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PSCQ1265RT	140	7	0.9
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FSCQ1565RP	210	11.5	0.7

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Viewpoint

APEC and PCIM, the Place for Engineers

Industry News

PCIM Europe 2006 Nuremberg, 30 May - 1 June National Opens European Power Design Center Linear Technology and Primarion Announce Digital Power Alliance IGBT Chip Line on 6" Wafer Fabrication

2011/20 Line>

Power Integrations Introduces Industry First Integrated Switcher IC

Power Player

A 100 Years of Power Control, Eric Carroll, Semiconductor Marketin

Marketwatch

What the World Really Needs (from Power Management), Chris Am

Cover Story

Optimizing Buck-Boost, Jürgen Neuhäusler, Senior Systems Engine

Power Semiconductors Part I

Driver with Dynamic Voltage Rise Control, Piotr Luniewski, Uwe. Motor Control Technologies, Jay Goetz, Field Applications Engine A Programmable BLDC Motor Driver, Siegfried Ritz, Lutz Göhler al 10A, 28V DC/DC µModule in an IC Form-Factor, By Afshin Odaba

Features

Portable Power-Serialization for Ultra-Portables, Mike Fowler, Fo
Measurement-Oscilloscope Software speeds SMPS Measureme
Manufacturing, Tektronix
Power Amplifiers – Isolation Amplifiers Offer Outstanding Dynami
Rohrer Mess & Systemtechnik

New Products.....

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CONTENTS

	. 2
t Power Soluti	4 4 6 6
Family With Peak Power Capability	8
g Manager, ABB Switzerland Ltd	.10
barian, iSuppli Corporation	.12
er, DC-DC Converters, Texas Instruments	.16
lansen, Michael Hornkamp, Infineon AG, Warstein	22
er International Rectifier HiRel Products	26
nd Steffen Becker. DMOS GmbH	.20
ee, Linear Technology Corporation	.36
irchild	.40
nts, Dave Ireland, EMEA Marketing Manager, Design and	
Characteristics. Helmut Rohrer.	.44
	.48
	-56

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Advertising Rates, Sizes and Digital File Requirements available at: www.powersystemsdesign.com

Your Free Subscription Request available at: www.powersystemsdesign.com/psd/ subslogn.htm

Registration of copyright: January 2004 ISSN number: 1613-6365 Issue print run: 20,000 Printing by: Central - Druck Trost GmbH & Co. Heusenstamm, Germany

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Send address changes to: circulation@powersystemsdesign.com Volume 3, Issue 3

APEC and PCIM, the Place for Engineers



The APEC conference and show in Dallas Texas has introduced a number of innovative products for Power Management. Power Integrations presented the PeakSwitch for more efficient stand by in power supplies. Micrel introduced an 8Mhz converter design where the inductor reaches a miniaturization that focuses to serve next generation portables. ZilkerLabs demonstrated a full Digital Power Management solution. Linear Technology and Primarion announced shortly after APEC an alliance to produce digital point-of-load (POL) products.

Digital Power will be more important as the amount of supply voltages grow in portable applications while the different levels of supply voltages for Micro controllers has the tendency to go to lower levels.

The chip device structures are still shrinking and as a result power consumption and supply voltage will be reduced. Our cover story by Texas Instruments introduces the novel Buck-Boost converter, a design to reach up to 96% efficiency.

Back to the old world. All of our designs have to take electromagnetic compatibility in consideration.

The EMV/EMC (electro magnetically compatibility) conference in Düsseldorf has shown that design and early research is important to EMC subjects. Testing and certifying is the result to pass the requirements set by laws all around the world.

The EMC compatibility has to be an integral part of design. Any electronic power design is a basic part of EMC considerations whether as a stand alone supply or drive or part of a system. European view of Power Electronics. Europe has its dominant applications in industrial and automotive while Asia and specific China has focus into volume production of power supplies serving the worlds market.

PCIM Europe in Nuremberg will have the

A short introduction on the upcoming PCIM Europe conference can be found in the news here in this issue. The summary of keynote papers gives you an idea of the topics upcoming in May in Nuremberg at the PCIM Europe conference.

Module manufactures, drive applications together with automotive requirements influence the PCIM. We will see the full line of materials and manufactures from passives to semiconductors up to solution levels.

As it has been a tradition for years, experts from the Industry will join me for discussions at the Podium. Here are the details to include in your plans for visiting PCIM Nuremberg. Hall12, Booth 353:

"Gate Drivers Optimized for MOS Devices" will be on Tuesday, 12:45 to 13:30.

"Digital Power and the Application Focus" will be on Wednesday, 11:00 to 12:00.

"Passive Components are the Spices in Design" will be on Thursday, 11:40 to 12:40.

The theme of each of the discussions are chosen to enhance awareness of future steps into technology and design improvement.

Also, Power Systems Design Europe is located at Booth 245 in Hall 12, directly across from the podium, stop in and see us!

Best regards,

Bodo Arlt Editorial Director The Power Systems Design Franchise

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At the heart of power electronics

PCIM Europe 2006 Nuremberg, 30 May – 1 June



Udo Weller, Manager Mesago PCIM GmbH.

The 2006 PCIM Europe International Exhibition and Conference, Europe's number one meeting place for all fields of Power Electronics, Intelligent Motion and Power Quality/Energy Management will take place from 30 May - 1 June 2006 in Nuremberg. According to Udo Weller Manager Mesago PCIM GmbH, talking about the importance of PCIM Europe 2006 "PCIM is the focal point engineers have their talk about future developments in power electronics".

The day before the exhibition a series of tutorials will help answer the key questions currently being posed in the power electronics sector. With ten full day tutorials on Monday 29 May 2006 the conference offers a streamlined program compared to last year. The tutorials will be led by top experts from the USA. Israel. France. Switzerland and Germany.

The PCIM Conference is being held in parallel to the Exhibition (30 May until 1 June 2006). The conference program with its focus

on power electronics, intelligent motion and power quality/energy management includes more than 170 first-time presentations delivered by speakers from 23 countries. The Scientific Advisory Board comprising over 50 international experts led by Prof. Alfred Rufer of EPFL. Switzerland has selected the best submissions to create a conference program with 24 sessions. The highlights include the keynote papers which open each day of the conference

Tuesday: A Break Through for Low Power Devices by John B. Jacobsen, Grundfos, Denmark

From a product point of view, technology is not the limitation for the commercial breakthrough in the power range $1/_2 - 21/_2 kW$. Today the challenge is how to make cost effective use of the vast opportunities available. Cost of packaging and production is often higher than cost of electrical components. To optimize for lowest cost at product level a good understanding and cooperation across disciplines is essential. Technology choices are discussed from packaging point of view for different generations of a 3 inch pump, that was enabled by the integration of a frequency converter.

Wednesday: Digital Electronics and Controls for Power Quality Systems – From the State of the Art to Future Trends by Silvio Colombi, General Electric Company, Switzerland

Reliability, performance and cost are key features in the power quality market. Today, advances in microelectronics, power semiconductors, energy storage systems and power converter topologies influence these features. In particular, with a hardware cost reduction of 30% per year and a computing power doubling every 6 months, it is more and more interesting to realize system features and functions in a digital way. In addition, the software costs nothing in production and the digital world opens the way to preventative maintenance, advanced diagnostics and improved connectivity. Based on several state of the art developments, the presentation will illustrate how a full digital electronics and advanced control algorithm make it possible to realize more reliable and flexible power quality products with superior performance and at a reduced cost. Future trends and limitation factors will be discussed.

Thursday: The Industrial and Research Network for Power Electronics in Europe by Thomas Harder, ECPE European Center for Power Electronics e.V., Nuremberg, Germany.

ECPE European Center for Power Electronics was founded in 2003 on the initiative of leading power electronics industries as an industrial and research network for power electronics in Europe. The focus of ECPE activities is put on research, education and advanced training as well as public relations for power electronics in Europe.

ECPE is driving precompetitive joint research in power electronics financed from an industrial research fund. This paper gives an overview and presents first results from the ECPE Demonstrator Programs: System Integrated Drive for Hybrid Traction in Automotive, Industrial Drives - System Integration and Power Supplies with Ultra-High Power Density, Furthermore, a European initiative of academia and industry to jointly develop power electronics research and technology roadmaps is introduced, with a medium to long term perspective up to 15 years.

The combination of exhibition and conference offers important value added benefits to the participants. The 27th PCIM represents the most important practice-focused forum for presenting and discussing recent previously unpublished research results and reports.

www.pcim.de

National Opens European Power Design Center

National Semiconductor announced the opening of a new Power Application Design Center in Europe to strengthen applicationand system-support services for engineers designing power supplies and power-management systems.

Located within the company's European headquarters in Füerstenfeldbruck near Munich, Germany, the centre gives power designers a full spectrum of engineering services, including reference designs,

product selection, circuit design, board layout and problem analysis.

National provides many power-application design services. These include an everexpanding list of free reference designs, educational online seminars and National's Webench online development tool.

Europe's Power Application Design Center is equipped with the latest measurement and testing devices, state-of-the-art layout and simulation software, and equipment for

milling and soldering printed circuit boards. Through special arrangements with selected vendors, the design centre also supports designers using high-voltage and power components outside of National's product portfolio.

http://power.national.com

www.national.com

Think Outside the Brick



Simple, Fast, Flexible 48V Isolated Conversion

Designing an isolated DC/DC supply is now as straight forward as designing a buck converter. Linear's new smart primaryside drivers and secondary-side controllers simplify design of isolated supplies for single-step conversion from 48Vps to a wide output voltage range and scalable load current: 0.6V to 52V at 10A to 200A.

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Secondary Side:

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LTC3706: Full-Featured LTC3726

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Linear Technology and Primarion Announce Digital **Power Alliance**

Linear Technology Corporation and Primarion, Inc announced an alliance to produce digital point-of-load (POL) products for the networking, computing and telecommunications infrastructure markets.

Linear Technology and Primarion will dual source Primarion's Di-POL family of PMBuscompliant digital DC/DC controllers, beginning with the PX7510. The PMBus standard enables system-level communications with multiple POL converters for programming and monitoring of complex power systems.

The agreement between the two companies involves dual sourcing and mutual promotion of programmable digital POL controllers targeting infrastructure applications including servers, network switches and routers. These digital power management and conversion products provide flexible, system-level control of sophisticated power management systems. The Di-POL controller ICs provide seamless power management in

high availability systems, enabling real-time programming and monitoring of key parameters to optimize performance and maximize system uptime

"This exclusive agreement with Primarion enables us to offer our worldwide customers state-of-the-art digital power solutions," stated Dave Bell, President of Linear Technology. "Our LTC7510 digital POL controller provides identical features to Primarion's PX7510, and is just the first member in a family of digital power solutions. These PMBus-compliant products provide a new level of design flexibility desired by certain customers, along with Linear Technology's outstanding reliability and worldwide technical support."

Ron Van Dell, President and CEO of Primarion, stated, "This alliance moves digital power management toward mainstream application by ensuring that customers have dual sources for this flexible digital power solution. Our Di-POL products are at the

leading edge in delivering the full value of integrated digital power management. We are excited to partner with Linear Technology to jointly advance the application of digital power solutions to an expanding group of high-volume infrastructure customers."

The PX7510 and LTC7510 are singlephase, step-down DC/DC controllers that provide for outputs down to 0.7V. A digital feedback control loop, combined with calibrated analog functions, provides a flexible, high performance solution. The industry-standard PMBus interface is used to implement all control functions via on-chip non-volatile memory, enabling easy design optimization with minimum component count for clean and efficient designs.

www.linear.com

www.primarion.com

IGBT Chip Line on 6" Wafer Fabrication



As of the 1st of January 2006, ABB Switzerland Ltd has converted its BiMos line in Lenzburg, Switzerland from 5" to 6" wafers. The conversion was started in late 2005 and officially completed for the New Year with exclusively 6" wafers now in process.

The change was essential to meet the demand for IGBT dies not only from ABB's own IGBT module production line but also from foundry customers who have generated a 25% CAGR since 2000.

The original BiMos fab, which started operations in 1998, was designed exclusively as a high power IGBT line and built entirely "from scratch" for power BiMos devices. As such, it is the most modern dedicated HP IGBT line in the world. ABB builds its own IGBT products in a local (but separate) encapsulation facility for modules and press-packs.

The line conversion has allowed an immediate 50% increase in capacity. "Not only did the conversion go to plan", says ABB's VP of Production, Tom Devine, "but it did not negatively impact any of our promised deliveries and additionally, we are enjoying even higher yields than on our former 5" equipment".

ABB has now discontinued all NPT and PT (non-punch-through/punch-through) IGBT chips in favour of its flagship SPT technology (soft punch-through) which is implemented across the full voltage range of 1.2 to 6.5 kV.

The new line will, off-course, also produce ABB's benchmark IGBT technology "SPT+" which was officially announced at PCIM Nuremberg in June 2005. This new generation of IGBTs will enter volume production in the later half of 2006, initially covering the voltage range of 1.2 to 4.5 kV. ABB will run both technologies on its new line for at least the next 5 vears

"ABB's IGBT investments in both devicedevelopment and production-capacity," says Roland Villiger, VP of Sales and Marketing "have propelled us to the same strong position in BiMos that we have traditionally enjoyed in BiPolar devices".

www.abb.com/semiconductors

Power Events

- PCIM Europe 2006, May 30 June 1, Nuremberg, www.pcim.de
- SMT/HYBRID 2006, May 30 June1, Nurembera, www.mesago.de
- SENSOR/TEST 2006, May 30 June1, Nuremberg, www.sensor-test.de
- EPE-PEMC 2006, Aug 30 Sep 1, Portoroz, Slovenia, www.ro.feri.uni-mb.si/epe-pemc2006
- MICROSYSTEM, October 5 6 , Munich, www.mesago.de
- ELECTRONICA 2006, Nov. 14 17, Munich, www.electronica.de
- SPS/IPC/DRIVES 2006, Nov. 28 30, Nuremberg, www.mesago.de

POWERpuzzler #11

(Z) is Key, the Importance of the Loss Allocation Factor

est your power supply design knowledge as it pertains to power delivery by trying your hand at answering the three questions below. Check your answers at www.powerint.com/puzzler11 and enter for a chance to win a new Apple iPod Nano.

The schematic below shows a 32 W average (81 W peak) Flyback power supply using a PeakSuitch power conversion IC. In a Flyback converter, output power can be expressed as follows:

$$P_{\alpha} = \frac{1}{2} \cdot L \cdot (I_{\alpha}^{2} - I_{\alpha \alpha}^{2}) \cdot f \cdot \frac{\eta}{Z \cdot (1 - \eta) + \eta}$$

where L is the primary inductance, I were is the initial and I wis the final primary current value for each switching cycle, f is the switching frequency, and η is the efficiency. The loss allocation factor (Z) indicates the proportion of losses between primary and secondary and is defined as secondary side losses divided by the total losses of the supply ($0 \le Z \le 1$). A value of 1 indicates that all losses are on the secondary side of the power supply while a value of 0 indicates all the losses are on the primary side.



Question 1: beginner

If the primary winding copper losses are increased by 100 mW and the secondary winding copper losses decreased by 100 mW.

a) What is the effect on the Z factor?

b) What is the effect on the primary inductance value?

Question 2 : advanced

Indicate in the above design which of the highlighted losses are primary (P) or secondary side (S) losses.

The answers to these questions can be found at www.powerint.com/puzzler11. Check out how well you did and enter to win an Apple iPod nano!



Question 3 : expert

For the following supplies would you expect the Z factor to be less than 0.5 (Primary dominated losses), equal to 0.5 (Balanced losses) or greater than 0.5 (Secondary dominated losses)? In what ways would you verify the Z factor in the above design?

Power Supply Application	P, B or S
3 W Cell phone charger	
25 W Set-top box supply	
DC Input standby power supply	
32 W (81 W peak) inkjet printer supply	

Power Integrations Introduces Industry-First Integrated Switcher IC Family With Peak Power Capability

PeakSwitch reduces cost of power supplies for printers, PVRs, modems and more

ower Integrations has introduced PeakSwitch™, a new family of ICs for power supplies with peakto-continuous power ratios of up to 3:1. The industry's first monolithic powerconversion IC with peak-mode operation. PeakSwitch enables highly integrated, energy-efficient power supplies for applications such as printers, personal video recorders (PVRs), audio amplifiers. broadband modems and DC motor drives.

Printers—an ideal application for PeakSwitch-require steep, momentary spikes in power delivery when a print job is initiated. For example, an inkjet printer that operates at a continuous level of 30 W during printing might require a burst of up to 80 W in order to activate the paper-advance motor. PeakSwitch sup-

plies this burst by automatically increasing the switching frequency of the IC's integrated MOSFET for several milliseconds before returning to continuousmode operation. This approach allows the use of transformers, capacitors and other components sized for the power supply's average continuous power rather than its peak power level.

PeakSwitch features a 700 V MOS-FET and low-voltage control circuitry integrated on a monolithic IC. The device employs ON/OFF control, providing low standby power consumption as well as constant active-mode efficiency. This enables compliance with all current energy-efficiency standards, including the proposed ENERGY STAR efficiency

standard for printers, which specifies power budgets during standby, sleep and active operation. Other key features include integrated auto-restart, hysteretic thermal shutdown and integrated freauency iittering to minimize EMI.

Until now, power supplies had to be over-engineered to accommodate high levels of peak power use. With PeakSwitch, designs only need to accommodate a power supply's continuous power requirements. As a result, designers can use smaller transformers and other components, resulting in a lower-cost power supply.

PeakSwitch is available in lead-free. plastic through-hole DIP-8 and higher power standard TO-220 packages.

Complete documentation for the PeakSwitch family is on the Power Integrations web site.

Design support includes a data sheet, an application note (AN-41), a Reference Design Kit (DAK-93) containing an operational 32 W continuous, 85 W peak, universal input AC-DC power supply and product samples, and the company's power supply design software program.

www.powerint.com/peakproduct.htm



The TPS63000 buck-boost DC/DC converter delivers up to 96% peak efficiency over a wide input voltage range of 1.8 V to 5.5 V up to 1.2 A. Extending battery life in one-cell, Li-Ion powered multimedia handhelds, the TPS63000 provides up to 28% greater run-time compared to a standard buck converter with a 3.3-V output - all from a space-saving 3 x 3 mm² QFN package.





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Power Player

A 100 Years of Power Control

By Eric Carroll, Semiconductor Marketing Manager, ABB Switzerland Ltd

he operation by means of " electric motors of elevators, locomotives, printing presses, travelling cranes, turrets on men-of-war, pumps, ventilating fans, air compressors, horseless vehicles, and many other electric motor applications too numerous to mention in detail, all involve the desirability of operating an electric motor under perfect and economical control at any desired speed from rest to full speed"-Harry Ward Leonard, 1896.

And thus began a century of power control, initially with DC machines, progressing to Power Electronic (PE) switches by 1923 (ignitrons), through transistors, thyristors, Gate Turn-Off Thyristors (GTOs) Insulated Gate Bipolar Transistors (IGBTs) and Integrated Gate-Commutated Thyristors (IGCTs). The search for AC motor control and high power DC to AC conversion by nonmechanical means began in the pioneering days of Ward Leonard but was not realised till the early 30's with the use of mercury arc rectifiers (MARs) and commutation capacitors. The 50's saw MARs in truly large (20 MW) line commutated inverters for High Voltage DC Transmission (HVDC). Thyristors were used to make self-commutated inverters in the 70's but they remained complex and expensive. This period also saw the development of Darlington transistors



which made low voltage drives economically viable: a self commutated device for a self-commutated inverter—the drives industry never looked back. The IGBT followed in the early 80's but these were still "low voltage" devices. "Low voltage" can be defined as a blocking voltage below 1700V since this is the device rating for use in the upper end of the low voltage networks (690V). Medium voltage networks start at 2.3 kV_{BMS} (and go to 33 kV_{BMS}) but they need "high" voltage semiconductors which only became available as self-commutated or Turn-off Devices (ToDs) in the mid 80's in the form of the Gate-Turn-off thyristor (GTO).



Figure 1. World revenues of High Voltage Switches.

Finally, a ToD capable of controlling large motors was available and this device was quickly adopted first, by the traction industry and later, as costs dropped, by the motor drive industry. In a sense, modern high power electronics was born in the mid 80's with this new ability to make large inverters cost effectively. The ability to control AC power cheaply and efficiently would take inverters into completely new areas as shown in the graph below.

The arrival of the HV IGBT coincided with the need for medium voltage drives and versatile HVDC systems. This was quickly followed by the IGCT in 1996 and the advent of further markets such as wind power (a Ward Leonard problem in reverse!) and co-generation in which an engine or turbine produces electrical power and the normally wasted thermal power is used to heat buildings or towns. Such systems (typically 1-30 MW) can achieve overall efficiencies of 80%. The converters are needed to match generator speed to line frequen-

cy and improve power factor. Waiting in the aisles is the UPFC or unified power flow controller. Grouped under "FACTS" or "Flexible AC Transmission Systems", the UPFC acts as a combined static compensator and line voltage regulator. It regulates and stabilises the flow of power, effectively controlling line impedance and avoiding power surges which have caused some spectacular outages in Europe and America in recent years. These 50 - 300 MW systems will become more common in the coming years as transmission capacity saturates and PE solutions improve in efficiency and costeffectiveness. Leonard, who sought efficient speed control, was a contemporary of George Westinghouse who believed in the distribution of AC power. Their 19th century visions have been vindicated by a century of history and continue to be so by the rapid progress of today's Power Electronics.

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What the World Really Needs (from Power Management)

By Chris Ambarian, Senior Analyst, iSuppli Corporation

n 1917, Vice President Thomas Riley Marshall was presiding over a session of the United States Senate—a session in which (according to Gillespie Research) "... some Senators were vociferously expressing personal views about items the country needed. Finally, Marshall leaned over to John Crocket, the Senate's then chief clerk, and uttered what has become his famous cigar quote: 'What this country needs is a really good five cent cigar."

Given the state of the world and our ever more compelling need for energy efficiency, I observe that as an industry we're careening along, working away at delivering new things, and I question: are they in fact things that the world needs?

This venue isn't exactly the US Senate, but I do have a thought or two about what the world needs (and doesn't need) from us in power management.

1. We do need better power transistors - but not very badly.

"Better" at this point generally does not mean faster. At low voltages, parasitics due to packaging are usually more speed-limiting than the transistors themselves. At high voltages, the switches generally (for example, in motor drives) can't even be used at their maximum speeds; they are slowed down to limit noise from them and from associated rectifier recovery. So while it still makes sense to tailor transistor speed by application, transistor speed itself is no longer a limiting factor to most applications. (RF amps are one notable exception-and most people exclude these



from power management discussions.) For most intents and purposes, better means more of what we're getting now: a low-cost device with a continuous improvement in losses at any given switching condition.

There is one other "better" that comes to mind: higher temperature operation. This will be important in one-and perhaps only one-mainstream application area: transportation (which includes hybrid passenger vehicles on up to locomotives). These are harsh, highambient environments. The ability to raise delta T via a high junction temperature (as should be possible with SiC) could be a tremendous potential advantage. But this presents a problem for mainstream applications: no reasonable packages can withstand 300-500 degree junction temperatures for very long, and if they could, you'd need to keep any hot surfaces away from other components (and from consumers too).

2. We don't need a (much) less expensive power transistor. One well-known power management



Power consumption - lifecycle phases

- - Duty cycle 0...100%
 - Delay time typ. 325ns

The Best-Selling 2-Channel IGBT Driver Core

The 2SD315AI is a 2-channel driver for IGBTs up to 1700V (optionally up to 3300V). Its gate current capability of ±15A is optimized for IGBTs from 200A to 1200A.

The 2SD315AI has been established on the market as an industrial standard for the last four years. The driver has been tried and tested within hundreds of thousands of industrial and traction applications. The calculated MTBF to MIL Hdbk 217F is 10 million hours at 40°C. According to field data, the actual reliability is even higher. The operating temperature is -40°C...+85°C.

The driver is equipped with the awardwinning CONCEPT SCALE driver chipset, consisting of the gate driver ASIC IGD001 and the logic-to-driver interface ASIC LDI001.

Chipset Features

- Short-circuit protection
- Supply undervoltage lockout
- Direct or half-bridge mode
- Dead-time generation
- High dv/dt immunity up to 100kV/us
- Transformer interface
- Isolated status feedback
- 5V...15V logic signals
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Let experts drive your power devices

CEO once pointed out (with some resentment) that though they are more complex and expensive to manufacture, power MOSFETs cost less per ampere than rectifiers. Go ahead, take a look. It's true.

So why might we need better power transistors? If they were the pacing item in the pareto chart of either cost, or losses, or EMI, or some similar negative measure. If you look at those charts, however, you'll see that transistors are not really the pacing item in any of them. It might be argued that they are a large component of BOM cost; however, lowering the BOM cost will not facilitate greater adoption; in many cases, giving the transistors away for free wouldn't facilitate greater adoption. Looking at total cost, you'll see other factors like administrative or installation costs that far outweigh the cost of the equipment.

So while transistors are obviously going to cost less and less over time, they can continue to do so for purely competitive reasons. There are not many applications that will truly be enabled by a lower power transistor price, or disabled by a failure to lower their price.

3. We do need better rectifiers.

Better in this case means more ideal recovery characteristics, lower leakage, and of course, lower cost. At low voltages, this looks like the "smart" rectifiers that have recently been discussed and/or introduced by a handful of suppliers. These are power MOSFETs with smart drives; the only challenge here will be cost.

At higher voltages, we're talking about rectifiers with the recovery characteristics of SiC Schottkys, at the cost of silicon. Some products have been introduced with characteristics close to this ideal; others are already on the way that should get even closer.

4. We need a better packaging system for high temperature operation in hybrid vehicles.

See number 1 above.

5. We need a clear quantification of the benefits of digitalized power control ICs.

We don't even need better ICs as much as we need case studies on the use of digital control techniques in power. At this point in the development of digitalized power, it's a foregone conclusion for the thought leaders that the market will largely be converted. However, this has not yet been communicated to the rest of the power world in a clear format supported by data (which is what many require). Mind you, the data does exist (otherwise I can guarantee you that Intel wouldn't be planning to convert all motherboard power over to digitalized techniques as they are). It's just not available to most engineers, and not in a clear and convincing format.

6. We need isolators that can stand off high voltages and pass tons of information per second, at a cost less than optos.

Why do we need them? To facilitate the easy passing of digitalized-power quantities of information between primary and secondary, and between system levels. For some time, I have been speaking about the notion of a "power operating system" (POS), and the potentially huge efficiency gains available; this isolation function has been one of the hurdles that needed to be overcome in order to make the POS a reality.

Happily, a few manufacturers have recently announced such products. Analog Devices and Silicon Labs have them (and similar technologies are also contained in some more integrated chips offered by National Instruments). The Analog parts use MEMS techniques; Silicon Labs' parts use a nifty GHz-range mod-demod approach done completely in standard CMOS. Both are faster than optos (up to 100-150Mbits/sec, with propagation delays around 10ns or less), cost the same or less, and logically should not degrade over time the way optos do. These would appear to facilitate all kinds of isolation and level shifting in a much more straightforward fashion. It appears that now all we need is for everyone to know about them.

7. We need better software.

Software??? Yes, software. The burgeoning realm of digitalized power will soon bring to the fore the importance of software construction Software is as engineered and manufactured as any hardware product—and in digitalized power systems, it will be at least as important to realizing potential efficiency gains. We will rapidly discover that poor software construction in power will be just as destructive to efficiency as it has been in other areas of the world economy.

8. We need to unambiguously quantify what the NET energy impact of our components and our equipment is on the world.

As an example, let's look at air conditioning—an item that's pervasive, that consumes a tremendous amount of the world's energy, and that will be pretty darned important to us as the world continues to get hotter every year. What are the alternatives? Dumb AC motors with a contactor. Slightly more efficient AC motors, perhaps with a couple of contactors for 2 operating points. A smart motor system with a variable speed drive and perhaps an optimized compressor. Perhaps a fully integrated system with a more sophisticated feedback loop and a processor-based power management (optimization) system. We already have a lot of these pieces in place, and the imagination could certainly lead to even more-efficient innovations. But considering only what we already have to work with, it's a pretty short leap to discover that an efficient system with a VS drive pays for itself (in terms of lower energy consumption) in most cases in less than 2 years-and that assumes some significant cost to install it. Given that such systems last upwards of 10 years, this is a huge energy impact. In this situation, it seems to me that any country truly committed to greenhouse gas reductions would do well to mandate (or even hand out) VS drives for all new installations, and to heavily incentivize retrofits. We can see

the beginnings of how logistically this will work—or not work—with the USA's current federal mandate for the phaseout of 10 SEER systems and transition to 13 SEER systems (even though 13 SEER is still achievable without VS drives). It seems sensible to me to extend this thinking to much higher efficiency ratings.

As importantly, it seems to me that this analogy can be applied by marketers of components. The truly successful component now and increasingly in the future will be one that feeds into the megatrend of energy efficiency. Your product had better create higher efficiency for your customer. And as most of us know, often the customer needs to be educated on how their system or their efficiency will benefit from a truly innovative product. And once you've handed your customer a (quantified) way of justifying the use of your product, you then begin walking the often long and often unpredictable path of encouraging adoption. Further to the point of one of my past columns in this magazine, this path can on the one hand involve purely voluntary forces, and at the other extreme your technology can be picked up by government regulatory agencies and forced upon the market as the only alternative.

There was a really interesting paper presented at APEC by Pierre Gildert of Ericsson Microwave Systems, which showed the individual components of total energy consumption through the entire life of a base station (Figure 1). Viewed in this way, it was completely clear 1) where the greatest opportunities for efficiency gain lie in this application; and 2) what the measurable impact of new components of that system would be. I believe that truly savvy marketers will use this approach to not only drive and differentiate their products, but to also do a service to the world by accelerating the acceptance of them.



For an old hardware guy like me, I find it amusing that I'm beginning to sound like an endless loop regarding the primary importance of software construction and efficiency marketing. But mark my words—these are where the greatest impacts on the future of power lay. And given how important power electronics are to our future, I'm hoping that we'll get it right.

Meanwhile, I'm going to go have that cigar—even if it did cost a fair bit more than five cents.

Christopher Ambarian is a senior analyst with the market research firm iSuppli Corp., El Segundo, Calif.

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Optimizing Buck-Boost

Conversion in portable equipment

Portable devices become increasingly rich in new features, they of course call for more processing power, which inevitably requires more power hungry processors, or multiple processors.

By Jürgen Neuhäusler, Senior Systems Engineer, DC-DC Converters, Texas Instruments

s portable devices like mobile phones, smart phones, digital still cameras and media players become increasingly rich in new features, they of course call for more processing power, which inevitably requires more power hungry processors, or multiple processors. On top of that, the supporting circuitry adds still more to the total power demands of the application and intensifies both the need for batteries with high energy density and the need for good quality power conversion.

Typically, batteries used for these kinds of portable devices, are based on Li-Ion technology. New types will support a wider operating voltage range, which means that the maximum input voltages will get higher and it will be possible to discharge batteries to lower voltages. However, this will also alter

the requirements of the power conversion circuitry.

To achieve highest power conversion efficiencies, linear regulators are being replaced increasingly by switched mode regulators. The wider battery operating voltage also requires different switched mode converter topologies. Whereas step down converters have been widely used for achieving highest efficiencies, it is more often the case that converters capable of generating higher and lower output voltages than the input voltage are required, so called buck-boost converters.

The traditional approach to buck and boost conversion has been to use more complex topologies like SEPIC, Flyback or ZETA converters. Like both step down and boost converters, these converters still use one active and one pas-

sive switch for power conversion. Buck boost conversion is achieved by adding an additional capacitor and an additional inductor in the case of SEPIC and ZETA converters or, a transformer in the case of the Flyback converter.

For some niche applications, inverting converters, which generate a negative output voltage compared to the battery voltage, can be a suitable solution. The simplest topology for this is the inverting converter, whilst the Cuk converter is more complex. The Cuk converter uses additional passive components like SEPIC or ZETA.

Another option is cascading boost and buck converters. This means, for example, generating a high voltage system rail and using step down converters for the required voltage rails in the system.



Figure 1. Basic Buck Boost Converting Topology Circuits.



Figure 2. Basic Inverting Buck Boost Converter Topology Circuits.

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Figure 3. Basic H-Bridge Type Buck Boost Converter Topology Circuit.



Figure 4. Efficiency Curves of Buck and Boost Converters.



Figure 5. TPS6300X based Buck Boost Converter.

Finally an H-Bridge type of converter, with 2 synchronously driven active switches and 2 passive switches, can be used.

Adding passive components for buck boost conversion always adds to the size and cost of the complete solution and at the very least makes the converters significantly bigger. This is not usually desirable in portable equipment, where the main objective is to keep the solution size as small as possible.

All the buck boost converter solutions discussed above have one thing in common, the switch current is significantly increased in buck boost conversion. But higher RMS currents in switches and passive components increase the total losses in the converter. This means that the achievable efficiency is potentially affected as well. For reasonable efficiency, it is at least necessary to increase the size of the switches and passives to keep the losses low.

When analyzing the efficiency curves of a standard buck. or. boost converter. it can be seen that the efficiency has its highest values when input and output voltages are close. Figure 4 shows efficiency examples of a boost and a step down converter.

The ripple current in the inductor and in the switches is at its minimum as well. This makes it obvious that the optimum buck-boost conversion is a dual stage approach. Looking at the basic circuits shows that this can be done by only using one inductor and the required switches for boost and step down conversion. Finally, this looks like the H-Bridge type buck boost converter shown above. But to achieve maximum efficiency and low stress in the passive components, the topology has to be driven differently. The control circuit must take care of using only one regulator at a time whilst keeping the other regulator passive. This is done by operating the step down converter part in 100% duty cycle mode, when the boost converter part is needed and operating the boost converter part in 0% duty cycle mode, when the step down converter part is required to operate.

This means, that simply by increasing the complexity of the control circuit, the converter always operates at the highest efficiency possible. An optimum efficiency curve looks like a combination of the efficiency curves of a boost and a step down converter. In this case the maximum, which is most important, is achieved when input and output voltage is in a similar range. This is the most important operating condition of a buck boost converter, since it usually spends most of its operating time in that condition. This more complex driving scheme also keeps the inductor ripple low. This allows small inductor values to be used to get a small solution size for the converter. The low ripple current also supports using inductors with a minimum current rating. Together this keeps the total solution size to a minimum.

The TPS63000 device family from Texas Instruments exhibits a perfect implementation of this concept. In







Figure 6. TPS6300X Efficiency.



Figure 7. Li-Ion Discharge with Buck-Boost and Step-Down Converters.



Figure 8. Efficiency during Li-Ion Discharge with Buck-Boost and Step-Down Converters.

Figure 5 the complete circuit diagram for a buck boost converter based on this device is shown. Although the device is capable of supporting up to 800mA output current in boost mode and up to

1200mA in step down mode, it uses only three tiny external parts, which are two 0603 size ceramic capacitors at the input and the output and an inductor with a 3 x 3 mm footprint. The device

itself is packaged in a 3 x 3 mm QFN package, which also helps to keep the total solution size low.

Figure 6 shows the efficiency, which can be achieved with this device at an example output current of 600 mA at an output voltage of 3.3 V. For the reason discussed above it shows its highest efficiency in the area where input and output voltages come close to one another.

Using a step down converter as compared to a buck-boost converter to discharge a Li-Ion battery is shown in Figure 7 and 8. Figure 7 shows the output voltage of both converters and Figure 8 shows the efficiency of both converters during discharge of the battery.

It can be seen that, although buck boost conversion is less efficient than step down conversion only, it allows a Li-lon battery to supply a load for longer by being discharged down to lower voltages. The test was performed using the TPS63001 as a buck boost converter and the highly efficient TPS62046 step down converter. Both converters supplied the same load current of 600mA at 3.3V output voltage. The test was terminated as soon as the battery voltage reached 2.5V (buck-boost) or the output voltage dropped below 3.3V (step down converter).

POWEP Systems Design

Power Semiconductors Part I





Driver with Dynamic Voltage Rise Control

Improved turn-off performance of IGBTs

A new approach for the control of Trench-/Field-Stop IGBTs which results in optimised turn-off behaviour. Analysis of Dynamic Voltage Rise Control and experimental results for the high current IGBTs of the 1200V- and 1700V- families.

By Piotr Luniewski, Uwe Jansen, Michael Hornkamp, Infineon AG, Warstein

he main challenge for most engineers working in the power electronic field is to design a converter with an efficiency close to one. As far as only hard switching is considered, this idea requires that the device be applied as a current switch with transition times as short as possible and with low collector-emitter saturation voltage. Therefore, the use of Trench-/Field-Stop technology in IGBTs enabled a significant reduction in on-state voltage without increasing turn-off losses. For turn-off at high DC-link voltage, high current and low temperature UCE overvoltages limit the useful range of operation. Problems are especially severe if the parallel connection of IGBTs is applied.

Dynamic Voltage Rise Control (DVRC) [1] uses the du/dt as a mean to sense the turn-off of the IGBT and to initiate a recharging of the gate to avoid UCE overvoltages. Due to this unique mode of operation it is possible to achieve smooth switching without significant drawbacks.

The driver system used in the tests consists of a board containing a DVRCcircuit as well as a fast bipolar booster stage directly mounted on top of the IGBT-module and a standard eupec EiceDRIVER-Board 2ED300C17-S for supplying power, isolating the control signal and providing UCEsat-protection.

With this approach the DVRC-circuit does not suffer from design restrictions due to parasitic inductances in the gate circuit. Furthermore, this setup allows for easy paralleling since every module is driven by an individual booster-stage and protected against overvoltages by an individual DVRC-circuit.

In this contribution, the new gate drive strategy is presented and experimentally validated for two cases:

- phase leg consisting of single switch modules eupec FZ2400R17KE3
- phase leg configuration using two dual modules connected in parallel (eupec FF1200R12KE3).

Standard resistive gate control

The most common method to limit di/dt, when standard voltage drivers are used, is to apply bigger gate resistor values. Applied to Trench-/Field-Stop IGBTs an influence on di/dt can only be observed if the gate resistor is increased significantly. From the cost point of view this seems to be attractive, but this solution suffers from unacceptable losses when used for high power Trench-/Field-Stop IGBTs.

The minimum value of gate resistor which can be used to obtain the maximum operating values for the FZ2400R17KE3 without any kind of feedback is 3.60hm. In the application the nominal DC-link voltage may be higher than the DC-link voltage referenced in the datasheet (900V for 1700V IGBTs) and additionally voltage fluctuation of the DC-voltage link have to be taken into account. Therefore, IGBTs have to switch properly with voltages and currents higher than the reference operating values provided in the datasheet. For this reason the range of test voltage used in Figure 1 has been extended to 1300V. The proper IGBT operation in this case requires a gate resistor with a value of 130hm and leads to high switching losses. Using such a high resistor value is only done for reference purpose and not recommended.

Dynamic Voltage Rise Control - the proposed strategy

For the reasons described above the approach of using a voltage driver with gate resistor for di/dt limitation seems to be an old fashioned strategy, especially in modern, high power converters. Already for high current modules equipped with IGBT chips of previous generations most engineers have chosen more sophisticated methods of driving. Usually they apply some kind of feedback. Active Voltage Clamping (AVC) and variations applied for overvoltage limitation are well known and are the most used method in practice [2] [3] [4]. These methods use collectoremitter voltage as feedback to sustain

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MIC49200	S-PAK-5	2	1.0, 1.8, Adj.	1.4V to 6.5V	400
MIC49300	S-PAK-5	3	0.9, 1.2, 1.5, 1.8 Adj.	1.4V to 6.5V	280
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Figure 1. Comparison of energy losses during turn-off transients of FZ2400R17KE3 versus value of the gate resistor and DC voltage link when: I_C=const=2400A, T_J=125°C, L_O=50nH.



Figure 2. Block diagram for IGBT paralleling using DVRC technology.

the IGBT in conduction within a time mainly determined by stray inductance given by the high power circuit. Proper AVC operation forces the gate voltage to rise up and the collector-emitter voltage is limited as a result of the di/dt limitation. This mechanism works correctly if the collectorcurrent responds immediately to the gate voltage. Due to the large delay between the dropping of gate voltage below the Miller Plateau and the rise of collector-emitter voltage observed in Trench-/Field-Stop IGBTs methods which use collector-emitter voltage as direct signal for gate control cannot be employed.

The idea of DVRC (Dynamic Voltage Rise Control) is a form of AVC where one part of feedback signal goes directly into the gate of the IGBT but a second part is sensed by the capacitor and is used as the control signal to an a dditional source.

For operation below reference conditions the AVC is not in operation because the UCE voltage will not reach the AVC activation point. Additionally, the DVRC function is fully independent from the AVC and enabled only after the turn-off command for certain time period. This feature protects the IGBT

against unnecessary DVRC operation when significant voltage spikes across UCE appear caused by other effects such as diode turn-off.

Driving paralleled IGBTs with individual boosters

For most circuits in Power Electronics, especially in the high power range, the half-bridge is the elementary building block. Many design engineers have already recognised that overvoltages can be avoided more effective if the half-bridge consists of dual modules instead of single IGBT modules. This approach enables the reduction of stray inductance in the commutation loop. But since the current rating of dual modules is usually limited to one third of the rating of single IGBT modules this approach often makes module paralleling necessary.

To drive paralleled IGBTs two different strategies may be applied. Either one large driver may be used to drive all the paralleled IGBTs or each IGBT may be driven by an individual driver. Both approaches have their merits, but both suffer also from severe drawbacks.

Single driver: low part count, simple protection, long gate connections requires symmetrical gate circuit layout, and circulating currents in the auxiliary emitter circuit.

Individual gate drivers: short gate connections may be realised with standard drivers, high parts count, deviation in propagation delay will lead to asynchronous switching of the paralleled IGBTs, and protection functions need to be coordinated.

Successful implementation of the DVRC-circuit requires a booster stage to be located on the PCB mounted directly on top of the IGBT. This configuration also allows the driving of paralleled IGBTs and avoids the drawbacks of the approaches presented previously. The 2ED300C17-S driver, provides isolated power supply, control signal isolation and protection for all the paralleled modules. Each of the modules has its own DVRC-board mounted on top containing



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the DVRC-circuit itself, the booster stage and buffer capacitors for the power supply. Due to the booster being directly on top of the IGBT gate circuit the inductance is no longer a problem. This approach avoids the redundancy inherent in the system using individual drivers, reduces complexity and circumvents the problems resulting from tolerance and drift of propagation delay. The idea of this approach is shown in Figure 2.

Experimental Validation

The experimental validation of the DVRC function has been carried out for the FZ2400R17KE3 single power switch and two FF1200R12KE3 dual power modules connected in parallel. In both cases the investigated modules were connected in a half-bridge configuration. To minimize gate stray inductance and to provide better heat dissipation of the driver output stage, the investigated transistors have been equipped with dedicated PCB demo boards. All investigations were done with a fixed 20hm gate resistor value.

Investigation of Single Module FZ2400R17KE3

The target of this investigation was to reduce the E_{OFF} energy to an acceptable level. The main focus was to get the best performances when the reference operation values for the modules are significantly exceeded. Therefore, the presented results refer to a situation



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at which the collector current is greater than 2400A and U_{CF} is varied in a range from 900V up to 1300V. Fig. 3 presents typical curves for I_C=3200A, UCE=1300V. In this case the U_{DVBC} was set to a value of 700V and UAVC was equal to 800V. Figure 4 presents the E_{off} obtained for nominal collector current and for overcurrent with DVRC and also for nominal $I_{\rm C}$ and a standard voltage driver with a gate resistor of 130hm. It can be seen that DVRC saves approximately 60% of Eoff and provides smooth curves in contrast to the gate resistor method.

Investigation of two FF1200R12KE3 Modules Connected in Parallel

To check if the DVRC provides safe limitation under severe operating conditions a test with two paralleled dual modules FF1200R12KE3 was set up. Collector voltages were measured to check if there is appropriate overvoltage protection provided for both of the modules Although both collector voltages are not exactly identical this test showed that the circuit does not suffer from variations in propagation delays and that the maximum collector-emitter voltage is not exceeded by any of the modules.

Conclusion

This article demonstrates that the challenges imposed by using Trench-/Field-Stop IGBTs in IHM modules can be coped with by using advanced driving strategies. With the methods pre-





Figure 4. Comparison of energy losses during turn-off of FZ2400R17KE3 between DVRC and gate resistor method versus DC voltage link at: I_c=2400A/3200A, T_J=125°C, L_o=50nH.

sented here the power electronic designers working in the high power range can take full advantage of the low forward voltage drop of the newest generation of IGBT chip technology without drawbacks in switching performance.

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Motor Control Technologies Challenge modern high reliability design

Designers of aircraft, military vehicles and other high-reliability systems are under pressure to save weight and improve performance, cost, efficiency and maintenance.

By Jay Goetz, Field Applications Engineer, International Rectifier HiRel Products

potential solution is to replace complex mechanical actuators with electrical systems. New platforms for motor control design are required, which are capable of meeting all the qualification and support stipulations surrounding high-reliability equipment.

Going Forward, Going Electric

Many of the actuators controlling essential functions such as environmental control, cooling and oil or fuel delivery on board modern aircraft are driven by hydraulic or pneumatic systems. These tend to be heavy and complex, and frequently require the addition of a mechanical subsystem such as a gearbox or other transmission to fully perform the desired function. Increased use of electrical subsystems, not only in aircraft but also in ground-based military vehicles and high-reliability industrial equipment, can bring many advantages.

For example, the standard "bleed-air" system on-board passenger aircraft has been eliminated in certain aircraft types now entering service. Localised variable speed motors positioned at the point of application now perform the bleed-air system functions, including powering the environmental control systems, hydraulic cooling and Auxiliary Power Unit (APU) starting. Consequently, a large amount of heavy tubing has also been removed from the airframe. The world's passenger aircraft manufacturers are also working towards replacing traditional gear-driven engine fuel pumps with direct drive variable speed motors, to reduce weight and eliminate the high costs of precision mechanical assemblies.

Similar savings are also applicable to military aircraft, delivering advantages such as better acceleration, manoeuvrability and responsiveness through savings in weight and physical size. The build time for a new plane can also be reduced, while easier spares back-up and field maintenance also enhances utilisation and turnaround time.

On the ground, remotely driven vehicles for army reconnaissance, surveillance, and targeting roles are also benefiting from this migration to high electrical content. Hub mounted traction drives, electric power steering and drive-by-wire, for example, are helping to improve responsiveness and allow quiet "stealth" operation.

Implementation challenges

Suitable electrical technologies must support variable speed operation and high maximum torque, in addition to low weight and small size, to match the versatility of their mechanical predecessors. Permanent magnet motors are typically the most suitable technology, since they can more easily change speeds without gearing, deliver greater torque per Amp, and are smaller and lighter than alternative motor technologies such as induction motors.

This leads to a requirement for PM motor controllers that enable wide-ranging speed and torque control, allowing the emerging all-electric implementations to achieve sufficient flexibility and efficiency. Achieving a high degree of control over the motor also minimises other design considerations such as acoustic noise, thermal performance, reliability and longevity.

A number of motor control solutions present themselves. However, traditional techniques for developing suitable electronic controllers are relatively slow and expensive. An analogue controller, for example, although relatively straightforward to design, is usually difficult to fine-tune and has limited ability to support sophisticated diagnostics and protection features such as soft-shutdown in the event of an over current trip. Commutation sensors, such as Hall effect sensors are also required. These require additional cabling, increase costs and can impair reliability.

A sensorless design supporting sophisticated control and protection capabilities is highly desirable, and it is this desirability that is driving recent developments in digital control. Now due to advances in high speed processing and HVIC power management hardware, digital sensorless vector control is becoming possible with sufficient bandwidth performance to replace analoaue drives.

However, developing a suitable control algorithm from scratch is time-consuming and demands considerable software skills, which are expensive and may result in losing control over the design if an external design house is used. In addition, software destined for use in a high reliability application must be approved by the relevant body, such as a civil aviation authority or military equipment approvals agency acting for the customer government. The certification process increases the cost and duration of the project.

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subsidiary of Infineon has been fully integrated into Infineon Technologies AG. The former eupec GmbH operates now as Infineon Technologies AG Industrial Power, based in

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Never stop thinking

Some configurable, software-based control algorithms are now available, which help simplify the algorithm development process. These may be hosted on a DSP or other processor running a real time operating system. However, execution is relatively slow and is also not considered deterministic due to the multi-tasking nature of software-based processors.

In a high speed cooling system, for example, a realistic torque control bandwidth of 4kHz requires a maximum computation update period of 25 microseconds. But a high performance DSP may take 15-20 is to perform with a typical off the shelf digital motor control algorithm. Although the DSP can meet the update demand, it will struggle to perform other functions such as power management and motor/drive protection, and host communications in a timely manner.

Offloading the motion peripheral functions to a hardware coprocessor adds to design and bill of materials costs and impairs reliability. Moreover, any future required increase in torque control processing speeds would likely tax the DSP's capabilities.

The standard algorithms are also not necessarily available pre-qualified for high reliability applications. Furthermore, even if a suitable algorithm can be found, this alone does not address wider challenges such as power electronics design, analogue current sensing, power management, overcurrent and overvoltage protection, and integration of the entire solution.

Hardware Acceleration

Implementing digital control in hardware allows some of the performance drawbacks of a software-based controller to be addressed. The resources of an ASIC or FPGA, for example, may be configured to perform parallel processing in hardware, therefore accelerating performance. The processing can also be made deterministic by scaling the level of parallelism. On the other hand, there is little support for designers bringing up a hardware controller from scratch, and production volumes often do not warrant commitment to an ASIC.

The Motion Control Engine (MCE), which was created by International Rectifier for commercial applications such as variable speed control of domestic appliances, industrial drives, and other motion control systems, now delivers a configurable, off the shelf hardware controller to the market. This has made controller design significantly easier, and saves time for designers seeking the advantages of variable speed PM motor control.

The MCE contains an embedded digital Field Oriented Control (FOC) algorithm, which is compatible with PM and brushless DC (BLDC) motors. This algorithm has been parameterised with access by writing to registers implemented in configurable hardware. This is achieved using a spreadsheetbased configurator tool running on an ordinary Windows PC (figure 1). Adjustable parameters include the gain

Motor Data & Design Parameters

(Motor nameplate, Current limits,

Parameters Spreadsheet

Translate high level input

parameters to digital

domain parameters

ServoDesigner

Import/Setup parameters and

download to HRMxxx Configurable

Servo Amplifier

Figure 1. Hardware Configuration using a Spreadsheet-

based Tool.

User

Engineering parameters

parameters

Max speed, overload etc..)

of speed and current loops, PWM period, and deadtime. Other configuration options include symmetric or asymmetric operation, allowing maximisation of the torque control bandwidth. Start up sequencing is programmable with supporting diagnostic routines available to ensure smooth closed loop control entry. In addition, operational switches allow selection of 3-phase PWM for maximum startup torque, with subsequent transfer to 2-phase PWM for minimum switching losses during normal operation.

IR's HiRel iMotion platforms also comprise compatible gate drive, sensing and power electronic technologies to create a turnkey motor drive solution. The gate drive, current sensing, voltage sensing, power supply control and other analogue functions that interface between the digital controller and the power stage are implemented in an analogue control section that uses monolithic high voltage IC (HVIC) technology. The power semiconductors provided as part of the solution combine thin wafer, nonpunch-through (NPT) IGBT with ultrafast, soft recovery diode to minimise conduction and switching losses without excessive noise generation.

> Hence, this platform (figure 2) is capable of addressing the algorithm development, power electronic design and hardware integration challenges facing designers seeking all-electric solutions for aviation, military and high reliability industrial applications. To be usable in these designs requires all components to be further qualified for use in a high reliability environment.

Modular High Reliability Design

It is now possible to combine this proven digital motor control IP with selected peripheral components to create a ruggedised motor control module, self-contained and pre-qualified for high reliability applications (figure 3). A great deal of built-in protection can

High Current low RDS(ON) Trench MOSFET SIX-PACK

New DCB based surface mount package for automotive applications



TYPE	Ven Max V	T==25°C	los: T:=90°C	Reserver T==25°C mto	Quint typ nC	te typ Its	Lead Options Design and defines Lead Derived
GWM 220-004P3-xxx	40	190	145	2,0	94	70	BL - Bent Leads
GWM 160-0055P3-xxx	55	160	120	2,3	86	100	SMD - Surface
GWM 120-0075P3-xxx	75	125	95	3,7	91	90	Mount Device
GWM 70-01P2-xxx	100	70	50	11	110	80	St Straight Leads



28

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Features

- · Low Rosten)
- Optimized intrinsic reverse diode
- · High level of integration
- · Multi chip packaging
- · High power density
- · Auxiliary terminals for MOSFET control
- Terminals for soldering (wave or re-flow) or welding connections
- Isolated DCB ceramic base plate with optimized heat transfer

Applications

- Electric power steering
- Active suspension
- Water pump
- Starter generator
- Propulsion drives
- Fork lift drives
- Battery supplied equipment

Benefits

- Highest reliability
- Easy assembly
- Optimized EMI behavior
- Extreme low power loss





Figure 2. Pre-Integrated, Compatible Hardware Modules.

be implemented, including bus over-or under-voltage, over-current, improper supply voltage, substrate temperature, loss of phase, under-speed and over-speed.

Another advantage of this modular approach is an inherently small footprint suitable for embedding in "tight" locations. Assembling the power stage using Insulated Metal Substrate (IMS) technology, allows the module to be bolted directly to a heatsink or cold-wall such as an aircraft bulkhead. This eases thermal design challenges, and facilitates integration into demanding or intensive applications without compromising performance or reliability. IMS provides a cost-effective solution, and is more mechanically robust than alternatives such as thick-film ceramic substrate or direct bond copper.

Since all gate drive and power electronic components are included, the module can be connected directly to

the motor using only 3 phase wires. Depending on the module, the output stage may be built with MOSFETs rated to 100V, or IGBTs rated to 600V or 1200V, for example, to suit high-voltage applications such as an aircraft DC bus, or low-voltage applications such as battery fed portable system for Future Combat Systems (FCS).

Pre-Qualified for High Reliability IR has already created a family of high reliability modules for high-voltage and low-voltage motor drive applications. These are delivered pre-screened to MIL-H-38534, which specifies severe environmental conditions, and backedup by suitable high reliability manufacturer support infrastructure.

Designers seeking the performance advantages of electrical actuation in high reliability applications can use this technology to quickly implement accurate high performance velocity and torgue



Figure 3. Ruggedised Module suitable for Direct Connection to PM Motor and Direct Mounting to Heatsink or Bulkhead.

control for PM motors, operating at high speeds (up to 25,000 rpm or greater) over a wide speed (up to 20:1) range, without commutation or position sensors.

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A Programmable BLDC Motor Driver

Controller with self-adjusting EMC conform behaviour

Modern motor regulators have to fulfil contrary requirements. Mainly in automotive applications high power efficiency and very low RF emission (EMC conformity) are two key demands of switching regulators. A new driver chip and development system for PWM-switching regulators with programmable self adjusting slew rate regulation technology driving power-FET-switches is presented.

By Siegfried Ritz, Lutz Göhler and Steffen Becker, DMOS GmbH

he apparent advantages of electronically commutated (brushless) DC motors like reliability, wearresistance, small dimensions, noiseless running and good controllability of speed and torgue on one side confront high expenses for controlling and driving electronics on the other side. This high expense actually hinders the wide application of BLDC motors. The high EMC requirements (electro-magnetic-compatibility) especially in automotive applications often demand additionally, expensive filter devices in the power line of the switch regulator motor systems due to RF oscillations generated during the PWM-switching of the power devices.

A driver/controller chip should therefore realize the following main features to be able to drive power switches for regulated motors in a wide application range with optimized cost of the whole driver/controller module: High power efficiency of the driving system, Low RF emission of the switching regulator itself and Low system cost.

High flexibility of the control and regulation algorithm (software development tools). Programmability of driver func-

tions and parameters to adapt the chip to the particular application (motor size, measurement und protection functions).

The presented driver/controller chip E910.46 is designed to act as physical interface between the controlling device (e.g. μ C) and the power switches (power FETs) driving the motor. The implemented programmable self adjusting slew rate regulation technology is able to switch the power FETs very fast (low switching losses) without generation of RF oscillations in the power lines. This technology works with a digital regulation of the driver currents. So the switching regulator generates very low RF emission while it works highly power efficient.

The Chip

The E910.46 is a PWM BLDC motor driver / controller to implement a motor regulator together with an n-channel power FET B6-configuration and a μ C. The ASSP can be programmed by SPI and driver channel inputs, acting in different applications: brushless EC motor, brush DC motor in H-bridge configuration or as single PWM regulated high side or low side switching motor system. The programmability of parameters (e.g. threshold values of overcurrent, overtemperature, motor failures, EMC conditions, etc.) can be used to drive motors of widely different size (motor currents in the range from some A to more than 100 A).

The switching technology with programmable slew rate regulation parameters (patented) enables an excellent EMC behavior (very low RF emission in the whole frequency range) and a high power efficiency up to 96 % (fall/rise time of PWM motor voltage down to < 200 ns) at the same time. The system cost and module size can be reduced because additional filter elements in the power lines are not necessary.

Kev Features

- · High voltage supply in the range Vbat = 6.0 V to 58 V
- Driving of up to 6 external n-channel Power FETs (3 high side- and 3 low side switches)
- · Programmability of functions and parameters by SPI IP interface
- · Self adjusting driver timing and power FET protection

Delivering More Power to Next Generation of Power-over-Ethernet





LM5072 Features

- Only PoE solution that supports up to 25W power with backward-compatibility to IEEE 802.3af (13W)
- · Offers 50% and 80% maximum duty-cycle options
- · 100V Rating protects Powered Device (PD) against line transients

Ideal for use in VoIP phones, conference phone systems, remote security and web cameras, access control readers, wireless access points and print servers.



· Unique programmable auxiliary dominant mode automatically reduces Power Sourcing Equipment (PSE) power draw





Figure 1. Block diagram and typical application of the E910.46 driver/controller chip.

- Protection against cross conduction with programmable dead time
- High power efficiency
- Low RF emission due to the field programmable self-adjusting driver technology
- · Three current measurement amplifiers and programmable overcurrent protection
- Overtemperature detection and protection on chip and externally
- · Programmable analogue measurement channels (temperature and motor currents)
- Position detection by BEMF
- Sleep / Wake-up mode system
- 5V or 3.3V interface to the control device
- · Development-kits available (programmable board and software with PC Interface)
- Operating temperature -40°C ...+125°C
- Package PLCC68

Development System

There is a hard-/software development system using the E910.46 chip available

the development system board are: 1. driver/controller chip E910.46 2. µC MC9S12DP256 (16 bit Motorola controller)

The main components and features of

- 3. power part: three n-channel power-FET half bridges
- 4. interfaces:

PC interface (parallel or USB port) to control the board by PC software (Delphi), interface to the development system of Motorola controller, direct μ C interface, high speed CAN interface, power part interface, motor interface (power part): Three motor phases (EC Motor) or up to three DC (brush) motors or H-bridge motor application and three hall sensor interfaces.

The demo/development board includes two software systems: First the PC software (based on Window2000, NT or XP) with graphical interface to control the whole board

(registers of E910.46 and the μ C MC9S12DP256)

Second the μ C software realizing basic algorithms of motor control and regulation like motor current regulation, motor voltage regulation, motor speed regulation or different commutation methods like block commutation, trapezoid PWM or field oriented commutation.

The user has the complete control of the logical behaviour by software implementation into the digital control device e.g. µC. In this way all control/regulation strategies of the motor can be realized by software development and the user



Figure 2. Demo/Development Board using the E910.46 chip and the μ C MC9S12DP256.



Figure 3. Switching behaviour of the BLDC motor switch regulator with constant power FET-gate current drive.



Figure 5. Conducted emission on power lines of the motor switching regulator, PWM duty ratio 30%, Imotor = 10 A, VBAT = 13.5 V setup 1 (red): constant driver current 300 mA setup 2 (green): slew rate regulation technology

can find out the control optimum and implement own motor control know-how by software development. By using the direct *u*C interface the customer can connect a control device of his own choice.

From the customer's point of view the E910.46 Development System makes it possible to drive and control motors in different configurations and with different parameters, develop his own control software and establish motor controller/driver system solutions in a very fast manner.

Due to the graphical PC interface the customer can verify different driver parameters by simply typing in these parameters via a PC.

Figure 2 shows the hardware of the E910.46 development system with a 24V BLDC-motor (right hand side: power part B6 bridge and motor interface, upper side: interface to the PC and to the development system of the μ C. lower side: HALL sensor interface).

POWER SEMICONDUCTORS PART I



Figure 4. Switching behaviour of the BLDC motor switching regulator with programmable self adjusting slew rate regulation technology.

Application and Measurement Results

The main application is the control of "big motors" in automotive environment e.g. fan cooler, air condition, pumps or automatic gear box. But general purpose EC or DC motors can be driven, too.

The E910.46 can be used as the basic chip to develop customer or application optimized motor switching regulators or power FET drivers with excellent EMC behaviour in a fast and secure manner.

The chip has been tested with different motors, all could be driven in EMC conform manner by choosing suitable parameters.

Figures 3. 4 and 5 show some measurement examples. The difference between the transients of motor voltages for constant driver current (Figure 3) and slew rate regulated driver current is mainly the absence of RF oscillations (Figure 4). The representation of this EMC conform switching behaviour in the frequency domain is shown in Figure 5.

The E910.46 chip is fabricated by ELMOS AG. Dortmund Germany. leader in automotive ASICs and ASSPs.

emc-opt@dmos2002.de

10A, 28V DC/DC µModule in an IC Form-Factor

Distribute the heat from maximum of surface

A DC/DC µModule is complete high power DC/DC power supply with built-in inductor, power control, power components and compensation circuitry in an IC form-factor.

By Afshin Odabaee, Linear Technology Corporation

uring the past few years, the leap in the processing power of FPGAs and processors and advancements in the supporting chipsets, combined with improvements in board layout and assembly techniques have led to smaller and lower profile yet more powerful systems. Standards such as AdvancedTCA, CompactPCI and AdvancedMC rely on very densely populated boards and lower profile circuit components to safely stack multiple boards next to each other while ensuring efficient airflow between boards. Surprisingly, in many of these systems it's not only the myriad of digital or logic ICs occupying the board that inhibits further reduction in size and height of a system. The DC/DC regulator portions of the board have a significant impact on the size, height and reliability of the system.

Unless digital system designers are resourceful in designing and debugging switch mode power supplies or they receive exceptional expert design assistance from the DC/DC supplier, much of the PCB area is and performance is often wasted due to substandard DC/DC regulator circuits. A poorly defined and constructed DC/DC regulator affects the whole system: bulky inductors, capacitors and MOSFETs occupy too much space and restrict air flow; DC/DC regulator's low efficiency will raise the board temperature and may require more PCB copper for heatsinking; slow transient response will require additional output capacitors which requires board space and increases the cost of the system, etc.

System designers lacking DC/DC power supply design expertise and resources or who required a quick solution often turned to point-of-load (POL) DC/DC regulator modules. These solutions are pre-manufactured DC/DC switchmode power supplies. In essence, a POL module is an open frame DC/DC circuit built on a printed circuit board (PCB) with through-hole or surface mount configurations.

These DC/DC modules have limitations, as the demand for higher processing power systems with lower top-to-bottom profile, higher reliability and denser layouts have rendered the performance of most POL DC/DC regulator modules marginal and sometimes inadequate. Moreover, the limitations have even forced system designers to reluctantly return to discrete DC/DC regulators because the flexibility of a discrete solution can provide a smaller, lower profile and better performance regulator circuit than a similar power-level POL DC/DC module.

If the system designer decides to construct a DC/DC regulator from discrete components then the optimum performance is best accomplished with expert design assistance from the supplier of the DC/DC regulator IC. Design support is needed from the beginning up to layout of the power supply including recommendations for part selection and simulation. On the other hand, if fast time-to-market is more important, then an instant power supply (pre-manufactured DC/DC module) is the answer. The challenge is to find a smaller and thinner solution than existing DC/DC POL modules and to increase performance at the same time, without sacrificing the performance of the power supply. The options are very few.

The Challenge for Point-of-Load (POL) DC/DC Regulator Modules

The majority of POL DC/DC regulator modules target a 5V-bus, which limits the options for modules that can distribute 12V- or 24V-bus to point-of-load voltages. Although POL modules have been satisfactory solutions for many digital system designs such as in embedded systems, POL's size and performance have limited use in the



Figure 1. LTM4600 μ Module is a complete DC/DC power supply with on-board inductor, MOSFETs, DC/DC controller, compensation circuit and input/output bypass capacitors.



Figure 3. The LTM4600 μ Module only needs a resistor to set the output voltage. Input and output bulk capacitors are usually available on a system board.

new generation of faster, more powerful and smaller systems.

The size and performance of a POL DC/DC module depends on the technology and design of the resident DC/DC controller IC. Slow switching frequency and transient response, weak MOSFET gate drivers, and low efficiency contribute to an increase in size and profile of the DC/DC POL module. On the other hand, if a POL is constructed with a fast switching frequency DC/DC controller IC, poor efficiency due to switching losses of optimum MOSFETs leads to overheating especially at high output power. Many designers resort to larger PCBs with oversized components. POL data sheets indicate a dramatic reduction in

output power derating curves. In other words, it seems impossible to achieve high output power, high input voltage, and optimum thermal performance without increasing the size of the POL module—a trend that is not in line with the requirements of system designers.

Smaller but More Volts, More Watts

It's foolish to consider a high power density DC/DC circuit, in discrete or module form, without investigating the thermal performance of the solution. A 100W/in² DC/DC POL module is unimpressive if it runs at 130°C with plenty of airflow and heatsinking, or if it runs at a comfortable temperature with the output power drastically derated. A 20W DC/DC POL power supply module can

POWER SEMICONDUCTORS PART I



Figure 2. With no requirement for an external inductor, MOSFETs and compensation circuit, the LTM4600's 10A synchronous switchmode DC/DC conversion design resembles that of a linear regulator.

only be shrunk to 50% of its current size and profile with advanced switchmode DC/DC controller IC, exceptionally lower gate capacitance and low $R_{DS(ON)}$ MOSFETs and above all a packaging with ultralow thermal impedance.

Linear Technology has combined the two technical disciplines of analog IC and packaging design to introduce the first member of its high power, high voltage DC/DC μ Module family. A DC/DC μ Module is complete high power DC/DC power supply with built-in inductor, power control, power components and compensation circuitry in an IC form-factor (Figure 1).

10A DC/DC $\mu Module$ the Size of an IC

The LTM4600HVEV operates from input supplies as high as 28V (4.5V_{MIN}) and delivers up to 10A to loads requiring regulated 0.6V to 5V. The lower input voltage range version, the LM4600EV, operates from up to 20V_{IN}. Both feature a fast DC/DC controller IC with approximately 800kHz switching frequency and proprietary N-channel MOSFET technology with low gate capacitance and low $R_{DS(ON)}$ which are responsible for the LTM4600's high operating efficiency (Figure 5) and complete miniature power supply fitting a 15mm x 15mm x 2.8mm LGA package. The LTM4600 switching regulator μ Module requires no external inductor or input/output bypass capacitors (Figure 2). As a complete



Figure 4- Thermal imaging of the LTM4600 μ Module with 24VIN, 3.3VOUT at 10A. (see www.linear.com/micromodule for more images).

power supply, it also includes compensation circuitry which frees system designers from the worry of tweaking the power supply for different loads or load conditions (Figure 3).

Where existing POL DC/DC modules are built on large PCBs in an openframe fashion, the LTM4600 is encapsulated in a tiny and low profile 15mm x 15mm 4x 2.8mm LGA package. The μ Module weighs only 1.73g and mounts like an IC. It requires no special pickand-place tooling.

An impressive feature of the LTM4600 is its extremely low junction-to-ambient thermal impedance (θ_{IA}) of 15°C/W (no heat or air flow). The laboratory thermal measurements have shown 83°C for total μ Module PCB temperature with 25°C ambient temperature while converting 12V to 3.3V at 10A. This results in even smaller thermal impedance of 13.5°C/W (no heat sink or airflow). The device dissipates heat from the top and bottom of the package, taking advantage of maximum surface to quickly distribute the heat without overheating (Figure 4). The μ Module's θ_{IA} is further improved with the addition of heat sink and air flow. A detail analysis application note titled LTM4600 DC/DC μ Module Thermal Performance is provided on www.linear.com/micromodule.

Only 2.8mm Thin, Mounts on the Bottom of System PCB

A CompactPCI board with a densely populated top side has little room to



Figure 5- LTM4600's synchronous DC/DC Switching and proprietary MOSFETs provide very high efficiency over wide output load currents (24VIN).

accommodate the size of an existing DC/DC POL module. Instead of increasing the PCB area to accommodate the POL, the less densely populated bottom side of the system board may offer a solution; however, the height of these modules exceeds the required minimum distance between boards in systems with multiple racks. Two main reasons for the gap are prevention of accidental contact between two boards and ease of air flow around the boards for cooling of the components.

The LTM4600's profile is only 2.8mm (Figure 1). The 2.8mm profile is almost the same height as most digital ICs on the board such as FPGAs and DDR memory. When mounted on the bottom side of a board, the thin profile of the μ Module allows continuous airflow over the entire back side of the board with insignificant intrusion to the space between the two boards.

Ultrafast Response to Load Transients

A unique capability of the LTM4600 is its no-clock latency current mode architecture. This architecture allows the μ Module to respond quickly to rapid load current changes with minimal additional output capacitors. Instead of waiting for a full clock cycle to pass before responding to a load change, the LTM4600's response is instantaneous, eliminating up to five external load capacitors required with other solutions. When a load step occurs, V_{OUT} immediately shifts by an amount equal to ΔI_{LOAD} *(ESR), where ESR is the effective series resistance of C_{OUT} . ΔI_{LOAD} also begins to charge or discharge C_{OUT} generating a feedback error signal used by the LTM4600 to return V_{OUT} to its stead-state value.

During this recovery time, VOUT can be monitored for overshoot or ringing that would indicate a stability problem. The internal loop circuitry of the LTM4600 provides adequate compensation to prevent overshooting or ringing while delivering a fast transient response. Figure 6 shows 12V_{IN}, 1.5V_{OUT}, 0A to 5A load step with only 2% variation of output voltage. In addition to transient response curves for different input and output voltages, the LTM4600's data sheet includes a comprehensive table of output voltage response versus input and output capacitances. Table 2 in the data sheet shows droop voltage, recovery time and load step for a variety of input and output voltages and capacitors.

Paralleling Two µModules for 20A Output

Two LTM4600 μ Modules can be paralleled to provide more than 10A output current. The μ Module's integrated OPTI-LOOP compensation and current mode control ensures excellent current sharing between the two μ Modules. By accurately balancing the load current between two devices, the LTM4600 minimizes thermal stress and overheating, even at full power and at high ambient temperatures.

Connecting two μ Modules for parallel operation is very simple and requires no extra external components. Simply connect three pins, including the output pin, and the LTM4600 automatically shares the load current. Please see the data sheet for the circuit diagram.

Load and Input Protection

The LTM4600 has a current mode controller which inherently limits the cycle-by-cycle on-board inductor cur-



(COUT = 3 x 22pF CERAMICS, 470pF POS CAP)

Figure 6- Ultrafast Transient Response with Minimum COUT (2% VOUT with a 5A step.)

rent, not only in steady state operation but also in transient state. To further limit current in the event of an overload condition, the μ Module provides foldback current limiting. If the output voltage falls by more than 50%, then the maximum output current is progressively lowered to about one sixth of its full current limit value.

Moreover, to prevent inrush current during startup, a user-adjustable softstart timer allows gradual and controlled startup of the regulator. The LTM4600 also features an integrated output overvoltage protection circuit. In an overvoltage condition, the μ Module turns off the internal top MOSFET and the bottom MOSFET is turned on and held on until the overvoltage condition clears.

A Guide for Manufacturing, Soldering and Reflow

The μ Module self-aligns to the land pad using surface tension during the solder reflow process and inspection techniques closely resemble those techniques used for Ball Grid packages. However, many factors contribute to a highly yielding PCB assembly process. A guide provided for the LTM4600's LGA package focuses on key areas such as PCB design, placement accuracy, stencil design, reflow and many more subjects. The guide, entitled "Recommended Land Pad Design, Assembly and Rework Guidelines for DC/DC μ Module in LGA Package," can be downloaded at www.linear.com/micromodule.

RoHS Compliant and Mountable Using Pb-based Solder Paste

The LTM4600 is RoHS compliant. However, unlike many lead-free packages which include matte-tin lead finish, the LTM4600 is offered with gold-finish pads. Gold-finish pads allow the μ Module it to be used with either PbSnor SnAgCu-based solder pastes for surface-mount processing (Figure 1).

This unique feature is especially attractive to companies that have not yet converted to lead-free manufacturing, where the LTM4600 can be qualified immediately for surface mounting with Pb-based pastes. This way there is no need to re-qualify the LTM4600 once the company decides to pursue lead-free production. In addition, lead-free exempt manufacturers such as military and some industrial companies can take

POWER SEMICONDUCTORS PART I

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advantage of the LTM4600's compact design, with assurance that the μ Module is RoHS compliant. A copy of the LTM4600 RoHS material declaration is available at www.linear.com/micromodule.

Conclusion

The LTM4600 DC/DC μ Module represents a new architecture for point-ofload power supplies, significantly simplifying the power design task. Innovative DC/DC design and improved packaging technology allows a digital system designer with minimal analog knowledge to quickly construct a high performance DC/DC power supply.

In addition to ease of design, the layout and its assembly are simple and straightforward. The LTM4600 uses the same pick-and-place machines as the digital ICs on the board. Although this μ Module is capable of delivering high output power, its excellent thermal characteristics allow it to be placed near other ICs. The LTM4600's small size and low profile design mean that digital system designers no longer must sacrifice expensive board space or compromise performance of the point-of-load power supply.

Samples and demonstration boards for both LTM4600EV and LTM4600HVEV are available from local Linear Technology sales offices. A simple design simulation program is also provided at www.linear.com/micromodule which also includes design guides, thermal analysis, and assembly guides.

www.linear.com

Serialization for Ultra-Portables

Power between cycles is reduced

Serialization is increasingly being adopted in the ultra-portable market primarily because one of the most critical factors in ultra-portable applications is the minimization of power consumption. Through innovative techniques, it is possible to reduce the power far beyond the first generation of serialization devices for ultra-portables.

By Mike Fowler, Fairchild

major breakthrough for low power serialization can be attributed to the recognition of the following facts. The frequency of transmission of serial interface can be completely decoupled for the frequency of transmission of the parallel interface. As long as the serialization sends the data across the interface and makes it available at the parallel outputs before the next parallel word is required, then the interface will work just fine. The faster the serial stream the less power used. There are no drawbacks to sending the data across as quickly as possible and many advantages.

There are two types of power consumption-static and dynamic Dynamic power is consumed during signal transitions. Static power is consumed all of the rest of the time. But, static power varies dependent on the state of the device. An example of this is that static power during standby is much reduced from the static power during actual operation. Additionally, a common mistake is to believe that dynamic power is dependent on the frequency of operation. This is not exactly correct. Dynamic power is based on the number of signal transitions per unit of time, not frequency of operation. This common misperception is due to the fact that, in most cases, the frequency of operation and

the number of transitions are directly proportional or, may be described as equally spaced in time.

The amount of dynamic power consumed by 10 identical transitions (e.g. edge rate, voltage swing, etc) is the same whether the 10 transitions happen in 10 ns or in 100 ns. So, if the dynamic power cycle time can be reduced, compressed if you like, into the shortest period of time then the static power can be reduced between these dynamic cycles by powering down the circuitry to a minimum of 0.5 mA (ten to twenty times lower than a standard SerDes).

A guick wake-up between dynamic cycles is also achieved and necessary. Fairchild has termed this mode of operation burst mode, in which the data is burst across the serial interface at a much higher (word) frequency than the incoming data is presented at the parallel interface. In this way, the second generation u SerDes can go into a pseudo-power down mode between transmissions. As an example of the advantages of pseudo-power down, the CTL differential serial I/O is partially powered down to a state that consumes little power and, yet, still has the capability to start operation within a few nanoseconds. This burst mode allows for average current consumption of approxi-

mately 2 mA during continuous operation (at 5.44 MHz with the current implementation), which is on the order of 5 to 10 times lower than previous SerDes on the market. The burst mode/pseudopower down operation also has the added advantage that, for interfaces such as a micro-controller, the power between cycles is reduced. The current consumed during the pseudo-power down between operations is on the order of 250 uA. It is often the case, especially with micro-controller interfaces, that operation is not required for extended periods, though the interface must stav active. Since the micro-controller interface is not in constant operation (versus, for example, a pixel interface), the u SerDes will be in pseudopower down all of the time between operations versus just a full power down during well-identified, extended periods of non-operation (e.g. the flip is closed on a cell phone). iThe pseudo-power down, on the current generation, allows for current consumption, in this state, on the order of 25 to 100 times lower power than previous SerDes on the market. As was the case with our first generation u SerDes, the true power-down (standby) state still consumes approximately 100 nA. To summarize the power minimization affects, the latest device compresses the cycle of dynamic power to a minimum (burst mode), automatically



Figure 1. Replacing the PLL with a gated ring oscillator (GRO). Compared to the PLL that takes 50% of the μ SerDes chip area and consumes 50% of the power, the GRO is 30% smaller and consumes 60% less power.











goes to a reduced power state between active transmission (pseudo-power down), and can still be shut down to negligible power when extended periods are identified (standby). Another big advantage of the burst mode has to do with the freedom to set the serial frequency to any desired value which is due to the flexibility provided by decoupling the parallel frequency from the serial frequency. Since the serial frequency is no longer bound by the parallel frequency used, the frequency of serial operation can be selected for minimum interference in sensitive bands across all harmonics. The burst technique, itself, is proving that it can reduce EMI at the specified serial frequency of operation.

Another aspect of this breakthrough in low power was the ability to eliminate the use of a PLL requirement. As long as the serial frequency was tied to the parallel frequency of operation due to historical, rather than rational, reasons a PLL was required. Besides power reduction, the elimination of the PLL added many benefits. By using a free running oscillator in a fixed frequency range, much of the power and awkwardness of the PLL is eliminated. With our previous generation we were able to reduce the use of PLLs to one through innovative techniques that still allowed for serialization and a unique word boundary technique that assured that the word boundary was continuously identified. Some SerDes for ultra-portable applications are still using two PLLs. The elimination of the last PLL also eliminated the need for an external clock reference. The external clock reference is troublesome, at best, when dealing with a micro-controller interface which does not provide a clock signal. It is an awkward interface and, often, uses up one of the very precious GPIO signals.

Further advantages to decoupling the serial and parallel frequencies, besides power, also exist. For those applications that use spread spectrum, this technique also allows for the parallel acceptance and transfer of any amount of spread spectrum, as long as the maximum frequency of the device is not exceeded. It is easiest to understand this, once it is understood that the frequency of operation is not reliant on the frequency of the incoming parallel interface. There is no need to lock. You can send one word of data, wait days, if you like, and then send another word of data. Or, another way to understand it may be that there is no minimum frequency of operation. The advantage to no minimum frequency of operation also means that two (or any number, actually) very different frequency interfaces can be supported easily from the same device. One very serious restriction to using PLLs is that the range of frequencies supported is limited since the range of lock of the PLL is limited.

The ability to use a fixed frequency free running oscillator was also predicated on the recognition that decoupling the parallel and serial frequencies of transmission was beneficial. Further, by using an oscillator, it is possible to run a very low power clock at both the serializer and deserializer (versus the power hungry PLLs). In this way, the control of information and timing no longer needs to be coordinated by the serializer. By having a low power clock on both sides of the serial interface it is possible to shut down the serial interface as quickly as possible for purposes of minimizing power (entering pseudo-power down). All timing information is available on both sides of the interface independently. This becomes an even more powerful concept when used with a full duplex device where, by its nature, clocks are required on both sides of the interface, anyway.

The CTL differential serial I/O is also continuing to be tuned to reduce power as much as possible with the restriction of avoiding susceptibility problems. Susceptibility is the ability of a signal to be affected by radiated noise(causing bit errors). Extremely small swing signals can be sensitive to both electrical and radiated noise. CTL has proven to be a robust solution that, due to its differential nature and the innovative current sense receiver, rejects extremely large amounts of both radiated and electrical noise. Another noise culprit, that is unique to the radio world, is voltage standing wave ratio (VSWR) which is electrical noise generated by the radio signal if the antenna is not perfectly tuned. All of these noise factors were recognized early in our development of the u SerDes and, since then, Fairchild has been improving the CTL by reducing the power consumption to lower and lower levels (as well as EMI) while still assuring that CTL can accommodate all of the noise in the environment. An additional consideration for noise is the fact that the u SerDes is used in an environment where the two devices (serializer and deserializer) are in separate subsystems connected by a very fine set of wires. The voltage levels can vary greatly and the ability to filter out noise is quite small (without adding significant expense). Differential signaling is the only choice for such an environment.

A whole host of other advanced features are available in the second generation u SerDes, such as support for dual displays and SPI interface. Also, some of the original features that made that u SerDes so successful have been refined further.

This new approach that Fairchild is taking to u SerDes design is expected to reap further benefits in low power capability as it is refined. These techniques that are required have already been identified. Fairchild has three more significant generational improvements already in planning and definition that will address a wide range of issues, such as deficiencies in the relationship between SerDes and ultra-portable applications, general explicit trends that need to be implemented in SerDes, and a radical new approach that will break the serialization paradigm.

www.fairchildsemi.com

Oscilloscope Software Speeds SMPS Measurements

Measurements simplified by oscilloscope-based software

Switch-mode power supplies often need to make complex measurements-involving harmonics or switching losses, for example. The "Hi Power Finder" feature of the power analysis software achieves this by showing a summary of the number of switching events and the maximum and minimum switching losses in the acquired data.

By Dave Ireland, EMEA Marketing Manager, Design and Manufacturing, Tektronix

ngineers working with switchmode power supplies (SMPS) often need to make complex measurements-involving harmonics or switching losses, for example. These tasks are greatly simplified by the availability of oscilloscope-based power measurement software which offers powerful analysis features as well as speeding pre-conformance measurements to ensure that emerging designs will qualify for certification. The software both speeds up the measurement process and delivers consistent, repeatable results. This article shows how these techniques can be used to speed the measurement of switching losses in switch-mode power supplies.

New switch-mode power-supply architectures feature much higher data speeds and gigahertz-class processors that need higher current and lower voltages. As a result, power-supply designers face new pressures in the areas of efficiency, power density, reliability and cost. To address these demands, designers are adopting new architectures incorporating synchronous recti-

fiers, active power-factor correction and higher switching frequencies. These techniques, in turn, create new potential problems, including high power dissipation at the switching device, thermal runaway and excessive EMI/EMC effects.

The power loss that occurs during the switching process is a key parameter in understanding these effects. During the transition from an 'off' to an 'on' state, the power supply experiences higher power loss. The power loss at the switching device while in an 'on' or 'off' state is lower because the current through the device or the voltage across the device is quite small.

The inductors and transformers associated with the switching device isolate the output voltage and smooth the load current. These inductors and transformers are also subjected to switching frequencies, resulting in power dissipation and occasional malfunctioning because of saturation.

Because the power dissipated in a switch-mode power supply determines the overall efficiency of, and the thermal effect on, the power supply, the measurement of power loss at the switching device and the inductors and transformers assumes great importance-especially for indicating power efficiency and thermal runaway.

Accurately measuring and analysing this instantaneous power loss for different devices involves a number of factors. In establishing a test setup for accurate power-loss measurement, it is necessary to correcting errors caused by propagation delay in the voltage and current probes. Power loss needs to be assessed at a non-periodic switching cycle and analysed while the load is changing dynamically. In addition, the core losses at the inductor or transformer need to be established.

The oscilloscope-based power analysis software, which runs on the latest generation of Digital Phosphor Oscilloscopes (Figure 1), shares a common "look and feel" with the oscilloscope user interface to provide intuitive navigation and ease of use. Key features of the software include a facility

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Figure 1.The Tektronix DPOPWR power measurement and analysis software runs on the company's DPO7000 Series of Digital Phosphor Oscilloscopes (DPOs).

known as "Hi-Power Finder", sophisticated report generation, a ripple finder, the ability to make magnetic measurements, and a quick and efficient automatic de-skew capability.

Differential measurements

In a typical switch-mode power supply, the current is controlled by a MOS-FET driven by a 40 kHz clock. This MOSFET is not connected to the AC main ground or to the circuit output ground. Therefore, taking a simple ground-referenced voltage measurement with an oscilloscope is impossible because connecting the probe's ground lead to any of the MOSFET's terminals would short-circuit that point to ground through the oscilloscope.

Making a differential measurement is the best way to measure the MOSFET's voltage waveforms. With a differential measurement, it is possible to measure the drain-to-source voltage (VDS), which can ride on top of a voltage ranging from tens of volts to hundreds of volts, depending upon the range of the power supply. The safest and most accurate way of achieving this is with a true differential probe in conjunction with a wideband oscilloscope.

For current measurements through the MOSFET, it is important to fine-tune the measurement system. This is achieved using the built-in DC offset trimmers in the differential probe, which minimises the chance of a measurement error resulting from quiescent voltages and currents in the measurement system.

De-skewina

Before making any power loss measurement in a switch-mode power supply, it is important to synchronise the voltage and current signals to eliminate propagation delay. This process is called 'deskewing', and is greatly simplified by using a de-skew fixture along with the power measurement software. The deskew fixture is driven by either the auxiliary output or the calibration output signal of the oscilloscope, although if desired it can be driven by an external source. The de-skew capability of the power analysis software will automatically set up the oscilloscope and calculate the propagation delay caused by the probing. The de-skew function then uses the oscilloscope's de-skew range and automatically offsets for skew.

Dynamic switching parameters

The differential probe is also required

to accurately characterise and measure the differential switching signal. A Halleffect current probe allows the current through the switching device to be viewed without breaking the circuit.

The 'switching loss' feature in the new software automatically computes the power waveform, and measures minimum, maximum and average power loss at the switching device for the acquired data. This is then presented as turn-on loss, turn-off loss and power loss: all useful data for analysing power dissipation at the device. Knowing power loss at turn-on and turn-off allows the user to adjust the voltages and current transitions to reduce the power loss.

Dynamic loads

During load changes, the control loop of the switch-mode power supply changes the switching frequency to drive the output load, and the resulting power waveform will be non-periodic in nature. The advanced measurement capabilities of the power analysis software automatically compute the minimum power loss, maximum power loss and average power loss, providing additional information about the switching device.

It is very important to capture the entire load-changing event and characterise the switching loss to make sure that it does not stress the device. The "Hi Power Finder" feature of the power analysis software achieves this by showing a summary of the number of switching events and the maximum and minimum switching losses in the acquired data. All the user has to do is to choose the point of interest within the range and ask the Hi Power Finder to locate it within the deep memory data. This, combined with the previously mentioned switching-loss capabilities, helps the user to quickly and effectively analyse the power dissipation at the switching device.

Power loss at the magnetic component

Another way to reduce power dissipation comes in the magnetic core area. In a switch-mode power supply, the inductors will be subjected to high-voltage,



Figure 2a. Minimum, maximum and average power loss during turn-on at the switching device.



Figure 3. The result of using Hi Power Finder, showing power waveform at the switching device at load change.

high-current switching signals which are not sinusoidal. As a result, power-supply designers need to monitor the inductor or transformer behaviour in a live power supply.

The power analysis software allows rapid B-H analysis to be carried out directly on the oscilloscope without the need for expensive and dedicated tools or for an external PC. The inductor and transformer will have different behaviour during the turn-on time and steady state of the power supply, and the ability to perform B-H analysis directly on the oscilloscope provides instantaneous viewing.

This magnetic analysis capability also automatically measures power loss and inductor value in a real-world powersupply environment. To derive the core loss at the inductor or transformer, all that is required is to make power-loss measurements at the primary and the secondary.

Conclusion

Key features of the power measurement and analysis software described in this article, including the ability to measure the power loss at the switching device, the "Hi Power Finder" capability and B-H analysis, provide the tools necessary to make rapid measurements on switch-mode power supplies.



Figure 2b. Minimum, maximum and average power loss at the switching device during the load change.



Figure 4. Instantaneous B-H plot for the acquired waveform, showing cursor linkage.

When used with a Digital Phosphor Oscilloscope, the software allows users to quickly locate the power dissipation areas of interest and to view the behaviour of power dissipation in a dynamic situation.

www.tektronix.com

Isolation Amplifiers Offer Outstanding Dynamic Characteristics

Guarantee galvanic isolation from point of measurement

The task for isolation amplifiers is to capture signals over the frequency band from DC to 500 kHz. To do this correctly they need outstanding dynamic characteristics. It is also absolutely necessary to guarantee exactly faithful transmission of the measured signal, no overshoots, and constant rise and fall times in all measurement ranges.

By Helmut Rohrer, Rohrer Mess- und Systemtechnik GmbH, Munich

solation amplifiers, otherwise known as separation amplifiers, guarantee the necessary galvanic isolation between the point of measurement (input) and the evaluation (output) in drive technology, in EMC measurements, and in the measurement of interference potentials on power supply networks between conductors and earth. This provides protection during measurements against excessive contact voltage (on account of high common mode noise signals) and against electromagnetic interference (EMI).

It is important that the separation between the common mode noise voltage and the measured signal voltage is high (high common mode rejection ratio, CMRR, meaning limited influence of common mode interference). The amplification parameters must be exceptionally constant, which is ensured by automatic calibration when the amplifier is switched on. Moreover the connection impedances must not affect the result of measurement and must be independent of frequency. This article describes the

ARCUS T303-A isolation amplifier and the ARCUS 930 series from Rohrer Mess- und Systemtechnik.

The task for isolation amplifiers is to capture signals over the frequency band from DC to 500 kHz. To do this correctly they need outstanding dynamic characteristics. It is also absolutely necessary to guarantee exactly faithful transmission of the measured signal, no overshoots, and constant rise and fall times in all measurement ranges.

Common mode rejection

It is important that isolation amplifiers have high common mode rejection. Thus particularly critical steep high-voltage interference impulses are virtually completely eliminated during measurement. This must occur over all measurement ranges equally.

With the ARCUS isolation amplifiers the switchable measurement ranges extend from ±10 mV to ±3 kV, allowing measured signals to be optimally resolved over a wide amplitude range

with high precision. The switching of the amplifiers is so arranged that here also common mode noise signals are highly suppressed, and measured results in the smallest range of ±10 mV are not corrupted by various interference signals. Particularly in this small measurement range, it can happen that interference impulses superimposed on the measured signal, or high and steep common mode noise signals, drive the amplifier into saturation. To ensure that no important information is lost, the recovery time from saturation must be negligibly small. With a recovery time of 1μ s from an overshoot in filter position <off>, corresponding to the ARCUS amplifiers rise time, rapid recovery from saturation is demonstrated which is exemplary. This value applies moreover to all measurement ranges (Figure 1).

Autocalibration

Autocalibration is exceptionally important for long-term stability. Every time an ARCUS isolation amplifier is switched on, an automatic check is carried out on the amplification and the zero point.

MDmeshII Power MOSFETs with super-low R_{DS(on)} give even lower power losses and easier driving for all your high-frequency SMPS applications.

Innovative products for multi-segment application systems











This is an automatic offset- and amplification installation (without input divider and pre-amplifier). The calibration constants are stored in an EEPROM. This is particularly valuable in small measurement ranges and after the amplifier has warmed up. Full precision is reached about 20 minutes after switching on.

Moreover by a longer press on the CAL button, an internal test and calibration can be started at any time. During calibration the green LED in the CAL button blinks, the amplifier is not ready for operation, and the output voltage does not correspond to the input voltage. The calibration takes about 20 to 30 seconds. After successful calibration the green LED lights up again continuously. If an error condition is detected, the LED turns red. Having regard to the required precision of 0.1 %, digital transmission has been selected, corresponding in speed to the demands of the application. The analog frequency range

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Figure 2. Switchable filters ensure that undesired frequency

components are suppressed. The illustration shows how 50

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Hz interference is eliminated.



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Figure 3. ARCUS series 930 isolation amplifier and ARCUS T303-A measurement amplifier.

extends from DC to 500 kHz and is protected by an antialiasing filter at 800 kHz against mirror frequencies. A switchable signal filter enables suppression of interfering frequency components superimposed on the signal to be measured. This is particularly important during quasi-static meaurements, where for example 50 Hz interference can be eliminated. Thus common mode errors in the ±10 mV measurement range at 5 kV and 50 Hz are not evident. (Figure 2)

Measure and capture

Various measurement ranges ensure the exact capture of the signal. The ARCUS T303-A has two inputs, one from ± 10 mV to ± 10 V and the other from ± 20 V to ± 3 kV. The isolation proof voltage is ±10 kV. The versions of the ARCUS 930 series have different measurement ranges extending between ±10 mV and ±1 kV, and an isolation proof voltage of ±6 kV. A high analog measurement signal is sampled with a16-bit ADC at 8 MSamples/s and digitally transmitted to the receiver side. There with a DAC an output voltage is produced according to the ±10 V stan-



Range: ±10 mV - ±3000 V

obtained.

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dard, giving flexibility. Operation of the **ARCUS** isolation amplifiers is intuitive, and possible manually with keys and an LCD display as well as with a computer.

After switching on at the power source the last-stored configuration is shown in the display. The LED in the CAL button shows the current operational status. To enable several pieces of equipment to be addressed over an RS232 interface with the help of the ARCUS 937 multiplexer, each one can be designated with a separate address. Using the ARCUS 937 interface multiplexer, 16 isolation amplifiers can be connected to COM1 or COM2 with the hyperterminal, and controlled. Likewise the measurement range, filter, indication of the output value as mean, peak OS, peak SS, maximum and minimum can be set. To prevent the user from encountering an excessive contact voltage during the measurement, the isolation amplifiers are subject to isolation voltage testing up to ±10 kV (7 kVeff). The input resistance is 2.5 M Ω (10 M Ω in the ±3 kV range), so that permanent input protection according to the measurement range from ±1 to ±4 kV is

For further safety reasons, the amplifier output is permanently protected against short circuits. Naturally the amplifiers are tested for EMC and comply with the CE directives. The amplifier is connected to the power supply over a cold device connector. It is switched on by means of a power switch with power filter. The top model ARCUS T303A has, as described above, two measurement inputs, each with a Lemo high voltage socket. It is mandatory to close off the unused input with the isolation cap delivered with the amplifier, and inseparable from it, in order to ensure voltage stability. For measurement there is a specially made lead 2.5 to 2.7 m long. It consists of two screened individual leads with a proof voltage between core and screen of 6 or 10 kV DC. One end has a suitable Lemo plug and the other can be specially made according to requirement. An outer silicone rubber covering provides the lead with mechanical protection It is also temperatureresistant from -60 to +200°C (Figure 3).

Summary

Thanks to their construction the ARCUS isolation amplifiers are outstandingly well suited for measurements both in the very small voltage range and in the kilovolt range. In addition to exceptionally high common mode rejection, emphasis has been placed in construction on operational reliability. This is shown by the isolation voltage test, the high input impedances and the output short-circuit protection. These isolation amplifiers are distinguished by outstanding dynamic characteristics ensuring that every measurement is correct. For precision measurements, exactly faithful signal transmission and the smallest signal rise and fall times have been achieved. Autocalibration ensures consistently accurate performance.

www.rohrer-muenchen.de

ARCUS® Isolation-Amplifier protect Men & Measurement Equipment

Isolation Voltage: 10 kVDC - 7 kVat , CMRR: >160 dB at 50 Hz Bandwidth: DC - 500 kHz Low Pass Filter: WB - 100 kHz - 3 kHz - 5 Hz



Chip-Scale Transformers



in a wide range of end applications. The Si844x products offer 50 percent faster data rates than existing digital isolators and consume less than 12mA per channel at 100 Mbps (data rates >10 Mbps).

The Si844x isolator product family uses chip-scale transformers fabricated in a standard CMOS process to deliver the industry's highest performance, easiest to use, lowest cost, isolators for us

Providing the most integrated four channel isolator, the Si844x is three times smaller than competing opto-coupler solutions which reduces the bill of material cost by as much as 50 percent. These devices also

meet the industry's stringent component certifications for isolation components, speeding certification approvals thereby getting the customer to market faster. The patented architecture for the Si844x's involves a unique RF encoding/decoding scheme. Its operation is analogous to that of an opto-coupler, except that an RF carrier is modulated instead of light. If logic 1 is transmitted, the 2.1 GHz carrier frequency modulates the logic 1 input after which it is decoded once across the isolation barrier. If logic 0 is transmitted, then no carrier frequency will be generated thus indicating logic 0. This simple architecture provides a robust isolated data path and requires no special considerations or initialization at start-up.

www.silabs.com

Energy Storage Solutions for Industrial Applications

Maxwell announced that it has introduced 16 new Energy-type Boostcap ultracapacitor

cells and multi-cell modules as part of its unique product family strategy to better meet the diverse requirements of the automotive. transportation, industrial and consumer electronics markets.

Michael Everett, Maxwell's vice president and chief technical officer, said that all of Maxwell's multi-cell modules are specifically designed to meet end-user requirements for durability and maintenance-free

operation. They include internal cell balancing that give designers "plug and play"

solutions, plus module-to-module balancing that makes them versatile building blocks for systems with higher voltage requirements. They deliver up to 10 times the power and longevity of batteries, require no maintenance and operate reliably in extreme temperatures. In transportation applications, they efficiently recapture energy from braking for reuse in hybrid drive trains, reducing fuel consumption and emissions. They also provide compact, lightweight, "life-of-the vehicle" solutions to stabilize automotive power networks and power new, all-electric subsystems, such as drive-by-wire steering. In

mission critical industrial applications, where backup power is critical for continued operation or a soft shutdown in the event of power interruptions, they provide reliable, costeffective, maintenance-free energy storage. In wind turbine blade pitch and braking systems and other industrial applications, they provide a simple, solid state, highly reliable, solution to buffer short-term mismatches between the power available and the power required.

www.maxwell.com

2nd-Generation SiC Schottky Diodes

Infineon Technologies introduced its second-generation Schottky diodes based on silicon carbide (SiC) technology. With the thinQ! 2G family, the company that pioneered SiC Schottky diodes enhances the unsurpassed switching behavior of its previous generation.

The SiC diodes have at least double the surge-current capability and improved ruggedness compared to the first generation. This allows them to handle higher start-up inrush and over currents and makes them ideal for PFC

(Power Factor Correction) applications in SMPSs (switched-mode power supplies). Unlike other high-voltage SiC Schottky diodes, system designers and power supply manufacturers do not have to oversize the diode for a given application and can use smaller and cheaper diodes, which can result in a 30 to 50 percent reduction in diode costs and increased application ruggedness. "Infineon's SiC Schottky diodes

enable system cost reductions for SMPS manufacturers," said Dr. Gerald Deboy, principal technical marketing, Power Management & Supply at Infineon Technologies. "Reduced switching losses and higher switching frequencies allow the use of smaller, cheaper and fewer passive components and cost-effective transistors. We expect that our second generation will move the entry point for the use of SiC devices to significantly lower power levels."

www.infineon.com/sic

Micrel launched the MIC2285, the industry's first 8 MHz, 500mA synchronous buck regulator for portable applications. Merging the best of LDO and buck regulator technology, this breakthrough solution is aimed at space-sensitive applications including ultra-thin cell phones, PDAs, GPS systems, digital cameras, and portable media players.

"Today's portable applications continue to demand increasingly smaller solution sizes. Cell phone manufacturers in particular, are competing with each other to provide the consumer with the sleekest phones while increasing functionality at the same time," noted Ralf Muenster, Micrel's director of marketing for power products. "By using a 470 nH chip inductor, Micrel offers designers the

only step-down regulator that enables a sub-1mm height solution. This will enable cell phone manufacturers to design more appealing slimmer phones." Besides its small size, the MIC2285 high efficiency solution also features ultra-low noise and fast transient response. By incorporating a LOWQTM LDO mode, the MIC2285 offers the best of both worlds. Under light load conditions, it can be switched into the LDO mode using a LOWQ pin, offering low noise operation with fast transient response, while at full loads it offers the efficiency of a PWM buck regulator. In portable applications, the processor consumes a minimal current during sleep mode. In the LDO mode, the MIC2285 offers good efficiency since it

Digital-DC Power Management and Conversion IC

Zilker Labs demonstrated the industry's first power management and conversion IC that provides the configurability, control and monitoring capabilities of digital technology while exceeding the efficiency of analog solutions. The ZL2005 is fully configurable for a wide range of applications by simple pin-strap connections, resistor selection or via the device's on-board serial port using the industry standard PMBus (Power Management Bus) command set. Based on Zilker Labs' proprietary Digital-DC technology, the ZL2005 eliminates the need for programming and dramatically simplifies power supply design, thereby improving time-to-market for embedded electronic system manufacturers.

"Zilker Labs' Digital-DC technology enables world class efficiency, and unlike competing digital solutions, does not require software development. The ZL2005 is the first digital power conversion IC that overcomes these two main impediments to widespread adoption of digital power," said Jim Templeton, founder and vice president of marketing at Zilker Labs. "Zilker Labs has filed multiple fundamental and implementation patents on this innovative technology and we have a full compliment of Digital-DC based products in the pipeline."

The ZL2005 integrates a compact, efficient buck controller, high-current adaptive drivers and full power and ther-

Power Connector for MicroTCA

Tyco Electronics announced the MINIPAK HD connector designed to carry high density power and signal as required in the developing MicroTCA Standard. The MINIPAK HD connector is designed to carry 280 Amps of current plus 72 signal contacts in a space of just 65mm X 27mm. The connector delivers current density exceeding 170 Amps per square inch and is designed to meet the output requirements of the Power Entry

Module for the MicroTCA Standard. "Tyco Electronics' MINIPAK HD connectors feature a popular hot-pluggable contact design to minimize contact damage during live mating and unmating cycles," comments Mike Blanchfield, global product manager for MINIPAK HD connectors.

The MINIPAK HD connector utilizes a flat-rock seating design for the compliant press-fit vertical receptacle. The mating

consumes a mere 20uA quiescent current. When the processor wakes up from sleep mode to full power mode, the LDO in the MIC2285 is able to provide the current step required with minimal output capacitance while the switching regulator takes over to power the processor. The IC operates from 2.7V to 5.5V input and features internal power MOSFETs that can supply up to 500mA output current in PWM mode. It can also operate with a maximum duty cycle of 100 percent for use in low dropout conditions. The MIC2285 is available in the 10-pin 3mm x 3mm MLF package with a junction operating range from -40°C to +125°C.

www.micrel.com

mal management functions in a single package, eliminating the need for complicated power supply manager chips and numerous discrete components. The ZL2005 is designed to be a flexible "building block" for DC power and can be easily adapted to designs ranging from a single-phase power supply operating from a 3.3 V input to a multi-phase supply operating from a 12 V input. In addition, the ZL2005 is the only solution on the market to integrate the PMBus code into the IC, allowing system designers to easily implement the benefits of the PMBus protocol.

www.zilkerlabs.com

right angle plug utilizes solder tails designed to accommodate pcbs from 0.062" to 0.093" thick. Tyco Electronics' MINIPAK HD connectors are RoHS compliant.

Samples and literature for Tyco Electronics' MINIPAK HD connectors are available through Tyco Electronics Sales Representatives.

Profiled Heatsinks



Extracting the heat from electronic components and devices under difficult conditions, in positions which are difficult to access, in both stationary and mobile applications, is often only possible by using tailor-made heatsinks.

In order to enable customers to cope with these special circumstances,

Fischer Elektronik offer particular lamella heat sinks designed to suit specific applications. These heat sinks consist of gooved plates made from aluminium or copper into which, in a special process, sheets made from the same materials are pressed or glued.

The lamella heatsink is designed in such a way that the desired dimensions and also the required thermal characteristics are achieved. It should be noted that this type of heatsink can only be used with forced convection, i.e. with air movement created for example by a fan.

Fischer Elektronik offer versions with single-sided or double-sided bottom plates, on which the components from which heat is to be withdrawn, are mounted. The customer can decide upon the thickness of the bottom and the other plates, as well as the overall dimensions to suit his requirements. The user should provide a sketch on a proforma provided for this purpose.

Other features such as drilled holes, threads, milled areas etc. and also various surface finishings are provided in accordance with customers' specifications.

Please contact us, our specialists will be pleased to give you additional information and advice.

www.fischerelektronik.de

3-Phase Drives Motor Control Kit



STMicroelectronics has released a Motor Control Reference Design Kit which will simplify the evaluation and implementation of practical 3-phase BLDC (Brushless Direct Current) and AC drive applications across three power ranges, up to 3kW. The dedicated ST chipsets used in the design provide smooth, quiet and efficient motor operation, yet the kit is quick and easy to set up, and CAD files are available to enable the layout to be reused directly in the production application.

The modular four-board kit consists of a control board, the STEVAL-IHM001V1, and three power boards – the STEVAL-IHM003V1/004V1/005V1 – which are designed for 300W, 1kW and 3kW motors. Its hardware architecture is based on an inverter topology designed for a range of 3-phase applications, including AC Induction Motor, PMDC/AC or BLDC/AC (6-step sensorless) control, and PMAC or BLAC (sinusoidal driven, with Hall sensors), as well as for single and 3-phase UPS (Uninterriptible Power Supplies).

The inverter stages of the power boards consist of six rugged, short-circuit protected IGBTs, with current capability determined by the board's power rating. The 300W and 1kW boards can operate directly from an AC or DC power supply, while the 3kW board uses only DC power; all provide an auxiliary power supply, and are host to the Control board via in-line connectors. The partitioned design between power and control boards provides highly effective system noise immunity.

Control of the reference design kit is based around an ST7FMC microcontroller, which is designed specifically for motor control applications and offers significant performance benefits compared to DSP-based MCUs. A dedicated graphical user interface enables easy configuration, with firmware libraries enabling customization to meet particular user requirements.

www.st.com/rdk



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SmartRectifier increases System Efficiency



International Rectifier introduced the IR1167 SmartRectifier IC for AC-DC power converters for laptops, mini-PCs, LCD and PDP televisions, game systems and other digital computing and home entertainment systems. The SmartRectifier IC simplifies and improves efficiency in secondary synchronous rectification (SR) in high power flyback and resonant half-bridge converter circuits, enabling smaller, cooler designs.

"In 100W to 300W flyback circuits, traditional complex and bulky current transformer control circuits waste energy because large reversing currents are required to sense polarity shifts through the SR MOSFETs. In contrast, IR's new SmartRectifier IC employs a new technique for precise, direct sensing of voltage thresholds across the SR MOSFETs, allowing fast, accurate control to minimize power losses," said Stephen Oliver, marketing manager at International Rectifier.

"The IR1167 can increase overall system efficiency by 1 percent and reduce MOSFET temperature by 10 degrees, while slashing SR parts count by 75 percent," Oliver added.

The IR1167 SmartRectifier IC uses IR's proprietary HVIC technology, making it compatible with all MOSFET gate types and offers direct connection to

IR's wide range of 30V to 200V SR MOSFETs. The benefits of the IR1167 SmartRectifier IC are further enhanced when used with IR's MOSFETs featuring optimized on-resistance and gate charge characteristics, such as the IRF7853, IRFB4110 and IRFB4227. These optimized MOSFETs work with the IR1167 as a "total chip set solution" to further maximize efficiency and power density in SR circuits.

Since the new IC works independently from the primary control, it can be used in a variety of transformer switching modes and applications with capacitive output filters. Independence from the primary side means that the IR1167 operates in low power "burst modes" to enable "1W Standby," and California Energy Commission (CEC) 80Plus compliance.

www.irf.com

Parts in SOD87 MiniMelf

Diotec replaces discontinued parts in SOD87.

The discontinued SOD87 series of semiconductor diodes at other vendors is replaced completely. Since many

years, Diotec is supplying equivalent parts in the MiniMelf package, and additionally alternatives in Melf, SMA und SMB. To make life easier for design engineers and purchasers, Diotec is

offering a complete cross reference list at:http://www.diotec.com/service/files/ne ws023_sod87replacement.pdf

www.diotec.com

	Companies in this issue				
Company	Page	Company	Page	Company	
ABB Lyon	1	International Rectifier	·C4	PowerSem	
ABB Switzerland	C3	International Rectifier .		Rohrer Mess &	
ABB Switzerland	1,6,10	Intersil		Rohrer Mess &	
Advanced Power Technology .	41	Intersil		Sanrex	
Anagenesis	1	iSuppli		Semikron	
Ansoft	11	IXYS		Silicon Labs	
Ansoft	1	LEM Components		ST Microelectro	
Artesyn Technologies	1	LEM Components		ST Microelectro	
CT-Concept Technology	13	Linear Technology		SynQor	
Danfoss	50	Linear Technology		Tektronix	
Danfoss	1	Maxwell		Texas Instrume	
Diotec	56	Micrel		Texas Instrumer	
DMOS	32	Micrel		Tyco Electronics	
Eupec	27	National Semiconduc	tor	Zilker Labs	
Fairchild Semiconductor	C2	National Semiconducto	r1,4		
Fairchild Semiconductor	1,40	Ohmite			
Ferraz Shawmut	15	On Semiconductor			
Fischer Elektronik	54	PCIM Europe			
Fuji Electric Device Technology	/31	PCIM Europe			
ICE Components	41	Power Integrations .			
Infineon Technologies	1,22,52	Power Integrations			
Ŭ		Ū.			

Please note: Bold-companies advertising in this issue

age	Company	Page
.C4	PowerSem	55
6,56	Rohrer Mess & Systemtechnik	51
,19	Rohrer Mess & Systemtechnik	48
1	Sanrex	54
.12	Semikron	1
.29	Silicon Labs	52
3	ST Microelectronics	49
1	ST Microelectronics	54
5	SynQor	1
6,36	Tektronix	44
.52	Texas Instruments	9
.23	Texas Instruments	1,16
,53	Tyco Electronics	1,53
.33	Zilker Labs	53
.1,4		
1		
1		
.45		
4		



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Configuration	3-phase driver	3-phase driver	3-phase driver
Voltage	600V	600V	600V
Dead time (DT)	290ns	2.5µs	1µs
Soft shutdown duration time	No	No	6.0µs
tortott	400/380ns	675/425ns	550/550/ns
Matching delay	40ns	No	100ns
Drive current Ip./Ip.	200/350mA	200/420mA	220/460mA
Desaturation blanking time	No	No	4.5µs
Independent half bridge driver	No	Yes	No
Cross conduction prevention logic	Yes	Yes	No
Undervoltage lockout	Yes	Yes	Yes
Integrated brake driver	No	No	Yes



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