Power Systems Design EUROPE

Empowering European Innovation

April 2007

ENERGY MEASUREMENT

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MarketWatch

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ENERGY EFFICIENCY

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Power Systems Design Europe

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How Green is the Valley?

What a month! With the APEC event plus a week in Silicon Valley and now with PCIM planning for the Lighting forum I am running with the top companies in this field - which I'll come to later- it's been a real slog. On the other hand, it has been extremely rewarding to get an up-to-the-minute briefing on what's going on at 'headquarters' both in the US and back here in Europe.

It has never been made so clear to me, the growing importance of our broad power industry. At every extremity of the industry, there is a real-world need for our expertise whether it is in power generation, transmission or consumption. It's not likely to change for the foreseeable future.

I keep talking about green pressure and legislation, but in effect these are the advertising campaigns that are subliminally converting us all along with general consumers to a sensitivity for conservation and 'green-ness'. The whole semiconductor industry, but power in particular, has been quick to see this opportunity for differentiation, no more so than in the white goods industry. Every manufacturer wants his products to be not only attractive in terms of labour-saving features, but also to demonstrate that their products are environmentally more-than-friendly. A love affair with the environment, that fits perfectly with consumer-conditioning. And the advertising is for free, courtesy of legislative bodies and reporting in the general media!

Nowhere is this more true than in the white goods sector to which this issue is dedicated. The volume and diversity of new products emerging at a staggering rate from all the top semi companies, is truly mind-boggling. From power factor correction devices to power modules and motor control circuits now even using DSPs, opens up a Pandora's box of tricks for making these 'necessities' of the modern world make the best and most economical use of resources while giving the consumer more 'bells and whistles' than he ever could have imagined he needed.

But it's not an easy business. While the consumer wants all these new features and to be simultaneously green, he is, after all, in the real world and on a budget. Bottom line is, he wants it for free and that makes the market fiercely competitive. Power semis and related providers have a tough job of selling against one another on both value-add and price platforms and there are many players. It will be an exciting and dynamic business to be part of, to watch and in my case, to report.

Still on the green side, last month we carried a Lighting feature which brought in a feast of articles, news stories and dialog with the companies associated with this industry. The response to my editorial request was so overwhelming and the quality of the inputs so good, that we will make next month's issue, May, the lighting Part II issue. I can promise you some good material. Co-incidentally, May is the month of PCIM in Nuernberg, Germany. Here I will run a forum on the first day; Tuesday 22nd entitled 'Lighting Leads the Way'. All the top companies in this field will present their case and I will hold open dialog with participants.

Additionally, we have launched a new editorial column in this issue, at the back of the magazine, called 'The GreenPage'. No prizes for guessing the subject matter! For this issue and in the future, articles and columns that we feel represents energy efficiency to the highest degree will be awarded with our GreenPage logo as a guide to the nature of the content.

PSDE Green Power
ENERGY EFFICIENCY

So, as always, I'll close by wishing you a good read and to thank you for the feedback to keep me on track with what you want and need from Power Systems Design Europe.

Cliff Keys

Editor-in-Chief, PSDE
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Intersil Announces Appointment of David Bell as President and Chief Operating Officer

Intersil Corporation has announced the appointment of David Bell as Intersil's President and Chief Operating Officer, effective April 2, 2007. In addition, Bell will become a member of the Company's Board of Directors.

Most recently, Bell served as President of Linear Technology from June 2003 until January 2007. Prior to becoming President, he served as Vice President and General Manager of Power Products from 2002 to 2003 and as General Manager of Power Products from 1999 to 2002. Bell started his career at Linear Technology in 1994 as the Manager of Strategic Product Development. He holds a Bachelor of Science degree in Electrical Engineering from the Massachusetts Institute of Technology.

Rich Beyer, Intersil's CEO commented, "We are very pleased to have Dave Bell join Intersil as our President and Chief Operating Officer. We believe that Dave's background and experience with a top tier, high performance analog company make him an ideal fit for this position. I am looking forward to partnering with Dave as we continue to build upon our success in the high performance analog space."

"I am excited about the opportunity to join what is already a talented high performance analog team," noted Dave Bell. "Intersil has a unique position that balances general purpose products with application specific products to address its four targeted end markets: high-end consumer, computing, industrial and communications. The Company has an extensive analog, mixed–signal and power management portfolio and has exceptional technical and manufacturing expertise."

www.intersil.com

Zetex Semiconductors Hosts Prime Ministerial Visit

Tony Blair with Zetex CEO Hans Rohrer (Centre) and Mick Conlon, Wafer Fab Production Manager, pictured during a tour of the Zetex Technology Park, Oldham.

Tony Blair, UK's Prime Minister, has visited Zetex Semiconductor's Oldham Headquarters during a fact-finding trip to the North West of England. He was accompanied on a one hour tour of the Zetex Technology Park by Zetex Chief Executive Officer Hans Rohrer.

"We were delighted to host the prime minister's visit. It gave us the opportunity to present the great team of people we have here in Oldham and to highlight the tremendous work they carry out. As the UK's only integrated silicon semiconductor device manufacturer, Zetex makes a significant contribution to the nation's high-tech economy and our future growth prospects are very strong," said Hans Rohrer.

During a 'hands-on' tour of the Zetex facilities, Mr Blair followed the complete manufacturing process, from initial design concept, through to silicon chip manufacture and final test. After chatting to the workforce on the shop floor, Mr Blair declared Zetex to be a prime example of a company that is helping to shape the future of the UK's high-tech sector.

www.zetex.com

Former BMW R&D Chief Joins Maxwell Technologies Board Of Directors

Maxwell Technologies, Inc. announced today that Professor Burkhard Goeschel, who retired in November 2006 as a member of the six-person Management Board of BMW Group, with overall responsibility for research, development and purchasing, has been appointed to Maxwell's board of directors.

Dr. Richard Balanson, Maxwell's president and chief executive officer, said that Goeschel's extensive experience and contacts in the automotive industry will make him a valuable strategic resource to management as the company accelerates development and delivery of ultracapacitor-based energy storage and power delivery solutions for transportation applications.

"Professor Goeschel understands ultracapacitor technology and how it can be applied to optimize energy storage solutions for hybrid and electric drive trains and to better satisfy the growing electrical system needs of all vehicles," Balanson said. "He has indicated that he intends to take an active role as a sounding board for our technical staff, as well as tapping his extensive worldwide network of transportation industry contacts to assist in Maxwell's business development efforts."

Goeschel, 61, joined BMW in 1978, and advanced through a series of technical and management positions in the company's automotive and motorcycle groups before being appointed to its Management Board in 2000. Earlier, he spent two years as a Group Leader for engine product development with Daimler-Benz. He holds a PhD degree in engineering from Stuttgart University and bachelors and masters degrees in mechanical engineering from the Technical University of Munich.

www.maxwell.com

National Semiconductor Delivers Power Management Design Seminar Series

National's power management experts are on tour in 9 cities across Europe beginning April 25th to discuss design fundamentals and techniques as well as application examples associated with the latest high-performance power management products. National developed these popular one-day intensive technical seminars to advise design engineers how to use the latest technologies, providing design tips and new product information. The seminars will cover all aspects of DC-to-DC converter topologies and methodologies, power management design techniques and implementation examples that efficiently provide power for circuits in the signal path. To register for a seminar, go to **www.national.com/eusemi-nars**

www.nsc.com

Infineon and Hyundai Enter Strategic Cooperation - Inaugurate Joint Innovation Center

Auto Partners (from the left): Woong-Chul YANG (Hyundai-Kia), Dr. Hyun-Soon LEE (Hyundai-Kia), Peter BAUER (Infineon), Claus GEISLER (Infineon)

Hyundai Motor Company has selected Infineon as a semiconductor partner for this long term strategic cooperation in order to develop automotive electronic system solutions for Hyundai and Kia vehicles. The cooperation includes the development of automotive electronics system architecture and related semiconductors, along with enhancements of Hyundai's current automotive electronic systems, based on the synergy of Hyundai's automotive electronics technology and Infineon's semiconductor know-how.

In addition to Infineon's complete chipset solutions and broad technology portfolio, including power semiconductors, microcontrollers and sensors, the company will contribute its expertise in automotive semiconductor development, in-depth application engineering know-how and high quality. Hyundai's responsibilities will include automotive electronic system architecture development, electronic system partitioning and electronic control units (ECU) design, and evaluation with innovative cost optimization, rigorous quality control and time-to-market. The two companies today also opened a joint innovation center.

The Hyundai Infineon Innovation Center (HIIC) will work on the functional and cost optimization of car electronics systems, as well as develop automotive electronic system architecture, including the design of ECU and application-specific integrated circuits (ASICs) in powertrain, safety and body applications for Hyundai and Kia vehicles.

The innovation center is located at the Yangjae-dong headquarters of the Hyundai-Kia Automotive Group in Seoul and will be co-managed by both companies. At the beginning, development activities will focus on automotive electronics system architecture and related automotive electronics products in body applications, such as light modules, HVAC (heating, ventilating and air conditioning) and door modules. The companies expect the first jointly developed products to be used in Hyundai and Kia cars starting 2010.

Based on semiconductor technology, the companies will cooperatively analyze existing Hyundai and Kia applications regarding cost optimization and system quality improvement by integration of functions and reduction of components using application specific standard products (ASSPs) or ASICs.

Hyundai and Infineon agreed not to disclose financial details regarding their cooperation and joint innovation center.

www.infineon.com/automotive

www.hyundai-motor.com

Cree Acquires COTCO Luminant Device Ltd.

Cree, Inc. has announced a definitive agreement to acquire privately held COTCO Luminant Device Ltd., headquartered in Hong Kong.

The acquisition of COTCO, a leading supplier of high brightness LEDs in China, will provide Cree with strategic access to this important and fast-growing solid-state lighting market. It also will provide Cree with a low-cost manufacturing platform and will help Cree to leverage its expertise in LED chips and intellectual property, as well as its investment in sales and marketing, to offer more value-added products in key markets for high performance LED screens, signage and solid-state lighting.

The transaction, which is subject to customary closing conditions, is targeted to close by April 2007.

"This acquisition is the next step in our strategy to enable the solid-state lighting revolution," said Chuck Swoboda, Cree chairman and CEO. "We are excited about having the COTCO management team join the Cree family and continuing to build on their success. We look forward to working together to expand our business in China and to transform Cree into a truly global company."

"We are excited about the merging of COTCO into Cree, which will provide COTCO with access to Cree's technology and comprehensive IP resources. This combination will strengthen COTCO's leadership position in the solid-state lighting supply chain," said Paul Lo, COTCO Holdings chairman.

www.cree.com

http://www.cotco.com

Power Events

- ***SMT Hybrid Packaging,*** *April 24-26, Nuremberg, Germany, <http://www.mesago.de/de/SMT/main.htm>*
- ***PICM Europe,*** *May 22-24, Nuremberg, Germany, <www.mesago.de/de/PCIM/main.htm>*
- ***Sensor+Test 2007,*** *May 22-24, Nuremberg, Germany, www.sensor-test.de <http://www.sensor-test.de/>*
- ***euroLED 2007,*** *June 5-7, Birmingham, United Kingdom, <http://www.euroled.org/2007/index.php>*
- ***The China International Power Supply (CPS EXPO),*** *June 13-15, Shenzhen, China, <www.cpsexpo.cn/en/index.html>*
- ***The China International Power Supply (CPS EXPO),*** *November 6-8,Shanghai, China, <http://www.cpsexpo.cn/en/index.html>*
- ***APEC 2008,*** *February 28-28, Austin, Texas, USA, www.apec-conf.com <http://www.apec-conf.com/>*

TI's New Boost Converter Enables Solar and Micro-Fuel Cell Design-in for Portable Electronics

With the evolution of new, mostly low voltage energy sources, comes a complete turn-around in conventional battery powered converter technology. The devices now needed to convert this new energy into a useable and fully protected form takes real innovation and a new approach. TI are committed to pioneering this area and have come a long way in finding innovative solutions to help the designer, at every step, with the undoubted future need to bring the next generation of highly differentiated products to market utilizing these new sources of energy.

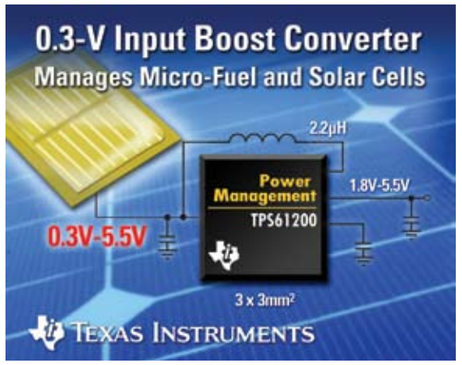
Texas Instruments has recently launched a new 0.3V Input Power Management Chip with 0.5V start-up which allows battery-driven products to tap into the new wave of low-power energy sources.

This device represents the industry's lowest input voltage DC/DC boost converter, which will enable portable electronic end-equipment to draw power from energy sources, such as solar and micro-fuel cells. The tiny power circuit can operate with input voltages lower than 0.3 V with high efficiency, allowing designers to overcome the low-voltage design barrier of incorporating alternative energy sources in applications, such as mobile phones, portable medical devices and media players.

The new TPS61200 step-up converter with integrated 1.5A switch supporting input voltages of 0.3V to 5.5V during normal operation, will continue to manage power down to 0.0 V if the under-voltage lockout pin is connected directly to the output voltage. The converter provides an extremely low 0.5V start-up capability in any load condition, and can operate with more than 90 percent efficiency. In contrast, today's best step-up converters can only support an input voltage beginning at 0.7V with start-up at 0.9V–ok for primary re-chargeable battery cells or main supplies, but not low enough to support new applications using energy harvesting power sources.

The TPS61200's ability to operate from a single solar cell eliminates the need for multiple solar cells in series, and eliminates the required protection circuitry associated with series connection. This opens the door to new potential innovative designs, such as a built-in solar-powered cell phone charger that uses indoor ambient lighting to help provide an infinite amount of standby time.

"Portable equipment designers, including those in the portable medical, wireless and portable audio fields, are continuing to look at how to apply solar and fuel cell technology into their devices to extend battery life and differentiate their products," said Uwe Mengelkamp, director of TI's DC/DC converter product line. "It's not certain what we will see first, but the ideas are endless. What is certain is that designers can use the TPS61200 to achieve



low-voltage operation to connect these new low-power energy sources with the ICs in their system."

Protecting the System at Low Voltages

The TPS61200, which comes in a 10-pin, 3 mm x 3 mm QFN package, offers several features that are critical during low-voltage operation, including output short-circuit protection, programmable under-voltage lockout and a unique "down-conversion mode" that helps protect the device when an input voltage rises higher than the output voltage. In addition, the converter can be disabled to further minimize battery drain. While the end equipment shuts down, the TPS61200 protects the system from receiving any additional power from the battery.

The integrated circuit's extremely low operating voltage also eliminates many of the design challenges that occur when operating a single-cell Alkaline, nickel-cadmium (NiCd) and nickel-metal hydride (NiMH) batteries to power anything from toys to portable medical devices. The TPS61200 extends the operating time of many pulsed-load applications that experience pass-load conditions at low-voltage inputs.

Design Tools – making it straightforward in a complex world

Designers can simplify their power design with the TPS61200 by leveraging TI's new Analog eLab™ Design Center, www.ti.com/analogelab. The recently announced design center features TI's SwitcherPro™ power supply design tool and a new release of TINA-TI™ 7.0 simulation environment, which includes switch-mode power supply simulation with acceleration.

This is a real breakthrough for the designer working with new energy, low power sources. TI's tools and support to the designer are aimed at making the implementation of these new products as straightforward and efficient as is possible.

The TPS61200EVM-179 evaluation module, application notes and TI's new Power Management Selection Guide are available through power.ti.com.

www.ti.com

Microsemi Launches First High Performance Power MOS 8 Ultra Fast FREDFETs

Their first ever high performance ultra fast FREDFETs (H_FREDFETs) added to their latest generation POWER MOS 8™ product line

The new MOS 8 H-FREDFET devices are designed for a broad range of 500V and 600V high performance applications including AC-DC offline power supplies, motor drivers, server and telecom power systems, solar inverters, single- and three-phase arc welding and plasma cutting equipment, battery chargers, semiconductor capital equipment, induction heating, and medical equipment such as magnetic resonant imaging (MRI) and computerized axial tomography (CT).

Key Performance Features

- Fast recovery body diodes: less than or equal to 200ns reverse recovery time (Trr) for the ultimate in reliability in ZVS application
- Superior oscillation immunity and reduced EMI
- Low gate charge
- Low switching losses
- Avalanche energy rated
- Lower thermal resistance

Advanced manufacturing processes for all the new MOS 8 products have lowered their thermal resistance and enabled higher current ratings for each die size and package type compared to earlier devices. Low capacitance and gate charge specifications enable high switching frequency capability and low switching losses. These devices provide significant additions to Microsemi's current Power MOS 5(r) and Power MOS 7(r) technology.

Volts(V)	RDS(on)	Id (A)	Part Number	Package Style
500	0.265	23	APT23H50B	TO - 247, D3
	0.153	41	APT41H50B	TO - 247, D3
	0.071	81	APT81H50L	TO - 264, T - MAX(r)
	0.071	56	APT56H50J	SOT - 227
	0.041	97	APT97H50J	SOT - 227
600	0.43	18	APT18H60B	TO - 247, D3
	0.23	33	APT33H60B	TO - 247, D3
	0.11	63	APT63H60L	TO - 264, T - MAX(r)
	0.11	44	APT44H60J	SOT - 227
	0.066	77	APT77H60J	SOT - 227

"Our new POWER MOS 8 family utilizes advanced technologies and manufacturing processes to deliver what our customers have asked for in our new generation of MOSFETs, FREDFETs, and H-FREDFETs," said Russell Crecraft, Vice President and General Manager of Microsemi's Power Products Group in Bend, Oregon. "Our Power MOS 8 family offers the industry's broadest range of high voltage, high power, high performance MOSFETs, FREDFETs, H-FREDFETs and PT IGBTs," he said.

MOS 8 H-FREDFETs have all of the features and advantages of MOS 8 FREDFETs, with continued low RDS(on) and the added benefit of a faster body diode recovery speed of less than or equal to 200ns. These devices provide superior ruggedness and reliability in applications where the body diode carries forward current, such as the popular zero voltage switching (ZVS) bridge topologies. All MOS 8 H-FREDFET devices are 100 percent tested for avalanche energy capability and are offered only in RoHS compliant packages.

The POWER MOS 8 family now includes ten H-FREDFET devices with power ratings from 23 to 97 amps, 500 and 600 volts.

MOS 8 technology utilizes a simplified manufacturing process that significantly lowers costs compared to previous Microsemi power MOSFET products.

www.microsemi.com

The Appliance of Science – Delivering Efficiency in White Goods

By Alex Lidow, CEO, International Rectifier

For the majority of us, white goods such as refrigerators, dishwashers and washer/dryers have become an essential part of modern life. Furthermore, a growing part of the world's population is finding those same goods within their own grasp.

Clearly, neither those who rely on, nor those who have newly acquired the appliance trappings of modern life want to give them up. Indeed, if anything, consumers expect more functionality and performance from their white goods without, of course, wishing to pay more. And because of the implication for electricity consumption, this growing demand for white goods concerns governments, environmental organisations, energy suppliers, OEMs and, ultimately, consumers themselves.

The concern stems from the fact that the majority of the world's electricity supply is derived from resources that can simply not be renewed at the rate we are using them. What's more, it is now widely accepted that the release of greenhouse gases into the atmosphere as a result of burning the fossil fuels used to generate the majority of electricity is one of the major contributory factors behind man-made climate change. Common sense would indicate that an increased prevalence of white goods can only contribute further to electricity use, speeding the elimination of scarce resources and doing further environmental harm. But does this really have to be the case? Fortunately, thanks to new ways of dramatically improving the efficiency of white goods, the answer to that question is 'no'. The key to resolving the seemingly contradictory requirements of meeting growing demand for white goods while reducing overall energy use lies in the choice and control of the electric motor at the heart of the appliance.

It is estimated that around 50% of the electricity consumed flows through the electric motors found in home appliances and other applications including factory automation, air conditioners, fans and pumps. The problem, however, is that the majority of these motors are simply not efficient. For this reason, the permanent magnet synchronous motor (PMSM) is now favoured for many domestic appliances and air conditioning units because it has a much higher efficiency than a traditional induction motor, especially for variable speed operation.

In the past, implementing complex variable speed motion control has been a major challenge. Now, however, things are changing thanks to the emergence of dedicated motor control platforms from companies such as International Rectifier. By incorporating all of the digital, analogue and power silicon, in addition to motor control algorithms, development software and design tools, IR's iMOTION™ platform, for example, provides a system-level variable speed motor control subsystem from front panel and power entry to motor terminals.

Platforms like these not only lower the cost of the technology being delivered, but also slash the energy needed to operate the device while enabling greater functionality (such as the better spin cycles, quieter operation, and range of fabric care options available in the new generation of washing machines). At the same time, such platforms eliminate the need for a specialized knowledge set, leaving engineers to concentrate on those aspects of a design that can deliver real competitive advantage.

On Tuesday, May 21st at the PCIM Europe Exhibition and Conference in Nuremberg, Germany
A Special Presentation:
13:00 - 13:45 hours
Delivering Global Energy Savings: Power Management with Difference
By Alex Lidow, CEO, International Rectifier

The more efficiently we use our energy, the better we live because the cost of energy saved goes back directly into our standard of living once the cost required to effect the energy savings is subtracted. Almost one third of the world's global consumption of all forms of energy can be saved as a result of improved power management. This presentation will discuss how adopting electronic power management technologies that deliver energy-savings at cost parity when compared to traditional electro-mechanical solutions will significantly grow our global standard of living while minimizing the impact on our environment.

www.irf.com

Earth in the Balance - How Power Management Can Save the World

Energy consumption by white goods represents a major opportunity

By Marijana Vukicevic, iSuppli Corporation

It's an inconvenient truth that we all must face sooner or later: the long-neglected issue of energy consumption in white goods.

For consumers, it's an issue of cost, as power-hungry appliances like air-conditioners, refrigerators and washing machines drive up electricity expenses. For the world as a whole, it's an issue of potential ecological catastrophe, as the electricity used to power such white goods is generated largely by the burning of fossil fuels—a major contributor to global warming, experts believe.

However, for the power-management industry, the high electricity consumption of white goods represents an enormous opportunity, offering a chance employ their expertise in reducing energy usage to benefit consumers around the globe—as well as to benefit the globe itself.

White goods represent the biggest users of electricity in homes. And as consumers in developing regions of the world increase their demand for such white goods, electricity usage is soaring, along with the volume of greenhouse gasses being spewed into the atmosphere by power plants.

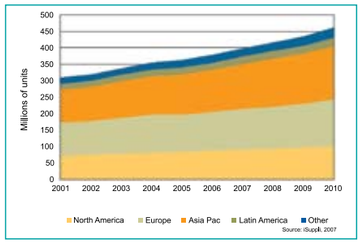


Figure 1. Worldwide Major Appliance Shipment Forecast.

The worldwide market for major appliances will expand to 462 million units in 2010, rising at a Compound Annual Growth Rate (CAGR) of 5 percent from 379 million units in 2006. During the period from 2006 to 2010, the fastest growing market for major appliances will be the Asia/Pacific region, with sales rising at a CAGR of 34.4 percent during the period. This will be followed closely by Europe, with a 30.7 percent CAGR and North America, with a 22.7 percent CAGR.

The figure presents iSuppli's forecast of worldwide shipments of major appliances. Among major appliances, the highest-volume product worldwide is the microwave oven, with the next most-popular devices being the refrigerator, kitchen cooker (range) and washing machine.

Driven by government programs that encourage consumers to buy energy-efficient appliances, consumer demand for more efficient and environmentally-friendly appliances is rising. To achieve better efficiency, appliances are integrating more semiconductor content for controlling, sensing, monitoring and connectivity.

Because of this, white goods will be the fastest-growing market for power-management devices during the next five years, according to iSuppli.

One widely-used approach in boosting efficiency is to add intelligent circuitry that can perform tasks such as driving the motor. Semiconductor suppliers that offer high-voltage regulators, pulse-width modulators (PWM), discrete Insulated Gate Bipolar Transistors (IGBTs), MOSFETS and diodes are in a strong position to serve this growing market. Such devices are being implemented in white goods in the form of discrete solutions as well as using modules.

Shipments of voltage regulators for white goods are expected to rise at a CAGR of 29.8 percent from 2006 to 2010. Meanwhile, shipments of interface products are expected to grow at an 18 percent CAGR, while transistors will rise by 12.1 percent and diodes by 6.1 percent.

Beyond that, more sophisticated controls are now being adopted in air conditioners and washing machines. These controllers differ from standard voltage regulators and instead are Digital Signal Processor (DSP) or microcontroller-based state machines.

In the beginning, designing systems with such controllers is not as easy as using standard regulators, but once the knowledge is acquired, the benefits are huge. iSuppli predicts sophisticated controllers will penetrate 8 percent of the worldwide white-goods market by 2011. Most of these controllers will be solutions that combine state machines and microcontrollers.

So, while global warming may be an inconvenient truth for some, it's a huge opportunity for the power-management industry.

www.iSuppli.com

The Digital Power Supply Revolution

At the recent Applied Power Electronics Conference, digital power supplies were featured everywhere, in papers, seminars, and poster sessions. Applications were widespread, in VRMs, power factor correction circuits, inverters, and dc-dc converters.

It's easy to start feeling overwhelmed with all this information on digital applications. And, in reading the material, to feel like you are perhaps missing the boat with your simple analog solutions. In this article, I'll examine some of the issues and misconceptions about digital control.

By Dr. Ray Ridley, Ridley Engineering

Digital Control is New?

Figure 1 shows the block diagram of a digital controller. At the input side, an a/d converter samples an analog waveform of the power supply, and converts it to a digital value. The analog waveform may be the output voltage, or some pre-processed waveform where it has already been compared to a reference.

Sampling is done carefully, in an effort to prevent switching noise from affecting the results. This sampling process can be quite complex, especially if there are multiple converters operating together in a system.

The resulting digital signal then enters the processor of the digital controller, which sends the gate drive to the system. The driver circuitry may or may not be included in the controller, and this was discussed in the December 2006 issue of this magazine.

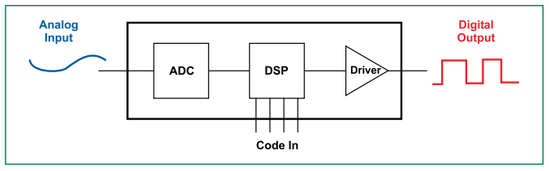


Figure 1: Block diagram of Digital Controller.

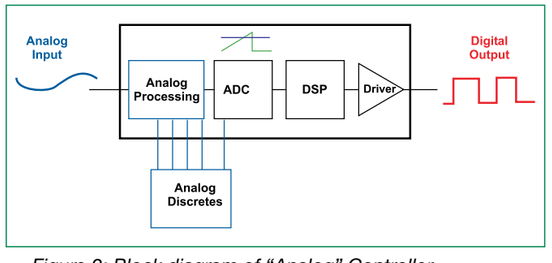


Figure 2: Block diagram of "Analog" Controller.

Much of the focus in recent years has been concentrated on solving digital output pulse resolution. Numerous researchers have devised solutions, including delay gates, to provide resolution beyond the clock frequency of the digital controller. This is important to avoid numerical oscillation.

Now let's look at the analog controller. Figure 2 shows a typical controller. The output voltage of a converter is processed with an analog amplifier, and discrete analog parts are used to compensate the feedback. The output of the error amplifier then is compared to a ramp with a comparator. The ramp also forms the clock of the converter.

The ramp-reference circuit is nothing more than a simple A-D converter, directly generating a digital waveform, and setting the width of the pulse at the output of the controller. If you look at the input and output waveforms of Figure 1 and Figure 2, one thing should be immediately obvious: the analog controller that we have used for over 20 years in this industry is, in fact, a digital controller!

It has all the features required—including ADC, digital processing circuitry, and digital output. It is also an incredibly elegant solution to the digital controller problem. The clock frequency does not need to be any higher than the desired switching frequency of the power supply, and yet the output digital pulse has infinite resolution. This is something the new digital controllers are still struggling to achieve.

It is very important to recognize that the controllers we've always used are digital controllers. It stops us from wor-

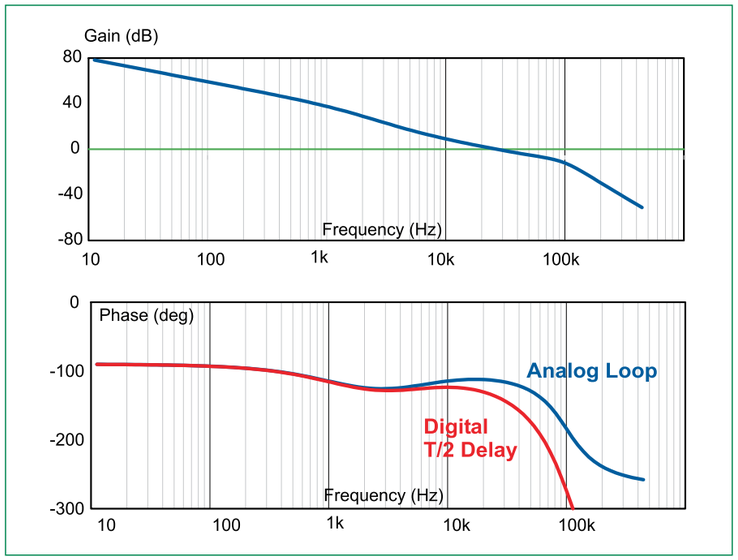


Figure 3: Loop Gain with Analog and Digital Controller.

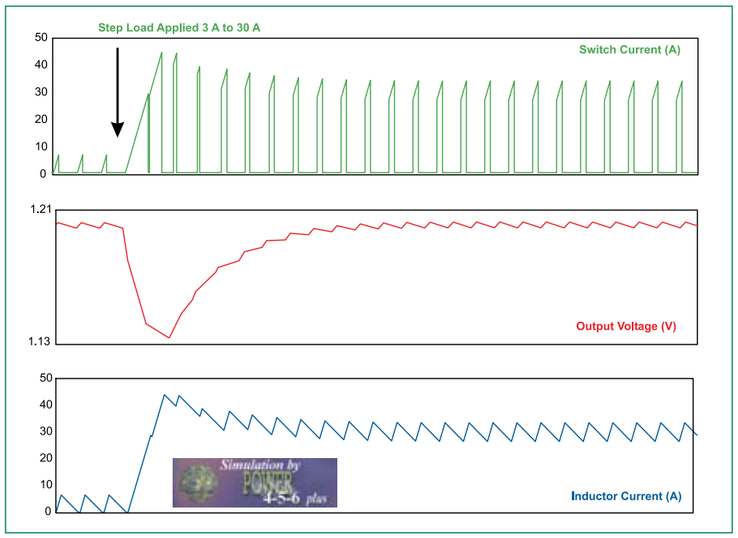


Figure 4: Step Load Response with Analog Controller.

rying about whether we are using the latest in technology—analog or digital—when in fact they are both digital with different implementations. And it moves us forward to consider what the real difference is between the old and new, and whether you need it.

The core difference is that the new controllers are programmed with software, whereas the old controllers are hard wired, and not as flexible. As we'll see in this article, the capability to reprogram may not be as important as claimed for your converter.

Digital and Analog Loop Gains

Papers on digital control invariably focus on the perceived advantages of the new controllers, and often make unfavorable comparisons to analog controllers.

The first area of comparison is control loop design and transient response. The digital controllers are advertised as being easier to customize, providing better transients, and pushing the converters to the their limits.

Figure 3 shows the loop gain of an analog-controlled power supply, compared to that of a digital power supply. An analog bode plot of the loop of a digital system is needed to assess final performance.

Notice that the loop gains are very similar, except that the phase delay of the digital power supply is greater than that of the analog power supply. This is due to the delay from sampling of the output voltage to the time when it is used. Long ago with analog controllers, it was recognized that a naturally-sampled modulator was superior in performance to a sample-and-hold function.

According to these curves, the analog controller is actually superior in small-signal response. Proponents of digital will argue that the digital controller can be programmed to override the small-signal response any time the output moves outside a preset boundary. Is it necessary? We can look at the step load response to answer this question.

The analog loop shown here has a crossover frequency of 25 kHz—one-eighth of the switching frequency. Figure 4 shows a 10% to 100% step load for a buck converter. Some papers make incorrect assumptions about loop gains, suggesting that for this particular converter with a 1/8 switching frequency loop crossover, it will take about 8 switching cycles for the converter to respond. However, you can see that this is clearly not true. Within one cycle of the step load being applied, the duty cycle of the control chip moves to its maximum value, and the drop in the output voltage is halted quickly. This is easy to achieve with the analog controller.

How about ruggedness? A touted feature of digital control is its adaptivity to different modes of operation. For example, crossing the boundary of CCM (continuous-conduction mode) and DCM (discontinuous-conduction mode) operation could be detected, and controller parameters changed. However, as we see in Figure 5, the application of

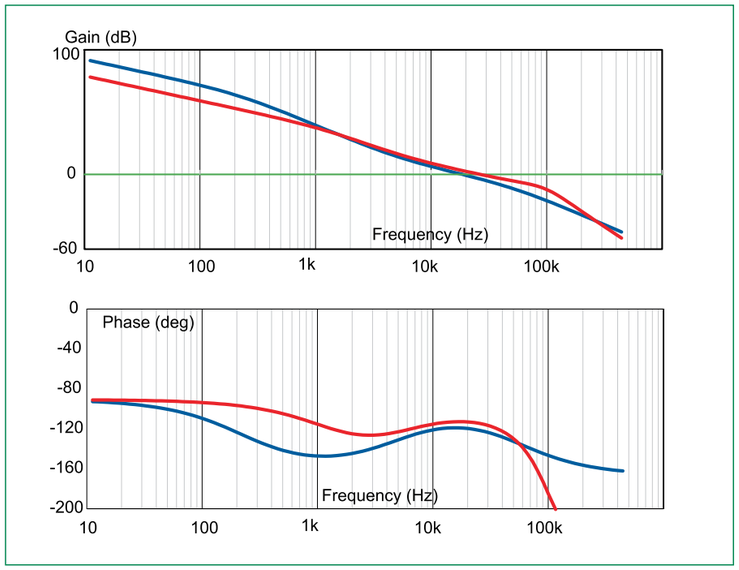


Figure 5: Loop Gain with Analog Controller in DCM and CCM Mode.

simple current-mode control achieves the same desired effect with an analog controller with minimal cost and effort. The loop gain of the converter is optimized regardless of the mode of operation.

What is the Design Impact of Digital Controls?

At last year's APEC, I was told by an engineer from one of the semiconductor companies that digital control would greatly simplify the design task. In effect, it would eliminate the need for the specialized power electronics engineer (or at least, that's what I inferred was being said), and anyone could design a power supply. He even claimed that the controller would soon be able to measure the power supply while operating, constantly adapting parameters without any input from a designer.

What is the truth? How much would such a power controller really help the power supply development task? Take a look at Figure 6, which shows a typical dc-dc power supply rated for about 100 W output. The control chip takes up perhaps 10% of the surface area of the board. During the design procedure, much time is devoted to magnetics, board layout, snubbers, thermal problems, cross-regulation, EMI, filtering, and ruggedness. Compliance testing and EMI testing alone can take weeks or months of development time.

Digital control chips offer nothing to short-circuit this time consuming process of power supply development in these areas. When it comes to closing the control loop, there is a difference. In place of discrete analog compensation parts, software replaces this task. But the compensation task is perhaps a few hours out of a complete design cycle when you know what you are doing. The digital controller will actually make this process longer due to the computer interfacing needed. You must still verify the results with extensive loop measurements under all conditions.

Where will Digital Help?

So is digital control unnecessary? Well, that depends on your application. If you have a straightforward dc-dc converter, you probably have no need for a software interface in the middle of your power supply. It will offer little or nothing to speed up your design or improve performance, and it will certainly be more expensive.

However, if you have a complex power system where you are processing data for multiple converters, for example, the digital controller can be essential. This is certainly the case for high-current point of load converters where multiple phases

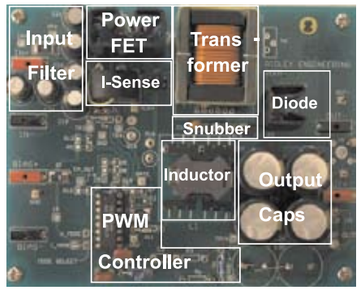


Figure 6: Switching Power Supply with Controller.

must be controlled in parallel with precise current sharing, shifting output voltages according to processor requirements, and PM bus communication.

So keep your eye on digital developments. Remember, you are already digital, and you already can achieve excellent performance. You are just trying to decide whether you want the burden and potential flexibility of software in the control loop to handle complex processing tasks that can become difficult with classic analog controllers.

In my career over the last 25 years, I have seen two other topics hit our industry and catch its attention like digital is doing. The first was the boom in research , and the second was the resonant converter frenzy in the 1980s. Both of these left behind some good solid technologies that filled certain niches, but left much of the world of power supply design intact. I suspect that digital control will do the same.

It has already penetrated the specialized niche of VRMs. It is trying to penetrate the world of PFC where analog can struggle with the complex functions needed. They will find some penetration here, but not without a fierce struggle from new analog controllers with novel solutions to the problem.

And in the world of "real" power—offline converters above 100 W, I would expect ultimately to see a class of controllers that combine the communications of digital with the necessary fast response of analog control features in the innermost modulation and protection loops.

www.ridleyengineering.com

TechTalk

Linear Technology Delivers the Goods

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

Directly after the APEC conference, held in Southern California, I hit the road with the PSDE team from Los Angeles to Silicon Valley, stopping only for fuel and a drive-through burger!

Among other companies, I visited Linear Technology in Milpitas, San Jose for a briefing and update from their senior management, technology and marketing staff. I was very impressed with the materials that I saw. What is coming through the pipeline is outstanding. Linear really is a huge resource of technical talent, placing great importance on their industry respected FAEs..these are definitely the guys you need when your design hits the wall - and whose design doesn't?

This relentless machine we call LTC is launching a constant stream of new products for our part of the industry. They do it very well. In fact, LTC is the model that many companies try to emulate. They have a unique ability to bring new products to the market that customers are craving for.

The company's strong commitment to new product development, together with a quality technical engineering resource and leadership, are the three key ingredients for their envied leadership and undisputed differentiation.

I was given a walk-through on what's coming through from the company and I put into summary form for your information, I'm sure you'll see the full versions soon enough.

A new, synchronous, single inductor buck-boost controller to drive N-channel MOSFETs, which can be customer selected to suit a particular application, from input voltages that can be above, the same as, or below the output. With an input range from 2.7V to 10V, the **LTC3785** is designed for applications using single or dual Li-Ion cells such as in palmtops, handheld devices, cell phones and wireless modems. The device is fully protected and achieves an efficiency of 95%. LTC's proprietary topology and control architecture employs drain-to-source sensing (No RSENSE) for forward and reverse current limiting. Additionally, the operating frequency can be programmed from100kHz to 1MHz and can be synchronized externally.

LTC will also launch a new Quad synchronous step-down regulator, **LTC3544**, featuring up to 95% efficiency with the individual outputs capable of 300/200/200/100mA. The device is suitable for portable equipment powered by Li-Ion/polymer batteries. Very small surface-mount inductors can be specified due to the 2.25MHz switching

Tony Armstrong: Product Marketing Manager, Power Products.

Don Paulus: Vice President and General Manger, Power Products.

Steve Pietkiewicz: General Manager, Power Products.

frequency. Also, the internal synchronous switches increase efficiency and eliminate the need for Schottky diodes. The device draws only 70µA quiescent current during operation and comes in a tiny low profile (3mm x 3mm) 16 lead QFN package.

Two very small devices (2mm x 2mm DFN) with large 3.4V to 40V inputs are the **LT3502/LT3502A** step-down regulators operating at 1.1MHz and 2.2MHz respectively. Output current is up to 500mA making the devices suitable for a wide variety of applications including 24V industrial supplies and automotive batteries. The constant frequency is above the AM radio band avoiding interference. Due to the high frequencies chosen, very small inductors can be specified and together with the internal boost diode, a very compact, efficient solution can be designed.

Finally, a great LED driver. The **LTC3496** is a triple output driver, ideal for RGB driving, operating as a constant-current source capable of driving 8 LEDs from each output. It operates in buck, boost or buck-boost modes and its current-mode architecture ensures stable operation over a wide range of supply and output voltages. Linear's True Color PWMTM dimming delivers up to 3000:1 dimming ratio with great precision and control. The device features LED open protection for each of the three independent outputs. With the gigantic growth in LED billboards and displays, this will, quite literally, be a product to watch!

The team discussion that followed the product and technology briefings was also of great interest to me. I asked exactly what drove the constant new product development as well as the numerous spins that come out of LTC at an unnerving rate to the casual observer.

The answer was surprisingly simple. Tony Armstrong, Linear's Product Marketing Manager for Power products, explained that the world-class position of LTC has not just happened by accident. The company has, of course, a top-flight engineering force as well as the FAEs already mentioned. It also has a pedigree in the area of packaging, with real-world footprint areas, meaning total area for a power supply for instance, that outstrip competition. It is the very simple, but hugely powerful - and often neglected - art of being very close and listening to what your customers want for their next design ..and the designs after that. This is the build up of a wealth of intelligence that helps steer this company from success to success in their new product development strategy. An envious and well earned position.

So, just a fraction of what's happening with the Linear Technology team. We are sure to see more great things coming from this leading analog company.

www.linear.com

Maxwell Introduces 390-Volt Ultracapacitor Module for Heavy Duty Transportation and Industrial Applications

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

Maxwell Technologies, has recently introduced a rugged 390-volt BOOSTCAP® ultracapacitor module to provide scalable, easy-to-integrate, energy storage and power delivery solutions for heavy hybrid and electric vehicles and heavy duty industrial applications requiring up to 1,170 volts.

The new Heavy Duty Transportation (HTM) module delivers leading performance and reliability and long operational life for vehicles and industrial systems that use electrical energy to enhance their efficiency and environmental compatibility. The newest addition to Maxwell's HTM product family features enhanced integration technology and up to 2.8 times greater energy storage than earlier products.

With all the news and hype in the media regarding energy sources, environmental pollution reduction and indeed with PSDE's new Green Page feature, I asked Adrian Schneuwly, Senior Director Worldwide Sales & Marketing, Maxwell Technologies a few questions.

I can see why we go for 'cleaner and greener' fuel, but isn't there a cost penalty for this?

"No, actually there are further cost advantages for vehicle integrators and transportation authorities to use ultracapacitor based products. The energy efficiency of ultracapacitor technology further enables energy and thus fuel savings, regardless whether the main engine is diesel, fuel cell or battery based. The long life of ultracapacitors and their reliability under harsh temperatures and conditions enables the reduction of down time and maintenance costs.

The main cost increase is for the installation of the hybrid drive train (electric motor, power electronics and energy management). The energy storage system is part of that additional cost, but as indicated, the cost advantage during operation compensates for the additional costs within a few years".

So what's wrong with just using a normal battery…even lithium batteries…..or fuel cells?

"Ultracapacitors can store and deliver high power or instant energy that a battery cannot. Sporadic demand peaks during acceleration or regenerative braking are a big component of the usage model for transportation and utility vehicles. Ultracapacitors are especially suited for these transient high power loads, while batteries or fuel cells are optimal for continuous average power demands, such as for cruising. Another option is a system based on the combination of batteries or fuel cells and ultracapacitors for fully electrical vehicles".

Is there a risk of overheating in comparison to the diesel engine?

"Maxwell's modules are design for high power throughput at high duty cycle. They are going through rigorous thermal simulation and testing

and providing they are used within specification, they will not cause over heating. We also provide integrated monitoring functionalities that enable the vehicle integrators to control and optimize the power, duty cycles and thermal behaviour for a specific application".

The new module meets or exceeds transportation industry requirements for watt-hours of energy storage and watts of power delivery per kilogram, and is designed to perform reliably through one million or more deep discharge cycles, or about 15 years of operational life for most vehicles or industrial systems. Integrated voltage management circuitry and monitoring capabilities and highly efficient, fan-driven, forced air cooling results in good thermal performance at high continuous currents.

The self-cooled HTM BMOD0018-P390 is encased in a rugged, splash- and dust-proof, IP 65-compliant, aluminium chassis. Each module is rated at 18 farads, and up to three modules may be linked in series to deliver a total of up to 1,170 volts. Maxwell also offers standard 16-, 48- and 125-volt modules, and a "Quick-Turn" program that offers shipment within 14 days of receipt of a customer purchase order for custom-configured modules for applications requiring up to 540 volts.

How do these Ultracapacitors get to be so efficient?

"Key to high efficiency of Maxwell ultracapacitor products is the intrinsic performance of the electrode. Maxwell is using its proprietary electrode material which reveals ultra-low internal resistance ESR. The ESR is responsible for the state-of-the-art performance of BOOSTCAP® products, resulting in very low power losses and thus high efficiency."

BOOSTCAP ultracapacitors deliver up to 10 times the power and longevity of batteries, require no maintenance and operate reliably in extreme temperatures. In transportation applications, they efficiently recapture energy from braking for reuse in hybrid and all-electric drive trains, reducing energy consumption and emissions. They also provide compact, lightweight, "life-of-the vehicle" solutions to stabilize automotive power networks and power new, all-electric subsystems, such as drive-by-wire steering. In mission critical industrial applications, where backup power is critical for continued operation or a soft shutdown in the event of power interruptions, they provide reliable, cost-effective, maintenance-free energy storage. In wind turbine blade pitch and braking systems and other industrial applications, they provide a simple, solid state, highly reliable, solution to buffer short-term mismatches between the power available and the power required.

But surely this is a very competitive emerging market…What about China?

"Maxwell Technologies understands the importance of China and as a result heavily invests in China. We have announced license as well as technology transfer agreements with Chinese partners to enable them to build products based on Maxwell's technology, and we work hard to support our customers in South East Asia and specifically China and further develop opportunities in this region".

How is ultracapacitor received by manufacturers of the new hybrid vehicles?

"At this point, we can say that most of the OEM manufacturers and tier-1 suppliers are developing and designing in hybrid drive trains in all kind of vehicles, and they are looking at ultracapacitors to meet their targets of high efficiency for highest possible fuel consumption and emission reduction. In terms of official announcements, we recently announced collaboration agreements with Kromberg-Schubert as well as an ultracapacitor based cold starter systems with AFL Alcoa."

Maxwell is a leading developer and manufacturer of innovative, cost-effective energy storage and power delivery solutions. BOOSTCAP® ultracapacitor cells and multi-cell modules provide safe and reliable power solutions for applications in consumer and industrial electronics, transportation and telecommunications. Maxwell's CONDIS® high-voltage grading and coupling capacitors help ensure the safety and reliability of electric utility infrastructure and other applications involving transport, distribution and measurement of high-voltage electrical energy. The company's radiation-mitigated microelectronic products include power modules, memory modules and single board computers that incorporate powerful commercial silicon for superior performance and high reliability in aerospace applications.

www.maxwell.com

Advances in Power Metering Drive Down Costs

Making it easy and proving the benefits

Even with the great strides made in the power efficiency of our appliances and industrial installations, there is still a relentless call to secure the provision of power for consumers and industrial users and reduce overall running costs.

By Lucio Di Jasio, Application Segments Manager, Microchip Technology

In a short period of time, the utility-metering industry has grown and matured enormously. Power meters, specifically, have been the major driving force – pushing the envelope and going beyond the simple replacement of traditional mechanical solutions. By fully embracing new electronic technologies, the power-meter segment stands to reap substantial benefits, including: Automated Meter Reading capabilities, sophisticated Anti-Tampering solutions, and Time-of-Use and Pre-Paid billing options. The faster the growth rate a geographical region enjoys, the more urgent the demand for metered power. Fortunately, new advanced analog and digital solutions are available from leading embedded-control manufacturers. As a result, designing advanced power meters has never been so easy.

Energy demand is an extremely strong indicator of the dynamic of a region and, in particular, its economic growth. Power usage increases as new factories are built, jobs are created and the population (the consumers) looks for more power to feed a growing number of appliances. Utility companies, therefore, play a key role in supporting such growth. There is a great responsibility in laying down the infrastructure. Choices made during the rush of the booming growth phase might come back to haunt them decades later, at enormous costs.

The design of a power distribution network is composed of two equally important elements: the physical layout of the network and the means to measure usage and collect the revenue – that is the metering system. Electronic energy meters have become a natural choice in all regions experiencing rapid growth, as the lack of legacy systems creates an ideal scenario to take full advantage of the new features offered by electronic solutions.

In particular, the flexibility of electronic meters allows for the implementation of three important collection (billing) strategies not available with previous mechanical solutions:

- Time of Use
- Pre-pay
- Automated Meter Reading

Time of Use technology is based on the ability of the meter to record energy consumption during different segments of the day and to apply different rates for each segment. This can be an important tool in the hands of the utility companies, as it can help encourage the customer to begin a more rational use of the energy throughout the day, balancing consumption and reducing peaks, therefore optimizing the overall usage of the network.

Pre-Pay technology, on the other hand, requires the meter to actually control the delivery of energy as soon as proof of payment is provided (via magnetic cards, smart cards and other technologies) in the exact amount allowed by the available credit. It is clear how the utility company can benefit from the complete removal of all the costs associated with credit collection/recovery.

In order to perform Time of Use and/or Pre-Pay functions, the electronic meter needs to incorporate a clock and calendar to keep accurate track of time, as in the hour of the day and day of the week (weekend days are typically off peak).

Automated Meter Reading (AMR) technology refers to the capability of the meter to communicate its reading to a fully automated collection and communication center, via the use of dedicated lines and/or existing networking infrastructure. Several technologies are currently employed to perform AMR in different regions, including:

- Radio Frequency (RF) for short-range applications – the ZigBee™ protocol

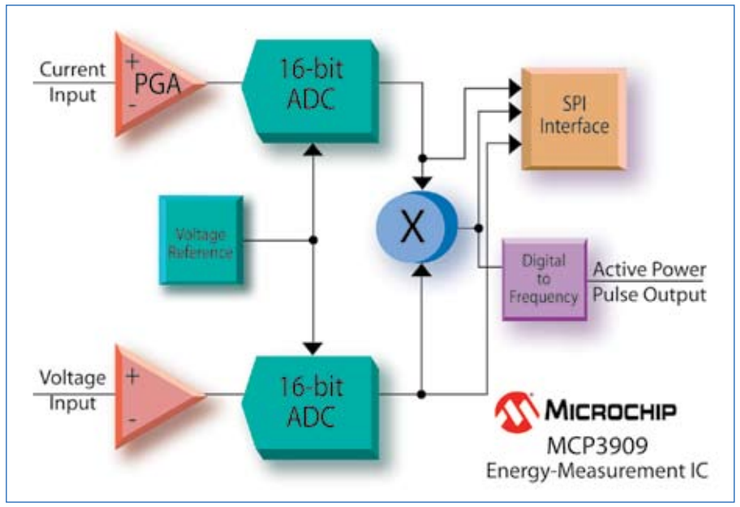


Figure1: Block Diagram of Microchip's MCP3909 Energy-Measurement IC .

is emerging as a new important contender.

- RF for long-range applications – tapping into an existing cellular phone network, for example.
- Data Modem – via a standard telephone network.
- Power Line Carriers (PLC) – for short- to medium- range data communication, using the power distribution network.

More often, though, a partially automated collection system provides a better compromise in terms of cost and reliability. This is especially true for developing regions where a full communication infrastructure might not be available at the time of deployment, and labor can still be considered relatively inexpensive. Instead of each meter communicating directly with the collection center, the reading from one or more meters in the same building is collected at a single point where a human operator connects an electronic "reader" device. The reliability of the digital transmission between the meter and the electronic reader (superior to a manual transcript) and the increased speed, accuracy and overall efficiency of the collection process justifies the adoption of AMR, even when a single meter at a time is accessed with this method. Partially automated solutions typically use one of the following technologies to achieve the link to the reader device:

- Serial Port (RS-485) – used for networking all the meters in a location (building).
- Infrared Link – used to perform the link to the actual reader, often through the meter faceplate.

To testify to the popularity of such an approach, it is worth observing how the use of an infrared link in China has been codified in the dedicated DL/T645 specification for electric meters, which defines an infrared protocol physical layer that is significantly different from other common infrared applications.

Other Compelling Features

There are other compelling features that are typical of electronic meters, they are:

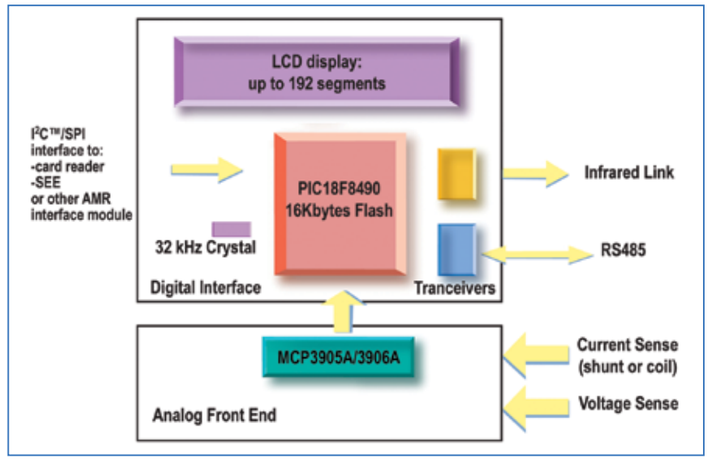
- Increased Accuracy: Electronic meters can offer easily 0.2 percent accuracy, where a mechanical solution would typically offer 2 percent. Hence, a single electronic hardware platform can be used to cover the requirements of a larger number of metering applications, increasing the production volume and reducing costs.
- Lower Power Consumption: While the industry has normally accepted solutions that require up to 2W per meter, it is clear that even such a small amount, when multiplied by millions of installations, can result in a significant cost to the utility.
- Low-Power-Factor Detection and Accurate Active Power Measurement: In recent years, the percentage of energy used in electric motors, ballast lighting and other low-power-factor applications have increased considerably (motors alone are believed to represent up to 40 percent of the average load), posing a burden on the utilities as the reactive power component (not metered) robs the network of precious capacity.
- Anti-Tampering Detection: Energy theft from meter tampering can be a big problem in some regions, so any modern metering design incorporates features specifically designed to identify these situations, such as:
  - ♦ Load Earthing – detecting return path currents (and unbalanced loading).
  - ♦ Reversing of Current Path – detecting the attempt to have the meter rewind.
  - ♦ Permanent Magnet Coil Saturation – using both shunts and coils on different channels and comparing the results.
  - ♦ Mains Voltage Disconnect – This can be detected as well a secondary source can be provided.

Electronic Meters Made Easy

To fulfill all the needs of the utility industry and help in the design of advanced electronic power meters, several semiconductor manufacturers have developed new solutions that provide ever greater simplicity and flexibility. The first ingredient of these solutions is the integration of all analog functions required to perform the voltage and current product in a single analog front-end (AFE) device. Such are the MCP3905A/6A and MCP3909 devices from Microchip Technology (see block diagram in Figure 1). Microchip's metering AFEs feature:

Figure2: MCP3905A & MCP3906A Reference Design.

Figure3: The MCP3909 Energy-Measurement IC Used in a 3-phase Meter, with the PIC18F2520 Microcontroller to Calculate Power.



The MCP3905A/6A is paired with a PIC18F8490 microcontroller for LCD display and AMR functionality.

- Two 16-bit delta-sigma analog-to-digital (A/D) converters provide a dynamic range of up to 1000:1 (in the MCP3906A and MCP3909 models) and a typical measurement error of 0.1 percent.
- Available in minuscule 24-pin SSOP packages, they consume only 4mA maximum current (consuming under 20mW or just a fraction of the available 2W budget) while operating in the entire -40 to +85 degrees C temperature range, with a reference thermal drift of just 15 ppm/°C.
- A programmable gain amplifier, combined with the great sensitivity of the current-sensing channel, allows for extremely small shunt values to be used (less than 200 µOhms).
- Tampering alert is provided automatically when a negative power condition is detected (inverted wiring).

The MCP3905A/6A and MCP3909 can be used with a few external components to implement a complete and inexpensive mono-phase meter (see Figure 2), but its performance can be augmented by pairing it with advanced Flash microcontrollers, such as the PIC18F8490. Additionally, the MCP3909 can be used in 3-phase meters by accessing the A/D converter data directly and sending it to the microcontroller for additional post-processing (see Figure 3). By using the Flash microcontroller as the computation engine to calculate power, the flexibility of the meter design increases dramatically. Automatic software calibration, flexibility in power calculation methods and additional security features can be implemented.

The PIC18 family of high-performance 8-bit microcontrollers has more than a hundred models based on Flash technology, and incorporates a variety of features and peripherals that are critical to energy metering applications. In the case of the PIC18F8490, the applicable features include:

- Input capture and compare logic to directly interface to the MCP3905/6 AFE (with frequency-modulated active power output).
- Onboard LCD display driver, allowing low power and inexpensive control of complex LCD displays (up to 192 segments).
- 16 Kbytes of Enhanced Flash program memory, allowing in-line (production) programming and calibration, as well as easy field firmware upgrades.
- Flexible code-protection scheme, to provide the security required to implement the encryption used by billing and AMR applications.
- nanoWatt Technology for power management, allowing very low-power operation to maintain long shelf life of the meter, but also high performance when required to perform AMR and billing.
- Onboard low power 32 kHz oscillator for Real Time Clock and Calendar support of Time of Use and other advanced billing functions (see Figure 4).
- Flexible Asynchronous Serial Communication port, capable of RS485

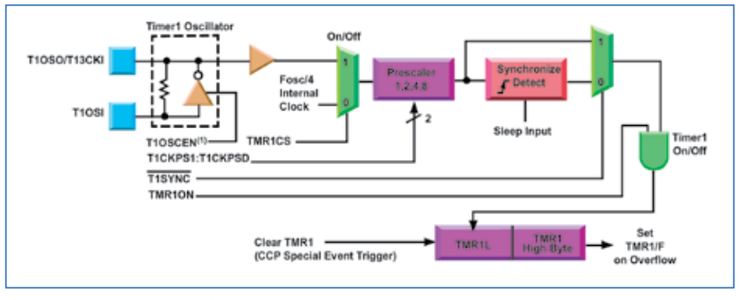


Figure 4: Dedicated 32 kHz Oscillator and Timer for RTCC Applications.

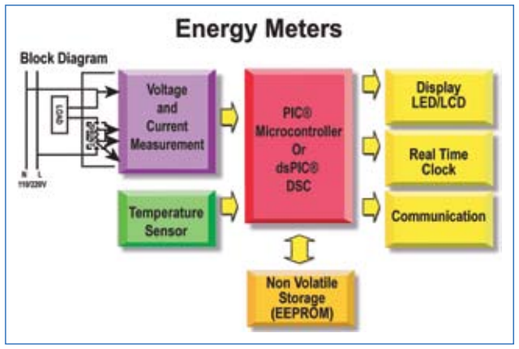


Figure 5: Block Diagram of Basic Energy Meter.

as well as DL/T645 infrared support of Automated Meter Reading applications.

- Flexible Synchronous Serial Communication port, to support connection to external non-volatile memory devices (Serial EEPROMS) using I2C™ and/or SPI protocols.
- Onboard 10-bit A/D converter, to assist in anti-tampering functionality and/or temperature sensing.
- Brown-Out detection and Low-Voltage detection circuits for robustness and more anti-tampering features.

Energy-Metering Design Center

The availability of documentation, complete application notes and reference designs can be even more important to the designer than the availability of silicon itself. Understanding the need to find all of the information necessary to create an energy-meter solution in one place, manufacturers are making available dedicated design Web sites, often referred to as Design Centers. Microchip is offering one such Design Center completely dedicated to utility metering applications: www.microchip.com/meter (see Figure 5). Microchip's energy-meter site presents the reader with a simple block diagram where each block links to a new page that is dedicated to a specific aspect of the design, such as:

- The analog front end
- Pulse sensing and counting
- LCD and LED display control
- Clock and Calendar solutions
- Brown Out and Voltage supervision
- The best and/or most often used microcontrollers and DSC devices
- Non-Volatile storage solutions
- Temperature sensing

Microchip's Utility Metering Design Center focuses on providing ready-to-use solutions to meter designers, rather than advertising products. It is a refreshing approach, where technical information is offered to the professionals from professionals, making designing and customizing electronic meters to the needs of a specific market easier than it has ever been before.

www.microchip.com

Higher Performance, More Functionality, Thermal Control – All in a Smaller Package

Advances in battery charger IC design boost product mobility

Demand for lighter, smaller, lower cost portable products shows no signs of diminishing. Users expect their portable devices to offer a wider array of functions than their predecessors without increasing footprint or weight.

By Bill Weiss, Product Line Director for battery management and voltage regulation, AnalogicTech

Functional integration and shrinking product footprints have had a profound impact on the portable consumer electronics marketplace and the rapid adoption of the convergent digital lifestyle over the past few years. Today, mobile handsets that integrate camera and GPS capability now fit into a case less than one-half inch thick. Portable media players that pack thousands of songs or images easily slip inside a shirt pocket. And Bluetooth™ headsets that squeeze together a baseband processor, a microphone and a RF transceiver weigh less than 140 grammes.

Despite these dramatic improvements in integration, reducing product footprint - and with it, system cost - remains a primary driver in portable system design. Historically, the integration of digital IC functions has far outpaced similar advances in analogue IC design. Recently, however, power management semiconductor manufacturers have achieved major steps forward, particularly in the area of battery charging.

Over the last year manufacturers have introduced a new generation of system power products that integrate multiple power management functions typically used in portable designs into a single die. Some products in this new category support the development of lighter, ultra portable devices, such as Bluetooth headsets, by combining a battery charger, a step-down converter to power the core processor, and an LDO to power RF circuits. Others target higher powered portable devices such as smart phones or portable media players by integrating a battery charger with multiple step-down converters. AnalogicTech's recently announced AAT2550, for example, combines a 1A battery charger with two 600mA step-down converters in a very small 4mm x 4mm QFN package. Designed for single-cell Lithium-ion/polymer batteries, the constant current/constant voltage linear charger integrates a pass device and reverse blocking diodes and offers a user-programmable charge current level. The two 600mA step-down converters operate at a switching frequency of 1.4MHz to maximise efficiency, minimize the size of external components and keep switching losses low.

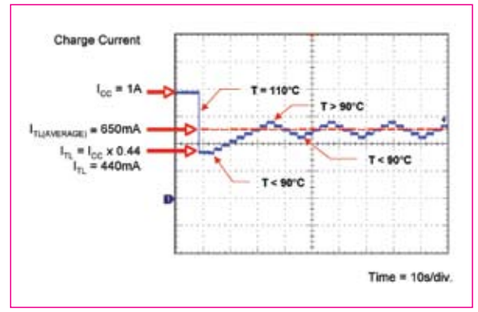


Figure 1: AAT2550's battery charger will enter thermal loop operation if/when Conditions cause the ICdie temperature to exceed 110°C.

Managing heat

One of the primary challenges IC de

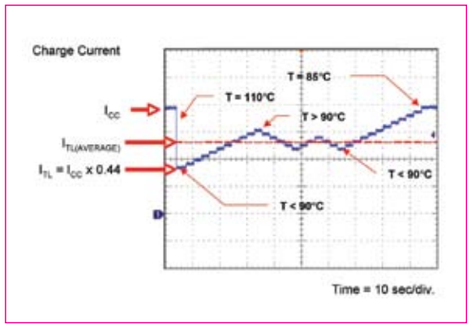


Figure 2: Initiating and resuming normal operation when TDIE<85°C.

signers face when they integrate three relatively high-powered blocks such as these into a single package is heat dissipation. When all three blocks operate concurrently, they can generate more heat than the package can dissipate. If thermal conditions exceed limitations, they could impact the operation of the buck converters and potentially cause a processor interrupt or system shutdown.

To address this problem, designers at AnalogicTech have developed a new digital thermal control loop into the battery charger that senses when the device is about to overheat and automatically throttles back the charge current to prevent overheating. This thermal management system continually measures the internal circuit die temperature. Whenever the internal die temperature exceeds a certain threshold (approximately 110 degrees C), the control circuit enters into digital thermal regulation mode (see figure 1). Once the thermal loop becomes active, the device reduces fast charge current by an initial factor of 0.44. The control circuit then re-evaluates the circuit die temperature every 3.3 seconds and adjusts fast charge current up or down in small steps of approximately 35mA until equilibrium current is reached which will ensure safe operation of the device at the existing ambient temperature.

If ambient temperature drops to less than 85 degrees C, the AAT2550 comes out of thermal regulation mode and automatically resumes charging at the full programmed constant current level (see figure 2). By constantly adjusting charge level to varying die temperature conditions, this intelligent thermal management system allows the battery charger to charge the battery safely over a wide range of conditions. Moreover, by using the maximum possible charge current, it minimises battery charge time for a given set of operating conditions.

New power sources

While portable system users have traditionally charged their devices primarily from AC power, the increasing mobility of today's society has increased demand to charge batteries from a wider variety of sources. Today a large number of users prefer to charge their smart phone, portable media player or digital camera from the USB port of a personal computer or computer peripheral. More often than not, convenience is driving this trend. Most personal computers or other computing devices feature USB ports so users can recharge their portable system virtually anywhere. And since a USB port supports bidirectional data transfer, as well as power and ground from the host system, users can recharge their battery and update files or download music or video files at the same time.

The rising use of USB ports as a power source presents new challenges for system designers. First, USB ports come in many variations and may only loosely comply with industry standards. As an example, industry standard USB ports supply a nominal 5V source with up to 100mA or 500mA of current, depending on type. This distinction necessarily will have a dramatic impact on charge time. A 500mA USB port can be used to charge a 500mA/hr battery in approximately one hour. But a user would have to wait five times as long to charge the same battery from a 100mA port.

Perhaps more problematic, however, is the highly dynamic nature of the power environment on a USB port. Often the battery charging function must share the available USB port power with its host system, or with other systems. As load demands change, the system must manage the battery charge current charge level to ensure USB port integrity, i.e. not overload, and thus crash the USB port. Typically USB ports feature a current limit protection system. Whenever a USB port is used for a charging function and to power the host system, the system designer must ensure that the battery charging function does not draw more current than the port can deliver or the current limit protection system will shut the port down, stop the battery charge cycle, and potentially crash anything else that is connected to that USB port. Therefore, designers must develop specific mechanisms to address this issue and ensure the USB port will not be overloaded during the charging cycle.

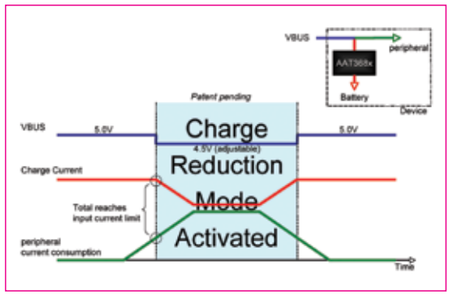


Figure 3:
- *Charger does not "rob" the current from input supply.*
- *Charger does not "rob" the current from input supply.*
- *Adjustable input voltage level.*

Intelligent charging

Until recently designers have addressed this problem by either shutting the battery charger off completely when sharing the USB port or by throttling the charge current back to a predetermined low level that necessarily extended the battery charge time to unacceptably long times.

Clearly the industry needed a new, more sophisticated and more intelligent approach to battery charging. Ideally this approach would allow portable system designers to charge the battery at the maximum rate available from a USB port without overloading the port by dynamically adjusting charge current as input conditions change. By automatically adjusting the constant current charge level to maintain a valid USB port voltage level, the charger IC could supply maximum charge to the battery and minimise charging time.

Over the last year or so power management IC manufacturers have begun to address this emerging need. A new generation of intelligent chargers now uses an algorithm-based mechanism to automatically adjust the charge level as the system demands more power. As the input voltage begins to sag, this intelligent control decreases the constant current charge level only to the extent necessary to keep the input voltage regulated and avoid a USB port shutdown.

AnalogicTech's AAT3685 battery charger IC offers an excellent example of this new capability. The device is a highly integrated, single-cell lithium-ion/polymer battery charger IC designed to operate with USB or line adapter inputs. To ensure users can charge the battery with available current from the charge supply while keeping the port voltage regulated, the AAT3685 adds an innovative optional charge reduction loop.

The charge reduction system on the AAT3685 becomes active when the voltage on the input falls below a preset threshold that is typically set at 4.5V. If the voltage tries to sag below that level, then the system throttles back the fast charge current level only to the extent necessary to maintain the input voltage above the prescribed threshold (see figure 3). The factory preset threshold is 4.5V. System designers can set a different threshold voltage by adding a simple resistor divider network to the circuit. If desired, the charge reduction loop can also be disabled.

By allowing the charger to continue to deliver to the battery the maximum current available, this charge reduction loop minimizes charge time while maintaining USB port integrity. It also helps simplify system design. The AAT3685 provides a single-wire digital interface that can be used to support high-speed, bi-directional communication between the battery charger IC and the system controller. The interface can be used to update the host controller on the battery charger's state, and thus the battery's condition. From the system designer's perspective, these tasks can now be implemented without the use of complex protocols, high precision timing or the use of multiple pins.

Conclusion

At the heart of the power system in this new generation of compact portable products lies the reliable Lithium-ion battery. Despite all the functionality they now offer, the success of most portable products still relies largely on the ability of the system designer to deliver longer battery life and shorter recharge times.

Recent advances in battery charger IC design offer portable system designers new opportunities to meet these stringent requirements. By adding a new level of intelligence to the battery charging process, these new devices promise to reduce charge time, autonomously offer closed loop functionality that previously required host system processor involvement, improve safety and lower design complexity while helping shrink product footprint.

www.analogictech.com

Implementing Robust Design Principles for Aircraft

Simulation improves analysis, reduces costs

Reliability is naturally premium in aircraft power supply design, but systems becoming more complex need better design tools and testing processes

By Michael Jensen, Synopsys Inc.

It is absolutely vital that aircraft electrical power systems are designed and manufactured to meet the highest possible quality and reliability standards.

Variations in design processes, however, can adversely affect system reliability and safety. These variations are generally characterized as differences in component or manufacturing tolerances, environmental conditions, and component ageing. System development activities must account for these sources of variation and minimize their impact on performance.

Investigating design variations is typically left until the prototype testing stage, but now the traditional hardware prototype test methods are not adequate to completely investigate all possible variations. In order to exhaustively check out all parameters on the complex systems found in modern aircraft, simulation is used to test and verify system performance.

Design teams can use this simulation process to create and analyze virtual prototypes of their designs, visualizing the sources of variation and see exactly how performance is, or could be affected. The result is a greatly enhanced system quality with lower hardware prototyping costs.

Implementing robust and rigorous design principles using simulation is among the best methods to analyze variations and improve system reliability.

Robust design primer

Robust design from Synopsis is a proven development philosophy focused on optimizing the performance, reliability and cost of a system. Its principles must be integrated into the design process right from the early stages of system development. There are several methodologies used in the industry to implement robust design principles, and though specific techniques differ between these methodologies, the intent is the same: to reduce the sensitivity of system performance and reliability to design variations. Four system factors determine performance: signal, response, noise, and control. The relationship between these factors is summarized below.

Signal factors are command inputs to the system. Response factors determine exactly how the system responds to these inputs. Noise factors are design variations that cause a system's response to deviate from nominal. Control factors are methods used by the design team to compensate for any variations.

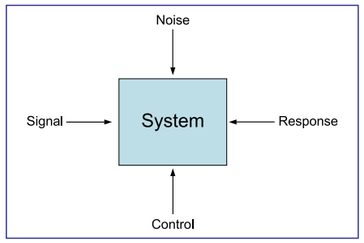


Figure 1: Factors affecting system performance.

The only practical way to completely analyze the interactions of these factors and investigate how their variations affect system performance is a robust design-based simulation flow. Such a simulation flow supports the following key design philosophy:

- Establish the baseline performance for the system's nominal design
- Determine which design parameters have the most effect on system performance metrics
- Fine-tune the critical parameters to optimize system performance
- Analyze system response as design parameters change within their tolerance range
- Ensure that system components remain within their specified safe operating limits
- Verify system performance as key components are driven to failure Leading edge system simulators, such as Saber® simulator from Synopsys®, support these design activities with the general simulation flow as shown below.

The nominal design stage verifies that the system meets nominal performance

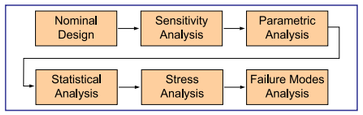


Figure 2: Robust design-based simulation flow.

criteria. A sensitivity analysis shows which system parameters most affect system performance. The parametric analysis looks at how the system's response is affected by changes in key component parameters. A statistical analysis examines the effect of random combinations of design parameter values. The stress analysis checks for components pushed beyond their operational limits and failure modes analysis investigates performance when components within the system are driven to failure.

This simulation flow can be compute intensive, particularly when conducting iterated analyses. Design teams need simulation tools that support this flow and have the added benefit of distributed computing capabilities. With distributed computing, large runs of iterated analyses are spread across a compute grid, thereby completing the simulation task in a fraction of the time needed for single-CPU execution.

System modeling

The efficient implementation of the flow shown in Figure 2, depends on simulation performance, which in turn depends on making intelligent modeling choices. Design teams must choose models appropriate to the simulation task. For the highest simulation accuracy and performance, they must select or develop models that focus on specific device or system performance metrics. The key is to use models that focus on the specific metric without including unnecessary detail. Models with too little detail may simulate quickly but not give accurate results; models with too much detail may be accurate but simulate slowly. Hardware description languages, such as the MAST® modeling language from Synopsys or the IEEE standard VHDL-AMS language, give design teams the technology needed to control model accuracy and additionally, improve simulation performance.

Putting it into practice

A 230VAC-to-28VDC power converter in an aircraft power system can be used to illustrate a robust design-based simulation flow.

The first step is to create a simulation model for the converter. An average switched model, shown below for this example, is often used at this stage of the design process. This level of model provides the best trade-off between detailed design and simulation performance. Ideal and fully-switched models can also be used, but simulation accuracy and performance may be affected.

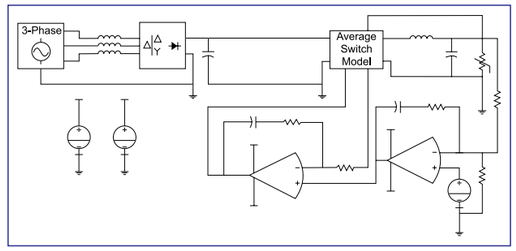


Figure 3: Averaged-switch 230VAC-to-28VDC converter model.

Using this circuit, the analysis process begins by focusing on at least one performance metric. In this example, the output DC voltage will be maintained within +/- 5% of its 28V nominal value. Following the simulation flow in Figure 2, the converter is first analyzed to determine its nominal performance as shown below.

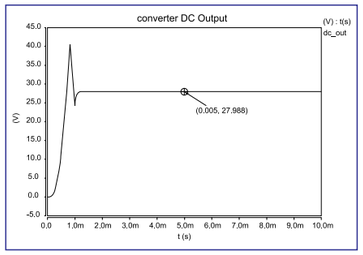


Figure 4: Nominal performance for the averaged-switch converter.

After start-up transients have settled, the DC output voltage is measured and found to be 27.988V, which is well within the +/- 5% tolerance.

A sensitivity analysis shows that the output voltage level is most dependent on the reference voltage and, to a lesser degree, the ohmic values of two resistors in the feedback path.

The parametric analysis uses this data to show that the value of the reference voltage and the two feedback resistors must be kept within very tight tolerances to maintain the specified output voltage. Based on this information, appropriate tolerances and statistical distributions are assigned to these component values. Maintaining stringent control of these three design parameters during a statistical analysis shows that tolerances for other components can be relaxed.

The stress analysis determines how close to maximum limits components are operated. Even though the averaged converter model doesn't contain all of the switching circuitry, the stress analysis shows that some components in the feedback path may become overstressed.

Finally, a failure mode analysis reveals that most device failures cause the output DC voltage to be out of tolerance. The design team can use this information to decide how to compensate for component failures.

Conclusion

Aircraft power generation and conversion systems must meet stringent reliability standards. These standards must be met despite variations in power system components, manufacturing processes, and environmental conditions. Robust design principles, coupled with leading-edge analysis tools like the Saber simulator from Synopsys, give design teams the virtual prototyping tools they need to analyze and account for the variations that most affect power system performance.

Design teams can use these tools to compensate for variations earlier in the design process. Shortened development schedules and reduced prototype testing are the result. Reliability and predictability are improved along with a healthy reduction in the development and manufacturing costs.

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White Goods Part I

Compact MOSFET Inverter Module for Highly Reliable Low-Power Motor Drives

Inverters are integral for energy-savings and high performance in motor drives

Motors consume approximately 20% of all electric energy consumed in the typical household. So, the term "energy-saving" is becoming very commonly used in the world of motor-driven white goods. Since inverter technology is being accepted by a wide range of users in the design of their products, the use of inverters is increasing, but needs careful design.

By Byoung-chul Cho, Dong-keun Jang, and Sung-il Yong, Fairchild Semiconductor, Korea

Inverter motors are used in home appliances such as air conditioners, washing machines, refrigerators, dishwashers and water pumps. Inverter drive applications are increasingly popular because they deliver precise frequency, starting current control and show high efficiency. Compared to a damper or a valve used to control the amount of air or water flow, an inverter can save a substantial amount of energy by controlling the speed. It does this by continuously adjusting the speed to maintain a desired situation under varying system conditions (variable torques like fans and pumps). This makes machinery of all types more productive, improves quality and more flexible with quick change over to run different materials.

Issues when designing the inverter

In order to design a motor drive that runs quietly, the PWM frequency should be higher to simulate a sine wave by adding many full voltage pulses in rapid succession. For this, inverters can output very high switching frequencies and with very rapid changes in voltage. This voltage change begins with a spike of over-voltage, which can burn pin holes in the motor's insulation causing short circuits. Any portion of the waveform that is not a sine wave is converted to heat in the windings. This is more prevalent on the older six step inverters but still can overheat or burn out some motors even on PWM inverters. To minimize these effects, additional external components such as load reactors should be installed to slow down the voltage change. Therefore, setting the right dv/dt helps to reduce the overall system cost.

A high dv/dt can cause electrical problems at the inverter-side. Gate-source voltage induced by Cdv/dt in the half bridge circuit might cause undesired turn-on of the MOSFET and deteriorate overall system efficiency. This is due to induced gate-emitter voltage with the Cgd (miller capacitance) and Cgs (gate-source capacitance), effectively forming a capacitive divider when the high dv/dt is applied to drain-source of MOSFET. Such abnormal operation will increase the inverter turn-on switching loss, which will eventually limit the power rating and stability of the system. The simple remedy for this could a proper gate drive using large turn-on gate resistance and small turn-off gate resistance. However, a large turn-on gate resistance can cause longer turn-on time delay and high turn-on switching loss. This delay is very critical to the current measurement system using external shunt resistor since the ambiguity of the current measurement increases especially at the low speed operation where the modulation index is small.

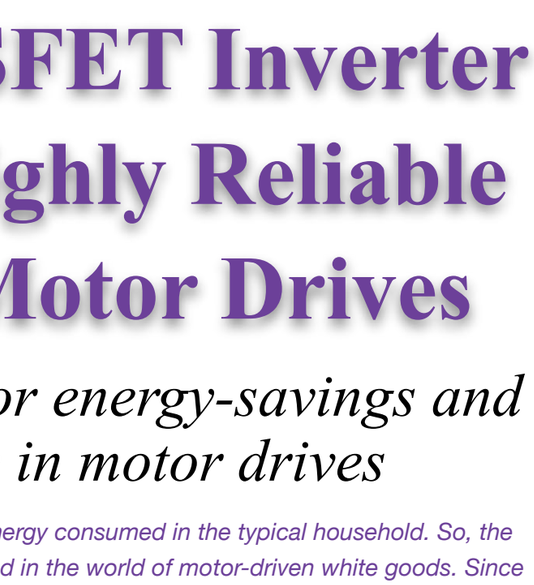


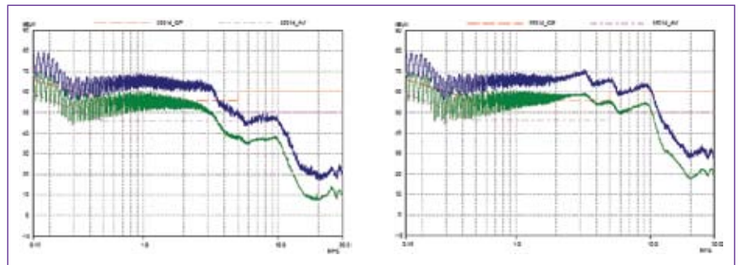
Fig 1: Internal Block diagram of Fairchild's new module.

Furthermore, small turn-off gate resistance accompanies high turn-off dv/dt. Therefore, the above issue cannot be solved completely by merely adjusting the gate resistance. Therefore, in order to get the best performance without instability, it is necessary to optimize C_{GD} / C_{GS}. This methodology involves design changes in the MOSFET devices that are usually not available to power system design engineers.

For lower power appliances such as fans, dishwashers and water pumps, MOSFETs have many advantages over IGBTs. First, one MOSFET can replace both an IGBT and FRD, resulting in cost savings. Second, in view of conduction losses, MOSFETs show better performance under 1A as the turn-on characteristic is ohmic and the conduction losses are proportional to the square of the drain current; unlike an IGBT where the current flows through the PN junction. Second, switching losses of MOSFETs are lower than that of IGBTs because of the lower threshold voltage and smaller current tail at the off period. Especially when switched off, the IGBT has a long tail current. This is because it is a minority carrier recombination device in which the gate of the device has very little effect in driving the device off. Third, MOSFETs have attractive ruggedness characteristics, such as longer short-circuit withstanding time and superior UIS (Unclamped Inductive Switching) performance. Fourth, lower temperature coefficient of threshold voltage will make MOSFETs less susceptible to transient conditions with high dv/dt.

The traditional approach for driving low-power inverter systems has been to use a discrete solution. However, system designers face a number of challenges when designing these devices in a non-integrated fashion; namely design flexibility, packaging and reliability. Traditional solutions using MOSFETs and gate drive ICs are not designed specifically for the gate drive ICs, making board design more complex and time consuming. Furthermore, there are increasing demands for compactness, built-in control, and lower overall-cost. A power module can fix this problem.

Fig 2: Range of package options for Fairchild's new module.



(a) New module by Fairchild Semiconductor (b) Conventional module

Fig.3. Measured EMC level of Fairchild new module and a conventional module

Fig 3: Measured EMC level of Fairchild new module and a conventional module.

Integrated Approach to Inverter Design

Fairchild Semiconductor has developed a new MOSFET inverter module for driving small brushless DC motors. This module implements a 3-phase inverter circuit including HVIC (High-Voltage IC) with UVLO (Under-Voltage Lock-Out) protection function in a transfer-molded full-pack package that measures 29 x 12mm as seen in Figure 1. With a specially designed MOSFET and dedicated HVIC, it provides optimized loss and EMC (EMI & EMS) characteristics to maximize the power density with a high reliability when in the field. In addition to the EMC, ruggedness there is another key factor determining field reliability. A MOSFET inverter also can provide a wider safe operating area (SOA) compared to other devices with the same rating. Package form is another extremely important consideration for designing a compact system because packaging requirements vary according to individual system design requirements. Fairchild provides a range of compact package options, including DIP (Dual-In-Line), Zigzag, and SMD (Surface Mounted Device), giving the designer freedom and flexibility as seen in Fig.2.

As stated previously, the inherent switching mode operation of power inverters used in industrial and domestic appliances, leads to many problems caused by unwanted harmonics. To minimize this problem, the dv/dt should be controlled under certain level. Fairchild Semiconductor has developed the new, more efficient module with a significantly lower EMC level by optimizing the internal MOSFET and drive IC design.

Finally, an experiment was carried out to test and verify this performance without taking any of the usual measures to reduce EMC, such as by the use of reactors or snubber capacitors. The prime goal was to see the difference just within the device itself. The results as displayed in Figure3 demonstrate that although both devices do not meet the EMC regulation without the normal snubber techniques, the peak and average EMC level of the new module is significantly lower in value than of that found in the conventional type.

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Capacitive Sensors in White Goods

Improved capacitive-sensing technology expands the realm of potential applications

With all the excitement about capacitive sensing in the portable media player, laptop PC and mobile handset markets, it is easy to forget that such interface technologies have been actively designed into White Goods applications for years.

By Ryan Seguine, Product Engineer, PSoC CapSense, Cypress Semiconductor, San Jose, Calif

Significant improvements in sensing algorithms and control circuitry have expanded the suite of applications in which the technology can be implemented. Designers are seeing the value of capacitive sensing as a mechanical button and membrane switch replacement as well as discovering new, exciting applications such as touchscreens and proximity sensors.

Sensing Capacitance

A capacitive sensor is constructed of a conductive pad, the surrounding ground, and its connection to a controller. In most applications, the conductive pad is a large copper footprint and the surrounding ground is a poured fill. A native (parasitic) capacitance, C_P, exists between these two objects. When a third conductive object, such as a human finger, is brought into proximity with the sensor, the capacitance of the system is increased by the capacitance of that object, C_F.

There are several methods for detecting the increase in capacitance caused by the addition of C_F. Field Effect measurement uses a AC voltage divider between a sensor capacitor and a local reference capacitor. Finger detection is achieved by monitoring the change in voltage on this divider). Charge transfer uses a switched capacitor circuit and a reference bus capacitance with repeated charge transfer steps from the

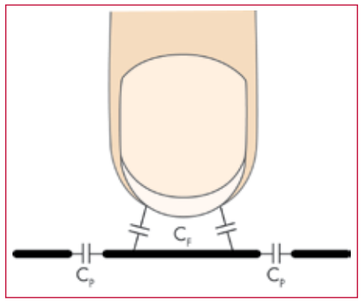

Figure 1: Illustration of capacitive sensing system.

smaller sensor capacitor to the larger bus capacitor. The voltage on the bus capacitor is proportional to the sensor capacitance. The capacitance can be determined by measuring the voltage after a fixed number of steps or by counting the number of steps necessary to reach a threshold voltage. A relaxation oscillator is a charge time measurement where the charging ramp is determined by the current source (usually fixed) and the sensor capacitance value. Larger sensor capacitors yield longer ramp times, usually measured with a PWM and a timer. Successive Approximation is a capacitance charging time measurement where start voltage is determined by successive approximation.

The successive approximation method (patents applied for by Cypress Semiconductor) implemented with the PSoC device uses a capacitance to voltage converter and single slope ADC. The capacitance measurement is achieved by converting the capacitance to a voltage, storing this voltage on a capacitor, and then by measuring the stored voltage using an adjustable current source.

The capacitance to voltage converter is implemented with switched capacitor technology. The circuitry brings the sensor capacitor to a voltage relative to the capacitance of the sensor. The switched capacitor is clocked by the PSoC's internal main oscillator.

The sensor capacitor is connected to the analog mux bus and is charged via a programmable current output digital-to-analog converter (iDAC) also connected to the bus. The charge on each bus is given by q=CV. SW2 is opened and SW1 closed to bring the potential across CX to zero and reducing the charge on the bus by a value proportional to capacitance of the sensor capacitor. This

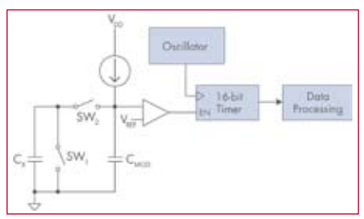

Figure 2: Schematic of capacitance sensing system.

(charge-discharge) is repeated so that the sensor capacitor is a current load on the bus.

With the switched capacitor circuit running, the iDAC uses a binary search to determine the value at which the voltage on the bus remains constant. This voltage is a factor of the switching frequency, the sensor capacitance and the iDAC value (current). The bus also functions as a bypass capacitor, stabilizing the resulting voltage. Additional capacitors can be added to the bus and affect performance and timing of the circuit.

$$V_X = \frac{1}{f_{OSC} C_X} I_{DAC}$$

$$V_{BUS} = V_{REF} - V_X$$

The calculated iDAC value is then used to charge the bus again and the time required to take the bus from an initial voltage to the comparator threshold is measured. The initial voltage with no finger present and therefore the charge time is known. A finger on the sensor increases the value of CX, decreasing the initial voltage and increasing the charge time measurement.

Figure 3: A finger on the sensor increases charge time measurement.

Building a Sensor

Capacitive sensors have diverse form and function. They can use a variety of media. Their implementation ranges from simple to complex. Application requirements determine sensor construction and implementation details.

Buttons and sliders are most common. Buttons are large conductive pads connected to the controller. Capacitance is measured and compared against a series of thresholds. Decisions can be made as digital outputs or with more analog characteristics for activation pressure or finger size. Sliders are linear or radial arrays of conductive pads. Center of mass algorithms determine the position of activation to a resolution far greater than the number of pins used to sense. Most often simple capacitive sensors like buttons and sliders deposited onto a printed circuit board using copper. Other substrates and deposition media such as silver ink can be used, however.

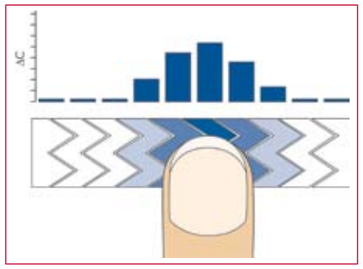

Figure 4: Center of mass algorithms determine the position of activation.

Dynamic user interfaces use buttons or activation regions that reconfigure in response to the display itself. These displays are moving the user experience forward by promoting more seamless and intuitive interaction. The construction of these systems is somewhat more complex that simple buttons or sliders. Projected capacitance touchscreens use transparent conductive materials over a display. The conductive surface is deposited onto a substrate such as glass or PET film and connected to the control circuitry. The substrate is then adhered to the overlay between the overlay and the display. The position of the activation is determined in the same way as a slider. Two sliders, one for each axis are intertwined to provide complete coverage of the display area. Activation is detected on both axes and the position exported as x- and y-data except on two axes. Because a projected capacitance touchscreen is behind an overlay, it is protected from impact, flexion, and environmental factors that plague traditional resistive touchscreens.

Proximity Sensors are essentially large buttons. The object of a proximity sensor is not to detect the exact position of a conductive object, rather the presence. Since the device does not need to know exact position, the response time may be slower (3-4ms vs. 250us). The sensitivity of a proximity sensor is much greater; 30cm can be achieved in a well constructed design. Since proximity sensors do not need to be associated with any display graphic, their placement on the device is more flexible. A copper ring around the outside of the control circuit board or a wire behind the overlay allows very basic, cost-effective construction of a proximity sensor.

Using a Capacitive Sensor

Usage of capacitive sensors is expanding. The described sensors have created new opportunities for designers to work with such flexible, durable and elegant design elements. Buttons are still used for basic menu navigation and

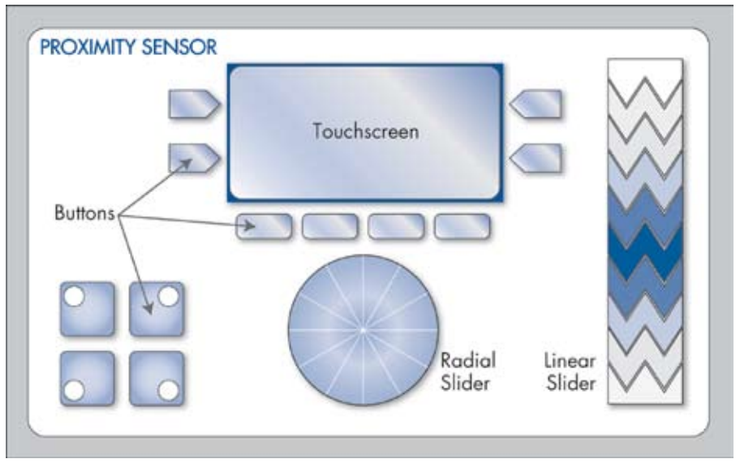

Figure 5: Illustration of proximity sensor arrangements.

Figure 6: The LG LA-N131DR air cleaner, developed by LG Electronics, uses five capacitive sensors for front panel display menu navigation buttons. Photo: LG Electronics.

activation. However, analog characteristics of buttons that are not expensive potentiometers are allowing easier and less expensive implementation of increased functionality and safety features.

The LG LA-N131DR Air Cleaner uses five capacitive sensors for front panel display menu navigation buttons. These buttons have allowed the designers to implement a seamless chassis design while still realizing the user interface. The capacitive buttons detect the presence of a human finger through four millimeters of glass. The control circuitry is located on the non-sensor side of a two-layer printed circuit board. LG uses the PSoC Mixed-Signal Array to control the sensors and output status to the main device processor.

Proximity sensors allow for reactive backlighting for night-time operation or for safety features requiring a larger activating element such as an adult hand or metal pot to engage the range-top controls. Proximity sensors, buttons, sliders and even touchscreens can be controlled by a single processor using PSoC. Firmware routines allow changes in state based on user inputs or host commands.

Create You Capacitive Sensing Application

The PSoC Mixed Signal Array is a configurable array of digital and analog resources, flash memory and RAM, an 8-bit microcontroller, and several other features. These features allow PSoC to implement innovative capacitive sensing techniques in its CapSense portfolio. Use PSoC's intuitive development environment to configure and reconfigure the device to meet design specifications and specification changes. New sensing technologies exhibit improved sensitivity and noise immunity, reduced power consumption, and increased update rate. For more information on PSoC, go to www.cypress.com. For more information on PSoC CapSense, visit www.cypress.com/capsense.

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Motor Control Designs for White Goods Demand Innovation

Plug-and-play modules reduce parts count and production costs

We are seeing more motor control designers turning to the power of the DSP. This is for good reason. It saves time and designs have lower component-count. Production runs can be scaled up easily, using very similar designs for differing applications.

By Jeffrey Reichard, CEO, Tier Electronics LLC and Andrew Soukup, Worldwide TMS320C2000™ Marketing Manager, Texas Instruments

Today's engineers must learn to prosper in an environment that emphasizes a plug-and-play design strategy. Most major white goods manufacturers, for example, have adopted the practice of considering even critical electronic subsystems (such as a motor controller) simply as a component.

This strategy keeps costs under control. It also allows the OEM to focus its internal design team's attention on value-added features instead of spending time designing various functions that can be outsourced to the OEM's suppliers.

Plug-and-play designs can place additional burdens on suppliers. For the circuit designer, it means creating flexible designs that are frequently a combination of subsystems.Typically, a main circuit assembly implements the basic functionality with one or more smaller assemblies providing the customization for optional interfaces, capabilities and even applications.

In motor control applications, the choice of processor is a vital step to ensure sufficient flexibility together with the ability to deliver a high level of performance at a low cost. Digital signal processors (DSPs) are increasingly being utilized in white goods for precisely this reason.

At the same time, the designer must use the kind of flexibility that DSPs provide, to achieve low manufacturing costs over a wide range of scenarios. Designs are most cost effective in terms of engineering time expended if they can ramp from initial trial production runs to 250,000 units or more with basically the same design.

Motor control a la carte

Here, we discuss a motor control design that takes flexibility to the next level. The same architecture can be used for a variety of motor control applications. It can also be adapted to different applications such as Uninterruptible Power Supplies (UPS), frequency converters and variable power sources.

For this particular white goods motor control application, the cost target was about €11 for a 1 horsepower motor (washing machine application) when the production run was ramped to over 250,000 units. The design needed to be flexible enough so that variations of the basic design could handle the requirements of a 5 hp motor (for a home air conditioner) or a half-horsepower (waste disposal) motor.

Module requirements

The absolutely key component choices at the design stage are the DSP and the IPM (Intelligent Power Module). Together, they deliver almost all the design's functionality. IPM requirements include voltage and current options in the range of 3 to 50 A and 600 VDC to 1200 VDC. Cost targets dictate DIP or SIP packaging.

A more subtle requirement for the IPM is that its drivers match directly to the IGBT to be used in the design. This simplifies the design effort by reducing component count, switching losses, and improving reliability, in comparison to designs that require external driver circuits.

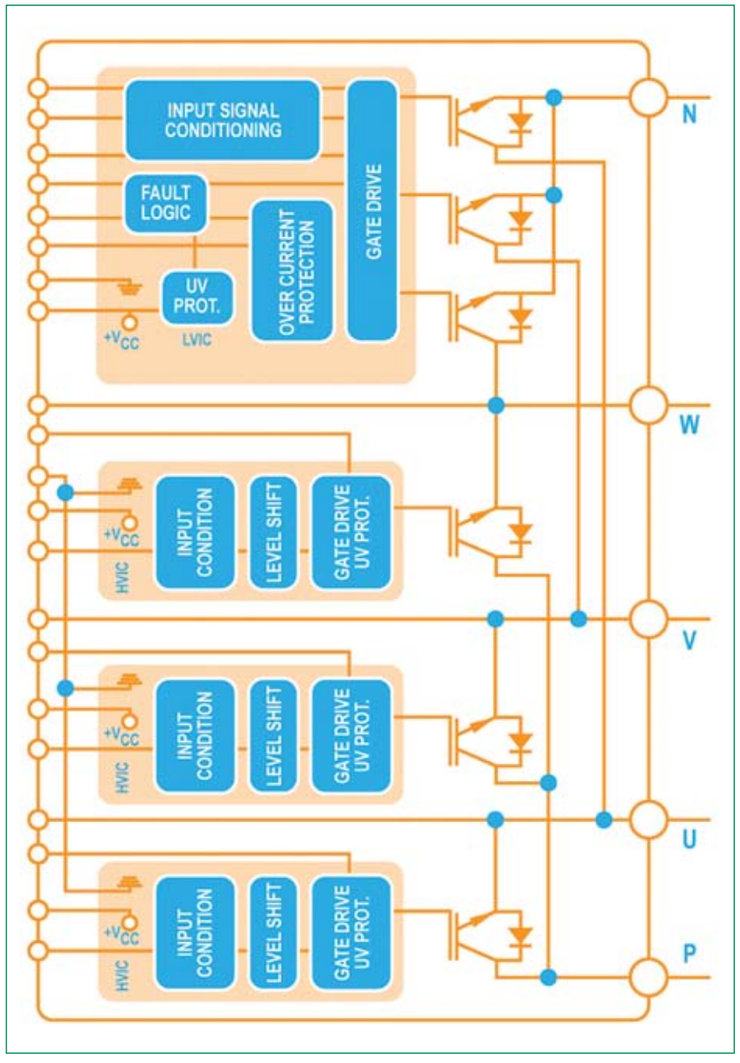


Figure 1: IPM for flexible motor control design with built-in protection circuits.

Some IPMs available today offer an array of built-in protection modes including under voltage, over voltage, over current, over temperature and shoot through. Choosing one of these IPMs reduces part count, engineering design time, and therefore final product cost. A diagram of a typical IPM is shown in Figure 1.

Processor requirements

The processor has stringent requirements. To handle field-oriented control (FOC) of brushless DC motors, it requires the signal processing capabilities of a DSP, cope with the normal level of function integration of an MCU and be inexpensive enough to be used with an induction motor. Digital signal controllers, such as those found in Texas Instruments (TI) TMS320C2000 platform, are designed for these applications. The choice of controller is determined by cost, performance, and manufacturing requirements.

The control optimized high speed DSP-based devices are capable of reading current and voltage signals during predetermined PWM patterns. This allows for simple sensors to be used to calculate individual phase leg currents and voltages by coordinating the internal A/Ds and PWM forced states. Functionality that is created by the DSP's speed allows a design team to use less expensive non-isolated sensors to replace their costly isolated counterparts.

Integrated features such as fast A/Ds, multiple communication channels, PWM modulators, and high speed operation are key to adding value. The DSP that has these features can be used to reduce design time, unit cost and manufacturing time. For example, one of the communication channels, CAN (Controlled Area Network), could be used for test and calibration data exchange during manufacturing to automate this phase of the product.

An RS-232 interface offers unsuspected value in contactless control. Safety regulations prefer contactless (which primarily means infrared) connections between the appliance's internal parts and its customer interface medium. RS-232 is a prime candidate for this type of communications due to its wide range of speed and control options. Contactless control also mitigates EMI concerns since the coupling capacitance is essentially eliminated.

Topology and packaging

A three-phase design with a single low-side current sensing resistor, an NTC temperature sensor, IPM power device, and DSP controller is the basic topology. This can be modified for two-phase and one-phase motors by simple re-programming of the DSP or through multiple resident programs.

The fast A/D converters make it unnecessary to use a differential amplifier for voltage feedback measurements. The accuracy and speed of the ADCs and the DSP allow the channels to be read sequentially without a differential amplifier. The signal error caused by the DSP can be extremely low since samples can be as close as 500ns.

Careful system partitioning is just as important in packaging. When white goods manufacturers view power controllers as plug-and-play components, there is usually little consistency between their specifications. In particular, different applications and OEMs specify quite different frame sizes for the PCB. But to be cost effective one design should accommodate all of them with a minimum of design changes.

TYPICAL COMPONENT COUNT		
COMPONENT	**DISCRETE/ MCU**	**IPM/ DSP**
IGBT/MOSFET	8	2
RESISTOR	101	38
CAPACITOR	84	50
ELECTROLYTIC CAPACITOR	4	1
DIODE	29	17
IC/PROCESSOR	19	6
OPTO	6	0
IPM	0	1
TRANSFORMER/ INDUCTOR	7	1
CRYSTAL	1	1
TOTAL	**259**	**117**

Figure 2: Comparative parts count.

FEATURES COMPARISON		
FEATURE	**DISCRETE/ MCU**	**IPM/DSP**
Component Count	259	117
Hardware	9 Sets	3 Sets
Protection	OC/OT/OV	OC/OT/OV/ UV/De - Sat/ Shoot Through
Sensors	3 x IFBK/1 x Res Div/Diff Amp/NTC	1 x IFBK/4 x Res Div/NTC
Uses	PWM Controller for Motor/UPS/ BLDC Motor/ Active Rectifier	PWM Controller for Motor/UPS/ Sensor Less BLDC Motor/ Active Rectifier /Harmonic Compensator

Figure 3: Fewer parts enhance reliability.

By treating the DSP and its support components as a single component and assembling these functions on a mini PCB and the IPM module with its related power components on a main PCB, a design that achieves a great deal of flexibility is accomplished. The main PCB which contains the IPM and other devices that change according to manufacturer, voltage, and power level make it a straightforward design that uses through-hole components along with the DSP component and can be changed easily without complicating the manufacturing processes.

Since each converter application uses the same DSP PCB assembly, it can be manufactured easily in large volume. It is then simply installed into any of the different forms of the main PCB, configured with the appropriate type of IPM.

Parts count and reliability

Figure 2 illustrates a comparison of the conventional MCU/discrete design approach versus the new methodology. The DSP/IPM design can cut the total parts count by 50%.

MTBF metrics are also improved by reducing the number of components. Additionally, mechanical stresses on the main PCB are reduced by using the DSP PCB assembly approach because the thermal stresses, normally associated with greatly dissimilar components on a common PCB, are eliminated. Circuit protection is enhanced by the utilization of specific IPMs and three sensors are replaced by one as compared to the MCU/discrete-based design. The differential amplifier can also be eliminated by using the fast A/Ds of the DSP. Figure 3 shows a few metrics related to reliability.

Lower cost, more functionality

By opting for more powerful and highly integrated components, the number of parts, manufacturing costs, and engineering costs can all be reduced. The plug-and-play approach of the motor controller with the two-board system produces manufacturing flexibility that keeps unit costs low.

This approach also allows production scaling from low volume to hundreds of thousands of units while maintaining a design that is highly cost effective. On the performance side, using advanced DSP and IPM components provides up to 30% better efficiency compared to conventional designs based on MCUs and discrete components. Finally, the reduction in parts count improves reliability.

www.ti.com

www.tierelectronics.com

Resettable Circuit Protection for Appliance Motors and Transformers

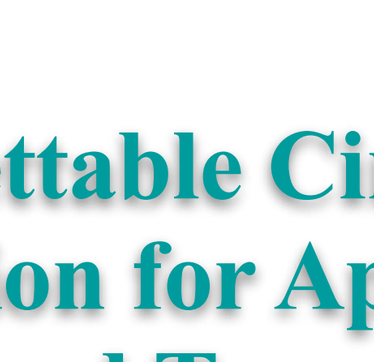
Better than fuses…and reduce warranty returns

These devices, with their low resistance, fast time-to-trip, low profile, and resettable functionality help circuit designers provide a safe and dependable product, comply with regulatory agency requirements, and reduce warranty repair costs.

By Faraz Hasan, Global Industrial & Appliance Marketing Manager, Raychem Circuit Protection products, Tyco Electronics

The latest generation of PPTC (polymeric positive temperature coefficient) devices includes components that are rated for line voltages of 120 VAC and 240 VAC and can be used in parallel for increased current capacity. Their low cost, resettable functionality and latching attributes make them a reliable, cost-effective circuit protection solution for the small and medium-sized electric motors used in home and professional-grade appliances.

In many electric motor and transformer applications, single-use fuses are used to help protect electronic circuits from damage caused by excessive current or heat. However, PPTC devices are rapidly gaining popularity, due to their resettable functionality and their ability to help provide protection for two fault conditions – overcurrent and overtemperature.



PPTC Principle of Operation

Although often referred to as "resettable fuses", PPTC devices are non-linear thermistors used to limit current. PPTC circuit protection devices are made from a composite of semi-crystalline polymer and conductive particles. At normal temperature, the conductive particles form low-resistance networks in the polymer (Figure 1). However, if the temperature rises above the device's switching temperature (T_{Sw}) either from high current flowing through the part or from an increase in the ambient temperature, the crystallites in the polymer melt and become amorphous. The increase in volume during melting of the crystalline phase separates the conductive particles resulting in a large non-linear increase in the resistance of the device.

The resistance typically increases by three or more orders of magnitude. This increased resistance helps protect the equipment in the circuit by reducing the amount of current that can flow under the fault condition to a low, steady state level. The device remains in its latched (high resistance) position until the fault is cleared and power to the circuit is cycled – at which time the conductive composite cools and re-crystallizes, restoring the PPTC to a lo w resistance state in the circuit and the affected equipment to normal operating conditions.

PPTC devices are employed as series elements in a circuit. Their small form factor helps conserve valuable board space, and, in contrast to traditional fuses that require user-accessibility, their resettable functionality allows for placement in inaccessible locations. Because they are solid-state devices, they are also able to withstand mechanical shock and vibration.

Performance Comparison: Thermal fuse vs. PPTC device

Tyco Electronics recently conducted comparison tests of their PolySwitch™ LVR series of PPTC devices as primary protection elements on a variety of transformers. The performance characteristics of the PPTC devices were compared to those of thermal fuses and ceramic PTC devices.

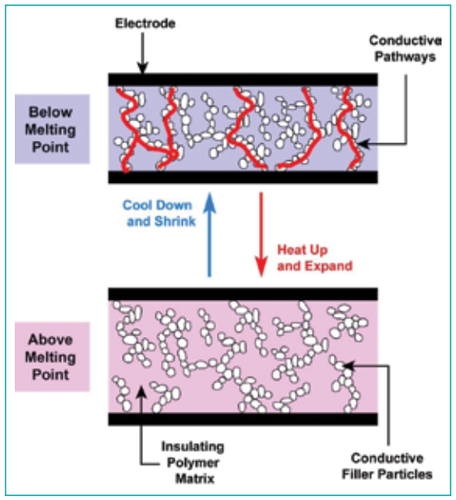


Figure 1: PPTC devices protect the circuit by going from a low-resistance state to a high-resistance state in response to an overcurrent or overtemperature condition.

Many transformer designs utilize a single-use thermal fuse as a primary protection solution. In this test, a short on the secondary side resulted in coil temperatures increasing to over 200ºC. The thermal fuse – rated at 115ºC and mounted near the center of the core – failed to open, and the insulation on the windings melted, destroying the transformer.

Figure 2 illustrates the results of a test in which a transformer was tested with the PPTC device installed as a primary protection element. A primary input voltage of $253V_{AC}$ was applied and a secondary short was simulated. Surface temperatures of the primary and secondary windings as well as that of the PPTC device were measured. The PPTC device started to trip when its external temperature reached approximately 95ºC, at which time the primary coil temperature was about 95ºC. Once the PPTC device tripped and limited the current, the coils began to cool.

The performance characteristics of the PPTC devices and the thermal fuses studied in similar tests on a $120V_{AC}$ transformer with a short on the secondary side are shown in the following table (Figure 3). These data demonstrate the advantages of the PPTC device's faster time-to-trip and its ability to limit the maximum coil temperature, thereby helping to provide some improved protection for the transformer windings, as well as the secondary circuitry.

Because PPTC devices transition to their high impedance state based on the influence of temperature, they help provide protection for two fault conditions – overcurrent and overtemperature. Overcurrent protection is provided when the PPTC device is heated internally due to I^2R power dissipated within the device. High current levels through the PPTC device heat it internally to its switching temperature causing it to "trip" and go into a high impedance state.

The PPTC device can also be caused to trip thermally by linking it to a component or equipment that needs to be protected against overtemperature conditions – such as a motor. If the equipment temperature reaches the PPTC device's switching temperature, the PPTC device will transition to its high impedance state, regardless of the current flowing through it. In this way, the PPTC device can be used either to reduce the current to the equipment to very low levels, or as an indicator to the control system that the equipment is overheating.

Motor Protection Strategy

Although generally reliable, electric motors are subjected to mechanical overloads, overheating, stalls, lost

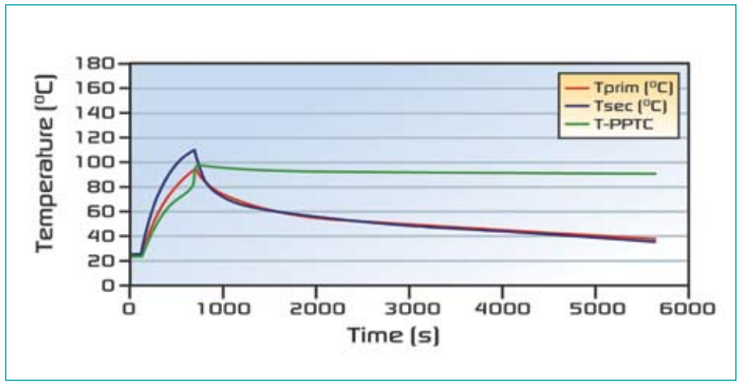


Figure 2: Effect of secondary short on $240V_{AC}$ transformer utilizing a PPTC device as the primary protection element.

Device	Time-to-Trip/Open	**Max Coil Temp (°C)**	Max Current (mA)
Thermal Fuse	>100 min	147	90
Thermal Fuse	51 min	157	89
Thermal Fuse	66 min	147	90
PPTC Device	11 min	107	87
PPTC Device	13 min	112	86
PPTC Device	11 min	103	88

Figure 3: Comparison of performance characteristics of thermal fuses and PPTC devices used as primary protection elements on $120V_{AC}$ transformer with a short on the secondary.

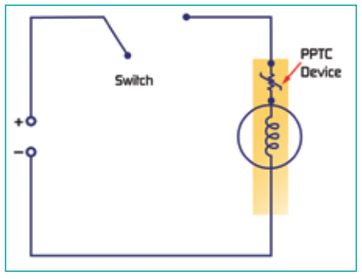


Figure 3: Comparison of performance characteristics of thermal fuses and PPTC devices used as primary protection elements on 120V_{AC} transformer with a short on the secondary.

neutral, severe overvoltage conditions, humidity and other damaging factors. Intermittent operation motors, such as those used in blenders and food processors, are usually designed to operate for a limited time. In general, operating these products for longer than the designed maximum limit, usually results in stalling, overheating and ultimately, failure. Fault conditions arise when the power is held on, either because of contact failure or customer misuse.

To prevent overheating, the circuit protection device used must "trip" quickly, but not sooner than intended, to avoid creating a nuisance condition for the user. The design challenge is to create a protection scheme that effectively protects the motor without nuisance tripping.

Nuisance tripping is often caused by inrush currents associated with certain electrical components found on motorized equipment. The major advantage of the PPTC device is that it can be specified with a trip current substantially below the normal operating current of the motor, but with a time-to-trip that is several times longer than a full system operating cycle, to avoid nuisance tripping.

Figure 4 shows how a PPTC device can be installed in a motor circuit to help protect against damage from overcurrent or overtemperature events. When the device is enclosed within the motor housing it reacts to the current flowing in the motor, as well as any temperature rise that may occur during a fault condition.

Summary

Resettable PPTC devices help protect electronic circuits from damage caused by electrical short, overloaded circuit or customer misuse. They are qualified for and widely used in appliance designs, compliant with the UL 1434 standard, and are compatible with lead-free solders and high-volume assembly processes. Their low resistance, fast time-to-trip, low profile, and resettable functionality help circuit designers provide a safe and dependable product, comply with regulatory agency requirements, and reduce warranty repair costs.

www.tycoelectronics.com

Sensorless Field Oriented Motor Control for Consumer and Industrial Goods

FOC provides higher efficiency, better dynamic response and less torque ripple

Sensorless FOC execution on Infineon's 8-bit microcontrollers XC886 and XC888 with 15 kHz PWM frequency and 133 µs current control response time only requires 58% of the CPU's performance…plenty of headroom for application specific functionality.

By Arno Rabenstein, Senior Staff Engineer Application Engineering, Microcontrollers, Infineon Technologies AG

Field Oriented Control (FOC) is increasingly being used in consumer and industrial motor control. The highly efficient programming of the 8-Bit Microcontroller with sensorless FOC algorithm in 16-bit arithmetics can only be realized by a nested utilization of the coprocessors MDU and CORDIC – called vector computer – and the 8051 compatible CPU itself. The MDU is a 16-bit multiply and divide unit, the CORDIC is a 16-bit co-processor dedicated for vector rotation and angular calculations.

Sensorless Field Oriented Control

A sensorless field oriented control (FOC) offers the full benefits of sinusoidal commutation at a minimum system cost.

There is just one shunt in the DC link necessary to acquire the phase currents. Figure 1 shows the block diagram of the sensorless FOC with speed control of a permanent magnet synchronous motor (PMSM). From a control point of view, the FOC is comparable with that of a DC motor. The basic concept is a cascade control with the important difference that the electrical variables (V_d, I_d, V_q and I_q) are turning with the rotor. Thus the currents measured at the stator (I and I) have to be transformed in the rotor coordinates (I_d and I_q). The controller for the currents is realized in the rotating system as PI-controller, whereas the field exciting d-component and the torque exciting q-component is controlled separately.

The speed controller adjusts - as for a DC motor - the reference value for the torque exciting current I_q. Due to the permanent magnets at the rotor, the reference value for the field exciting current I_d is set to zero.

The output of the current controllers represents the reference voltages (V_d and V_q) in the rotor coordinates. These values are transformed into the stator coordinates (V and V) in order to calculate the polar coordinates (norm and angle). Using space vector pulse with modulation, the norm and angle values are converted in three phase currents by modulating the high-side and low-side switches of the power inverter accordingly.

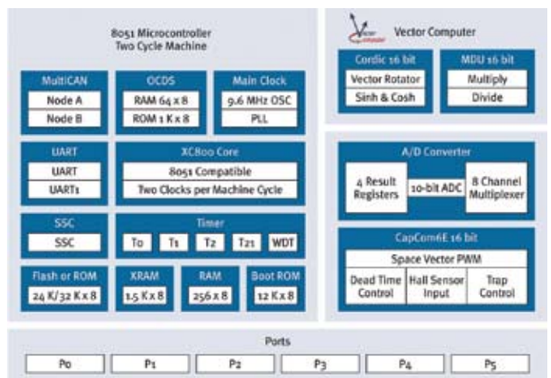


Figure 1: Block Diagram of 8-bit Microcontroller XC886/888 with vector computer.

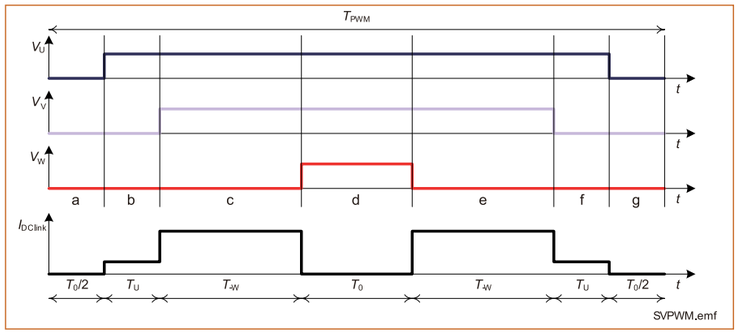


Figure 2: Space Vector Pulse Width Modulation: Three-phase inverter output signal and DC-link current I_Dclink.

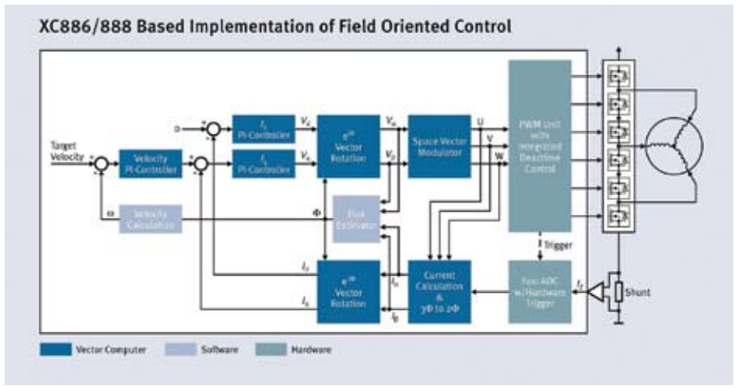


Figure 3: Sensorless Field Oriented Control of PMSM motor.

A space vector is a sinusoid whose center is able to "float" in space. The inactive states are used as an off time during the switching period when creating the space vector. A three-phase space vector is represented by a hexagon which can be divided in six sectors. Any desired voltage-space vector will consist of a "real" voltage from one of the phases and an "imaginary" right-angle voltage created from the other two phases.

The space-vector algorithm will determine the time required at a first active state, a second active state, and an inactive state to produce the desired magnitude and angle of the space vector. See figure 2 as an example. The first active state (b&f) is TU, the second active state (c&e) is T_W, the inactive state is T_0 which appears twice, first as (000) vecor (a&f), second as (111) vector (d).

If we translate the voltage waveform to the phasor diagram, we can see that the space-vector-modulation technique has a maximum predictable voltage of V_Dclink * sqrt(3). A space-vector-modulation system does not constrain the phasor center, yielding a 15 percent increase in available motor voltage. For a smooth rotation, it is the control of the sinusoidal current, not the shape of the voltage waveform that generates the magnetomotive force.

Acquisition of Actual Values

In order to estimate the rotor position by a single shunt measurement, the PWM pattern generation and the triggering of the ADC for current measurement must be very fast and accurate. Any jitter in the trigger point will influence the actual rotor's angle estimation. As a result, the total harmonic distortion of the sinusoidal current signals will increase.

The XC886/888C(L)M microcontrollers implement the above requirement using an event-based hardware trigger from the PWM unit CapCom6E towards the ADC. The event based trigger eliminates any interrupt latency and enables fast and accurate current measurement The ADC provides in total four result registers, from which two are used to hold the appropriate DC-link current values I_{DClink}. The ADC sample time is as low as 250 ns. As the current is measured in time slot (b) and (e) of figure 3, there is always enough time for conversion available.

The voltage model is a simple model for rotating field motors which is based on dedicated differential equations. In order to determine the actual angle of the rotor, the flux vector >Psi< can be calculated by integrating the voltages.

$$\vec{\Psi} = \int (\vec{v}_s - \vec{i}_s \cdot R)dt - (\vec{i}_s \cdot L)$$

The integration is simplified by replacing it by a lowpass filter with a very low cut-off frequency.

FOC Drive Application Kit: CANmotion

Infineon plans to launch an evaluation platform for FOC at PCIM Europe 2007. This CANmotion platform is featuring the XC886CM (TQFO-48 package), a 24V BLDC motor, a plug-in power supply and a CDROM providing the complete sensorless FOC source code, a free development environment for compiling and debugging and a comprehensive documentation. A CAN to USB bridge, built by using the XC886CM, is available for hexcode download and parameter adjustment.

For further details on Infineon's Sensorless FOC algorithm and the FOC Drive Application Kit, please refer to www.infineon.com/XC800-FOC.

Summary

Unlike most competitive FOC implementations that are hard-coded, XC886/8 microcontroller based solutions offer the added benefit of software re-programmability to give you more versatile application options.

Sensorless Field Oriented Control implemented on the 8-bit microcontroller families XC886 and XC888 of Infineon is the perfect answer to energy related regulations and pricing pressure for appliance manufacturers.

www.infineon.com/XC800-FOC

APEC - The Powerhouse of Conferences

The Applied Power Electronics Conference, APEC, this year held in Southern California, exceeded expectations on all fronts. The whole area including conferences, technical break-out sessions and the adjacent exhibition were bustling with activity. It was a real feast for me to see so many power companies together. It underscored the fact that our industry is still gaining momentum, enthusiasm, talent and stature. I met and talked with as many companies as I could and would really recommend a visit if you can. For many it is not feasible so I have tried to pull together a space-limited selection to give you a sense for what APEC is about. I hope you enjoy it and can make it next year in Austin Texas.

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

50% Board Space Saved with Fairchild's Integrated FET Plus Driver Muti-Chip Module

At my meeting at APEC, Fairchild Semiconductor introduced the FDMF8700, the first model in a new suite of highly integrated "FET Plus Driver Multi-chip Modules" for use in high-current synchronous buck applications supporting Intel's DrMOS Vcore DC-DC converter standard. It provides a fully integrated power-stage solution offered in a space-saving 8 x 8mm micro-lead frame (MLP) package. The layout and size of the switches and driver die are optimized to enable higher-frequency operation and are intended for use in desktop and server VR11.x vCore conversion, high-current DC-DC point-of-load converters and small form factor voltage regulator modules. The FDMF8700 enables designers to maximize footprint power density, reduce component part count/BOM cost and shorten time to market.

"The FDMF8700 FET Plus Driver is specifically designed to achieve an optimum application solution by using components that are matched electrically, thermally and mechanically to the input and output characteristics of each element, leading to superior module performance unattainable any other way," said Guy Moxey, director of Fairchild's low voltage market segment.

From the briefing, I received some compelling evidence that due to customer requirements, Fairchild had gone ahead and developed this family to solve specific issues in the industry. The ideal matching achieved by the company's endeavours has resulted in the first family members. When I pressed them on competition I was given a firm commitment that this new development from Fairchild promises to make alternative solutions available seem "somewhat less than world class" in terms of comparative performance. Good answer, I thought!

The FDMF8700 is the first product in the new FET Plus Driver Multi-chip Module family and is available in a 56-pin (8 mm x 8 mm) MLP. This lead (Pb)-free product 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

Infineon Covers it All in Power

I met with the Infineon team, headed up by Arunjai Mittal, senior VP for Infineon's Automotive, Industrial and Multi-market (AIM) power management and drives group.

Here I received a detailed overview of where they are taking the company. I'll give a brief overview.

The briefing concentrated on the area of energy efficiency, a hot topic in both industry and legislation currently and for the foreseeable future. In terms of the focus areas, Infineon will concentrate on Automotive, in providing higher fuel efficiency, smart solutions for high power applications in drives and battery longevity through power management. As one would expect from the world's number one power semiconductor company, the fields of activity are diverse and intense. In short, they are everywhere.

The AIM group will serve multiple markets too many to mention, but for our area in power it covers powertrain, instrumentation, motor control in everything from micro power to real heavy engineering power management.

Energy efficiency in this context covers power generation from conventional and the 'new' renewable and natural sources..the company is renowned for it's work in IGBTs, power transmission, and in power consumption with the broad range of power modules and leading products such as CoolMOS and Silicon Carbide diodes.

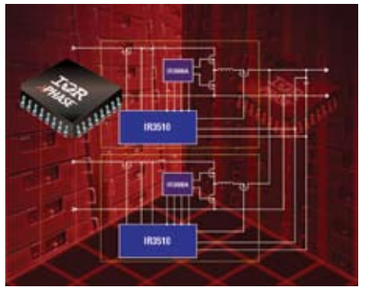
There are staggering power savings potentials in all these areas and Infineon have invested much resource to maintain its leadership. The company have recently opened a new 260,000m^2 hi-tech park in Kulim, Malaysia costing 1 billion US dollars, so it's safe to say they are committed.

So, whether we are loading our new washing machine, or designing mobile phones, locomotives or power plants, Infineon will be in there.

www.infineon.com

Special Report – APEC 2007 Roundup

IR Introduces N+1 Redundancy and Hot-Swap Capability to XPhase Family of Chipsets for Multi-Phase DC-DC Buck Converters



International Rectifier, with a very strong presence at the conference, introduced a new chipset in their XPhase® family of control ICs and phase ICs for scalable multi-phase, interleaved buck DC-DC converters, adding N+1 redundancy, hot-swapping capability and a host of protection features. IR's new chipset, comprising the IR3510 XPhase Control IC and companion IR3086A and IR3088A Phase ICs, is ideal for powering high-availability CPUs and servers in fault-tolerant applications where live insertion is required.

The IR3510 Control IC implements a simple and efficient synchronous buck topology, combined with input MOSFETs for hot-swapping and output MOSFETs for ORing, to ensure complete system protection against failures such as short circuits. To extend MTBF, average current mode control is used to implement droop sharing between converters without any single point failure modes, thus enabling N+1 redundancy. Additionally, the chipset provides input isolation protection, allowing hot-swapping of power modules without damage, while enabling 100% availability of power to the system.

I asked Jeff Sherman, senior marketing manager of IR's DC-DC multi-phase computing products what was special about IR's hot-swap offering.

"International Rectifier's Hot-Swappable N+1 redundant XPhase voltage regulator chipset is the first to incorporate hot-swapping and active ORing along with a full-featured multi-phase VRM controller," said Jeff. "We believe it will quickly become a standard in high-availability applications," he added.

Hot Swappable N+1 redundant AC-DC and DC-DC converters using transformer-based power topologies have been available for many years to provide board-level bulk power in server, telecommunication and netcom systems. Transformer-based topologies, however, are no longer viable solutions for directly powering advanced microprocessors due to decreasing operating voltages, increasing currents, and the proliferation of power rails required. Until now, point-of-load converters have been unable to provide N+1 redundant power along with the required input to output isolation.

About XPhase

XPhase is IR's distributed multiphase architecture that consists of control ICs and phase ICs that communicate using a simple five-wire bus scheme. Phases can be added or removed without changing the fundamental design. The five-wire analog bus consists of bias voltage, phase timing, average current, error amplifier output and VID voltage. By eliminating point-to-point wiring between the control and the phase ICs, the five-wire bus shortens interconnections, and reduces parasitic inductance and noise. This simplifies PCB layout and gives a more robust design.

Part Number	Function	Package	Size	Max Fsw (kHz)
IR3510M/MTR	Control IC	32-lead MLPQ	5mm x 5mm	1000
IR3086A	Phase IC	20-lead MLPQ	4mm x 4mm	1000
IR3088A	Phase IC	20-lead MLPQ	4mm x 4mm	1000

www.irf.com

Intersil's Supervisors Provide 26 Programmable Voltage Trip Points

Intersil displayed a broad range of products, about 80% of which are directly due to customer (OEM and ODM) requests, and talked about their patented R3 (Robust Ripple Regulator) technology which enabled the company to design into Intel. The company, which has a reputation for foreseeing market trends, predicts there will be a demand for more info to be available both to and from power management chips to enable to do much more than their primary function on a system level. This was a message I have heard again since.

The company also introduced two new supervisors, the ISL88016 and ISL88017, offering pin-selectable voltage trip points along with popular functions such as power-on reset (POR) control, supply voltage supervision, and manual reset assertion in a small 6-pin TSOT package. Both supervisors are designed for low power consumption as well as high threshold accuracy and are especially suitable for portable and battery-powered applications.

These supervisors have the unique feature of allowing users to program the voltage trip point from 1.60V to 2.85V in 50mV increments on the ISL88016 and from 2.15V to 4.65V in 100mV increments on the ISL88017. Trip point selection is made by connecting the three VSET pins to VDD, GND or floating. By allowing users to select from 26 different VTRIP voltages on each device, the same supervisor part can be used on different platforms and projects without the need to qualify a different part when a custom voltage trip point is needed.

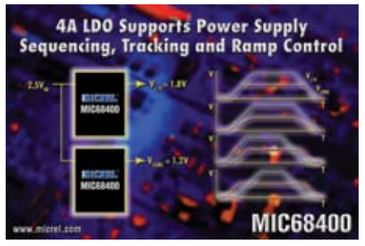
The ISL88016 and ISL88017 supervisors help to monitor a critical supply voltage and assert reset during low voltage conditions so that the main system components such as the microprocessor or microcontroller do not operate with insufficient voltage. Therefore, these supervisors help to ensure more reliable system operation.

Potential applications for the ISL88016/7 span portable battery-powered devices and medical monitoring equipment to industrial control and factory automation systems. The ISL88016 and ISL88017's combination of small package size, low power consumption, and adjustable VTRIP that does not need additional external components or software, makes them versatile general-purpose power products.

The ISL88016 and ISL88017 are available now in a 6-lead TSOT package

www.intersil.com/power

Micrel Launches New Products at APEC



Micrel has introduced the 4A MIC68400, the latest addition to its MIC68000 family of LDOs designed specifically for powering FPGA, CPLDs, DSPs and microcontrollers. The devices are aimed at applications such as broadband modems, routers, servers, storage networks, and wireless base stations. The MIC68400 is currently available in volume.

The company also launched the MIC68220, a compact dual 2A LDO regulator aimed at powering FPGA and microcontroller applications including broadband modems, routers, set-top boxes, home entertainment systems, storage networks, wireless base stations, and car infotainment systems. The MIC68220 is currently available in volume.

Dual 300mA ULDO Gives Designers Astounding Footprint Reductions

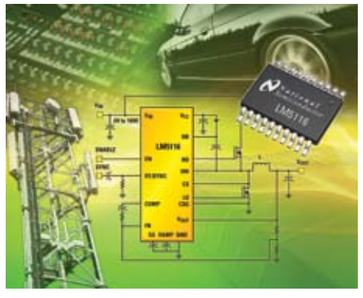
Micrel launched a new addition to its family of tiny dual ultra-low dropout voltage (ULDO™) linear regulators. The MIC5335 offers a record 300mA/channel in a tiny 1.6 x 1.6 mm MLF® package with a package height of just 0.6 mm. The devices are targeted at advanced portable applications including cellular phone RF power, camera modules, imaging sensors for digital still and video cameras, PDAs, portable media players (PMP) and PC cameras. The MIC5335 is currently available in volume.

Highly Efficient DC-DC Converter with Two LDO Outputs to Power DSPs, DMB, DVB-H and Mobile Graphics Chipsets

Micrel's MIC2810 is a highly efficient, flexible power management IC that provides three output voltages and a power on reset in a tiny 3mm x 3mm MLF®-16 package. The solution is ideal for use in cell phones, smart phones, PDAs, cameras, portable media players, wireless LAN cards and Bluetooth applications. The device is also suited to powering Complex Programmable Logic Devices (CPLDs) from a 3.3V or 5V rail in general purpose applications. The MIC2810 is currently available in volume.

www.micrel.com

National's LM5116 100V Synchronous Buck Controller Features Emulated Current-Mode Control for High Step-Down Ratios



I met with National's David Pace who is Director of the Phoenix Design centre for Power management. We talked about the company's newly launched LM5116, the industry's first 6V to 100V current-mode buck controller for telecommunications, automotive and industrial control applications.

The device joins National's portfolio of synchronous buck controllers, offering extended input voltage range and load current capability. Again, the company is maintaining its philosophy of keeping sophisticated technology simple for today's hard-pressed power designers with a comprehensive offering of on-line tools, evaluation boards and samples.

The LM5116 is well-suited for step-down regulator applications from a high voltage or widely varying input supply. I was particularly interested in the current mode control utilizing National's patented "emulated current-mode" (ECM) technology which reduces the noise sensitivity of the pulse-width modulation (PWM) circuit

enabling reliable control of the very small duty cycles necessary in high input voltage applications.

The ECM control overcomes the noise susceptibility and duty cycle limitations of traditional peak current-mode control by emulating, rather than actually sampling, the buck switch current signal. This is key because it is the switch current signal that causes the noise. Accurate emulation fixes the problem in a very elegant way. The emulated current signal is developed by charging a capacitor with controlled currents that produce a capacitor voltage waveform directly proportional to the current in the buck switch. Developing the current signal for the PWM through the ECM technique minimizes the effect of switching noise, yet maintains all the benefits of current-mode control.

The device features a host of technical and design goodies too numerous to cover in this brief section, but for more detailed information about the LM5116, including information on how to order evaluation boards and samples, visit http://www.national.com/pf/LM/LM5116.html.

The LM5116 is available in a power-enhanced TSSOP-20 package featuring an exposed die attach pad to aid thermal dissipation.

www.national.com

Power Integrations Announce New Products at APEC

DPA-Switch

Power Integrations, extended its DPA-Switch® DC-DC IC family with the introduction of the 10 W DPA422, which enables designers to develop efficient power supply designs for Power Over Ethernet (PoE) applications, and is especially suitable for Class 2 PoE implementations for applications such as VoIP telephones.

Andy Smith, Power Integrations' product marketing manager for the DPA-Switch family explained: "Integrated PoE solutions available on the market are a costly answer to a simple requirement. In contrast, by using our DPA-Switch family plus a few low-cost discrete components, designers can achieve a similar solution–simply, reliably and cost-effectively."

Power Integrations' DPA-Switch family is the only scaleable family of parts available that covers all current and proposed PoE classes from 3 W to 30 W and beyond. Rated at up to 10 watts output power, the new DPA422 has been specifically designed to meet the power requirements of IEEE802.3af Class 2 Powered Devices (PDs).

LinkSwitch

The company announced that all members of its LinkSwitch(r)-TN, -LP and -XT families of ICs are now available in SO-8 packaging, enabling emerging applications such as LED lightbulbs and miniature chargers.

LinkSwitch devices are fully monolithic 700 V buck and flyback power converter ICs that are capable of both operating directly off a universal (85 to 265 Vac) AC mains input and providing a low-voltage constant-voltage/constant-current (CV/CC) output. These small devices are ideally suited for powering applications with significant circuit-size constraints, such as slim-line cell-phone chargers, small appliances, LED light bulbs and other miniaturized electronic equipment. Power Integrations' power conversion ICs combine high-voltage analog and low-voltage control circuitry on the same die, which reduces the board area consumed by the power supply, enhances reliability and improves output power quality.

LED light bulb Reference Design Kit

PI also introduced a reference design kit (RDK-131) for ultra-small power supplies that helps designers deliver energy-efficient LED alternatives to power-hungry incandescent lights. The kit helps designers produce a power circuit that fits inside the LED light bulb socket, and also ensures that their incandescent-replacement LED light bulbs will pass EMC requirements for conducted and radiated electrical noise.

Unlike incandescent light sources, which can be powered directly from the mains supply, each LED light bulb requires a power supply to be incorporated within the Edison (E27) or Bayonet (GU10) sockets.

http://www.powerint.com

TI High-Performance ORing Controllers Protect Server and Telecom Power Systems from Transients

Texas Instruments gave a briefing which included introduction of a family of ORing power controllers that improves power distribution in 12-V blade servers, N+1 telecom systems and redundant low-voltage processor power supplies. These chips provide a high-efficiency replacement for ORing diodes, and offer intelligent monitoring and control of power supplies to prevent the tendency for bus transient events due to board insertions and removals from causing board-damaging faults or voltage spikes during operation. At the briefing I saw that a fairly unhealthy looking glitch had no untoward effect on the supply voltage.

The new TPS241x family of ORing controllers support input voltages of 3 V to 18 V, and can control power supply voltages down to 0.8 V. When used with a low Rdson N-channel MOSFET, the controllers significantly increase system efficiency and reduce power dissipation compared to today's hot, inefficient (and environmentally poor) ORing diode solutions. The TPS241x devices seamlessly manage power distribution to multiple

supplies, while protecting the system from potentially dangerous reverse-current or transient events by providing a super-fast turn-off response of 130 nanoseconds. In addition, these controllers feature a programmable turn-off threshold and an input filtering function to protect the power supply's integrity, especially when the system needs to adjust to extreme and heavy-use operating conditions.

The TPS2410 and TPS2412 controllers incorporate linear gate control, giving a power system designer greater flexibility to implement ORing in high-power applications. The TPS2411 and TPS2413 controllers utilize ON/OFF gate control to support low-power buses that may experience large transient steps.

The devices come in a 14-pin, plastic, thin small-outline package. Evaluation modules for the TPS2410 and other TI hot swap controllers and power management application notes and design tools are available through power.ti.com.

www.power.ti.com

New Tyco PolySwitch™ - Protection from Over-Current and Over Temperature Damage for Motors and Transformers

Raychem Circuit Protection, a business unit of Tyco Electronics, has announced the introduction of its PolySwitch™ LVR series of resettable circuit protection devices. PolySwitch LVR devices help protect electric motors and transformers used in commercial and home appliances from failures caused by mechanical overloads, overheating, stall, lost neutral and other potentially damaging conditions.

The PolySwitch LVR series includes components that are rated for line voltages of 120 VAC and 240 VAC, for up to 2A of operating current at 20°C. They offer low resistance, fast time-to-trip, a low profile, and resettable functionality to help circuit designers provide a safe and dependable product, comply with regulatory agency requirements, and reduce warranty repair costs.

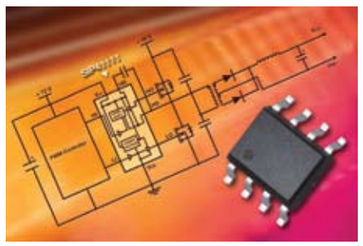
Unlike single-use fuses, PolySwitch devices do not require replacement after a fault event. After the over-current condition is eliminated and power has been removed, the circuit is restored to normal operating condition. Compared to bimetal breakers, they offer greater flexibility, longer lifespan, and lower electromagnetic interference (EMI).

The PolySwitch LVR devices' reset-table functionality and latching attributes make them a reliable, cost-effective circuit protection solution for both intermittent and continuous-operation motor applications.

The RoHS-compliant devices are widely used and are compliant with the UL 1434 standard, and are compatible with lead-free solders and high-volume assembly processes.

www.circuitprotection.com

Vishay Unveils SKYFET™ Technology



At Vishay I received a briefing from Michael Choi, Director for Market Development who detailed the company's new SKYFET technology for a new range of industry leading high performance MOSFETs.

These MOSFETS are really special in that they incorporate the Schottky diode within the monolithic die eliminating the more usual external component and associated parasitic problems.

The new devices feature Improved Switching performance by over 15% enabling the design of faster and more efficient DC-DC converters with much greater efficiency over competition, especially in the problematic low current area.

Also, as the switching frequency is increased, a much smaller inductor and filter capacitor can be implemented, giving a credible and valuable space saving.

New 75-V, 2-A Half-Bridge MOSFET Driver for Automotive, Power Conversion, and Class D Audio

The new SiP41111 is particularly well suited for automotive applications, which often require voltages up to 40 V or 60 V. The device may be used in high-intensity discharge lamps in automobiles, as well as in high-voltage buck converters, push-pull converters, full- and half-bridge converters, active-clamp forward converters, power supplies, motor control, and class D audio systems in a variety of end products. The device is offered in the SOIC-8 and renowned thermally enhanced PowerPAK® SOIC packages.

www.vishay.com

New Cost-Effective Thermal Management Material for High Brightness LED Applications

Bond-Ply® TCP-1000, a new dielectric material from The Bergquist Company, satisfies the extreme thermal challenges of applications using high brightness LEDs (HB-LEDs). Without proper thermal management techniques HB-LEDs quickly warm-up, reducing their light out-put. Life-time is also related directly to the junction-temperature, so the selection of a good thermally conductive substrate helps considerably in reducing the risks of over-heating the HB-LED.

Using Bond-Ply TCP-1000 as a circuit board laminate delivers more effective heat transfer from temperature-sensitive components than standard pre-preg materials. It competes effectively with constructions made from epoxy glass-on-aluminium and is equally easy to process in PCB manufacturing.

Bond-Ply TCP-1000, which comes in the form of a Metal Core PCB, offers superior thermal performance over standard FR4 substrates at a highly competitive price. The aluminium base layer comes in standard thicknesses of 1.0 and 1.6mm whereas the circuit-foil is available in 35µm and 70µm. Other foil thicknesses are available upon request. Laminated panels are available in 18 x 24-inch as well as 20 x 24-inch sizes.

Bergquist also offers circuits that are custom configured to specific design parameters.

Designed specifically to offer an alternative to various FR4 configurations, Bond-Ply TCP-1000, with a thermal conductivity of 1,5W/m-K, has a thermal performance that is at least 3.5 times better, supporting the high performance levels needed for applications with increased lumens per Watt while managing the LED junction temperature effectively.

Continuous use temperature range is -40°C to +130°C and dielectric breakdown strength is 5000 VAC minimum.

www.bergquistcompany.com

New Varistors Have Higher Surge Current Capability

EPCOS has developed the new LS41 and LS42 series of varistors with higher surge current capability. They are designed for surge voltage protection in industrial and consumer electronics. Both series have retained the compact dimensions of the proven series LS40 of 37.5 x 46mm^2 (W x H). The surge current capability of the LS41 was increased by 25 percent. It is now 50 kA at a pulse form of 8/20 µs. These types are designed for rated voltages of 130 to 460 VAC.

For the LS42, the capability was increased by as much as 62 percent to 65 kA. This series is designed for rated voltages between 250 and 460 VAC.

Approval to UL 1449 and CSA 22.2 standards has been obtained for both series.

www.epcos.com/varistors

Expanded Portfolio of Precision Linear and Low Dropout Regulators

ON Semiconductor has introduced four new high performance bipolar Low Dropout (LDO) Linear Regulators with output current ranging from 0.5 A up to 3.0 A and industry-leading low noise performance.

These 1 A to 3 A linear regulators offer output voltages down to 0.9 V and employ a special composite architecture that provides extremely fast (< 1.0 micro-seconds) dynamic (a.k.a., transient) response to changing output loads. Delivering industry-leading low noise performance without the need for a bypass noise reduction capacitor, the devices help reduce overall system costs and free up valuable board space. Providing low ground current independent of output load, these devices reduce power losses. In

particular, the 500 mA NCP3335A LDO can sustain inputs voltages up to 16 V and employs a special voltage reference and feedback mechanism that offers extremely tight output accuracies over operating conditions of load, line and temperature. Output accuracies for all the devices are from sub 1 percent at room temperature and sub 1.5 percent across the operating range of line, load, and temperature conditions.

NCP3335A - 500 mA LDO with enable. It is available with 2.5 V, 2.85 V, 3.3 V, 5.0 V and adjustable output voltages. Offered in a Pb-free Micro8™ package.This device is also offered in a Pb-free 3 mm x 3 mm DFN-10.

NCP5661 - 1 A linear regulator with enable. It is available with 1.2 V, 1.5 V, 1.8 V, 2.5 V, 2.8 V, 3.0 V, 3.3 V and adjustable output voltages. Offered in a Pb-free DPAK package. Also available in a Pb-free 3 mm x 3 mm DFN-6.

NCP565 - 1.5 A linear regulator. It is available with 1.2 V, 3.3 V and adjustable output voltages. Offered in a Pb-free D2PAK package. Also offered in a Pb-free 3 mm x 3 mm DFN-6.

NCP5662 - 2 A linear regulator with enable. It is available with 1.5 V, 3.3 V and adjustable output voltages. Offered in a Pb-free D2PAK package.

NCP5663 - 3 A linear regulator with enable. It is available with 1.5 V and adjustable output voltages. Offered in a Pb-free D2PAK package.

www.onsemi.com

Heater Module Provides Instant Heat

Providing design engineers with an instant heating technology primarily for the automotive and transportation windshield washer applications, TT electronics IRC Wire and Film Technologies Division, in cooperation with AB Automotive Electronics, a division of TT electronics that specializes in automotive control designs, has developed a windshield washer fluid heater module that utilizes patent-pending technologies and construction designs.The module combines IRC's anodized aluminum substrate technology with a thick film resistive element to produce a tubular instant fluid heater. Unlike conventional "reservoir style" washer fluid heating systems, the Anotherm® Windscreen Module does not use any power until heated fluid is required, resulting in an energy-efficiency of more than 95%.

According to Wilson Hayworth, product manager for IRC's Wire and Film Technologies Division, the windshield washer fluid heater provides heated fluid in about five seconds. "Due to the power limitations of most vehicles at 14.5Vdc, a preheat period of typically five seconds is required prior to the first fluid dispense. Our windscreen fluid heater module is able to provide this heat due to the low thermal mass of the system," said Hayworth.

"The Anotherm module heats quickly and evenly, thus it does not boil away additives such as methanol or ethanol, which are often added to improve the cleaning effectiveness and prevent the windshield washer fluid from freezing." The heating system will be available for model year 2009 platform releases, Hayworth continued.

www.ttelectronics.com

New Range of Shielded Current Transformers

VACUUMSCHMELZE has introduced a new family of current transformers designed specifically for us in IEC-standard electronic electricity meters. The new transformers comply with national standards for meters protected against manipulation attempts using external magnetic fields.

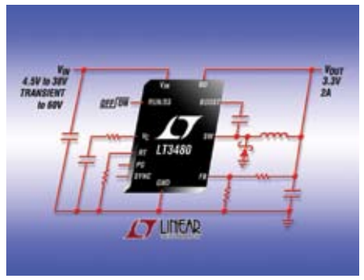
Electronic electricity meters are increasing in popularity all over the world. Free from mechanical wear and tear, they permit remote reading, are network-enabled and support multiple tariffs. However, rising energy costs are accompanied by an increase in the number of cases where meters of this type are subjected to manipulation. External magnetic fields can be used to influence the measuring circuit and reduce the power consumption registered.

The current transformers in the new X151 range feature integrated shielding and are protected to the highest level against manipulation attempts.

The traditional approach of shielding the entire meter - a complex procedure involving high space requirements – is now rendered unnecessary, enabling compact and secure meters to be designed cost effectively.

www.vacuumschmelze.com

38V, 2A, 2.4MHz Step-Down DC/DC Converter Offers Quiescent of Only 70µA Plus 60V Transient Protection



38V, 2A (IOUT) Step-Down DC/DC Converter with IQ = 70uA and 60V Transient Protection.

Linear Technology Corporation announces the LT3480, a 2A, 38V step-down switching regulator with input transient protection up to 60V. Its Burst Mode® operation keeps quiescent current under 70µA in no load standby conditions. The LT3480's 3.6V to 38V input voltage range and 60V transient protection make it ideal for load dump and cold-crank conditions found in automotive applications. Its 3A internal switch can deliver up to 2A of continuous output current to voltages as low as 0.79V. The LT3480's Burst Mode operation offers ultra-low quiescent current that is well suited for applications such as automotive or telecom systems, which demand always-on operation and optimum battery life. Switching frequency is user programmable from 200kHz to 2.4MHz, optimizing efficiency while avoiding critical noise-sensitive frequency bands. The combination of its 3mm x 3mm DFN-10 package (or thermally enhanced MSOP-10E) and high switching frequency keeps the external capacitors and inductor small, providing a very compact, thermally efficient footprint.

The LT3480 utilizes a high efficiency 3A, 0.25Ω switch, with the necessary boost diode, oscillator, control and logic circuitry integrated on-chip. Low ripple Burst Mode operation maintains high efficiency at low output currents while keeping output ripple below 15mVPK-PK. Special design techniques and a new high voltage process enable high efficiency over a wide input voltage range while the LT3480's current mode topology enables fast transient response and excellent loop stability. Other features include external synchronization (from 250kHz to 2MHz), power good flag and soft-start capability.

The LT3480IDD and LT3480IMSE are guaranteed to operate from -40°C to 125°C operating junction temperature.

www.linear.com

Companies in this Issue

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

Power Systems Design Europe **GreenPage**

Welcome to the GreenPage

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

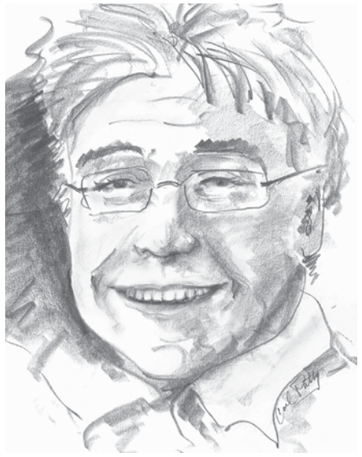
It may sound a little mysterious, but the time has come for us to give an open engineering forum to what is fast becoming an issue of paramount importance. As engineers the issues are well known. Simple. Inefficiency makes for waste, heat and pollution.

I am really interested in what's going on out there and will keep a watchful eye on what is happening, both in the industry as well as the wider view. I want to report from the sources of information I have currently, that is: the companies who supply me with news, article writers, our readership, wire newsfeeds and other contacts. In the meantime I'll make a start with what I've seen recently.

We have seen through our PSDE lighting feature (March 2007) that LEDs will 'lead the way', indeed, at this year's APEC there was much dialog on the topic. Cree presented some interesting material:

The DOE (US Department of Energy) international outlook figures of July 2005 projected a 50% increase in WW energy consumption over the next 20 years. In the US, for example, lighting is responsible for over 20% of electricity consumption. One can just imagine that this fact alone will really pile on the pressure for significantly better technology.

We also hear from the 2006 AMS (American Meteorological Society) Statement on Climate Change (October Draft):



"There is adequate evidence from observations and climate models that climate is changing; that humans have significantly contributed to this change…".

Very powerful stuff. Whatever our own personal views on this are, there is a powerful force which is gaining momentum in the public's eye. It is having its effect. Certainly, as an example, there is a very strong swing towards the preference of energy efficient white goods. We are all getting sensitized to it by the constant discussions and reports in the media. Hence the huge business opportunity in this area which makes a relentless demand for innovation in power design engineering as well as in the semiconductor power products needed to help achieve it. We now have hugely better Power Modules, MOSFETS, IGBTs, Converters, Drivers, Inductors, LEDs, Ballasts, Schottky's, just scan the previous pages. And it will, without doubt, continue.

Even the facilities operators and engineers in the semiconductor manufacturing industry have been told they can reduce energy consumption by half, save water used in processing, and conserve expensive and hazardous chemicals by applying state-of-the-art resource-efficiency techniques and measures to their silicon production and semiconductor fabrication facilities. It all makes complete sense, but nevertheless, it sounds a daunting task when you need to ramp production immediately to fulfill demand for all those near-zero $R_{DS(on)}$ MOSFETS for the new super-efficient white goods!

But companies are taking the whole issue of energy conservation very seriously. Hewlett Packard has recently announced it will cut energy consumption by 20% by the year 2010 throughout its supply chain. This will no doubt be a very large project within the company and will consume human resource, a precious commodity for any company in these days of minimizing costs and maximizing production efficiency.

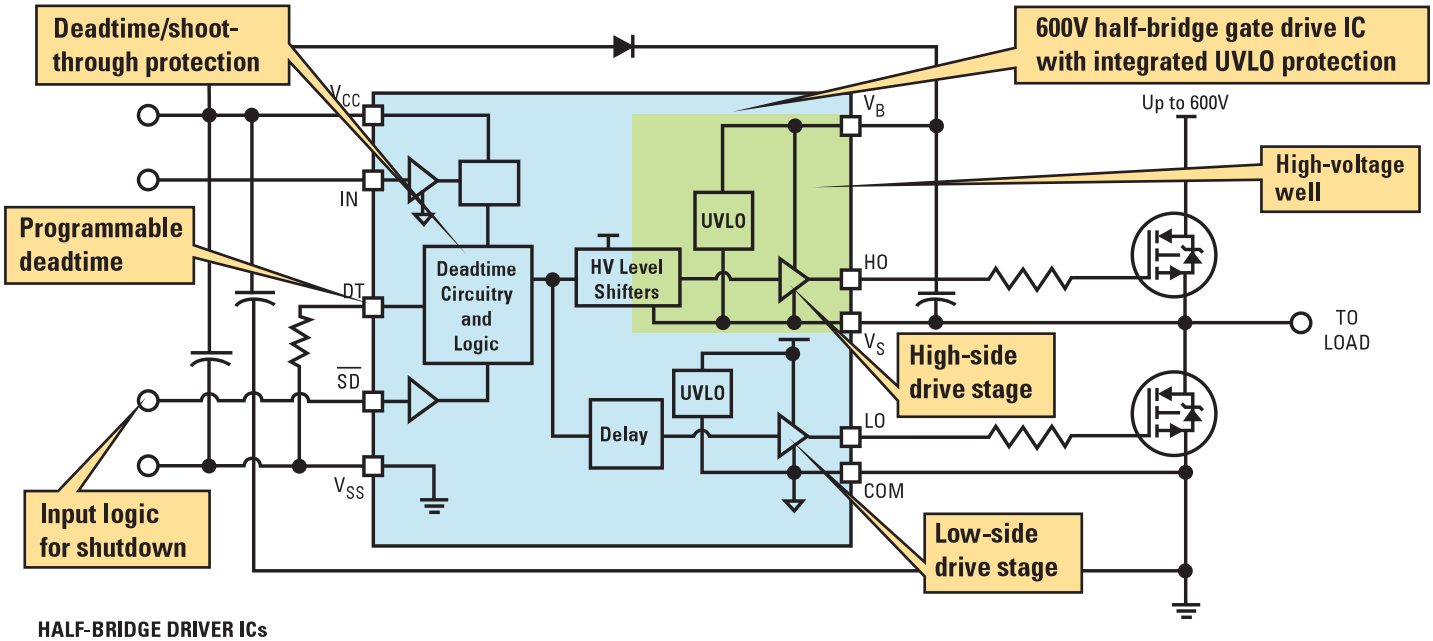
You would have seen the new approach from Texas Instruments in this issue's PowerLine feature, by 'grasping the nettle' on new energy sources. These sources will turn the conventional power supply in portables upside down. They are 'green' but do not behave like 'normal' batteries and need different DC-DC conversion characteristics. I believe that manufacturers of portable equipment will be quick to latch on to these new sources and produce 'greenly-differentiated' products. Yet another challenge for our industry and one that will, for sure, be met.

So, I hope this sets the scene for you. Please send me your views, inputs and news. I'll do my best to include all relevant 'green-based' material in forthcoming issues of PSDE to give you a regular and relevant update through this medium we call the GreenPage.

www.powersystemsdesign.com/greenpower.htm

IR SETS THE STANDARD FOR 600V ICs

Rugged, Reliable, Highly Integrated



HALF-BRIDGE DRIVER ICs

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

INDEPENDENT HIGH- AND LOW-SIDE DRIVER ICs

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

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

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

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

Features:

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

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