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Bodo´s Power Systems

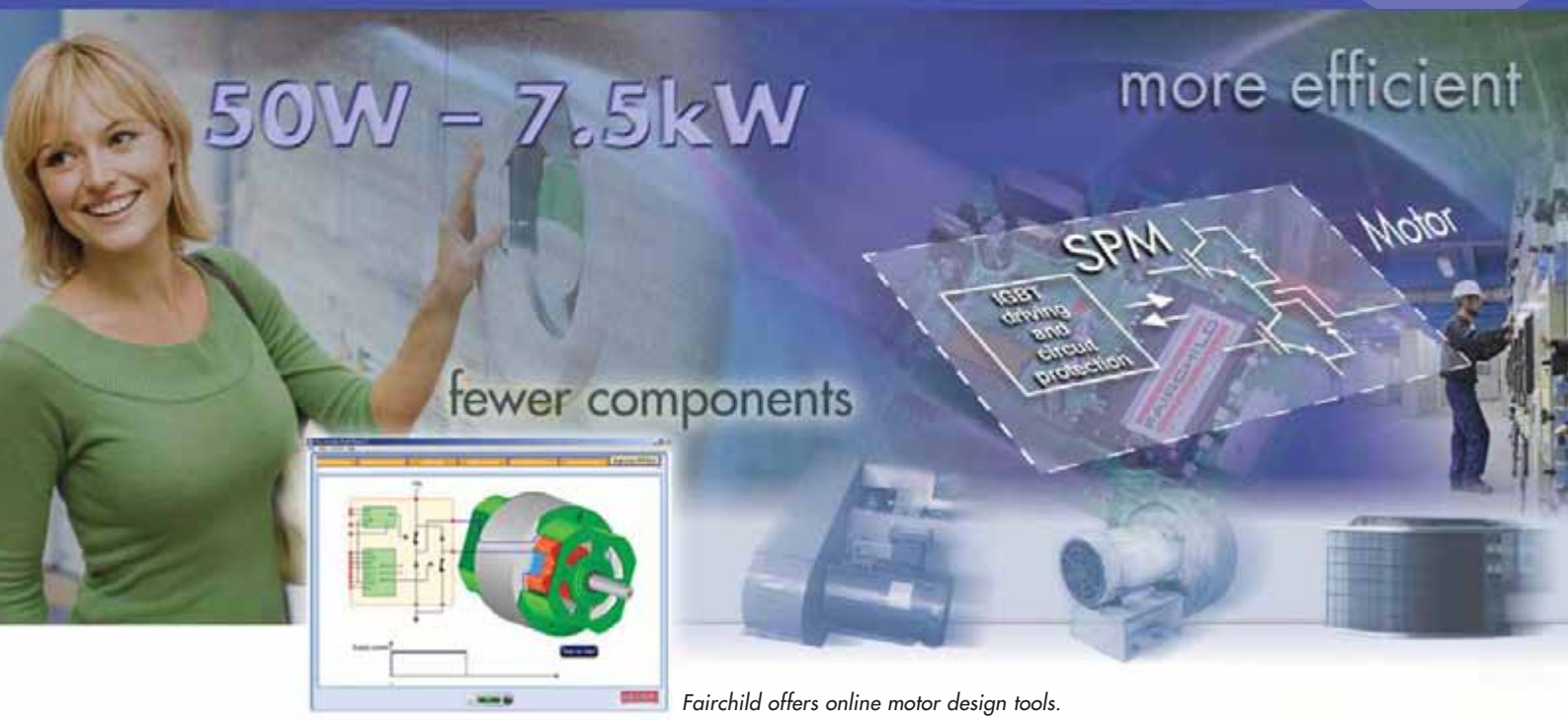
Systems Design Motion and Conversion

March 2007

IGBT Modules
Optocouplers
Battery Charger

FAIRCHILD
SEMICONDUCTOR®

Energy-saving inverter designs: 50% less cost, size and time.



Fairchild offers online motor design tools.

Integrated power modules simplify your designs

Smart Power Modules (SPM™) are just what you need to dramatically improve the performance/cost ratio of variable speed designs. Available for motor ratings from 50W to 7.5kW, every SPM includes:

- An integrated drive and protection solution built with our leading power components
- Fairchild's combined power and motion design expertise
- Best-in-class packaging technology that reduces board space while providing excellent thermal performance

SPM Series	Motor Ratings	Description
Motion-SPM	50W to 7.5kW	3-phase IGBT or MOSFET inverter
SRM-SPM	2kW	Single-phase asymmetric bridge
PFC-SPM	1kW to 3kW	Partial switching converter module
	3kW to 6kW	Power Factor Correction (PFC) module

Our SPM series includes solutions for consumer and industrial inverter designs, as well as options for switched reluctance and PFC.

If you prefer to build your own drive with discrete components, all the building blocks inside our SPM, including IGBTs, HVICs and MOSFETs are also available for your motion power path.

If energy and cost savings are your problem, Fairchild has your solution.

For more motor design information, including online design tools and application notes, visit www.fairchildsemi.com/motor.

problem **solved**

www.fairchildsemi.com

the power franchise™

Bodo´s Power Systems

CONTENTS

Bodo´s Power Systems

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Events

EMV 2007, March 6-8, Stuttgart, www.e-emv.com

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PCIM China 2007, March 21-23, Shanghai, www.pcimchina.com

TI Power Supply Seminars Q2, www.ti.com/europe/power07-b

Hannover Fair, April 16-20, Hannover, www.hannovermesse.de

SMT Hybrid, April 24-26, Nuremberg, www.mesago.de

PCIM Europe, May 22.24, Nuremberg, www.pcim.de

Sensor+Test 2007 May 22.24, Nuremberg, www.sensor-test.de

EPE, September 2-5, Aalborg DK, www.epe2007.com

Electrical Power Quality and Utilisation, Oct. 9-11, Barcelona. www.epqu2007.com

Semiconductor Industry Anniversary Birthdays

My life has been greatly influenced by electronic innovations. Previous generations laid the foundation for the most exciting technology of the last century - the semiconductor. In the year I was born, semiconductors in industry began. The enormous need to have more efficient technology available to everyone has influenced engineers and scientists to continuously develop semiconductor technologies – elements now no longer visible to the normal view of our eyes. Innovators of the past have approached their retirement age, but many keep working – just for the satisfaction and enjoyment of what they are doing and in helping the digital youngsters to calculate smooth analog functions. We note with sorrow the recent passing of Bill McMurray, an ikon in power electronics, both at GE and in our industry.

Silicon Valley has been recognized as the place where most of the innovations in Semiconductor IC technology started. Discrete transistors were the first parts designed into applications that had been powered by vacuum tubes. We will see many companies and names in industry celebrating their anniversary. Fairchild is one of these, having gone through many changes and now prospering – early engineers from Fairchild helped name Silicon Valley and gave the start to many successful companies in semiconductors. Our view is forward-looking – but careful to include the wisdom developed by history.

Power devices have become more important as the hunger for power has grown in a host of applications with increased electronic functions. Fortunately the efficiency of switches has more closely approached the ideal device, reducing losses towards a physical minimum. In the past, heat dissipation of electronic equipment was included in calculations of the building infrastructure needed for heating. Cooling was needed in the summer, but the heat was a benefit in winter. And today's automobiles are changing toward full electronic control, with electric and combustion motors working hand in hand as hybrid systems to minimize the energy needed to drive.

Global worming has started to wake up even non-technical politicians trying to understand how to help with conservation of our energy resources. I hope that all contributing companies in my magazine have a focus on more green power solutions. We have to be careful to hand over a world to our children with an infrastructure that allows them to stay alive and healthy. Energy consumption statistics show a huge potential for waste reduction – but also show increasing consumption in the less-developed regions and their danger of matching well-developed regions in wasting energy.

Semiconductors have an avalanche behaviour – as is used in well behaved zener diodes.

Our nature also shows avalanche behaviour and we can be astonished at the results. My learning curve for engineering started as a little boy - testing the electrical outlets in the apartment to blow the only fuse and scare my parents. My parents were smart in getting me an electric train to redirect my curiosity. We need more young engineers. The right toys will help direct their talents in the right direction – good avalanches will continue to happen.

Looking forward to seeing you during 2007, having the chance to chat, and hearing your opinions.

Best Regards

To help your innovation we make ourselves small.

Minisens, FHS Current transducer

Minisens is taking miniaturization to the next level as it is a fully fledged current transducer for isolated current measurement including magnetic concentrators in an IC SO8 size. This allows you to include all the functionalities you are looking for into the space that you have available.

- Non-contact current measurement with no insertion loss
- Isolation provider
- Attractive price
- Flexible design allows a wide range of current measurement from 2-70 A_{RMS}
- +5V power supply
- Access to voltage reference
- Ratiometric or fixed gain and offset
- Standby mode pin
- Dedicated additional fast output for short circuit detection
- High performance gain and offset thermal drifts

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At the heart of power electronics.

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Wurth Electronics Acquires Midcom Inc.

On January 23rd the management of the Wurth Electronics eiSos Group announced the acquisition of Midcom Inc., headquartered in Watertown, South Dakota (USA). The previous owner, the Holien Group, sold the transformer division for strategic reasons. Midcom is based in Watertown, SD with the majority of staff is employed in the production facilities in Longgang near Shenzhen and in Fuling near Chongqing.

Norbert Heckmann and Oliver Konz, managing directors of the Wurth Electronics eiSos Group said: "This acquisition is an important element in the Wurth Electronics long term business strategy". With the motto "More than you expect", Wurth Electronics eiSos gained a lot of attention in the area of passive components through dynamic worldwide sales activities and service orientation. "We expect through Wurth Electronics Midcom – the new name of the company – a push in US sales activities through the strong existing brand recognition. With this acquisition we secured expertise in development and production of transformers as well as the necessary production capacities for future growth. While Midcom previously primarily focused on key accounts, we will expand products availability to our broad customer base without compromising service and availability, for which we are know for. At the same time our Chinese manufacturing facilities remain focused toward the production of customer specific solutions." The current product range extends from standardizes LAN transformers for digital applications to ADSL transformers and customer specific solutions for power applications. Despite the previous focus on the US market the whole product range is available in RoHS.

www.we-online.com

Successful Offer for System General

Fairchild Semiconductor announced the successful completion of the previously-announced tender offer by one of its wholly owned subsidiaries to acquire up to 100 percent of the outstanding shares of System General Corporation for NT$93 per share. 65,459,517 shares of System General stock were acquired on February 5, 2007, representing 95.59 percent of System General's outstanding shares. The tender offer expired as scheduled and was not extended. The total amount paid for the tendered shares was approximately $US 185.7 million, based on current exchange rates. The purchase price was funded with cash. The company intends to acquire the remaining System General shares through a share swap and merger, provided that certain conditions are met, including regulatory approvals, which the company expects to obtain.

"We are pleased that we were able to achieve a successful tender in only eight trading days," said Mark Thompson, Fairchild's president and CEO.

In the transaction, approximately 250 System General employees will join Fairchild, including the current management team. System General will continue normal operations under its name prior to the share swap, and will operate as an independent business within Fairchild during that time. After the completion of the transaction, Fairchild and System General's management will work together to combine the power conversion businesses of each company and form a single business unit targeting worldwide AC/DC offline power conversion applications.

www.fairchildsemi.com

Sharing Electronic Component Expertise

It is common knowledge that persons who specialize in one field do not usually try to keep up with the latest trends in other fields. Engineers in the systems manufacturing industry are no exception.

Their knowledge of IC solutions and digital technology is second to none, but they are often unable to keep up with the latest developments in analogue technology. This trend is likely to accelerate as a new generation of engineers gradually takes over in the engineering departments. Help is at hand from Ecomal's Technical Support Center (TSC). The company, which has its European headquarters in Germany, is one of Europe's oldest and most experienced distributors of electronic components, and it offers engineering workshops on site. The seminars, which address the latest trends in active and passive component technology, normally last two to four hours and are limited to a relatively small number of participants. Taking applications such as power supplies and sensors as the starting point, the seminars look at ways of using new active and passive component strategies and products to optimize designs. The recurring problems and limitations which are associated with familiar solutions are analyzed. Thomas Steidl, Manager of Ecomal's European Technical Support Center, explains that these discussions generally turn into genuine applications support. If you are not familiar with the latest solutions, you run the risk of becoming a victim of self-imposed limitations when you develop your new products.

The groups discuss questions and answers which are related to actual problems. What is the solder resistance of certain materials? What component has the best characteristics within a certain temperature range? What are the latest trends in package design and how can power losses be minimized? Which solution is best from the cost standpoint?

www.ecomal.com

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 award-winning 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
- Schmitt-trigger inputs
- Switching frequency DC to >100kHz
- Duty cycle 0...100%
- Delay time typ. 325ns

Driver stage for a gate current up to ±15A per channel, stabilized by large ceramic capacitors

Specially designed transformers for creepage distances of 21mm between inputs and outputs or between the two channels. Insulating materials to UL V-0. Partial discharge test according IEC270.

Isolated DC/DC power supply with 3W per channel

More information: www.IGBT-Driver.com/go/2SD315AI

CT-Concept Technology Ltd. is the technology leader in the domain of intelligent driver components for MOS-gated power semiconductor devices and can look back on more than 15 years of experience.

Key product families include plug-and-play drivers and universal driver cores for medium- and high-voltage IGBTs, application-specific driver boards and integrated driver circuits (ASICs).

By providing leading-edge solutions and expert professional services, CONCEPT is an essential partner to companies that design systems for power conversion and motion. From custom-specific integrated circuit expertise to the design of megawatt-converters, CONCEPT provides solutions to the toughest challenges confronting engineers who are pushing power to the limits.

As an ideas factory, we set new standards with respect to gate driving powers up to 15W per channel, short transit times of less than 100ns, plug-and play functionality and unmatched field-proven reliability.
In recent years we have developed a series of customized products which are unbeatable in terms of today's technological feasibility.

Our success is based on years of experience, our outstanding know-how as well as the will and motivation of our employees to attain optimum levels of performance and quality. For genuine innovations, CONCEPT has won numerous technology competitions and awards, e.g. the "Swiss Technology Award" for exceptional achievements in the sector of research and technology, and the special prize from ABB Switzerland for the best project in power electronics. This underscores the company's leadership in the sector of power electronics.

CONCEPT

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Info@IGBT-Driver.com
www.IGBT-Driver.com

Let experts drive your power devices

Global Distribution Agreement for Power Devices

Digi-Key Corporation and Cree, Inc. announced the signing of a global distribution agreement for Cree's silicon carbide-based power devices.

Cree, Inc. is a market-leading innovator and manufacturer of silicon carbide semiconductors that enhance the value of power, solid-state lighting and communications products by significantly increasing energy performance.

Digi-Key is currently stocking Cree's Schottky diodes with voltage ratings ranging from 300V to 1200V and current ratings from 1A to 20A. These products are featured in both Digi-Key's print and online catalogs and are available for purchase directly from Digi-Key. This new distribution agreement will enable Digi-Key to fulfill both the design and production quantity needs of its diverse customer base.

"Cree's expertise in silicon carbide brings greater energy performance to a number of power applications, including power factor correction in personal computer and laptop power supplies," said Mark Larson, Digi-Key president and CEO. "We are very pleased to add Cree to our line card and certain that its products will be of consequential interest to many of our customers."

"This agreement with Digi-Key is another major step in achieving Cree's strategic plan to build world-class sales and marketing reach," said Jorge Aguilar, Cree vice president and general manager for power devices. "We are pleased to participate in Digi-Key's extensive sales network, which can significantly accelerate the sampling and design-in process for our customers."

www.digikey.com

www.cree.com

Arrow UK distributes FRIWO Power Supplies

Arrow Electronics has been awarded UK distribution rights for FRIWO Power Supplies, one of the world's leading manufactures of low-voltage external power supplies and chargers for medical, IT, communications, domestic appliances, power tools and industrial applications.

The new agreement covers the entire FRIWO product range, including a wide variety of switchmode units whose low weight and extremely compact size make them particularly suitable for feeding portable devices. The range also includes an extensive variety of lead acid, nickel cadmium, nickel metal hydride, and lithium ion chargers, as well as accessories such as interchangeable output connectors, exchangeable mains input plugs and power cords. These products expand Arrow's already extensive power supplies portfolio, which encompasses products from sub-1W DC/DC converters to high-power AC/DC supplies.

Arrow's agreement is with Haredata Electronics, acting as agents for FRIWO

Power Solutions (FPS). Explaining the benefits of the agreement, Shaun Winstanley, Managing Director of Haredata, commented: "As a design-in stocking distributor with first-class logistics services, Arrow has an unrivalled reach into the UK market. The company also provides excellent technical support and harnesses its global capabilities locally through a network of 10 regional business centres. I look forward to a long and successful business relationship between our organisations."

Steve Sessions, Arrow's power supplies marketing manager for the UK and Ireland, added: "The addition of FRIWO Power Solutions to the Arrow power supply range means that we can provide a cost-effective, dependable solution for every power requirement, including portable devices. FRIWO sets the highest standards of quality. For example, in medical technology the company sets market-wide standards with leakage currents of less than 10 microamperes. Added to that, the company is based in Germany, which means that design and support is close at hand, and products are manufactured in the Far East, with the associated price benefits."

Based at Ostbevern in northern Germany and with operations worldwide, FRIWO Power Solutions is a business unit of the FRIWO Group, which is owned by CEAG AG. Andrew Laverack of Haredata (left) and Steve Sessions of Arrow shake hands on the FRIWO distribution agreement.

www.arrow.com

www.friwo.de

New Executive Board

maxon motor ag will be getting a collective Executive Board on 1 March 2007. After the current CEO Jürgen Mayer steps down to become Chairman of the Board of Directors, a three-man team will be in charge of running the company. The Speaker will be chartered engineer Mr Armin Lederer and he will be assisted by maxon majority shareholder Dr. Karl-Walter Braun and chartered engineer Mr Eugen Elmiger. Dr. Ulrich Claessen who is taking charge of the Development Department, joins the Enlarged Executive Board on 1 April 2007.

Mr Lederer joined maxon in 2001 as Head of Production and member of the Enlarged Executive Board. He has been responsible for production, personnel and procurement since 2005, as well as being a member of the Executive Board. He will also become Speaker of the Executive Board from 1 March 2007. The 48-year old previously worked for Diehl GmbH + Co in Nurnberg as Head of the Subsystems product area and was also a member of the Enlarged Executive Board of a subsidiary.

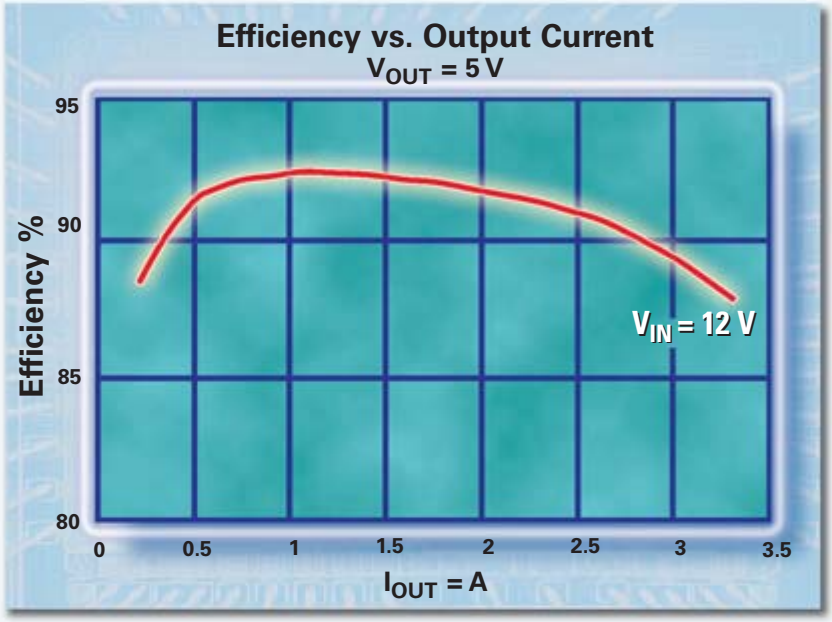
Mr E. Elmiger has been a senior manager at maxon motor ag for 16 years. The 43-year old electrical engineer has been a member of the Executive Board and Directors of Sales/Marketing since first of January 2006. A boost for the Development Department, Dr. Ulrich Claessen will be the new Head of Development at maxon from 1 April 2007. The 51-year old has been Vice President of Microbiotics at the Swiss Center for Electronics and Microtechnology (CSEM) in

Alpnach since 2000. The former Head of Development, Dr. Raniero Pittini, will now be in charge of pre-development. On the photo from left to right: Dr. Karl-Walter Braun, Dipl.-Ing. Armin Lederer and Dipl.-Ing. Eugen Elmiger.

www.maxonmotor.com

POWER MANAGEMENT

3-A, Easy-to-Use, 36-V Input Step-Down Converter



▸ TPS5430 Applications

- Set top boxes and digital television
- Industrial and LED lighting power supplies
- Distributed power systems for 12-/24-V bus

▸ TPS5430 Features

- 5.5-V to 36-V input
- 110-mÝ, 5-A peak MOSFET for high efficiency
- Fixed 500-kHz switching frequency
- 1.5% reference accuracy
- Internal compensation for few external components
- Built-in over-current protection and thermal shutdown
- Software tool and evaluation module available for a quick and easy design
- Small, thermally enhanced 8-pin SOIC package

3-A SWIFT™ Devices

Specifications	TPS5430	TPS54350	TPS54310	TPS54317
V_{IN} Range	5.5 V to 36 V	4.5 V to 20 V	3.0 V to 6.0 V	3.0 V to 6.0 V
V_{OUT} Min	1.22 V	0.9 V	0.9 V	0.9 V
Switching Frequency Max	500 kHz	700 kHz	700 kHz	1.6 MHz
Price 1k (US $)	$1.75	$2.05	$2.35	$2.50
Package	HSOIC-8	HTSSOP-16	HTSSOP-20	QFN-24

Visit www.ti.com/swift-e to see a complete listing of **SWIFT** devices that support up to 14 A.

Software tools, free samples, evaluation modules, the new **Power Management Selection Guide** and **Reference Design Cookbook II**

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Technology for Innovators™

Texas Instruments

STMicroelectronics Committed to Alliances in Crolles

Crolles, France, January 16, 2007 - STMicroelectronics (NYSE: STM), one of the world's leading semiconductor companies, has today restated its strong commitment to technology alliances with partners. The Company confirms the continuation of its technology development at Crolles, following the announcement of the withdrawal, at the end of 2007, of NXP Semiconductors from the Crolles2 Alliance among ST, Freescale, and NXP.

The Crolles2 Alliance partners will work together to complete the program on 45nm CMOS and effectively manage the transition throughout 2007.

STMicroelectronics strongly believes that the shared R&D business model, exemplified by the Crolles2 Alliance, contributes to the fast acceleration of semiconductor process technology development. ST is therefore pursuing an expansion of its portfolio of alliances and is now in discussions with major semiconductor companies to continue and reinforce technology cooperation in Crolles, as of 2008.

The Crolles2 Alliance was formed in 2000 and renewed in 2002 when Freescale (then Motorola) joined the existing alliance of STMicroelectronics and NXP (then Philips Semiconductors) to create and manufacture future-generation technologies and System-on-Chip solutions more quickly and more cost-effectively. The Alliance consolidates the work of three of the world's leading industry players in semiconductor research and process and library development with the mission to develop advanced processes. In 2002, the partners of the Crolles2 Alliance also signed a joint development program with TSMC for process technology alignment. Additionally, in 2004, the partners of the Alliance signed the Nanotec-300 research program with CEA-LETI for development of the 45 and 32nm process technology nodes, thus further extending the partnership.

The Crolles2 facility is one of the world's most advanced centers for R&D and the results achieved there have been instrumental in maintaining Europe's place as a stronghold in the semiconductor industry. The Crolles2 Alliance has delivered outstanding results for the 90nm and 65nm generations, and has contributed significantly to the technology strength of the member companies who have continually ranked in the global top 10 of semiconductor companies.

www.st.com

Freescale and IBM Announce Agreement

Companies to collaborate on future semiconductor technologies Freescale Semiconductor and IBM (NYSE: IBM) today announced that Freescale will join the IBM technology alliance for joint semiconductor research and development. The agreement includes Complementary Metal Oxide Semiconductor (CMOS) and Silicon-on-Insulator (SOI) technologies as well as advanced semiconductor research and design enablement transitioning at the 45-nanometer generation. Freescale is the first technology development partner in the IBM technology alliance to participate in both low-power and high-performance technology research and development. This agreement brings together Freescale's leadership in key embedded markets, including automotive, networking, wireless, industrial and consumer, with IBM's success in developing world-class technology and industry-leading systems expertise.

This alliance will enable Freescale to further strengthen its manufacturing strategy. In addition to leveraging owned capacity in internal fabs and its existing relationships with leading foundry manufacturers, Freescale will have access to the combined manufacturing capacity of IBM's Common Platform partners. The Common Platform provides its semiconductor fabrication partners with synchronized manufacturing processes to help ensure the maximum flexibility and lowest development investment for multi-source, high volume manufacturing.

"This partnership creates an exciting opportunity to combine the complementary strengths of Freescale and the IBM Alliance," said Sumit Sadana, senior vice president, Strategy and Business Development and acting chief technology officer, Freescale. "This industry-leading technology roadmap will enable Freescale to deliver substantial value to our customers."

"Freescale's addition to the IBM technology alliance is a significant vote of confidence for IBM's collaborative model and the work we are doing jointly with our technology partners," said Lisa Su, vice president, Semiconductor Research and Development, IBM. "Freescale will be a valuable addition to our team, with its deep expertise in semiconductor process development and fast growing embedded applications, like automotive, networking and wireless.

www.freescale.com

www.ibm.com/chips

All-time high of 30%

For the year 2006, Semikron International boasted record turnover growth of 30%, plus a 136% growth in the sector SEMiX IGBT semiconductor modules, which are used primarily in variable speed drives.

Semikron International has reached a 30% turnover increase for the business year 2006. At the same time - according to the market study "The worldwide market for power semiconductors 2006" conducted by IMS Research - the business sector semiconductor modules is estimated to have grown by around 10% within the same period. The main driving force behind this growth was Europe thanks to high export figures. Investments in key Asian markets also delivered above-average growth rates and were regarded as instrumental in this turnover increase.

"These high growth rates allow us to make further investments and push ahead with new technological developments to help boost our growth markets," explains Peter Frey, General Manager at Semikron International, confidently.

Another potential growth booster in the drives market is the latest development SEMiSTART, a semiconductor module designed specifically for soft-start devices. Thanks to the ultra compact design of this antiparallel thyristor module, a 400kW soft-start device featuring SEMiSTART has just one sixth of the volume of the same device with conventional capsule thyristors. Plus, due to pressure contact technology and double-sided chip cooling, these modules can withstand overload currents of up to 3000 A for an overload duration of 20s.

www.semikron.com

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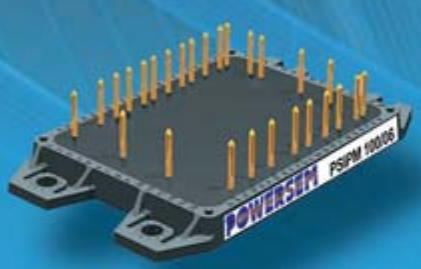
20 years of innovation

POWER SEMICONDUCTOR MODULES

developed and manufactured
by **POWERSEM GmbH, Germany**



Diode/Thyristor Modules

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MOSFET Modules

IPM Modules

Diode Modules

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AC/DC Controllers

Subassemblies

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Battery Charger Controller Improves Efficiency and Extends Battery Life

Intersil's ISL6257 provides ±0.5% charge voltage accuracy and a programmable charge current Limit, adapter current limit and charge voltage for configuration to a wide range of Li-Ion/Li-Ion polymer battery packs.

Intersil introduced the ISL6257, a narrow VDC (voltage direct current) charger controller for Li-Ion/Li-Ion polymer batteries in notebook computers. This device is designed to meet the NVDC-I requirements for better efficiency and longer battery life.

The ISL6257, the only true narrow VDC charger controller on the market, offers the best overall accuracy and features narrow VDC output, which allows the system to operate from the regulated charger instead of the adapter. The use of the Vbat as the system voltage as opposed to the adapter allows the notebook to run at a maximum of 12.6V instead of adapter voltage, increasing the overall efficiency of the system and improving battery life and thermal management in the system.

"The ISL6257 is the only NVDC-I charger on the market that is optimized for this application, allowing customers to run their laptops at much lower battery voltages," said Majid Kafi, director of Intersil's Notebook Power products group. "This provides better efficiency, longer battery life and improved thermal management."

Improved Efficiency and Longer Battery Life

Intersil's ISL6257 provides ±0.5% charge voltage accuracy (-10 °C to +100 °C) for precise charge voltage, increasing battery life. This device also provides a ±3% accurate battery charge current limit for precise charge current control, allowing the maximum charge rate and further extending battery life.

The ISL6257 provides a fixed 300kHz PWM (pulse width modulation) synchronous buck controller with diode emulation at light load. This constant frequency simplifies the design process. Diode emulation improves efficiency and prevents adapter voltage boosting. This feature is not present on many competitors' parts.

The ISL6257 has a type III output voltage control system that allows the regulated output to respond quickly to transient loads with minimal change in output voltage. This reduces the power supply rejection requirements for all downstream power supplies. No other charger offers this feature.

The ISL6257 has a fast input current limit response to prevent overcurrent shutdown of the adapter. The device's input voltage range from 7V to 25V supports most adapters. The ISL6257 also supports 2-, 3- and 4-cell battery packs, which meets most notebook battery pack requirements.

A ±3% accurate input current limit provides precise input current and allows higher charge rates without exceeding the adapter current limit. This device also has a ±25% accurate battery trickle charge current limit.

Key Features:

±0.5% charge voltage accuracy (-10°C to +100°C)
±3% accurate input current limit
±3% accurate battery charge current limit
±25% accurate battery trickle charge current limit

Programmable charge current limit, adapter current limit and charge voltage
Fixed 300kHz PWM synchronous buck controller with diode emulation at light load
AC adapter present indicator
Fast input current limit response
Input voltage range 7V to 25V
Support 2-, 3- and 4-cells battery packs
Up to 17.64V battery-voltage set point
Control adapter power source select MOSFET
Thermal shutdown
Aircraft power capable
DC adapter present indicator
Battery discharge MOSFET control
Less than 10iA battery leakage current
Support pulse charging
Charge any battery chemistry: Li-Ion, NiCd, NiMH, etc.
Pb-free plus anneal available (RoHS compliant)

Target Applications

Notebook, desknote and sub-notebook computers; Personal digital assistants.

About Intersil's Power Management Portfolio

Intersil's high-performance analog ICs provide innovative power management solutions for applications in the computing, communications, peripherals, display, networking, telecommunications, industrial, instrumentation and battery-powered products markets. Intersil is a leading supplier of PWM controller ICs with over two billion units shipped. Intersil offers a broad portfolio of power management ICs, including single and multiple output switching regulators, integrated FET DC/DC controllers, battery management ICs, hot plug controllers and power MOSFET drivers. To learn more, visit Intersil's Power Management page at http://www.intersil.com/power.

www.intersil.com

Intersil Battery Charger ICs

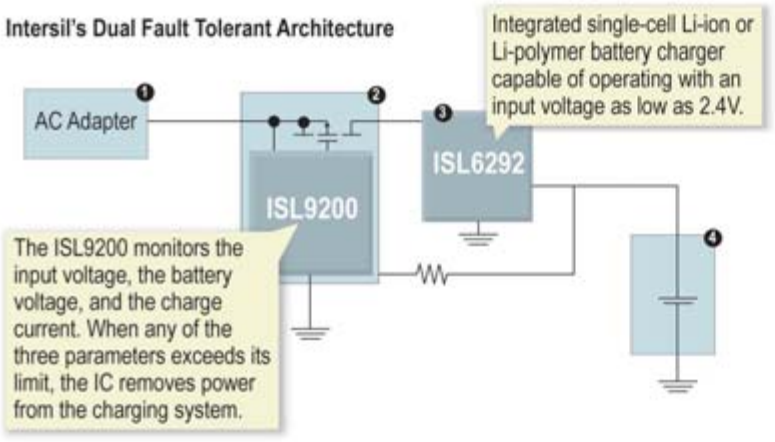
High Performance Analog

The Scariest Thing Inside Your Handheld Should Be Your Pictures

There is a real monster out there. Protect your customers from the onslaught of counterfeit and non-OEM battery packs with Intersil's innovative Dual Fault Tolerant charging system. Our integrated triple-level protection approach reduces components and cost while improving design flexibility and system reliability.

The ISL9200 is a Fault Protection IC optimized to provide redundant safety protection in Li-ion battery charging systems. Together with the ISL6292 Battery Charger IC, Intersil's integrated battery charging system will keep even a counterfeit battery within safe operating limits.

Intersil's Dual Fault Tolerant Architecture



Dual-Fault FMEA (Failure Mode and Effects Analysis)

POTENTIAL FAILURES ❶	❷	❸	❹	Consequence of Dual Failure
●	●			❸ will fail but the protection module in the battery pack will protect the battery cell.
●		●		Both ❷ and ❹ will protect the battery cell.
●			●	❸ will limit the battery voltage. ❷ has an additional level of protection.
	●	●		The protection module in the battery pack protects the cell.
	●		●	❸ will limit the battery voltage to 4.2V, within 1% error.
		●	●	❷ will sense an over voltage case and remove the power from the system.

- User programmable overcurrent protection threshold
- Input overvoltage protection in less than 1µs
- Battery overvaltage protection
- High immunity of false triggering under transcients
- High accuracy protection thresholds
- Warning output to indicate the occurrence of faults
- logic warning output to indicate fault and an enable input to allow system to remove input power.
- Small, thermal enhanced DFN package.
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HIGH PERFORMANCE ANALOG

What an Evolution! – The End of Neglecting Power Management in System Designs?

By Werner Berns, Application Design Centre Manager Europe, National Semiconductor

I still remember my first steps in electronics, back in the late 70's, early 80's. I did my first "developments" with some ICs in the DIL package from the 7400 family. Most of these ICs had 14 (16) pins, the ground connection was at pin 7 (8) and the positive power connection was on pin 14 (16). The power supply was just a +5V and usually built with the famous LM7805. This part could supply up to 1A output current and that was more than enough for all the beautiful inventions at that time. But, there was just a little problem sometimes. Strange oscillations at the output disturbed the functionality from time to time. A bad ground connection or a wrong capacitor was found as root cause later on. Hints about this behaviour were found "quickly" in one of the electronic magazines of these days, such as "Elrad" or "Elektor". Of course, the internet was not available and not even the word "internet" was known.

Since these days, almost everything has changed. The LM7805 carries a long beard and if still used at all, it does not play a major role anymore. The single +5V power rail is completely gone and if still existing, it's just one rail out of many. But one thing is the same over all the time - in the past and in the future: The reasons which caused oscillations at my LM7805 are still valid and become even more important, because systems get more complex, get smaller and operate at higher frequencies.

Unfortunately, there is one more thing which, in my opinion, changes too slowly but definitely must be changed. This is the role which power design plays in the overall system development. In too many cases it is still playing a minor role and does not experience the attention it should get. The best power designs are those that play a key role from the beginning of the system concept phase. Like in a mobile phone:

Everyone gets furious when the mobile phone battery gets empty, just in the moment when you want to make an important call. The battery standby and talk time became a key selling argument for a mobile phone. The designers do everything possible to extend these times or at least to keep them constant while adding more power-consuming features. But what about the charging unit? Many people just leave it in the wall socket, ignoring that it will consume power while not in use. Does anyone pay attention?

Efficiency remains one of the key parameters to watch. But also the extremely increased complexity and power conditioning requirements are key elements. Many car infotainment systems for example bear ten and more power rails. Latest processor, FPGA and DSP technologies demand lower and lower voltages (sub 1V) at higher currents. There is nothing in sight that this trend changes soon. This ever lowering supply rail voltage can be a real challenge for the power designers. Not paying the required attention from the beginning on can result in a system that suffers from bad performance and/or stability. The word "management" in Power Management gets a new key meaning in today's applications: managing many different power rails, take care of its sequencing and shut those off which are currently not required or at least get them into standby condition to achieve higher efficiency at low loads. Digital Power is a new hype and comes in many different "flavours". Starting from just controlling digitally via dedicated signals or via communication buses (e.g. PMBus), it can reach a level where the analogue control loop can be influenced by changing certain parameters on-the-fly (such as output voltage or compensation) and stops at a point where the whole control loop is implemented digitally. While this adds a lot of flexibility to the Power Management system, it does not mean it lowers the cost of the power unit itself. Most commonly, the opposite is the case. But in very complex systems, such as a 3G base station, it can positively impact the costs for maintenance and power consumption and therefore justifies higher component costs.

The field of Power Management has become an extremely interesting topic over the years and is gaining importance in system designs if it is not already a key element. And one more thing remains untouched: Power Management is everywhere!

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Never stop thinking

THE LENNOX REPORT

ELECTRONIC COMPONENTS INDUSTRY

GENERAL

An OECD report forecast Euro-zone growth at slightly faster than 2% annually over the next two years but points to need for structural overhauls to make growth durable. They include attacking a high cost and relatively rigid labor system, high taxes, lack of innovation and relatively weak EU actions, further complicated by the entry of new member states. The low cost countries are disputing the right of veteran members to impose their higher labor costs on work done in their areas by third countries.

SEMICONDUCTORS

Through November 2006 worldwide semiconductor market growth was reported by the WSTS as 9.4% over 2005 but eleven-month sales in Europe remained basically flat at +1.1% in dollars and +1% in Euros. Comparable November percentages, all in dollars and positive, are 12% for the Americas, 6.8% Japan and 12.8% Asia Pacific. In Europe November sales grew 4% sequentially driven by microprocessors and microcontrollers accounting for about 30% of the region's turnover with DRAMs also performing above average. The ZVEI is cautiously optimistic for the current year if by latest end of the first quarter a positive trend occurs.

Hewlett-Packard researchers have developed flexible electronic circuits capable of modifying and up-grading circuits in computer-based consumer products even after they have been sold. The technology is based on advances in nanocomputing creating circuits on a molecular scale interacting with today's silicon wires and transistors.

Upcoming events include INC3 Nanotechnology Conference, Brussels, April 16-19, 2007. Contact www.inc3.inc-conf.net.

NXP will drop its CMOS technology alliance with Freescale and STMicroelectronics located at Crolles near Grenoble by the end of this year in favor of closer cooperation with Taiwan's foundry TSMC.

Infineon's SCI-worx affiliate, an IP and communications design specialist, has been acquired by Silicon Image as the firm restructures after the separation from memories, is reportedly looking at acquisitions in Japan. Without the Qimonda split-off Infineon would have grown 29.5% in 2006 moving to the N° 4 spot but instead Infineon fell to N° 14 while Qimonda moved to up N° 12, so iSuppli. Infineon expects demand for power semiconductors to be higher than supply this year.

Texas Instruments, the world's N° 3 semiconductor producer, claims to lead in the reach of its products across customer segments, is N° 1 in the number of customers served and the biggest supplier to the mobile phone industry, so its CEO Rich Templeton.

Acquisitions include the assets of QED Technologies by Cabot Microelectronics, Acqiris by Agilent Technologies, Brooks Software by Applied Materials, Alphasem by Kulicke & Soffa, Brion Technologies by ASML, PXIT by Agilent and PowerDsine by Microsemi.

OPTOELECTRONICS

News from Philips includes full ownership of Philips LumiLeds Lighting, the sale of its car-use disc drive operations to Lite-On IT and also a 49% stake in a new firm, Philips & Lite-On Digital Solutions, originally based on a venture by BenQ Corp. As previously reported Philips plans to dispose of all its shares in LG. Philips LCD and will outsource panel supply as well as take a $ 93 M impairment charge in TPO Displays Corp. where it owns 17.5%.

PASSIVE COMPONENTS

Epcos has developed ferrite cores minimizing energy losses and offers modules containing both passive and active devices to give complete functionality of a WiFi front end.

Maxwell has obtained a largest-ever order for its ultra-capacitors, 3 M devices for wind turbine systems. The company employees 300 worldwide.

OTHER COMPONENTS

The 2006 image sensor market is expected to have grown over 30% in units to 1.9 B and 12% in value to over $ 7 B with CMOS sensors more than 60% of total, up from 45% in 2003 and expected to reach more than 80% by 2008.

Appointments include Mike Edwards, VP worldwide sales and marketing, Antenova, and Paul Jap Asia Pacific sales director, C&D Technologies.

DISTRIBUTION

The major news is undoubtedly the planned acquisition of TTI, a $ 1.2 B American passive component distributor with an estimated $ 300 M European sales, by the Berkshire Hathaway Group (headed by Warren Buffett) subject to governmental approvals. The sale includes TTI's catalog division Mouser Electronics which is expected to become active in Europe. TTI founder and chairman Paul Andrews as well as his management team will remain in place.

News from Arrow includes a statement by its CEO William Mitchell predicting around 17% annual global sales growth thanks to rapidly expanding Asian business. Asia-Pacific revenue which climbed 62% to $ 1.9 B in 2005 should climb to about a third of turnover in five years compared to under a fifth now. The firm was ranked 5th in a recent survey "Information Week China 100" as a most innovative user of IT in mainland China. Mr. Mitchell expects the electronic components market to remain soft in the first half of 2007 with an uptick in demand thereafter. Analysts expect Arrow 2006 revenue to have grown 22% to $ 13.63 B.

Farnell InOne will expand its Linear Technology offerings by 500 devices, has launched an online guide featuring over 1000 new electromechanical components while archrival Electrocomponents has added Kemet as a North American franchise for its Allied Electronic subsidiary and has added FAEs both in France and the Netherlands to aid even small customers. All this in anticipation of increased European competition from Digi-Key and TTI's Mouser.

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19-Apr-07	Eindhoven	Netherlands
23-Apr-07	Edinburgh	UK
24-Apr-07	Birmingham	UK
25-Apr-07	London	UK
26-Apr-07	Limerick	Ireland
7-May-07	Munich	Germany
8-May-07	Heidelberg	Germany
9-May-07	Hannover*	Germany
10-May-07	Zurich	Switzerland
22-May-07	Milan*	Italy
23-May-07	Vienna	Austria
24-May-07	Prague	Czech Republic
25-May-07	Warsaw	Poland
29-May-07	Helsinki	Finland
30-May-07	Stockholm	Sweden
31-May-07	Copenhagen	Denmark
4-Jun-07	Novosibirsk*	Russia
6-Jun-07	Tomsk*	Russia
8-Jun-07	Moscow*	Russia

*Simultaneous translation facility

Multiple Hands Drive Demand for Increased Efficiency

Regulations and Customers continue the push for Green Power

Regulators and the open market have demanded that power supplies become more efficient. While this has been evident for the last few years, the combined drumbeat is getting louder and not only will it have impact on efficiency, but it will have an impact on the power supply market as a whole.

By Jeremiah P. Bryant, Managing Research Analyst, Darnell Group

The visible hand of government regulators and Adam Smith's "invisible hand" of market forces are conspiring to drive the ac-dc power supply market towards higher efficiencies. While power supply makers are willing to move, they will only do so if it is cost-neutral or if they can pass on increased costs to OEMs. Passing on costs has always presented problems. However, as the end customers in data center and industrial markets have become more aware of the energy cost of using lower-efficiency power supplies, OEMs may be more willing now then ever to support higher-efficiency as an end product differentiator.

Increased energy efficiency has always been a desired goal, but on the list of wants, it has always scored well below other characteristics, most notably price. However, as energy prices rise and systems require more power, the need and benefits that arise from increasing energy efficiency begin to mount. The increasing demand for higher-power power supplies directly stems from the rising power requirements in fast-growing applications such as blade servers and Power-over-Ethernet (PoE). As a result of application trends, the 500W and above segment is not only the fastest-growing segment, but it is growing at a rate that is more than double the average growth rate of the market. As seen in figures 1 and 2, in terms of actual units, the greater than 500W market will remain the smallest over the next five years, but its relative power consumption will become the largest.

With the move towards higher wattages, it isn't surprising that there is a corresponding move towards higher efficiency. That said, when government regulators initially began to target efficiency they started with lower wattage external adapters and battery chargers. Energy Star began focusing on efficiency by creating a voluntary external power supply efficiency specification a few years ago. Other agencies, most notably the California Energy Commission (CEC), made this specification mandatory with the start date in the coming year. Following the success of the efficiency regulation, regulators have moved their focus to markets with greater energy savings potential. One of the largest of these markets is embedded computer power supplies. Energy Star recently updated its computer specification, which is scheduled to go into effect during 2007. The new specification calls for 80%+ efficiencies at 20%, 50% and 100% of the rated load.

Other programs are also pushing for similar efficiencies. The 80 Plus program offers $5 to $10 rebates on qualifying power supplies used in desktop PCs and desktop-derived servers. To qualify, a power supply must be at least 80% efficient at 20%, 50% and 100% of the rated load and have power factor correction of .90 at full load. The $5 to $10 rebates are paid as incentives to OEMs to absorb the incremental cost. Currently, the 80 Plus program has $4 million to $5 million

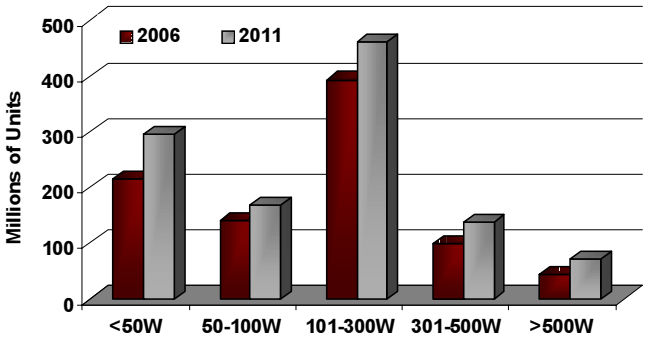

Figure 1: Worldwide Embedded AC-DC Power Supply Sales by Wattage.

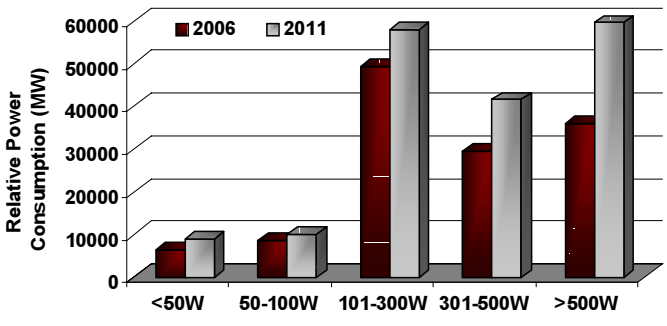

Figure 2: Worldwide Embedded AC-DC Power Supply Power Consumption by Wattage.

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1200V : 225A - 450A

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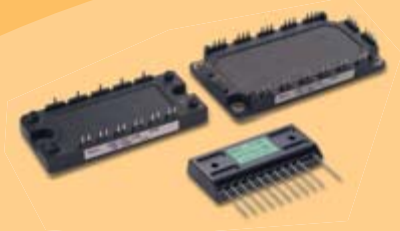
1700V : 1200A - 3600A

2-Pack
1200V : 800A & 1200A
1700V : 600A & 1200A



6-Pack IGBT
600V : 15A - 150A
1200V : 10A - 150A
1700V : 100A & 150A

PIM IGBT
600V : 30A - 100A
1200V : 10A - 75A

New TMD Modules

6-Pack IGBT
600V : 5A - 20A
1200V : 5A - 25A

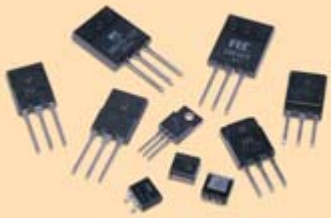
PIM IGBT
600V : 5A - 20A
1200V : 5A - 25A

High Power 6-Pack
1200V : 225A - 450A
1700V : 225A - 450A

2-Pack IGBT
600V : 50A - 600A
1200V : 50A - 450A
1700V : 150A - 400A

1-Pack IGBT
600V : 600A
1200V : 200A - 800A

IPM-IGBT
600V : 15A - 300A
1200V : 15A - 150A



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in funding for the rebates, with a similar amount expected in 2007. By the end of August 2006, more than 70 SKUs have qualified.

Are these programs having any impact on the market? According to one of the largest PC power supply makers, “all the top notebook, PC and server vendors (IBM, Lenovo, Dell, HP, Apple and Gateway) are actively engaged in sourcing power supplies that are 80%+ efficient.” While the OEMs are initially targeting energy-conscious customers such as governmental and educational institutions, this is only the beginning. “By the end of 2007, virtually all notebooks, PCs and many low-end servers will have 80%+ [efficient] power supplies,” according to the company.

However, regulators are only hitting the tip of the iceberg. Many high-wattage applications, such as blade servers, enterprise servers, PoE, CATV, Medical Lasers, Home Audio and many other applications (see figure 3) are outside of current regulations.

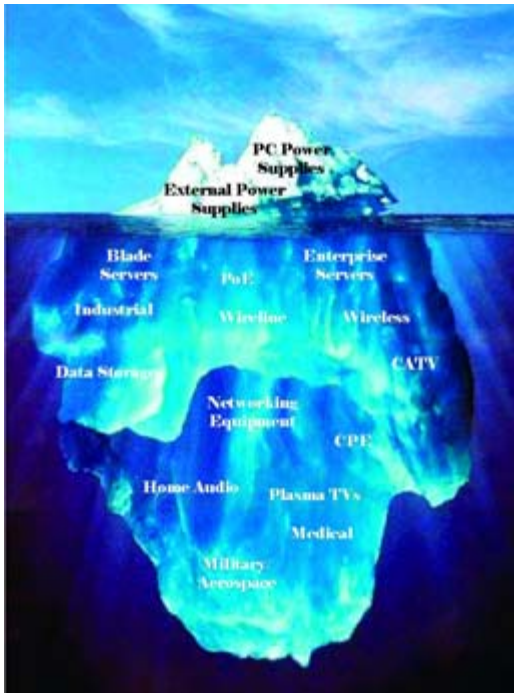

Figure 3: Efficiency regulations are only hitting the tip of the iceberg, so market forces will need to be the primary driver of increased efficiency.

Even if the regulations and incentive programs are effective, customers are demanding higher-efficiency power supplies. This is especially true in data centers, where the electricity cost to run servers is approaching, and can even surpass, the acquisition price of the server. Some end customers, such as Google, have taken things into their own hands. According to a recent article in CIO magazine, Google “builds their own servers for efficiency.” While Google has many reasons for building their own servers, one of the most important is that they can save costs on power consumption by using more efficient power supplies.

While regulating computer power supplies and external power supplies and the demand-pull felt in the data center market are driving efficiencies higher, this is only the tip of the iceberg. Higher wattage power supplies in communications, industrial, commercial and other applications are rife with opportunities for regulators. Additionally, as these markets hear about the savings that data centers have made via the use of increased efficiency power supplies, the demand-pull will continue to grow.

This demand-pull will help solve one of power supply makers’ greatest problems. They are always looking for markets where they can sell a product with a price premium or looking for a feature that will allow them to charge a premium. Conversely, their customers—the original equipment manufacturers (OEMs)—are always looking for a lower-cost power supply. Given that OEMs are usually larger and have more options then the power suppliers, power supply prices are low and falling. However, power supply makers are gaining unspoken allies that may help them fend off the unrelenting drive to lower prices. Government regulators and the “customer’s customer” are demanding higher-efficiency power supplies. While OEMs are not likely to pay significantly higher prices for greater efficiencies, the demand for higher efficiency may offset the typical 3% to 5% annual power supply price decline.

Over the last three years, typical efficiencies have continued to rise. As seen in Figure 4, which includes data from over 150 new power supply launches from over 30 companies, typical efficiencies have continued to edge up each year. In 2005, the main gains were made in the lower wattages associated with external power supplies. However, over the last year, the higher wattage front ends have seen the largest increase in typical efficiency.

While these increases will help demand for the companies that have developed higher these higher efficiency power supplies, the larger net effect for the market will be increased competition—not only price competition, but also efficiency competition. However, since increasing efficiency by a significant amount typically involves increasing research and development spending, companies will need to get higher return on investment from this R&D spending. The desire to increase this return will be one of the driving factors that continues to the consolidation trend that the power supply industry has faced over the last few years.

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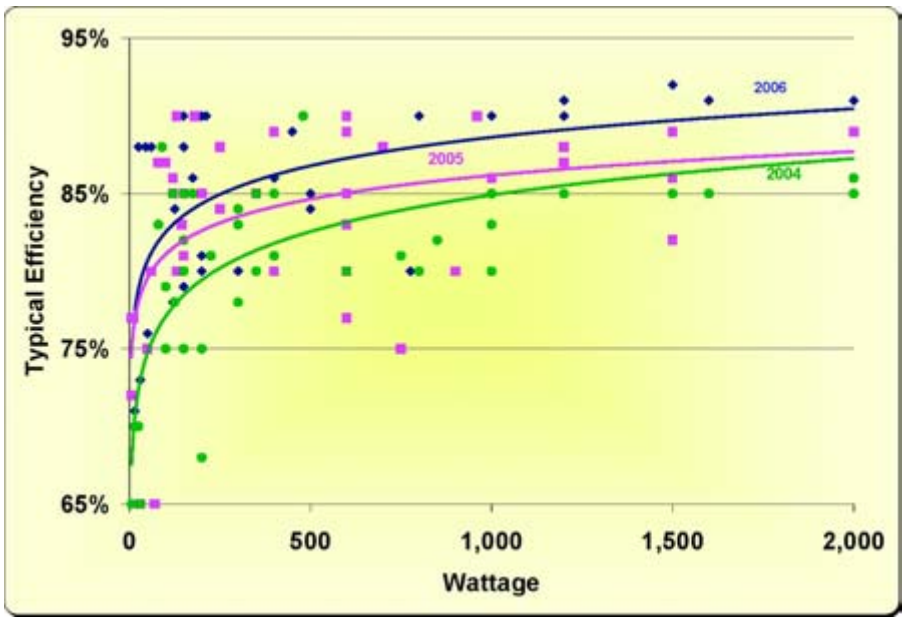

Figure 4: Typical reported power supply efficiency by wattage level for new products reported on PowerPulse.Net compared with wattage.

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Interview on Technology of Current Transducers

with Paul Van Iseghem, President & CEO LEM

By Bodo Arlt, Editor BPSD

Bodo Arlt: What end markets drive current transducer technology?
Paul Van Iseghem:
For LEM there are four focus markets that drive the current transducer business development.
Our business started 35 years ago when the founder of LEM, Mr Jean Pierre Etter developed the first current transducer intended for the Geneva tramway. The traction and trackside applications were the first market and original driver. Our second and today still largest market are the industrial applications which include motor drives, welding and various power conversions like for the new energies such as solar power and wind power. These two areas form the traditional business for LEM. The third area is the automotive application where LEMs transducers fulfill two important functions: the battery management of the car and the drive by wire applications such as electronic power steering and braking. Energy and Automation is the fourth and newest area for transducer technology. We are experiencing solid growth rates and working hard to develop new products for all markets.
Actually the traditional markets do very well during this era with increasing energy prices!

Bodo Arlt: What is LEM's position besides the wide range of standard transducers?
Paul Van Iseghem:
LEM has focused on specific industries in order to further grow and develop our business. Our goal is to maintain and strengthen our market leadership position by targeting new markets and new applications with new products. For this it is vital to understand both the different industries and their applications in order to anticipate what our customers will need. Close collaboration with our customers is a tradition at LEM and we can offer both standard and specially customized products.

BodoArlt: What are the technologies that can offer innovation for leadership?
Paul Van Iseghem:
There are different technologies to measure current and voltage. LEM has become the market leader by choosing the best method for the respective product. The measurement is always based on either Hall-effect, Fluxgate or Rogowski technology. LEM has decided to focus the development in two key directions:
Miniaturization where we have just successfully launched a fully fledged current transducer in an SO8 package. For the first time we have managed to integrate the magnetic concentrators onto a chip.
The second direction that we are heading towards is a higher level of integration in our transducers. In our newest Energy & Automation products that are primarily intended for the Automation market we have managed to integrate interfaces to microcontrollers for example.

Bodo Arlt: Is the next generation of products more in silicon?
Paul Van Iseghem:
There is a clear trend towards smaller and higher performing transducers. To support this demand we have decided to develop our first ASIC (Application Specific Integrated Circuit) about 8 years ago. Thanks to our profound knowledge and IP today we have taken this development to the next level and integrated the sensing elements, the magnetic circuit and the electronics into a chip by launching the Minisens – the first fully fledged transducer in an SO8 package. You can see Silicon has become a part of our solution.

Bodo Arlt: What makes LEM different from other suppliers?
Paul Van Iseghem:
LEM has maintained a leadership position both in terms of market share but also in terms of our cutting edge technology. Being able to offer our customers these high quality products and the customer service to match are our real advantages. We have an in-depth product and application knowledge that is unparalleled in the industry. LEM is unique to offer a 5 year warranty to all its products .worldwide!

Bodo Arlt: What makes LEM different from traditional discrete suppliers?
Paul Van Iseghem:
LEM refused to look at the Components business as a Commodity business. Through innovation –new applications-new products, we consistently develop new markets. This dynamic is quite different from many others.

Paul Van Iseghem

Paul Van Iseghem is the Chief Executive Office and President of LEM. He became CEO and President in 2004, having held the role of President of LEM Components since 2000. Prior to his appointment as President, Paul was a member of the board of LEM Holding SA from 1999-2000. Paul has been credited with consolidating the company's position as the leading manufacturer of electrical transducers and driving a programme of innovation that has expanded the markets addressed by LEM.
Paul has held senior roles within a number of leading companies in the electrical sector, including Chief Operating Officer for Valmont Europe, Chief Operating Officer, VP Operations, EMEA for UTC Carrier and World-Wide VP Engineering and Operations for ITT Cannon. Paul achieved a Ph.D. in Engineering, Material Science from the University of California, Los Angeles USA.

Bodo Arlt:
How much is LEM involved in the customer's application?
Paul Van Iseghem:
The close collaboration with our customers is one of LEMs competitive advantages. We are very happy to be able to work together and develop special solutions for our customers this way. This is how the first transducer for the automotive industry was created. We had a request from a major manufacturer for a transducer to manage the battery in a car and developed this for them.

Bodo Arlt: How much is LEM involved in motor applications using the advantage of transducers?
Paul Van Iseghem:
As already mentioned earlier, the electric motor drives are the main contributors for the current transducers. These variable speed drives need very close integration with current measurement. With the new concepts to drive motors without speed control it is even more important to have a precise current control.

Bodo Arlt: What will be the next new transducer products?
Paul Van Iseghem:
The Minisense is the ground-breaking new product that we are currently launching. This tiny transducer has a huge potential. It is opening new markets such as the white goods and the HVAC industry which are new applications for us.
The Minisens has been the feature product of your February edition.

Bodo Arlt: What will be the future for transducers in Power Metering?
Paul Van Iseghem:
As part of our Energy & Automation segment we have just launched Wi-LEM (Wireless Local Energy Meter) this is a product that is focused on sub- metering the power consumption in factories and buildings. Sub-metering is a very powerful tool and allows you to allocate responsibility and take actions for reducing peak power by implementing smart solutions.

Bodo Arlt: Do we expect other monolithic solutions for transducers in the future?
Paul Van Iseghem:
The Minisens is based on a monolithic solution. With this product we have an invention that will take a long time to surpass. We have achieved the highest performing and low cost level of integration on a chip today.

Bodo Arlt: Who are your competitors you believe will stimulate the race for leadership?
Paul Van Iseghem:
LEM has 800 employees world-wide and a very dedicated management team. Together with our strategic priorities we are well on track for success. I appreciate healthy competition though to the benefit of a dynamic development of our business.

Bodo Arlt: Thank you Paul for the time and we look forward to a successful future for power transducers.

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Powering the Modern Electronic Revolution

Digital control has the ability to raise power supply performance to the next level

If a single event were to define the start of the modern electronic revolution, it would have to be the 1958 invention of the Integrated Circuit (IC). The independent work of two inventors, Robert Noyce, co-founder of Fairchild Semiconductor and Jack Kilby of Texas Instruments, resulted in each being awarded succeeding patents.

By Steve Mappus, Systems Engineer, Fairchild Semiconductor

The initial roadblocks likely revolved around concerns regarding feasibility, manufacturing, test and which applications might most benefit from this technology. However, it wasn't until 1961 when Fairchild Semiconductor introduced the first commercially available IC when a more interesting problem was noticed. While the IC had initiated the trend toward circuit miniaturization, other electronic systems, namely linear power sources, remained large and bulky by comparison. In many ways the invention of the IC, the start of the modern electronic revolution, drew attention to the fact that power technology was lagging. If commercial power sources were to keep pace with IC development, then drastic size reduction would be necessary. Ironically, it would be the invention of the IC itself that would, in time, enable the technology to overcome this obstacle.

Robert Noyce, Ph.D
12/12/27 – 06/03/90

Linear power supplies operate from a rectified, low frequency (50 Hz - 60 Hz) off-line transformer and require a large amount of bulk capacitance proportional to the power demand of the load. The bridge rectifier and series pass element make them inherently inefficient, especially when low output voltages are required. Even prior to 1961, it was well understood that switching the energy storage elements at a higher frequency would be necessary to reduce power supply size. The problem was that the transistors required to switch off-line power at higher frequencies were not readily available. Driven by the smaller size and higher efficiency requirements of the aerospace industry, much of the power research done in the early 1960s was concentrated in the area of low voltage DC to DC conversion, which resulted in the development of the buck, boost and buck-boost, switch-mode topologies. The introduction of high voltage, bipolar power transistors in 1967 then made it possible to apply similar switching techniques, previously used in DC to DC conversion, to off-line power conversion.

Throughout the early 1970s some companies began offering commercially available switch-mode power supplies targeted at the military and industrial market segments. The half-bridge converter topology was the preferred choice because the voltage rating on the two primary transistors is limited to the peak input voltage. The DC output voltage was regulated using the pulse width modulation (PWM) control technique switching at 10 KHz - 20 KHz, offering major improvements in terms of size, weight and efficiency compared to linear power supplies.

PWM control is considered the essence of switch-mode power supply design and as IC development continued to progress through the early 1970s, many of the required analog and digital circuit blocks were beginning to appear in IC form. The idea of combining the individual circuit functions into a single IC eventually led to the industry's first integrated PWM controller, the SG1524, designed at Silicon General in 1975. The invention of the SG1524 achieved much more than merely combining existing circuit blocks into a single chip. The functional requirements of the analog circuits demanded the IC be developed using a bipolar process but digital ICs were not typically produced this way. By monolithically integrating analog and digital circuits, the SG1524 challenged the notion that ICs had to be developed using either an analog or a digital process. The SG1524 also included the ability to protect the power stage via an internal current limiting function. The desire to achieve even higher levels of protection, monitoring, control and drive integration is still ongoing as more advanced power ICs continue to flood the industry.

Even though the SG1524 was able to switch as high as 300 KHz, bipolar power transistors are hindered by slower rise and fall times. Therefore, power supplies, for the most part, remained stalled around 25 KHz until the first available discrete power MOSFETs appeared in 1975. Compared to bipolar transistors, similarly rated MOSFET devices can switch at higher operating frequencies.

Techniques used to manufacture early MOSFETs were similar to planar IC development processes until Siliconix released the first trench power MOSFETs in 1994. Using a refined open cell trench process, Fairchild Semiconductor introduced their PowerTrenchTM family of MOSFETs in 1998, which resulted in even higher cell densities while maintaining low gate charge. As the number of competitors providing power MOSFETs grew, the process of how they

were manufactured became as proprietary as the devices themselves and quickly became the second component necessary for achieving higher performance, smaller size power systems. As MOSFET characteristics rapidly improved, power supply designers often reaped significant efficiency benefits by sometimes doing little more than swap earlier generation devices with newer ones. Achieving similar improvements today place more emphasis on the skills of the designer and less dependency upon device improvements. Nonetheless, the topic of gate drive and MOSFET selection is still considered a critical step toward achieving the highest possible converter efficiency.

From the mid 1970s, much of the advancement experienced in the field of power electronics was driven by the demanding needs of emerging growth technologies. Electronic industries such as aerospace, industrial, telecom, medical, automotive, consumer and wireless each had unique requirements that continue to challenge semiconductor companies and power designers alike. It is impossible to mention all the significant power contributions that have resulted from such an exhaustive collaboration but in 1981 IBM released the Model 5150, which was adopted as the first personal computer to have the PC name associated with it. Today's modern computing industry consists of PCs (more commonly known as desktops), workstations, notebooks, mainframes and servers. Computing would turn out to be a "sleeping giant" to the power supply industry, pushing the limits of how power is processed, delivered, managed, cooled and packaged.

One example worth mentioning is the distributed power architecture (DPA) commonly used today. The realization of the DPA arrived through a combination of requirements for higher power density, more flexibility, lower EMI levels, higher reliability and a higher level of system power performance. As shown in Figure 1, a DPA first converts the AC line voltage to a distributed DC voltage bus such as 48 V, although for high power, server applications this voltage can be as high as 350 V.

The integration of a PFC converter (AC to 400 V) and DC to DC converter (400 V to distributed DC) stage became commonly referred to as a "rectifier", within the context of a DPA. The rectifier output is then used as the input to an intermediate bus converter (IBC) which then steps the voltage down to a quasi-regulated 12 V or lower. The 12V IBC voltage gets converted to the usable point of load (POL) DC voltages which usually range between less than 1 V to 5 V.

This advanced level of power processing, driven mostly by the microprocessor requirements, continues to spur the design of many novel PWM controllers and drivers, discrete and passive devices and technology patents. And, just as the previous 20 years, power supply design continued its progression within the shadows of IC (microprocessor) development.

Throughout the mid 1980s the need to squeeze more power out of smaller sizes continued to press on and in 1984 Vicor introduced the first "brick" module, a 4.6"x2.4"x0.5" DC to DC converter that achieved a power density of about 25 W/in3. This small converter size was made possible by switching at extremely high frequency, made possible through zero-current switching techniques. Using families of high density bricks, Vicor had proposed a configurable, building block approach to power supply design. As power designers gradually began to accept the brick concept, the converter module industry quickly became crowded with numerous competitors each proposing their unique spin.

The demand for smaller packaging extended beyond the design of brick modules to also include discrete power devices. In 1985 the surface mount DPAK was introduced which started the campaign toward power, surface

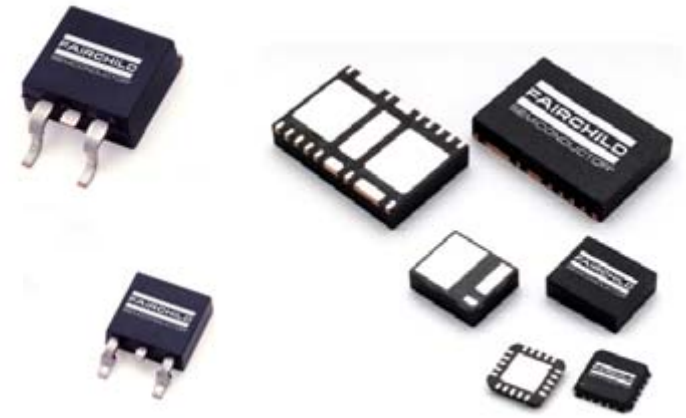

Figure 2. QFN packages for multi-die modules and high power applications

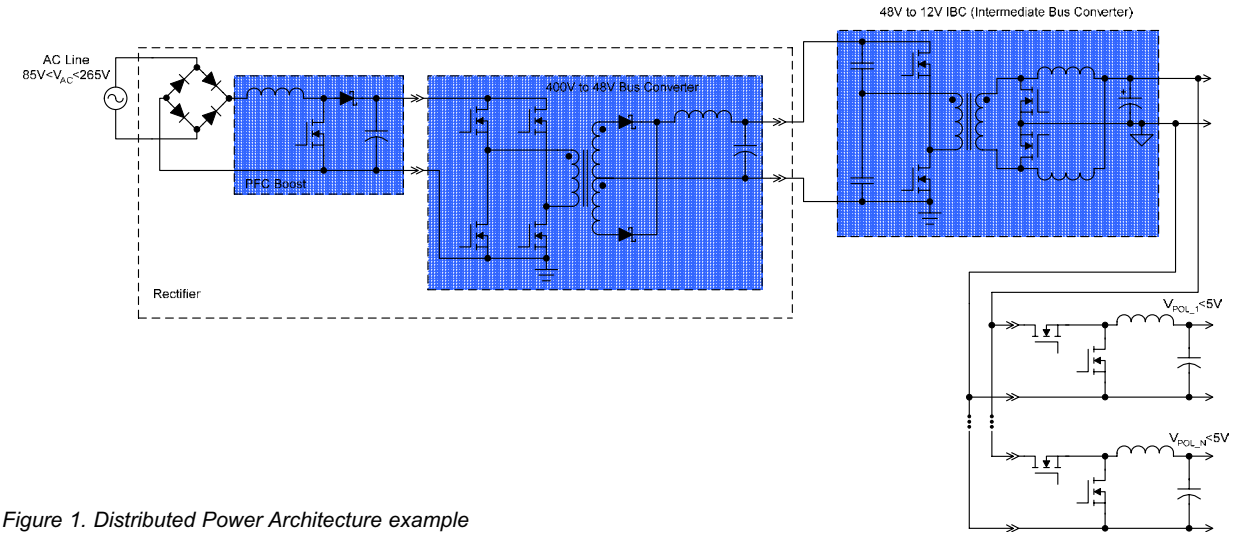

Figure 1. Distributed Power Architecture example

mount technology. Power packages such as the DPAK and its successor, the D2PAK offered additional thermal benefits over more commonly used through-hole packages. Modern surface mount power packages such as the quad flat no-lead (QFN) shown in Figure 2, can include multiple power devices co-packed into a single module.

Fairchild Semiconductor is one of the few suppliers of power management ICs able to co- package discrete devices with gate drive, protection and control IC functions. The success of multi-die modules are just one example of how the power industry is embracing technologies that optimize system power through higher levels of component integration.

Figure 3. FSQ-series green mode FPS

The 1990s ushered in on the explosive growth of the internet. By virtue of the sheer amount of hardware infrastructure required to support the World Wide Web (WWW), power electronics is to the internet what gasoline is to automobiles. There are currently more than one billion people worldwide who regularly use the internet. Every access point requires a PC (or wireless handheld device) to surf through the power hungry network of modems, routers and servers that make up millions of host computer sites all over the world. Furthermore, with global power consumption growing at a yearly rate of nearly 2%, the issue of adequately maintaining aging power-grids has become a huge concern. Initially, reducing demand at the load makes more economic sense; however the problem would still need to be addressed from the power grid. With government legislation and various special interest groups stepping in, power efficiency is now in the global spotlight. The One Watt Initiative is one example of a proposal by President George W Bush in 2001 which aimed to reduce standby power losses to below 1 W.

Historically, designers have been most concerned with power supply efficiency during a systems full load or active state where operating temperatures tend to be highest. The One Watt Initiative and other similar energy saving programs have challenged designers to rethink the efficiency issue. The result is a new generation of power management ICs, such as the Fairchild Power Switch (FPSTM) FSQ-series, highlighted in Figure 3. The FSQ-series FPS contains an integrated PWM controller and current sensing MOSFET which consumes less than 0.2 W when operating in standby mode. Power controllers that enable power supplies to achieve higher efficiency during standby mode are commonly referred to as "green mode" due to the environmental benefits they offer.

Even as more "green mode" features are expected to enter the industry, power systems have mostly remained analog in the sense that they are optimized using fixed passive components chosen to meet a specific set of known operating specifications. As load requirements become increasingly complex, the limitations of a pure analog approach become apparent. Digital control has the ability to raise power supply performance to the next level in many respects. Imagine being able to manage multiple power rails, change regulation set points based upon load dynamics, achieve high efficiency across a wider load range, dynamically adjust the way faults are handled and achieve real time control loop optimization under all conditions. Digital control can yield better overall efficiency results because the system power is managed more efficiently according to the demands of the load.

As the power supply industry is sitting on the cusp of what appears to be the next defining milestone, will digital power be able to meet the demands of the modern technology revolution? As with any new technology, optimism is often met with skepticism but with several proposed solutions already revealed and more on the way, the early adopters will be the first to answer.

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Exploring the Behaviour of Parallel IGBT Modules

Tested under extreme SOA conditions

The extreme ruggedness of high voltage SPT-IGBT modules has enabled the investigation of new limits in IGBT SOA performance when operating in parallel. In this article, a set of results is presented where two 3300V/1200A SPT-IGBT modules were tested in parallel under extreme RBSOA conditions with a forced temperature difference of up to 100 °C. Current and voltage waveforms were recorded and the associated redistribution mechanisms during the dynamic avalanche and Switching-Self-Clamping-Mode SSCM are discussed.

By Arnost Kopta, Ulrich Schlapbach, Munaf Rahimo

The power electronics community upholds a long wish list of improvements targeted at the power semiconductor device electrical performance. Despite the fact that the IGBT offers the user a wide range of attractive electrical characteristics, further improvements and superior performance is continuously required. Parallel operation of IGBTs represents an important topic in many systems, due to the inherent nature of MOS controlled devices to operate in parallel in order to achieve the required average current as demanded by power electronic applications. The circuit layout and spread of device parameters will always result in an imbalance in current sharing between the devices under static and dynamic conditions. Therefore, the device and circuit designer has to deal with a number of issues depending on the application to make the system reliable. The effect of the circuit and device parameters on the dynamic performance has been thoroughly investigated in the past. The negative effects of the gate drive design, stray inductances, temperature variations and the spread of device parameters have been shown to be the main cause of unbalanced current sharing in paralleled IGBT modules. The majority of previous investigations were carried out under moderate switching conditions and for lower voltage rated IGBTs. This work, however, focuses on high voltage IGBTs modules with paralleling effects under high stress levels and different temperatures.

Recently, it was demonstrated that the performance of HiPak modules employing the highly rugged HV-SPT IGBT chips is capable of attaining new levels of turn-off RBSOA [1]. These characteristics of the SPT-IGBT range have allowed us for the first time to study the effect of externally induced temperature variations on the current mismatch between IGBT modules under extreme RBSOA conditions. Those include dynamic avalanche and an operational mode referred to as Switching Self-Clamping Mode (SSCM), characterized when the overshoot voltage reaches levels close to that of the static breakdown voltage [2]. The benchmark module results presented will provide a new outlook for high voltage system designers aiming for an all-around performance improvement in future high voltage applications.

3300V SPT-IGBT parallel operation during dynamic avalanche and SSCM

A number of tests were carried out in order to take a closer look at the current sharing between paralleled IGBTs under SOA conditions. In the beginning, a single 3300V/1200A SPT-IGBT module with 3 separate “legs” (sections) in parallel was tested at 4000A and 2.65kV DC link voltage. No clamps or snubbers were used in the test fixture. The current was recorded for each leg and is shown in Figure 1. The waveforms show very uniform current sharing between the three legs even as the module enters the dynamic avalanche and SSCM stages of operation. A variation of around only 1% was observed between the current in each leg of the module. This is a negligible figure and thus no current de-rating is needed under SOA conditions. This is a consequence of using lower turn-off gate resistance values (RG) than those required by conventional technologies resulting in shorter turn-off delay times, thus improving current sharing between individual IGBT chips within the module.

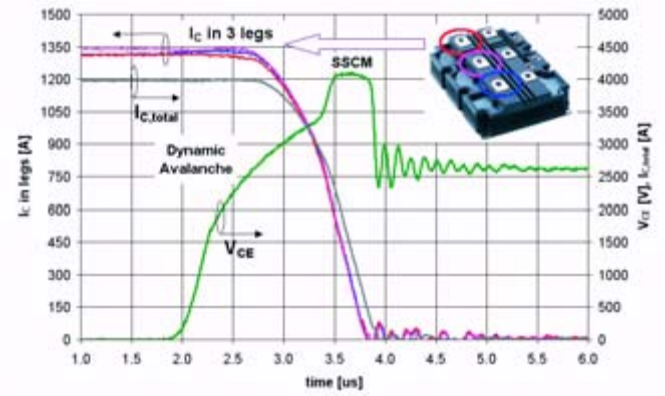

Figure 1: 3300V/1200A IGBT module RBSOA at 125°C VDC=2650V, Ic=4000A, RG=1.5Ω, LS=280nH.

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Temperature induced current mismatch in 3300V modules during dynamic avalanche and SSCM

The main investigation was carried out on two 3300V/1200A SPT-IGBT modules in the test set-up shown in Figure 2. The RBSOA tests were carried out at high currents while operating with a low gate resistance value. Also, neither clamps nor snubbers were used in the test fixture. The two modules were capable of turning off more than 6000A at a DC-link voltage of 2600V in spite of the temperature induced current mismatch and associated redistribution mechanisms. By forcing large temperature variations between the two parallel modules, the current redistributions were magnified, and therefore, can be better analyzed for exploring the limits of device operation under such extreme conditions. This work was especially focused on current mismatch effects and redistribution mechanisms during dynamic avalanche and Switching-Self-Clamping-Mode (SSCM). By maintaining one module at a fixed temperature of 125°C, and varying the second module temperature between 25°C and 125°C, a full set of turn-off results were obtained for the current sharing mechanisms. The modules showed excellent ruggedness and capability of withstanding both dynamic avalanche and SSCM in spite of a forced temperature difference of up to 100°C.

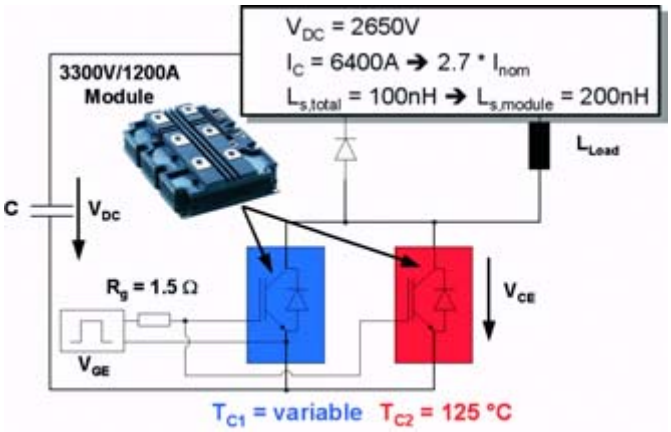

Figure 2: Measurement set-up for turn-off of parallel-connected IGBT modules, where the modules are at different temperatures. Each of the schematic switches corresponds to a full 3300V/1200A module.

Figures 3, 4, and 5 show RBSOA turn-off waveforms at 6400A and 2600V for three cases, where the second module was tested at 125°C, 105°C and 25°C, respectively.

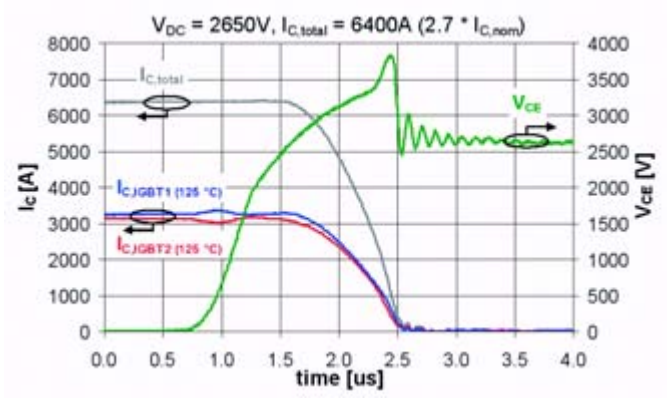

Figure 3: Turn-off of parallel-connected modules with no temperature difference at 125°C. There is very little current redistribution.

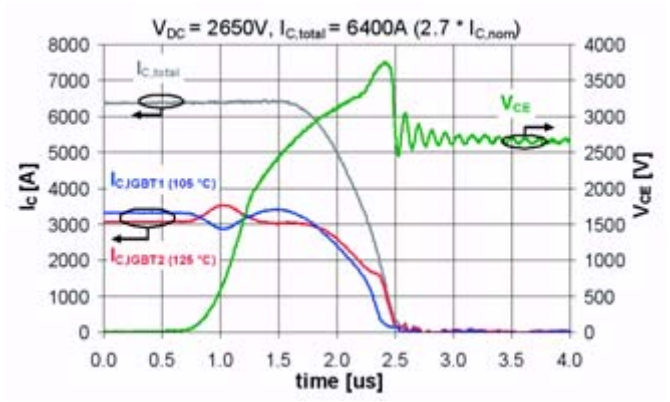

Figure 4: Turn-off of parallel-connected modules with a temperature difference of 25°C. There is moderate current redistribution.

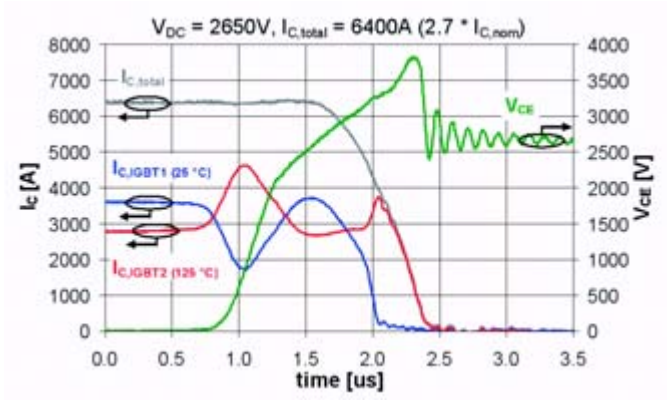

Figure 5: Turn-off of parallel-connected modules with a large temperature difference of 100 °C. A large current redistribution was observed.

As expected, the waveforms show a clear trend in increased current mismatch with increasing temperature difference between the modules. We will now briefly analyze the waveforms in Figure 5 with the help of Figure 6 by including also the gate voltage waveform. The temperature mismatch was in this case 100°C, showing a number of distinct phases with substantial current redistributions between the two modules.

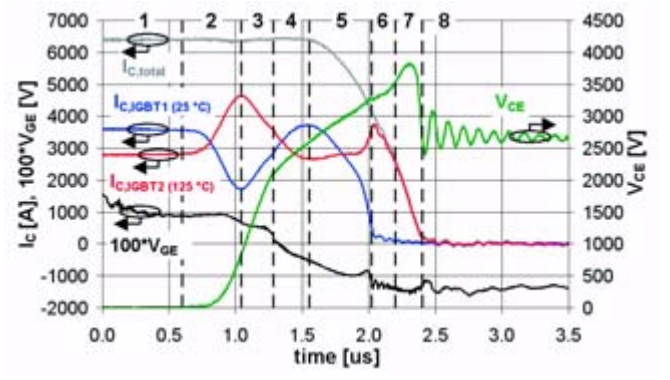

Figure 6: Different stages during turn-off of parallel-connected modules with a large temperature difference of 100°C.

The current mismatch during the switching transient will depend on the following temperature dependent parameters: MOS-channel injection (threshold voltage and transconductance), excess carrier concentration in the N-base (lifetime, mobility and anode emitter efficiency) and avalanche generation (critical electric field). Prior to the switching transient (at t<0μs), the cooler module carries a significantly higher current due to the positive temperature coefficient of the IGBT chips. In order to explain the current redistribution mechanism during the switching transients, the following observations are important: Firstly, during conduction, the hot IGBT has a higher plasma concentration in the N-base than the cold one in spite of its lower current density. This can be explained by the lower mobility, the higher lifetime and the higher anode emitter efficiency of the hot IGBT. Secondly, the initial voltage rise dVCE/dt will depend on the cathode current density JC and the initially stored carrier plasma concentration. For a given plasma concentration, dVCE/dt will increase with increasing JC. On the other hand, for a given JC, dVCE/dt will decrease with increasing plasma concentration in the N-base. In parallel operating IGBTs, VCE has to be the same across both devices and therefore, the current will always redistribute into the slowest IGBT (the one, which has the lowest dVCE/dt when switched alone).

During stage 1, the gate-drive begins to discharge the IGBT gate and VGE starts dropping. However, both IGBTs are still in the active (on-state) region. During stage 2, the gate voltage drops further and the MOS-channel of both IGBTs enter the saturation region and VCE starts rising. In this stage, the stored charge in the IGBT will determine the further course of the switching transient. Coming into stage 2, the hot IGBT has both a higher plasma concentration and a lower current density, which means that it is the slower one in terms of dVCE/dt. As discussed above, the current therefore has to commutate from the cold to the hot module. At the beginning of stage 3, VGE drops below the threshold voltage of the cold IGBT. In this stage, dVCE/dt is still determined by the hot module, which is limited by the higher stored plasma concentration. The channel injection in the cold IGBT comes to an end, and as a consequence, dynamic avalanche sets in. This slows the cold IGBT down and as a result, the current starts again to redistribute from the hot to the cold module. At this point, the voltage waveform presents no evidence that the cold module is in dynamic avalanche because the total voltage rise is still determined by the hot module. In stage 4, the hot module also enters into dynamic avalanche. Avalanche generation will, however, be higher in the cold IGBT due to the temperature dependence of the critical electrical field. The high avalanche generation will therefore slow down the cold IGBT, which will once more force the current to redistribute from the hot to the cold module. Up till the end of stage 4, the total current in the two modules remains at 6000A. During stage 5, the total current starts dropping. Due to the fact that the cold IGBT originally had a lower stored plasma concentration than the hot one, the electric field has in this stage penetrated deeper into the N-base and consumed most of the stored charge. Therefore the current in the cold module starts dropping and reaches zero in the beginning of stage 6. All the current now flows in the hot module, which still has a significant stored charge, whereas the cold module has reached its static off-state. In stage 7, the hot module will also run out of charge. Throughout this stage, there is still a substantial energy stored in the stray inductance, which does not allow the current to drop to zero. Instead, the hot module enters into SSCM and dissipates this stored energy. Finally, in stage 8 the current in the hot module has reached zero and the turn-off transient is completed.

These results show that the modules are perfectly capable of withstanding such extreme conditions and reveal exceptionally stable performance under all operating conditions within the limits of device capability. These results will help designers optimise their systems in order to make use of this recently acquired high SOA capability especially for high voltage applications.

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Specifying Optocouplers for Safe and Robust Industrial Systems

Isolators for IEC/EN/DIN EN 60747-5-2

In the industrial field the system level safety standards are IEC (International Electrotechnical Commission) 6041 for worldwide or international standards, UL5082 (from Underwriters Laboratories) for the United States and EN 501783 (from the European Union) for Europe. At the component level for optocouplers, the safety standards are IEC 60747-5-24 for international, UL 1577 for the United States and EN 60747-5-2 for Europe.

By Jeremy Seah Eng Lee, Alexander Jaus, Patrick Sullivan and Chua Teck Bee; Avago Technologies, Isolation Products Division

Equipment and component safety is a major aspect of designing a robust, reliable and user-safe industrial system, especially when high voltages (defined as above 48 VDC, 110 VAC) are involved. These type of systems are usually surrounded by motor starters, servo drives, programmable logic controllers and power converters, hence, providing a safe environment for personnel to work in plays a vital role in system design. In addition to this, system critical applications are expected to be failsafe since a breakdown in components, which result in machine failure, will be costly for the business.

As one example, the migration of Ethernet from operation in an office environment to the industrial environment has called for a change from hardware that only has to operate in an office to hardware operating in the harsh and rugged conditions of the factory floor. Adding this to the integration of Ethernet into Fieldbus and Device levels, the accuracy of data collected at the receiver end is now much more important than ever before.

Various forms of galvanic isolation—including isolation transformers, magnetic isolators using giant magnetic resonance and optical isolators (optocouplers)—are used extensively in industrial networking systems. They allow electrical circuits with highly diverse voltage levels to work together as a system and be interconnected while remaining electrically isolated or galvanically separated from one another. Galvanic isolators are also used to ensure error-free data transmission, retain data integrity and protect interconnected equipment for high-speed Fieldbus communications. Applications also include industrial input-output systems, sensors and temperature controlling systems, power supplies and regulation systems, electric motor control and drive systems, instrumentation and medical systems.

The three main applications for galvanic isolation are:

• **Protection against voltage transients:** These are potentially high current or voltage surges that may damage components or cause potentially life-threatening electric shocks to the equipment operators. They are usually brief and intense surges between two circuits or systems.

• **Protection against ground loop currents:** These are unwanted signals between interconnections of different ground potentials, which cause disruptive ground loops. They are usually found in communication networks having different grounds at various connecting nodes. The potential difference between these grounds can be alternating current (AC) or direct current (DC) with a combination of various noise components. If the voltage potential is large enough, it may cause damage to equipment (e.g. communication ports), transmission error or degradation of data signals. Long-term ground loop conditions can result in heating and burning of circuit boards thus damaging components and creating the potential for electric shock.

• **High-voltage level shifting:** With the migration of digital ICs to lower operating voltages, the need for devices to separate sensitive electronics from high power electronics is growing. In order to ensure reliable information exchanges and preventing current flow between different ground reference voltages there is a need to use isolation. For example, in a motor control application, the electronic system of a motor consists of two stages, the low voltage controller and the power module. Within such a system, it is important to protect and insulate the two stages from switching transients and common mode voltage fluctuations. At the same time, it is necessary to provide level shifting and signal isolation of interface control and feedback circuits.

Safety Standards for Galvanic Isolation Devices

International safety standards are published to ensure consistent rules to make equipment safe. These standards are concerned about public safety in the areas of electrical shocks, mechanical hazards, fire and EMI. At system and component levels, there are many isolation safety standards varying both geographically and with equipment applications. In the industrial field the system level safety standards are IEC (International Electrotechnical Commission) 6041 for worldwide or international standards, UL5082 (from Underwriters Laboratories) for the United States and EN 501783 (from the European Union) for Europe. At the component level for optocouplers, the safety standards are IEC 60747-5-24 for international, UL 1577 for the United States and EN 60747-5-2 for Europe.

It is known that for future optocoupler standards, the IEC will take the lead and its standards will become more universal. For IEC 60747-5-2 approval, an optocoupler's components undergo stringent qualification tests that include environmental, mechanical, isolation and electrical testing. The criterion for passing the component is the Partial Discharge (PD) test with a rigorous upper limit of 5 pC (picocoulomb).

Insulation

Insulation is defined as the property of a material that resists the flow of current until it breaks down. The fundamental principle of designing for product safety is the separation of circuits that present a danger of electrocution from other circuits, or certain parts of the equipment which a user may come into contact or which connects to other equipments. The circuit must be safe not only during normal usage but also under fault conditions. Two main levels of insulation with clear distinction of safety are Basic Insulation5" and Reinforced Insulation6". Reference 7 provides a good discussion concerning the definition of insulation categories by the IEC.

As of January 2004, the German safety standard certification for optocouplers VDE 0884 was replaced by IEC/EN/DIN EN 60747-5-2. This is now the safety standard directly applicable to optically isolated devices. Although this standard specifically pertains to only to optical isolators, devices using other isolation technologies such as magnetic or capacitive isolation barriers have also surprisingly and perhaps erroneously, obtained certifications to the optocoupler safety standard. However, their recognition is limited to Basic Insulation only, and this level of insulation may not provide failsafe operation. This means that devices that are certified and approved under IEC/EN/DIN EN 60747-5-2 with recognition for Basic Insulation only provide basic protection against electrical shock. They cannot be considered as failsafe8 and therefore such devices should not used in applications where parts of the equipment are accessible to an operator. Table 1 shows the IEC/EN/DIN EN 60747-5-2-related characteristics of an Avago HCPL-0720 CMOS Optocoupler9.

Optocoupler Basics

A basic optocoupler consists of a light emitting diode (LED), a photodetector and an optically transparent, electrically insulating dielectric (Figure 1). When a current drives the LED, it emits light, which is coupled to the photodetector through the dielectric. The photodetector generates a current that is proportional to the coupled light. This current can be manipulated by various circuitry to perform specific functions. The major function of an optocoupler is to prevent high voltages or rapidly changing voltages on one side of the circuit from damaging compo-

nents or distorting transmissions on the other side. This is done by optically passing desired signals while maintaining electrical isolation between two systems.

Reliability of High Voltage Insulation
Optocouplers are often used in environments where high voltages are present. Though many safety standard regulations have been established to provide guidelines on the application of high voltages, the problem with high-voltage insulators is the uncertainty in reliability due to poorly understood ageing and failure mechanisms under electrical and thermal stress.

Electrostatic Discharge
One of the primary causes of component failure in high-speed logic circuits is Electrostatic Discharge (ESD)11. ESD occurs in various situations, during improper device or board handling, through improperly designed interfaces or if a lightning or other phenomenon that causes a large voltage spike on a device interface. When devices are damaged by ESD, the affected devices may cease to function, exhibit parameter degradation or demonstrate high failure rates. The only repair is the replacement of the damaged component.

Optocouplers are excellent for protecting against ESD problems especially in situations where two systems are being linked in electrically demanding environments. Optocouplers allow ground isolation making it possible for systems to remain electrically neutral within themselves even though they may be floating in an electrically noisy environment. Such areas include motor control, switching power supplies, industrial networks and medical applications.

Electromagnetic Interference (EMI)
Electromagnetic interference (EMI) can be defined as any electromagnetic disturbance that disrupts, degrades or otherwise interferes with authorized electronic emissions limiting the effective performance of electronics and electrical equipment. It can be induced intentionally, as in some form of electronics warfare, or unintentionally as a result of spurious emissions and responses, intermodulation products, atmospheric disturbances (including lightning) and extraterrestrial sources (such as sunspots). Radio Frequency Interference (RFI) is a special class of EMI in which radio frequency transmissions (usually narrow-band) cause unintentional problems in equipment operation. Radio frequency interference can originate from a wide range of sources such as mobile phones or power lines, transformers, medical equipment, electromechanical switches and many others unintentional emitters that can be found especially in the industrial environment.

Description	Symbol	HCPL-772X Option 060	HCPL-072X Option 060	Units
Installation classification per DIN VDE 0110/1.89, Table 1				
for rated mains voltage ≤150 V_{rms}		I-IV	I-IV	
for rated mains voltage ≤300 V_{rms}		I-IV	I-III	
for rated mains voltage ≤450 V_{rms}		I-III		
Climatic Classification		55/85/21	55/85/21	
Pollution Degree (DIN VDE 0110/1.89)		2	2	
Maximum Working Insulation Voltage	V_{IORM}	630	560	V_{peak}
Input to Output Test Voltage, Method b[1] V_{IORM} x 1.875 = V_{PR}, 100% Production Test with t_m = 1 s, Partial Discharge < 5 pC	V_{PR}	1181	1050	V_{peak}
Input to Output Test Voltage, Method a[1] V_{IORM} x 1.5 = V_{PR}, Type and Sample Test, t_m = 60 s, Partial Discharge < 5 pC	V_{PR}	945	840	V_{peak}
Highest Allowable Overvoltage† (Transient Overvoltage, t_{ini} = 10 sec)	V_{IOTM}	6000	4000	V_{peak}
Safety Limiting Values (Maximum values allowed in the event of a failure, also see Thermal Derating curve, Figure 11.)				
Case Temperature	T_S	175	150	°C
Input Current	$I_{S,INPUT}$	230	150	mA
Output Power	$P_{S,OUTPUT}$	600	600	mW
Insulation Resistance at T_S, V_{IO} = 500 V	R_{IO}	10^9	10^9	Ω

Table 1: IEC/EN/DIN EN 60747-5-2 Insulation Related Characteristics for Avago HCPL-772X and HCPL-072X Optocouplers with Option 060

There are two forms of EMI, radiated EMI and conducted EMI. While radiated EMI is interference that travels from a source through the air to the receiving source, conducted EMI travels along a conducting path. Both can lead to transmitting unwanted electronic signals, which propagates along with the desired signal, thus interfering with the proper operation of the equipment or device by alternating normal operating parameters. These failures are generally categorized as electromagnetic interference or EMI failures.

Addressing EMI issues is a major challenge. When electromagnetic interference is suspected, the first step in resolving the problem is to determine the mechanism for energy transfer to the affected device(s): radiation, conduction, or induction. Improvements can be achieved by limiting the amount of induced energy either by removing the root cause (physical separation) or by protecting the failing device, e.g. by shielding in the telecommunication area. There are costs involved in this process too. The best way to avoid potential EMI problems is by choosing less sensitive or immune devices, by optimizing the layout to minimize coupling effects and proper shielding.

Looking at available isolators, most consist an integrated CMOS or bipolar IC. The coupling unit, which is the main differentiator between the different technologies available today, is optically coupled isolators (optocouplers), magnetic coupled isolators (magnetic couplers) and capacitive coupling isolators (capacitive couplers). Each of them behaves differently in the presence of strong electromagnetic fields. While the optocoupler LED/photodiode combination is known to be immune against electromagnetic interferences due to the optical coupling path, the magnetic isolators do have its limitations with respect to EMI due to their microstructure and the magnetic coupling. Failures of the magnetic couplers can occur when the magnetic field is at DC level (0 Hz) as well as at various frequencies at different levels of field strength.

The key factor for designers is to avoid potential future EMI problems in their applications, especially those used in the industrial environment and in close proximity to the motor control. Optocouplers are the best choice to use as they do provide superior EMI performance and can withstand much higher electromagnetic fields compared to all other isolators currently available in the market.

We have discussed four factors when designing a safe and robust industrial system. They are:

• The various safety standards for isolation devices, noting whether an optocoupler provides Reinforced Insulation, which provides failsafe operation.

• Reliability of high voltage insulation, which will minimize the frequency of component breakdown due to high voltage surges into the system. Note that Avago's optocouplers can endure a high-voltage of 3.75 kV for a minimum of 168Hrs without failure.

• Electrostatic Discharge (ESD), which causes system degradation or malfunction. Taking note that even at an ESD voltage level of 11 kV, Avago's optocouplers did not shows any dielectric breakdown failure.

• Electromagnetic Interference (EMI) is another factor that causes failure of industrial systems.

While designers may consider size, low power and cost in their initial selection for isolation products, it must not be forgotten that the basic requirement for isolation is actually to isolate unwanted signals while insulating against high voltages. Therefore, the four points highlighted above serve as a good selection criteria when you intend to design a safe and reliable industrial system.

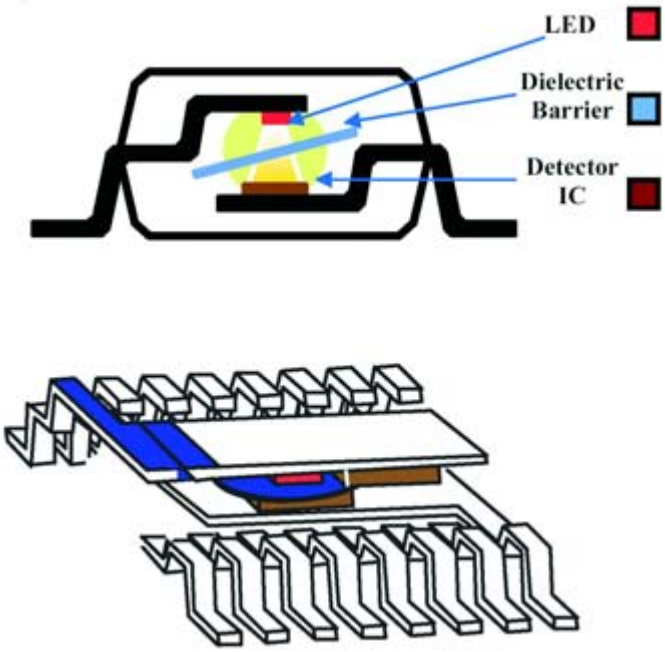

Figure 1: Cross section and side view of an Avago optocoupler

www.avagotech.com

References

IEC 604: Industrial International standard for equipment and machines (http://www.iec.ch)

UL 508: US Industrial standard for machines (http://www.ul.com/)

5 EN 50178: European standard for industrial equipments (http://www.newapproach.org/)

IEC/EN/DIN EN 60747-5-2: (http://www.cenelec.org/)

Basic Insulation: Insulation applied to live parts to provide basic protection against electric shock (http://www.601help.com/Disclaimer/glossary.html)

Reinforced Insulation: Single insulation system applied to live parts, which provide a degree of protection against electric shock equivalent to double insulation under the conditions specified in IEC 60601-1. (http://www.601help.com/Disclaimer/glossary.html)

7.Isolation and Safety Standards for Electronic Instruments, National Instruments Developer Zone (http://zone.ni.com/devzone/conceptd.nsf/webmain/6D1C1BE6590C0D4A86256C1A0078763C?opendocument)

8.Failsafe: A mode of system termination that automatically leaves system processes and components in a secure state when a failure occurs or is detected in the system.

Avago HCPL-0720/7720 and HCPL-0721/7721 40 ns Propagation Delay, CMOS Optocoupler Data Sheet Page 6 (Publication number: 5989-0790EN). A PDF version of the document can be downloaded at: http://cp.literature.avago.com/litweb/pdf/5989-2135EN.pdf

Avago Regulatory Guide for Isolation Circuits (Publication number: 5989-0342EN). A PDF version of the document can be downloaded at: http://cp.literature.avago.com/litweb/pdf/5989-0342EN.pdf

Maximizing Integrated Battery Charger Performance

Intelligent thermal control managing power

New multi-function power management ICs promise to reduce PCB size by integrating multiple blocks onto a single chip. Such integration can threaten system integrity by exceeding the thermal limits of the device package. An intelligent thermal control circuit eliminates this problem by dynamically managing power usage and, in the process, maximizing battery charger performance.

By Bill Weiss, Product Line Director, AnalogicTech

As designers of the latest generation of consumer electronics products have increased functional integration and reduced product footprint, they have also increased the number of power management circuits required while applying pressure to integrate them together into fewer packages and less PCB area. Today a growing number of products, including smart phones, digital cameras, handheld instruments, MP3 players and portable media players, are built around a relatively high powered processor or DSP that requires different voltages to power its core and an I/O. Sometimes the power supply for the I/O also powers other ancillary application circuitry. Many of these systems are powered by a single-cell Lithium-ion battery sized in the 1000 to 1500 mAh range. Accordingly, they require multiple voltage converters and a fairly sophisticated battery charger circuit to support basic operation.

In this new breed of portable products described above, traditionally portable system designers have used single function buck converters and battery charger ICs to power the processor core, processor I/O and charge the battery. Today IC developers can dramatically reduce the required PCB space by integrating these blocks together, e.g. one IC containing a 1A battery charger and two step-down converters capable of delivering up to 600 mA of current each in a compact 4 mm x 4 mm QFN package.

The problem power IC designers face, however, is the cumulative heat these three power functions generate when inside the same IC. While power dissipation capability varies with several factors, together these three common power functions can easily generate more heat than the single IC package can handle. When that occurs, the heat generated could adversely impact the operation of the buck converters and potentially cause an I/O error, a processor interrupt or a system shutdown. At the same time, if the battery charger circuit does not run at maximum efficiency or is interrupted, the user would experience an extended battery charge time and possibly reduced charge cycle life. As a result, designers face a formidable challenge. How do they integrate these functions, guarantee the operation of the system and still maximize charge current to the battery and, in the process, minimize charge time?

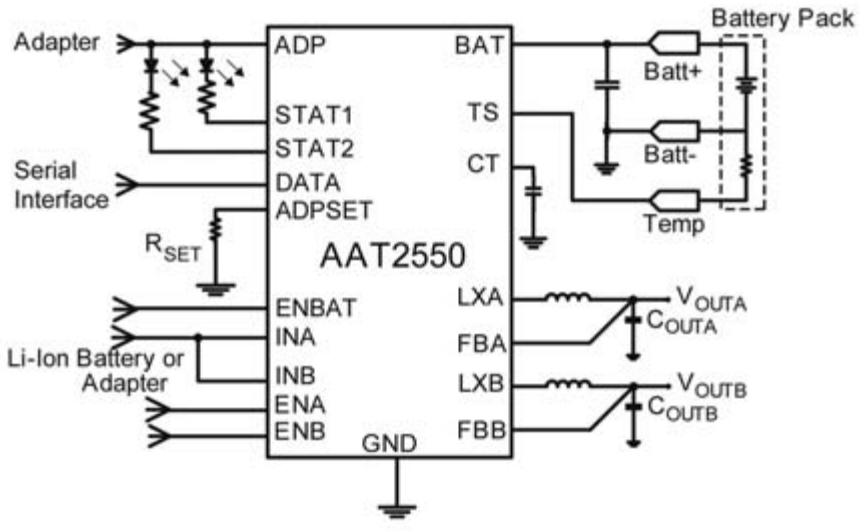

Figure 1 : AAT2550 Typical Application Diagram.

Digital Thermal Control

To address this problem engineers at AnalogicTech have recently developed a digital thermal control loop circuit for their new AAT2550 SystemPower™ IC. Designed to reduce PCB real estate requirements in space-constrained portable applications, this IC combines a 1A battery charger with two 600 mA step-down converters in a 4mm x 4mm 24-pin QFN package. The battery charger in the device is a constant current/constant voltage linear charger with an integrated pass device and reverse blocking protection. The charge current on the device is programmable, via an external resistor, from 100 mA to 1 A. Both step-down converters operate at a relatively high 1.4 MHz switching frequency allowing the use of small external components. Each converter's efficiency is optimized for all load conditions from no load to 600 mA. Both converters operate off a 2.7 to 5.5V input and feature independent input, enable and feedback pins. No load quiescent current is 27 µA per converter. An integrated soft start function eliminates voltage overshoot when the enable or voltage input is applied.

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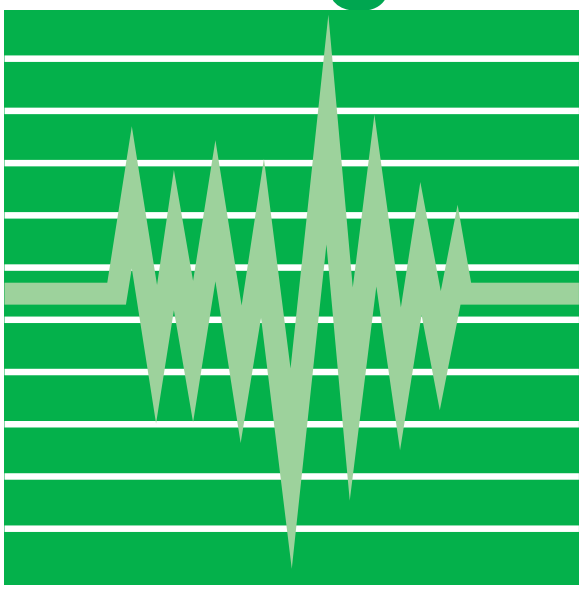

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To control power dissipation and heat generation, and thus maximize performance, the IC includes an innovative digital thermal control loop circuit which monitors die temperature and automatically throttles back charge current when demand on the power system increases the die temperature in excess of the power dissipation capabilities of the device package. This thermal control circuit activates only when the die temperature exceeds 110º C.

Once that threshold is reached and the digital thermal control loop becomes active, the control circuit reduces the fast charge constant current (ICC) by an initial factor of 0.44. From that point forward the circuit measures the die temperature every 3.3 seconds and throttles back or increases the charge current in small incremental steps of approximately 35 mA until equilibrium current is reached which reduces the IC temperature to a safe level and ensures safe operation of the device, and thus the system in which it is used.

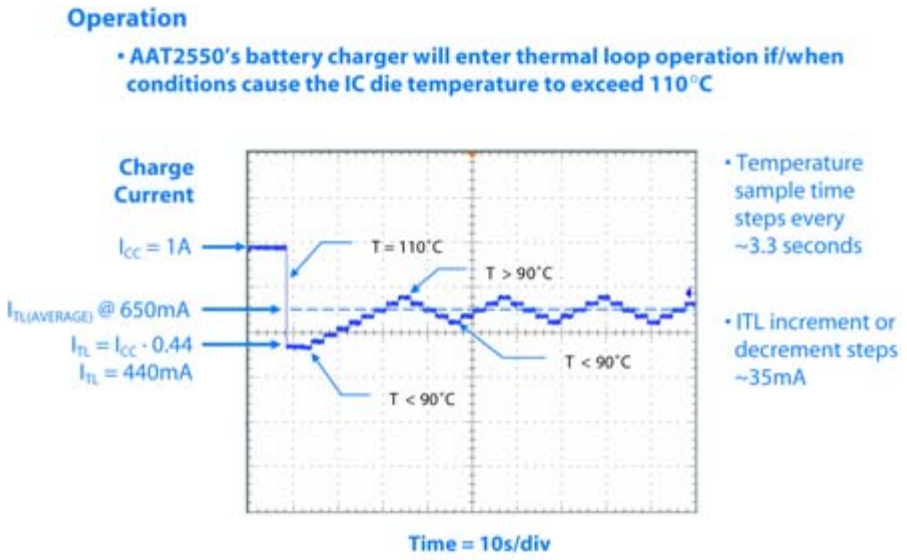

Figure 2: Digital Thermal Control Loop 1.

This ability to automatically adjust the battery charge current up and down in small incremental steps distinguishes the digital thermal control loop circuit in the AAT2550 from alternative approaches. Traditionally, IC designers have not managed battery charger die temperature, or have managed battery charger die temperature only by setting two distinct charge current levels, one high for maximum charge current and a second low to ensure IC integrity. Once the die temperature exceeded its thermal limits, the charger was reset to the lower predetermined current level. In most cases this second charge level was set lower than necessary to protect the device. By moving to an extremely low charge current, however, this predetermined, dual-level approach also ensured that the charger did not utilize all current available within the IC's temperature limits and thereby unnecessarily extended the charge time.

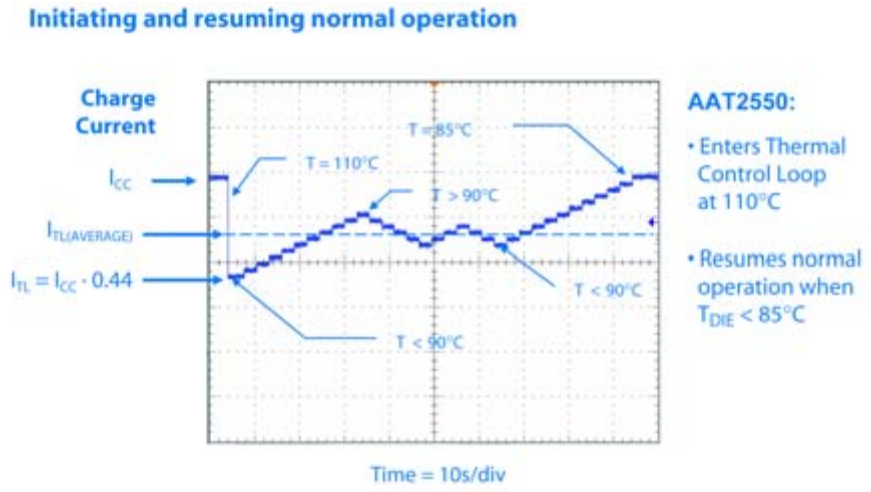

Figure 3 : Digital Thermal Control Loop 2.

AnalogicTech's digital thermal control loop offers a more dynamic approach to the problem. Once the digital thermal control loop is activated and the current is reset, the circuit continuously monitors the die temperature and adjusts the charge current up or down to meet thermal limits. This allows the device to adjust the charge current as the current used by the two integrated step-down converters increases or decreases. By constantly adjusting the charge level to varying die temperature conditions, this intelligent thermal management system permits the battery charger to charge the battery cell safely over a wide range of conditions. Furthermore, by utilizing the maximum available charge current, it ensures the battery will be charged in the shortest time possible for a given set of conditions, and even over a dynamically changing set of conditions.

If the die temperature drops below the threshold of 85º C, the AAT2550 terminates its thermal regulation mode and automatically resumes charging at the full programmed constant current level (see figure 3).

Conclusion

Given the relentless pressure to build portable electronics devices in smaller footprints, the integration of multiple system power management functions into single-chip, highly integrated devices offers attractive possibilities. To take advantage of these new devices, however, designers will need more intelligent and automated schemes for managing the large amounts of heat generated when multiple high power functions are brought together on the same die. By allowing users to maximize charge current and minimize battery charge time while reducing PCB footprint, the digital thermal control loop described above offers an important step in this direction.

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Vertical Structure to Optimize On-Resistance in Power MOS

The lower resistance allows a smaller chip

Consumer products have become a leading technological and market driver of the semiconductor industry, fostering an ever-increasing demand for power density in devices targeted for that segment.

By Dick James, Senior Technology Advisor, Chipworks

Chipmakers have found that by reducing power losses, they can boost real power without going to larger chips. Their efforts have helped foster a burgeoning market for more-efficient power devices.

In the late 1990s, Infineon (former Siemens) introduced a line of power MOS chips they dubbed CoolMOS, aimed at switch-mode power supplies. The company claimed that the chips had much lower on-state resistance than regular MOSFETs, thus reducing conduction-based power losses and improving switching time. This breakthrough was accomplished in a chip area one-fifth the size of an equivalent surface-doped MOSFET.

The high breakdown voltage required of power NMOSFETs usually mandates a thick, low-doped n-epitaxial drift layer in the device between the source diffusion on the top surface and the drain diffusion on the backside. This kind of device structure essentially dictates that the higher the breakdown voltage (thicker epi), the higher the associated on-resistance—since the current flow moves vertically through the drift layer—and the slower the switching speed.

The CoolMOS structure gets around this problem by increasing the n– epi doping by an order of magnitude and introducing compensating p– columns that keep the integrated charge in the drift layer at the appropriate level for the required breakdown voltage. The basic structure features the p– columns embedded in an n– epitaxial layer on an n+ substrate.

In the “on” state, the current is conducted through the n– epi regions, and in reverse bias, both the columns and the epi deplete completely, giving the breakdown voltage equivalent to the integrated doping of the epi layer. Since the n– epi is more highly doped than a conventional device, the lower resistance allows a smaller chip for the same on-resistance or a higher power for the same size chip. The depth of the epi layer and columns can be adjusted to achieve the required specifications: Infineon has CoolMOS products ranging from 500- to 1000-V tolerance.

This sounds fine in theory, but how does it work in practice?
Chipworks analyzed an Infineon SPP02N80C3 CoolMOS n-channel device, rated at 2 A and 800 V, with an on-state resistance of 2.4 W. The C3 designates the third generation of the technology, and it was manufactured at the Villach fab in Austria.

Figure 1 shows a photo of the 4.3-mm^2 die, showing the gate contact on the left and the remains of the aluminum 10-mil source-contact wire on the right. Figure 2 depicts a cross section of the die; the die is 210 µm thick, with the top 60 µm being the n– epi layer. On close examination, one can almost see some structures in the epi layer, which are the p– columns.

Considering the low doping levels in the epi, the scanning capacitance microscope (SCM) is the imaging tool of choice, since it distinguishes n and p doping best in lightly doped samples. Figure 3 is an SCM plot of two p– columns, 42 µm deep, clearly showing the undulating structure that offers clues about how the columns form. The microscope does not distinguish the metal and poly at the

Figure 1: Photo of the 4.3-mm2 die

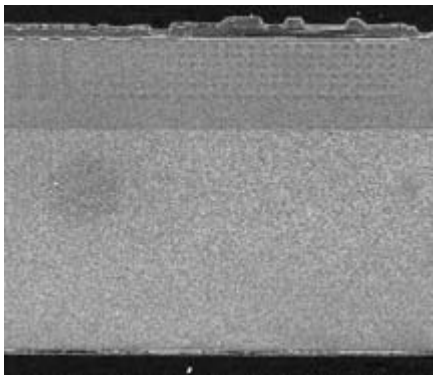

Figure 2: Cross section of the die

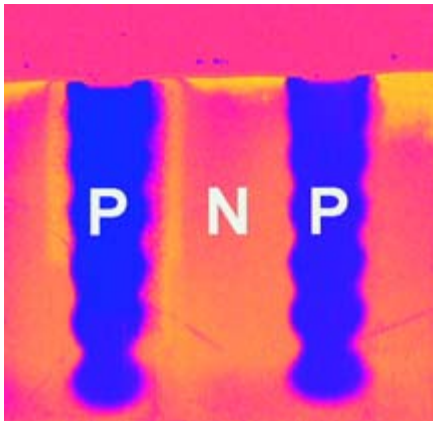

Figure 3: SCM plot of two p– columns, 42 µm deep

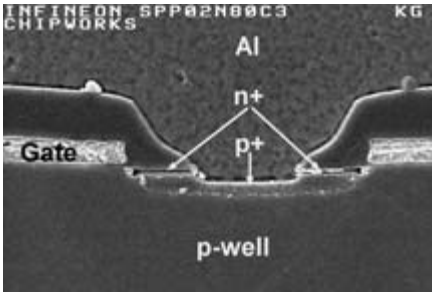

Figure 4: Within the p-well there is a p+ contact region and the n+ source diffusion

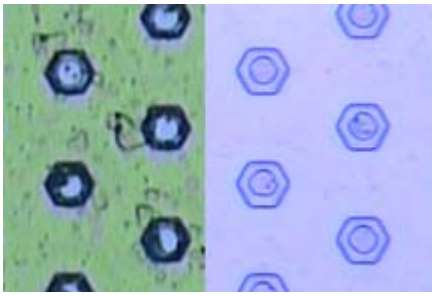

Figure 5: The polysilicon pattern (left) and the diffusion outlines (right)

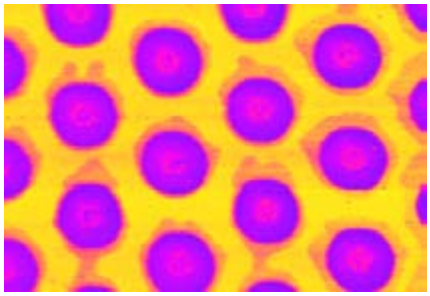

Figure 6: SCM image of the array beveled into the p-wells

sample surface. Secondary ion mass spectroscopy and spreading resistance probe analyses reveal that the substrate was antimony-doped to ~5 × 10^{17}; the epi is phosphorus-doped to ~5 × 10^{14}; and the columns are boron-doped to ~1 × 10^{15} atoms/cm2.

Given the shape of the columns, it seems clear that they are made by depositing successive epitaxial layers (in this case, seven layers), implanting boron after each epi growth step, and outdiffusing to merge the boron implants. Obviously, the dose and thermal budgets must be carefully tuned to obtain the required doping uniformity.

At the surface, the device looks fairly conventional. The columns extend from the p-wells that underlap the gate electrode and define the channel length. Within the p-well there is a p+ contact region and the n+ source diffusion, as shown in Figure 4. The source metal is 5.5 µm thick and the gate polysilicon is ~0.5 µm thick, with a channel length of ~2 µm and a 90-nm gate oxide. There are about 12,400 cells in this device.

In plan view, one can see that the cells are hexagonally shaped, defined by the gate, in a hexagonal array. Figure 5 shows the polysilicon pattern (left) and the diffusion outlines (right). Figure 6, an SCM image of the array beveled into the p-wells, indicates that they are circular, with the same hexagonal layout. The p+ contact regions can be seen faintly in the center of each well.

The CoolMOS devices offer a good example of the innovative design seen in other chip market segments, yet they do so without employing deep submicron technology. Because of this, Infineon is well placed to take some of the oft-ignored but essential power-chip market that exists in the shadow of the much-hyped processor and memory segments.

www.chipworks.com

Trends in Battery Powered Portable Devices

Power rail requires a fixed 3.3V output

The year of 2006 turned out to be a stellar year for the shipment of battery-powered portable electronic devices. During the course of 2006, consumers bought over 950 million cell phones, 220 million notebooks, 140 million MP3 players, 90 million DSCs and 10 million GPS systems.

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

However, another category of products not mentioned, are hybrid versions of two or even three of these product functions, such as portable media players (PMP) or digital media broadcast (DMB) products. These too, include a Lithium-Ion battery as their main power source, and are fast becoming a significant player in the area of consumer electronics.

The advantages of a PMP are that they can play both MP3 and MP4 formats. Therefore, a single device can be used to listen to music or watch a movie from a DVD-CD, or from a web site downloaded file. Many of these PMPs include a hard disk drive (HDD) for high capacity storage capability. Typically, this allows a device to store over 150 hours of video or 1,200 hours of music. However, manufacturers of these PMPs are under ever increasing pressure to pack all of these features into an already constrained form factor while simultaneously gaining longer runtimes.

Since most PMPs have the functionality of both a video player and a MP3 player, the internal electronics requires multiple low voltage output rails at varying power levels. The reason for this is clear; the majority of the digital large scale integrated (LSI) ICs have operating voltage of 1.5V or less. At the same time, memory and I/O voltage requirements can vary between 2.5V and 3.3V. Thus, it is becoming impractical to use multiple point-of-load (POL) DC/DC converters directly from the Li-Ion battery, and so system designers are adopting a more integrated approach.

Similarly, cellular phones do more than just allow people to talk with each other. Most 'Smart' cellular phones allow web browsing, wireless transfer of emails, photography, streaming video, TV reception and even GPS capability. An embryonic trend is to also include a micro hard disk drive for high capacity storage capability; allowing these Smart phones to also have high-density storage capability. Most of the HDDs used have platters of 1" in diameter, or less. There are10GB micro-drives on a single platter with only 1" in diameter which are already proven and available, with 0.8'' diameter platters are on the near term horizon. The 1" disk drives only need about 300mA at 3.3V for normal operation; however, during spin-up peak current demand can be as high as 500mA. Future 0.8" models will need less nominal current and will have peak currents less than 400mA.

Looking at the Smart phone block diagram in Figure 1, it is easy to see how the increasing

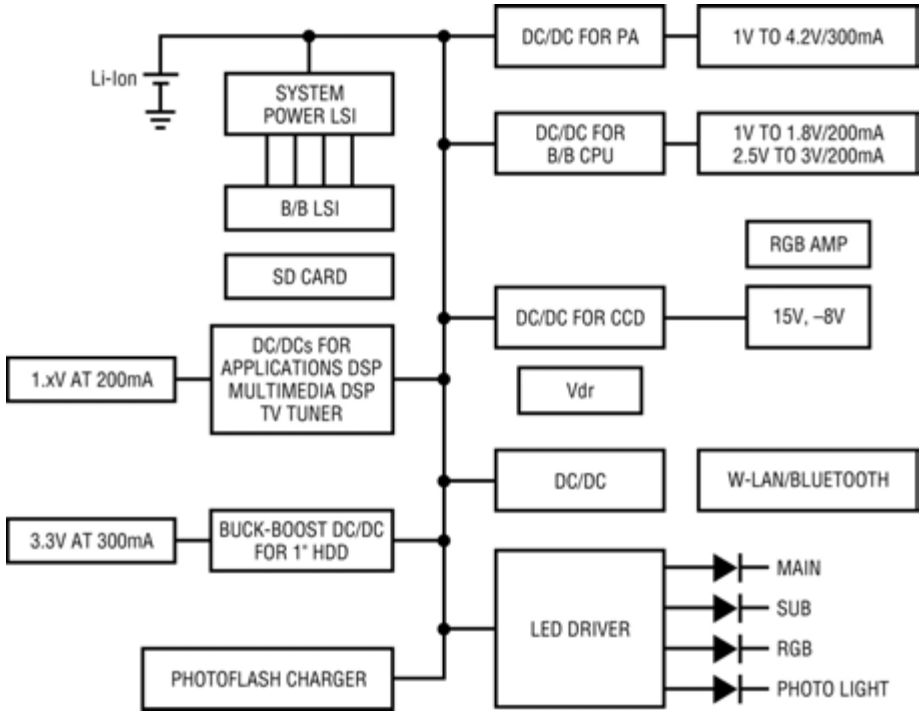

Figure 1. Block Diagram of a Smart Cellular Phone

number of features is also driving the need for more low voltage output rails at varying power levels.

The Use of a HDD in a PMP or a Smart Phone

A key driver for the adoption of a HDD inside a PMP or Smart phone has been the need for large and easily read/writeable compact storage. Consider the case of the PMP, It can usually be powered from an AC adapter, a Universal Serial Bus (USB) cable, or the Li-ion battery; however, managing the power-path control between these power sources presents a significant technical challenge.

Another common DC/DC converter problem is to generate a regulated output voltage which lies somewhere between a wide range of input voltages. To help put this problem into a clearer perspective, it is useful to consider a single cell Li-Ion battery PMP with a 3.3V power rail. Having a conventional lithium-cobalt oxide cathode cell means that its discharge profile is from a high of 4.2V down to 3.0V. Nevertheless, the system power rail requires a fixed 3.3V output. As can be seen, the output voltage is at times above, below and also equal to the input voltage range for the Li-ion battery.

The traditional approach taken to solving this type of problem has been to use either a single-ended primary inductance converter (SEPIC) or a buck/boost converter. These types of converters will deliver a fixed output voltage whether the input voltage is above, below, or equal to the output voltage. However, there are some significant drawbacks when using SEPIC converters:

Complicated design due to the multiple inductors or bulky transformer required. The control loop is complex and difficult to stabilize under a wide input voltage range typical with Li-Ion battery applications.

The solution footprint is large and also has a high height profile.
The efficiency of conversion is low – usually mid-70s to low 80s percent.
Thermal problems can arise at higher output power levels.

A more effective approach would be to use a single inductor-based converter that can control four internal switches to perform the step-down, step-up and 100% duty cycle modes. This type of 4-switch buck-boost converter would have the advantage of being easy to design, have high power density and also provide high efficiency operation due to its synchronous drive capability.

Supplying 3.3V at 500mA for HDD Spin-Up

It is clear that designers of PMPs have a number of options available to ensure that battery life is optimized for their particular configuration. A combination of multifunction ASSPs can provide the necessary voltages and power levels to provide optimum system performance while ensuring that the power drain on the battery is minimized during normal operation.

However, an ASSP might not be able to utilize the complete energy density of the newer cathode chemistry Li-Ion batteries such as Sony's Nexelion product family. The reason being that once the battery's voltage

is below the required 3.3V output level, the ASSP cannot boost this battery voltage to the required output level. Since the Nexelion battery range is 4.2V down to 2.5V, this would leave over 30% of the battery's energy un-used. In this instance, a more simplified building block approach is a good alternative to supplying a HDD with the necessary power during the natural discharge cycle of this newer type of Li-Ion battery. In this case, a monolithic synchronous buck-boost converter that can deliver a fixed 3.3V output regardless of whether the input voltage was above, equal to, or below the output voltage would be the ideal solution. Fortunately, Linear Technology has recently released a new buck-boost converter to address this specific need; it is the LTC3532.

The LTC3532 is a high efficiency, fixed frequency, buck-boost DC/DC converter that can regulate an output voltage above, below, or equal to the input source voltage with a single inductor. The input voltage range is 2.4V to 5.5V and its output voltage range is 2.4V to 5.25V. Its peak output current capability is 500mA at an output voltage of 3.3V. The LTC3532's architecture provides a continuous transfer function through all operating modes, namely step-down, pass through and step-up. This makes the LTC3532 ideal for extending battery run-time in single cell Li-Ion, multi-cell alkaline or NiMH applications where input voltage decreases as the battery discharges. See figure 2 below for compete schematic of the LTC3532.

Thus, in a single cell Li-Ion battery powered PMP, a 1" miniature HDD needs a constant 3.3V at a nominal 300mA, with 500mA peak currents. The output voltage from the Sony's Nexelion battery varies from 4.2V down to as low as 2.5V. The LTC3532 would operate in step-down mode while the battery voltage declines from 4.2V to a nominal 3.3V. At 3.3V, the LTC3532 will operate in 4-switch buck-boost mode. This 4-switch operation ensures a smooth switchover between buck and boost modes, providing no jitter, ripple or erratic noise generation. Once the battery voltage drops below 3.3V and continues down to 2.5V, the LTC3532 operates in step-up mode. Compared to a conventional step-down converter, using the LTC3532 can extend the useful life of the battery by over 30%.

A Multiple Output DC/DC Converter for 4 Low Power Rails

It is clear from the above discussions that there is also a growing demand for a moderately integrated switching DC/DC converter that can supply multiple outputs with high efficiency operation at moderate current levels. Such a converter would easily find a home in either a PMP or Smart phone.

Linear Technology has recently introduced the LTC3544 to bring an optimized, compact solution for just this purpose. The LTC3544 is a quad synchronous step-down DC/DC converter which operates at 2.25MHz and has four independent outputs with continuous current output capability of 300mA, two times 200mA and 100mA, respectively. Its 2.25V to 5.5V input voltage range makes is well suited for Li-Ion/polymer battery-powered devices. The high switching frequency operation, combined with a 3mm x 3mm surface mount package allows for the use of small surface mount inductors and capacitors while providing a compact solution footprint. Finally, it's internal synchronous switches increase efficiency and eliminate the need for external Schottky diodes.

Conclusion

Designers of battery powered portable devices have a number of options available to provide for the adoption of a HDD within their product or provide for a small compact DC/DC converter for their low power rails. Fortunately, manufactures like Linear Technology are offering a range of products in this area to simplify the designer's task.

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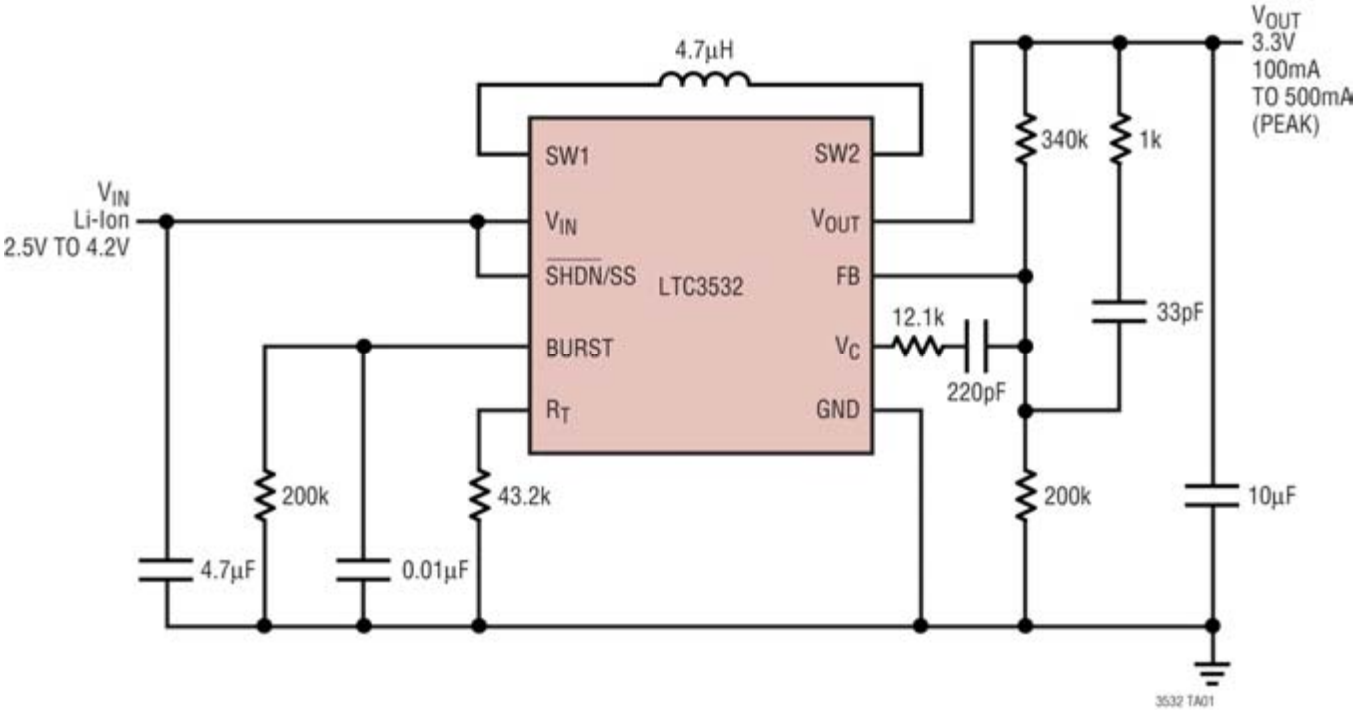

Figure 2: Miniature Hard Disk Drive Power Supply using the LTC3532.

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The Challenge of Packaging Small Power Devices

Better Electrical Performance, Lower Cost, High Reliability

The demand for smaller and thinner devices is dictating the development of packaging and interconnecting techniques for discrete power semiconductors. This trend is driven by requirements of space-critical end applications, and enabled by ongoing substantial improvements in silicon efficiency.

By Siegbert Haumann, Christoph Luechinger, Orthodyne Electronics Corporation

Up until now, fine wire ball bonding and Copper strap attachment have been the main interconnect techniques used in power packages smaller than the TO-252 (DPAK). However, increased requirements for better electrical performance, higher reliability and especially lower overall cost, now expose weaknesses in each of these existing techniques.

Large Aluminum wire bonding, the most commonly used interconnect technique in DPAK and larger size power devices, was so far not a viable alternative due to the package size requirements. However the technique's proven strengths, reliability, flexibility and low overall cost are very much desired for producing modern small power packages in an economical way.

Figure 2: Shift to smaller packages

The recently introduced large Aluminum ribbon bonding process (PowerRibbon™), developed by Orthodyne Electronics, overcomes the package size restrictions and allows the application of the strengths and benefits of the large Aluminum wire bonding process in smaller power packages. It adds the additional benefits of a wide process window and higher productivity. All in all, PowerRibbon™ bonding offers a near perfect fit between requirements and capabilities, providing a very attractive alternative to the used techniques up until now.

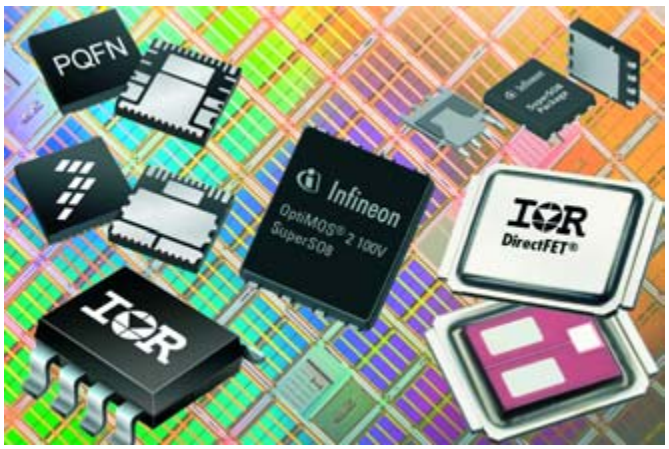


Figure 1: State of the art packages in industry

Packaging Trends

TO-XXX packages are the standard for medium power discrete devices. Over the last ten to fifteen years there has been a steady shift of growth from the TO-220 to the smaller TO-252 (DPAK) (see Figure 2).

Large Aluminum (Al) wire bonding (5 to 20mil) is the main interconnect technique used in these packages. Ongoing developments in high performance wire bonding equipment and expertise, enables such devices to be interconnected reliably, with very high yield and at low cost. The main interconnect method for smaller, lower power packages, especially the SO-8, is Gold (Au) ball bonding with wire diameters in the range of 1 to 3mil.

Advances in power chip technology enabled a trend towards smaller packages, with the same or similar current capabilities which the larger TO-XXX packages had only a few years ago.

This makes sense from an economic viewpoint. For constant cost per wafer the price per die decreases with die size. A smaller and/or more efficient die allows the use of a smaller package, which means less material per device and therefore lower cost. Smaller devices require less area on a printed circuit (pc) board, contributing to cost savings on the system level. If all this enables new applications, economy of scale will bring additional cost benefits.

Portable applications drove requirements that were difficult to achieve by the existing packages. They require very efficient power devices of very small size. In addition, high end applications in telecom and computing require the best possible electrical and thermal performance together with a small enough footprint. These needs spurred significant efforts to develop new packaging and interconnect designs, including wire bond free designs. While wire bond free

designs address the performance requirements, most of them are proprietary, non-standard, with manufacturing costs remaining questionable.
But, while performance is an initial enabler, cost must become inline with market needs. Hence the drive to standard, non-proprietary packages and interconnect technologies that provide good electrical performance, the needed footprint and reliability at a reasonable cost. Leadless SO-8 or PQFN-type packages fullfil this requirement.

Available Interconnects

Fine gold (Au) wire bonding becomes less and less effective even in small power packages where large wire diameters are desired. The high material cost runs against the need to increase the interconnect cross-section to accommodate higher current requirements. Its less expensive sibling, copper (Cu) wire bonding, reduces wire material cost and can improve electrical performance. However, the more difficult process caused by Copper's material properties (hardness, oxidation behavior) adds additional (process, yield) cost. An area bonded Cu strap (clip) enables the desired electrical performance, but cost, flexibility and reliability remain questionable. The use of large aluminum (Al) wire in small power packages, appreciated in larger power packages due to its flexibility, reliability and low cost, only applies to some select applications. Its use is limited to wire sizes on the lower range of its capabilities due to package size contraints.
In order for the broad range of mainstream applications to benefit from the recent developments in power chip technology, there is therefore a need for an overall effective interconnect technology with performance sufficient and cost low enough for the majority of applications.

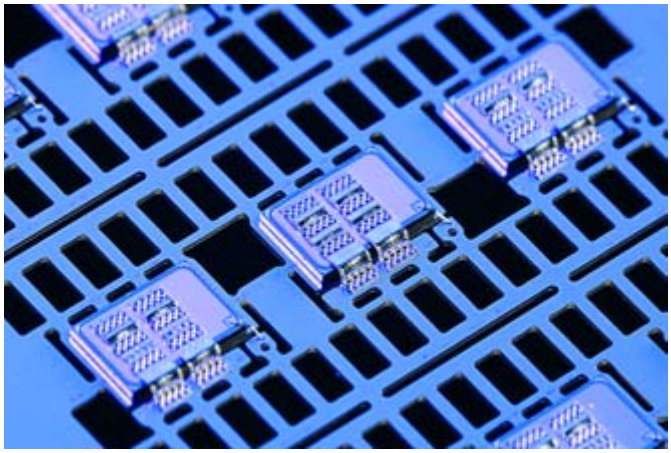


Figure 3: Layout of small power packages

PowerRibbon™ Bonding

PowerRibbon™, developed by Orthodyne Electronics, represents the ultrasonic bonding of large Al ribbon in the range 20x4mil up to 80x10mil and is an evolutionary extension of large Al wire bonding. The round cross-section of the wire is replaced by the rectangular cross-section of the ribbon. Al material composition and mechanical properties are equivalent to large Al wire. The change in the geometry of the cross-section diminishes the horizontal flexibility, but increases the vertical flexibility of the interconnect. Horizontal flexibility, the capability to bond wires under large forced angles, is important to interconnect configurations with a complex structure such as TO-XXX packages and multi-chip applications.
Vertical flexibility, the decoupling of thickness and width, i.e., the possibility to choose ribbon thickness and width independently, enables fitting a large interconnect cross-section, with a minimum number of ribbons, into the space given by an application.
The user is now able to benefit from all the desired features offered by large Al wire bonding: its cost benefits, electrical performance, reliability and flexibility in small SO-8 and PQFN devices.
Figure 3 shows that the layout of small power packages such as the standard SO8 or PQFN-type packages is perfectly suited for PowerRibbon™ bonding. The wide source lead along a large portion of the heat sink and die allows the ribbon to cover a large portion of the die with a minimal number of straight ribbons.

Performance, Reliability and Cost

Performance

According to Table1 the electrical resistance for 1mm length of 40x4mil Al ribbon is approx. 0.26mOhm, while it is approx. 11.35Ohm or nearly 43 times higher for 1mm length of 2mil Au wire or approx. 8.39Ohm or nearly 32 times higher for 1mm length of 2mil Cu wire.

	Ribbon	20x4mil Al	30x4mil Al	40x4mil Al	50x5mil Al	60x4mil Al	60x6mil Al
Wire	Resistance /mm length	0.52	0.35	0.26	0.17	0.17	0.12
2mil Al	13.32	25.5	38.2	50.9	79.6	76.4	114.6
3mil Al	5.92	11.3	17.0	22.6	35.4	34.0	50.9
4mil Al	3.33	6.4	9.5	12.7	19.9	19.1	28.6
5mil Al	2.13	4.1	6.1	8.1	12.7	12.2	18.3
6mil Al	1.48	2.8	4.2	5.7	8.8	8.5	12.7
8mil Al	0.83	1.6	2.4	3.2	5.0	4.8	7.2
2mil Au	11.35	20.0	30.0	40.0	62.5	60.0	90.0
3mil Au	5.04	8.9	13.3	17.8	27.8	26.7	40.0
2mil Cu	8.39	15.9	23.9	31.8	49.7	47.7	71.6
3mil Cu	3.73	7.1	10.6	14.1	22.1	21.2	31.8
4mil Cu	2.10	4.0	6.0	8.0	12.4	11.9	17.9
5mil Cu	1.34	2.5	3.8	5.1	8.0	7.6	11.5
6mil Cu	0.93	1.8	2.7	3.5	5.5	5.3	8.0

Table 1: Wire to ribbon conversion table for equal electrical resistance at identical loop length. Calculations are based on the electrical resistivity ρ of the materials in typical bond wire quality: ρ_{Al}=2.7x10-6Ohmcm; ρ_{Au}=2.3x10-6Ohmcm; ρ_{Cu}=1.7x10-6Ohmcm. Note that the values can vary due to dimensional variations of the ribbons and wires.

But the maximum number of fine wires that can be bonded in a standard SO-8 package is limited by the size of the source lead, depending on the width of the lead to 20…22 wires for 2mil diameter.
For a die with approximate dimensions 140x100mils and a typical source metallization thickness of 4µm, the interconnect resistance (main loop plus spreading) of a configuration with two parallel 40x4mil ribbons with 2 stitches on the die each is approx. 0.5mOhm, which would be the equivalent to 18 Cu wires with 3mil diameter, the maximum number of wires that fits into this package. Considering that each bond joint represents a potential yield loss, this is an attractive alternative.
If a device is operated at higher frequencies, inductance and skin effect in the interconnect need to be considered. Inductance primarily affects the switching behavior of a device. Skin effect reduces the effective interconnect cross-section, causing a significant resistance increase, and therefore power loss, at higher frequencies.
Inductance is mainly a function of the geometry of the interconnect, with the length being the main factor. Ribbon offers similar inductance behavior as a strap and performance benefits compared to any round wire alternative.

Reliability

Although configurations with large bonded joints on the back and top side of the die can be made reliable by appropriate design and material choice, configurations with wire or ribbon interconnects on the top side of the die are inherently more forgiving and therefore more reliable, under operating conditions.

In several evaluation activities, standard and leadless SO-8 devices passed typical reliability tests, specifically (a) temperature cycling (500 cylces @ -65°C/+150°C), (b) high temperature storage (1,000 hours @ 175°C), (c) pressure cooker test (168 hours @ T_a=121°C, RH=100%, 15PSIG), and (d) Moisture Sensitivity Level 2 (MSL2) with standard preconditioning, all without any ribbon bonding related failure.

Figure 4: Orthodyne 7200plus

With their monometallic bond on the die, and the gate bonded with Al wire, Al ribbon bonded parts enable reliable operation up to chip junction temperatures of 175°C, which is a requirement in automotive applications.

Cost

All the different interconnect technologies have some weakness in at least one cost category.
The high wire material cost is the main weakness of Au ball bonding.

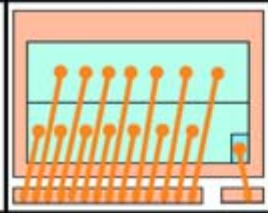
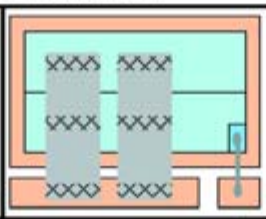
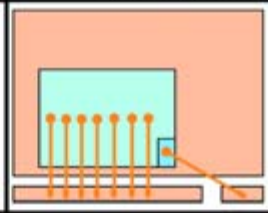
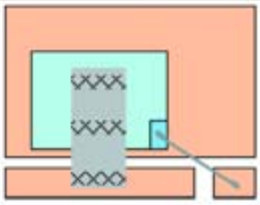
Die Size Range	length ≥120mil, width ≥70mil for DS		length ≥70mil, width ≥40mil for SS, ≥70mil for DS	
Typical Die Size	9mm², for example 140milx100mil		4.5mm², for example 100milx70mil	
Layout For Typical Die Size				
Electrical Performance	22x2mil Au: 1.6mΩ(1) 14x2.75mil Au: 0.8mΩ(2) 18x3mil Cu: 0.5mΩ(1)	2x40x4mil DS: 0.5mΩ(2)	5mil Cu strap: 0.5mΩ(2) 7x2mil Cu: 4.5mΩ(2)	1x40x4mil DS:1.1mΩ(2) 1x60x4mil DS: 0.7mΩ(1)
Material Cost	22x2mil Au: 2.5cents(4) 14x2.75mil Au: 3.0cents(4) 18x3mil Cu: 0.3cents(5)	2x40x4mil Al: 0.2cents(3)	7x2mil Cu: 0.1cents(5) 7x2mil Au: 0.6cents(4)	1x60x4mil Al: 0.1cents(3)
Productivity	1,500h⁻¹, per head(5)	~ 1,800h⁻¹, per head(6)	~3,200h⁻¹, per head(5)	~3,200h⁻¹, per head(6)

Table 2: Overview for performance characteristics of two sample die configurations for the standard SO-8.
Assumptions:
Values for electrical on-resistance are for 10V gate drive, estimated from data for the device resistance. (1)Estimated or extrapolated from measurements on similar configurations; (2) Measured. SS = Single Stitch on the die, DS = Double Stitch, TS = Triple Stitch; (3) Al ribbon cost at low material order quantities; (4) Au wire cost at Au price of $500 per ounce.; (5)Estimate, (6) Typical, based on a 5-row matrix frame.

At $500 per ounce the Au material cost per SO-8 device with approx. 22mm total wire length is 1.7cent for 2mil Au wire, and 3.0cent for 2.75mil Au wire.
Cost of 2x40x4mil Al ribbon in corrosion resistant quality and approx. 2x3.5mm length is approx. 0.2cent at low order volumes.
An area contact design like Cu strap demands a non-standard metallization that requires additional process steps on the wafer level, adding additional cost on the order of $20 per wafer. For a 6" wafer with dice of 6mm² size this adds approx. 1cent to the cost of a device. A strap specific to one die is inflexible and therefore costly. One strap type for several similar die sizes, limits the electrical performance. This makes such designs attractive for high performance applications, but less competitive for mainstream applications.
Cost of Cu wire is approx. 10 times lower than for Au wire with the same dimensions. However, the Cu ball bonding process operates at a lower yield and lower process speed compared to the Au ball bonding process. Its material properties require special material handling and packaging including a cover gas to prevent the Cu from oxidation during and after the flame-off process. Despite these measures, the process seems to remain rather sensitive, especially for cratering when bonding over active area.
In contrast, bonding a soft Al ribbon is a very gentle process, due to the geometry, and potentially even more gentle than Al wire bonding, which is known to be best suited for bonding over active area. In addition, Al ribbon configurations only require a few bonds on the die, offering much better conditions for minimal bond yield loss, compared to Cu wire bonding.

As an example, Table2 gives an overview of ballpark figures for electrical performance, material cost and productivity of some select configurations for the standard SO-8 package.

Conclusions

Large Al ribbon bonding is an evolutionary improvement of large Al wire bonding. It preserves most strengths of that technology and adds new ones, which make it very effective in interconnecting standard SO-8, and SO-8 size and smaller PQFN packages.
Al ribbon bonding offers better electrical performance than fine Au at a much lower cost. It offers comparable electrical performance to Cu wire bonding at comparable cost. But for bonding over active areas its gentle bond process enables a higher yield than Cu wire bonding. Its electrical and thermal performance is comparable to the performance of Cu strap bonding but offers lower cost and higher flexibility. In addition, the monometallic Al-Al system on the die enables reliable operation up to 175°C chip junction temperature.
All these strengths are possible with package layouts that follow established standards, and don't require specific proprietary package and interconnect designs. Therefore it allows using well-known processes and equipment.
In summary, Al ribbon bonding is the most attractive interconnect technique for small power packages for mainstream applications which require good electrical performance and reliability, at reasonable cost.

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Film Technology has Wind in its Sails

Film capacitors overcome internal defects

Aluminium electrolytic capacitors present serious deficiencies for the higher voltages required in the very latest wind power applications. In contrast, film technology offers significantly improved life expectancy, environmental performance and power handling.

By Gilles Terzulli and Craig Hunter, AVX

Wind power is a fast growing market around the world. Higher prices for fossil fuels and concerns over environmental impact have been two of the main driving factors. Further to this, improved efficiency of windmill power generation is also developing at a rapid pace. One element of this is higher voltages in generator systems, where the capacitors are actually located inside the converter.

Below is a typical circuit diagram showing the location of the DC filtering capacitors, used in a windmill application.

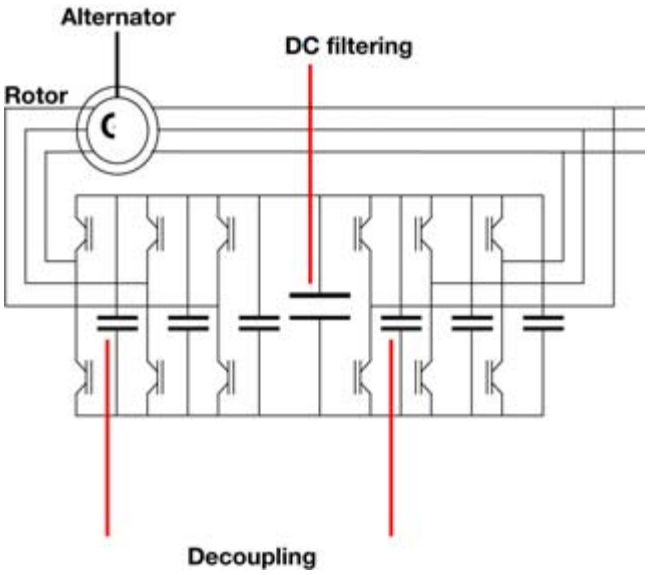

Figure 1: The location of the DC filtering capacitors

Historically many wind power systems have used capacitors with voltages around 500VDC, but today the "sweetspot" is in the voltage range 600VDC to 1350VDC depending on the output ac voltage from the alternator. This is because higher voltages are increasingly used to reduce power loss in the alternator and converter of the windmill. Higher voltages allow lower rms current for the same power. In this area, non-gas impregnated film capacitors offer significant technical advantages over previously used electrolytic capacitors.

DC filtering capacitor function

The DC filtering function smoothes voltage wave form and limits the magnitude of ripple voltage.

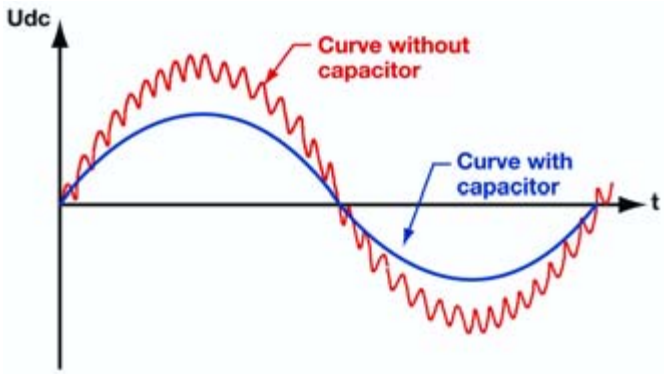

Figure 2: DC filtering function smoothes voltage wave form

AVX power film capacitors are able to provide a real boost to wind power stations, with extremely high capacitance values of up to 48,000 µF available.

Controlled self-healing

One major advantage is the ability of film capacitors to overcome internal defects. The latest dielectric films used for DC filter capacitors are coated with a very thin metallic layer. In the case of any defect, the metal evaporates and therefore isolates the defect, effectively self-healing the capacitor. As wind power systems are normally located in remote locations, this feature can significantly reduce ongoing maintenance costs and ensure higher efficiency of usage in the installed system.

Technology comparison Film vs. Aluminum

With today's dry film technology the gradient of voltage can reach more than 500V/um for discharge applications and 250V/um for DC filtering applications. These film capacitors are designed to withstand CEI 1071 standards. This means they are able to handle multiple voltage surges of up to twice the rated voltage, without significantly decreasing product lifetime. It also means the designer need only account for nominal voltage requirements when specifying his system.

By comparison, due to the process technology, the thickness of aluminium foil used in electrolytic capacitors is key to reaching higher voltages. However, there is a trade-off: the higher the voltage, the lower the available capacitance. In addition, higher voltage (500V) electrolyte conductivity reaches 5kohms/cm compared to around 150kohms/cm for lower voltage versions. This also limits rms current

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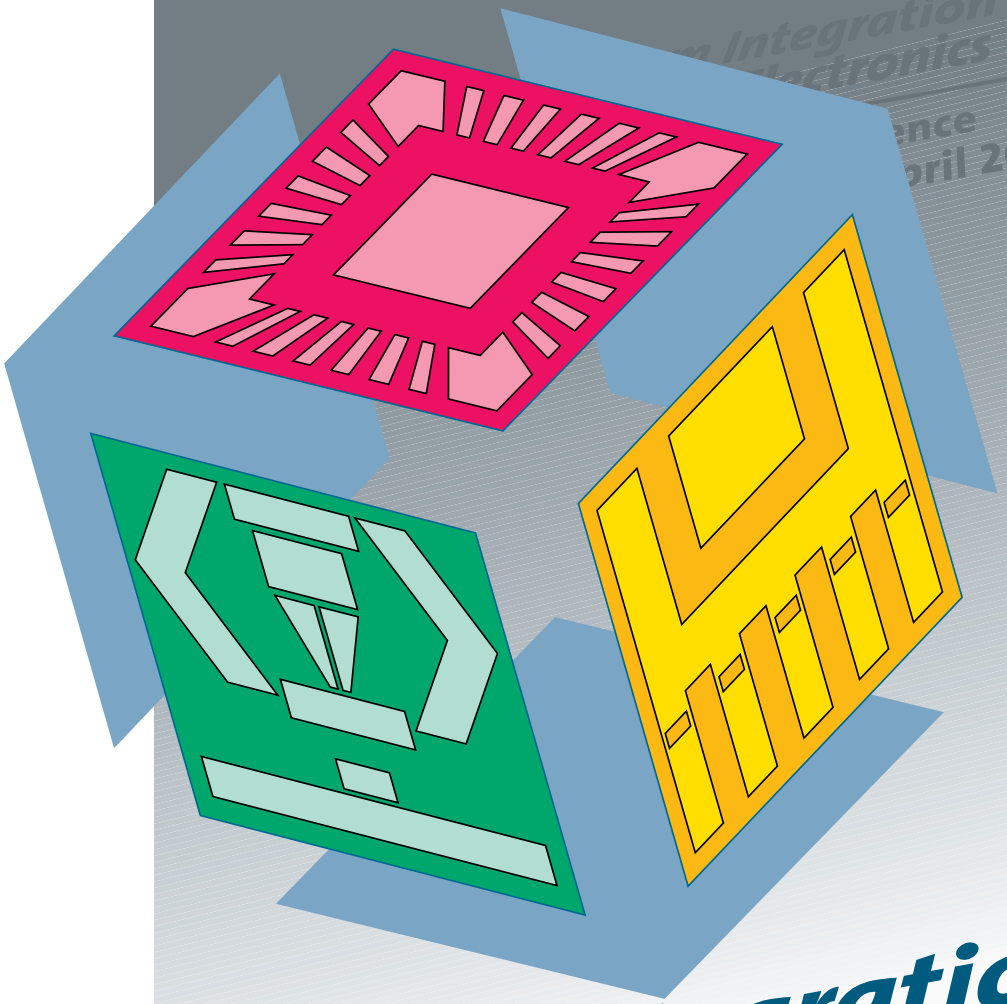

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values to about 20mA per µF, compared to 1A per µF for film capacitors. A major requirement for DC link capacitors is its ability to handle ripple current. Here film capacitors have a major advantage. Using aluminium electrolytics would require banks of several capacitors being used. Not because the capacitance value is required, but simply to handle the current. Using film capacitors would mean the designer need only consider the minimum capacitance value required for his system. As a result, designs which use film technology frequently save space.

In order to reach the necessary higher voltages of the systems being designed and deployed today, it would be necessary to connect multiple electrolytic capacitors in series. It would then also be necessary to balance the voltage. This would require connecting a resistor to each capacitor because the insulation resistance of each individual device will vary.

Another concern in using electrolytic capacitors would be that if a reverse voltage or over voltage higher than 1.5 times rated voltage occurs, it would cause a chemical reaction. Should it last long enough, the capacitor may suffer complete failure. This would be where the capacitor might explode or suffer a pressure release where the electrolyte may evaporate. To overcome this, the system designer would need to connect a diode in parallel to erase the potential problem.

This means that, although it is technically possible for aluminium electrolytics connected in series to attain the necessary higher voltage levels required by today's wind power applications, there are some very important deficiencies which would require the use of additional components or require careful design to ensure they operate successfully.

Another issue is that of surge voltage. The capability of aluminium electrolytics to withstand surge voltages is limited to approximately 1.2 times the nominal voltage. This means designers must take surge voltage into account when specifying these types of capacitors.

Higher voltage film capacitors (above 1200V) utilize non-toxic organic oil filled technology and can operate up to 100kV. These capacitors along with the dry film technology discussed earlier can be considered environmentally friendly solutions, because they do not use acids and therefore do not represent a risk to the system itself.

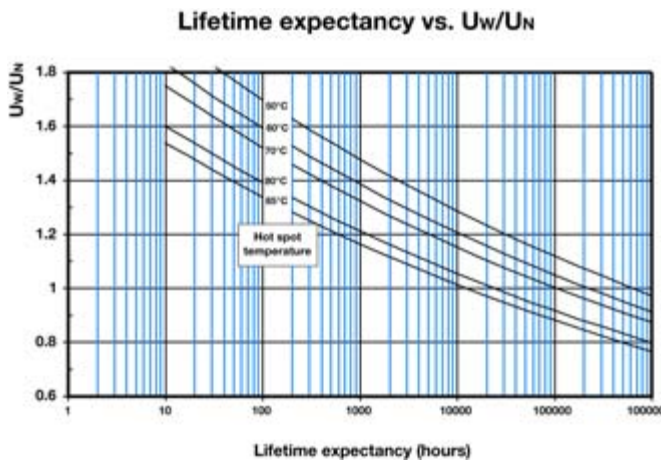

Figure 3: Main advantage of film capacitors is life expectancy

Both types of film capacitors can also be stored without concern, as unlike electrolytic capacitors, they have no "dry out" / wear-out mechanism.

Life expectancy

However, the main advantage of film capacitors is life expectancy. Our internal data shows that AVX controlled self-healing DC filtering capacitors exhibit a capacitance fall of a maximum of just 2% after 100,000 hours operation. When added to the fact that compared to aluminium electrolytics, complete device failure is very unlikely to occur. This means that during the full lifetime of an installed wind power system it is not necessary to change the capacitors. This represents a major maintenance saving for the user.

Film capacitor developments

Since the early 80s, significant improvements have been made in the application performance of DC filter capacitors. This has been achieved through the use of either combinations of metallized films or by using different segmentations of metallization on the dielectric films. In fact, power film capacitor manufacturers continue to develop much thinner films and improved segmentation techniques, which will result in the continued release of superior performance devices.

Figure 4: FFLC series film capacitor for DC filtering.

Summary

System voltages are continuing to increase in wind power/windmill applications. As these voltage requirements have risen they have passed the 600V barrier which represents a major hurdle for aluminium electrolytics. These are limited in voltage and require connection in series to successfully address this application, which can add significant cost in terms of space, as well as being much more complex to design and install.

Film capacitors (both dry and non-toxic organic oil-filled), offer significant technological advantages, including superior life expectancy and environmental performance as well as the ability to handle the various types of "in-application" technical issues (over-voltage and reverse voltage) which can easily occur.

When considering the fact that these systems are often deployed in remote locations and would require the minimum amount of maintenance and down-time, the advantages of using of film capacitors in these kinds of DC filtering applications appears to be overwhelming.

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PCIM Europe 2007 offers a unique overview of solutions, products and services associated with Power Electronics, Intelligent Motion and Power Quality/Energy Management, as well as the latest trends in the industry.

Facts & Figures 2006

- Exhibitors: 208 companies and 72 represented companies from 24 countries
- Exhibition space: 10,000 sqm
- Visitors: 5,783 trade visitors from 47 countries

Key exhibit categories:

- power semiconductors
- passive components
- products for thermal management
- sensors
- servo-technology
- energy management

General Information

Venue:

Tutorials on Monday 21 May 2007
at the Arvena Park Hotel, Nuremberg
Conference 22 – 24 May 2007
at CCN West Nuremberg Messe

Early registration rates until 13 April 2007!
Register now at www.pcim.de

Organizer:

Mesago PCIM

Mesago PCIM GmbH
Rotebuehlstr. 83 – 85
70178 Stuttgart, Germany
E-Mail: pcim@mesago.de
www.pcim.de

Supported by:

Bodo's Power Systems | Power Electronics Europe | Power Systems Design

Conference Hotline: ++49 711 61946-49

Exhibition Hotline: ++49 711 61946-73

Tutorials Monday 21 May 2007

Half Day Morning

1 Efficient Thermal Management of Power MOSFETs, Vital to Improve the Reliability of your Power Conversion Application
Dr. Axel Kleinitz, ON Semiconductor, Germany

2 Ultracapacitors: Advanced Energy Storage for Peak, Bridge and Emergency Power Applications
Dr. Adrian Schneuwly, Maxwell Technologies, Switzerland

3 Review and Comparison of the different Energy Storage Means within the Power Quality Field
Jean-Francois Christin, Jean-Paul Beaudet, MGE UPS, France

Half Day Afternoon

4 Practical Guidelines for Designing Secure Power Architectures for critical Process, Datacenters and Medical Applications
Jean-Francois Christin, MGE UPS, France

5 Power Quality – A shared Responsibility
Dr. Johan Enslin, KEMA Consulting, USA, Walter Hulshorst, KEMA Consulting, The Netherlands

6 Strategies and Solutions for a Simulation Based Product Definition Process in Power Management IC and System Design
Dr. Thomas G. Wilson, Transim Technology, USA

Full Day

7 Higher Efficiency Power Conversion through »Intelligent« Power Processing
Ionel Dan Jitaru, Delta Energy Systems, USA

8 Design with MOSFET and IGBT Power Modules
Prof. Josef Lutz, Chemnitz University of Technology, Germany
Dr. Tobias Reimann, ISLE GmbH, Germany

9 Design Considerations for High Frequency Linear Magnetics (Excluding H.F. Conductor Skin and Proximity Effects)
Bruce Carsten, Bruce Carsten Associates, USA

10 Best Power-Factor Correction Techniques
Dr. Richard Redl, ELFI S.A., Switzerland

11 Electromagnetic Compatibility for Higher Frequencies Power Designs
Jacques Laeuffer, Consultant, France

12 FPGA's in Drive Technology with training on Sigma-Delta Analog to Digital Conversion Technology
Prof. Jens Onno Krah, Cologne,
Rolf Richter, EBV Elektronik GmbH, Germany

13 Condition Monitoring, Fault Diagnosis, and Fault Tolerant Electric Motor Drives
Prof. Hamid Toliyat, Texas A&M University, USA

Conference 22 – 24 May 2007

Tuesday 22 May 2007

Automotive	Thermal Management and Stresses	DC/DC Power Conversion I	Motors and Actuators
LUNCH			
Innovative Power Devices	Renewable Energy Systems Energy Storage	DC/DC Power Conversion II	Passive Components Technologies
Poster/Dialogue Session			

Wednesday 23 May 2007

High Power Modules	Control in Power Electronics	Unity Power Factor and Harmonics	Drive Technologies
LUNCH			
Low Power Packages	Thermal Characterization	Active Filters	Embedded Motion
Poster/Dialogue Session			

Thursday 24 May 2007

DC/AC Power Conversion	Energy Saving and Improved Efficiency via Power Electronics	Power Quality Solutions	Software Tools and Applications
LUNCH			
UPS/Special Converters	Metering and Diagnostics	Sensors	Drives for Special Applications

as by January 2007 / subject to change without notice.

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- Travel and general information

→ **at www.pcim.de**

Design tool for easier Development

The AlCap design tool for scaling capacitor banks for frequency converters has been improved and extended. The library has been extended with the new types of the B43454, B43474 series with screw terminals and the B43305, B43540 and B43508 series with snap-in terminals having been listed in the new data book (ordering number EPC:27013-7600). At the same time, the software has been updated with a full reworking of the user interface, including error messages, help functions and the calculation procedure. Furthermore, the results are now able to be saved as PDF files.

Version 4.0 of the ferrite tool has also been reworked to allow calculation of user referred parameters and to give access to the digitalized material data for all EPCOS ferrites and their graphic displays. The database contains all the materials covered by the 2007 Data Book. These include the materials N45, T36 and T66 for broadband transformers, as well as the materials N51 and N95 for power transformers. The complex permeability and impedance can now also be displayed as a function of the frequency: the same applies to the transferable power, with due consideration of skin and proximity effects. In addition, the distortion (third harmonic) can now be calculated under specific circuit conditions at various temperatures.

With Ceramic capacitors, the latest innovations mean the DC bias curves for various ceramic materials are now available on the internet. These allow the developer to determine how a capacitor's capacitance changes as a function of the applied DC voltage. TKC curves have also been set up for various capacitors, enabling capacitance change to be determined as a function of temperature.

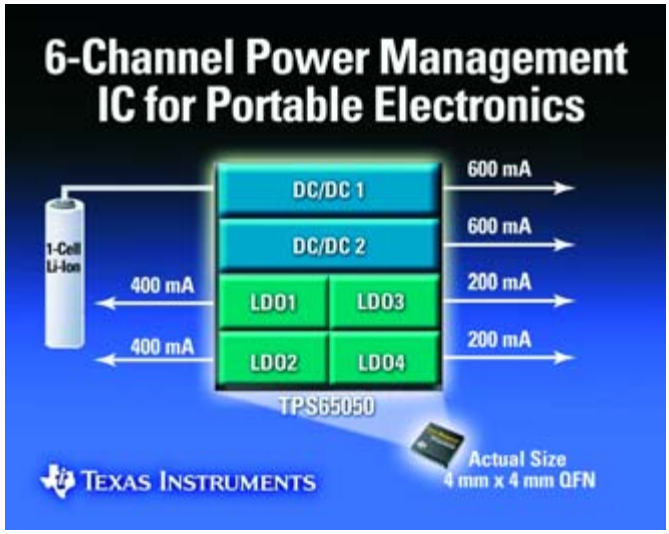
www.epcos.com

Six-Channel Power Management for Portable

Texas Instruments introduced a family of six-channel power management integrated circuits (PMICs) for single-cell, lithium-powered portable electronics. Combining high-performance power building blocks in a single 4 mm x 4 mm package, the easy-to-design devices support power system requirements of advanced application processors used in smart phones, portable media players, navigation systems and other electronics. See: www.ti.com/sc07019.

TI's TPS65050 family of converters efficiently manages power in today's leading applications processors, such as TI's OMAP™ processors, TMS320C55x™ generation of digital signal processors (DSPs) and others. The six-channel devices maximize up to 95 percent efficiency across a wide range of point-of-load currents up to 1 A.

The TPS65050 integrates two 2.25-MHz step-down converters to support the system's core, peripheral, I/O or memory voltages. Both of the converters, which operate at input voltages from 2.5 V to 6 V, allow the device to operate in a power-save mode at light-load currents, and can be placed in a shutdown mode when power consumption is reduced to less than 1 uA. The TPS65050 also integrates two general-purpose, 400-mA linear dropout (LDO) voltage regulators and two 200-mA LDOs that can be enabled with an external input pin for each LDO. In addition, the LDOs support an input voltage between 1.5 V and 6.5 V, which allows each to be supplied from one of the integrated step-down converters or directly from the battery.



www.ti.com

Fully-Protected High-Side Automotive Power Switches

International Rectifier has introduced a new family of fully-protected, high-side intelligent power switches (IPS) that leverage next-generation silicon in enhanced packaging to deliver improved power density and response times. The new IPS60xx family is designed for tough automotive applications, including transmission and gearbox, solenoid drivers; lighting control; and brushed DC motor control for seats, window lifts, and wipers.

IR's new fully protected single-chip devices deliver impressive gains in RDS(on) and consume much less board area for the overall solution. For example, the full-featured IPS6011 delivers a maximum on-state resistance of 14mOhms in a DPak. The IPS60xxPBF family integrates power MOSFETs with a host of standard protection features for over-current, over-temperature, ESD, and active clamp. An integrated charge pump allows the device to be driven in high-side topologies without additional components. The new IPS family also features reverse battery protection, actively turning on the output MOSFET during a reverse battery event. This feature almost eliminates current flow through the body diode and significantly reduces power dissipation in the part during an event, improving reliability and again eliminating the need for more components. Finally, these devices provide diagnostic feedback to the microcontroller, allowing detection of basic faults such as open load and short circuit.

All devices are RoHs compliant and Q100-qualified for automotive applications and are available in a variety of packages. Data sheets and an application note (AN-1117) are available on the Web.

www.irf.com

5W Adapter with Universal Input

Phihong USA has developed a USB adapter with a series of interchangeable plugs. Designated the PSB05R Series, the 5W adapter is available with four interchangeable clip adapter plugs for use in virtually any power outlet around the world. The worldwide use allows a single part number to be used, simplifying inventory and approvals.

"The adapter and interchangeable clips allow manufacturers to develop and produce one top assembly piece, and then configure the clips depending on where the adapter will be distributed," said Keith Hopwood, vice president of marketing for Phihong. "This enables OEMs to test and approve only one product design, which can then be used for distribution in any country in the world."

The PSB05R Series adapter is ideal for applications involving wireless communications, peripherals, portable equipment, and networking.

The PSB05R Series adapter is available at a competitive cost; since only one top assembly part number is required, it reduces the OEM's cost of stocking multiple finished items for various geographic destinations. Also, conventional fixed blade adapters require safety and EMC testing, approval and evaluation. By taking only one product through this process, as opposed to the typical four to five different versions, development time and cost is significantly reduced.

Measuring just 2.97 inches x 1.25 inches x 1.81 inches, and weighing only 2.16oz., the adapter features a USB socket and low leakage current. The device is CEC-compliant and meets UL 94 Vo flammability.

The 5W adapter features a no-load power consumption of less than 0.3W at 240VAC, and a low leakage current of 20mA. AC input voltage ranges from 90VAC to 240VAC with a DC output voltage of 5V. The device has a maximum over-voltage protection of 8VDC.

The adapters meet cUL/UL, TUV, SAA, CE, and C-Tick safety requirements.

www.phihong.com

Magnets for Wind Turbines

VACUUMSCHMELZE presented its new NdFeB-based permanent magnets with high stability against demagnetization, designed specifically for use in wind generators.

These magnets feature temperature stability up to 230°C as well as a very small variation in the magnetic properties. They are also designed for outstanding corrosion stability in salty air and damp atmosphere.

To date, wind energy installations have primarily comprised double-fed asynchronous generators with gear system (around 85% of windpower installations) or synchronous generators with electric excitation, which account for the remaining 15% of windpower systems. In comparison with these conventional systems, permanent magnet synchronous generators offer an array of advantages: Using permanent magnets in the rotor of the generator enables power losses to be cut by one-third. The high pole numbers that can be achieved with magnets enable the generators to be adjusted to the low rotation of the rotor blades, so that a gear system is unnecessary or a single-stage planetary gear is sufficient.

The use of permanent magnets is more efficient, and thus more cost-effective. Maintenance is minimized, also reducing costs throughout the lifespan of the system. These low-maintenance, high-efficiency synchronous generators are ideal for the wind farms of the future, the majority of which will be sited offshore.

VACUUMSCHMELZE has all the expertise necessary to optimize the generator design with regard to the magnetic circuit and assembling of magnetic modules.

www.vacuumschmelze.com

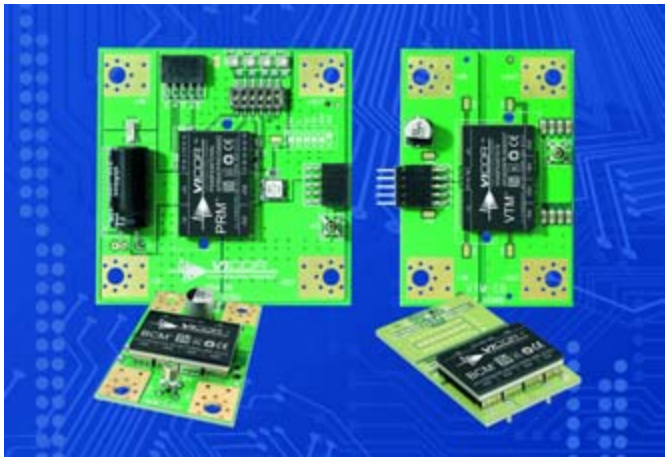
V·I Chip Evaluation and Validation Boards

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

FPA technology and the families of V•I Chip power components offer a fundamentally new and improved approach to distributed power. Factorizing DC-DC power conversion into its basic functions ¾ isolation and transformation in the VTM units and regulation in the PRM module ¾ maximizes power system performance and cost effectiveness. Unregulated BCM converters complete the line-up.

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

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

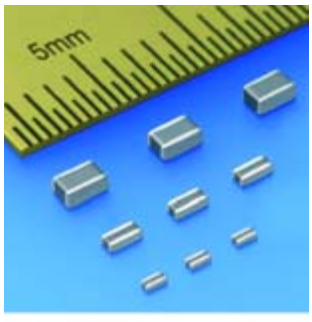


The customer evaluation boards are equipped with test sockets, trim pots, and convenient input and output connections. They provide design engineers with a jump start toward implementing this leading edge technology in technically challenging applications, meaning faster time to market and faster return on design investment.

www.vicorpower.com

WK Series Double Capacitance Over Previous Devices

TAIYO YUDEN announces a significant new addition to its expanding family of high-performance multilayer ceramic capacitors (MLCC). The nine models in the new WK series employ "reverse geometry" terminations and other design improvements to provide industry-leading performance relative to device size. WK series maximum capacitance values are, respectively, 0.47µF, 4.7µF and 10µF in the EIA 0402, 0603 and 0805 case sizes. These ratings represent an almost two-fold performance improvement over previous company devices of equal size. The WK series includes the industry's smallest low-ESL devices (now in 0402) and the industry's highest-capacitance values for both 0603 and 0805. Series inductance ratings are 0.47µF to 1.0µF, with voltage ratings of 4V (0402; 0603), 6.3V (0603; 0805) and 16V (0805). All part numbers specify ±22% capacitance change and a temperature range of -55C to +105C.



Representing TAIYO YUDEN's entry into the low-ESL (Equivalent Series Inductance) capacitor market, the new reverse-geometry MLCCs are so named because their length-to-width ratio has been reversed. Forming the electrodes on the long dimension of the device, instead of end-wise, widens and shortens the current path between terminations, thus reducing inductance and resistance—a particularly desirable attribute for decoupling circuits.

www.yuden.us

LDO Provides Stable Power for GSM Cell Phones

Intersil introduced the ISL9003A LDO (low dropout) regulator. This device combines superior PSRR (power supply rejection ratio) for stability and low noise for integration, making it ideally suited for GSM (global system for mobile) portable wireless applications.

In GSM cell phones, the RF PA switches on and off at a rate of 217Hz. During the on state, the RF PA sends data to the base station and the off state allows the phone to conserve battery power. During this on/off state the cell phone battery can drop as low as 500mV from its nominal voltage. The ISL9003A with a PSRR of 90dB is immune to these wide voltage drops, providing a very stable output voltage rail and continuous 150mA of load current.

The ISL9003A, with an output noise of just 20ìVRMS, also provides a discrete solution that enables integration of several modules or functions into a cell phone. This low noise, along with the PSRR, allows this device to be interfaced with an RX transceiver module or a camera module in a cell phone, as applications like this require a high level of performance that is not often achieved in integrated PMIC solutions.

The ISL9003A has a no-load quiescent current of 30ìA (typical) and 0.5ìA shutdown current and is stable with 1ìF of MLCC output capacitance with an ESR of up to 200mÙ. It comes in many fixed voltage options with ±1.8% output voltage accuracy over temperature, line and load. Other output voltage options are available on request.

www.intersil.com/power

Step-Down Converter for Portables

Developed with space-constrained portable applications in mind, AnalogicTech's AAT1149 high performance, fast transient, 400mA step-down converter enables the use of the industry's latest 0603 footprint, 1mm high inductors for the smallest possible total solution size.

Developers of mobile handsets and modules for new smart phone applications, such as Digital Media Broadcast (DMB) and Digital Video Broadcast (DVB), strive to drive down system thickness and footprint. By enabling the use of a 0603 footprint 1mm high inductor, and coming in a small, 2.0 x 2.1 mm SC70JW package, the AAT1149 delivers the power these applications need while setting new standards in solution size and power efficiency. The AAT1149 delivers 400mA of load current from an input range of 2.7V to 5.5V. Output voltage is programmable via external feedback resistors from 1.0V to VIN. The step-down converter achieves up to a high 98 percent efficiency. No load quiescent current is only 45µA. The 3MHz switching frequency allows the use of extremely small external components and keeps switching losses low.

To prevent damage during overload conditions, the AAT1149 adds current limit protection. An over temperature protection circuit disables switching if internal dissipation becomes excessive. An integrated 70µs soft start feature limits current surge and eliminates output voltage overshoot at startup. Specified over the -40 to +85 degrees C temperature range, the AAT1149 is available in a Pb-free, 8-pin SC70JW package that measures only 2.0 x 2.1mm.

www.analogictech.com

ADVERTISING INDEX

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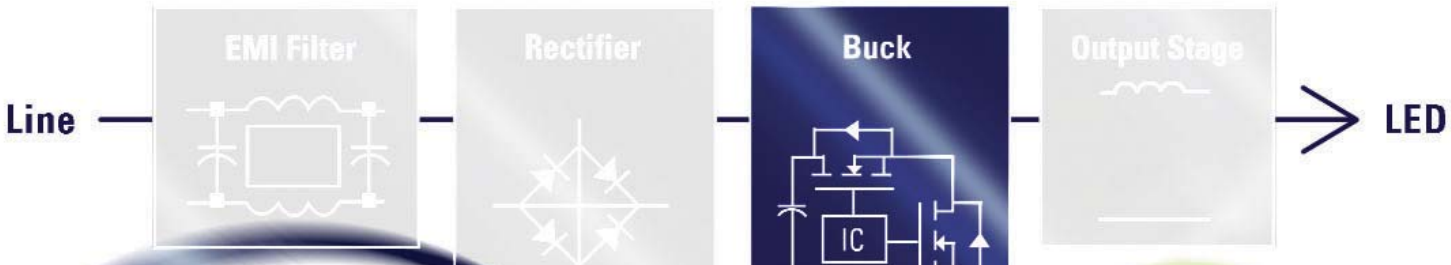

IR's high-brightness LED driver IC's, adapt and compensate to LED parameter variations to enable a highly accurate and inherently stable design.

FEATURES

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

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

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