNB supply voltage regulators. All are designed for high efficiency, using Allegro's advanced BCD process.

These low-noise block converter regulators are monolithic linear/switching voltage regulators, specifically designed to provide the power and interface signals to an LNB down-converter via a coaxial cable. The integrated boost switch in each device has been optimized to minimize both switching and static losses. To further enhance efficiency, the voltage drop across the tracking regulator has also been minimized.

The A8290 (single) and A8286 (dual) devices provide the higher output current required by the latest satellite set-top box applications. The A8286 provides up to 650mA per channel and 1.0 A total continuous lead current, while the corresponding figures for the A8290 are 500mA and 750mA. The A8291 (single) and A8292 (dual) versions have lower current limits for more traditional requirements.

All four devices offer 'push/pull' output stages with the ability to sink and source current, and a static current limit with overcurrent timer mode.

They also offer a 'cable disconnect' function in addition to a wide variety of other diagnostic capabilities.

The regulator ICs require few external components because the boost switch, compensation circuitry, and sense resistor are all integrated into the solution. The A8290 and A8291 also integrate an output filter bypass FET. A high switching frequency is chosen to minimize the size of the passive filtering components to further assist in reducing cost.

All four devices are available in the 5 x 5mm QFN/MLP-28 package.

www.allegromicro.com

AVX Demonstrates Leading Capacitor Technologies

Highest capacitance radial and axial leaded MLCCs

I met with Jonathan Lennox, responsible for Technical Marketing of Ceramics at AVX who presented the newly developed radial and axial leaded multilayer ceramic capacitors offering high capacitance levels of up to 1.0mF at 50V and 100V in SR21 radial and 3.3mF at 10V in an SA10 axial configuration.

The new SkyCap® series radial leaded ceramic capacitors are an extension of the existing SR21 family, which provide increased efficiency by allowing very high capacitances at around half the previously available package volume. SkyCap capacitors are the industry's leading conformally coated radial leaded MLC. They have been RoHS-compliant since January 2005.

SpinGuard® axial leaded capacitors now use the X5R dielectric for the first time and offer a high capacitance of 3.3mF at 10V. These components are also RoHS-compliant and are a suitable replacement for tantalum axial leaded devices.

AVX is the first company to offer this size of radial leaded MLC capacitor in this capacitance value with 100V rating. AVX is also first to market axial leaded MLC with the X5R dielectric. The company continues to make developments and support customers who need improved performance in leaded devices, while many competitors have de-emphasized the through-hole devices to concentrate on SMD devices.

Both capacitors are ideal for use in commercial and industrial power supplies as well as other applications requiring higher capacitance values.

New low profile, low ESL multi-anode 'Mirror' Tantalum Capacitor

The New TPM series multi-anode "mirror" configuration multianode tantalum capacitors have been developed by AVX, delivering reduced height, lower self inductance and lower Equivalent Series Resistance. The new symmetrical design reduces ESL to 1nH – half that of standard D case sized devices. Low ESL enables a higher resonant frequency up to 500kHz (mirror D case), delivering more efficient filtering in DC/DC power switching converters. The new design also reduces the height of the new tantalum capacitors from 4.3mm (E case) to 3.1mm (D case) with even further reductions planned, down to 2.0mm maximum height.

The mirror anode configuration is also better for thermal power dissipation; hence higher ripple current can be achieved using only one capacitor. This allows downsizing of the power supply without compromising the output current ratings.

Multianode mirror tantalums are available as D case devices within AVX's existing TPM series. Complying with RoHS requirements, TPM capacitors are designed for 3x reflow, 260°C peak temperature lead-free assembly systems, and feature an operating temperature range of between -55°C and +125°C.

Mirror TPM capacitors have a capacitance range of 10 to 1000mF, are rated at 2.5 to 50V and have an ESR range of 25-140mW. High voltage (35 and 50V) devices will be especially attractive for telecommunication applications where design height is becoming an important parameter: capacitance values 10-22mF, ESR 65-140mW on a single 35-50V capacitor are difficult to attain within the 3.1mm maximum height using any other technology.

Cap Arrays with FLEXITERM® Termination Resist Cracking

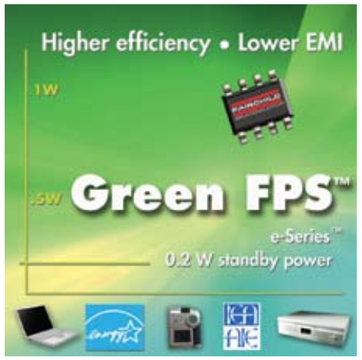
FLEXITERM arrays from AVX can withstand over twice the PCB deflection of standard MLC devices without cracking.

The addition of a layer of epoxy silver in the termination means that the array is able to absorb mechanical stress which helps to protect the internal structure against short circuit failure. FLEXITERM arrays are offered in two or four element packages from 0405 to 0612 case sizes and are all RoHS compliant.

These arrays can be used in a number of high volume commercial decoupling applications, such as mobile communications as well as in higher temperature automotive systems, for example in engine management, control systems and dashboard electronics.

www.avx.com

Fairchild Optimize Power Efficiency and System Reliability in Flyback Designs



Fairchild, committed to a greener and less wasteful environment, demonstrated convincingly with a presentation from Alfred Hesener, Marketing Director Europe, the huge need for responsibility towards our environment. The company has now introduced their Green FPS e-Series, a new family of Fairchild Power Switch (FPS™) products to provide high energy efficiency and system reliability in DVD player, set top box, LCD monitor and other sub-25W power supply designs. Based on Fairchild's proprietary valley switching technique, the Green FPS products raise power conversion efficiency by 1% and reduce EMI up to 5dB compared to conventional hard-switch converter topologies. These highly integrated FPS devices combine the functionality of a fully avalanche rated SenseFET, a current mode pulse width modulation (PWM) IC and many protection functions, simplifying design and improving system reliability. Utilizing advanced burst mode operation, the Green FPS e-Series devices meet standby power regulations by reducing standby power consumption to below 0.2W at no load conditions (below 1W at 0.5W load).

Designs employing Green FPS e-Series products provide superior system reliability and space benefits compared to discrete MOSFET/controllers, RCC switching converters, or conventional hard-switching solutions due to space saving 8 lead DIP and 8 lead LSOP packaging and the inclusion of a variety of protection circuitry. This circuitry includes over-voltage protection (OVP), over-load protection (OLP), abnormal over-current protection (AOCP) and thermal shutdown protection (TSD). Additional features include an integrated fixed oscillator, under-voltage lock out (UVLO), optimized blanking and gate turn-on/turn-off driver, and temperature compensated precision current sources for loop compensation.

These products meet or exceed the requirements of the joint IPC/JEDEC standard J-STD-020C and are compliant with European Union regulations now in effect.

Samples are available now, production quantities in 8 weeks.

www.fairchildsemi.com

Products	V_{DS} Max (V)	$R_{DS(ON)}$ Max (Ohms)	Peak Current Limit (A)	Output Power Max (W)		Package	Price (1000pcs, each)
				@85 -265Vac	@230Vac		
FSQ0165RN	650	10	0.9	13	15	8DIP/8LSOP	$0.84
FSQ0265RN	650	6	1.2	16	20	8DIP/8LSOP	$0.95
FSQ0365RN	650	4.5	1.5	19	25	8DIP/8LSOP	$1.01
FSQ311	650	19	0.6	8	10	8DIP/8LSOP	$0.67
FSQ321	650	19	0.6	10	12	8DIP/8LSOP	$0.67

Infineon Powers Forward in White Goods and Industrial Applications

CiPoS™ Modules: *Intelligent Power Increases Efficiency and Reliability of Home Appliances*

Infineon introduced a new family of highly integrated intelligent power modules that contain nearly all of the semiconductor components required to drive electronically controlled variable-speed electric motors. Reflecting Infineon's commitment to improving energy efficiency of electrical drives, the new CiPoS (Control Integrated Power System) modules are designed to enable energy-efficient operation of consumer appliances as washing machines and air conditioners, offering efficiencies of up to 94 percent.

The use of variable-speed motors to reduce the energy consumed by household appliances is growing in response to regulatory requirements and consumer demand. Concurrently, smart design of drive control electronics to make best use of these motors presents manufacturers with further opportunities for efficiency and savings.

The new CiPoS modules incorporate a three-phase inverter power stage with a SOI (Silicon-On-Insulator) gate driver, boot strap diodes and capacitors, and auxiliary circuitry in a compact, high-performance, fully isolated package. Based on a combination of Infineon's TrenchStop™ IGBT (Insulated Gate Bipolar Transistor) and EmCon™ (Emitter Controlled) diode technology, they eliminate as many as 23 discrete components. This can reduce manufacturers' costs in decreased inventory and logistics costs, reduced circuit board space, simplified layout and assembly, improved overall reliability, reduced EMI and shorter time-to-market. The CiPoS modules represent a ready-to-use solution for all motor drive systems with a power rating of up to 3 kW.

The CiPoS modules also offer the industry's lowest junction-to-case resistance, which increases output current by up to 20 percent compared to other available modules. For example, the junction-to-case thermal resistance of the IGBTs of the CiPoS module IKCS-12F60AA is 3.6°C/W (degrees Celsius/Watt), and of the EmCon diodes is 4.9°C/W. At a nominal operating voltage of 15V, this low resistance results in an output current of 6.0A, compared to the 5.0A produced by the closest competitor. This makes a higher output power possible in designs with equivalent-sized heatsinks compared to alternatives, or the use of a smaller heatsink for the same power Interfacing to the microcontroller is through direct connection of the control terminals supported by pull-up resistors. A feedback control loop can be easily implemented by adding an external operational amplifier.

Engineering samples of the first family members, which are in RoHS-compliant single-in-line modules best-suited to washing machine and similar applications, are available now.

Production-level quantities are expected to be available in the third quarter of 2007. Dual-in-line versions suited for higher-power HVAC applications are also planned.

www.infineon.com/cipos

PrimePACK Modules: *Optimized for Industrial Applications*

The new PrimePACK™ modules in the 1200V and 1700V voltage classes are up to 45 percent lighter when compared to modules with the same power. This family of compact IGBT modules enable power converter system solutions to be optimized for industrial drives, windmills, elevators, traction or auxiliary drives, power supplies and heating systems in trains and tractors.

PrimePACK modules are based on innovative packaging that also utilizes the advantages of the Infineon IGBT4 chips, which feature excellent electrical ruggedness. The unique module design offers advantages, such as the special layout of the IGBT chips inside the module that significantly improves heat distribution. The IGBT chips are closer to the baseplate's screw-fastening points, resulting in a low thermal resistance between the baseplate and heatsink. Internal stray inductance is reduced by approximately 60 percent from that of comparable modules.

The half-bridge configuration and modular design of the modules make it easy to scale the converter power by employing different module sizes or by connecting the modules of a given type in parallel. Modules are available in both 1200V and 1700V voltage classes and in two module sizes - the 89mm x 172mm PrimePACK 2 and the 89mm x 250mm PrimePACK 3 and are up to 45 percent lighter than comparable modules with the same power.

Volume production of the 1700V PrimePACK modules is available now. Volume production for the 1200V version will begin in September 2007. The modules are RoHS-compliant and meet fire protection requirements in accordance with NFF16-101 and 16-102.

www.infineon.com/primepack

Isolated Surface-Mount Current Transducer Family Operates from Single +5V Supply

Application Manager for Business Segment Industrial, Bernard Richard, demonstrated to me a new current transducer, the HMS model, which is designed to operate from a single +5V power supply. The new unit measures only 16 (L) x 13.5 (W) x 12 (H) mm and integrates a primary conductor. It is directly surface-mounted onto a printed circuit board, reducing manufacturing costs.

Four standard models are available to cover nominal AC, DC, pulsed and mixed isolated current measurement of 5, 10, 15 or 20 A_{RMS}, up to 50 kHz, with a measuring span of up to ±3 x I_{PN}. The same mechanical design is used for all four models so that they can be used to measure current across a complete range of end products.

The internal reference voltage (2.5V) is provided on a separate pin or can be forced by an external reference (between 2 and 2.8V) for reference thermal drift cancellation. Gain and offset are fixed and set so that, at I_{pn}, the output voltage is equal to Ref in or Ref out ±0.625V.

A unique LEM ASIC designed for use with open-loop Hall-effect technology has been used to provide performance improvements. These include better offset and gain drifts and linearity, in addition to an extended operating temperature range (-40 to +85°C) compared to traditional discrete technology.

These products are compatible with standard production techniques such as pick-and-place automation and flow soldering including RoHS temperatures.

An additional version of the HMS transducer is under development for PCB mounting through holes instead of surface mounting and will be available in the next few months.

The transducers are CE marked, conform to the EN 50178 standard and are recognised for industrial applications such as home appliances, variable speed drives, UPS, SMPS, power inverters (solar, wind, etc) and air-conditioners.

The HMS is supplied with a five-year warranty, as are all LEM industrial products.

www.lem.com

Microchip Introduces 2MHz, 500 mA Switching Regulator

Markus Austermayer, Field Sales Engineer for Microchip presented the MCP1603, a new 2MHz, 500mA switching regulator. This low-power switcher provides adjustable and fixed output voltages, operating efficiency of up to 90%, and is available in Thin SOT-23 (TSOT-23) and 2mm x 3mm DFN packages and is ideal for extending battery life and reducing heat dissipation in a variety of portable, handheld electronic devices.

It also features a low quiescent current of 45µA, a standby current of only 100nA, under voltage lockout (UVLO), over-temperature and over-current protection and auto transition from PWM to PFM modes for lower energy use and heat dissipation, as well as longer battery life. With an input voltage range of 2.7V to 5.5V and either an adjustable output voltage range of 0.8V to 4.5V, or a fixed output voltage range between 1.2V and 3.3V, the MCP1603 switcher can cover the entire Li-Ion, Li-Polymer, NiCd and NiMH voltage range.

The new MCP1603 Evaluation Board (Part number MCP1603EV) demonstrates using the MCP1603 as a Buck switcher. This board is available now at www.microchipdirect.com.

The MCP1603 switching regulator is available now. Samples can be ordered at sample.microchip.com. For further information, visit Microchip's Web site at www.microchip.com/MCP1603.

In addition, I was told about the company's investment in Regional Training Centres in UK, Germany, Italy and France where workshops in local language are delivered by Microchip experts, focusing on application-driven solutions.

To support its customers still further, Microchip has recently developed a suite of web-based design tools.

www.microchip.com

Micronas Demonstrates Most Accurate Linear Hall Sensor for Greener Automotive Performance

I talked with Peter Zimmermann, Market Manager Automotive at Micronas about the announcement of the HAL 82x family of programmable Hall-effect sensors, designed to meet the latest accuracy requirements of many automotive applications.

"We designed the HAL 82x to meet the increasing demands on engine management in the automotive industry. Ever more accurate readings of key vehicle parameters means lower emissions and better fuel economy. This sensor offers the highest precision to meet the requirements of next-generation throttle valve position sensors. This reduces pollutant and CO_2 emissions." Other target applications for the device include linear movement measurement, flow measurement, position detection and contact-less potentiometers.

Like its predecessors, the HAL 82x has an integrated EEPROM to store the sensor parameters. Proven in previous generations of Micronas Hall-effect sensors, the EEPROM is extremely robust and reliable, even at the allowed maximum junction temperature of 170°C.

The sensor's high accuracy is based on the 14-bit signal path, the integrated digital signal processing and the ratiometric 12-bit analog output. The sensor also features a multiplexed analog output. With this new output format, developed by Micronas (patent pending), the 12-bit D/A-converter of the HAL 82x achieves the actual resolution of a 14-bit-converter, while avoiding the small quantization intervals. This delivers an excellent signal-to-noise ratio on the output.

Micronas designers put extra effort into minimizing the drift of sensitivity and offset over the temperature range. This guarantees long-term stability of the main parameters, which helps to ensure the car's optimum performance for many years. The differential non-linearity (DNL) is below one LSB. Electrostatic discharge (ESD) is a severe issue in automotive applications and the 4-kV rating of the HAL 82x significantly surpasses other existing linear Hall sensors.

Automobile trouble-shooting and repair is enhanced by an integrated wire break detection system. This makes it easy for the engine control computer to detect and report problems with the car's wiring.

Micronas offers a development board for design and production of the Hall sensors. The required software is available free of charge.

The RoHS-compliant HAL 82x is available in the TO-92UT package, suitable for overmolding, and operates at ambient temperatures between –40°C and +150°C.

www.micronas.com

Special Report - PCIM Europe 2007 Roundup

National Launches Industry's Highest Power PoE PD Controller with Auxiliary Power Support

National's Werner Berns, application design centre manager for Europe, gave me a run-down on the new Power-over-Ethernet (PoE) powered device (PD) controller with adjustable output current level and the special ability to interface with any DC-DC converter topology.

The new LM5073 integrates a programmable interface port including a hot-swap controller exceeding the standard IEEE 802.3af specifications, enabling designers to operate PoE appliances at power levels of 30W or more. For greater flexibility, the LM5073 separates the PD interface from the DC-DC converter to support a wide variety of isolated and non-isolated DC-DC converter topologies. Applications include IP telephony, remote security cameras, card readers, wireless access points, PoE-enabled industrial automation systems and point-of-sale terminals.

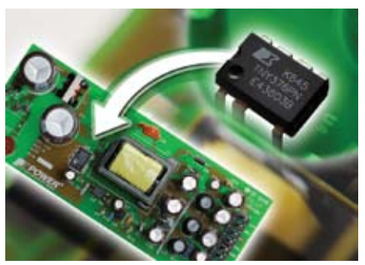
The LM5073 PoE controller supports PD designs that are fully compliant with the IEEE 802.3af standard. If more power is required, the low RDS(ON) hot-swap MOSFET and programmable DC current limit extend the range of LM5073 applications to more than twice the power level of IEEE 802.3af compliant devices. The LM5073 also provides the flexibility for the PD to accept power from unregulated auxiliary sources such as AC adapters and solar cells in a variety of configurations. The 100V maximum voltage rating simplifies selection of the voltage suppressor that protects the PD from network transients.

National's LM5073 can be used with the DP83848 single port or DP83849 dual port 10/100 Mbps Ethernet physical layer device to provide a space and cost effective system solution for PoE Ethernet compliant designs. The power for the node (following the PoE standard) is supplied by standard CAT5 cable and connectors via the National devices, which eliminates the need for expensive external power supplies while delivering full Ethernet connectivity.

Offered in a 14-pin TSSOP with exposed pad for improved thermal performance, the LM5073 integrates a 100V, 700 milli-Ohm, N-channel MOSFET as well as the PD signature and under-voltage lockout resistors. It provides configurable front and rear auxiliary inputs that accept power from AC adapters to reduce the power draw on the PoE power sourcing equipment. Complementary control outputs provide a flexible interface to the best DC-DC converter topology for the particular application. For non-isolated applications, the LM5073 can be paired with National's LM5007 and LM5010 buck regulators or the popular LM5574, LM5575 and LM5576 high-voltage SIMPLE SWITCHER® product family. For higher-power isolated systems, the LM5073 can be paired with National's LM5020 or LM5026 pulse-width modulation (PWM) controllers. For more information on the LM5073 or to order samples and an evaluation board, visit http://www.national.com/pf/LM/LM5073.html

www.national.com

Power Integrations' TinySwitch-PK IC Delivers 280% Peak Power



Reference Design Kit (RDK-115)

Power Integrations' product marketing manager, Andrew Smith demonstrated the advantages of the *TinySwitch®-PK* integrated power supply control IC with peak power mode. TinySwitch-PK can deliver up to 280 percent peak power for short periods of time, enabling designers to specify transformers rated for the continuous power level which significantly reduces size, weight and cost of designs. With its high level of integration and robust feature set, *TinySwitch-PK* enables simple, flexible designs with far fewer components than competing discrete and integrated solutions.

Many consumer products have seldom-used motors, buzzers or lights that require extra power for short periods. DVD player drawer-opening motors or PVR disk drive motors are good examples. The rest of the time, the hardware performs standard tasks and consumes much less power, yet all the system components — such as transformers, output diodes and bulk storage capacitors — must be specified for use at the occasional higher power requirement. The challenge in these systems is to design a power supply that can provide the necessary peaks when needed, but does not burden the application with peak costs. By automatically entering into a special peak mode — doubling operating frequency and boosting current limit for the duration of the peak power requirement, *TinySwitch-PK* coaxes up to 280 percent of the design power level out of the same transformer and integrated MOSFET. Moreover, it simplifies the transformer construction for multiple-output designs. Due to the chip's higher operating frequency, the number of primary turns may be reduced, making it easier to match common voltage ratios and consequently

fit all of the turns onto a short bobbin, reducing total copper usage and cost.

TinySwitch-PK features a 700V MOSFET alongside low-voltage control circuitry on a monolithic IC. Other features include integrated auto-restart, input under-voltage and output over-voltage protection, hysteretic thermal shutdown, and frequency jittering to minimize EMI.

The device also includes selectable current limits, allowing designers to choose any of three current limit values for each family member without any additional IC pins or external components. This capability enables designers to optimize their power supplies for either maximum efficiency or greatest power output.

Complete documentation for the *TinySwitch-PK* family can be found on the Power Integrations web site. The new product family is also supported by a reference design kit (RDK-115).

www.powerint.com

Systel's Digital Control Makes Lighting Control Simple

Systel is a mixed-signal semiconductor company in the field of research, development, engineering and manufacturing of Digital Configurable Power Control and Management Controllers, providing innovative solutions for the power electronics market. The company has launched the IDC2000, the second generation of its digital power controller ICs, and applications based on broadly patented technology and methods. These ICs are a family of novel single chip controllers, a concept based on Systel's Universal Power Management Mixed-Signal SoC Controller (UPMC) technology.

The IDC2000 proprietary architecture is a breakthrough System-on Chip digital based concept for Power Control and Power Management evolved by Systel during decades of research and development. It contains all the required end-product control functions for the lighting and building automation applications field, including street lighting.

In Lighting, the IDC2000 IC family is able to implement almost any type of power topology and control function that a designer could imagine to create newly featured high performance networkable and non-networkable (regular) multi-lamp electronic ballasts at the lowest market price.

The IDC2000 IC family allows a single ballast to implement multi-channel topology that operates any combination and type of linear or compact fluorescent, LED or HID lamp, with each lamp individually controllable for full On-or-Off control or dimming to the lowest level determined by the design. Lamps will be driven by the highest standards and specifications envisioned by the designers.

The IDC2000 ICs enable innovative multi-channel topologies for dimmable or non-dimmable multi-lamp and multi-fixture ballast solutions (central ballast). In the latter, each fixture could be controlled separately and use different types of lamps, located at varying distances without affecting light quality at a price competing with simple regular ballasts.

In building control Systel has taken advantage of the IDC2000's features to develop highly specified applications to achieve the largest possible energy saving solutions with a short payback term of less than 2 years in both retrofit and new buildings. The IDC2000 is highly applicable for all the active components of the building control system (ballasts, central and local remote controllers, multiple networkable sensors, remote controllable actuators to drive HVAC and other devices). Uniquely, the IDC2000 allows smart load shedding without affecting user comfort, such as modifying air conditioner settings at the local controller and shutting down individual lamps within a fixture.

In residential applications in which savings are a relevant factor, the IDC2000's features with embedded power line modem will provide highly competitive solutions that cannot be outrivaled in cost and performance, together with robust and smart control at the level of individual elements.

In other lighting fields, such as flat panel backlight applications with fluorescent and LED lamps, the unique multi-channel IDC2000 platform features with its synchronization capability to external signals will allow the industry to develop solutions with the highest envisioned performances and algorithms at the lowest cost.

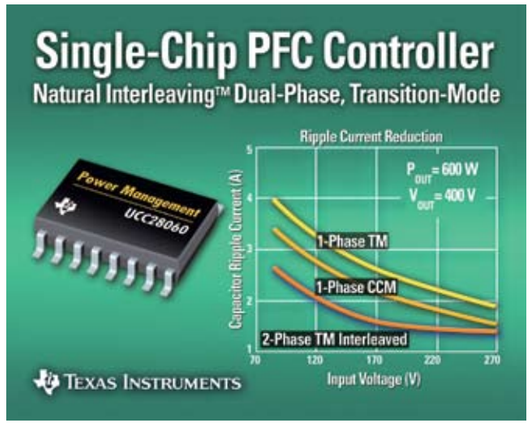
Systel's IDC2000 parametrical tuning configuration provides an exceptionally short time to market. The user friendly GUI tools, such as the PDK-L3, developed by Systel for fluorescent lighting, can "mold" the IDC2000 to almost any power topology and create any control algorithm desired by the designer, including debugging the end-product in a fraction of the time required by other types of controllers. The IDC2000 was built from the ground up to provide an unprecedented single chip solution allowing previously unaffordable applications with the highest specifications, while exhibiting the most advantageous cost performance ratio achieved in the industry.

The IDC2000 was designed with the goal of being the most comprehensive digital architecture with none of the drawbacks of devices currently in the marketplace. The IDC2000 was designed to overcome the speed limitations of "micros" and "DSPs" and their arduous programming, without the disadvantages of analog solutions, using parallel processing based on dedicated Configurable Hardwired Engines.

The IDC2000 platform based on Systel's UPMC digital technology, a truly different IC power controller concept, was created as a Generic Configurable Architecture allowing designers to create their own "Customized ASIC" solution for Lighting and Building Control.

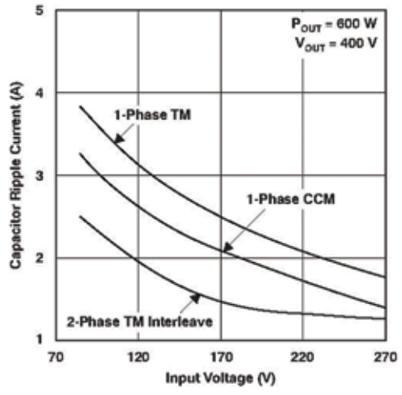
www.systelpower.com

TI Launches Energy-Saving, Single-Chip Power Factor Control for Consumer Applications



I was fortunate enough to meet with Larry Spaziani, Product Line Manager for TI's power supply control products. He gave me an overview of the newly launched UCC28060, the industry's first single-chip, interleaved, transition-mode power factor correction (PFC) control circuit that helps lower power system cost and save energy in consumer applications such as digital TVs, personal computers and entry-level server platforms.

The UCC28060, a two-phase high-performance controller for 75- to 800-W applications, simplifies power system design, minimizes switching losses, and saves system cost and valuable board space when compared to traditional single-phase, transition-mode or continuous-conduction mode (CCM) topologies. In certain customer applications, designers have been able to reduce their overall bill of materials cost by as much as 20 percent, while at the same time achieving higher levels of performance in a smaller, thinner and lighter power supply design.



Ripple Current Reduction

The UCC28060 helps designers to efficiently meet or exceed the world's most stringent power factor requirements for consumer electronic systems. It features Natural Interleaving™ technology, which reduces the input and output current ripple, distributes magnetics to improve thermal management, and provides light-load phase management. The UCC28060's ripple cancellation feature significantly reduces ripple current compared to single-phase or alternative "master-slave" interleaved solutions. In addition, the feature allows a designer to reduce capacitor size by 27 percent, and it gives designers the ability to use a much smaller and less expensive electromagnetic interference (EMI) filter.

The PFC controller's light-load phase management enables a power supply to operate at high efficiency over the whole range of the load, enhancing system performance and aiding OEMs' efforts to achieve the stringent 80 Plus and Energy Star® compliance. Phase management allows the user to turn phases of the power supply on or off so that only the phases required to power the load are enabled. The UCC28060 can increase efficiency by up to five percent at light load conditions.

Safety is a critical concern of all power system designers, and the UCC28060 offers several unique system control and protection features to improve power system reliability. The device incorporates the industry's first "failsafe" over-voltage protection circuit, which provides dual paths of voltage sensing to protect against shorts to an intermediate voltage. If undetected, such shorts could lead to a catastrophic failure on the board. Secondly, the PFC device provides in-rush current management to prevent MOSFET conduction during in-rush events, while eliminating reverse recovery events in the system output rectifiers. Finally, the UCC28060 employs sensorless current shaping to protect the system from potential damage that may otherwise occur during "brown-out" conditions and recovery.

Samples of the UCC28060 are available in a 16-pin SOIC package. An evaluation board, power factor correction application notes and data sheets are available at power.ti.com.

TI also demonstrated at the PCIM Europe conference its Digital PFC Adapter Board, based on the TMS-320F280x digital signal controller. This board helps analog and digital power supply designers evaluate and detect power factor correction in power systems that support consumer and industrial applications. The PSFB2808 board is used with TI's F2808 eZdsp Starter Kit and free downloadable C2000 Power Factor Correction Software, and is available through Tier Electronics.

www.ti.com

www.tierelectronics.com

Toshiba Launches New Motor Drive and Control Products

Next generation single-chip inverters

Toshiba Electronics Europe (TEE) held a press conference at the show to launch a new generation of single-chip inverters for brushless DC (BLDC) motor applications operating with voltages up to 500V. Available in PWM and non-PWM versions, the new devices integrate into a DIP26 package full three-phase inverter bridge operation and other key features including protection and integrated bootstrap diodes.

The new TPD412x family of DIP26 single-chip inverters is ideal for home appliances such as refrigerators and washers as well as industrial motion control applications including pumps and fans. Increasingly these products use BLDC motors to deliver high accuracy and long-term reliability alongside efficient energy use and low levels of noise and vibration. Single-chip inverters are a vital component in reducing the component count, complexity, development time and cost of BLDC motor-based designs.

The new chips combine high- and low-side drivers with six IGBTs to supply current to the motor stator coils. Integrated fast recovery bootstrap diodes reduce component count and cost, while additional on-board functions include protection against over-temperature, overcurrent and undervoltage conditions. Three members of the family also incorporate PWM circuitry and three-phase distribution logic in the same DIP26 package.

Toshiba's new single-chip inverter line-up features devices with output voltages of 250V and 500V. The 250V inverters offer a 1A output current, while the 500V versions are available with output currents of 1A, 2A or 3A. All of the inverters can interface directly with a host microprocessor.

Toshiba has used silicon on insulator (SOI) technology and a trench isolation structure to bring together low and high voltage circuits in a reliable monolithic device measuring just 32 x 13mm. At 3.8mm (max), package thickness is 27% lower than existing HZIP23 packages, while improved thermal resistance reduces requirements for external cooling.

Toshiba's six-input 500V/2A and 500V/3A single-chip inverters are in mass production now. Additional devices including versions for sensor-less motor control will join the line-up during the course of the year. In addition to the devices themselves, Toshiba is also developing evaluation boards to allow designers to quickly and easily assess inverter performance in target applications.

Single-Chip Sensorless Sine wave ASSP for BLDC Motors

Toshiba also announced the industry's first single-chip sensorless motor controller application specific standard product (ASSP) to offer full-wave sine wave PWM motor drive output. The new TB6582FG will significantly reduce the complexity and component count of brushless DC (BLDC) motor applications ranging from home appliances and pumps to industrial automation and automotive motion control.

Unlike MCU-based alternatives, the new device is a cost optimised state machine which does not even require programming. Specifically, the TB-6582FG takes the analogue speed inputs supplied by a host microcontroller and provides a complete full-wave sine wave PWM drive output without the need for additional processing. The sinusoidal motor coil current waveform provides for smoother BLDC motor operation and lower electrical and acoustic noise than is possible with conventional PWM outputs while still allowing designers to realise the benefit of PWM efficiency.

Toshiba has integrated on-board circuitry that accurately calculates rotor speed and position using phase current information, allowing designers to eliminate the need for Hall sensors. This not only reduces component count but also improves application reliability, while making the TB6582FG ideal for applications where addition of sensors is not practical or commercially unviable.

The TB6582FG features a built-in triangular wave generator with a carrier wave frequency of f_{osc}/252Hz and an integrated dead time function that allows safe operation of the power FETs in a push-pull configuration. Control of motor rotation speed in both forward and reverse directions is achieved by changing the PWM duty cycle based on the input from the host microcontroller.

Suitable for operation with supply voltages from 6.5V to 16.5V, the new motor controller SoC features an on-board regulator that provides a typical reference voltage of 5V. Lead angle adjustment capability allows designers to tune their applications for optimum efficiency.

www.toshiba-components.com

Special Report - PCIM Europe 2007 Roundup

Tyco Electronics Roundup

As expected, Tyco demonstrated a broad range of its latest products and services. I have captured the main points for your information, but recommend following the web addresses provided for further information.

***fast*PACK 0 H 2nd gen**

H-Bridge Module for Fast Switching Applications

The fastPACK 0 H 2nd gen is a new family of fast switching H-bridge modules in the *flow* 0 package. With this family, Tyco Electronics addresses the needs of higher power fast switching applications, such as welding, switch mode power supply and solar energy conversion, requiring frequencies of up to 250 kHz.

The entire family consists of 15 different versions at 600V and 8 different versions at 1200V. Combining the different diode types, substrates and the optional DC link capacitor mentioned above, the family provides the optimum solution for any application within this power range and frequency.

***flow*90PACK 1 + *flow*90CON 1**

Sixpack and Rectifier now available in 90° housing

After its very successful *flow*90PIM series – Tyco presents a sixpack (*flow*90PACK 1) and a rectifier configuration (*flow*90CON 1) in the 90° housing. These modules are dedicated to motor and servo drive inverters, which require the heat sink to be in an up right position (at 90° mounting angle) in respect to the PCB. This package provides many benefits in addition to the standard Power Module features.

The *flow90*PACK 1 family (sixpack with NTC) is available for up to 600V/75A and 1200V/35A. The *flow90*CON 1 family (3 phase input rectifier with brake chopper), optionally half controlled is available for up to 1600V/75A.

***flow*PACK 2**

Sixpack in IGBT4 1200V technology with 150A at 1200V

A new member of the *flow*PACK family that extend the power spectrum at 1200V up to 150A. The *flow*PACK 2 includes a sixpack and a NTC packed in very compact flow 2 housing. IGBT4 technology improves the EMC behaviour due to softer switching. The baseplate of the module leads to an optimal heat dissipation of module and heatsink. The Module is equipped with a mechanically isolated NTC.

This module is dedicated to motor and servo drive manufacturers which require high power density on minimum space.

The *flow*PIM 2 family (sixpack and NTC) is available at 1200V in 75A, 100A and 150A.

NEXT GEN. POWER FACTOR CORRECTION MODULES

New modules in flow0 housing

A new P80x PFC power module family to support the increasing demand of modern electronic equipment for higher output power and smaller footprint. The product is incorporating state of the art components ranging from high speed IGBTs and Tandem diodes for cost sensitive solutions to low Rdson MOSFETs and SiC diodes for high switching frequencies and outstanding efficiency. With a maximum continuous output power of 8kW at 230V input voltage and switching frequencies of up to 400kHz the new PFC modules are well suited for all kinds of high power applications like welding equipment, motor inverter and power supplies.

***flow*PHASE 0 – EXTENSION 600V**

Extension of flowPHASE 0 half bridge power module family

Tyco Electronics has extended its family of high power modules in the *flow* 0 package. Besides the 1200V half bridge module family, ranging from 50A to 150A, now also available are further 5 half bridge modules spanning 75A to 200A at 600V.

The *flow*PHASE 0 family is ideal for a modular approach in motor inverter design and manufacture. It enables the use of the same power module and PCB design for a complete series of products in of different power ranges, thus reducing the development and manufacturing cost.

***flow*PIM 2 3rd gen 100A /1200V IN IGBT4 TECHNOLOGY**

The ultra compact 100A PIM Module

Now the 3rd generation of Tyco's biggest PIM Module, the *flow*PIM 2 3rd gen. It includes rectifier, brake chopper, inverter and mechanically isolated NTC with improved pinout. This Module is equipped with IGBT4 technology in order to improve the EMC behaviour and can support currents up to 100A at 600V/ 1200V. The *flow*PIM 2 3rd gen is the optimal solution for motor drive manufacturers who require high power density on minimum space for compact devises.

The *flow*PIM 2 3rd gen family (rectifier, BRC, sixpack and NTC) is available in 600V/ from 50A up to 100A and in 1200V/ form 35A up to 100A.

***flow*SIM**

A New Class of Power Module Simulators

The new *flow*SIM simulator for Tyco's Power Module products. This LabView based tool allows the simulation of three and single phase outputs as well as three and single phase input stages and PFC circuits, supporting applications like motor drives, solar inverter, UPS and switch mode power supplies.

*flow*SIM uses real measured data gathered during the characterization of the power modules for the calculation of the power losses providing access to up to 2 million data points per module. Previously this tool was only partly available for engineers in the application notes. This combination of simulation for the application output wave forms and calculation of the power component losses based on real measured data provides an extremely high simulator performance in terms of accuracy and speed.

Tyco Electronics will support all new standard products with the new *flow*SIM simulator, which can be downloaded free of charge from:

www.flowPIM.com

Melze Measures the Power

At my Vacuumschmelze press meeting I had with Patrick Trost, Director for sales Europe, he gave me a rundown on the company's major exhibits.

Evaluation kits

VAC's patented closed-loop current sensors with magnetic field probe feature outstanding sensor precision. The system electronics are almost wholly integrated in the IC 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 which are or will soon be available.

Core Sample kit

VAC also presented a new core sample kit comprising nanocrystalline VITROPERM® toroidal tape-wound cores for EMC applications. A convenient plastic case contains around 65 cores in various sizes and types, with external dimensions ranging from approximately 10 to 40 millimetres. In graduated permeability ranges from 18,000 to over 100,000, the kit provides developers with the maximum scope for laboratory experimentation.

Common Mode Chokes with VITROPERM® cores demonstrate superior broadband attenuation properties even at high operating temperatures of up to 150 degrees Celsius. Thanks to the combination of high permeability and high saturation flux density, small size Common Mode Chokes with fewer turns can be produced that deliver outstanding high-frequency response.

10 years of CTs

VAC has for ten years produced Current Transformers for Electronic Electricity Meters. Since the first developments in 1997, VAC achieved significant growth rates in this section – due to worldwide trends in replacing mechanical meters with electronic versions. Due to the high quality and reliability, global meter manufacturers adopt VAC's current transformers for their next generation electricity meters giving VAC a considerable market share in ANSI and IEC regions.

This includes special CTs, which are protected against tampering with magnets as well as specific transformers for tampering detection. In addition, the Hanau-based enterprise offers new modules for three phase applications and specific CTs with integrated primary copper bars based on cores of new alloy of VITROPERM® family.

www.vacuumschmelze.com

Vicor Announce MIL-COTS 28V DC-DC V•I Chip Modules

I met with Paul Yeaman, Vicor's principal product line engineer, who talked me through these newly launched modules delivering a stunning 20% more power at 1/3 the volume in a rugged, miniature package.

Vicor's new MIL-COTS 28V DC-DC V•I Chip module product line consists of a 28 Vdc input PRM™ regulator and a family of VTM™ current multipliers with output voltages from 1 to 50Vdc.

The PRM and VTM chipset provides the full functionality of a DC-DC converter but also features high efficiency and higher power density, fast transient response, low noise, and flexible thermal management. With each module weighing only 1g and measuring just 32.5 x 22 x 6.6 mm, the chipset offers clear advantages for designing power systems in mission-critical portable and airborne applications.

A PRM and VTM chipset can provide up to 100 A or 115 W for a system density of 172 A/in^3 or 198 W/in^3 and because the PRM can be located, or factorized, remotely from the point of load, these current and power densities can effectively be doubled at the load itself. The modules may be paralleled for higher power arrays. A compatible filter (M-FIAM7) is available that provides EMI filtering in compliance with MIL-STD-461 and transient suppression in compliance with MIL-STD-1275, MIL-STD-704 and DO-160.

The V•I Chip package is compatible with standard pick-and-place surface-mount machinery and assembly processes. It provides flexible thermal management through its low junction-to-case and junction-to-board thermal resistance.

A MIL-COTS PRM and VTM chipset is available now in OEM quantities. MIL-COTS V•I Chips are in mass production and are available immediately from stock. Evaluation Boards are available to evaluate the entire family of MIL-COTS 28 V DC-DC V•I Chip Modules. Each PRM and VTM is surface mounted to a unique PWB that can be mated using integral connectors. Evaluation boards are also available from stock.

V•I Chip Through-Hole Packaging Option

Vicor have now introduced a through-hole packaging option for all V•I Chips including MIL-COTS. This is in addition to existing surface mount (SMT) compatible packaging, doubling the available range.

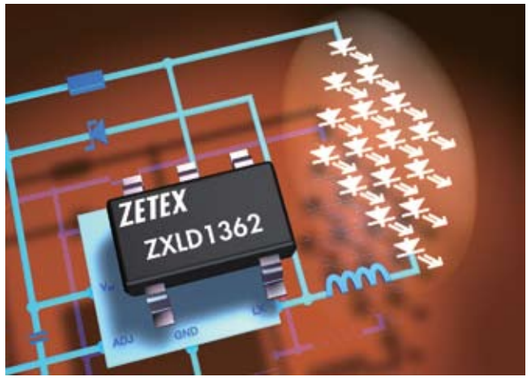
Through-hole products are electrically and thermally identical to the SMT versions and are compatible with both hand soldering and wave solder techniques so they are perfect for fast prototyping or large production runs. Through-hole assembly facilitates multi-chip cold-plate or heatsink mounting and makes system assembly simpler, faster, cheaper and available now.

The new through-hole packaging option is compatible with both leaded and lead-free solder. For the MIL-COTS market, this option aligns with the Vicor MIL-STD MFIAM filters for a complete solution. Power designers in a broader range of applications can take advantage of the benefits of V•I Chips.

Information on board layout and 3D models as well as data sheets for all V•I Chip products, application notes and demo board user guides are available now. Please visit:

www.vicorpower.com

Zetex Miniature LED Driver Tackles High Power Tasks



I was fortunate at PCIM to meet with Colin Davies, Global Applications Manager for Zetex. The company is renowned for the design and manufacture of high performance analog ICs and providing high efficiency power management and signal processing solutions through combination of ASICs and building block components for audio, video and linear applications as well as motor control and DC-DC conversion.

At the show, the company launched the ZXLD1362, high power LED driver.

Operating from a 6V to 60V input supply and achieving up to 95% efficiency, the ZXLD1362 can drive up to 16 high power LEDs with an adjustable output current of up to 1A. Provided in the tiny TSOT23-5 package, this LED driver is the smallest of its kind in its current rating, with a maximum footprint of 2.8mm x 2.9mm and off-board height of 1mm.

Simple to use and requiring just four external components, this highly integrated chip supports a range of flexible LED brightness and thermal management schemes. Output current can be adjusted by applying either PWM or DC voltage control signals to the adjust pin. Application of a low voltage signal turns the output off and puts the device into a low current standby mode.

Supporting an operating frequency of up to 1MHz, the ZXLD1362 is able to offer highly sensitive and accurate LED brightness control, with a typical dimming ratio of 1000:1 cited at 300Hz. A soft-start feature can also be achieved by the addition of an external capacitor.

Integrating a 60V MOS switch and a high-side output current sensing circuit, which uses an external resistor to set the nominal output current, the chip enables high power LEDs to benefit from ground referenced return paths, of particular importance in architectural lighting applications.

To simplify thermal control, the input resistance of the chip's adjust pin has been set at 50kΩ in order to be compatible with common thermistor values. The chip's compact design and ability to comfortably withstand high-voltage transients, means it will also appeal to space-starved automotive and industrial applications.

This product is a drop-in upgrade for many lower power solutions, including Zetex Semiconductor's own ZXLD1350 (30V, 350mA) and ZXLD1360 (30V, 1A).

For more information visit:

www.zetex.com

Miniature SIP Packaged Device is Smallest Safety Approved 1W DC/DC Converter

C&D Technologies has extended its NMJ series of low power DC/DC converters to include eight new single output models. The devices are the world's smallest UL60950 safety standard approved 1W converters.

The NMJ series is housed in fully encapsulated, UL 94V-0 rated, 7-pin SIP packages with a footprint of just 1.91cm^2, making them ideal for use in applications that demand a miniature, safety approved solution. With reinforced system of insulation the NMJ is production tested at 5.2kVDC operation at full 1W load, without heatsinking, is possible between 40ºC and +60ºC.

The single and dual output (with power sharing) DC/DC converters use an advanced internal SMD construction and toroidal magnetics to help them achieve a power density of up to 0.42W/cm^3. The complete NMJ series provides engineers with a choice of 5V or 12V inputs. Available outputs are 5V, 9V and 15V.

Up to 11 million hours calculated MTTF using MIL-STD 217F FN2 method, allows for usage in high reliability, long life applications. The RoHS compliant NMJ series offers pin and functional compatibility with the C&D's NMV series of SIP DC/DC converters, giving designers upgradeability for systems requiring safety agency recognition.

www.cd4power.com

Aluminum Electrolytic Capacitors: Ultra-Compact Solution

The new snap-in aluminum electrolytic capacitors of the B43305 and B43508 series from EPCOS offer converter solutions with significant space saving ability. The components feature the same electrical properties as earlier types, but are smaller by up to two case classes. That corresponds to a height reduction of 5 and 10 mm. In this way the components enable the design of even smaller power supplies and frequency converters. The further miniaturization was achieved by the use of new materials, an improved capacitor winding design and an optimized concept for the mechanical construction. The B43305 series covers the capacitance range from 68 to 3300 µF and is available for voltages of between 200 and 450 V. It has an operating life of 2000 hours at a temperature of 85°C. The product's dimensions of between 22 x 25 mm (diameter x height) and 35 x 55 mm mean EPCOS ranks among the best-in-class manufacturers.The B43508 series covers the capacitance range from 82 µF to 2700 µF at voltages of between 200 and 450 V. The product is designed for use at temperatures of 105°C and then attains an operating life of 3000 hours. The 1000 µF / 400 V type stands out in the 22 x 25 mm to 35 x 55 mm range and can be regarded as a benchmark in this class.

www.epcos.com/alu_snap

Complementary 40V MOSFET for Size, Cost and Reliability in LCD Designs

40V Dual DPAK MOSFET

Fairchild Semiconductor introduces the FDD8424H, a complementary 40V MOSFET that provides Dual DPAK packaging and industry-leading thermal dissipation to increase system reliability, reduce board space and decrease overall system cost. Optimized for half- or full-bridge inverter designs, the FDD8424H is ideal for use in backlighting units (BLU) for LCD TVs, LCD monitors, motor drives and lamp drives. Compared to alternative solutions, the FDD8424H in Dual DPAK provides thermal resistance that is five and 10 times lower than solutions using 8-lead and dual SOIC (SO8) packages, respectively. In addition, the integration of a P-channel high-side MOSFET and an N-channel low-side MOSFET into a single package allows a common drain connection within the device, simplifying board layout and reducing design time.

"Fairchild's FDD8424H offers display designers the ability to optimize the footprint and the thermal performance of their inverter designs," said Mike Speed, Fairchild's marketing manager for Communications and Consumer Products. "The optimization of RDS(ON) and gate charge (Qg) in a Dual DPAK offers improved switching performance compared to conventional SO8 solutions, resulting in lower heat dissipation and increased efficiency. Also, the FDD8424H provides 12 percent lower case temperature in backlighting inverters while driving eight CCFL lamps."

This lead (Pb)-free device meets or exceeds the requirements of the joint IPC/JEDEC standard J-STD-020C and is compliant with European Union regulations now in effect.

www.fairchildsemi.com

Companies in this Issue

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

Power Systems Design Europe

Green Page

We know what needs to be done … but can we do it in time?

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

It seems to me, finally, that the whole industry has well and truly taken up the challenge for the absolute need to conserve energy, not just to be more efficient to save costs, but to take the broader and longer term view for the sake of our environment.

It sounds great, but in spite of this, the whole idea of the conservation of electrical energy, and therefore fuel emissions, seems to get blown away when we consider the huge increases needed decade-on-decade in the IT data server industry. These guys need more and more computing power to serve their customers, but are requested to conserve electrical power. Unless there is a meteoric advance in technology, existing demand from the power source industry will have to be scaled up considerably.

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. Almost all of this growth is attributable to growth in the numbers of servers (particularly volume servers), with only a small percentage associated with increases in the power use per unit.

Total direct power consumption for all servers in the U.S. in 2005 was about 2.6 million kW. Including cooling and auxiliary equipment increases that total to about 5 million kW, equivalent (in capacity terms) to five 1000 MW power plants."

This represents a huge amount of fuel and with it, I would guess, plenty of environmentally-unfriendly emissions. In this area alone, there must be colossal progress made just in order to stand

still, let alone make progress. A frightening thought for the environment.

On the plus side, the Microcell technology used in Firefly's new 3D and 3D^2 carbon-graphite foam batteries represents a significant advance in lead-acid battery performance. The company has now teamed with NorthStar to bring the technology into production with advanced lead-acid battery manufacturing techniques. A large portion of the funding for this phase of development is provided by the US Army, which has awarded Firefly a contract under its "Silent Watch" program. This is a project that seeks to develop batteries with sufficient capacity to power electrical equipment in military land vehicles during stealth operations.

According to Mil Ovan, Sr. Vice President of Firefly, the lead-acid electrochemistry of conventional batteries is unchanged in Microcell technology. Rather, new physical geometries enabled by the use of carbon foam allow a greater utilization of the full energy potential of lead-acid battery chemistry. The theoretical limit for the chemistry itself is 170 Whr/kg. The fundamental advance embodied in Microcell technology is the use of carbon-graphite foam, which replaces the conventional lead grid as an electrode.

At the hugely popular and successful PCIM show in Nürnberg (22-24 May), I was fortunate enough to speak with Alex Lidow, CEO of International Rectifier. It was really a refreshing pleasure to hear the rationale he has set as a culture point for his company and did not contain the usual technology pitch one might expect from such a discussion.

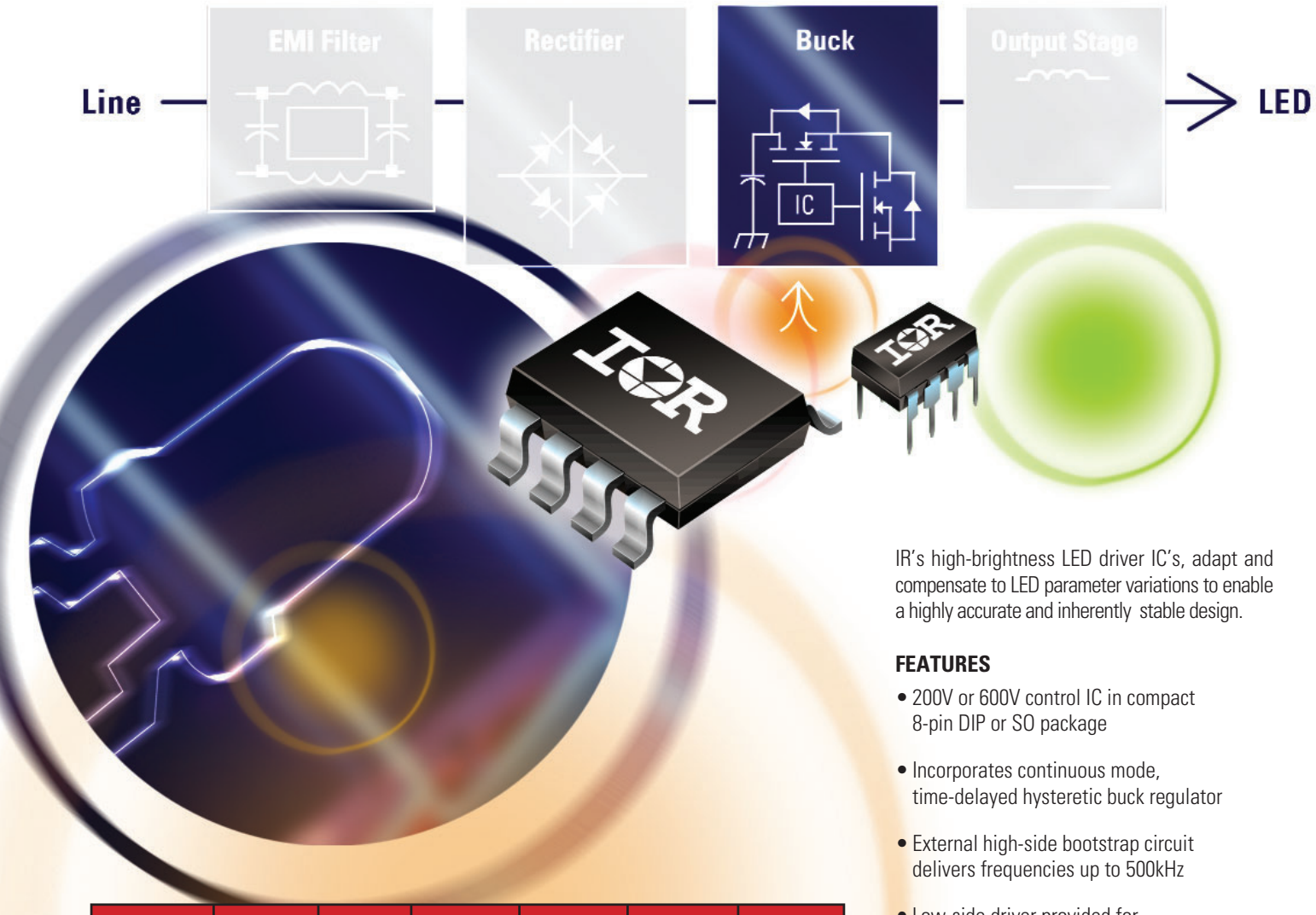
Alex told me very directly that it just isn't good enough to simply churn out products that are labeled 'energy efficient', 'green' or 'cost saving' as is becoming increasingly popular these days. He told me there is a much broader consideration that must be acknowledged when one looks at the total picture, i.e. the energy required, pollution potential and cost to actually produce such a 'wonder product'. The fact that the product may be popular does no good if the actual manufacture of the product pollutes the environment. A real 'wow moment' that I want to report in depth in a later issue.

So hopefully, we get to a stage where the power industry can get its more efficient, cooler running and greener produced parts into these power hungry industries as a matter of some urgency. It puts a huge responsibility on our industry and generates a very challenging opportunity for us all.

www.powersystemsdesign.com/greenpage.htm

PRECISE, RELIABLE, HIGH BRIGHTNESS LED DRIVER ICs

For Constant LED Current Regulation



IR's high-brightness LED driver IC's, adapt and compensate to LED parameter variations to enable a highly accurate and inherently stable design.

FEATURES

- 200V or 600V control IC in compact 8-pin DIP or SO package
- Incorporates continuous mode, time-delayed hysteretic buck regulator
- External high-side bootstrap circuit delivers frequencies up to 500kHz
- Low-side driver provided for synchronous rectifier designs
- Micro-power startup of less than 500µA
- 140ns deadtime for continuous current regulation
- Auto restart, non-latched shutdown and PWM dimmable capability

Part No.	Package	Voltage	Load Current Regulation	Micro-power Start-up	Deadtime	Frequency
IRS2540PbF	DIP8, S08	200V	+/-5%	<500µA	140ns	<500kHz
IRS2541PbF	DIP8, S08	600V	+/-5%	<500µA	140ns	<500kHz

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

International IOR Rectifier
THE POWER MANAGEMENT LEADER