Power Systems Design EUROPE

Empowering European Innovation

December 2006

PowerLine

Power Player

MarketWatch

TechTalk

Design Tips

Special Report - electronica 2006 Roundup

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The Show Must Go On....

After the tidal wave that we conveniently call electronica, it's time to return to the panics we left behind in order to get the show going and to give the final push for business before the year is out. The show this year was no disappointment with the target set at 3,000 plus exhibitors and 75,000 plus visitors it was the show that makes the heavy workload and financial outlay for all participating companies worthwhile. The characters are still there. The flamboyant, the heavy-tech, the gurus and the presidential types still abound and flourish.. even in these lean and mean times. Maybe not in their original guise, but the industry seems to conserve its talent and make good use of it.

As you will see from our MarketWatch section from iSuppli, the consumer segment will see a mild and short slowdown, but I really believe from what I've seen and heard at the show, that we will then continue to see a strong power business through 2007.

The mood at the show was very much up-beat with the hundred or so power companies I talked with. CEOs, engineering, marketing and PR reps from these companies were bristling with highly competitive enthusiasm for the short and medium term outlook. It was not just the facts that impressed me, but the attitude of these folks. Business has been tough and companies are not the same any more, bottom line delivery is the name of the game these days with little time for chit-chat. Everyone is under pressure to deliver, and with an industry such as ours, it seems that everyone is striving for the ultimate in silicon differentiation and customer satisfaction. There was much at the show to impress and I have tried to give a fair overview of the products, technologies and services on offer. For me it was the first electronica that has carried on to the official end. No-one was seen sneaking out from their stand on Friday afternoon, although I did notice a few cork-popping celebrations. Thank heavens for team orientation! If you were fortunate enough to visit the show, I'd be very interested in hearing your take from your own perspective.

I am very pleased to announce that the Power Systems Design Europe steering committee has a new member, our first lady, so to speak, from Fairchild. She comes from an engineering role and is based in Germany. I would like to welcome her to our team. She is

Marion Limmer , Technical Director Europe, TASC & Power Resources, Fairchild Semiconductor, Fuerstenfeldbruck, Germany.

We shall be working together with the other steering committee members and the circulation management team here at PSDE, to get some really up-to-date news from the various industry sectors represented and to give you a credible, feet-on-the-ground insight into the developments and future direction and trends within our great industry.

In this issue we have another selection of industry contributed articles, interviews and product news for you. I am trying to maintain the technical content depth and variety that this industry offers and am thankful to all of you who make these contributions that give us such a powerful insight as well as those who take the time to give me the all-important feedback for my future guidance.

So let's move on and into this issue. I hope you enjoy this month's selection and would like to wish you all a well deserved break over the forthcoming Holiday Season period. Maybe a good time to send me an insight into your new design project.

Cliff Keys.

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

International Rectifier's Founder Eric Lidow Receives Lifetime Achievement Award

The Reed Electronics Group has selected IR chairman and founder Eric Lidow as this year's recipient of the Lifetime Achievement Award.

The award is presented to an outstanding individual who has made a tremendous impact on the electronics industry. Chairman of the Reed Electronics Group, Stephen Moylan, said, "This year's winner of the Elektra '06 Lifetime Achievement Award is a truly worthy recipient. He has been a pioneer of a technology which has had a profound and lasting impact on the power electronics industry and has founded a company whose name is now instantly recognized around the globe as a leader and innovator in the power semiconductor market."

Lidow founded International Rectifier in 1947 and was an early pioneer of a then rare global enterprise business model. Under his leadership, International Rectifier developed a number of key power management technologies now pervasive in the industry, among them the HEXFET® power MOSFET.

The lifetime achievement award, part of the European Electronic Industry Awards, was presented at the Elektra '06 gala in Munich on November 15. Past recipients include Pasquale Pistorio, Dr. Hermann Hauser, and Professor Hugo De Man.

www.irf.com

Werner Rogall leads global sales for EPCOS

Werner Rogall (56) has taken over as head of EPCOS' global sales. He brings with him 25 years of experience in the sales of active and passive electronic components at EPCOS and its predecessor companies. Rogall will continue to serve as head of business administration within sales, a position he has held since 1988. Rogall succeeds Monika Arntz, who has left the company.

Joining Rogall in the management team of sales is Joachim Thiele (43), who has managed the DC film capacitors business unit since 2003. Thiele started his career in 1990 in product marketing for film capacitors at Siemens Matsushita Components, which he then led from 1994.

Rudolf Strasser (54) assumes the reins as head of the regional sales unit of Germany/Switzerland. Strasser has held positions in both sales and product marketing in his 25-year plus career at EPCOS and its predecessor companies, among others as sales engineer for semiconductors and as head of product marketing and design for ferrites. Strasser succeeds Elmar Schmid (66), who has retired.

www.epcos.com

Plan of Action by EC Welcomed by Infineon Chief

Infineon Technologies has unveiled a new product, OptiMOS®3, that will further improve the energy efficiency of power supply units. According to Business & Financial Press, a high proportion of all the electrical energy used in the world today flows through PSUs into everyday equipment such as computers, TVs and consumer electronics. This is where Infineon's OptiMOS®3 will be used, outperforming many existing power semiconductor solutions. It requires one third fewer components and two thirds less space in the PSU. According to Infineon's calculations, the power generated by an entire 360-Megawatt power plant could be saved if OptiMOS 3 was fitted to deliver the right efficiency to all computer server power systems in use.

"I welcome the plan of action announced recently by the European Commission to improve energy efficiency," says Dr. Wolfgang Ziebart, President and Chief Executive Officer of Infineon. "The plan marks an important step toward mastering the huge energy policy challenges that face Europe today. Our innovative semiconductors are making a major contribution to increasing energy efficiency and conserving ever more scarce resources."

The plan presented by the European Commission cites a series of measures that together make up a broad spectrum of cost-efficient initiatives to improve energy efficiency. They include measures to make energy-consuming products, buildings and means of transport more efficient, and to do the same for power generation. Products from Infineon are deployed in every link in the energy value chain, from generation through distribution to the efficient use of electrical energy. Data from market research organization IMS Research indicates that Infineon's sales of power semiconductors rose from USD 950 million in 2004 to USD 1.06 billion in 2005.

www.infineon.com

Zetex joins OSRAM's LED Lighting Elite

Zetex Semiconductors has become a certified partner of OSRAM's 'LED Light for you' network. The network aims to provide a worldwide source of technical expertise in all aspects of LED lighting.

Based around an open web platform, the network offers users up-to-date information on the latest developments in LED optics, thermal management and electronic control, and helps identify the most appropriate OSRAM approved technology partners.

The certification reflects Zetex Semiconductors' expertise in power management and mixed signal design and the standing of the company's ZXSC and ZXLD range of highly integrated LED driving solutions.

"This is a great achievement for Zetex which clearly recognises the lead we are taking in LED management and control," said Zetex CEO, Hans Rohrer, "Our certification means we can really help to shape the future of LED lighting solutions."

"By getting early access to the very latest LED based lighting projects and technologies, we will be able to better define our product developments and participate in some exciting collaborative marketing initiatives."

100% owned by Siemens, OSRAM is one of the world's leading lighting manufacturers and holds key patents in LED powered lighting.

www.zetex.com

Microsemi to Acquire PowerDsine Ltd.

Microsemi Corporation announced that it has entered into a definitive agreement to acquire PowerDsine Ltd. With this acquisition, Microsemi expands its portfolio of product offerings to include a broad range of Power over Ethernet (PoE) solutions and further enhances its strong analog and mixed signal design capabilities.

The transaction complements Microsemi' s analog mixed-signal product portfolio and bolsters the Company's presence in the communications market. PowerDsine has been a pioneer in the development of PoE and is a leader in this fast-growing market. The number of PoE enabled switch ports is estimated to grow from approximately 28 million in 2005 to over 100 million by 2009. The growing demand for PoE capability has been driven by a range of networked applications including VoIP phones, WLAN access points and remote security cameras that increasingly rely upon power delivered over the network. Ethernet switch vendors look to PoE solutions from PowerDsine to integrate this complex power management and communications capability into their product offerings. Microsemi will continue to support PowerDsine's product roadmaps for both the midspan and integrated product lines.

PowerDsine employs approximately 136 employees worldwide, which includes 94 engineers, and has facilities in Hod Hasharon, Israel; San Jose, California; and Melville, New York; and regional sales offices in China, India, Japan, Taiwan and the United Kingdom.

www.microsemi.com

www.powerdsine.com

Primarion Partners with CPES and CoPEC to Advance Digital Power Technology

Primarion has announced its support for the Center for Power Electronics Systems (CPES) and Colorado Power Electronics Center (CoPEC). These two university centers are dedicated to the research and development of digital power technology.

Digital power is a new, emerging technology that will significantly benefit from advanced research. Primarion has committed to offer intellectual and monetary support for the advancement of digital power research.

Established in August 1998, CPES is one of the nation's relatively few National Science Foundation Engineering Research Centers. Its vision is to provide the nation with the capabilities to become a world leader in power electronics. The center entails a consortium of five universities, including Virginia Tech, University of Wisconsin-Madison, Rensselaer Polytechnic Institute, North Carolina AT&T State University and University of Puerto Rico-Mayaguez.

From its 1983 launch, the University of Colorado's power electronics group has transformed into the Colorado Power Electronics Center (CoPEC). CoPEC industrial sponsors include leading semiconductor and power supply companies committed to the advancement of power management applications.

www.cpes.vt.edu

www.primarion.com

http://ece-www.colorado.edu/~pwrelect

STM and Velox Semiconductor to Launch GaN Schottky Diodes for Power Applications

STMicroelectronics and Velox Semiconductor Corporation have announced an agreement to jointly introduce GaN (Gallium nitride) Schottky diodes into the market, with a long term goal of establishing both companies as dual-source suppliers of the devices. GaN-based diodes will enable the design and production of Switch Mode Power Supplies (SMPS) for computers, consumer applications, and industrial products that are smaller, more efficient, and lower cost.

ST and Velox offer complementary skills that the two companies believe will accelerate the development of the critical technologies – increasing the likelihood of success, leveraging the capital costs required, and increasing the quantity and quality of product offerings available. Velox has developed 600-volt GaN Schottky diodes and the diodes are in the final stages of development before transition to production. ST will help complete the development, perform product qualification, and will market and distribute the diodes.

"Both companies believe that the GaN devices will provide one of the best trade-offs for the 600-volt power device market in the medium term," said Ricardo de Sa EARP, General Manager, Application Specific Discretes Division, STMicroelectronics. "We believe that the deal with Velox enables ST to introduce a new and fast-growing product line, quickly, and with the minimum of R&D and capital investment."

"Our agreement with ST will help Velox to answer our customers' needs for reliability of supply, and will enable faster qualification at a larger number of customers," said Thomas Hierl, CEO of Velox Semiconductor. "Combining ST's manufacturing, reliability and quality expertise with Velox GaN technology will create a true dual-source supply for GaN devices."

GaN is a wide bandgap semiconductor material, currently used typically in optoelectronic applications, and in high-power and high-frequency devices. In SMPS applications it enables the implementation of higher frequency power-factor correction circuits which offer benefits in efficiency, product size, low noise, smaller heatsink requirements, and higher yield.

The use of a GaN device provides reduced switching losses in both the diode and MOSFET, elimination of active snubber components, increased efficiency and improved temperature performance.

www.st.com

www.veloxsemi.com

Power Events

- ***APEC 2007,*** *Feb 25 - Mar 1, Anaheim, California, USA, www.apec-conf.org <http://www.apec-conf.org/>*
- ***PCIM China 2007,*** *March 21-23, Shanghai, China www.pcimchina.com <http://www.pcimchina.com/>*
- ***electronicaChina 2007,*** *March 21-23, Shanghai, China http://www.global-electronics.net/?id=21317*
- ***PCIM Europe 2007,*** *May 22-24, <http://en.wikipedia.org/wiki/N%C3%BCrnberg_%28disambiguation%29> Nürnberg, Germany http://www.mesago.de/en/PCIM/main.htm*

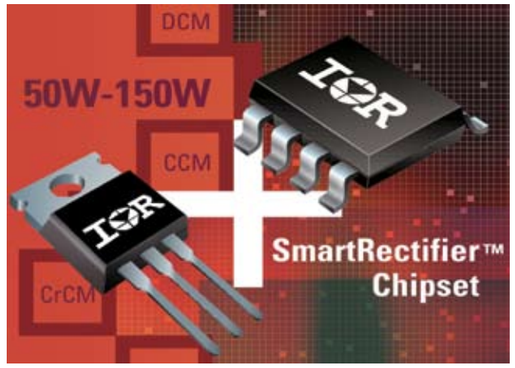
SmartRectifier™ IC Boosts Overall System Efficiency One Percent Using 75 Percent Fewer Components

The IR1166 SmartRectifier from International Rectifier is an eight-pin IC which simplifies the design of mid-power secondary synchronous rectification (SR) circuits of resonant half-bridge converters and flyback converters designed for 50-150W discontinuous conduction mode (DCM), critical conduction mode (CrCM), and continuous conduction mode (CCM). Enabling smaller and cooler supplies the IR1166 is used for AC-DC power converters in laptops, mini-PCs, LCD and PDP televisions, game systems, home theater audio, motor drive, and other digital computing and home entertainment systems.

IR's new SmartRectifier IC uses a new technique for precise, direct sensing of voltage thresholds across the SR MOSFETs, allowing fast, accurate control to minimize power losses in mid-power flyback circuits. In contrast, traditional complex and bulky current transformer control circuits waste energy because of the large reversing currents required to sense polarity shifts through the SR MOSFETs.

Compared to discrete solutions, IR1166S increases overall system efficiency by one percent while using 75 percent fewer components, and allowing a 25 percent reduction in SR system cost.

The IR1166 SmartRectifier IC works independently from the primary control and enables synchronous rectification so it can be used in a variety of transformer switching modes and applications with capacitive output filters. Furthermore, when "burst mode" occurs on the primary side, the secondary side remains unaffected, complying with California Energy Commission (CEC) 80Plus™ and "1W Standby."



Optimized Chipset Solution

This new device, based on IR's proprietary high voltage IC (HVIC) technology, is compatible with all MOSFET gate types, and offers a direct connection to a wide range of 40V to 200V SR MOSFETs. When used with IR's standard and logic-level HEXFET® power MOSFETs, the new IC reduces losses dissipated in the SR MOSFET by 50 percent, reducing the number of MOSFETs needed in the circuit or enabling the use of smaller packages, such as surface mount SO-8 parts. These optimized MOSFETs work with the IR1166 to create a "total chipset solution" to further maximize efficiency and power density in SR circuits.

In addition to the SmartRectifier IC, there will be an IRAC1166-100W 100W flyback converter reference design available that operates in CrCM. This reference design demonstrates the SmartRectifier features by resolving the output rectification function using a combination of one IR1166SPbF IC and two IRF7853 (SR) MOSFETs in parallel. The entire solution uses only three SO-8 packages for low-side output rectification and requires no heat-sink.

The new IC is available immediately in an SO-8 package and soon in DIP-8 package, which are both lead-free (PbF) and compliant with the Restriction of Hazardous Substances Directive (RoHS).

Design Tools

In addition to data sheets, application notes and technical papers available on the Web at www.irf.com, SmartRectifier online design software is available on IR's myPower website (http://mypower.irf.com). Designers simply enter application conditions and performance requirements to obtain recommended IC and MOSFET chipsets that can then be sorted by performance and system cost. Daughter cards are also available that offer a fast and simple way to compare the efficiency and simplicity of IR's SmartRectifier solution to alternative design approaches in existing designs.

www.irf.com

Shrinking Power Management Footprint

By Ralf Muenster, Director of Marketing, Power Products, Micrel Inc.

Since the 1970s, Moore's law has held: transistors have doubled in density every 24 months. Semiconductor companies have achieved this by deploying smaller and smaller process geometries with more gates on a chip. Conversely, shrinking analog power management circuitry hasn't been as straight forward. Low-drop-out (LDO) linear regulators continue to thrive due to cost, low solution component count, ease of use and low noise. Advances allow LDOs to be squeezed into smaller packages while performance specs improve and more functions are integrated so fewer or smaller external parts are needed.

Micrel has recently managed to package dual 300mA LDOs in a 1.6 x 1.6 x 0.55 mm MLF package to set a new industry benchmark for current density. Despite their small size, the parts have ultra-low dropout voltages of only 70 mV at 300mA, and more than 70 db Power Supply Rejection Ratio. Engineers can reduce the footprint of their systems by 72 percent compared to standard 3 x 3 mm packages. Single versions are available in a 1.2 x 1.6 x 0.55 mm MLF package. These small packages parallel the form factor of bumped dies without the drawbacks in manufacturability and low thermal performance.

While LDOs are small, cheap and easy to use they are not very energy efficient when the input and output voltage differential is larger than a few hundred mili-Volts. DC-to-DC switching regulators can provide a very efficient means of translating between two DC voltages even if the input and output differentials are large.

So, why haven't switching regulators completely taken over? First, switching regulator solutions are more costly, use up more space and generate more noise than linear regulators and can therefore be a challenge. Second, switching regulators have a larger footprint than linear regulators because they need a bulky inductor and a larger output capacitor.

Reducing the size of the inductor and output capacitor will be key to broader acceptance of high efficiency switching regulator solutions in many space- constraint applications. The most promising approach has been is to shrink the inductor size is by switching at faster frequencies. Until recently, switching regulators operated with frequencies of several hundred kHz. The inductor size of a switching regulator is inversely proportional to its operating frequency. Buck regulators, operating at 100 kHz, commonly use inductors in the range of 47uH. In comparison, switching regulators, operating at 1 MHz, just need 4.7uH of inductance. Assuming everything else is equal, this type of solution reduces the volume of the required inductor by 90 percent.

Responding to the demand for smaller inductors in space-sensitive applications, many analog IC suppliers have been furiously engaging in a speed race over the past few years, coming out with switching regulators featuring faster and faster frequencies. TI announced a 3MHz device in 2004. This was followed by Linear Technology and Maxim announcing 4MHz capable devices last year. In 2006, Micrel broke the 8MHz barrier by offering the industry's first 8MHz buck regulator. This solution features a tiny 0.47uH chip inductor that is smaller than the IC itself and provides another 95 percent reduction in inductor volume compared to a typical 1MHz solution. Now, the inductor has shrunk 200 times in volume compared to a 100 kHz converter.

Eliminating the inductor completely, Micrel has recently started sampling an inductorless high efficiency buck switching regulator. The device, the MIC3385, is rated for up to 500 mA and comes in tiny 3mm x 3.5mm x 0.9mm MLF® package. In spite of the missing inductor, the ripple performance is below 8mV and efficiency is respectable with up to 90 percent. It features a LDO light load mode with only 20uA of ground current. This light load LDO also assists the switcher during demanding load transients allowing for a significant reduction in output caps.

Digital chips are continuing to shrink through integration and the use of smaller process geometries. Analog power management advances are continuing to be made through innovative packaging and creative designs that shrink the overall solution size and external component sizes. These trends will drive IC power management choices for some time to come.

www.micrel.com

MarketWatch

Brief Slowdown Ahead for Power Management Semiconductors

By Marijana Vukicevic, iSuppli Corporation

After out-performing the overall semiconductor market during the first half of 2006, the power-management chip sector is undergoing a short and mild slowdown that should last only through the end of the year, iSuppli Corp. believes.

While the first-half growth was partly due to the increasing need for more efficient and smarter power management, the reason behind much of this expansion was a rise in prices for the most part, due to an increase in raw material costs. Because of this, iSuppli believes the power-management semiconductor market is due for a short and mild slowdown. However, this brief deceleration will not affect the power management chip market in 2007.

Power management semiconductor revenue in the fourth quarter will decline to $5.8 billion, down 4.3 percent from $6.1 billion in the third quarter, and down 0.6 percent from $5.84 billion in the fourth quarter of 2005. This follows

a 0.8 percent sequential increase in the third quarter compared to $6 billion in the second quarter, and a 9.5 percent increase from $5.5 billion in the third quarter of 2005.

In comparison, power management semiconductor revenue in the second quarter grew 4 percent sequentially and 13.1 percent compared to the same period a year earlier. In the first quarter of 2006, revenue was down 1 percent compared to the seasonally strong fourth quarter, but up by 9.4 percent compared to the first quarter of 2005.

Figure 1 shows iSuppli's forecast for power management semiconductor shipment revenue during the period from 2005 to 2007 by quarter.

The third quarter brought stable prices for most power management semiconductor average selling prices (ASPs) as lead times shortened. However, by the end of the third quarter, pricing began to decline, as did sales growth.

For the whole of 2006, power management semiconductors are predicted to have a strong performance, with revenue expected to rise to $23.7 billion, up 7.7 percent from $21.99 billion in 2005.

The strongest segment within the power-management semiconductor market is voltage regulators. This area is predicted to grow by 27.8 percent in 2006 compared to 2005 due to rising demand for energy-effective designs and devices.

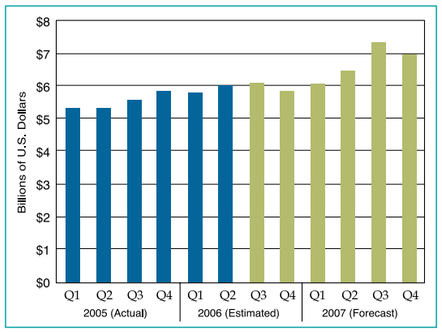


Figure 1: Quarterly Estimate and Forecast of Worldwide Power Management Semiconductor Revenue. (In Billions of U.S. Dollars)

A powerful 2007

Despite a weak second half of 2006 for the overall power management semiconductor market, expectations are high for a strong 2007. Worldwide power-management semiconductor revenue will rise to $26.8 billion in 2007, up 13.1 percent from 2006.

Again, the leader in revenue growth is predicted to be the voltage-regulation segment, with switching regulators expanding the fastest in that area.

As for the power discretes, Metal-Oxide-Semiconductor Field-Effect Transistors (MOSFETs) will take the lead, particularly high-voltage power MOSFETs, whose revenue will grow at an average rate of 15 percent sequentially for the next few years. As demand rises next year, ASPs also are predicted to increase by the end of the second quarter of 2007 with allocation expected for several package types.

www.iSuppli.com

Gate Drive Design Tips

In this article, we return to basics of converter design—how to turn on and off the power FET in a modern dc-dc power supply. There have been many articles and application notes on this topic in the past, and the reader is encouraged to read these for more background information [1].

By Dr. Ray Ridley, Ridley Engineering

Direct Drive from the PWM Controller

Most modern control chips incorporate an output driver stage, usually consisting of a totem-pole arrangement of two transistors. This output can be used to directly drive the gate of a power FET, as shown in Fig 1.

The direct connection can be used when the control circuit shares the same ground reference as the power circuit, and power levels are relatively low.

Data sheets show that several amps can be provided from the PWM controller output, more than enough to drive low-power devices. However, a FET input is a large capacitance, and it's usually not a good idea to try and use the full available current. It can lead to increased EMI due to rapid turn-on and turn-off, excessive reverse recovery loss in rectifiers, and noise issues inside the PWM controller itself. Clock jitter, and sporadic interruptions in the normal operations can occur. [2].

It's a good idea to limit the current from the PWM controller with the network shown in Fig. 2. Two resistors are used—one to control the turn-on time, and one to control the turn-off time. A diode is used to separate the two functions, but can be omitted in some cases if the timing is less critical.

We usually turn on the FET slowly when running a low-power converter. Don't be afraid to experiment with the value of the resistor R_{on}. I've used values as low as 1 ohm, and as high as 1 kohm in designs. My rule of design is to increase the resistor while monitoring the switching waveforms and power dissipation in the FET. If the temperature starts to rise significantly, cut the value

of the resistor in half. For a DCM flyback, it is surprising how slowly you can turn on the device without significant switching loss.

Turn off needs to be faster to provide rapid shut down during overcurrent conditions. Experiment with different values, rather than simply using the values shown in the application notes. For more information on how fast you have to control the FET, refer to [3].

Dedicated Gate Drivers

As power levels rise, you will find the values of the gate resistors need to decrease to minimize switching loss. For higher power circuits, it is common industry practice to use a high-current driver chip. This prevents interference with the PWM controller, and also allows better layout of the PCB. There are many good drivers on the market, or you can even build your own high-current totem-pole driver if you want to raise performance while reducing costs.

Isolated Gate Drives

At higher power levels, we start to use topologies such as the two-switch forward converter, half-bridge converter, or full-bridge converter. All of these topologies require a floating switch to be driven.

There are silicon solutions to this problem. I would use these for low voltage applications, but not for off-line circuits. High-side integrated drivers remove too much control from the

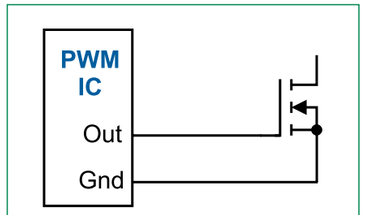


Figure 1: The power FET is driven directly from the output of the PWM controller.

Figure 2: Slow-down resistors are used to control the turn-on and turn-off time of the power FET. We usually turn the device off faster than it is turned on in order to achieve fast current protection.

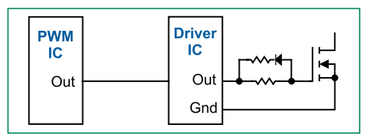


Figure 3: For larger power devices, and higher power switching, it's a good idea to use separate gate drive circuits to switch the devices rapidly. Gate resistors are still used, but are not shown here.

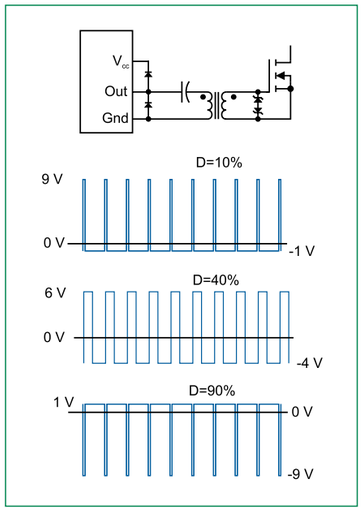


Figure 4: The most rugged scheme for isolated drives uses a gate drive transformer as shown. Catch diodes are needed for reactive current drives, and a dc blocking capacitor prevent saturation of the transformer. The capacitor causes a level shift in the output drive voltage, and this varies with duty cycle.

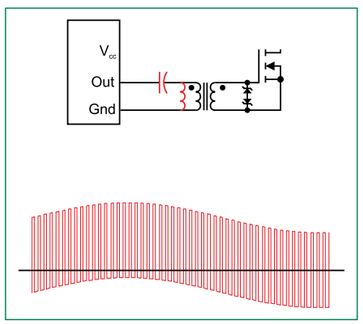


Figure 5: The dc coupling capacitor can ring with the magnetizing inductance of the gate drive transformer, usually during start-up and transients. This ringing should be properly damped to ensure safe operation.

designer, and do not provide the same level of protection, isolation, immunity from transients, or common-mode noise rejection as a well-designed and implemented gate drive transformer.

Fig. 4 shows the most rugged way to achieve a floating drive. The output of the drive chip couples through a dc-blocking capacitor to a small transformer (usually a toroid for high performance.) The secondary is connected directly to the gate of the FET, and any slow-down resistors should be placed in the primary of the transformer. Note the use of zeners on the gate for transient protection. Catch diodes are needed at the output of the driver, and should not be omitted even if initial tests show that there is no problem with the reactive current in the transformer.

The circuit of Fig. 4 provides a secondary gate waveform with a negative value when the FET is off. This greatly enhances common-mode noise immunity, crucial for a bridge circuit. However, the negative waveform also has the disadvantage of reducing the voltage applied when the switch is on. At short duty cycles, the positive pulse is largest. At a 50% duty cycle, half the available gate voltage is lost. At large duty cycles, there may not be enough voltage to properly turn the FET on. The transformer-coupled circuit is most effectively used with duty cycles from 0-50%. Fortunately, this is exactly what is needed for the forward, full- and half-bridge converters.

Notice in Fig. 5 that the dc coupling capacitor can give rise to a low-frequency ringing superimposed on the gate drive waveform. The usual solution to this is to use a large value of capacitor which lowers the Q of the ringing waveform. Make sure you test all transient conditions, especially start up when the capacitor is initially discharged.

DC-Restorer Circuit – Watch Out!

Occasionally, you may run into a high-voltage circuit that needs an isolated gate drive close to 100%. In the past, the circuit of Fig. 6 has been recommended for this application.

A diode and capacitor on the secondary restore the dc value of the gate drive, and allow the gate to be driven to duty cycles of up to 90% or more. However, there is a serious flaw in this circuit, and it is not recommended for use without very careful analysis.

The circuit works well during steady-state operation (a gate load resistor is recommended), but when the PWM controller shuts off, the dc blocking capacitor is connected across the gate drive transformer for an indefinite period. This can lead to saturation of the transformer, as shown in Fig. 6b. When the transformer saturates, the secondary is a short circuit, and the secondary capacitor can turn on the FET. The saturation can be avoided with a gapped core, and smaller value of capacitor, but this will increase the reactive current needed from the gate driver, and may produce other problems.

Isolated Gate Drives for the Bridge Converters

The half- and full-bridge converters are isolated applications that need a very rugged drive scheme. During the switch off time, the opposite side of the bridge will turn on, impressing a high common-mode voltage to the off device.

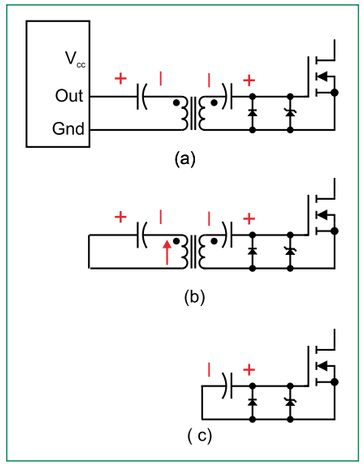


Figure 6: This dc-restorer circuit has been suggested for many years for circuits that require an isolated drive in excess of 50% duty cycle. This circuit can very often lead to failure when the power supply is turned off, and is not recommended.

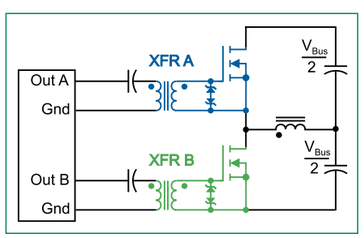


Figure 7: Two separate gate drive transformers are recommended for the half-bridge converter.

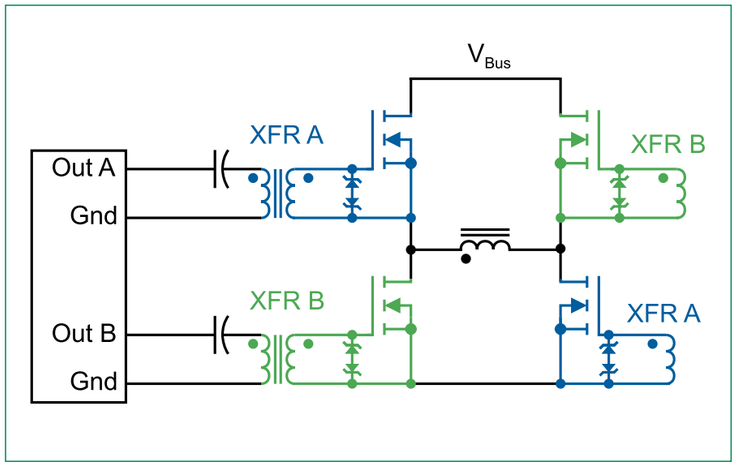


Figure 8: The full bridge converter also uses two transformers for rugged design. Two FETs are driven from two separate secondaries of each gate drive transformer.

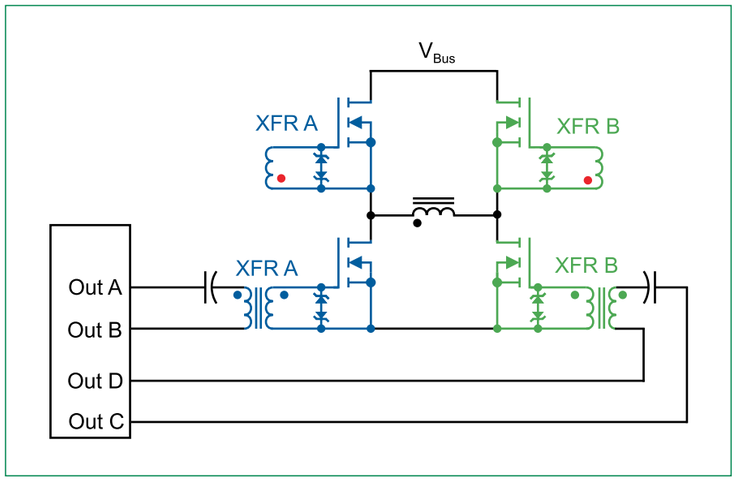


Figure 9: The phase-shifted full bridge uses a bi-directional transformer on each leg, Note the polarity of the secondaries.

Fig. 7 shows the recommended scheme for a half-bridge converter. Two gate drive transformers should be used. Do not try to use just one transformer with a tri-state operation, which may be presented as a technique in some application notes.

The full-bridge converter, shown in Fig. 8, also needs two gate-drive transformers. Dual secondaries on each transformer are used to drive the pair of FETs on the diagonally-opposite legs of the bridge. For both types of bridges, the gate circuit should be thoroughly tested during start up transients where the highest peak currents are seen, and the negative drive of the gate is the smallest.

The phase-shifted bridge in Fig. 9 also has two gate drive transformers, but notice the different arrangement. Each side of the bridge operates at a fixed 50% duty cycle, allowing the use of single gate drive transformer with dual secondaries of opposite polarities. This is one of the few circuits where the bipolar drive gate circuit can be used reliably. The only caveat is to be wary of the shut-down condition where ringing waveforms can turn on a device—there is no negative drive under this condition.

Summary

Gate drive circuits are a crucial part of design. Make sure you use the right scheme, and do not blindly copy an application note. Gate drive transformers add a level of ruggedness to your design that cannot be achieved with silicon solutions. If you are designing at high power levels, they are an essential element. While you need to think through all the components in a gate drive, be careful not to overcomplicate the design. Additional active elements to supposedly speed up the device switching do not usually offer improvements in overall performance, but they do introduce new potential failure mechanisms. Keep your gate circuits as simple as possible.

Additional Reading

[1] "Design and Application Guide for High Speed MOSFET Gate Drive Circuits", Lazslo Balogh, Texas Instruments Application Note.

[2] "Six Reasons for Power Supply Instability", Ray Ridley, www.switching-powermagazine.com

[3] "Power Supply Stress Testing", Ray Ridley, www.switchingpowermagazine.com

www.ridleyengineering.com

TechTalk

Linear's New 6A and 12A DC/DC uModules Provide Instant Power Supplies in Compact Packages

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

Linear Technology has just completed a tour of Europe to launch to press and customers five new family members of their high voltage, high power DC/DC uModule™ point-of-load (POL) regulators. These ultra-compact products provide new features and output power capabilities beyond what one would expect from such a small package. Based on customer feedback and analysis on the highly successful LTM4600 10A device, the company forged ahead to produce the derivatives forming the new family.

"These are products based on what we learnt directly from our customers" asserted Tony Armstrong, Power Product Marketing Manager from Linear's HQ in California, US. "We had a winning product with the '4600 but many customers wanted more functionality such as lower current (and therefore cost) options, PLL, track margin and remote sense capabilities..and all within the same small footprint! We went to work and have now delivered to exceed expectations."

In addition to the compact, high performance DC/DC conversion circuitry, the µModule family packaging itself very effectively removes heat. It's always easy for manufacturers to claim very high power-density solutions, but Linear have overcome the difficult task of preventing overheating with their uModule family.

The DC/DC controller and MOSFETs are proprietary and manufactured by Linear Technology. Gate capacitance, $R_{DS(ON)}$, switching frequency, dead-time, etc. are all controlled and optimized by Linear Tech designers for best performance depending on target applications.

Tony Armstrong presents Linear's uModule technology.

Digital system designers especially will certainly benefit from the quick, high-power DC/DC design now available to them. Layout and modeling software is also available for quick turn-around and the layout can be used across a system by copying-and-pasting. It's that simple.

The LTM4601, LTM4602 and LTM4603 each contain all the components required to build a 6A to 48A point-of-load (POL) regulator, including the inductor,

New 6A and 12A DC/DC uModules Provide Instant Power Supplies in Compact Packages.

V_{IN}: 4.5V-28V ; V_{OUT}: 0.6V-5V			Features			LGA Package (θ_{JA}:15°C/W)	
Part Number	I_{OUT}	Current Sharing	PLL	Track, Margin	Remote Sense	Height	Area
LTM4602	6A	Combine two or more for higher current				2.8mm	15x15mm
LTM4603	6A		v	v	v		
LTM4603-1	6A		v	v			
LTM4600	10A						
LTM4601	12A		v	v	v		
LTM4601-1	12A		v	v			

Table 1: New uModule Family: Complete DC/DC Regulator Solutions. (Note: New devices are in bold font)

power MOSFETs, DC/DC controller, compensation circuitry and input/output bypass capacitors. The devices' compact 15mm x 15mm x 2.8mm LGA package protects the solution from the external environment and the modules' thermal enhancements provide highly efficient heat removal. The uModule packages provide the size, form-factor and simplicity of a surface-mount IC. Designing with this family of uModule POL regulators requires no knowledge in switchmode power supplies, greatly simplifying the task for a digital circuit designer. Circuit simulation models and layouts are available for each device. The uModules serve a broad range of applications, including industrial automation, RAID and high availability systems, blade servers, medical imaging, wireless basestations, computing, and networking systems.

Each DC/DC uModule is rated for operation from 4.5V to 28V (20V for the standard voltage version). The output voltage is adjustable with one resistor from 0.6V to 5V. The new features added to the new family include phase-lock loop (PLL) synchronization for lower switching noise as well as for PolyPhase™ operation for paralleling multiple uModule regulators to deliver higher output current, true differential remote sensing for precision regulation of low voltage, high current loads such as FPGAs, DSPs and ASICs, and tracking/margining for proper startup of multiple voltage rail systems.

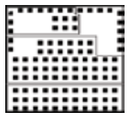
"The huge saving that can be made by a customer in terms of time-to-market and specialist effort in moving away from a discrete design using perhaps 20-30 components is very compelling, added Armstrong. A customer can realize about 50% size reduction with no bulky inductor or capacitors to worry about, easily implement this on either side of his board using conventional production methods and enjoy Linear's leading silicon technology and impeccable reliability track record. We source the silicon from both our two fabs in the US, so no problem with single sourcing. Add to this, the fact that this highly efficient thermal package has gold plated contacts and is RoHS compliant and you have an outstanding device for today's space constrained applications."

The LTM4601, LTM4602, LTM4603 and the previously announced LTM4600 uModule feature a current-mode architecture and provide fast short-circuit protection as well as over- and under-voltage protection. Because of their small size and light weight (1.73g) they can be handled by any pick-and-place machine. In addition, their low profile design is effective in enabling unobstructed air flow especially in very dense systems.

www.linear.com

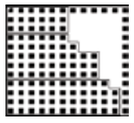
LTM4600

LTM4602



LTM4601
LTM4601-1

LTM4603
LTM4603-1



LTM4601 & LTM4603

The LTM4601 is a full-featured 12A output uModule DC/DC solution. It includes PLL, tracking and margining, and remote sensing. The LTM4603 is rated for 6A and has the same features, footprint and layout as the LTM4601. Each device is offered in two voltage options: 4.5V to 20V or 4.5V to 28V and rated for operation from -40°C to 85°C.

LTM4601-1 & LTM4603-1

The LTM4601-1 and LTM4603-1 are identical with the LTM4601 and LTM4603, respectively, except the remote sense function is removed. They allow current sharing by paralleling the outputs of multiple devices for higher load current. Each device is offered in two voltage options of 4.5V to 20V or 4.5V to 28V and rated for operation from -40°C to 85°C.

LTM4600 & LTM4602

The LTM4600 is a 10A uModule DC/DC intended for POL solutions compatible with the reduced feature set. The LTM4602 is rated for 6A and has the same features, footprint and layout as the LTM4600. Each device is offered in two voltage options of 4.5V to 20V or 4.5V to 28V and rated for operation from -40°C to 85°C.

*flow*SIM - A New Class of Power Module Simulators

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

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

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

Figure 1 shows the simulator main page with power module selection and application setup in the upper half and simulation results in lower half.

Figure 2 shows the inverter stage detailed information including power losses and dynamic thermal behavior of the simulated component which is also taken into account for the simulation. The detailed power loss information allows the designer to confirm the part selection in terms of switching speed and conduction losses. It also enables the calculation of total losses and therefore the validation of the selected heat sink.

Figure 3 shows the detailed parameters for the IGBT used in this application for an inverter switch. *flow*SIM also allows the adjustment of the gate drive based on customer requirement.

I saw this tool demonstrated at electronica in November by Werner Obermaier, Manager Product Marketing for Tyco's Industrial Products division and was very impressed. The parameters were well defined and the information laid out for easy 'intuitive' use, unlike some design tools that seem to require an advanced degree in computer science to operate and navigate.

It provides a 'real-world' look at the design to enable the engineer to make good decisions based on sound operational data provided in a highly readable format. In short, a practical tool to help speed-up product selection and to make the hard-pressed power designer's life a little less stressful.

Tyco Electronics will support all new standard products with the new flowSIM simulator, which can be downloaded free of charge from the following web address: www.flowPIM.com

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www.tycoelectronics.com

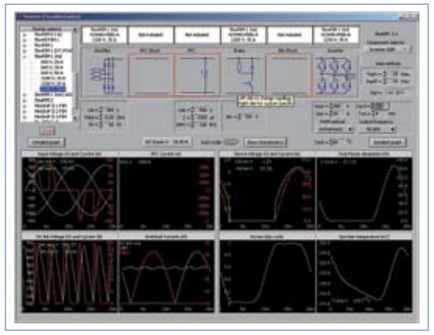

Figure 1: flowSIM main page.

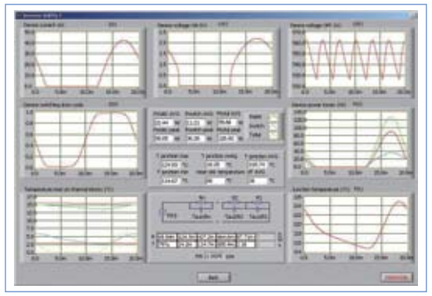

Figure 2: Inverter stage detail information.

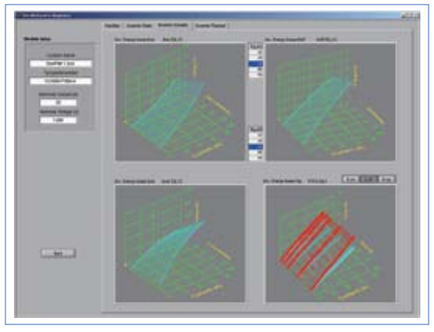

Figure 3: Detailed inverter parameter.

Building Low-Power Portable Multimedia Devices

The design art of power conservation

How do you build battery-efficient portable media devices when the market demands a host of power-hungry features? Read on..

By Cor Voorwinden, Bill Poole Jr. and Boris Bobrov, Manager, i.MX Applications Engineering, Freescale Semiconductor

From hybrid cars to MP3 players, energy conservation is growing more important for many machines that we use every day. Exceptional power management is especially important in portable electronic devices such as smart phones and portable media players. No-one wants a phone to run out of power during an important call, or a handheld videogame to die right before the next level. As electronic devices become more sophisticated and feature-rich, their applications need more power and their hardware takes up more space. At the same time, consumers are demanding smaller, sleeker and cooler designs.

Each new feature that you add to an electronic device will consume more power. Yet consumers don't want a bulky battery adding size and weight to their slim gadgets, and designers don't want to cut back on features to accommodate a big battery. Manufacturers are always concerned with time-to-market issues, whether to meet the demand for a new trend or to get the next "killer device" on shelves in time for the holidays.

Platform for a Low-Power Portable Multimedia Device

Freescale has engineered a platform for multimedia devices that meets the demand for low power consumption and fast time to market. This platform combines a power management and user interface (PMUI) IC with an applications processor. Each component has its own advanced power management features. They also were engineered to take advantage of each other's power management features and form the backbone of a portable multimedia device.

Freescale's MC13783 is a highly integrated power management, user interface and audio component for gaming devices, smartphones and portable media players. The i.MX31 multimedia applications processor is optimized for low power consumption and multimedia performance in portable devices. Together, they provide the components necessary to create a portable multimedia player or audio device while providing all the interfaces for Wi-Fi®, Bluetooth® or other connectivity.

Benefits of All-In-One Design

There are several advantages to an all-in-one power management and audio solution. Design engineers have the benefit of multiple options for tasks such as power sequencing, amplification, charging, display lighting and more. Manufacturers can build tiered products with one part, without the need to redesign from the ground up when the market changes. Consumers ultimately can benefit from the lower overall costs of a highly integrated system. Substantially integrated hardware platforms can reduce part count and inventory, and lower overall system costs.

Figure 1 is an example of the myriad of audio, video, storage, memory, security, interface and connectivity options that a portable device can have with this combination.

The MC13783 is dedicated to handset and portable applications covering Global System for Mobile Communications (GSM), General Packet Radio Service (GPRS), Enhanced Data for GSM Evolution (EDGE) and Universal Mobile Telecommunications System (UMTS) standards. This device, implements high-performance audio functions suited to high-end applications such as smartphones and UMTS handsets. Freescale PMUIs, including the MC13783, control and supply the power to the various subsystems within a mobile communications device. They also manage power supply charging; control value-added features such as "fun lights" for aesthetic product lighting; enable touch-screen inputs; provide audio amplification for speakers and microphones; and support the CEA-936-A car-kit interface.

Based on an ARM1136JF-S™ core, Freescale's i.MX31 multimedia

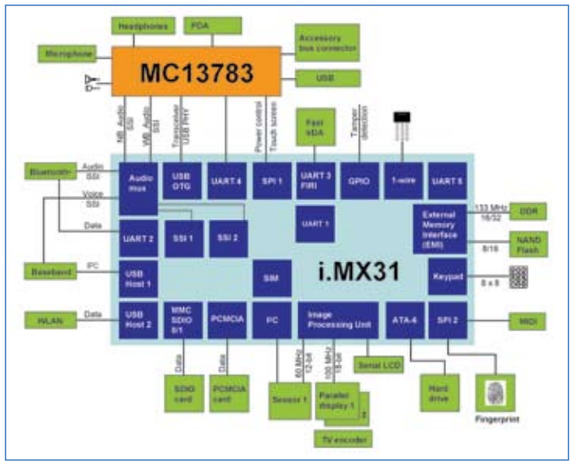

Figure 1: i.MX31 and MC13783 Compact System Architecture Example.

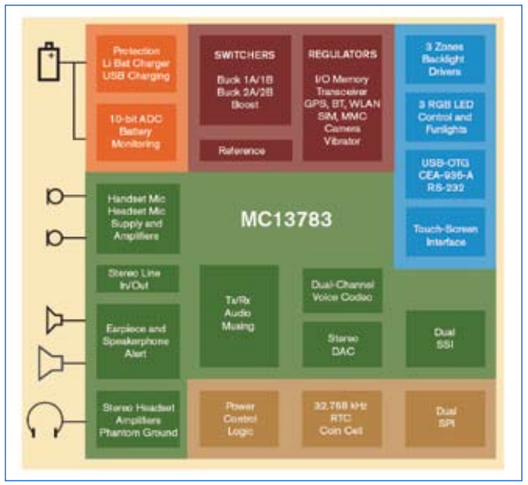

Figure 2: MC13783 block diagram [optional].

applications processor, starting at 532 MHz with a vector floating point coprocessor and L2 cache, is designed for wireless devices running computationally intensive multimedia applications such as digital video broadcast and videoconferencing. It is also ideal for mobile devices favored by the power user who keeps several applications running at once. Target devices include feature-rich smartphones, digital video recorders, digital cameras and mobile gaming.

Power-Saving Component Combination

Freescale's MC13783 power management and user interface (PMUI) IC is ideally suited for the i.MX31 multimedia applications processor and is included in the i.MX31 application development system. In fact, they were engineered to work together. The PMUI IC allows i.MX31 to take advantage of its built-in energy saving features, including dynamic voltage and frequency scaling and dynamic temperature process compensation.

The i.MX family of applications processors incorporates numerous features to enhance use time and battery life by reducing power consumption. These features include:

- Power gating
- Variety of low power modes
- Smart techniques for short wake-up time from low power modes
- Dynamic temperature process compensation (DTPC)
- Automatic dynamic voltage and frequency scaling (DVFS)
- Low-power clocking scheme
- Active well biasing (AWB)

Some of these features are implemented entirely within the i.MX31. To take full advantage of DVFS, DTPC and power gating require the use of a power management device, such as the MC13783, designed with i.MX31 in mind.

Low Power Modes

Having many power saving modes allows the designer to trade off between power consumption in standby and recovery times. One of the important features is the hardware handshake of the i.MX31 clock controller with peripherals before entering a low-power mode. This allows the relatively power-hungry ARM® core to enter a low-power mode immediately without waiting for the peripherals to complete their tasks.

Independent low-power modes for different power domains include:

- Stop: Clocks off
- Doze: Turns off the clocks and phase-lock loops (PLL). Clocks for specific peripherals can be switched off automatically in doze mode by pre-programming the clock controller module. This mode is useful for processes that require quick reactivation.
- Wait: In this mode, the ARM11™ MCU clock is stopped, but the i.MX31 bus switch (MAX) and all peripherals' clocks remain active. This mode is useful for running low-MIPS applications that primarily involve peripheral activity, such as a viewfinder that can be run with minimal ARM11 involvement.
- Hibernate: The power supply of the entire IC is shut down. All internal data is saved to external memory prior to hibernate.
- State retention: In this mode, all clocks are switched off and the PLL is disabled. External memory is put in low-power (self-refresh) mode. State retention uses less power and has a longer wake-up time than doze mode, but there is no need to recover any data after the wake-up.
- Deep sleep: In this mode, the power supply of the ARM platform (a major power consumer) is shut down. Any relevant register data should be saved before entering deep sleep mode.

Three separate power domains—the ARM CPU, peripherals and the PLLs—provide the ability to save power in one domain while the others remain functional. Power gating provides the ability to shut down the most power-hungry platform power domains in standby mode.

Dynamic Voltage Scaling

Dynamic voltage scaling (DVS) is a mechanism that allows designers to balance the performance demands of processors with the high amount of power needed to satisfy those demands.

Full processor and software system performance happens at the maximum run speed when operating at the highest voltage needed for that particular part and temperature. During less demanding periods of nominal run speed, the required performance can be obtained at a slightly lower voltage, resulting in a significant power savings. When the software is idle, the processor can be stopped and the voltage can be lowered further, since speed is not needed and the system requires only enough voltage to hold the state of registers. Some typical examples include 0.9 V STOP, 1.2 V RUN at nominal speed and 1.6 V RUN at maximum speed.

The transition between two set points must be smooth and controlled. This is achieved on the MC13783 with a DVS range of 0.9 V–1.70 V, which transitions in mini-steps of 25 mV each in configurable time steps. This appears as a ramp from one voltage to the next. Figure 4 shows the ramp up and down of the voltage domain as a result of DVS.

Figure 3: i.MX31 block diagram [optional].

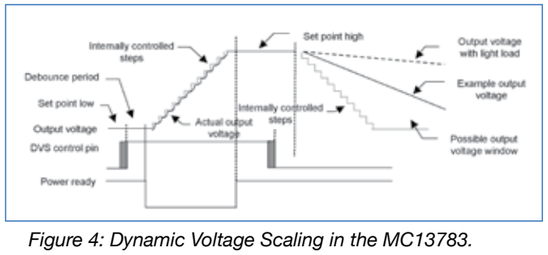

Figure 4: Dynamic Voltage Scaling in the MC13783.

i.MX31 Power Management Techniques

The i.MX31 multimedia applications processor is built using Freescale's Smart Speed™ technology with some powerful enhancements. The DPTC mechanism measures reference circuits' delays dependent on the process speed and temperature. The DPTC then lowers the voltage to the minimum level needed to support the current operating frequency. Automatic DVFS allows on-the-fly frequency and voltage adjustment according to the current performance requirements of the system. By lowering the frequency it is possible to lower the operating voltage, thereby dramatically reducing the power consumption. The automatic DVFS hardware mechanism monitors the processor load and controls the supply voltage and the frequency with minimal software and operating system involvement.

Active well biasing reduces standby leakage by up to 15 times by lowering the well voltage of the transistor. Standby leakage is a great concern in sub-micron manufacturing processes' IC designs in the semiconductor industry. Traditionally, the only shortcoming of this technique is the necessity to add an AWB charge pump to support the separate well supply. The i.MX31 processor solves this problem by integrating its own AWB charge pump on-chip.

In the i.MX31, careful and power-friendly IC design with three levels of clock hierarchy allows shutting down clocks to the parts of logic that are not used by the running application. Technology choice allows optimum trade-offs between speed and low power/high-performance/leaky transistors (low voltage threshold), versus ultra-low power semiconductor circuits (high voltage threshold) for functional modules with modest performance requirements.

MC13783 Power Management Techniques

Freescale's PMUI family is built with energy efficiency in mind. Power domains are split and can be cycled on and off under processor control as needed. Buck switchers are used whenever practical for improved efficiency and battery life. Multi-mode regulators have low consumption standby operation. Smart system orchestration of power is facilitated by monolithic integration and centralized control, addressing supply sequencing, operational modes, streamlined programmable interface and more.

The four buck switchers on the MC13783 can operate in several modes, including pulse width modulation (PWM) and pulse frequency modulation (PFM). Two PWM modes are available: the first mode trades light load efficiency for continuous switching. The second mode offers better light load efficiency by allowing the absence of switching cycles at light output loading. This "pulse skipping" feature improves efficiency by reducing dynamic switching losses simply by switching less often. PFM, the lowest power mode, provides a "free running" power level that requires less clock precision and allows switching whenever the application demands it. PFM can be combined with the DVS control for greater power savings.

The MC13783's 32.768 kHz crystal oscillator provides a power advantage in timekeeping. Ordinarily a function such as a PDA alarm will drain current because more components have to remain on. In a portable device powered by the MC13783/i.MX31 combination however, each component—including the i.MX components—can shut down, and only the crystal oscillator and timekeeping module (RTC) will remain powered. Upon a turn-on event detection such as the PDA alarm, the MC13783 will then wake up the entire handheld.

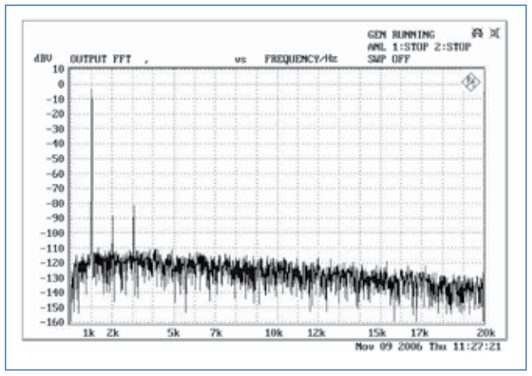

Figure 5: Stereo DAC and Headset Speaker Amplifier Output, 32Ω Load.

Flexible power-up sequencing on the MC13783 can eliminate the need to add extra costly controllers. There are 15 selectable power-up sequencer modes; this suits a wide variety of platforms and allows designers to manipulate power-up sequences. At power-up, after an 8 ms initial delay during which the core circuitry is enabled, all regulators and switchers are sequentially enabled at equidistant steps of 2 ms to limit inrush current. A designer could choose to use I/O lines on the i.MX31 processor to control the regulators powering the vibrator motor or a SIM card, instead of using the slower SPI bus.

Carkit and USB Standards

Integrated, optimized routing for the CEA-936-A carkit interface standard and USB On-The-Go provides ease of use and reduces system cost. The carkit standard is driving new capabilities for battery charging, data communications and audio routing through a standard mini-USB connector. An i.MX31/MC13783 mobile device would allow users to charge their batteries directly from a PC or car stereo through a USB cable or plug-in cradle. Hands-free phone calls or stereo playback can be directly interfaced to a carkit-capable stereo. With CEA-936-A compatibility, a mobile device only needs one connector for both USB connectivity and a charger. The single mini-USB connector can also work as a headset output.

Analog to Digital Converter

The MC13783's ADC contains 11 general purpose inputs that can take the place of many kinds of external circuitry, helping to save cost at the system level. They can be used to enable conversion on other elements in an application such as a temperature sensor or ambient light sensor. Designers can use these inputs for a range of tasks, including comparator logic and resistive touchscreen capability. The ADC is also used for accurate battery capacity metering, including on-chip scaling for voltage and current readings.

Backlight Functions

Three sets of tricolor RGB LED drivers support a wide variety of lighting use cases such as alerts, displays, keypad lighting, fun lights or other product differentiators. These LEDs could be used for applications such as case lighting, or a navigation button with a backlight which is independent of the backlight for other keys. Partial lighting, especially for keypads, can save a great deal of current.

In the MC13783, one single boost switcher provides power for backlight and USB On-The-Go applications. An adaptive boost mode can scale the boost output voltage to the minimum necessary, reducing power dissipation across the current-sinking main display backlight drivers. This improves overall power efficiency when the backlights are active for extended periods.

Audio Options

The MC13783 contains all of the components needed to play and output stereo audio, from the 16-bit stereo codec to a variety of line, headset and speaker amplifiers with adjustable gain paths. Dual voice ADCs provide for stereo recording from two microphones, or stereo recording from an analog source such as an FM radio module.

Two audio bus interfaces provide flexible audio architecture with either wideband or narrowband audio, or both, and support for dual processors. The i.MX31/MC13783 combination provides mixing, volume and balance control of voice, stereo audio and FM radio for increased flexibility and a richer user experience.

Figure 5 is a graph of the high-quality audio output generated using the i.MX31/MC13783 evaluation board. The graph shows the following:

- 0 dBFS @ 1.02 kHz stereo DAC digital input level
- Headset speaker single-ended amplifier load at 32Ω + 22uF
- Stereo DAC main clock at 13 MHz, sample rate of 44.1 kHz
- MC13783 SSI is master (master mode)
- A-weighted output spectrum

Digital and Analog

The i.MX31 is a mixed analog and digital audio system with multiple audio ports. When MC13783 and i.MX31 are combined, the analog and digital signals can be mixed. For example, one port could handle a narrowband signal and one could simultaneously handle a wideband signal. Analog mixing of the converted audio streams enables applications such as simultaneous voice conversation and MP3 playback. The mixed audio can be output to any output amplifier.

A battery-supplied loudspeaker amplifier with high power supply rejection ratio (PSRR) provides high output power, and can also be used as an earpiece amplifier with a single speaker. The MC13783 is prewired for stereo loudspeakers, for an easy upgrade to stereo loudspeaker applications. Stereo headset and line-out amplifiers are also provided.

Conclusion

With power management and small form factors emerging as critical factors in the coming generations of portable device design, it makes sense to use components that are highly power-aware and highly integrated. The combination of the MC13783 PMUI IC and the i.MX31 multimedia applications processor offers a host of power-saving techniques.

www.freescale.com

Low Power USB 2.0 PHY IP for High-Volume Consumer Applications

Built-in yield optimization supports advanced technology implementation

Extensive optimization for low power and size has resulted in a USB 2.0 PHY that can help design teams meet their overall goals in terms of lifetime cost, power, interoperability and development timescales.

By Gervais Fong, Product Marketing Manager, Synopsys Inc

The USB protocol has become a pervasive standard in the world of computing and consumer electronics. While few design teams would today contemplate designing their own USB intellectual property (IP), this semiconductor IP is far from commodity silicon. Synopsys introduces a second USB 2.0 PHY IP product line (titled DesignWare® USB 2.0 nanoPHY), which has been further optimized for low power, area, manufacturing cost and system performance targeted to mobile and high volume consumer applications. This offers designers a choice of highly-differentiated USB PHY cores for 0.13-micron processes and below.

With the proliferation of USB in mobile consumer devices, there are many key criteria that design teams look for when licensing IP, such as cost, system performance (interoperability), reliability, and power. Diligent technical evaluations have become a key part of the 'make versus buy' decision for all but the simplest IP cores.

The competitive dynamics of global consumer electronics markets are driving down costs and putting further pressure on the design cycle. Consequently, overall design productivity and total cost of IP ownership are also issues that must be considered. For example, while the avoidance of design re-spins is a familiar design goal within most projects, the problem of reliability, in terms of field failures, can have a profound influence on the total cost of ownership. Manufacturing yield is another factor that can have a significant effect on lifetime cost. Both of these issues are directly affected by the key specification parameters of the USB PHY. Lastly, interoperability is another requirement that is critically important to interface IP. The issue of interoperability goes beyond just satisfying the requirements for 'logo' certification. Interoperability is a function of the design's specification and operating margin, which in turn can impact device yield and the economics of manufacturing production.

With increasingly demanding specifications on power, driven by the need for longer operating life in portable devices, a low power design for the IP enables the overall SoC power budget to be maintained—a critical issue for battery-powered devices such as smart phones, MP3 players, digital cameras and flash drives. Within this context of an increasingly demanding set of business and technology drivers, Synopsys has introduced a second USB 2.0 PHY IP product line that is optimized for portable and high volume applications that require low power, small area, and high yield.

The new DesignWare USB 2.0 nanoPHY is based on and complements Synopsys' current market-leading USB 2.0 PHY that is certified in 180-nm, 130-nm and 90-nm CMOS digital logic processes. Chosen by leading semiconductor companies, ASSP manufacturers, and foundries, the current USB 2.0 PHY product line is in high volume production with over two dozen process port and configuration combinations. Synopsys' extensive experience in meeting rigorous quality and yield requirements with the original PHY has been applied to the development of a complementary PHY product line optimized for mobile and high-volume consumer applications. Specifically, the Synopsys DesignWare USB 2.0 nanoPHY is built on an innovative USB architecture, which has been designed to address the key issues of low power, cost and interoperability to take advantage of the latest, state-of-the-art process technologies such as 90-nm and 65-nm.

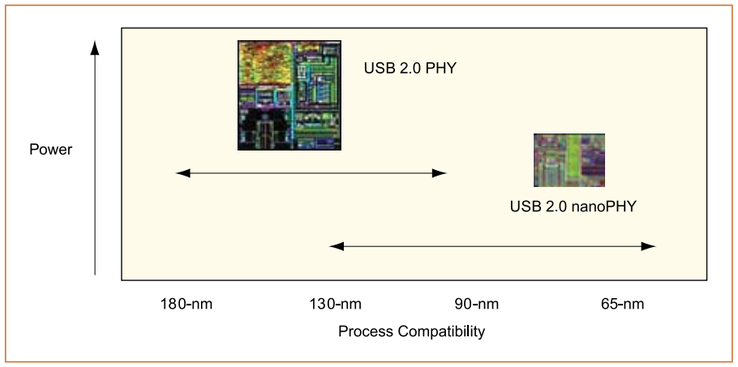

Figure 1. Synopsys USB 2.0 PHY and nanoPHY Comparative Power and Area.

USB 2.0 nanoPHY Optimizations for Area, Power, and Pincount

Current-generation USB 2.0 PHY IP designs are typically in the region of 1mm2 to 1.2mm2 in area. Depending on the specific foundry process, the new DesignWare USB 2.0 nanoPHY breaks this size barrier by approximately 50%. This significant area reduction has been achieved through a combination of architectural and implementation optimizations. For example, a redesigned PLL/DLL architecture has eliminated the need for complex clocking circuitry, which contributes significantly to the overall reduction in area. The PHY is floorplanned in such a way that as the digital block scales with the smaller process geometries, the overall macro area is allowed to shrink—this is not always the case with mixed-signal designs.

A holistic approach to low-power design has drastically cut the power requirements for the USB 2.0 nanoPHY core. Power has been reduced in both the digital and analog blocks of the PHY. The redesigned PLL/DLL, with optimized clocking scheme, has removed the need for a significant amount of high-frequency clocking circuitry. Active power consumption is further reduced through the use of a new transmit architecture, combined with an extensively optimized clocking scheme within the receive and transmit paths. Reducing the power demands of the PHY by up to 50% not only extends battery life but also may mean that a lower-cost power supply can be used. This is an important issue in portable, battery-operated products.

The low-power architecture has other benefits. By reducing the supply current requirement, the overall power consumption is lowered and enables the pin count to be minimized (by half) without sacrificing any functionality. The ultra-low pin count design is a major advantage in terms of enabling the use of lower-cost packaging. Alternatively, package pins can be made available for other signals. The need for fewer pins also reduces the cost of production test, as well as considerably easing SoC integration.

Yield Optimization

With the transition from 130-nm to the latest 90-nm (and below) process geometries, yield has assumed a much higher priority. With interface protocols such as USB, chip yield is linked to the performance of key specification parameters, such as PLL jitter performance and bandgap variation, as well as being dependent on chip area. A lower chip yield, even by as little as two or three per cent, can cause manufacturing cost increases which may overwhelm any savings that are achieved with a smaller die area. With this in mind, the DesignWare USB 2.0 nanoPHY includes several features that directly enhance yield through the optimization of key USB operating parameters.

First, the system design targets a high level of quality from the IP directly 'out of the box'. This concept is illustrated by the example eye diagrams (Figure 2), which demonstrate the superior margin that is achievable when using the DesignWare USB 2.0 PHY versus another competitive PHY.

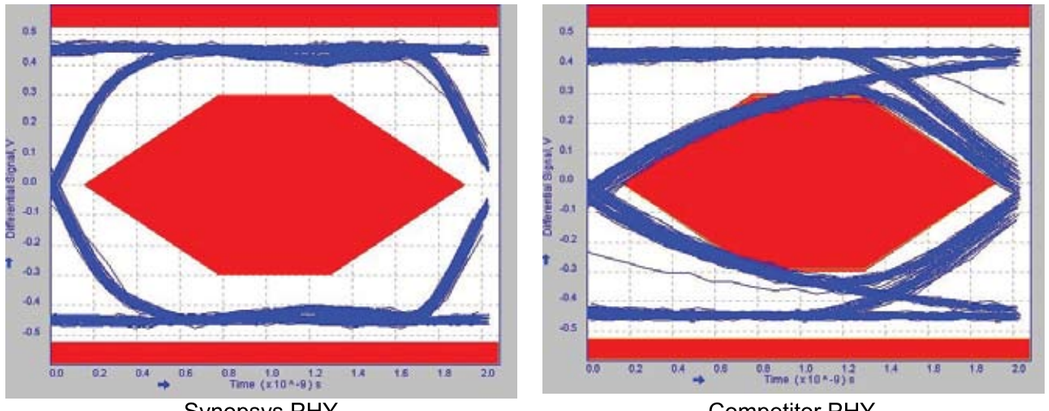

Figure 2. Example Synopsys USB 2.0 PHY Eye-Diagram Margin.

Requirement	nanoPHY Feature
Support latest process technologies	• 130-nm, 90-nm, 65-nm • Low-power and advanced process support • Multiple foundries
Small area	• Significantly smaller (~50%) • Scalable digital block • Optimized clocking circuitry based on new PLL/DLL architecture
Low power	• Significantly lower (~50%) • HS transmit architecture reduces peak HS current consumption • Optimized analog block reduces power • Optimized digital clocking strategy reduces digital power consumption
Low cost of ownership	• Reduced pin count ensuring simpler integration and packaging • Smaller power supply design due to reduced power consumption • Architecture, designed for yield providing excellent operating margins
Interoperability	• Excellent operating margins • System-level tuneability • Expertise in USB certification and achieving interoperability

Table 1. Synopsys USB 2.0 nanoPHY Feature Summary.

There are two key USB specification parameters which are particularly challenging to meet: the rise-fall time and crossover points in the Full-Speed and Low-Speed operating modes. The new transmit circuitry in the DesignWare USB 2.0 nanoPHY, provides superior operating margin, which enables very tight control over these key USB specifications. This new architecture reduces the variation of these specifications and ensures less sensitivity to process shifts.

The USB 2.0 specification dictates that the HS/FS/LS transmitter has a controlled source impedance of 45-ohms. Therefore, one of the important PHY design tasks is to create an accurate 45-ohm on-chip source impedance. Synopsys uses a very direct method for automatically tuning the source impedance that contributes to the overall design robustness and hence, optimized yield. This new approach to tuning utilizes a reduced amount of analog circuitry and is therefore, less sensitive to process variation, as well as offering improved accuracy.

Interoperability

Many of the measures that have been taken to improve yield are also beneficial to the interoperability of the PHY. Interoperability is a requirement at two levels—between the PHY and USB digital controllers, and with other USB products. Interoperability can be straightforward to achieve if all of the components in the system are operating under typical conditions. However, foundry processes vary from slow to fast corners, PCB designs may introduce electrical variations, and even USB cabling performance may vary considerably between manufacturers. The worst case scenario is that a PHY that worked perfectly in the lab suddenly develops interoperability issues, which show up as a field failure. Such cases can be disastrous for the success of the product and extremely costly to investigate and correct.

The key to achieving excellent interoperability, even at extreme corner case operating conditions, is to aim for excellent performance margins from the default design without any modifications. This is exactly what has been achieved with the Synopsys DesignWare USB 2.0 nanoPHY IP core.

However, to deal with real world situations, a number of parameters can be adjusted to allow for system-level tuning of the eye shape. For most situations the default setup will be adequate and the USB PHY will work 'out of the box'. Providing access to the key parameters which enable the eye shape to be customized ensures that the USB PHY can be set up to accommodate extreme system conditions and special cases due to process or packaging variation, without having to modify the board layout or re-spin the GDS. The key parameters can be tuned by making metal strapping changes outside the macro, without having to interfere with the internal layout.

Synopsys has an unsurpassed track record of high-speed USB and On-The-Go (OTG) logo certification and customer success at the 180-nm, 130-nm and 90-nm process nodes. The knowledge gained from all these experiences have been embedded into the design of the USB 2.0 nanoPHY. This combined with superior operating margins will help minimize the chip designer's verification effort required during development, as well as reducing the possibility of field failures. All of these factors contribute to a lower cost of ownership.

Summary

Despite USB being a ubiquitous standard, clearly not all USB PHY implementations are the same. The Synopsys DesignWare USB 2.0 nanoPHY core has been designed for the latest sub-micron, low-power process nodes to offer the lowest area, power and cost for mobile and high volume consumer applications. The DesignWare USB 2.0 nanoPHY builds on the success of Synopsys' current USB 2.0 PHY product, which has been licensed to leading semiconductor and ASSP customers accounting for tens of millions of production units. Considerable industry expertise in USB design and certification, combined with Synopsys' robust development methodology, ensures that the USB 2.0 nanoPHY is delivered with a consistently high level of quality. Together with extensive optimization for low power and area, this approach has resulted in a USB 2.0 PHY product line that can help design teams meet their overall goals in terms of lifetime cost, power, interoperability and development timescales – the critical success factors for complex SoC development.

www.synopsys.com/products/designware/usb_solutions.html

Optimized Power Factor Correction Utilizing Follower Boost mode

A solution to provide reduction of conduction losses with smaller inductor size and minimal switching losses

This article describes a circuit that can operate in 'traditional' mode but also in the so named 'Follower Boost' mode. A comparison between the two options follows in terms of performance and cost-effectiveness, including experimental results.

By Joël Turchi, ON Semiconductor

Traditionally, a PFC stage is actually a boost pre-regulator that outputs a constant dc voltage (390 or 400 V typically). Since the downstream converter that loads the PFC stage does not necessarily require a constant input voltage to properly operate, and providing the hold-up time specification is not too severe, why not to let the PFC stage output stabilize at a dc level that varies within a controlled range as a function of the load and line conditions, for example, between 200 and 400 V in a wide mains application?

That is the idea behind the 'Follower Boost' mode that makes the pre-converter output stabilize at a level that varies linearly versus the ac line amplitude. This technique aims at reducing the difference between the output and input voltages.

Such an option may appear strange until it is understood that the efficiency of boost converters increases when the difference between the output and input voltages diminishes.

Two equations highlight the benefits of this mode:

The formula that expresses the MOSFET duty-cycle: ($d = 1 - \frac{Vin}{Vout}$) that clearly shows that the MOSFET duty-cycle decreases when the output voltage is reduced. For instance, if the input voltage is 120 V, the duty-cycle is 70 % when Vout = 400 V and 40 % when Vout is 200 V.

In other words, the follower boost limits "d" and hence, the portion of the coil current that flows through the MOSFET. Consequently, this operation mode drastically reduces conduction losses.

The expression of the current ripple: $\frac{Vin}{L \cdot f} \cdot (1 - \frac{Vin}{Vout}) = \frac{Vin}{L \cdot f} \cdot d$ shows that the coil current ripple is proportional to the duty cycle and hence, the follower boost tends to decrease it. It can be seen immediately that the follower boost allows the use of a smaller inductor for the same specified ripple.

Given that in practice, the coil inductance is chosen high enough to limit the ac component of the current to an acceptable level, the Follower Boost mode lowers the size and the cost of the coil. Figure 5 portrays this benefit in a 300 W, wide mains application.

In addition, it is clear that a reduction of the output voltage leads to a diminution of the switching losses. This is the third benefit of this technique.

As can be seen from the data sheet, the following equation gives the maximum average power a NCP1653 driven PFC stage can provide to the load:

$$< Pin > \max = \frac{K}{Rcs2} \cdot \frac{Vac}{Vout} \quad (1)$$

where:

- K is a constant (refer to the data sheet for more details).
- Rcs2 is the pin5 resistor ("R3" of figure1)

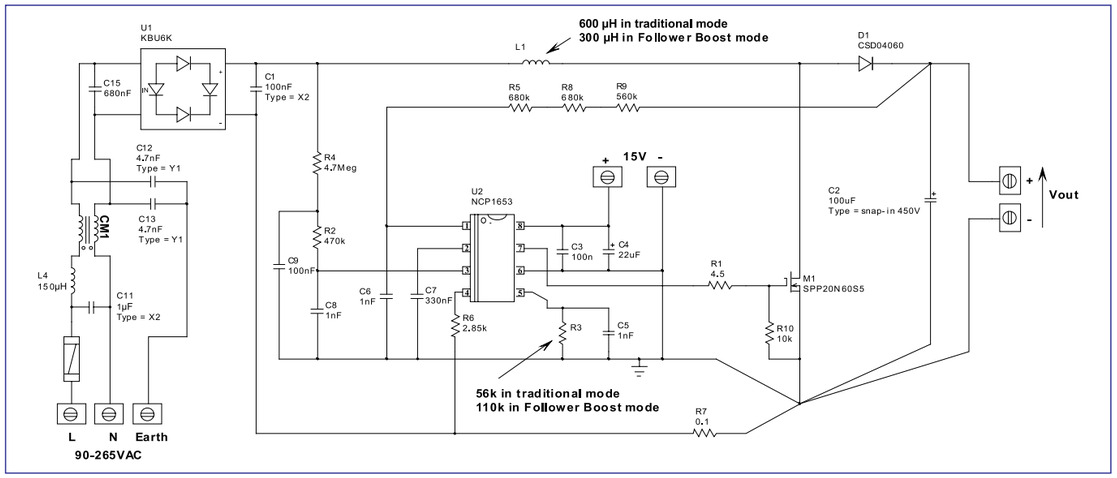

Figure 1: 300 W, wide mains, application SchematicTo force the follower boost mode, only the R3 resistor has to be modified. For sure, it makes sense to reduce the coil to take benefit of the follower boost…

- Vac is the rms line voltage
- Vout is the output voltage

K and Rcs2 being constants, equation 1 shows that the power capability depends on the output voltage level. For instance, suppose that K and Rcs2 are dimensioned so that the low line power capability is 150 W if Vout = 400 V, equation (1) shows that the PFC stage will be able to provide 300 W only if Vout drops to 200 V.

This is the follower boost principle: we dimension the NCP1653 external elements so that the PFC stage cannot provide the full power unless Vout stabilizes at a target voltage that is low compared to the regulation level.

More specifically, one can deduce that the power capability (see figure 2):

- Is inversely dependent of the output voltage and hence maximum at the lowest Vout level (Vout=VoutLL).
- Is proportional to the line magnitude and then, minimum at low line (Vac=VacLL)

Hence, one must calculate Rcs2 so that the PFC stage can supply the full power at low line and at the minimum output voltage required.

Finally, Rcs2 must be selected so that if Pmax is the targeted power capability:

$$Rcs2 = \frac{K}{P\max} \cdot \frac{VacLL}{VoutLL} \quad (2)$$

Combination of equations (1) and (2) leads to:

- $Vout = Vac \cdot \frac{P\max}{P} \cdot \frac{VoutLL}{VacLL}$, where P is the power, as long as the output voltage is below the output regulation level (VoutHL)
- *Vout* = *VoutHL*, when the system tends to force Vout to be higher than its regulation level (the regulation block clamps the follower boost characteristic).

This is the follower boost characteristic also portrayed by figure 3.

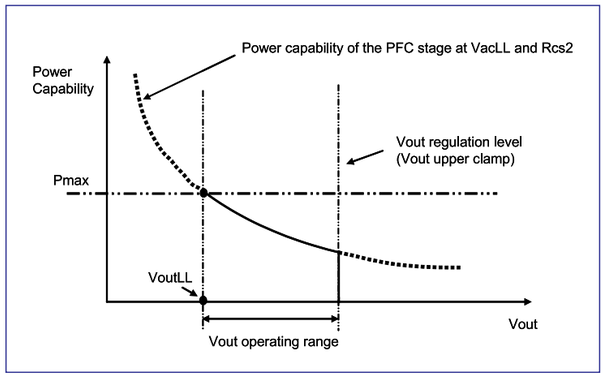

Figure 2: Power capability of the PFC stage as a function of the output voltage level.

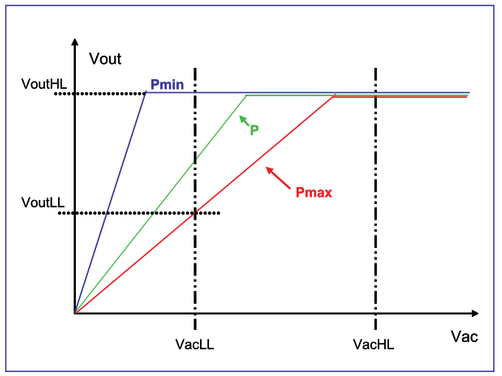

Figure 3: Follower boost Characteristic.

Vac=110V	Follower Boost			Traditional Mode		
Pin (W)	Vout (V)	eff (%)	THD (%)	Vout (V)	eff (%)	THD (%)
86	384	89	11	385	91	10
164	378	92	6	380	92	7
288	337	94	4	374	93	4
330	282	94	6	370	93	4

Vac=220V	Follower Boost			Traditional Mode		
Pin (W)	Vout (V)	eff (%)	THD (%)	Vout (V)	eff (%)	THD (%)
82	386	94	19	387	92	14
123	385	94	16	387	95	11
163	384	94	14	386	93	9
220	382	95	11	386	95	8
310	371	96	9	385	95	9

Figure 4: Performance Comparison between Follower Boost and traditional mode.

Experimental results

A performance comparison has been performed between the Follower Boost and traditional modes using the application of figure 1 (300 W, wide mains). The measurements were made on the same boards. Simply as noted in figure 1, the coil and R3 were changed as a function of the tested mode.

As shown by figure 4, the Follower boost mode improves efficiency without significantly degrading the THD. In addition, as shown by the following figure, the coil size is dramatically reduced. If required, the coil could also be made a bit less "squeezed" in order to minimize its losses and further improve efficiency.

Implementation

The design is straightforward:

- Download the NCP1653 design worksheet available at http://www.onsemi.com/pub/Collateral/NCP1653%20WORKSHEET..XLS

- For operation in tradition mode: enter the regulation level required ("Vout") and enter the same value in the "VoutLL" cell and the Excel spreadsheet returns the maximum Rcs2 value needed

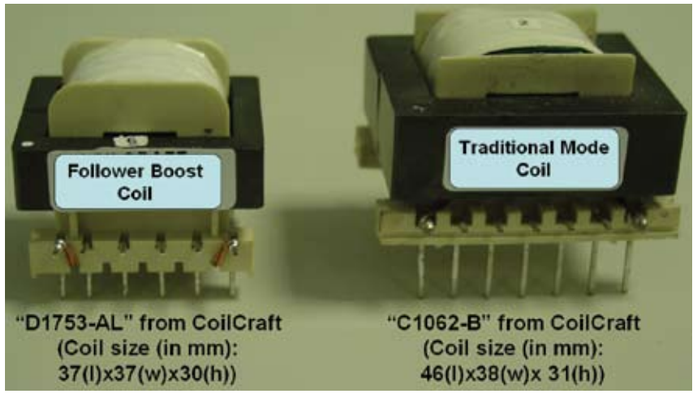

Figure 5: COILCRAFT coils used for the comparison.

- To implement the follower boost: select the minimum acceptable output voltage in your application and fill "VoutLL" accordingly. For instance, enter 200 V and the Excel spreadsheet will give the Rcs2 value to implement.

- In both cases, the Excel spreadsheet also computes coil inductance and other key dimensioning elements.

The NCP1653 can operate in traditional mode. However, in applications where some variations of the output voltage are acceptable, it features the follower boost mode (FB) that improves the efficiency and dramatically reduces both the size and cost of the coil. The output voltage range is programmable: according to requirements and selection of a wide or narrow spread available.

The NCP1653 worksheet (available on the web) automatically computes the value of the single resistor that adjusts the target FB characteristic.

http://www.onsemi.com/pub/CollateralNCP1653%20WORKSHEET..XLS

Wi-LEM Wireless Local Energy Meter for Plug & Save

Energy costs and environmental issues becoming dominant

Sub-metering is an extremely powerful tool and LEM, a specialist in the measurement of electrical parameters, introduces a new generation of wireless sub-metering devices to dramatically reduce total cost of ownership.

By Loïc Moreau, Corporate Manager, MacroComponents, LEM SA

It is now obvious and recognised by the majority of the worldwide experts that cheap energy will no longer be a reality. Indeed, increasing fossil energy price, new legislation and taxes to reduce the CO_2 emission or liberalisation of the electricity and gas industries are cumulated factors to confirm this long term trend. What can be done? This question had already been asked 30 years ago after the first "oil shock" and the answer was pragmatic: the best energy is the energy that we don't consume. This is why the concept of energy efficiency is currently making a strong come back in the last 5 years. Indeed, the European Commission has launched several directives since the end of 90's which follow that direction (e.g. "Energy Labelling", "Energy Performance of Buildings"). However, the most recent one, European Directive 2006/32/EC, signed in April 2006, is the most explicit because the goal is clearly stated "to promote the development of a sustainable market for energy efficiency and energy services". Within this directive we find multiple initiatives to force utility companies to help their customers reduce their consumption by improving visibility and providing advice. "Improving visibility" is probably the key point as this makes the user responsible and introduces a real behaviour change. The most appropriate method is to measure and display the energy consumption, which is exactly what sub-metering does.

Electrical Sub-metering: a powerful tool!

Electrical sub-metering provides powerful information about how, where, and when electrical energy is used. This enables energy managers to make important decisions that will save electrical energy and improve efficiency. Electrical sub-metering can be used effectively by a wide variety of energy users:

- Managers of office buildings and other commercial property can use sub-metering to more accurately allocate both electrical energy and rebill costs to tenants.
- Manufacturing companies and other industrials can use sub-metering to assign energy costs to individual departments or product lines, thereby identifying energy as a true product cost that can be managed and optimized.

There are compelling reasons to install electrical sub-metering, a couple of which are discussed below:

1. Identify performance problems in processes and equipment

Sub-metering can help identify sources of energy loss, including:

- plugged heat exchanger coils in chiller plants;
- clogged inlet filters on air compressors;
- wearing of (or loss of) lubricant motors, load bearings, or gear boxes; and
- control failures that cause equipment to run continuously or at inappropriate times.

2. Determine equipment and system efficiency

Is the energy efficiency of installed office or manufacturing equipment acceptable? If electrical sub-meters are positioned strategically on circuits that feed key pieces of equipment, energy managers can develop powerful energy metrics (statistics or benchmark values) for evaluating the performance of installed equipment.

3. Audit before and after energy use for projects intended to improve efficiency

Energy efficiency projects are often not viewed as central to a company's business. Sub-metering can supply two

types of supporting evidence to help justify these projects:

- Before a project: to gather measured data that quantifies the energy savings opportunities.
- After a project: to gather measured data that verifies the expected rate of savings.

4. Discover opportunities for potential energy efficiency improvements

Sub-metering can help pinpoint energy savings opportunities by answering two questions:

- Who is using the most energy, and how are they using it? Information gathered from electrical sub-meters can allow an energy manager to focus on the biggest savings opportunities in each building or process area.
- Energy savings compared to what? An ongoing benefit of electrical sub-metering is sound, detailed documentation of a building's or facility's historical energy use patterns. Having a solid database of previous energy use can increase confidence in projections of energy savings.

5. Allocate energy costs to specific departments or processes

Some common methods of estimating energy allocation (based on square meters of floor space, number of workers or occupants, or the capacity of the electrical supply circuits) have the disadvantage of spreading energy savings from one area throughout an entire facility and thereby provide no incentive for departments within a facility to reduce their own energy use. A sub-metering system provides data that can be used to analyze and allocate energy cost information.

6. Assign accountability for energy users

Simply making energy efficiency a factor considered in managers annual performance evaluations can shave several percentage points from a company's overall energy expenditure. One way to compare the relative energy efficiency performance of departments is to analyze energy use per unit manufactured or per tenant occupant.

7. Verify the accuracy of utility bills

Few bills are taken on faith as much as electric power bills. Given the many thousands of Euros paid for energy every year by the owners and operators of most buildings and facilities, identifying even small accounting errors can quickly recoup sub-metering costs.

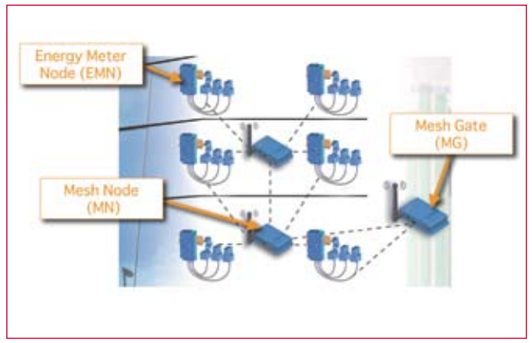

Figure 1: Wi-LEM (Wireless Local Energy Meter).

Limitation of the existing sub-metering offering

Even if the majority of energy and facility managers recognise the benefits of sub-metering, the key barrier to implementation is the cost. This can be divided in two parts: the hardware and the installation and commissioning costs. Regarding hardware cost, the actual product offering is a modular approach based on a current transformer with 5A standard output and a wide range of energy sub-meters (e.g. pulses or buses output, local display, active and reactive energy, panel or DIN mounting...). The actual product choice gives good flexibility but when the number of measuring points becomes important this model is less adaptable. Firstly manufacturers have to make money and add their own margin on each component. Secondly, in this case the remote reading functionality is almost mandatory because a daily manual reading of each sub-meter would not be relevant and quite expensive. Usually to reduce the hardware cost, the system integrator uses a low cost pulse output energy sub-meter associated to a pulse/bus converter (frequently RS 485 Modbus) to build a distributed network. This type of converter usually has input multiples of 4 (4, 8, 16…) which means that the end user has to pay more when the number of sub-meters varies. Additionally it sometimes needs an auxiliary 24 VDC power supply. Therefore, the installer has a significant number of components to install inside an existing cabinet where available space is frequently limited and this then often requires an additional auxiliary cabinet, increasing hardware and installation costs.

The second and major part of the project cost is network installation and commissioning. To achieve accurate energy monitoring the most effective method is to position electrical sub-meters as close as possible to the end use of the energy – ie: per floor, per group of usage (HVAC, lighting, compressors) or per department, or basically almost everywhere throughout the building. Based on the existing wired solution, this also means longer installation time and greater cost and often significant disturbances for workers, such as wall drilling. Particularly relevant for facilities with customers. In most countries the building will be used all week which means that installation is restricted to nighttime or the weekend which thus increases labour costs even more.

Wi-LEM: a new generation of sub-meters

Wi-LEM (Wireless Local Energy Meter) is a real innovation in the world of electrical sub-metering and has been designed to respond to the emerging requirements of the energy efficiency and energy service market. It comprises of a constellation of several components as shown in Fig.1. The platform consists of several elements: Energy Meter Nodes (EMN), Mesh Gate (MG) and Mesh Nodes (MN).

Energy Meter Node (EMN)

This is the sensing component used to measure various parameters. By measuring (see Table 1) active and reactive energy, maximum current and minimum voltage amongst other parameters the EMN provides much more information than a traditional sub-meter.

Measurement is done within a time interval programmable from 5 to 30 minutes. In order to reduce hardware cost

Measurement Values (e.g. 3 phases):

	Configurable Reading Interval (5 to 30 minutes)													
	Interval Based Values										Cummulated Values			
	L1			L2			L3			SUM	L1	L2	L3	SUM
	Av	Min	Max	Av	Min	Max	Av	Min	Max					
Current (A)			■			■			■					
Voltage (V)		■			■			■						
Active Energy (kWh)*	■			■			■			■	■	■	■	■
Reactive Energy (kVarh)	■			■			■			■	■	■	■	■
Apparent Energy (kVA)	■			■			■			■	■	■	■	■
Frequency										■				

* Accuracy (IEC 62053): Active Energy Class 1

Table 1: Measurement Values (3 phases).

Less components to install	Saves space and time
Wiring simplified	Saves time & reduces risk of error
Compact size	Saves space, no need for an auxiliary cabinet
Wireless output	Installation anywhere in the cabinet = flexible
EMN calibrated at factory	Accuracy of the entire acquisition chain guaranteed
Less references to manage	Simplified order process (one supplier)

Figure 2: Inside the cabinet Benefits.

and simplify installation, the EMN uses a pre-wired split core current transformer. As calibration is done at the factory, the accuracy of the complete acquisition chain is guaranteed and conforms to IEC 62053 Active Energy Class 1 and Reactive Energy Class 3. To achieve the equivalent level of accuracy with a traditional current transformer and sub-meter the developer would need to use a class 0.5 accuracy which represents higher cost devices, especially for split core current transformers.

A variety of EMNs are available for 120 and 240 VAC voltage according to the power network configuration (Star or Delta), a frequency of 50/60 Hz and configured for nominal currents from 5 to 100A.

During the design phase, the emphasis for LEM's project team was the key requirement "fast and easy to install". The resulting EMN has several features reflecting this. The most obvious is the split core current transformer which enables installation without the need to disconnect the primary cable. It offers two alternative methods of installation: DIN rail or panel mounting. Because the main application target for Wi-LEM is building retro-fit, the limited space available inside existing cabinets was also a challenge. (Fig. 2 Inside the cabinet: Benefits) To solve this issue LEM designed the EMN in a compact size. Additionally, the wireless output provides greater flexibility because it can be installed anywhere inside the cabinet with much less constraints than for a wired solution.

In conclusion, combining a split core current transformer with the sub-meter and integrating a wireless communication output, optimizes hardware and installation cost for the installer and system integrator.

The Mesh Gate (MG)

This is the second part of the platform. It is a stand-alone gateway that manages the wireless network in total transparency for the user. The MG is always aware of the network configuration, i.e: which EMNs are connected and what is the best route to transmit the data. The wireless network is a mesh configuration, based upon the 802.15.4 ZigBee-standard, which has proven robustness in industrial and commercial environments. It can manage up to 240 EMNs and stores the latest data transmitted that the PC software can request by using a MODBUS RTU protocol through a serial interface RS 232 or RS 485.

The Mesh Node (MN)

This is the last part of the platform - a simple repeater which extends the range of the network by acting as an intermediate point and can be added to the network without any need for additional configuration or programming. Communication distance between EMN and MG is traditionally limited to typically 25 metres line of sight, however, by using a MN it means that whatever the topology of the site, the Wi-LEM can always be deployed which is not the case for point-to-point networks. Also, because the number of MNs is not limited, redundancy is possible which brings flexibility and robustness to the network, particularly relevant for critical applications.

Conclusion

The long-term energy price increase must be seen as an opportunity to reduce overall consumption. By designing the Wi-LEM and lowering the total cost of ownership of an electrical sub-metering network, LEM is clearly a pioneer with a strong desire to help development of the energy efficiency and energy service market.

www.lem.com

Portable Digital Video Interface Design Challenges and Solutions

Current Transfer Logic Reduces Power Consumption & EMI

High quality display requirements in cell phones and other handheld devices with high throughput digital signals, together with EMI and power consumption constraints become increasingly challenging for the designer.

By Jeff Ju, Asia Pacific Technical Marketing Manager, Signal Path Analog Group, Fairchild Semiconductor

In most cell phone designs, the interface between baseband processor and LCD module uses TTL technology with signal swing from 1.8V to 2.8V range. These TTL signals have a relatively slow edge to minimize the EMI emission. Additional EMI filters are added to even further reduce the EMI emission at harmonics (3rd or 5th) of base frequency of TTL signals. For example, for 4Mbps data transfer, its 3rd and 5th harmonics are at 6MHz and 10MHz.

To meet the high quality display needs of future 3G cell phone designs in such small panel applications, the data bus width of the cell phone design migrates from legacy 8-bit to 16-bit or even 18-bit mode. Significantly increased connector/cable numbers and expensive EMI filters contribute to the higher BOM while EMI emission becomes even worse due to the potential of simultaneous switching of all 18-bit parallel TTL data at the same time.

The trade-off between EMI and power consumption surges presents another design challenge. Slow TTL signal edge helps EMI emission reduction but the same time can worsen the leakage current while the address/data bus switching.

This becomes a dilemma in the design since most designs are expected to have very slow edges since the FPC cable length in most portable design is about 100mm. In addition to EMI benefit, the slow edge of TTL signals helps avoid bit error rate due to the signal reflection during the transitions of logic '0's and '1's.

At the same time, the slow edge limits how fast the signal can switch and consequently the data throughput, which is not suitable for future high resolution display applications.

Fortunately with the industry moving from parallel TTL I/Os to serial LVDS or TMDS interfaces multiplexed by high

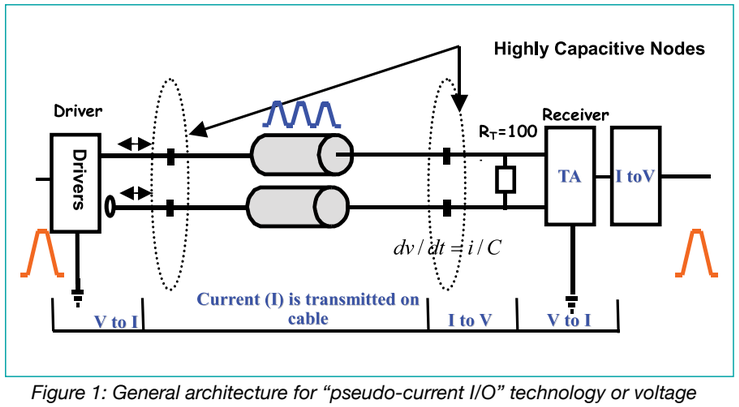

Figure 1: General architecture for "pseudo-current I/O" technology or voltage sense based receiver.

Technology	EMI	Power (Static & Dynamic)	Cable Distance Of Driving capability	Application Implication	Penalty
$V_O\_V_I$	High	High	Short	EMI filter needed	Cost goes up with passive components and increased the PCB board area
$I_O\_V_I$	Medium	Medium/High	Medium/Long	Due to Fast edge rate, encoding scheme is needed for high throughput	Additional latency is inserted into data path due to encoding
$I_O\_I_I\_D$	Ultra Low	Ultra Low	Long	None	None
$I_O\_I_I\_S$	Ultra Low	Ultra Low	Short	Suffer from external noise and no common-mode noise rejection capability	Need to shield the cable media very carefully with increased BOM cost

Table 1: Comparison between purely voltage based I/O technology, pseudo-current I/O technology and CTL technology

speed PLL circuits, this concept benefits consumer applications such as large screen LCD/Plasma TVs with significant cable reduction and AC performance improvement. Naturally, this serialization concept also migrates into portable and handheld video transmission applications with panel sizes smaller than 5 inches. By serialization, cell phone designers can significantly reduce the design cycles and reduce the BOM with much less time spent in EMI emission debugging.

But one of the key technical hurdles that emerge, is the choice of serial interface technology for such applications. TTL technology clearly cannot be considered as a viable candidate.

How about the serial interface used in consumer or PC applications such as Low Voltage Differential Signaling technology (LVDS) or Transition Minimized Differential Signaling (TMDS) technology? Although this technology has superior EMI performance with encoding scheme, it consumes higher power than battery-based portable devices can tolerate. For example, LVDS consumes at least 3.5mA per channel while TMDS consumes at least 8mA per channel. For LVDS and TMDS, we can categorize these technologies as “pseudo-current I/O” interfaces since they are not truly current-based interfaces. Their drivers source the current but the receivers sense the differential input voltages converted by 100 ohm termination resistors at receiver sides.

Let’s have a close look for the limitation of the LVDS and TMDS signaling technology. Figure 1 is a general architecture for “pseudo-current I/O” technology or any voltage sense based receiver.

The driver sources the current in the loop, which is converted to voltage by the termination resistors (to match 100 ohm differential impedance of the media). The input of the receiver is highly capacitive mainly due to cable capacitance, ESD diode parasitic capacitance, stub capacitance and the receiver input capacitance.

This capacitance effectively limits the slew rate of the signals due to the fact of dv/dt=i/C. Consequently this highly capacitive node needs to consume more current or power to switch faster with enough slew rates, which is not an ideal solution for portable applications. Power consumption and EMI emission are both critical in such applications. Faster slew rate means potentially higher EMI emissions particularly for applications with differential signal traces not closely coupled.

So far, the limitation of LVDS and TMDS technology is clearly defined. Let us look at receiver side again in Figure 1. If we can change the receiver from a voltage-sensed receiver to a current-sensed receiver, all slew rate and throughput issues are eliminated while at the same time, the power consumption is even lower. This change eliminates the trans-conductance amplifier in the receiver for the “pseudo-current” I/O technology, which would not only reduce the propagation delay, but would also greatly reduce the effect of parasitic capacitance on the channel bandwidth.

This concept forms the foundation for Current Transfer Logic (CTL™). By sourcing (1mA) from either plus or minus outputs and getting 0.5mA back to driver minus or plus pins, 0.5mA current will be absorbed into the receiver plus and minus pins to detect the logic ‘1’s and ‘0’s. CTL is a truly current transfer technology, which is fundamentally different from LVDS and TMDS technology. This technology features much lower power consumption with 1mA only per channel, which saves 70% power versus traditional LVDS technology, which is significant for portable applications. Since the signal swing of CTL technology is so tiny (about 65mV), it uses much slower slew rate to achieve the same throughput as LVDS technology.

Slower slew rate means less EMI emissions. In addition, the CTL driver output common-mode voltage is set by its receiver companion. With such a scheme, it eliminates the need for common-mode feedback circuitry usually used in traditional LVDS technology, which further reduces the power consumption.

Table 1 is a quick comparison between purely voltage based I/O technology, pseudo-current I/O technology and CTL technology. “$V_o\_V_I$” means TTL drivers have voltage output and receivers sense the voltage input. “$I_o\_V_I$” means technology such as LVDS/TMDS with drivers having current output property and receivers still sensing the voltage input. “$I_O\_I_I\_D$” means CTL technology. “$I_O\_I_I\_S$” means some competition technology in the market with single-ended current sense scheme.

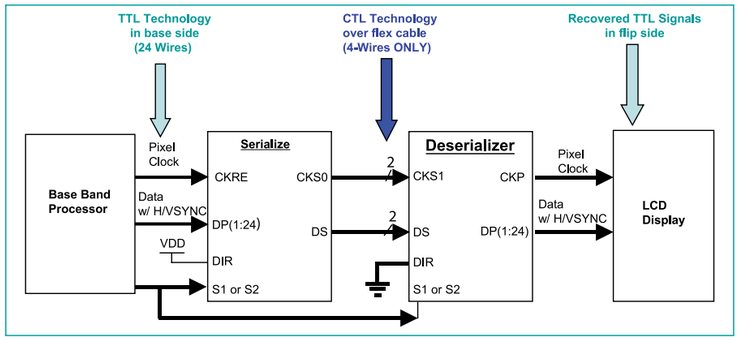

Figure 2: CTL™ Technology implemented in uSerDes™ chipsets used in Cell Phone LCD panel “WRITE” Applications.

From the comparison above, CTL technology is clearly the best interface choice for portable high speed video transmission. An important feature of CTL is that this technology still maintains the differential signaling property to be immune from system noise. A test has been done on a CTL to TTL translator, where an RF signal generator with a near field antenna injects coupling interference to the running 500Mbps CTL data stream. The interference signal here used is up to 2.1GHz. TTL output of the translator has negligible perturbation under such stressing.

Figure 2 is an application examples of CTL technology used in Fairchild uSerDes™ family products in cell phone applications to WRITE the RGB/YPbPr data to a LCD display in flip side with serial rate up to 520Mbps across FPC cable or uCoax.

By serialization, 16/18-bit display data and control signals (TTL) are transmitted through FPC cables or uCoax with only 4-wires needed, which significantly reduces the BOM. Due to its insensitivity to the capacitive load, Current Transfer Logic (CTL) technology can easily transmit the high resolution display data from baseband processor to LCD modules. Due to its ultra low EMI emission (<-76dbm at fundamental frequency), there is no need to add an EMI filter on the line, which further lowers the BOM.

With the proliferation of integrated functions in next generation cell phone design such as portable media players and high resolution camera sensors, designers spend much more time in the optimization of the high-throughput digital video transmission to balance between EMI and the bit error rate. The truly current sense based interface such as CTL offers end customers a much easier way to significantly reduce time to market while offering superior EMI performance and dramatically lowering power consumption, critical for portable applications.

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Designing From AC to IC

Component advances place new demands on power supply designs

Smaller and faster devices require extremely low voltages and high currents which place new demands on the designers of power supplies necessitating new solutions.

By Rob Hill, Vice President of Global Product Development, C&D Technologies Limited

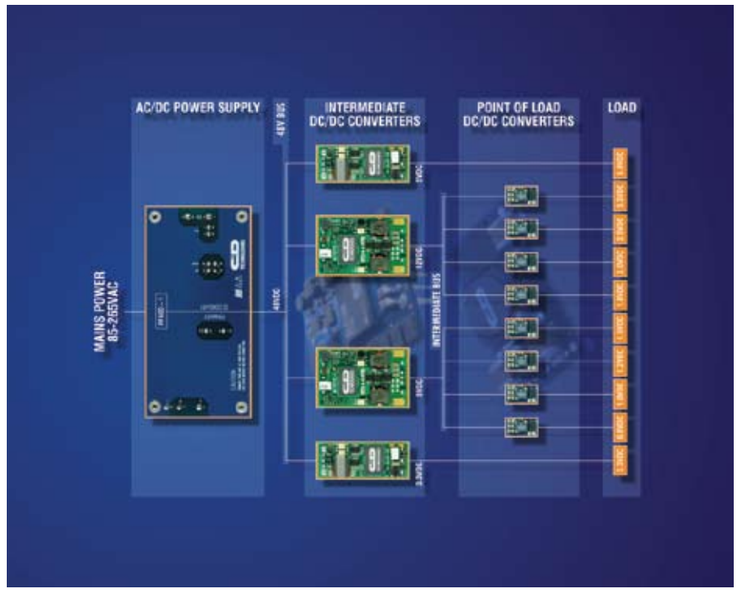
Integrated Circuit (IC) manufacturers are developing smaller and faster devices that require extremely low voltages and high currents. These advances place new demands on the designers of power supplies – demands that are ever more technically challenging and necessitate different solutions to those that have been delivered in the past. Fast, low voltage, high current ICs, for example, demand a power feed that is highly regulated and has excellent transient response performance. The inevitable demand for downsizing, from equipment manufacturers and the end market, place further pressures on the system designer. As a result, it is more important than ever to carefully consider every element of the equipment power architecture - from the initial AC input to power delivery at IC level – and take into account the latest trends, technologies and expectations for power supplies.

Managing power from the outside world

The furthest point from the IC is the AC input, and AC/DC power supply requirements for individual applications differ greatly. In the past there has been a tendency to place most emphasis on board level power design and leave AC/DC implementation until later in the development cycle, when the best-fit power supply from a wide range of standard products has usually been selected. However, choosing a standard power supply is not always ideal, and may require designers to make compromises or alter their product design - a step that can increase component count, cost, and time-to-market. An alternative is to have a fully custom power supply designed and manufactured. However, unless production volumes are high, this option can prove expensive. There is also a significant time element to be considered to cover the initial design phase, construction and testing of prototypes, plus tooling and manufacture of production ready units.

More recently, a third alternative has become available in the form of modular power supplies. Both custom and standard modular designs combine the major benefits of standard power supplies - fast time to market, industry standard form factors, and proven reliability - with the flexibility and application specific attributes of a custom product. A further benefit is that mid-design cycle changes can be made quickly and cost effectively, helping to get products to market on time and on budget.

In addition to rapid production turnaround, many modular power supplies are able to further reduce time-to-market through their conformity with standards for power factor correction plus CE and UL approvals.



Distributed power architectures

Isolated DC/DC converters are used in modern high-density distributed power architectures (DPAs) to convert the voltage rails provided by the AC/DC power supply to the lower voltages needed to drive board level circuitry. For this, most designers choose packaged DC/DC converters.

Standard isolated DC/DC converters are available in either SMT or through-hole versions, with industry standard half brick, quarter brick and eighth brick form factors making it easy for designers to allocate board space before committing to specific modules from specific manufacturers. In addition, innovations such as Position Perfect™ pin technology, developed by C&D Technologies, improve the ease and accuracy of assembly of the DC/DC converter module onto the PCB. This system eliminates the possibility of movement during assembly and assures co-planarity.

Despite shrinking sizes and higher levels of integration, many DC/DC modules will operate continuously at high temperatures without the need for heatsinking or forced-air cooling. Furthermore, in applications where higher-powered DC/DC converters are used and thermal management is required, it is often possible to utilize existing fans to cool the modules. Additionally, some of the latest thermal management materials such as gap fillers may allow the converter to be coupled to a frame or chassis rather than having to incorporate costly, space consuming, dedicated heatsinks. In many cases designers may also have a choice of either open-frame or encapsulated designs. Open-frame modules have a thermal advantage, as air – either forced or convected - is able to circulate freely between components to help dissipate heat. Although encapsulated versions may run hotter, the fact that they are totally enclosed can provide a higher degree of immunity from electromagnetic interference (EMI). Again, the designer needs to make a choice based on the specific requirements of the application.

Amongst the additional functionality incorporated in the latest DC/DC converters are output trimming and remote output sensing. Many devices can also be switched on and off remotely using either positive or negative logic signals. Thermal shutdown and protection against output over-voltage and over-current conditions are also often standard features.

Importantly for low voltage, high current designs, manufacturers of DC/DC converters can now achieve high efficiency levels. For example, the C&D Technologies SLC100 achieves 91% efficiency. These standard open-frame quarter brick converters can deliver up to 40A at voltages as low as 1.0VDC and are designed to meet the low voltages demanded by modern high-speed logic and memory. They are ideally suited to driving Point-of-Load (PoL) converters.

Point-of load converters

In addition to traditional DPAs, there is a trend in a growing number of telecommunications, industrial, and data communications systems, to multiple stage power conversion processes based around an intermediate bus voltage of 5.0V, 12.0V, or, in some cases, 8.0V. These Intermediate Bus Architectures (IBAs) are helping to fuel the market for non-isolated point of load (PoL) DC/DC-converters.

PoL converters supply the high-accuracy voltages and high currents required by the latest FPGAs, ASICs, DSPs, and microprocessors. Despite the accuracy of their outputs they can usually accept a wide voltage range at their input. A key characteristic of PoL converters is their very high levels of efficiency. Such efficiency is essential to minimise the losses that multiple staged conversion creates. One other advantage of the PoL is that these devices also typically offer small surface mount or SIP form factors, giving designers significant circuit design flexibility and allowing the converter to be placed as close to the load as possible. This is important for the following reasons. Firstly, it minimises track resistance, reducing copper losses in the pcb, secondly lowering power line inductance, which can induce voltage transients that interfere with the response to the load, and, finally, it ensures that the load transient response demanded by modern high-performance FPGA's, ASIC's, DSP's and microprocessors are met.

In summary, the sensitive devices being supplied by PoL modules are

afforded a high degree of protection by the built-in functionality provided. Protection includes continuous short circuit, output over-current and over-temperature protection. The C&D Technologies NNL series is an example of PoL converters targeted at Intermediate Bus Architectures (IBAs). Designed for use with nominal 3.0V – 5.5V and 10.8V – 13.2V IBAs, the NNL05S series deliver high precision output voltages and a maximum 5.0A output current.

In any distributed power system it may be desirable to include power line filtering to reduce ripple and meet regional EMC standards. Traditionally capacitive elements will have an effect, however both capacitive and inductive elements will significantly reduce both input and output ripple and noise for each stage in a distributed power system.

A word on standards and MTTF

When selecting power supply modules, compliance with industry standards is a pre-requisite, regardless of whether considering AC/DC input modules, isolated DC/DC converters, or PoL devices. In addition to the obligatory CE mark for European designs, there are various EN and UL standards for specifications such as safety, power factor correction and EMI levels. Designers should always ensure that the products chosen meet all the appropriate standards, that they are fully aware of what each standard covers, and how the standard relates to their own specific design.

As well as formal standards, widely acknowledged and adopted standards such as those relating to the module form factor and pin-out must also be taken into account. Adherence to such 'de facto' standards allows designers to allocate space within their equipment prior to module selection, as well as allowing interchangeability between products from different suppliers as design requirements change and products evolve.

One final point to consider when specifying power supply modules is mean time to failure (MTTF). The need for long operating life is essential to high availability applications and is desirable in most other applications. Fortunately, designers can now expect many DC/DC modules to be specified with an impressive MTTF of one million hours or more. However, as manufacturers use different methods to calculate MTTF, it is vital that the designer satisfies his- or herself that they understand how the datasheet figure has been attained.

www.cdtechno.com

Intelligence Overcomes Power Struggles

No two applications are identical

A programmable system like iMP offers around 200 million options based on the same hardware, configurable via PC-based software to suit any design scenario

By Stuart Lester, Power Solutions Director, UR Group Ltd

The last year has seen a great deal of discussion about the benefits and dangers of applying 'intelligence' in power systems. As well as the talk, there have also been some significant actions, as manufacturers and power system designers have extended the concept of distributed power and intermediate bus architectures. It is now not uncommon to find sophisticated digital controllers embedded within products: and digital communication between modules within power systems, via I^2C or PMbus, is a routine occurrence.

Thus far these developments have been concentrated mostly in the realm of DC/DC architectures. But now there are signs that the trend is moving into the AC/DC world. Astec Power recently launched the industry's first digitally-controlled switching AC/DC power supply, dubbed the iMP range, demonstrated for the first time at Electronica (Munich, 14-17 November).

But why would anyone want an intelligent power supply? The first reason is the relative ease with which engineers can produce a configuration that will satisfy application-specific requirements. Power supply designers are familiar with the adage that no two applications are identical, and a programmable system like iMP offers around 200 million options based on the same hardware, configurable via PC-based software.

The second reason is also related to speed. The intelligent power supply accelerates not only the 'design' part of the process – defining the required configuration – but also the 'production' phase. At UR Group's facility in Swindon, UK, the company is using the concept to offer customers turnaround times as short as 48 and 24 hours.

Whilst historically the major use for such a service would be for short-run and prototyping purposes, there are now a substantial number of manufacturers who can neither forecast their unit requirements, nor tolerate standard production lead-times: in particular the four-, eight- or even 12-week delays typical for large-scale offshore manufacturing.

The classic user of UR's quick-turnaround offering is an industrial OEM who knows that it will require hundreds of units per year, but who cannot predict more than a few weeks ahead whether its need in any monthly period will be for – say – 10 or 50 supplies. Such unstable demand is becoming increasingly commonplace in many sectors. For example, UR's customers include manufacturers of analytical medical devices; communications test and measurement kit; semiconductor equipment; outdoor signage; and inspection or materials analysis instruments.

The first step in using the service is for the customer to provide UR a summary of the requirement – usually in terms of what voltages need to be supplied, power levels, and any special constraints such as size or over-voltage protection. This allows the company to come up with a hardware specification: the relevant base equipment can then be delivered to the customer.

At this point the strength of the programmable approach shows itself. The customer can use a PC-based configuration utility to work on the finer points of the design, adjusting parameters such as current limits, and introducing special tolerance values or extended voltage ranges. The system lends itself to an iterative approach – for instance, the designer can experiment with lower fan speeds to improve noise performance, whilst monitoring the impact of changes on the operating temperature of the working assembly.

Once the design is fixed, the configuration data is passed back to UR, which issues a corresponding part number. Future orders are built, programmed and tested at the Swindon facility as required.

The advantages of intelligent AC/DC supplies don't, however, end with fast turnaround time. Building to RoHS and WEEE standards becomes much easier when the system is based on a relatively small number of hardware components, supplied by a global manufacturer that, like Astec, is itself compliant.

The supplier's role in ensuring RoHS compliance is well-understood, but

traditionally, other type approvals have been more troublesome. Building with compliant components does not necessarily make a compliant system, and so equipment such as medical devices have in the past needed to go through a lengthy testing and approval process. Suppliers such as UR, therefore, have in-house capabilities for testing conducted and radiated EMC emissions and immunity; thermal chambers and thermal imaging equipment for optimising PSU designs; and facilities for highly-accelerated life testing and stress screening (HALT and HASS).

An intelligent power supply, however, can be pre-approved to a variety of standards: the iMP, for instance, complies with the EN 60601 medical standard for non-patient connected equipment, and meets the safety and performance requirements of UL and CE. Thus it is pre-tested for factors such as electromagnetic susceptibility, harmonic distortion and isolation; and can cope with defined levels of environmental stress such as shock and vibration. This cuts out both the time and cost of gaining additional approvals.

Increasingly, advanced applications also inherently need the level of control, monitoring and data logging that an intelligent supply can provide. Functions such as monitoring the temperature or output voltage of the supply can help both in providing real-time control and in giving early warning of potential problems. And it is increasingly important that power subsystems behave in a predictable fashion, both in sequencing at power-up and in shutting down in the event of an unexpected failure. Achieving a graceful shut-down and taking the correct actions to flag an error condition may be – literally – a matter of life and death.

Finally, there is the question of economics. Choosing between modified standard, configurable and full-custom power supply options has been a complex issue for designers for some time: but greater intelligence can only lend weight to the arguments for configurability. Partly this is due to the increased simplicity with which a configuration for an intelligent power supply can be built using a PC and the target hardware. The iterative nature of the process is also an advantage, allowing early delivery of an initial hardware platform, which can be fine-tuned along with the overall system design right up to sign-off for production.

All of these factors reduce the amount of engineering effort needed to implement a power supply design: and they are in addition to the economy-of-scale aspects that reduce the costs of configurable hardware when compared to small-run custom products.

Despite all this, the truism remains that every application is different: so for large-scale mass production, OEMs are likely to continue to tolerate lead-times measured in weeks, in return for drastically reduced unit costs.

But even in this sector, customers are demanding that suppliers offer more value-add, typically including metalwork, control PCBs, connectors and switches, thermal management components and EMC filtering. In this sense the move towards intelligence is token of a wider trend: the tendency to ‘disaggregate’ and focus on core value-add means that OEMs are likely to continue to demand more from their power systems, and the suppliers of those systems, for some time to come.

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Do You Like Candies?

Learn how to select the right "flavour" for your application

This article aims to cut through the jungle of different controller schemes, explaining the differences between architectures, highlighting the advantages and disadvantages.

By Michele Sclocchi, Principal Application Engineer, National Semiconductor Europe

Have you ever stopped in front of a candy store, bewildered by the varieties and hundreds of different colours, flavors and shapes. Such varieties can make your decision very difficult. You may end up choosing the candy you are more comfortable with, or you venture to a new flavour that does not necessary meet your taste. You can have the same experience when approaching a switching power supply design with the difficulty of selecting the most appropriate control scheme.

The design of a step-down switching power supply can be a very straightforward procedure, starting from initial specifications, select the proper "core" of the design, surround with a number of external components, and complete the design with a simulation and verification. With today's varieties of different control-schemes, the decision can be quite challenging. In order to choose the most appropriate controller or regulator a deep inside loop must be taken.

The "classic" PWM control scheme:

The most common controller is the classic Pulse Width Modulation scheme (PWM), where an internal clock leads the beginning of each duty cycle, which corresponds to the ON transition of the main MOSFET. The off time is timed by the control voltage (Vc) compared with a saw-tooth ramp (Vp). (figure1) The saw-tooth ramp can be generated by three different methods, leading to voltage mode, voltage mode feed-forward, and current mode control schemes:

Voltage mode: Classic

A constant saw-tooth ramp is internally generated and has a constant amplitude.

Voltage mode avoids the complications of slope compensation required with current mode control, it's less susceptible to noise, and generally requires smaller blanking time on the output current sense. The loop gain and the bandwidth increase with the increase of the input voltage.Voltage mode is widely used for its simplicity in low output current applications, where the input line is relatively stable with slow line transient.

The modulator and power stage gain is:

$$\frac{V_{out}}{Vc} = \frac{Vin}{Vp} \cdot \frac{1 + s \cdot R_C \cdot C}{1 + s \cdot \left(R_c \cdot C + L/R_L\right) + s^2 \cdot L \cdot C} \quad (1)$$

Where:

R_C is the ESR of the output capacitor, R_L is the resistance of the output load. L and C are respectively the inductance and the capacitance of the output filter.

The regulator loop gain, $H_{(S)}$ is:

$$H(s) = \frac{V_{réf}}{Vout} \cdot A(s) \cdot \frac{Vin}{Vp} \cdot \frac{1 + s \cdot R_C \cdot C}{1 + s \cdot \left(R_c \cdot C + L/R_L\right) + s^2 \cdot L \cdot C} \quad (2)$$

The modulator and power-stage gain increases directly with the input voltage (V_{in}). The frequency-dependent term is the transfer function of the LC network. This network has a double pole given by the inductor and output capacitor, and it has a zero resulting from the output capacitor C and its ESR.

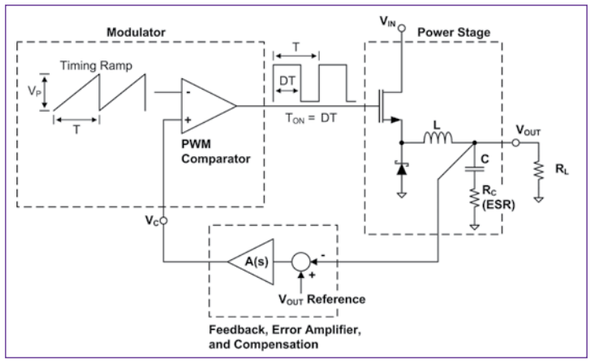


Figure 1: Voltage mode buck regulator basic architecture, National Semiconductor Simple Switcher scheme.

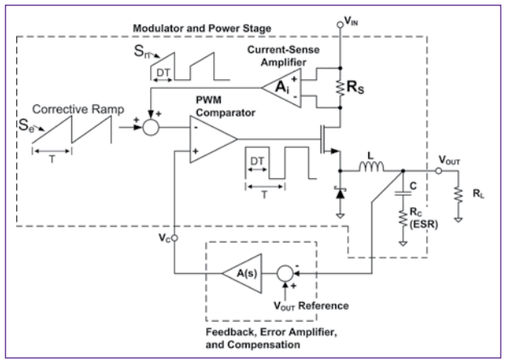


Figure 2: Current mode buck regulator basic architecture, National Semiconductor LM5642 scheme.

Voltage mode feed-forward:

The slope of the sawtooth ramp changes with the input voltage removing the variability of the loop gain and bandwidth with changing input voltage. The voltage mode feed-forward scheme eliminates the dependence of the input voltage (V_{in}) on equation (1) and (2).

Line transient responds is improved because the regulator changes the duty cycle before a change occurs in the output voltage as a result of the input voltage change. The other advantage associated with the voltage mode feed forward scheme is that it allows the loop gain to be optimized over the entire input voltage range.

Current mode: Traditional and high performance

Rather than using a constant saw-tooth ramp to control the duty cycle, current mode control uses the sawtooth ramp generated by the output inductor current. (figure 2)

A current sense amplifier detects the inductor current by measuring the current on the main MOSFET when it is conducting. A fixed corrective ramp is added to avoid the problem of sub-harmonic oscillation when the duty cycle is greater than 50%.

At the beginning of a switching period, the switch is turned on, and the inductor current is sensed by R_S and the current sense amplifier. This current sense signal is added to a corrective ramp, and when the sum of these two waveforms exceeds V_C, the comparator output goes low, turning off the output switch. In current mode scheme, the modulator, output switch, and inductor operate like a transconductance amplifier, supplying a regulated current to the output. As a result, the gain in this stage is not affected by changing V_{in}, as it is in a basic voltage mode control, instead gain changes with load resistance.

Current mode control offers several advantages, such as: good current sharing between phases connected in parallel, better compensation due to the single pole of the L-C output filter, precise cycle by cycle current limit, and immunity to input disturbance.

If we look more in detail on the compensation stage of a classic current mode controller, the gain of modulator and power stage are is:

$$\frac{V_{out}}{Vc} = \frac{R_L}{R_i} \cdot \frac{1}{1 + \frac{R_L \cdot T}{L} \cdot \left(m_c \cdot D' - 0.5\right)} \cdot \frac{1 + s \cdot R_C \cdot C}{1 + \frac{s}{\omega_p}} \cdot \frac{1}{1 + \frac{s}{\pi / T \cdot Q_P} + \frac{s^2}{\omega_N^2}} \quad (3)$$

Where R_i is the current sense gain:

$$R_i = A_i \cdot R_S \quad (4)$$

and D' is the off duty cycle: D'=1-D (5)

The compensation ramp factor is given by:

$$m_c = 1 + \frac{S_e}{S_n} \quad (6)$$

where Se is the corrective ramp slope and Sn is the slope of the sensed current waveform.

$$\omega_p = \frac{1}{C \cdot R_L} + \frac{T}{L \cdot C} \cdot \left(m_c \cdot D' - 0.5\right) \quad (7)$$

The damping factor is given by:

$$Q_p = \frac{1}{\pi \cdot \left(m_c \cdot D' - 0.5\right)} \quad (8)$$

The first term of equation 3 indicates that the gain is a function of load resistance (R_L) and the current sense gain (R_i). The second term gives the compensation ramp term. When the corrective ramp slope (S_e) is greater than the positive slope of the current sense waveform (S_n) the compensation ramp factor (m_c) increases enough to attenuate the gain.

The third term gives the dominant low-frequency characteristics. It has a zero due to ESR in the output capacitor, and a single pole (ω_p) that is mostly determined by the value of the output capacitor and load resistance.

The fourth term contains two poles at half the switching frequency. The peak of these two poles are controlled by the damping factor (Q_p) controlled by the corrective ramp. If the ramp is too small, the poles will cause the regulator loop gain to peak above 0 dB

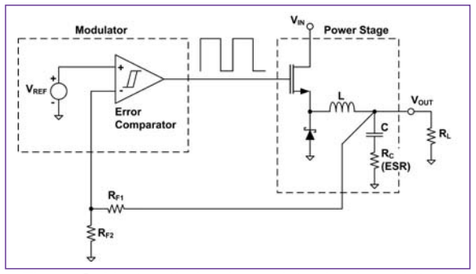


Figure 3: Hysteretic buck regulator basic architecture, National Semiconductor LM3485 scheme.

at half the switching frequency when the duty cycle (D) is greater than 50%. This is the cause of sub-harmonic oscillations that can occur with current mode control.

One of the main disadvantages of current mode control is the difficulty to measure the current with smaller duty cycle. This measurement can be quite susceptible to noise and the modulation can be erratic at times.

Hysteretic control method: Simple and fast

Another possible solution is the hysteretic control scheme (figure 3). The modulator is simply a comparator with few mV of input hysteresis built in, that compares the feedback voltage to a reference voltage. When the feedback voltage exceeds the reference by half the hysteresis voltage, the comparator output goes low, turning off the switch. The switch will remain off until the feedback voltage falls to half the hysteresis voltage below the reference. This topology is extremely fast to react to load transient, it's very simple and it does not require frequency compensation.

The main problem associated with this solution is that the switching frequency is not set by an oscillator, it is not constant and is dependent on many variables. The frequency depends very much on the variation of component parameters and operational conditions. Input voltage, load current, inductor value, output capacitor and especially its equivalent series resistor (ESR) can all have a huge impact on the switching frequency.

This method of controlling a DC voltage has some advantages and some disadvantages. Positive arguments are the easy control loop. It is very easy to get such a controller stable. Long calculations or exhausting iterations to find the right compensation components are not necessary.

The control loop is not only very stable but also extremely fast with a delay response of only about 90ns. This in combination with a very large duty cycle range of up to 100% yields an extremely fast transient response. It is superior to competing regulator architectures as PWM current mode or voltage mode.

As mentioned above there are some disadvantages of such a control scheme as well. As the switching frequency is not set by a controlled oscillator, it will vary with different external components and with input voltage changes. If the switching frequency has to be fixed in a certain application it might be difficult to find the right design.

Hysteretic constant on time: Simple, fast and constant frequency

As mentioned above, the hysteretic scheme has some interesting advantages, with the only major problem of an un-predictive switching frequency. If in a classic hysteretic control scheme, a one-shot on time inversely proportional to the input voltage is added, the switching frequency remains relatively constant.

The basic buck regulator equation for any buck regulator operating in continuous conduction mode defines the duty cycle D of the buck switch:

$$D = \frac{Vout}{Vin} = Ton \cdot Fs \quad (9)$$

Where T_{on} is the on-time and F_s is the operating frequency.

If the on-time is set inversely proportional to the input voltage V_{in}:

$$Ton = K \cdot \frac{Ron}{Vin} \quad (10)$$

Where K is a constant and R_{on} is a programming resistor, substituting T_{on} of equation (10) in the equation (9) and solving for F_s:

$$Fs = \frac{Vout}{(K \cdot Ron)} \quad (11)$$

Since V_{out}, K, and R_{on} are all constants, the operating frequency will also be a constant. In practice, the actual operating will vary slightly about 10%, due to non linearities in the one shot, propagation delays, and non-ideal switch voltage drops.

As result of the discussion above this makes the whole system solution very cost effective. Such a concept is easy to use as loop compensation or other stability issues are not existent. Also the transient response is very fast because the circuit does not have bandwidth-limiting feedback components. Due to these facts the concept combines many of the advantages of a PWM fixed frequency concept and a hysteretic mode concept into one solution.

In discontinuous operation, the switching frequency decreases together with the load current. Decreasing the switching frequency at light load decreases switching losses, maintaining power conversion efficiency.

Conclusions:

Understanding functionality inside any controller is essential in order to understand its advantages associated with a particular application. National semiconductor, has a significant advantage in offering a wide variety of solutions for any application and power-size, together with software simulation, technical support and training material that facilitate the selection and the design of your power supply. Additionally technical information regarding switching power supply techniques are posted on the articles/application-note sections of National Semiconductor web site.

The author would like to thank professor Nicola Femia, Frederik Dostal and Robert Bell for their contribution to the power courses contents.

www.power.national.com

Special Report electronica Roundup

Special Report electronica 2006 Roundup

With the passing of electronica, we are left with a pile of info, memories of the products, technologies and that all-important ingredient called people. It was a better than usual event with a lot of enthusiasm and drive for success from the exhibitors. If you were fortunate enough to be there, I'm sure you'd agree. But for those who could not get to the biggest electronics event in our region, I have pulled together, in alphabetical order, a small selection of the offerings I was fortunate enough to see. The coverage here is only a sample of what was on display at the show and space does not allow me, in this issue, to give more detail. But it may whet your appetite and make you a little more assertive with the time and travel request next time around.

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

Ansoft Run Successful Application Workshops Across Europe

Ansoft's "Leading Insight" Application Workshops, held throughout Asia, North America, and recently Europe in conjunction with electronica in Munich, were aimed at making it easier than ever to stay connected with the latest techniques and trends associated with the design of high-performance electronic components, circuits, and systems.

Presentations and interactive poster sessions by invited speakers together with Ansoft's technical staff covered:

- IC Design and Verification
- Signal and Power Integrity Simulation
- Electromechanical and Power Systems Design
- RF, Microwave, and Antenna design
- Advanced Packaging and PCB Design

These seminars, held during Ansoft's European road show, were developed in close collaboration with their customers to ensure the content was totally focused and completely relevant to the audience. Participation and feedback to-date has been extremely positive and the company is convinced that the face-to-face contact with delegates and direct exposure to Ansoft's US and European presenters and experts has accelerated the ability of designers to apply the tools available from Ansoft into current designs.

The array of partners who contributed and supported the whole tour makes an impressive list. Delegates profited from contributors such as International Rectifier, Panasonic, Philips, Samsung, UMC, Xilinx and many others. "They all did a great job and the audience at every location was very appreciative. Even during our participation at the electronica show, we had delegates from our recent seminars stopping by to register their satisfaction" concluded Thomas Liratsch, Country manager, Ansoft, Germany.

www.ansoft.com

Avago Technologies Demonstrates Range of High-Brightness LEDs

Avago Technologies introduced the industry's first Half-Watt (0.5-W) high-brightness red-orange and amber light-emitting diodes (LED) in an automotive-industry-standard PLCC-4 surface-mount (SMT) package. This new series of 0.5-W Power LEDs feature the industry's smallest package size and are optimized for long operating life under severe environmental conditions making them ideal for automotive exterior lighting applications.

The 0.5-W ASMC-QxB2-Txxx series of SMT LEDs are the latest addition to its family of Envisium™ Mid-Power LEDs. The target automotive applications for these new LEDs include rear combination lamps, center high-mounted stop

lights (CHSML), tail lights, brake lights, side mirror turn-signal repeaters, and marker lamps for trucks and trailers. The high brightness output per LED and small package footprint (3.2 L by 2.8 W by 1.9 H mm) of the 0.5-W Envisium series provide the automotive lighting designer with greater flexibility in designing the size, shape and appearance of lighting assemblies. They can also be easily soldered using conventional surface mount techniques to minimize production costs.

Avago launched a pair of high-performance, 24-watt red, green and blue (RGB) light-emitting diode (LED) modules for a wide range of decorative, architectural and specialty lighting applications. These new, high-power LED modules, which are the first in the industry to provide up to 480 lumens of light output, target customers who want an easy to use lighting solution that has the ability to display a variety of colours.

From a discrete LED supplier, the company has emerged to offer total solutions for illumination and lighting applications. Key products include high brightness and high power LEDs, PLCC surface-mount LEDs, color sensors, and display backlighting module solutions. These LEDs and display modules address a wide range of markets, including electronic signs and signals, automotive, solid state lighting and LCD display backlighting. More information is available at:

www.avagotech.com/led

www.avagotech.com/icm

AVX Launches New Passives

AVX Corporation, international supplier of passive components and connectors, offered a broad selection of passive electronic components and connectors.

The new 9175 connector from AVX's Elco Europe Division allows users to easily connect individual wires to a single row of contacts using IDC technology. Currently available as 2-and 3-way IDC connectors, the part is both low-profile (3.45mm) with a small PCB footprint (2 way: 5.0x2.5mm, 3 way: 7.5x2.5mm) and allows for quick, easy assembly thanks to a dedicated single-wire insertion hand tool.

AVX has produced a ceramic capacitor designed to virtually eliminate the risk of short-circuit failure. FLEXISAFE™ components are terminated with the award-winning FLEXITERM™ layer to absorb shock and prevent internal cracking resulting from board flexure and temperature cycling damage. In conjunction with this technology, FLEXISAFE™ parts are structured with a "cascade electrode design" to protect the ceramic capacitor from low insulation resistance failure that results from thermal stress, repetitive strike ESD and placement damage.

The L0402 LGA inductor based on thin-film technology, provides excellent high frequency performance and rugged construction for reliable automatic assembly. These small structures yield extremely tight tolerance inductors in virtually any value, and as tight as 0.05nH in low value 0402 devices. Further, Land Grid Array termination styles reduce parasitics and result in higher Q than standard termination style thin-film inductors. In addition, LGA termination technology helps miniature SMT inductors self-align during the assembly process as well as allowing for an inherent low-profile, excellent solderability and improved heat dissipation.

www.avx.com

Chipworks Structural Analysis and Transistor Characterization

Die Seals of (left) UMC- and (right) Toshiba-Fabbed Virtex-5s

Chipworks, the industry leader in reverse engineering and analysis of semiconductor chips and systems, today announced they have analyzed twin samples of the Xilinx XC5VLX50 Virtex-5 FPGA, made in a 65-nm process. One twin was manufactured at Toshiba and the second was manufactured at UMC. Chipworks is taking immediate orders for its Structural Analysis Reports: Xilinx/UMC (SAR-0612-801) and Xilinx/Toshiba (SAR-0612-802.)

In addition, Chipworks' has DC Transistor Characterization underway for the two devices to compare the impact of structure on performance - critical competitive information at advanced nodes. The results will be delivered in the DC Transistor Characterization Reports, TCR-0612-801 (Toshiba) and TCR-0612-802 (UMC) and will provide a clear and quantitative analysis on exactly how these new Xilinx 65-nm transistors perform.

Both devices have 12 metal layers (11 copper and one aluminum) visible in the images above, in addition both are fabbed from 300 mm wafers. In addition both use tensile nitride strain on NMOS transistors. However, Chipworks analyses have revealed significant differences in the metallization and dielectric structures. Other differences will be detailed in Chipworks' reports. As these devices ramp into production it will be interesting to note if these differences have an impact on the performance, cost or power consumption of the Virtex-5.

"The Virtex-5 demonstrates Xilinx's use of multiple foundries to expedite 65-nm device manufacturing, providing them with a hedge against process problems while increasing their volume production capability," says Julia Elvidge, Chipworks' President. "In addition, Xilinx's relationships with Toshiba and UMC ensure that they remain at the forefront of technology."

In addition to transistor performance analyses, Chipworks reports provide intelligence into the structural and process elements Xilinx used to achieve performance improvements with the Virtex-5 while using less power and dropping the cost by 45% from earlier generations. Chipworks' customers rely upon this type of information to learn from their competitors, improve their own designs and speed their time-to-market.

www.chipworks.com

New LED Indicators and Light Engines Reduce Costs

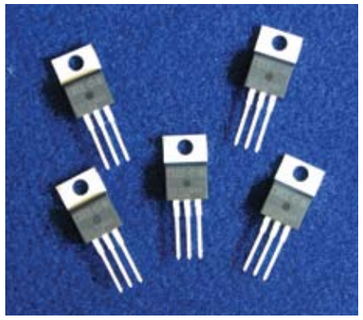
In addition to standard Neon and Incandescent based panel mount indicators, CML Innovative Technologies (CML-IT) launched a new range of indicators, light engines, hole and SMT mounted LED light sources. These recently introduced devices benefit from much longer service life compared with original Incandescent based indicators and therefore help reduce maintenance costs on large control panel or general lighting applications.

All indicator ranges are available off the shelf in a number of different lens (conical, flat and round) and termination styles, with voltages ranging from 2 up to 250V and a wide variety of colours.

The company demonstrated a broad range of LED products for use as spotlights, point-of-purchase, cabinet/display-case lighting or for general illumination applications such as architectural, landscape or task lighting.

www.cml-it.com

Cree Announces First Power Switch and Diode Co-Pack



Cree, Inc. a market leader in silicon carbide (SiC) power semiconductors, announced sample availability of its first power-device combination pack (co-pack). The new Cree co-pack solution is designed specifically to reduce costs and increase efficiency of inverters used in solar, UPS and motor-drive power applications.

The new Cree CID150660 co-pack features a 6-amp/600-volt Cree SiC Schottky diode combined with a 15-amp silicon insulated gate bipolar transistor (IGBT) from International Rectifier. It is available in an industry-standard TO-220-3 package.

"Cree's new co-pack provides inverter designers with the potential to achieve new levels of efficiency at power levels up to 3 kW," said Stuart Hodge, Cree manager of applications engineering for power devices. "This is the first in a series of co-pack products targeted to reduce IGBT switching losses up to 50 percent and reduce overall inverter losses up to 25 percent. When compared to traditional silicon-based pn diodes, Cree's SiC-based Schottky diodes and co-pack solutions provide lower switching losses, higher frequency operation, and higher power densities."

Additional information about Cree power devices and co-pack solutions, including device specifications and application notes, may be obtained by visiting:

www.cree.com

Enpirion Announces Second-Generation 3A and 6A DC-DC Converters with Integrated Inductors

I talked with Paul Greenland of Enpirion, Inc., leading provider of integrated inductor DC-DC converters, at the electronica exhibition in Munich, Germany. He was there to support the release of the company's second-generation products with 3A and 6A load current ratings. "These new 3A and 6A converters deliver benchmark performance and highest power density at the time when space-constrained customers with demanding loads need it most," said Greenland, Enpirion's VP of Marketing and Applications.

Enpirion's converters already offer up to 70% reduction in DC-DC converter footprint over competing solutions. Second-generation products offer an additional 25% reduction in area. Reduced footprint is crucial in today's new products where PCB area is at a premium, consumed by increased functionality, content and bandwidth.

Efficiency has also been increased and the integrated MOSFET switches have been optimized to provide higher efficiency over the operating range, achieving improvements by as much as five percentage points over preceding products.

Internal low loss and inductance connections constrain switching currents to the smallest area, within the package.

Enhancing thermal performance eliminates the need for thermal de-rating or forced-air cooling in ambient temperatures below 85°C.

"As CMOS geometries trend towards 95 nm and below, internal circuits become more sensitive to supply voltage ripple and noise. Up to this point, sub-95 nm chip-set customers have found it necessary to increase output filter capacitance dramatically in order to use conventional regulator or controller-plus-switch solutions without nuisance resets interrupting operation. This is not the case for Enpirion, which satisfies the requirement with a standard filter.

The EN533x and the EN536x require two multi-layer ceramic filter capacitors and one soft-start timing capacitor. Output voltage is programmed via a 3-pin voltage ID for the EN5335QI and the EN5365QI, and by an external resistor divider for the EN5336QI and the EN-5366QI. Increasing load current capacity is simple, up to four 6A converters may be paralleled, delivering a maximum of 24A" concluded Greenland.

www.enpirion.com

Industry's Smallest ATCA Dual-Input Bus Converter

Emerson Network Power, announced the industry's smallest front-end power solution for use on latest-generation telecoms cards. The new Artesyn dual-input ATC210 bus converter is a fully integrated solution that occupies 20-40% less space than competitive solutions. It combines an exceptionally small footprint, high power density isolated dc-dc converter with advanced digitally programmable power management functions. The converter has a 5.9 x 4.6 cm footprint and a typical full load efficiency of 89%, yielding a power density in excess of 4 Watts per cubic centimetre.

The ATC210 is expressly designed for use in ATCA systems, and is an ideal design choice for many other space-constrained systems that employ distributed power architectures.

The ATC210 bus converter is rated at 210 Watts. It has dual inputs, each capable of accommodating a very wide input voltage range of -36 V to 72 V, and generates two independent, isolated dc outputs. The main 12 V output can deliver up to 17.5 A and is intended for powering an on-card intermediate bus. The secondary output is for supplying peripheral power management circuitry; it is rated at 1.8 A, and is resistor programmable over the range 3.13 V to 3.47 V. The converter is equipped with I2C serial bus and direct high-speed interfaces for monitoring, reporting and digital programming of fault thresholds. Built-in power management functions include input ORing, inrush control and transient protection.

www.artesyn.com

More Current Handling Capacity with Same Volume

EPCOS presented the new B43540 snap-in aluminum electrolytic capacitor specifically for link-circuit applications in frequency converters. The ESR and internal thermal resistance have been optimized to enable a 20 percent increase in current handling capacity in comparison to previous products of the same volume. With a capacitance range from 68 to 2200 µF, the capacitors are designed for voltages from 200 to 400 V.

With diameters of only 25 to 35 mm and insertion heights from 25 to 55 mm, they have an operating life of 10,000 hours at a temperature of 85 °C.

www.epcos.com

Fairchild Semiconductor's Motion-SPM™ Ideal for Low-Power Inverter Motor Designs

In addition to their broad range of solutions for energy efficiency powerfully demonstrated at electronica, Fairchild Semiconductor introduced the FSB50325S (250V), FSB50250S (500V) and FSB50450S (500V), three new Motion-SPM™ devices available in 29mm x 12mm surface-mount-device (SMD) packages. The Motion-SPM in SMD enables designers to achieve the highest levels of energy efficiency, compactness and low electromagnetic interference (EMI) required by small (50-125W) inverter motor drive applications such as water pumps, dishwasher motors and fan motors.

Each Motion-SPM integrates six fast-recovery MOSFETs (FRFET™) and three half-bridge high-voltage ICs (HVIC) into one thermally efficient package providing low-loss and low EMI characteristics. The Motion-SPM also provides better system ruggedness and a larger safe operating area (SOA) than either IGBT-based power modules or one-chip solutions.

Designers can now choose the most appropriate package from SMD or Tiny-DIP (dual in-line package). For information about Fairchild's entire SPM portfolio, please go to:

www.fairchildsemi.com/spm

Intersil Launches Battery Authentication for Counterfeit Protection

Intersil introduced the ISL9206, a fixed-secret hash engine based on Intersil's second generation FlexiHash™ technology. The device is suitable for protection against unapproved third-party products for a wide variety of low-cost applications. A counterfeit prevention solution utilising the ISL9206 offers safety and revenue protection at the lowest cost and power.

The ISL9206 provides security level achieved through a challenge-response scheme that does not require a fixed challenge and therefore eliminates situations where eavesdropping on the communication bus could reveal the secrets. Intersil's ISL9206 is ideal for use in systems such as mobile phones, printer cartridges, power tools, and medical devices that require active authentication to protect consumers against fraud and to protect intellectual property. Mobile phones utilising Lithium-based batteries are particularly vulnerable to counterfeit batteries and the ISL9206 will help to identify counterfeit batteries so the system can take appropriate action.

The ISL9206 is available now in a 5-lead SOT-23 or a 6 lead 2x3 TDFN package.

www.intersil.com

IR Introduces Sensorless Motor Control Platform for Variable-Speed Pumps Slashing Energy Consumption by 50%

IR's sensorless sinusoidal motor control platform delivers quiet operation and high efficiency for variable-speed pump applications up to 300W. By controlling pump operation over a wide range of flow requirements, variable-speed pumps can cut energy consumption by up to 50 percent.

The latest iMOTION™* integrated design platform consists of a mixed-signal controller, the IRMCF371, and companion intelligent power module for the power stage, as well as algorithms, development software, and design tools.

The IRMCF371 mixed-signal control IC for pumps integrates all the control and analog interface functions required for sensorless sinusoidal control of permanent magnet synchronous motors (PMS) using DC link current measurements.

The IRAMS06UP60B is a compact, intelligent power module optimized for electronic motor control in appliance applications that features a three-phase inverter with IC driver in a compact single in-line (SIP1) package.

Design tools include communications software running on the 8051 microcontroller that gives the PC-based MCEDesigner™ software access to the control parameters and system variables in the shared memory. This allows modification of the controller set points and control loop gains and other constants without needing to modify or compile software.

Data sheets and application notes are available on the International Rectifier Website

www.irf.com

Maxwell Technologies Introduces 125-volt Boostcap® Ultracapacitor Module For Heavy Hybrid And Electric Vehicles

Maxwell Technologies, introduced a compact, fully integrated, 125-volt BOOSTCAP® ultracapacitor module to provide an easy-to-integrate building block for scalable energy storage and power delivery solutions for heavy hybrid and electric vehicles and heavy duty industrial applications requiring up to 1,500 volts.

This high-performance module is designed specifically to satisfy global demand for ultracapacitor-based braking energy recuperation and torque assist systems for hybrid bus and truck drive trains and electric rail vehicles. It is designed to perform reliably through one million or more deep charge/discharge cycles, which equates to more than 15 years of operational life.

In addition to managing high current, this module is built to withstand the harsh environments and extremely demanding duty cycles that are typical with heavy transportation applications.

The HTM BMOD0063-125 is encased in a rugged, splash-proof, IP 65-compliant, aluminium chassis, weighs less than 50kg and measures 315x425x744mm. The complete data sheet is available at Maxwell's website http://www.maxwell.com/ultracapacitors/products/index.asp. Up to 12 modules may be linked in series to deliver a total of us much as 1,500 volts. Maxwell also offers a complete line of standard 15- to 48-volt multi-cell pack and modules, and recently announced 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.

www.maxwell.com

New 30A High Efficiency Synchronous Buck Controller for PoL, DC-To-DC Applications

Micrel Inc. launched the MIC2159, a synchronous buck controller featuring high efficiency, less components, small size and thermal capability point-of-load DC-to-DC conversion. The IC is targeted at networking, telecom/datacom, server, graphic card, and storage applications.

The MIC2159 operates from 3V to 14.5V input voltage range, allowing the device to deploy step down voltages for systems using 3.3V, 5V, and 12V power busses. With a programmable minimum output voltage of 0.8V, the MIC2159 can power the latest generation CPUs, DSPs, FPGAs, and ASICs. Powerful internal gate drivers allow the device to power external MOSFETs that can provide up to 30A of output current. The MIC2159 operates at 400 KHz, allowing the smallest possible external components and is capable of efficiencies of greater than 95 percent.

The MIC2159 is offered in a low-pin count, small and thermally capable ePAD MSOP-10 package.

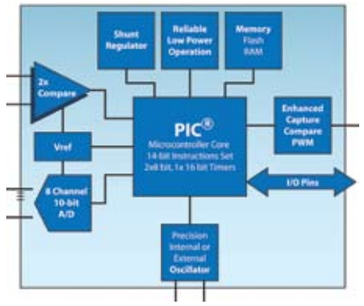
www.micrel.com

Microchip Introduces PIC® Microcontrollers with Internal Shunt Regulator

Microchip announced the first general-purpose, Flash PIC® microcontrollers with peripherals for cost-effective control of power supplies, fans or small motors. The 14-pin PIC16F616/610 and the 8-pin PIC12F615/609 microcontrollers can substantially reduce component count and cost with specialised peripherals such as full-bridge Pulse-Width Modulation (PWM) with deadband control, Timer1 Gate Control for pulse width measurement, a comparator with hysteresis for hall-effect sensor interfaces, and an A-to-D converter for temperature and other monitoring functions.

These devices add an internal shunt regulator which allows the PIC microcontroller to run from higher voltage rails without the addition of external voltage regulators.

Many higher voltage applications, such as motor controls and power supplies, require components to step down the input voltage. These new "HV" PIC microcontrollers allow engineers to design systems running from 2.0V up to a user-defined maximum without having to add a regulator, reducing cost and board space even further.



In addition, such applications often require intermediate voltages for power drivers and other components. The PIC16F616/HV616 family can provide these using the built-in S/R latch to implement a switch-mode power supply.

Specific application examples include home appliances, cooling-fan and other motor control, power tools, system control and monitoring, battery chargers and power supplies.

These new microcontrollers are supported by Microchip's development tools, including the free MPLAB® IDE (Integrated Development Environment), the low-cost MPLAB ICD 2 (In-Circuit Debugger) and the MPLAB PM3 Universal Device Programmer.

The PIC16F616/610 and PIC16HV616/610 microcontrollers are available in 14-pin PDIP, SOIC, TSSOP and QFN packages. The PIC12F615/609 and PIC12HV615/609 are available in 8-pin PDIP, SOIC, DFN and MSOP packages.

All of the devices are available now for sampling at sample.microchip.com and volume production at www.microchipdirect.com. For additional information visit Microchip's Web site at:

www.microchip.com/startnow

First Power Management Unit Launched with Integrated Buck-Boost Converter and Charger

National Semiconductor introduced an industry first flexible power management unit (PMU) with an integrated buck-boost converter to its family of digitally programmable, multiple-output power management devices.

In portable media players where mini hard disk drives typically require a 3.3V supply, a buck-boost converter extends battery life. Li-Ion batteries, a popular choice for portable media players, have an operating voltage range of 2.9V to 4.2V. When the battery is fully charged, the converter steps the voltage down to supply the hard disk drive, but when the battery voltage drops to lower than 3.3V, the converter steps up the voltage. This technique increases the run-time of the player up to 10 percent over that achieved by a traditional buck converter.

The LP3910 PMU includes a dual-source battery charger to power a device from a wall adapter or USB and a digital I2C compatible interface. The integrated battery charger supports power routing, which allows system usage immediately after an external power source has been detected. The I2C interface allows design engineers to customise electrical specifications such as output voltage and switching modes to the end application. The digital interface provides the flexibility to use the same device for multiple solutions that require different output voltages.

An efficiency of up to 96 percent is further enhanced by a dynamic voltage-scaling feature that enables the device to adjust the output voltage in real time to match the computing workload and clock frequencies of the corresponding processors. The end result is longer battery life in energy-sensitive systems such as personal media players.

www.national.com

Reduced Time-to-Market with New PI Expert 6.5 and Online Rapid Transformer Sample Service

Power Integrations, Inc. launched a new version of its popular PI Expert power supply design software – plus a new online Rapid Transformer Sample Service (RTSS) for transformer prototyping. PI Expert 6.5 includes PI's latest TinySwitch®-III, PeakSwitch™ and LinkSwitch®-LP products, and automates power supply circuit design, component selection and transformer construction, while RTSS promises to trim days from the construction of transformer designs generated by the software. This combined new offering from PI enables OEMs with little power supply experience to successfully prototype their own hardware, and overcomes a critical hurdle for power supply merchants rushing to redesign their products ahead of new energy-efficiency rules that come into effect in 2007.

The new PI Expert 6.5 provides a built-in PI product selector guide and offers extended PI device support and component libraries. It also offers three new design optimization features: control loop simulation and feedback circuit calculations to enable circuit optimizations, and mechanical diagrams in PI

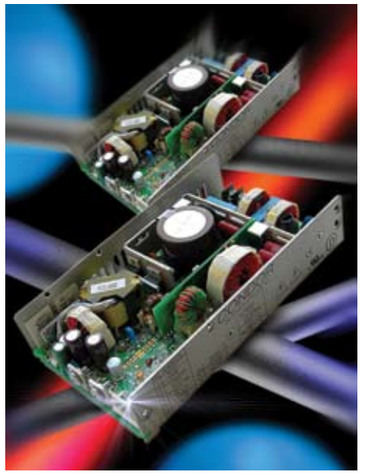
Transformer Designer to enable transformer winding accuracy.

A transformer sits at the heart of every power supply design, affecting operation, safety and EMI performance. PI Expert produces winding specifications for the PI Transformer Designer utility using patented EMI-reducing shield-winding algorithms. The transformer output from PI Expert can be submitted to the RTSS for rapid prototyping and delivery. Sample services are available from two providers today, Power Integrations and ICE Components; other providers may be added in the future.

The latest PI Expert 6.5 suite is available for free download at http://www.powerint.com/designsoftware.htm

www.powerint.com

New Hi-Rel 400 Watt Power Supply



SL Power announced the next family in its line of mid-power internal power supplies. SL Power Electronics designs, manufactures and distributes internal switch mode and linear power supplies for the medical and commercial/ITE electronic segments of the global power supply market under the Condor brand name.

The Condor GNT400 family offers OEM customers flexibility in design and performance. This new product family delivers 300 watts of power if convection cooled or up to 400 watts with the optional fan. There are four standard output models available from 12V to 48V. The product platform will meet requirements up to 56V for OEM customers that require higher voltages. Two additional auxiliary voltages with output currents up to 10A are also available as options.

The GNT400 is compact and designed to be 1U compatible. Measuring 4 inches by 7 inches by 1.5 inches (9.5 cubic inches), commercial/ITE models are approved to EN60950 and are fully RoHS-6 compliant. In addition, all models are power factor corrected with compliance to EM55011/22 conducted noise level B.

Medical versions feature UL/IEC/EN60601-1 safety certification approvals. The GNT400 has efficiency ratings in excess of 86 percent with MTBF of 300,000 hours. It also is available with a variety of connector options to accommodate unique OEM requirements.

www.slpower.com

TI Unveils Integrated Power Management IC for DaVinci™ Technology-Based Portable Electronics

Texas Instruments introduced the first power management integrated circuit (PMIC) fully optimized to support all power system requirements of a multimedia device based on DaVinci™ technology. Simplifying power design in portable media players, digital still cameras and other lithium-battery powered electronics, this device provides dynamic voltage scaling and up to 95 percent power conversion efficiency.

TI's TPS65023 converter manages the power in a TMS320DM644x digital signal processor (DSP) based on DaVinci technology with high-performance digital control and maximum efficiency across the wide range of load currents up to 1.5 A. The device integrates three step-down converters to support the system's core voltage, peripheral, I/O and memory voltage. It uses an I^2C communications interface to implement a dynamic voltage scaling technique that digitally adjusts the core output voltage level between 0.8 V and 1.6 V, allowing the system to conserve power. The interface is compatible with fast/standard and high-speed mode I2C specification, which allows data transfer up to 400 kHz. All three step-down converters allow the device to operate in a power-save mode at light-load currents, and can be placed in a shutdown mode when power consumption is reduced to less than 1µA.

The device also integrates two general-purpose, 200-mA linear dropout (LDO) voltage regulators that are enabled with an external input pin. Each LDO operates with an input voltage range between 2.5 V and 6.5 V, which allows each to be supplied from one of the integrated step-down converters or directly from the battery.

The TPS65023 is available in volume production from TI and its authorized distributors in a 40-pin, 5 mm x 5 mm QFN package. Evaluation modules of the TPS65023, application notes and TI's comprehensive portfolio of power management ICs are available through through power.ti.com..

www.ti.com

Current Sense Resistors Provide Increased Thermal Management

Providing design engineers with a small footprint device with increased heat dissipating capability for power supply designs, TT electronics IRC Wire and Film Technologies Division's OAR-TP Series open air sense resistor is designed for applications requiring the transfer of heat away from circuits and solder joints. Available in 1W or 3W rating, the resistor is being specified for current sensing, feedback, low inductance, as well as surge and pulse applications.

According to David Winkler, Product Manager for IRC's Wire and Film Technologies Division, the current sense resistor has gained worldwide acceptance because of its narrow footprint and thermal management capabilities. The 1W OAR-TP resistor measures just "300" in height, while the 3W device has a height of 1.25". Because many power supply designs are already tightly packed at the PC board level, the additional height does not create any profile issues, but rather improves cooling efficiency.

www.irctt.com

Tyco Electronics Separates from Tyco International

Tyco International announced the separation plan at electronica and intends to complete the separation into three independent publicly traded companies in the first quarter of 2007.

Each company will have its own independent Board of Directors and strong corporate governance standards.

Tyco Electronics is one of the world's largest suppliers of electronic components, including connector systems, switches, relays, inductive and radar sensors, heat shrink products, touch screens, magnetics, resistors and inductors, battery assemblies, wire and cable, fiber-optic and wireless components and systems, identification and labeling products, as well as related tooling assembly devices. Tyco Electronics has nearly 99,000 employees worldwide.

The three companies are as follows:

Tyco Electronics, the world leader in passive electronic components and a leader in active wireless and fiber optic components and systems, complete power systems and premise wiring.

Tyco Healthcare, one of the world's leading diversified healthcare companies.

The combination of Tyco Fire & Security and Engineered Products & Services, a global business with leading positions in residential and commercial security, fire protection and industrial products and services.

Tom Lynch (Left), who has broad experience in the communications and electronics industries, serves as Chief Executive Officer of Tyco Electronics, which had $12.2 billion in revenues in 2005. Dr. Juergen W. Gromer (Right), who has led Tyco Electronics since 1999, continues as President of Tyco Electronics. In addition, he is responsible for the Electronic Components Group of the company.

www.tycoelectronics.com

Vicor V·I Chip Components Reduce Energy Costs Increase Efficiency and Power Density

Vicor announced a full family of V·I Chip™ components, enabling complete power systems using Factorized Power Architecture (FPA). FPA separates or 'factorizes' regulation and voltage transformation functions into flexible, high-performance building blocks. V·I Chip components are high-density (up to 1.2kW/in^3), high-efficiency (up to 97%), high-speed power conversion modules, and are all released for mass production.

The PRM™ (non-isolated regulator) and VTM™ (current multiplier) components deliver the most efficient 48V direct-to-load power conversion system in mass production today. For low voltage/high current requirements (e.g. microprocessors), the VTM module enables 91A/in^2 point of load (POL) density.

In traditional 48V architectures, Vicor's intermediate bus converters, the BCM™ modules, offer four times more power density than any other converter. The 48V BCM modules are available with output voltages of 1.5V$_{out}$ to 48V$_{out}$ and up to 300 W.

The V·I Chip family is in mass production now with immediate sample availability and four-week production lead times.

For more information on the V·I Chip family and FPA, including data sheets, application notes, and customer evaluation boards, visit

www.vicorpower.com/vichip

Companies in this Issue

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

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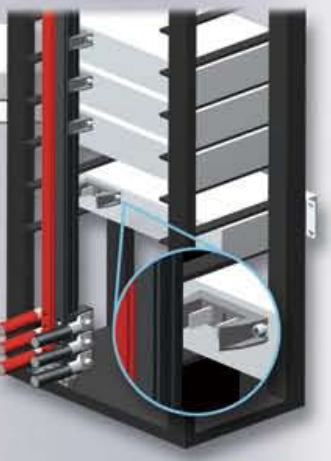

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- High Power Density
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- Continuous Power Over Full Rail
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- Efficient Cost Per Amp
- Eliminates Discrete Connectors

www.thepowerrail.com

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Bus Bar for Pluggable Circuit Breakers

Multiple Connections with Minimal Voltage Drop

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