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COVER STORY

Power Solutions for Mobile TV Applications in Cellular Handsets

Mobile phones have evolved from simplistic devices of portable communication to dynamic multi-functional pieces of technology. Today, despite drastic reductions in size, users demand more and more features, ranging from internet connectivity to video highlights. These features necessitate modifications to the power solutions deployed in the handset; very efficient power management solutions that are small in real estate are required in order to maintain battery life. This article looks at delivering the miniature high-efficiency power management solutions needed to power up processor applications such as DVB-H modules. Full story on page 36.

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Hot Spot for (Power) Electronics

Meet, greet and lead. This is just as true for each of the circa 2,961 exhibitors in 14 halls as it is for the numerous forums and conferences at Electronica 2008 from November 10-14 in Munich. All this makes the fair the crucial international platform for making decisive contacts and holding meetings with customers at upper management levels. Market researchers are forecasting a growth rate of between 5 and 8% for the worldwide semiconductor market in 2008. The German Electrical and Electronics Manufacturers' Association (ZVEI) is anticipating a growth rate of 5.1%. The corresponding figure for the worldwide market for electronic components is 5.5%. But market researcher iSuppli is warning of significant potential downside if economic conditions continue to worsen, because the credit crisis is impacting the semiconductor market on several levels.

Greater comfort, increased safety, reduced CO_2 emissions – all made possible by the advent of modern automotive electronics. Strategy Analytics market researchers predict that the global automotive electronics market will generate a market volume of $220 billion by 2014. Automobile electronics will play an important role at Electronica 2008, firstly as a focus area in Hall A6 and secondly in the electronica automotive conference 'electronics meets automotive'. The objective is to develop a platform in which the current challenges in automobile electronics at international level can be presented and discussed by automobile manufacturers, their component suppliers and electronics companies. The conference is also unique throughout the world in that it has a very international format and is closely linked to the fair. A total of around 1,200 companies will present products and applications relating to automobile electronics.

OEM users looking for power supplies for the next system generation will also find their solution at electronica 2008 such as power supply units, AC/DC and DC/DC converters, batteries, storage batteries and closed or open frame uninterruptible power supplies (UPS). The approximately 250 exhibitors will present simply everything which can be assigned to the 'power supply' segment. In addition to that many other exhibitors classified in other trade fair segments, for example semiconductor manufacturers, will have important power supply components in their product portfolio. Market researcher IMS anticipates an annual growth rate of 10% alone for ICs used in power supply systems during the next five years. In particular, the rising demand in the area of consumer electronics, the increasingly complex design of power management systems and growing interest in energy-efficient products will catapult the world market for voltage-regulating systems to a volume of $15 billion by 2011. In the area of complete systems, the submarket for uninterruptible power supply systems actually grew by 20% last year. The global volume currently amounts to around $7.4 billion. Energy harvesting cecomes a challenge. The term 'energy harvesting' summarises methods in which energy can be generated from the immediate environment. Microgenerators called 'energy scavengers' can generate energy from light, sound, temperature differences or vibrations in order to replace or supplement batteries. In this issue, you will find a preview of TI's Electronica activities as well as a feature covering the basics of energy harvesting.

Another trend is the replacement of the traditional basic material of silicon by silicon carbide (SiC) and gallium nitride (GaN) for the benefit of reduced on-resistance and lower conduction voltage drop. GaN is a wide bandgap semiconductor material, currently used typically in optoelectronic applications, and in high-power and high-frequency devices. In power supply applications, it enables the implementation of higher frequency power-factor correction circuits which offer benefits in efficiency, product size, low noise, smaller heatsink requirements, and higher yield. International Rectifier Corporation recently announced the successful development of a GaN-based power device technology platform that can provide customers with improvements in key application-specific figures of merit of up to a factor of 10, compared to state-of-the-art silicon-based technology platforms to drastically increase performance and cut energy consumption in end applications in a variety of market segments such as computing and communications, automotive and appliances. Thus, we have drilled down in this subject with an interview and detailed feature within this issue. Enjoy reading!

Achim Scharf
PEE Editor

Murata Ranks First in DC/DC Converters

Murata manufacturing was the largest supplier of DC/DC converter modules in 2007, according to IMS Research's latest study of the worldwide power supply market, holding a market share of 12.5%. Delta Electronics was the second largest supplier, followed by Emerson, with the total market for DC/DC converters estimated at $2.9 billion in 2007.

"The DC-DC converter module market continues to be a tough environment, with high price erosion, new entrants emerging from Asia, and increasing competition from discrete solutions", commented David Dewan, power supply market analyst. "The standard board-mount DC/DC converter module business is becoming increasingly commoditised and the likely implementation of the IPC 9592 guidelines by Tier-1 suppliers will drive standardisation and could compound price pressures". Despite this, the non-isolated market was estimated to have seen large growth in 2007, growing 12.3% year-on-year, and accounting for nearly 25% of the total DC/DC converter module market. It is projected to account for nearly 30% of the market by 2013.

The power conversion standard, IPC-9592, Requirements for Power Conversion Devices for the Computer and Telecommunications Industries, covers, in 75 pages, the complete range of power conversion product attributes, including product specifications and document requirements; design for reliability; design and qualification testing; and manufacturing conformance testing. "With the release of IPC-9592, the power supply industry will have a standard that will facilitate communication between the customer and supplier at a level that is unprecedented in this industry", said Scott Strand, senior technical staff member, Integrated Technology Delivery Quality, IBM. Strand is also chairman of the IPC Power Conversion Devices Standard Subcommittee which was formed specifically to address industry concerns, and comprises representatives from leading original equipment manufacturers (OEMs) and power conversion equipment suppliers, such as Alcatel-Lucent, Cisco Systems, Dell Inc., Emerson Network Power, Hewlett-Packard Co., IBM, Lineage Power and Murata Power Solutions. "One of the most important aspects of the IPC-9592 standard is that it improves our ability to serve customers by harmonising the requirements for design, qualification, and production test practices. Suppliers that adopt this standard will be better able to provide customers reliable products that they demand", added Jerry Strunk, technical manager of qualification & compliance, Lineage Power.

IPC member companies may request a free copy of IPC-9592 within 90 days of its publication. Non-members may purchase the new standard for $80.

www.imsresearch.com
www.ipc.org

Power Semiconductor Devices and Technologies Tutorial

The European Center for Power Electronics (ECPE) will organise a tutorial on modern power switches including SiC and GaN (December 4-5 in Nuremberg).

The tutorial starts with the presentation of relevant basic principles of modern power semiconductor devices. Blocking capability of the devices, unipolar and bipolar current transport and gate control will be discussed. Diodes, MOS transistors (including Cool MOS) and IGBTs will be treated in detail, including their dynamical properties, safe operation and temperature limits. As a consequence, the benefits expected from wide band gap semiconductors (SiC, GaN) will be discussed.

This introductory part is also the base for the next part devoted to power device models and the increasing role of virtual prototyping in power electronics. The following chapters will demonstrate the state-of-the art and development lines of monolithic smart power devices and intelligent IGBT control circuits. Finally, a short overview of hybrid power electronic integration and the most relevant aspects (cooling, reliability and EMC problems) will be presented.

This tutorial is aimed at engineers who are engaged in power electronics and want to improve their knowledge and understanding of power devices including the developments expected in near future. The course instructor is Prof. Dieter Silber (University of Bremen); Co-instructors are Dr. Peter Tuerkes (Infineon Technologies, Munich) and Dr. Reinhard Herzer (Semikron, Nuremberg).

www.ecpe.org

Digi-Key and Alpha & Omega Sign Global Distribution Agreement

Digi-Key Corporation and Alpha & Omega Semiconductor have announced that the companies have signed a global distribution agreement.

Alpha & Omega Semiconductor, Inc. (AOS) is a fabless semiconductor company that develops analog power management solutions offering a wide portfolio of Power MOSFETs, Power ICs, and Transient Voltage Suppressor products. AOS products stocked by Digi-Key are featured in its 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 very diverse customer base.

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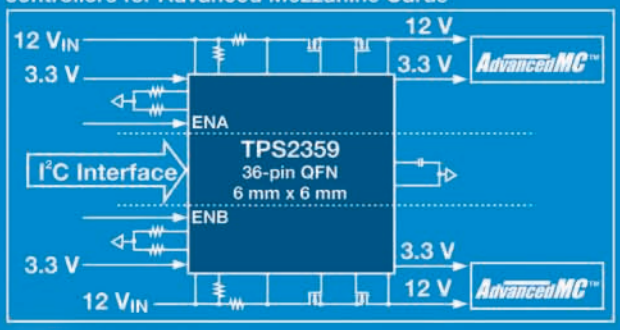

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TEXAS INSTRUMENTS

Annual Meeting at IR

International Rectifier Corporation announced that, based on the preliminary results from its 2007 annual meeting of shareholders on October 10, shareholders have re-elected all three of the Company's nominees to the Board of Directors, Jack O. Vance, Thomas Lacey and Mary B. Cranston over the dissident slate of candidates nominated by Vishay Intertechnology, Inc. ('Vishay').

In addition, shareholders voted to ratify the Company's appointment of PricewaterhouseCoopers LLP as the Company's independent registered public accounting firm for fiscal year 2008 and approved a stockholder proposal requesting the adoption of a compensation recoupment policy.

Moreover, the preliminary results indicate that shareholders defeated Vishay's attempt to acquire the majority of IR's shares.

www.irf.com

Lineage Power To Acquire Cherokee International

Lineage Power Corporation, a Gores Group affiliate and a provider of AC/DC and DC/DC switching technologies, has announced that it has entered into a definitive merger agreement with Cherokee International, under which Lineage Power will acquire all of the outstanding shares of Cherokee International.

Under the terms of the agreement, stockholders of Cherokee International will receive $3.20 per share of common stock held, in an all cash transaction, representing an aggregate enterprise value of approximately $105 million.

The transaction has been unanimously approved by the board of directors of Cherokee International, and certain stockholders have agreed to vote their Cherokee International shares in favour of the transaction.

According to Ryan Wald, Managing Director of The Gores Group, Cherokee will become a division of Lineage and will continue to be a leader in the custom power solutions marketplace.

Lineage also announced that its board of directors has named Craig A. Witsoe as the new CEO.

Witsoe will be based at the company's Dallas headquarters and will report to the board of directors. Witsoe recently served as president of Tyden Group, a producer of product identification and cargo security technology. At Tyden, Witsoe globalised operations.

Previously, Witsoe spent 16 years as an executive at General Electric, where he most recently served as president and general manager of GE Specialty Film and Sheet, a $500 million business headquartered in the Netherlands with 700 employees.

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Gearing Towards Energy Efficiency

electronica 2008
components | systems | applications

Worldwide trends and innovations in the electronics industry will be presented during electronica 2008 at the New Munich Trade Fair Center from November 11 to 14, 2008. Around 3,000 exhibitors and 78,000 visitors are expected to attend electronica 2008; in 2006 approximately 2961 and 77,800 respectively attended this event.

In 14 exhibition halls the world's leading trade fair for components, systems and applications will present the spectrum of electronics, ranging from semiconductors, embedded systems, displays, sensor technology, measuring and test equipment, and electromechanics/system peripherals through to electronic design.

The topic of energy efficiency will feature in every exhibition hall during electronica 2008. Six talks examining this topic from different aspects will be given during the ZVEI Forum: what potential energy savings are possible in lights and drive units through high-performance semiconductors; what contribution can the semiconductor industry make towards halting climate change; what potential do digital lighting solutions contain; and what form do energy-intelligent solutions take.

The CEO Round Table on the first day of electronica 2008 will provide a unique opportunity to experience the CEOs of world leading companies live in podium discussions. The topic of semiconductors and climate protection will be discussed by Peter Bauer, President & CEO of Infineon Technologies AG, Rich Beyer, Chairman of the Board & CEO of Freescale Semiconductor Inc., Carlo Bozotti, President & CEO of STMicroelectronics, and Brian L. Halla, CEO & Chairman of the Board of National Semiconductor.

In addition to communications and security, energy efficiency is one of the three main areas in which Infineon Technologies also wants to become more closely involved in the future. Peter Bauer, the recently appointed CEO will therefore report on how his company is using first-class technologies for different application areas to help reduce power consumption and environmental pollution. Rich Beyer will contribute to the climate discussion through his report on the status quo and the plans of his company regarding energy efficiency. The Texan semiconductor manufacturer recently attracted

Worldwide trends and innovations in the electronics industry will be presented during electronica 2008 at the New Munich Trade Fair Center from November 11 to 14, 2008
Photo: Messe Munich

Automotive electronics including hybrid drive trains were one of the attractions at electronica 2006, as shown at Freescale's booth, and are one of the focus areas of electronica 2008 Photo: AS

attention because one of its low-consumption processors is being used in an 'eco PC' which has a power consumption of only 2W. Climate protection is also a very important topic at National Semiconductor. In particular, the company has been involved in the field of energy-saving power management for many years and recently entered the photovoltaic market with new technologies. Brian L. Halla will speak about the successes and plans of his company and will also give his assessment of how the market will develop in future. The objective of STMicroelectronics is to also reduce energy consumption and CO_2 emissions. The company's portfolio of energy-efficient electronic components ranges from microcontrollers and MOSFETs through to logic ICs. Carlo Bozotti, CEO of the semiconductor group, will describe which ecological trends will have to be considered on markets in future and which strategies STMicroelectronics is pursuing in this case. The CEO Round Table will be chaired by William C. Ramsay, Deputy Director of the 'International Energy Agency' (IEA), Paris. The IEA is supported by 27 nations and was founded in 1974 after the first great oil crisis as an information and cooperation platform for sustainable and environmentally-compatible energy generation.

Focus areas such as automotive, wireless, embedded systems und micronano systems will be presented by means of separate exhibition sections and a series of talks. Two 2-day conferences will also be held on the subjects of automotive and wireless.

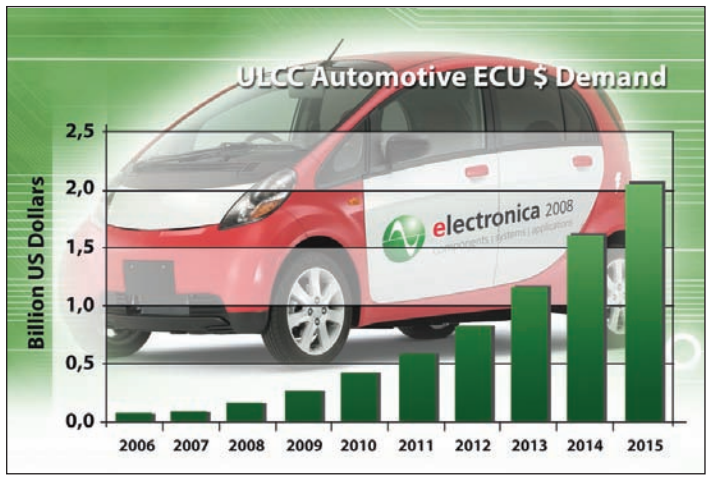
Automobile Electronics

Greater comfort, increased safety, reduced CO_2 emissions – all made possible by the advent of modern automotive electronics. Strategy Analytics market researchers predict that the global automotive electronics market will generate a market volume of $220 billion by 2014.

The nano age has begun – also in the automobile sector. The era of 'ultra low cost cars' was opened with the launch of the Tata Nano, the 'One Lakh Car' ('100,000 rupee vehicle') from Tata Motors. Especially due to the enormous demand in fast-developing countries such as China and India, the niche product of cheap cars has become an automobile segment with a promising future. Strategy Analytics is predicting a great future for 'ultra low cost cars', i.e. cars costing between $2,000 and $5,000. Whereas the market for 'normal' vehicles weighing less than 3.5 tonnes in the now normal price segments will only grow moderately by an average of 3% per annum between 2010 and 2015, the market for 'ultra low cost cars' will almost explode with an annual growth rate of 25%. In 2015 almost 7 million vehicles will be produced in the low-price segment.

The 'downsize' trend in Asian countries is also having lasting impacts on the automobile electronics market. Although current cheap vehicles such as the Tata only contain very few electronics compared with average European vehicles, the enormous growth in this sector, along with increasing use of electronics to comply with emission regulations and satisfy higher customer demands will, according to an estimate by Strategy Analytics, exceed growth on the market as a whole. For example, electronic control units (ECUs) alone in 'ultra low cost cars' will increase on average by 36% per annum between 2010 and 2015, and finally peak at a market volume of more than $2 billion. By contrast, the total market for ECUs in this 5yr period will only grow on average by a

Development of the market for electronic control units (ECUs) in 'ultra low cost' vehicles up to 2015 Source: Strategy Analytics



Leading experts from system suppliers and automobile manufacturers will discuss on November 10 and 11, 2008, at the electronica automotive conference in Munich how environmental protection, sustainability and energy efficiency in automotive electronics could be optimised Photo: Messe Munich

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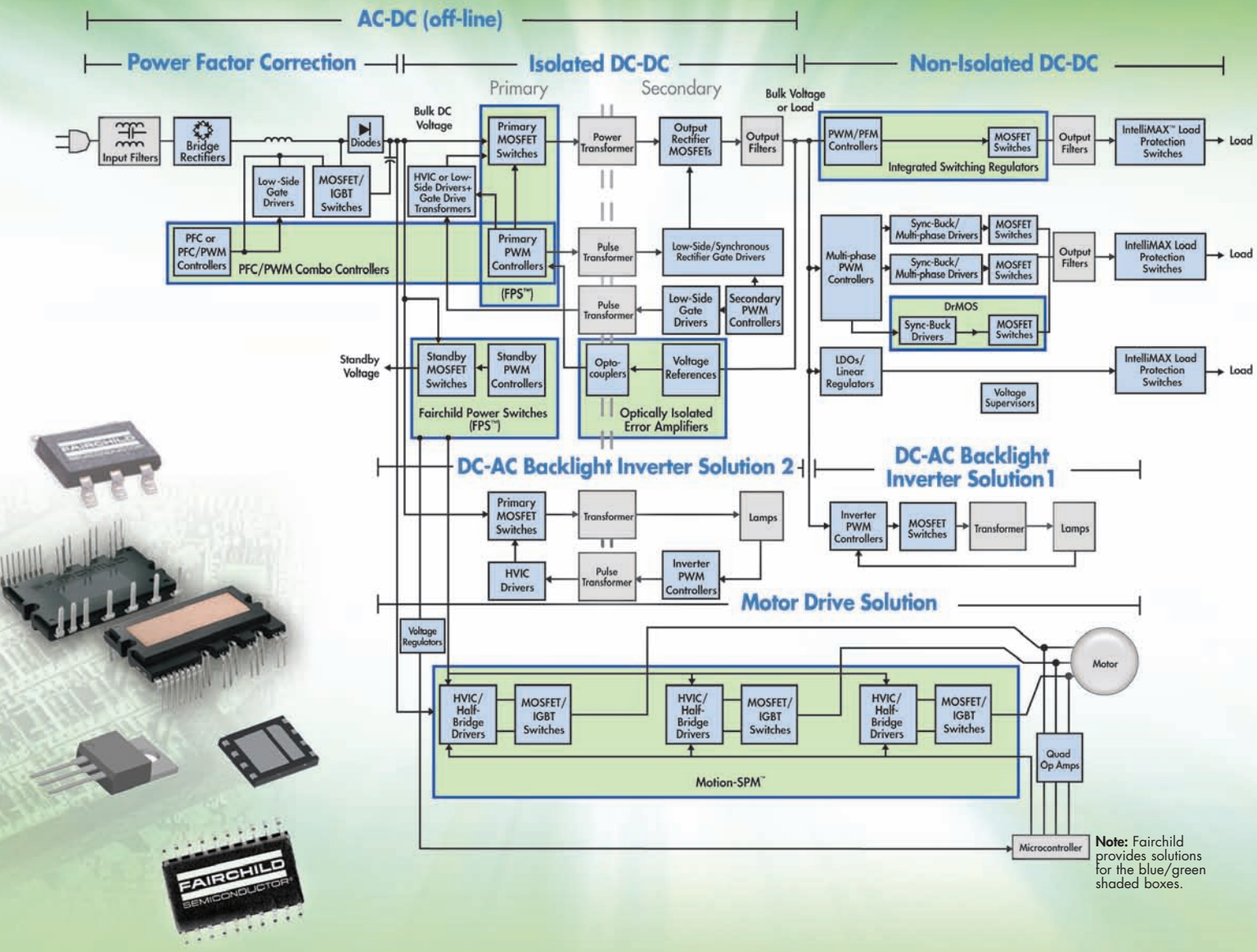

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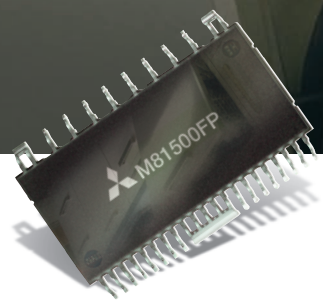

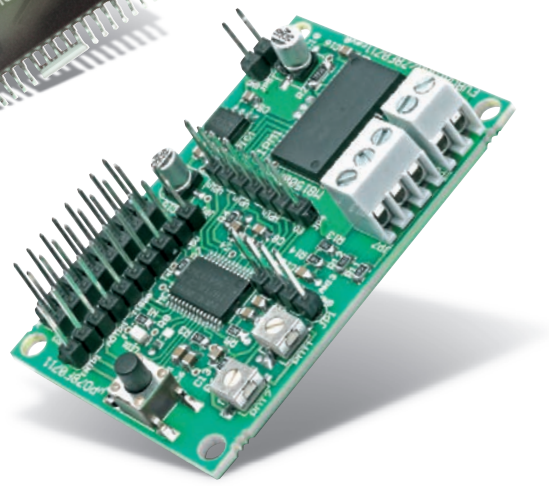

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moderate 5% and will amount to a good $72 billion in 2015.

Automobile electronics will play an important role at electronica 2008, firstly as a focus area in Hall A6 and secondly in the electronica automotive conference 'electronics meets automotive'. The objective is to develop a platform in which the current challenges in automobile electronics at international level can be presented and discussed by automobile manufacturers, their component suppliers and electronics companies. The conference is also unique throughout the world in that it has a very international format and is closely linked to the fair. A total of around 1,200 companies will present products and applications relating to automobile electronics.

The automotive conference program was developed jointly by Messe München and the Conference Program Committee whose members include high-ranking representatives from leading companies in the automobile industry, their component suppliers and system suppliers, for example BMW AG, Infineon Technologies, DaimlerChrysler, Brose Fahrzeugteile, TRW Automotive, Valeo, Freescale Semiconductor and Tyco Electronics.

The main items on the conference agenda are topics such as hybrid vehicles, low cost cars or the i-car. Talks will be given by Yin Tongyao, CEO of Chery Automobile from China, Dr. Dirk Rossberg from BMW, Peter Lück from Volkswagen, Hans-Peter Feustel from Continental and Tsutomu Miki from Reneasas Technology. The topics on the first day of the conference are aimed at experts holding senior management positions in automobile manufacturers, automotive component suppliers and systems suppliers. The agenda on the second day is geared towards the needs of experts from technical management. The conference will take place in the Munich International Congress Center (ICM) and will start on 10 November 2008, i.e. one day before electronica is scheduled to begin.

Right from the first day the 'electronica automotive conference' gets down to business by plunging into the widely discussed trend towards ultra-low cost cars. In his talk on 'Ultra Low Cost Cars - Opportunities and Challenges' (10th November 2008, 11:30 to 12:00) Ian Riches, Director of 'Global Automotive Practice' at the market researcher Strategy Analytics, will be examining the resulting challenges for developers and suppliers of automotive electronics and semiconductors, while also presenting the most promising applications. Peter Lück, Senior Manager at Volkswagen Powertrain Development, will take a look at the future of the automobile. His talk on 'Electrification of Powertrains at Volkswagen' (10th November 2008, 10:00 to 10:30) will illustrate how the electrification of the powertrain will effect not only the characteristics, but also entire nature of drive and vehicle concepts with additional reference to the requirements and technologies of the storage battery and electric drive. The talk on the 'Demands and Realisation of Automotive Power Electronics' (10th November 2008, 13:30 to 14:00) given by Hans-Peter Feustel, Continental Automotive, will deal with the challenges of hybrid vehicles in the context of power electronics. The expert on this subject will examine the consequences and necessary measures in terms of the design layout of hybrid power supply systems, focussing in particular on mechanical and thermal mechanical loads. He will also present a protection concept, examining specific solutions for realising power electronics in hybrid applications.

In addition to participating in the 'electronica automotive conference' as speakers or delegates, leading automobile manufacturers and industry suppliers will also be actively involved in the electronica trade fair itself, both as exhibitors and visitors. At electronica 2006 13,000 of the 78,000 trade visitors in total registered as prospective exhibitors in the automotive exhibition area, including top employees and executives from Fiat, Peugeot, Nissan, Honda, BMW, Toyota, Daimler, Porsche, VW, MAN, Ford, Audi, Opel, Renault, Rolls-Royce, Skoda and Volvo, as well as Bosch, Alpine, Hella, TRW, Valeo, Visteon, Conti VDO, Harman/Becker, Johnson Controls, Lear, Kostal and Magneti Marelli.

Wireless congress

The 'Wireless Congress: Systems & Applications' is being held for the fifth time at the ICM on November 12 and 13, 2008. This Congress is aimed at developers, system designers, technology decision-makers and

Electronica 2008 will exhibit a comprehensive range of products for power supply developers and OEM users of power supply systems

systems managers. Every technical aspect of current and future wireless technologies, primarily for industrial use, will be described in around 50 talks.

Trends in power supply technology

OEM users looking for power supplies for the next system generation will also find their solution at electronica 2008 such as power supply units, AC/DC and DC/DC converters, batteries, storage batteries and closed or open frame uninterruptible power supplies (UPS). The approximately 250 exhibitors will present simply everything which can be assigned to the 'power supply' segment. In addition to that, many other exhibitors classified in other trade fair segments, for example semiconductor manufacturers, will have important power supply components in their product portfolio.

The market for power supply solutions is enormous since, ultimately, no electrically driven system can be operated without power. Market researchers from IMS Research are anticipating an annual growth rate of 10% alone for integrated circuits (ICs) used in power supply systems during the next five years. In particular, the rising demand in the area of consumer electronics, the increasingly complex design of power management systems and growing interest in energy-efficient products will catapult the world market for voltage-regulating systems to a volume of $15 billion by 2011. In the area of complete systems, the submarket for uninterruptible power supply systems actually grew by 20% last year. The global volume currently amounts to around $7.4 billion.

High-performance electronics for solar electricity generation is placing increasingly higher demands on suppliers of high-performance electronics in regard to power density, efficiency, lowest possible footprint, and reliability. Related solutions such as new converter structures and high-performance semiconductors will be shown at the fair. More and more importance is also being attached to standardisation. A higher standardisation level is attained, for example, by using modular power electronics building blocks (PEBBS).

Power packs for medical electronics must be mobile, efficient and compact, but also satisfy higher insulation requirements (IEC 60601 – Basic safety and essential performance of medical electrical equipment). They must be quiet (coupled with optimum cooling) and have low leakage current. Integration of configuration, control and monitoring functions in DC/DC and AC/DC converters with lower costs is also a prerequisite, along with maximum efficiency and a smaller design.

Converter technologies will also play an important role in future solar electricity generation. The market for photovoltaics is currently experiencing growth rates of between 30% and 50%. In 2007 alone, solar systems with a total output of between 3 and 4GW were installed. The total capacity of the systems installed throughout the world (2007) corresponds to 10GW. One interesting subaspect: around 40 different types of power supply ICs are used to convert solar energy into electricity. They include, in particular, ICs with low-frequency converters (50 or 60Hz), high-frequency converters (16 to 100kHz) and transformer-less ICs. Transformer-less ICs attain an efficiency of 97% (with bipolar switching) or 98% (with unipolar switching) whereas low-frequency and high-frequency converters have a maximum efficiency of up to 95%. The future standard target will be at least 98%. The trend among high-performance semiconductors in solar electricity generation is also towards the replacement of the traditional basic material of silicon by silicon carbide (SiC) and gallium nitride (GaN) for the benefit of reduced on-resistance and lower conduction voltage drop.

Energy harvesting becomes a challenge. The term 'energy harvesting' summarises methods in which energy can be generated from the immediate environment. Microgenerators called 'energy scavengers' can generate energy

Displays: The technological trends of displays and their power supply will be some of the spectacular subject areas at electronica 2008
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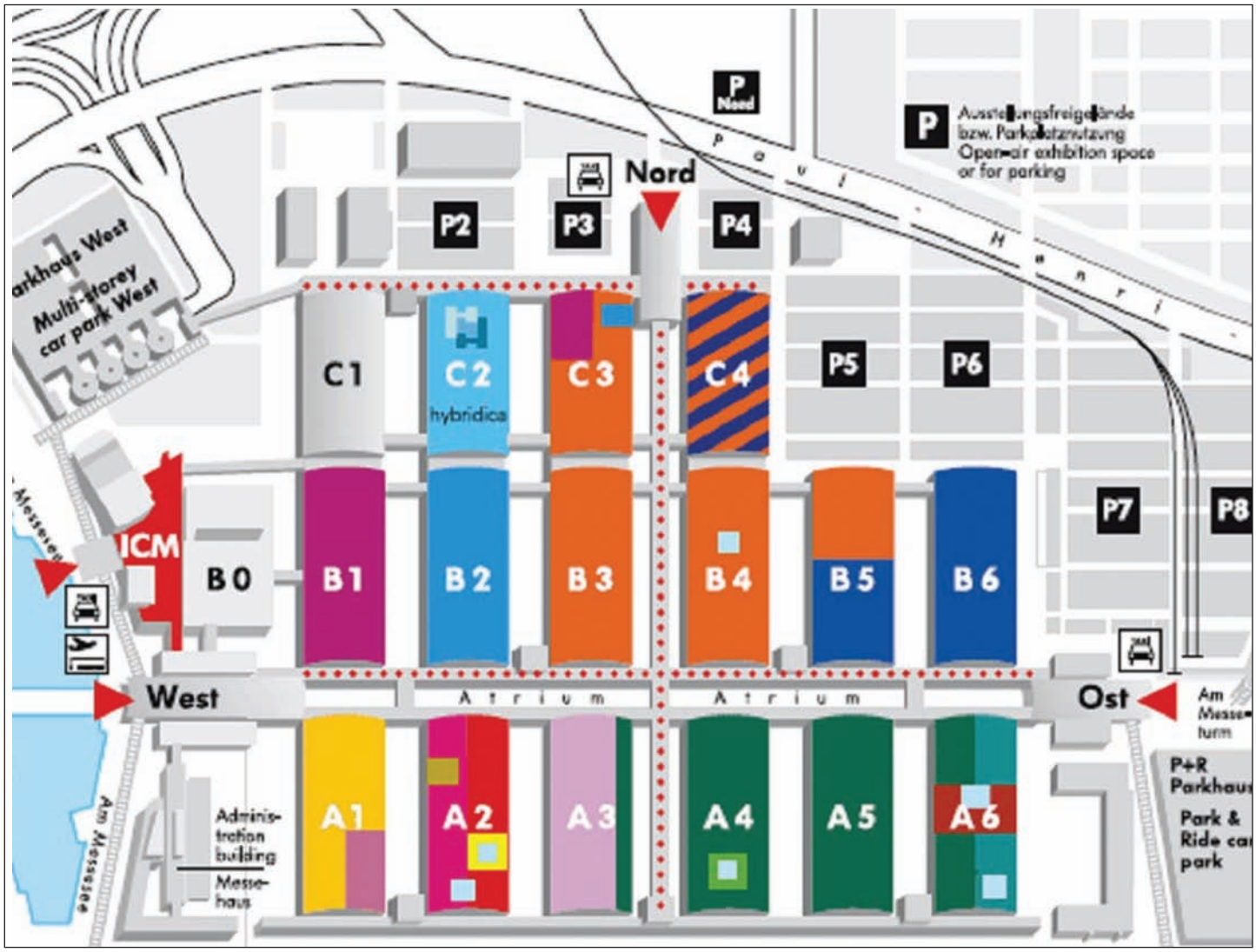

Hall assignment of electronica 2008. Dark green marked halls contains semiconductors, blue halls power supply technology, pink halls displays, brown halls automotive forum & exhibition, blue halls passive components Source: Messe Munich

from light, sound, temperature differences or vibrations in order to replace or supplement batteries. For example, these energy scavengers will be able in future to charge mobile phones as people walk, drive heart pacemakers through the beating of a person's own heart, or feed waste heat and engine vibrations to air conditioning systems or other electronics in automobiles. Even though this topic sounds very futuristic, the first representatives of a new generation of power management ICs are already available on the market. They accept input voltages right down to 300mV and supply a maximum input voltage of 5.5V.

Display trends

The year 2007 marked a turning point on the worldwide display market: at the end, more liquid-crystal displays (LCDs) had been sold than traditional tube TV sets. The market research institute DisplaySearch estimates that by 2015 around 90% of all display elements sold will be LCDs. Forecasts such as these are encouraging and inspiring an entire industry because modern flat-screen TV and computer screens, as well as the displays of mobile devices such as notebooks, cell phones or MP3 players require excellent background illumination which is provided by LEDs or organic LEDs (OLEDs). iSuppli is expecting that the current LED market volume in this application alone will increase from $6 billion to $12.3 billion by 2012.

However, background illumination is not the only driving-force behind the (O)LED market. Rapidly coming to the fore are new, environmentally-friendly, energy-efficient, reliable and extremely colour-flexible signaling, lighting and illumination concepts in industry through to applications in housing and building engineering, as well as, for example, the increasing number of (O)LED applications in modern cars. The technological trends for displays and LEDs/OLEDs and their power supply will certainly be some of the most spectacular subject areas in hall A3 at electronica 2008.

Companies such as Optrex also provide a 'clearer view' behind the steering wheel. Their transparent signage displays are based on OLEDs which are integrated in the windscreen and conveniently supply information and warnings. Their high efficiency, wide range of colours and now also their increasing durability are making versatile OLEDs attractive for more and more applications ranging from a brightly coloured iPhone display through to the new 11in Sony OLED television. Organic LEDs are also becoming more important as regards illumination: Osram has already achieved a service life of more than 5,000hr for warm white OLEDs with a brightness of 1000cd/m². Luminous tiles, LED wallpaper and luminous partitions therefore no longer seem like futuristic ideas.

The display boom is creating, in particular, demand for high-brightness (HB) LEDs. ISuppli estimates that the market for HB-LEDs is worth $3.7 billion (2006) and expects it to double in volume to more than $7 billion by 2010. This, in turn, is fueling demand for high-brightness (HB) LED driver products with which several LEDs can be controlled simultaneously or very high light efficiency is possible. Strategies Unlimited is anticipating that the market volume of $865 million (2006) will increase to $1.9 billion in a few years (2011). The beneficiaries of this boom are electronica exhibitors such as Texas

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Instruments, for example with LED drivers for controlling high-resolution video display screens, or National Semiconductor, for example with high-current LED flash drivers or special online LED development tools which can reduce designs of LED power management solutions from weeks to minutes. A large number of technology leaders will also present their solutions at electronica 2008, for example Linear Technology with an integrated BIAS and white light LED voltage transformer solution for small to medium-sized TFT (thin-film transistor) LCD panels, and STMicroelectronics whose product range includes constant current LED drivers with an automatic energy saving function.

LEDs are also making advances in the automobile industry. They are used as efficient and background illumination for the dashboard and, as brake lights, replace the conventional white light bulbs, but also halogen and xenon lamps. Market researchers such as IMS estimated the worldwide sales of LEDs in the automobile industry at $650 million in 2006. The market volume is expected to double to $1.3 billion by 2016. Alone, the demand due to prescribed daytime driving with lights in an increasing number of countries will lead to a growth explosion with LEDs in this sector from $5 million in 2007 to over $100 million in 2013. This will also benefit Osram Opto Semiconductors, one of the leading companies in the industry and an exhibitor at electronica 2008. The company's LEDs are already used, for example, as full headlights for a new SUV from Cadillac.

Visitors to electronica 2008 will be able to obtain a clear impression of the numerous advantages and application areas of (O)LEDs on the large number of exhibition stands. New stand concepts will be formulated in which lighting no longer comes from excessively heat-generating light bulbs, but from power-saving, energy-efficient LED light sources.

Hybridica for hybrid components

In parallel to electronica, the first international trade fair hybridica (www.hybridica.de) will be held in hall C2. The exhibition focuses on all phases of development and production, from raw materials, tool and die manufacturing and surface treatment to stamping techniques, plastics processing and, finally, finished hybrid components. More and more components, including power modules, are made from the combination of metal and plastic. Using hybrid components has competitive advantages, especially in the automotive industry, electronics and electrical engineering as well as in the IT, telecommunications and computing sectors.

www.electronica.de

iSuppli Trims 2008 Chip Forecast and Sees Warning Signs

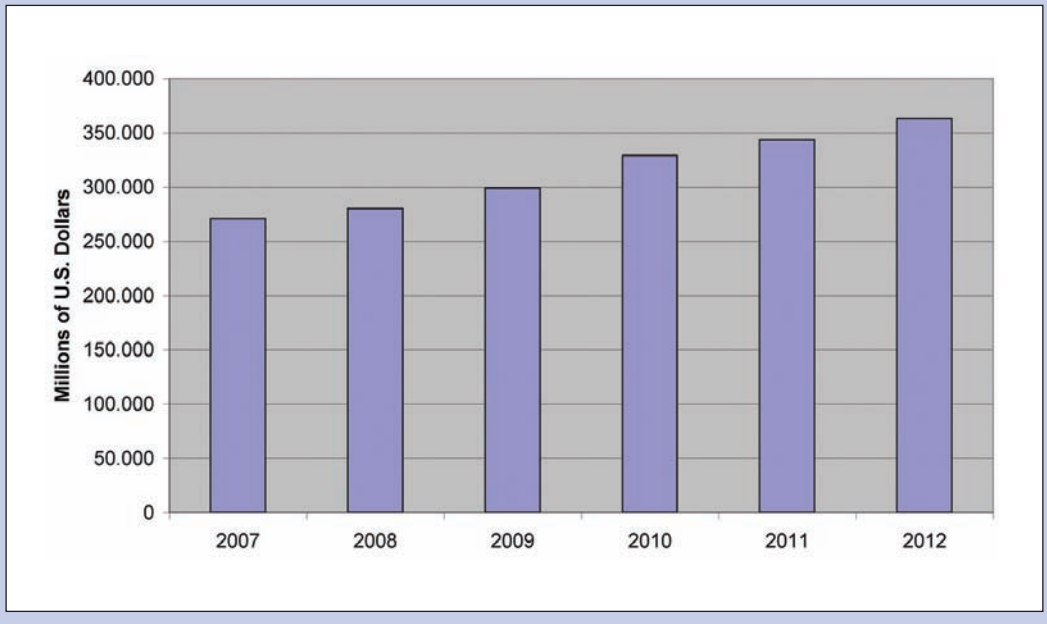
Market researcher iSuppli has trimmed its forecast for 2008 worldwide semiconductor revenue growth in October, but is warning of significant potential downside if economic conditions continue to worsen.

Global semiconductor industry revenue is expected to rise to $280.1 billion this year, up 3.5% from $270.6 billion in 2007. iSuppli's previous forecast, issued in August, predicted 4% growth for the year.

The US Semiconductor Industry Association reported that global semiconductor sales rose 5.5% in August, compared to a year earlier, indicating that chip sales growth continues to track according to iSuppli's expectations. However, signs appeared in September that the semiconductor market may be feeling the impact of the credit crisis and economic downturn.

"The credit crisis is impacting the semiconductor market on several levels. The first level is demand for electronic equipment from the Wall Street firms themselves, which is expected to drop and thus decrease demand for semiconductors. The second level, and a much more significant factor, is the impact on corporations in general. With companies unable to get credit, the crisis could spread to the wider economy, impacting demand for electronic equipment and semiconductors. The final level, and the most significant area of impact, is the broader effect on consumer confidence and spending if the overall economy collapses", said iSuppli's Dale Ford, senior vice president market intelligence.

www.isuppli.com



iSuppli's forecast of global semiconductor revenue up to the year 2012

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Power Management and Energy Harvesting

electronica 2008
components | systems | applications

Besides DSPs, Power Management and Energy Harvesting is one of the focal points of Texas Instruments (TI) at electronica 2008.

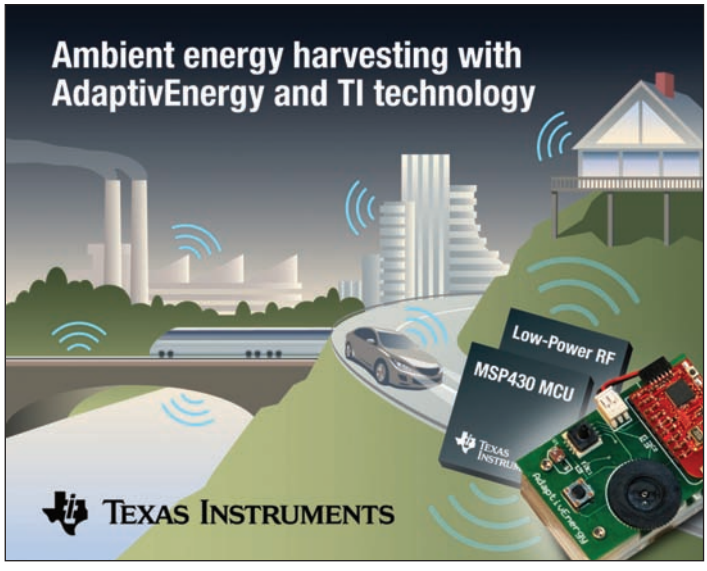
"Power management has been a real growth driver at TI with a revenue of $1 billion in 2007", said Uwe Mengelkamp, in charge of TI's worldwide business. The company announced the smallest and thinnest 500mA, step-down DC/DC converter for space-constrained applications. The TPS62601 achieves up to 89% efficiency and 30µA typical operating quiescent current from a 0.9 x 1.3 x 0.6mm chip scale package roughly the size of a flake of pepper. The synchronous, switch-mode device's fixed frequency of 6MHz allows the use of one external 0.47µH inductor with a height of 0.6mm and two external low-cost ceramic capacitors. The converter also applies energy-saving techniques to help maximise battery run-time.

It automatically enters a power save mode during light-load operating conditions via an automatic pulse frequency modulation and pulse width modulation switching feature. In shutdown mode, the current consumption is reduced to less than 1µA. DC voltage regulation accuracy is 1.5%. The device's load transient response, wide input voltage range of 2.3 to 5.5V and 1.8V of output allows it to support single-rail voltage requirements. Typical applications are memory modules, GPS modules, Bluetooth and Wi-Fi modules or other wireless micro-modules used in ultra-thin smart phones, digital still cameras, portable disk drives and media players.

In addition to the TPS62601, TI provides a broad range of power management battery management solutions for handheld devices. Examples include the 3MHz bq24150, switch-mode battery charger integrated circuit, the system-side bq27500 battery fuel gauges, and DC/DC converters that support RF power amplifiers and core supply voltages.

Energy harvesting becomes reality

Demonstrating the advantages of energy harvesting and radio frequency (RF) technology for wireless sensing, monitoring or ambient intelligence,



A design kit makes energy harvesting a reality

"Power management has been a real growth driver at TI", stated TI's Uwe Mengelkamp Photo: AS

AdaptivEnergy has developed a demonstration kit to harvest energy and power TI's low power MSP430 microcontroller (MCU) and RF technology to collect data, control the operation of a system or send sensed data to central collection sites. The Joule-Thief energy harvesting device is based on AdaptivEnergy's Ruggedized Laminated Piezo technology, which enables compact energy harvesting modules to power applications such as wireless sensors. These wireless sensors could be used to gather ambient intelligence to detect and report critical conditions in factories, automobiles, office buildings, homes and other environments – all without wiring or batteries.

Joule-Thief technology combines AdaptivEnergy's stressed-biased RLP energy harvesting beam that converts vibrations or movement into usable electric energy. The RLP Smart Energy Beam allows up to 10 times more strain to be applied to the piezoceramic than other piezoelectric energy harvesting devices, creating more converted electric power for system use. In addition to directly sensing movement, the design accepts inputs from external sensing elements that can help detect strain in bridges and high-rise buildings, equipment fatigue in factories, excessive temperatures, the presence of dangerous chemicals, unsafe events in automobiles and a variety of other environmental conditions.

Complementing the RLP Smart Energy Beam and collection electronics is active intelligence and communications based on a chipset consisting of an MSP430F2274 microcontroller and a CC2500 RF transceiver, which allows the Joule-Thief design to gain as much processing and transmission as possible from the charge stored in a capacitor. AdaptivEnergy offers a Energy Harvesting Demonstration Kit that includes a RLP Smart Energy Beam along with collection and storage electronics in a matchbox-sized package, allowing developers to easily explore harvesting energy from vibrations (see also our feature on energy harvesting).

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Synchronous Buck Controllers Increase Output Power

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National Semiconductor introduces a new family of Simple Switcher synchronous buck controllers and an end-to-end MOSFET selection tool to simplify switching controller designs as well as switching regulators.

The new controller family under the PowerWise brand includes four synchronous buck controllers suited for communications and industrial systems. The LM3150 features an adjustable switching frequency and output voltage, and the LM3151, LM3152 and LM3153 feature a range of fixed frequencies of 250 to 750kHz, along with a fixed 3.3V output voltage. Input voltages range from 6 to 42V with output current capability up to 12A. The new controllers feature 93% peak efficiency at load and require just 11 external components. "Simple Switcher is our best selling product family with over 25,000 customers per year. This family has now been enhanced with an analogous controller increasing the output current from 5 to 12A without changing the power stage through hysteretic buck, constant-on-time and emulated ripple mode topologies", explained National's Product Line VP Power Management Michael White. The patent-pending emulated ripple-mode technology allows for the use of low equivalent series-resistance (ESR) output capacitors which reduces system size, complexity and output voltage ripple.

Controller designs are more complex than integrated switching solution designs due to the challenges associated with selecting external MOSFETs. National's Webench suite of online tools has been expanded to include MOSFET selection and analysis for a quick and easy controller design. "Webench allows not only for searching for our components, but also for numerous passive components and MOSFETs from vendors such as IR, Renesas and Vishay, but not Infineon. Currently, we have 176,000 Webench users, 77,000 of them in Europe. Here, the focus is more on individual designs rather than of mass-produced power supplies", White added.

The new MOSFET selection tool is the first to provide end-to-end support for switching controller designs, including MOSFET selection, MOSFET optimisation and design simulation. The tool includes technical data on a variety of vendors' MOSFETs, allowing the designer to sort and select MOSFETs by thermal parameters, power dissipation and price. In total, 22 optimisation graphs and charts offer views of the impact of optimising the design for efficiency or footprint over various operating ranges. The designer can analyse power dissipation of the MOSFETs at different frequencies, efficiencies and footprints, as well as over the load current and input voltage operating ranges. Once the MOSFETs are selected and optimised, Webench provides electrical simulation of the complete circuit's dynamic behaviour in both frequency and time domains. The designer can then run thermal simulations of the complete solution, including the MOSFETs, to analyse thermal characteristics. When complete, a design report summary is created and a custom prototype power supply kit can be ordered. Webench will be enhanced in the near future for optimisation of distributed power and at system level.

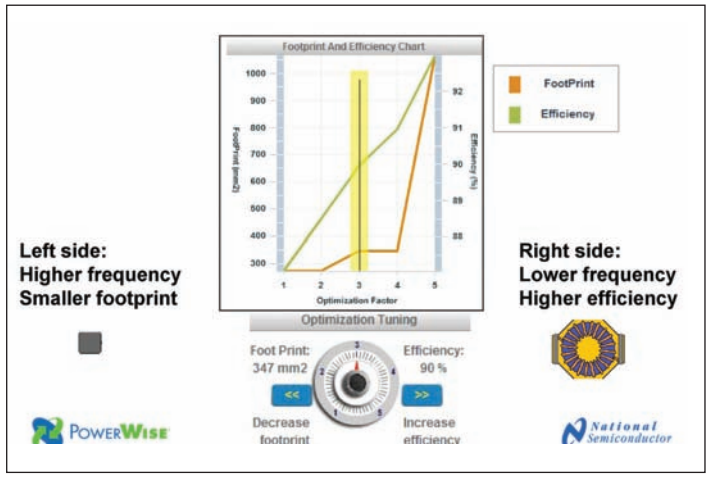
"Currently, we have 176,000 Webench users, 77,000 of them in Europe. Here, the focus is more on individual designs rather than of mass-produced power supplies", said National's Michael White Photo: AS

Step-down voltage regulators

The company has also added 11 new step-down voltage regulators which support a variety of load currents from 0.5 to 5A. Designed with voltage mode control, the family includes the LM22670, LM22671, LM22672, LM22673, LM22674, LM22675, LM22676, LM22677, LM22678, LM22679 and the LM22680. Each provides a fixed switching frequency at 500kHz and adjustable switching frequency or frequency synchronization up to 1MHz which allows for electromagnetic interference (EMI) reduction in noise-sensitive automotive, industrial and communication applications. Available in an industry-standard 8pin PSOP package and new 7pin TO-263 thin package, the step-down voltage regulators also feature adjustable frequency, precision enable, external soft-start and adjustable current limits. The new Simple Switcher step-down voltage regulators are pin-to-pin compatible with National's LM267X series of regulators, which include the LM2670, LM2671, LM2672, LM2673, LM2674, LM2675, LM2676, LM2677, LM2678 and LM2679.

The new TO-263 thin package is manufactured from lead-free solder and halogen-free mould compounds. The TO-263 thin package is footprint and PCB drop-in compatible with that of the standard T0-263 package. Overall package thickness is 50% thinner than standard TO-263 packaging (2.00mm versus 4.57mm). It features improved moisture sensitivity levels and comparable thermal performance to the standard TO-263 packaging. Available in standard tape-and-reel, the package received industry approval from the JEDEC JC-11 committee in May 2008 under registration number 10-447. "This new package features 10% better thermal behaviour though it is much smaller", White pointed out.

www.national.com/power



Webench allows for several optimisation steps such as efficiency versus footprint, without having detailed knowledge of the underlying physics

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Towards New Power Semiconductor Materials

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

The use of a GaN device provides many advantages for the user, including reduced switching losses in both the diode and the MOSFET, elimination of active snubber components due to there being no voltage overshoot at turn-off, increased efficiency, and improved temperature performance. The reduction in switching losses in GaN devices can be applied in a number of ways to optimize the user's circuit design; by increasing efficiency, reducing heatsink requirements, or reducing the current rating of the transistor. The operating frequency can be increased to allow the use of smaller passive components, or to achieve acoustic requirements. The absence of high frequency oscillation at turn-off reduces RFI filter requirements.

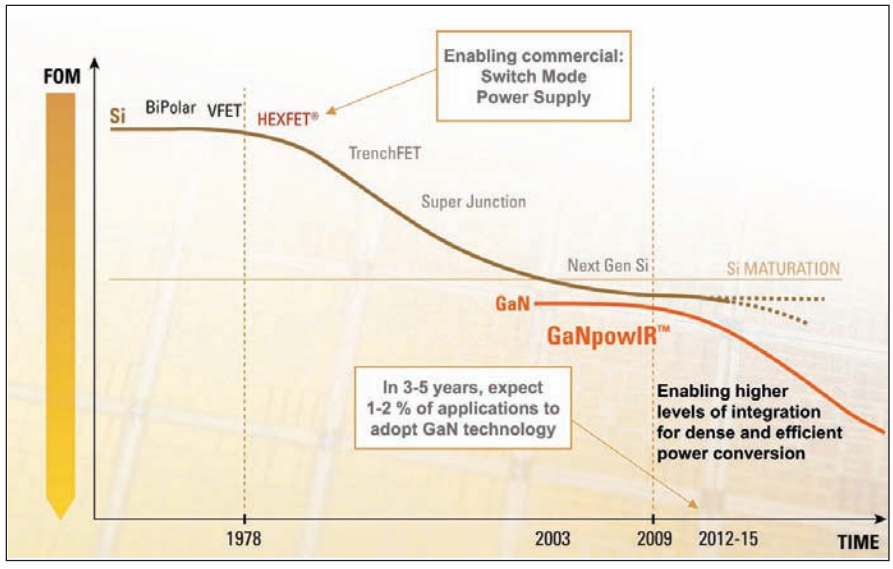
In November 2006 STMicroelectronics and Velox Semiconductor Corporation announced an agreement to jointly introduce GaN Schottky diodes into the market, with a long-term goal of establishing both companies as dual-source suppliers of the devices. Velox has developed 600V GaN Schottky diodes and the diodes are in the final stages of development before transition to production. ST should help complete the development, perform product qualification, and market and distribute the diodes. In October 2007 Velox announced that it will develop 1200V, 100A, GaN-on-Silicon transistors for automotive and power supply applications. Rohm of Japan announced the successful development of GaN devices in November 2007, but will use this technology for voltages up to 200V and silicon carbide (SiC) for breakdown voltages of 1000V and above.

"Our GaN technology will have an industry impact as the introduction of the power HEXFET by IR some 30 years ago", said IR's President and Chief Executive Officer, Oleg Khaykin Photo: AS

New GaN player at Electronica

International Rectifier Corporation announced recently the successful development of a GaN-based power device technology platform that can provide customers with improvements in key application-specific figures of merit (FOM) of up to a factor of 10, compared to state-of-the-art silicon-based technology platforms to drastically increase performance and cut energy consumption in end applications in a variety of market segments such as computing and communications, automotive and appliances. The GaN-based power device technology platform is the result of five years of research and development by IR based on the company's proprietary GaN-on-silicon epitaxial technology. "The high throughput, 150mm GaN-on-Si epitaxy, together with subsequent device fabrication processes which are fully compatible with IR's silicon manufacturing facilities, offers customers a world-class, commercially viable manufacturing platform for GaN-based power devices. We fully anticipate the potential impact of this new device technology platform on the power conversion market to be at least as large as the introduction of the power HEXFET by IR some 30 years ago", said IR's President and Chief Executive Officer, Oleg Khaykin. Prototypes of several new GaN-based product platforms will be available to leading OEM customers at electronica 2008.

Thus, PEE has taken the opportunity to interview Michael A. Briere, Executive Scientific Consultant, ACOO Enterprises LLC,



Power technology and device driven evolution in power electronics with IR's HEXFET as the starting point Source: IR

"We expect that by 2013 about 1 to 2% of all power conversion applications from 20 to 1200V will use GaN based power devices", comments Michael A. Briere, Executive Scientific Consultant Photo: IR

under exclusive contract to International Rectifier Corp. about the properties and commercial expectations for GaN technology and devices.

PEE: GaN and SiC belong to the wide band-gap semiconductor material with SiC already used in power diodes (600/1200V, up to 30A) and GaN mainly used for RF power transistors. What was IR's motivation to conduct research in GaN rather than SiC?

SiC based power device platform are inherently too expensive to service the broader power conversion market. GaN-on-Si technology offers the potential for commercially viable products, with compelling competitive advantages, throughout the application range for 20 to 1200V.

PEE: Are there any problems associated with IR's GaN process (6in wafers) such as micropipes which has slowed down the adoption, not to mention the other defect mechanisms of SiC?

As IR's GaN-based power device technology platform is compatible with IR's silicon manufacturing facilities, we can offer customers a commercially viable manufacturing platform for GaN-based power devices.

PEE: Some vendors prefer GaN for low-voltage devices (up to 200V) and SiC for higher industrial voltages. What is IR's strategy?

IR's GaNpowIR technology is targeted to address applications from 20 to 1200V.

PEE: Is IR's technology capable for manufacturing vertical structures (trench) in contrast to existing lateral GaN devices?

IR's GaN power technology platform utilises proprietary GaN-on-Si hetero-epitaxial techniques as well as CMOS compatible device structures and fabrication processes.

PEE: Will IR make use of GaN Foundry services which are offered by Triquint or Virginia Tech?

IR currently manufactures its GaN based technologies utilising in-house fabrication facilities, though cost-effective and secure outsourcing is a potential option.

PEE: What are IR's first GaN products – Diodes, MOSFETs or IGBTs? When will they be released and what is the total available market by 2013?

The first GaN based products are expected to be released to production by the end of 2009. These will include system solution modules as well as potentially discrete devices (e.g. FETs and diodes). We expect that by 2013 about 1 to 2 % of all power conversion applications from 20 to 1200V will use GaN based power devices.

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GaN Based Power Devices: Cost-Effective Revolutionary Performance

A novel gallium nitride (GaN) based power device platform promises to deliver figure-of-merit (FOM) performance that is at least an order of magnitude better than existing silicon MOSFETs. **Michael A. Briere, Executive Scientific Consultant, ACOO Enterprises LLC, under exclusive contract to International Rectifier Corp.. USA**

Some 30 years ago, International Rectifier introduced the first commercially viable silicon MOSFETs, called HEXFETs, to enable rapid adoption of switch mode power supplies (SMPS) over then dominant linear supplies which used bipolar devices. Since that time, this Si based technology platform has continued to evolve to satisfactorily serve myriad markets. But silicon MOSFETs have now approached a performance plateau, while cost of advancements has increased dramatically. Concurrently, next generation and emerging applications are demanding further substantial leaps in power conversion performance.

Hence, to meet the new requirements of forthcoming applications, new materials and transistor structures are needed to fill this gap. Although, silicon carbide (SiC) FETs have emerged on the scene in the past 10 years to address these issues, they suffer from significant cost premiums due to limited quality material supply, as well as the intrinsic cost structure of the material. Additionally, SiC based technology is not scalable.

Envisioning such a need, IR scientists and engineers have developed a revolutionary gallium nitride (GaN) based power device technology platform that promises to deliver performance that is at least 10 times better than existing silicon devices to enable dramatic reductions in energy consumption in end applications.

In fact, over five years of device R&D has resulted in a proprietary GaN-on-silicon epitaxial process and device fabrication technology that heralds a new era in power conversion. IR expects the potential impact of the new GaN based device technology platform to be at least as significant as the introduction of HEXFETs some three decades ago. Referred to as GaNpowIR, the company plans to offer a broad range of commercially viable products (20 to 1200V) supporting discrete as well as circuit solutions (modules and chipsets).

Benefits of GaN

Structurally, bulk GaN substrates have been prohibitively high-priced, requiring the use of hetero-epitaxial films. However, major substrates used for GaN epitaxy until now, such as SiC or sapphire, have also been relatively expensive. While silicon was a very attractive low cost alternative, it remained difficult because of defects and deformations due to intrinsic mismatch in lattice constants and thermal expansion coefficients. Recently, solutions to these epitaxial process difficulties have been developed. This program has leveraged the extensive experience in GaN epitaxy and devices that has been achieved through the efforts of a wide community of investigators, focused mainly in the fields of GaN RF devices and LEDs. This hetero-epitaxial process allows for volume deposition of GaN based material on low cost silicon wafers, costing about 100 times less than SiC.

As shown in Figure 1, the basic current GaN-on-Si based device structure is a HEMT, based on the presence of a two dimensional electron gas (2DEG) spontaneously formed by the intimacy of a thin layer of AlGaN on a high quality GaN surface. Ohmic

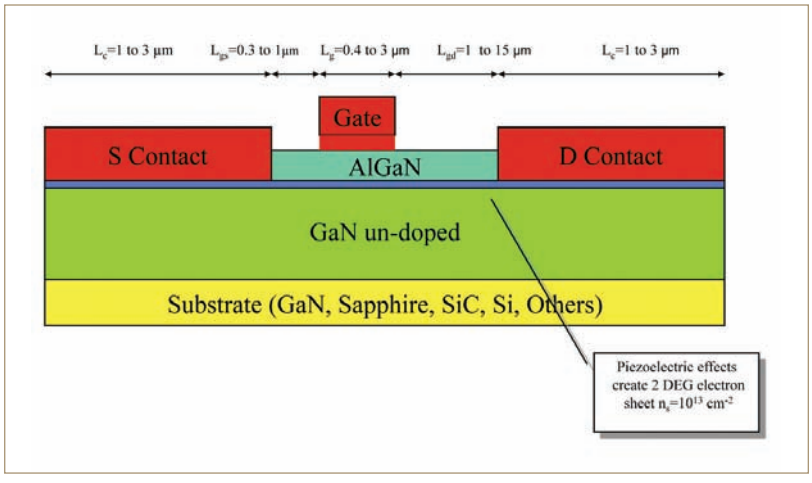


Figure 1: Basic GaN based device structure is HEMT

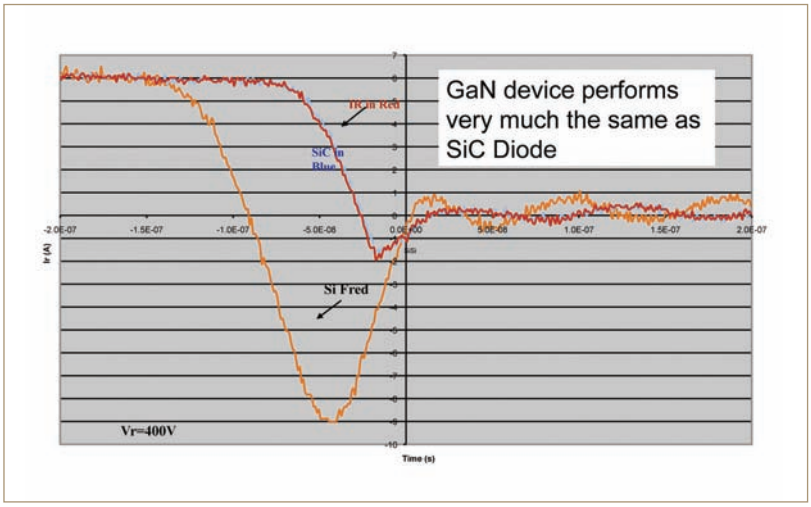


Figure 2: Reverse Recovery (Q_{rr}) performance for GaN device is same as SiC diode

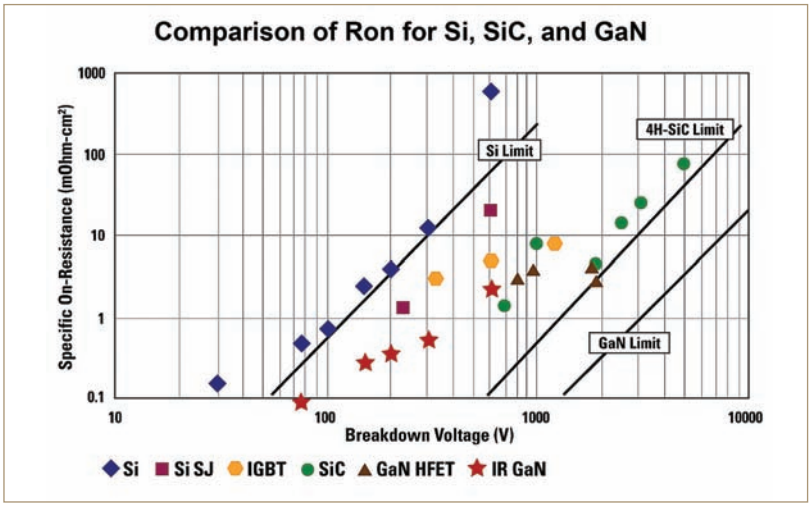


Figure 3: Comparing specific on-resistance of IR's GaN-on-Si based HEMTs with silicon and SiC power MOSFETs

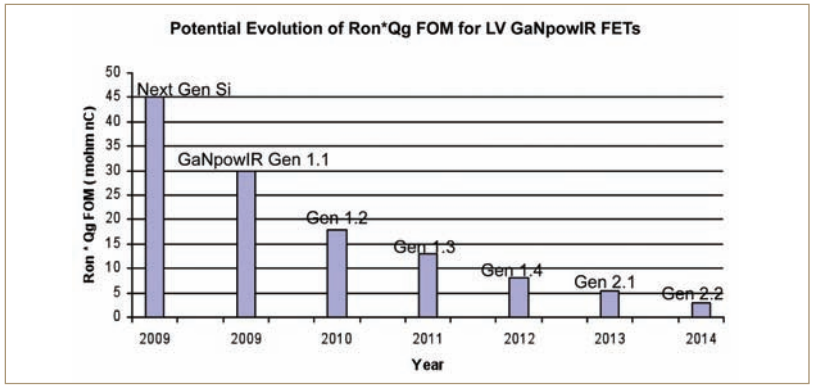
contacts are made to the 2DEG, typically using Ti/Al based metallurgy. An insulated or rectifying metal gate structure is formed between the ohmic contacts and provides for the field induced modulation of the 2DEG. It is clear then that the native nature of this device structure is a JFET with a high electron mobility channel and conducts in the absence of applied voltage (normally on). Several techniques have been developed to provide a built-in modification of the 2DEG under the gated region, providing for normally off behaviour.

Internal studies show that GaN based power devices can offer performance that is comparable to SiC but at much lower cost. Prototype tests conducted show that reverse recovery (Q_{rr}) characteristics for high voltage GaN diode function is same as for commercially available SiC diodes, both being significantly better than state of the art silicon fast recovery diodes (FRED) (Figure 2).

A combination of high electron mobility and higher bandgap provides GaN with a significant reduction on device specific on-resistance $R_{DS(on)}$ for a given reverse hold-off voltage capability than both SiC and silicon devices, as shown in the calculated material limit curves for (non-highly compensated) unipolar devices in Figure 3. Also shown are representative, best case, published measured results for the three materials, as well as for highly compensated (SJ) and bipolar (IGBT) device structures in Si. Results from the early development of GaNpowIR platform are also shown (IR GaN). It is clear that an order of magnitude improvement in specific on-resistance can be achieved for GaN based devices over silicon counterparts, even at the early stages of GaN power device development.

Since GaN based power devices achieve a combination low gate

Figure 4: Potential evolution of $R_{(on)}$ * Q_g FOM for low voltage GaNpowIR HEMTs



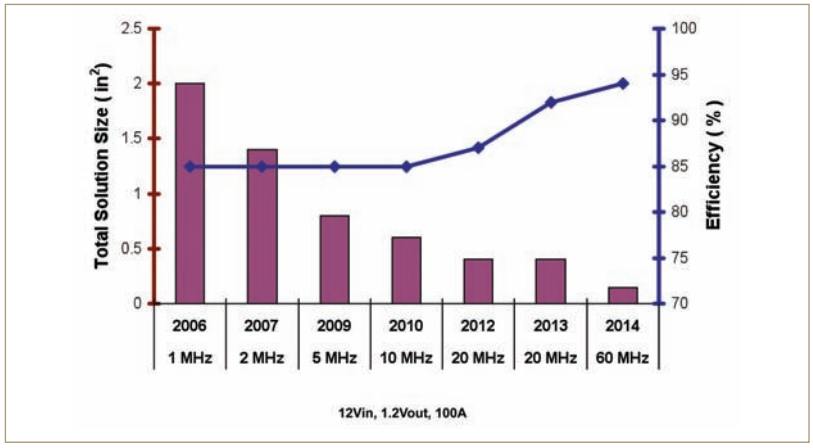


Figure 5: Projected evolution of size and power conversion efficiency for a 100A, 12 to 1V converter (including output filter), corresponding to improvements of the power switch FOM, $R_{(on)} * Q_g$

capacitance and low on-resistance, it permits much higher frequency switching converters than competing silicon transistors. Results based on device modeling indicate that $R_{(on)} * Q_g$ figure of merit (FOM) for first generation GaNpowIR HEMTs, to be introduced in 2009, is 33% lower than that of state of the art silicon MOSFETs. On going engineering efforts are expected to provide further significant improvements in the next few years. Figure 4 shows that $R_{(on)} * Q_g$ for GaNpowIR devices is expected to be as low as 13mΩ-nC by 2011, representing a 50% improvement over GaN based devices introduced in 2009.

By 2014, the $R_{(on)} * Q_g$ FOM for GaNpowIR is expected to be below 5mΩ-nC, an order of magnitude improvement over state of the art Si based devices available in 2009.

Figure 5 depicts the expected effect of the improvements in $R_{(on)} * Q_g$ FOM of the power switch on the size and efficiency of a DC/DC converter, including the output filter. Current state of the art converters perform 12 to 1V conversion efficiently up to 2MHz. The GaNpowIR technology platform is expected to enable efficient power conversion to greater than 50MHz in the near future.

GaN roadmap

IR's GaN based power device roadmap anticipates that initial prototypes will switch efficiently at 4 to 5MHz, with commercial products introduced over the next few years will support switching frequencies of 10 to 60MHz.

While products for general availability are expected to be released by the end of 2009, several prototypes of power conversion solution using the new GaN based power devices will be demonstrated at the Electronica 2008 trade show in Munich, Germany.

Powering Microcontrollers from Ambient Energy Sources

The green power movement has spawned intense interest in the need for clean and renewable energy sources. This attention is usually focused on large scale power generation to supply homes and industry. However, the need for clean and renewable energy also finds a place with low power applications such as remote microprocessors or industrial sensors. Ambient light, heat and vibration sources can generate power for microcontroller or microprocessor circuits as described in the following. **Scot Lester, Applications Engineer, Texas Instruments, USA**

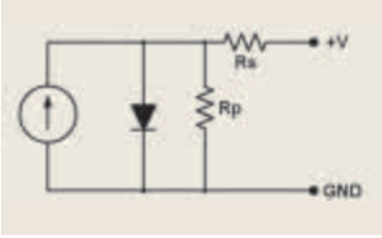


Figure 1: **Solar cell model**

Remote sensors or processors are normally powered with a battery that requires occasional replacement and pose an environmental hazard when not disposed properly. For some applications, it may be physically difficult or impossible to reach the remote device to change the battery. For other applications, environmental conditions such as high ambient temperatures or mechanical movement make the use of a battery unreliable. For these types of applications, using localised ambient energy sources, otherwise known as energy harvesting, to power the remote device makes sense.

Harvesting power by solar energy

Solar power is the most widely known and used energy harvesting power source today. The solar cell is comprised of a P-N junction with metal electrodes. Photons strike the P-N junction which causes electrons to be ejected from the N-Type material. The number of ejected electrons and, thus, the amount of current that can be generated, is proportional to the number of light photons striking the P-N junction. This P-N junction forms a P-N junction diode, therefore many characteristics of the solar cell parallel those of a diode.

Figure 1 shows the electrical model of a solar cell. It is comprised of a current source shunted by a parasitic diode. The amount of current generated by the current source will be proportional to the surface area of the solar cell and the amount of light incident on it. Since this current source is shunted with a diode, the cell's output voltage is clamped to a value equal to the forward voltage of the diode minus some voltage drop due to current flowing through the series parasitic resistance (R_S), which is due to the electrodes and semiconductor material. From a system standpoint, the solar cell appears to be a current source with a current capability proportional to the amount of light.

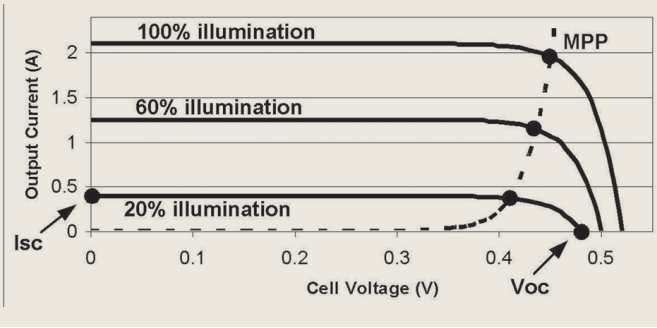
Figure 2 shows the typical characteristics of a 100cm² silicon solar cell with three different solar illumination levels. The cell is capable of generating a maximum of 0.4A with 20% illumination.

The maximum current at this illumination occurs when the cell is shorted and therefore the output voltage is zero. The 0.4A is therefore the short circuit current (I_{SC}). Conversely, the maximum output voltage of 0.45V occurs when there is no load on the output and the output current is zero (open circuit voltage V_{OC}. The values of I_{SC} and V_{OC} will vary depending on the illumination level, the material composition of the cell and the temperature of the cell.

The output power is zero when operating at the V_{OC} or I_{SC} points. Between these two points there is a point where the maximum amount of power can be extracted from the cell, called the Maximum Power Point (MPP). Figure 2 shows three MPPs for the three different illuminations, they move higher in voltage (from 0.41 to 0.44V) as the illumination increases.

Solar cells can be stacked in series to increase the output voltage. They may also be stacked in parallel to increase the output current capability. For low power applications, it is beneficial to use a single cell. However, the output voltage of the cell, a nominal 0.5V, is typically too low to power a microprocessor or other circuits. This voltage must be stepped-up to a usable voltage such as 3.3V via a boost converter.

Figure 2: **Typical solar cell I-V curve**



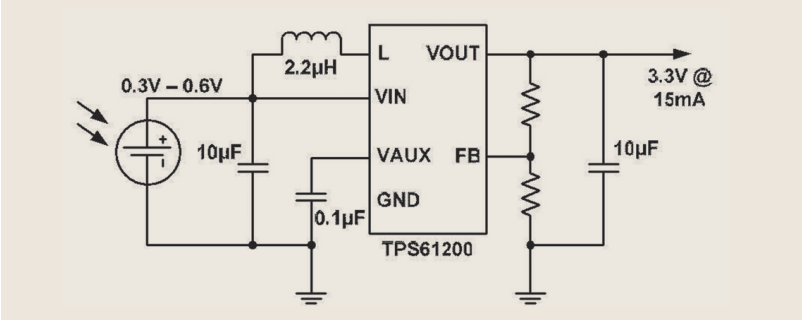


Figure 3: **Solar cell boost converter with TPS61200**

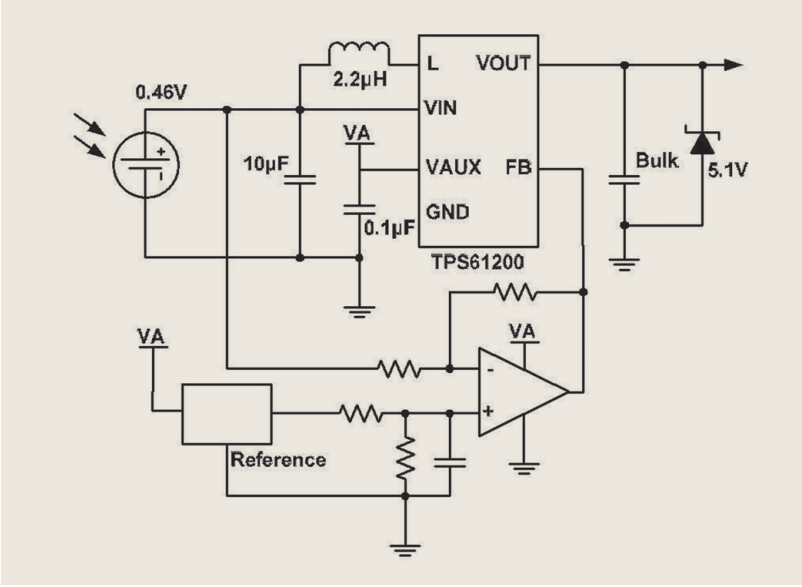


Figure 4: **Constant power boost converter**

The most critical specification for the boost converter is that it can start up from the cell's open circuit voltage at typically 0.5V. Once the boost converter starts and draws current from the solar cell, the cell's output voltage will start to decrease toward the MPP. The boost converter must be able to continue to operate with input voltages as low as 0.35V for the cell shown in Figure 2, in order to provide power over a wide range of illumination levels. Figure 3 shows a boost converter specifically made to operate from a single solar cell. The converter will start switching when the input voltage is 0.5V or higher. The converter can continue switching with input voltages as low as 0.3V and is configured to provide a regulated 3.3V with up to 15mA of output current.

The converter regulates the output to a fixed voltage by drawing what power is available at its input. If the cell is fully illuminated, the converter may not necessarily be operating at the MPP point. The converter could actually draw more power from the cell if needed. Some applications do not require a regulated output voltage, but rather require that the maximum power is harnessed from the cell. An example of such an application would be a battery or super capacitor charger. In these applications, the converter needs to harness the maximum power available from the cell, by operating at the MPP point of the cell, and store it in a bulk charge storage device. The super capacitor's voltage is allowed to increase up to the maximum voltage allowed by the system. The feedback loop of the converter can be modified to operate the cell at its MPP point.

Figure 4 shows how the feedback loop of a standard converter can be modified to draw the maximum power. In this circuit, the duty cycle of the converter is adjusted to keep the input voltage at 0.46V which is the MPP point for the cell at full illumination. This, in effect, makes the converter a regulated or constant power converter rather than a constant voltage converter. A 5.1V Zener diode is used to clamp the output voltage so that the capacitor does not charge up to a voltage that is beyond the rating of the capacitor or the converter.

Figure 5: **Basic components of a thermoelectric generator cell**

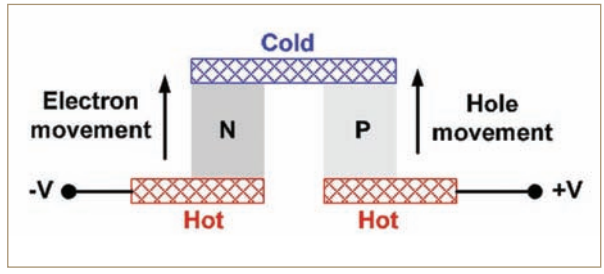
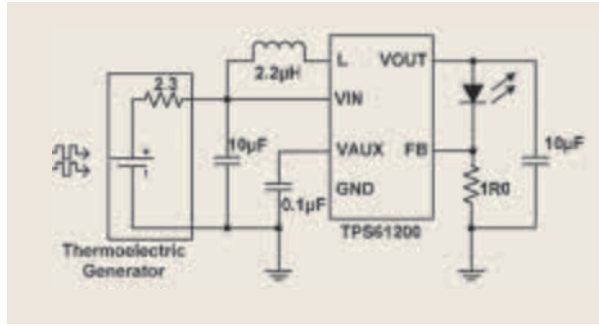


Figure 6: **Boost converter TPS61200 to power a 500mA LED**



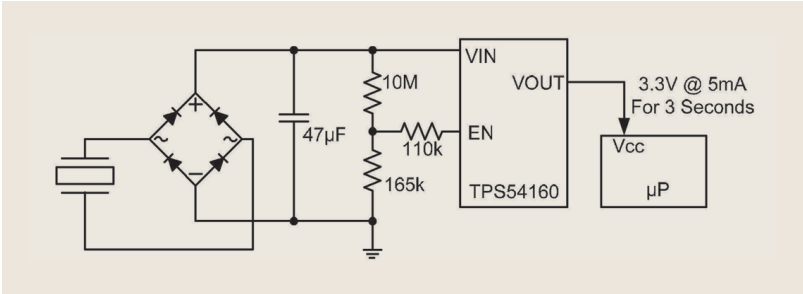


Figure 7: Regulator for a piezoelectric generator powering a microprocessor for 3s

Harnessing thermal energy

There are many instances where excess or waste heat is available to power circuits. This heat flow can be used to produce electricity to power circuits.

A thermoelectric generator is comprised of two surfaces, one hot and one cold, separated by N- and P-type semiconductor materials. The electrons in the N-type material that are closest to the hot surface are more energised than the electrons near the cold surface. The hot energised electrons move toward the cold less energised electrons. The P-type material has a similar effect, but with holes rather than electrons. The hole and electron movements produce a current that can be used to power circuits. Figure 5 shows the basic components of a thermoelectric generator cell. These cells can be stacked in series to increase the output voltage, or in parallel to increase the output current capability. A typical thermoelectric generator will have hundreds of these cells in series and parallel, in order to produce a useable amount of power.

The amount of power produced by the thermoelectric generator is determined by the geometry and materials of the cell, and by the temperature difference between the hot and the cold surface. The reliable generation of power requires that the temperature difference remain high between the two surfaces. The temperature of the hot surface will usually be determined by the heat generating portion of the system. The designer must provide a method to remove thermal energy from the cold surface to keep the surface cool. This will usually be a large heat dissipative surface with some amount of air flow. If there is no heat removal from the cold surface, then the cold surface will eventually heat up to the same temperature as the hot surface and no power will be generated.

The output power and internal resistance both vary with temperature. Additionally, the output voltage varies with temperature and output current due to the internal resistance. For these reasons, there is almost always some form of DC/DC converter used to regulate the voltage from the generator. Figure 6 shows a thermoelectric generator used to drive a high power white light LED with 500mA of current. The thermoelectric generators output is rated at 2.8V but varies anywhere between 2 and 2.8V, depending on the amount of heat applied and the load. The DC/DC converter used (also TPS61200) has 0.3 to 5.5V input voltage range, so it can fully illuminate the LED once the output of the generator is above 2V. Below 2V the converter will be power limited. It will still continue to illuminate the LED, but at a lower current.

Generating electricity from vibration

Generating electricity from vibration or other repetitive movement is accomplished using a piezoelectric (PE) material, a crystalline material that is electrically neutral in its normal state. The crystal contains both positive and negative charged material, however, the non-symmetrical physical arrangement of the crystal makes the net potential difference across the crystal zero. As a force is applied in one direction to the crystal, the crystal lattice shifts slightly which moves the charged partials relative to each other so they no longer make a net zero potential difference along one axis. A very large potential difference is created between one face of the crystal and its opposite side. Electrodes are mounted to these two sides, one plus the other negative, so that energy can be extracted from the PE material.

Since there is not a large number of excess electrons available in the crystal, the generator has a low current capability, but with a very high output voltage. The magnitude of the output voltage will relate directly to the amount of deflection or stress in the crystal. Once the force is removed from the crystal, the crystal will relax back to its normal state, typically with some amount of mechanical oscillation. The output voltage of the PE material will therefore look like an AC generator.

Depending on the physical and electrical characteristics of the generator, each spike may contain between 1 and 5mJ of energy. Each output spike is typically not sufficient to power a circuit. To be useful in powering circuits, the high voltage pulse train needs to be rectified and used to charge a bulk energy storage element such as a battery or a capacitor. Since the energy must be collected and stored in order to obtain usable amount of power, the piezoelectric generator is best used in system requiring intermittent operation. The system must wait until there is enough energy stored in the bulk capacitance, so that the system can complete its task before the storage device is discharged.

Figure 7 shows a simplified schematic of a power converter that is suitable for piezoelectric energy harvesting. The 47µF capacitor provides the bulk energy storage for the rectified high voltage pulse train from the piezoelectric generator. The three resistors on the enable pin of the TPS54160 set the enable and UVLO voltage thresholds. In this example, the power converter will remain disabled and in a low quiescent current state until the voltage on the bulk capacitor reaches 55V. Once the voltage on the capacitor is 55V, the TPS54160 will enable itself and provide a regulated 3.3V output to the microprocessor. The voltage across the bulk capacitor will decrease rapidly as the converter provides power to the microprocessor. The device will continue to provide current to the load until the voltage across the bulk capacitor decreases to 4V. The TPS54160 will then disable itself and re-enter a low quiescent current state. With this example, the bulk capacitor and TPS54160 can provide a regulated 3.3V output at 5mA of current for 3s for the microprocessor to complete its task

Conclusion

There are several ambient sources of power available in the environment such as vibration, solar and thermal energies that can be used to power microprocessors or microcontrollers. Each source has a variable output that is dependent on many electrical, mechanical or physical properties, so the output power must be conditioned or regulated in some manner in order to be usable. Low and/or wide input voltage range converters help to ease the implementation of an energy harvesting system.

Literature

PCIM 2008 Proceddings (ISBN 978-3-89838-605-0), pages 489 - 494.

Power Solutions for Mobile TV Applications in Cellular Handsets

Mobile phones have evolved from simplistic devices of portable communication to dynamic multi-functional pieces of technology. Today, despite drastic reductions in size, users demand more and more features, ranging from internet connectivity to video highlights. These features necessitate modifications to the power solutions deployed in the handset; very efficient power management solutions that are small in real estate are required in order to maintain battery life. This article looks at delivering the miniature high-efficiency power management solutions needed to power up processor applications such as DVB-H modules. **Jose Escobar, Applications Engineer, Portable Power, National Semiconductor, USA**

A processor application such as Digital Video Broadcasting Handheld (DVB-H) is a good example of a new technology being included in cell phones. Figure 1 illustrates a common DVB-H module and Table 1 highlights the module's typical power requirements. Battery consumption is a major concern for processor applications and is addressed with the use of high-efficiency regulators. Switching and linear regulators are used for powering up DVB-H modules and the combination of these regulators - when implemented correctly - can provide an improved DVB-H power solution and prolong phone battery life.

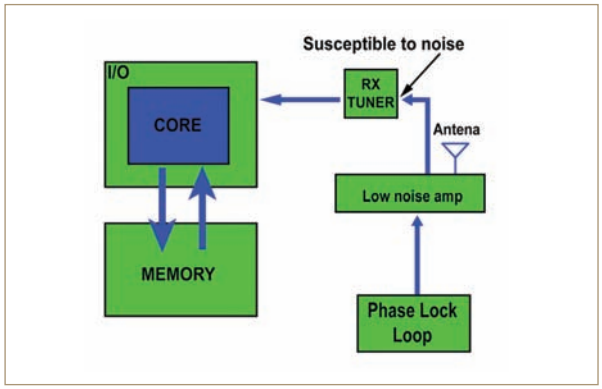


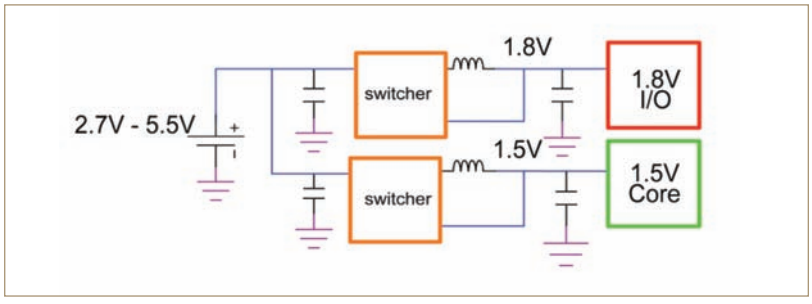
Figure 1: **Common blocks for a DVB-H module**

Block	Supply Voltage	Current
Memory	1.8V – 2.8V	< 100mA
RX tuner	1.8V – 3.3V	< 150mA
I/O	1.5V – 2.8V	< 250mA
Core	1.2V – 1.8V	< 350mA
PLL	2.5V – 3.2V	< 100mA

Table 1: **Power requirements for DVB-H**

Smaller solution size via post regulation

As previously mentioned, solution size is critical for mobile phones, especially for the implementation for DVB-H modules. The switching regulators in Figure 2a are efficient when powering up two important blocks for a DVB-H module; however, they



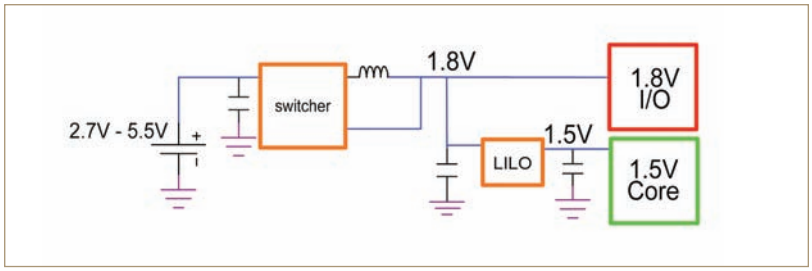


Figure 2: **Dual output with six external components (a) and dual output with four external components (b)**

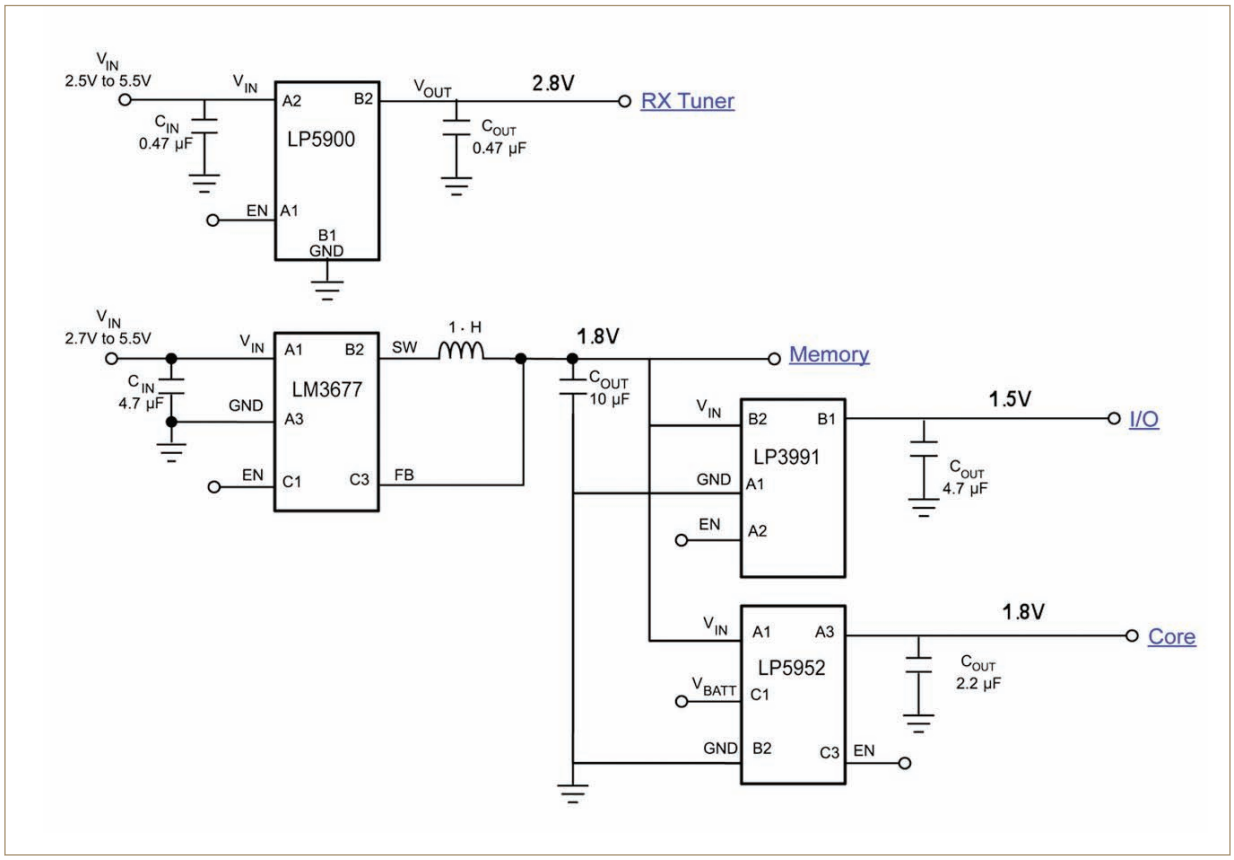


Figure 3: Schematic representation of 65mm² PCB for powering up DVB-H module

require four capacitors and two inductors. A more convenient and better approach for powering the I/O and core is to use a post-regulation scenario as shown in Figure 2b. A simple high-efficiency switching regulator with the combination of a low-input low-output LDO (LILO) leads to a significant reduction in component count as well as maintaining high efficiency.

A special trait of the LILO LDO is that it can perform with low input voltages, (less than 2V), and still provide a constant output voltage. A typical LDO's' efficiency is very low when powered from a standard Lithium-ion battery (V_{IN} = 3.2 to 4.5V). At lower input voltages the efficiency is high, while at higher V_{IN} values, the efficiency starts to roll off. The efficiency is higher at lower V_{IN} because the voltage drop across the LDO is lower. This is why a typical LDO with a V_{IN} range of 2.7 to 5.5V should not be used in post regulation. Instead, a LILO LDO is preferred since it delivers higher efficiency values due to its input supply requirements.

Using its own product range, National Semiconductor has been able to demonstrate a solution for powering up a DVB- H module that measures just 65mm² (Figure 3) thanks to MicroSMD package devices and low profile small

Device	Test on Device	Secondary Effect from Test =
Switcher	Line Transient "A"	Line Transient on LILO "B"
Switcher	Load Transient "C"	Line Transient on LILO "D"
LILO	Load Transient "E"	Load Transient on Switcher "F"

Table 2: A typical line/load transient on the switcher or LILO has secondary effects on the system

external components. The board consists of an LM3677 - the smallest 3MHz buck regulator - an ultra low noise LP5900 linear regulator, and two LILO LDOs (LP3991 and LP5952). The LP5900 is ideal for powering up RF tuners that are susceptible to noise.

Figure 4: Typical line transient for LM3677TL (switcher)

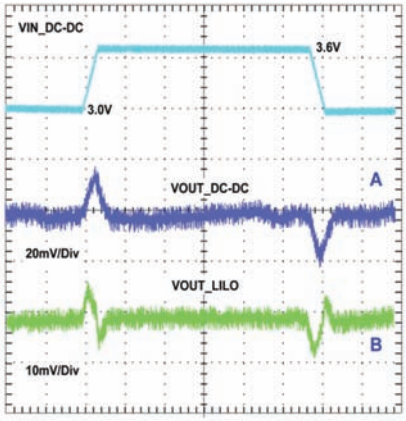
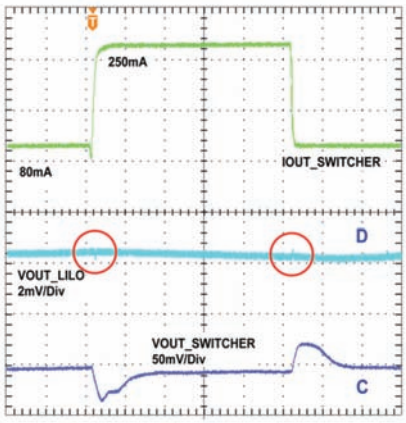
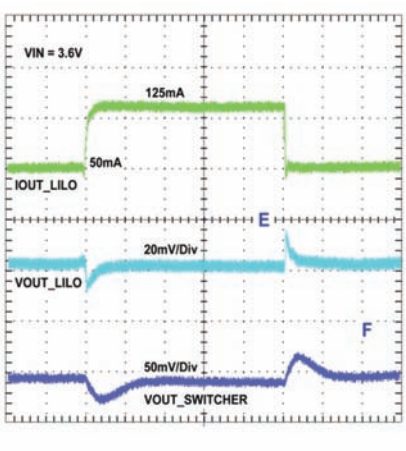


Figure 5: Typical load transient for switcher LM3677TL (a) and typical load transient for LILO LP3991 (b)





The 1.8V output of the LM3677 drives both the LP3991 (1.5V_{OUT}) and LP5952 (1.2V_{OUT}) for the core. This post-regulation arrangement delivers overall efficiency greater than 75%, due to a minimal difference between V_{IN} and V_{OUT} of both LDOs. These LDOs not only minimize component count, but the output capacitors also filter away any sub-harmonics from the LM3677 switching regulator. This filtering is effective up to 10MHz, which is the resonant frequency of the LDOs' output capacitors.

Intelligent automatic switching

The LM3677 offers up to 600mA output current while using intelligent automatic switching between PWM and PFM modes for high efficiency. The device is in PWM mode when the output current is approximately 80mA or greater. For lighter loads the part switches to PFM which reduces the current consumption (I_Q = 16µA, typical).

Both the LP3991 and LP5952 are ideal for post regulation applications where accurate low output voltages are needed. The V_{IN} range for the LP3991 is 1.65V ≤ V_{IN} ≤ 3.6V and the V_{IN} range for the LP5952 is 0.7 ≤ V_{IN} ≤ 4.5V.

The LP5900 is an ultra low noise (6.5µV RMS) LDO appropriate for supplying voltages for sensitive nose blocks such as RF tuners and receivers.

Requirements for LILO in post-regulation scheme

Besides efficiency and noise management, V_{OUT} tolerance of the switcher is a design consideration to the system. The V_{OUT} tolerance of the switching regulator must be considered to satisfy the minimum input voltage of the LILO. For example, the input voltage range of the LP5952 for post regulation = 0.7V ≤ V_{IN} ≤ 4.5V and the minimal input voltage for a given output voltage is V_{IN_min} = $V_{OUT\_NOMINAL}$ + 0.3V. If the target output voltage of the LP5952 is 1.5V, the following must be taken into account: For the LM5952TL – 1.5V V_{IN_min} = $V_{OUT\_NOMINAL}$ + 0.3V = 1.5V + 0.3V = 1.8V (input supply requirement); for the LM3677TL – 1.8V (assuming +/- 2.5%) V_{OUT_min} = 1.755V (cannot support V_{IN_min} for LILO – LILO in dropout mode) V_{OUT_max} = 1.845V; choose LM3677TL – 2.0V V_{OUT_min} = 1.95V (will support V_{IN_min} for LILO, and enough head room for transients) V_{OUT_max} = 2.05V.

Transient performance for LILO in post regulation

Transients can occur often in the system. Whether it is a line transient (a change in the input supply) or a load transient (a change in the output current), the output voltage of either the switcher or LILO will vary. Below are some examples of line and load transients in the system. Every time the switcher's output voltage undershoots/overshoots due to a line or load transient, the LP3991 and LP5952 will also experience a slight undershoot/overshoot. Although this variation occurs, the magnitude of these undershoots/overshoot are less than 10mV (Table 2, Figures 4, 5a, and 5b).

Conclusion

When a post regulation configuration is constructed properly, it will reduce component count, establish a miniature solution size, extend battery life, and achieve an overall efficiency of about 80%. Design must be looked at carefully when building the ideal post regulation network - a simple switcher along with a typical LDO will not do the trick. Instead, a combination of a high switching regulator with a low input low output LDO is the perfect way for powering up processor applications such as DVB-H modules mobile phones.

Literature

'Novel Architecture for Capacitor-Free Low Drop-Out Regulators', Power Electronics Europe, pages 28 – 29.

Active ORing Solutions in Redundant Power System Architectures

In its simplest form, an ORing device is a diode that protects the system against an input power source fault condition. A diode ORing device allows current to flow in one direction only, thus isolating the fault from the redundant bus, allowing the system to keep running off the remaining redundant power source(s). New active ORing solutions combining a high-speed ORing MOSFET controller and a very low on-state resistance MOSFET in a high-density thermally enhanced package feature very low on-resistance and fast dynamic response, eliminating the drawbacks of previous diode and MOSFET Oring solutions.

Carl Smith, Director Strategic Marketing & Business Development, Vicor/Picor, Andover, USA

A basic redundant power architecture that might be

used in high-end systems like servers and telecomms and communications infrastructure equipment essentially comprises two or more power sources driving a load. ORing solutions are required to protect the redundant bus and the system in the event that one input power source fails. Redundant power architectures are used on a variety of different bus voltages, depending on the type of end system, typically including low voltage 5, 3.3, 2.5 and <1V, intermediate bus voltages of 9.6 and 12V, and medium voltage -48 and 48V.

Diodes are effective protection devices that will disconnect an input power source short circuit virtually instantaneously. Nevertheless, a diode in an ORing application spends most of its time in forward conduction mode, all the while dissipating power and heat due to the high forward voltage (VF), and creating an undesirable requirement for significant thermal management overhead and increased board space to be allocated.

In the past, system power levels and demands on improved density were lower and, in many cases, standard ORing diodes were tolerable from a performance perspective. Conventional solutions are no longer acceptable for today's high-end systems.

Active ORing solutions drastically reduce power losses and size

An active ORing solution is the combination of a Power MOSFET and a controller IC. The MOSFET has an on-state resistance characteristic, $R_{DS(on)}$, that when multiplied by the square of the current through the device, creates power loss in the MOSFET. This can be substantially lower than the power loss of a schottky diode for the equivalent current. In fact, active ORing solutions typically show a 10x reduction in power loss versus diodes.

However, active ORing does have trade-offs. A MOSFET, when it is turned on, allows current to flow in either direction through its channel. If an input power source fails due to a short circuit, a large reverse current will be induced and will be allowed to flow through the MOSFET as long as its gate is enhanced. If the redundant bus is exposed to an input short circuit for a prolonged period of time the bus voltage will discharge, thus bringing down the system. Because of this, it is essential that the active ORing solution be very accurate and capable of extremely fast detection of reverse current fault conditions. Once the fault has been detected, the controller is required to turn off the MOSFET as fast as possible, and thus, in turn, isolate the input fault from the redundant bus and prevent any further reverse current.

The controller IC senses information across

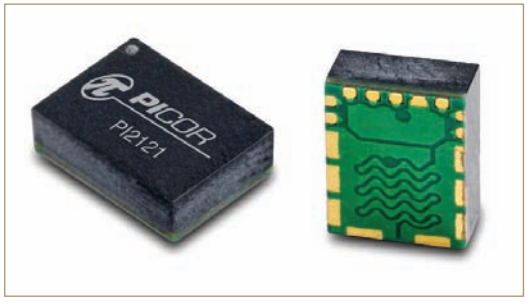


Figure 1: Full function active ORing solution of 5 x 7 x 2mm thermally enhanced LGA

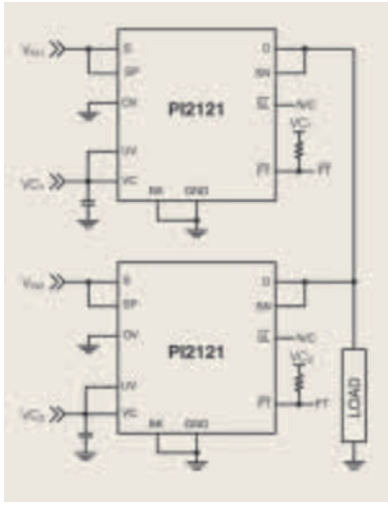


Figure 2: **Typical application of PI2121 high-side active Oring**

the MOSFET to determine the magnitude and polarity of current flow through it. The most critical parameter is the reverse current threshold, that when exceeded, provides an indication of an input power source failure. It is very important that the reverse current threshold have tight accuracy to provide consistent and fast detection of a fault, and the response time to the fault needs to be extremely fast to limit the amount of reverse current and potential voltage droop on the redundant bus. The speed of an active ORing solution is critical as it determines the magnitude and duration of reverse currents. In some of today's low impedance power architectures, this can make the challenges even more significant. Higher peak reverse currents can require larger MOSFETs to be used to prevent reliability concerns, which add cost and increase real estate.

To summarise, an active ORing solution must deliver the following attributes: (1) accuracy with respect to the reverse current threshold across the MOSFET, (2) fast response time from detection of reverse current, (3) high efficiency resulting in very low power dissipation and lack of dependence on thermal management overhead, (4) small size and (5) ease of use.

Benchmark active ORing solutions

A line of full-function active ORing solutions (Cool-ORing Series) from Picor Corporation (a subsidary of Vicor Corp.) combines a high-speed ORing MOSFET controller and a very low on-state resistance MOSFET in a high-density thermally enhanced land-grid-array (LGA) package. These solutions achieve as low as 1.5mΩ typical on-state resistance while enabling up to 24A of continuous load current over a wide range of operating temperature. The LGA package (5 x 7mm) is thermally enhanced (see Figure 1) and can be used in low voltage, high side (Figure 2) active ORing applications. Picor's Cool-ORing solutions offer over 50% board space savings versus conventional active ORing solutions. They enable extremely low power loss (Figure 3) with fast dynamic response, as fast as 160ns, to fault conditions, critical for high availability systems. A master/slave feature allows the paralleling of devices for high-current active ORing requirements.

These devices provide very high efficiency and low power loss during steady-state operation, while achieving high-speed turn-off of the internal MOSFET during an input power source fault condition that induces reverse current flow through the MOSFET. The PI2121 is an 8V, 24A solution suitable for ≤5V bus applications, the PI2123 is a 15V, 15A solution suitable for ≤9.6V bus applications and the PI2125 is a 30V, 12A solution suitable for ≤12V bus applications. The

Figure 4: **Universal active ORing controllers in industry standard packages (10-lead 3 x 3mm TDFN and 8-lead SOIC)**

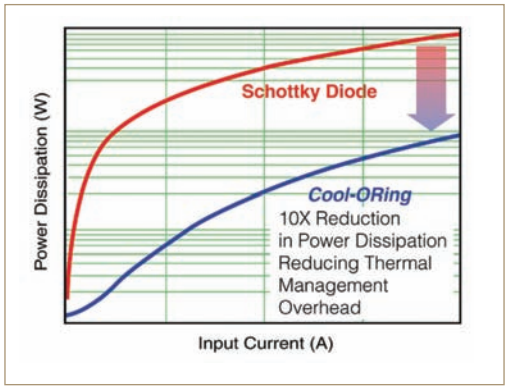


Figure 3: **Power dissipation comparison between Cool-ORing solution versus industry standard Schottky diode solution**

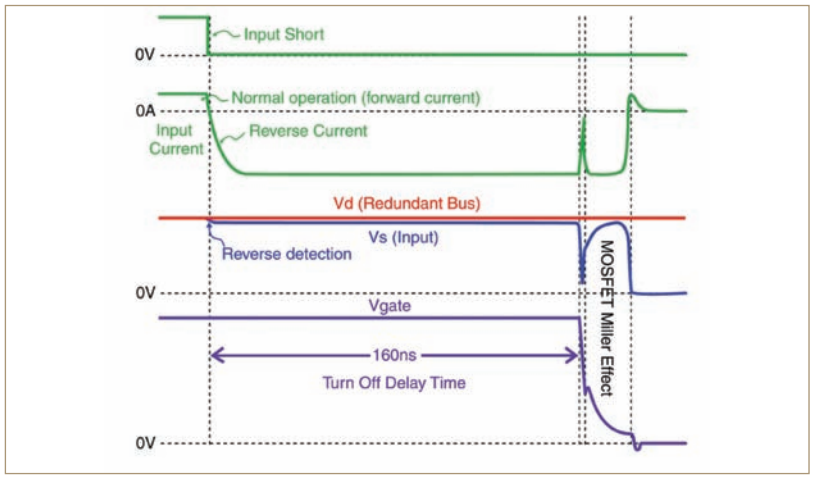


Figure 5: ypical dynamic response of PI2001 to an input power source short circuit fault condition

typical on-state resistances are 1.5, 3 and 5.5mΩ respectively for the PI2121, PI2123 and PI2125.

Cool-ORing solutions are also available as stand-alone controllers that are capable of driving external industry standard N-channel MOSFETs (Figure 4) and are functionally similar to the full-function integrated solutions. The controller enables an extremely low power loss solution with fast dynamic response to fault conditions (Figure 5), critical for high availability systems.

Picor's PI2003 controller is specifically optimised for use in -48V redundant power architectures, and is suitable for systems requiring operation during input voltage transients up to 100V for 100ms. The low quiescent current of the PI2003 enables simple low-loss biasing directly from the -48V rail.

Combining active ORing with a load disconnect feature

There are a variety of end systems employing redundant power architectures that require protection, not only against input power source failures, but also from output load fault conditions. For end systems requiring the performance and protection of active ORing while demanding protection against output load fault conditions, a new solution is required.

The Cool-ORing family also includes solutions that incorporate a load-disconnect feature. The PI2122 full-function solution integrates a high-speed controller with back-to-back configured MOSFETs and the PI2002 is a discrete controller for use with industry standard MOSFETs. The PI2122 is a 7V, 12A solution with an effective 6mΩ typical on-state resistance enabling very high efficiency. The PI2122 solution works as an active ORing solution, but also senses for excessive forward current that would be indicative of an output load fault condition. If the forward over-current threshold is exceeded, then the back-to-back MOSFETs will be turned off. In addition, this device will turn off the MOSFETs in the event of an over-temperature, over-voltage and under-voltage condition. Figure 7 shows some typical applications using the Cool-ORing solutions with the load disconnect feature.

Figure 6: Typical applications of PI2001 high-side active ORing (left) and PI2003 low-side active ORing (right)

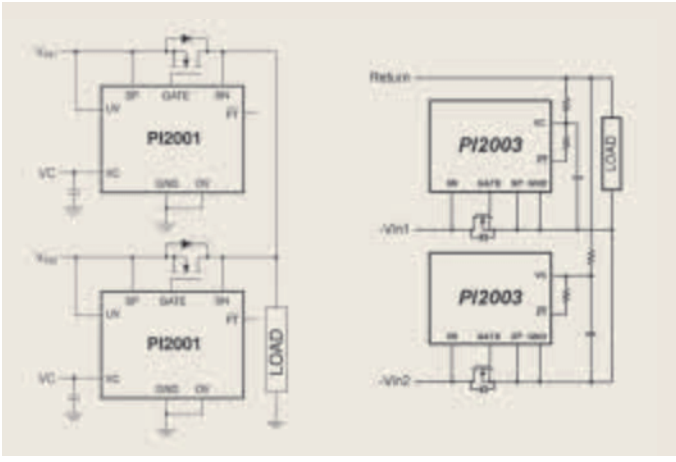
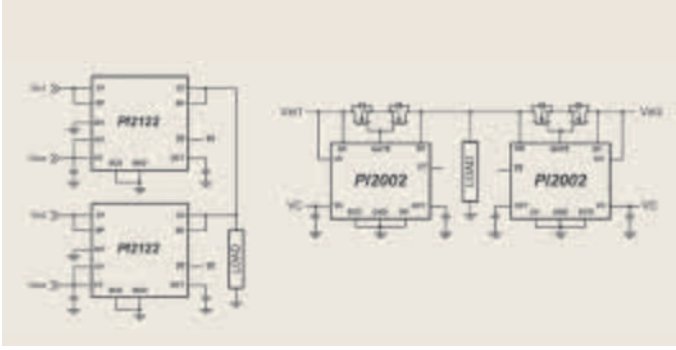


Figure 7: Typical applications: high-side active ORing with load disconnect



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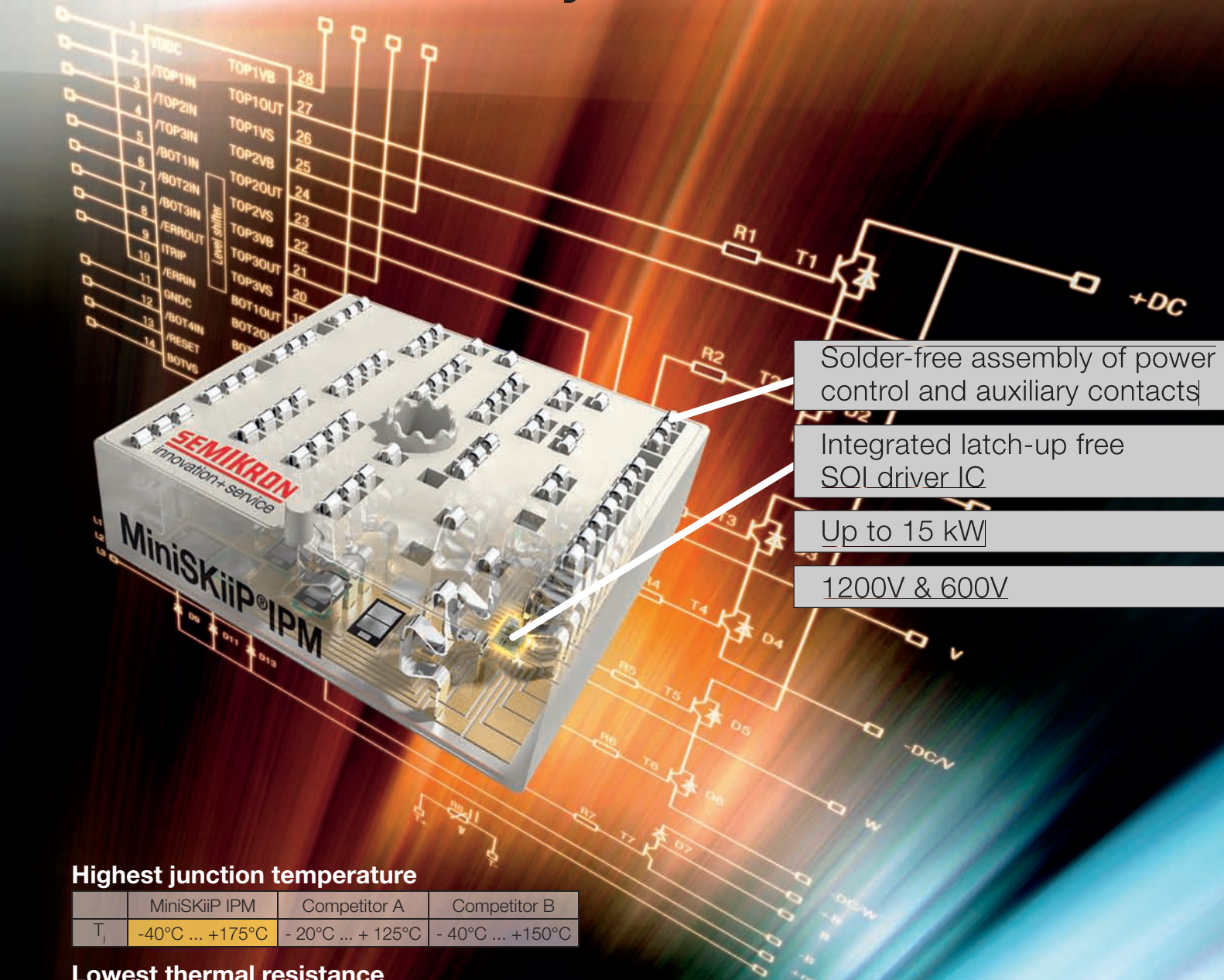

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Increased Development Efficiency through ECAD-MCAD Collaboration

Collaboration between mechanical designers (using MCAD tools) and PCB designers (using ECAD tools) is becoming a priority for many product development teams. Allowing the PCB designer and mechanical designers to view layouts including thermal analysis, suggest and approve/reject changes, and view this information on their own tool is a large step forward in advancing this collaboration, with the ultimate goals being shorter design time with fewer re-spins. **Larry Kenyon, Mentor Graphics Corporation, Systems Design Division, Longmont, USA**

Electronics companies today, especially in the consumer products sector, are faced with increasing technical and business challenges. With each subsequent generation of product, competition generally demands that more functionality be delivered in tighter spaces, products need to be brought to market faster, and product cost increases to the end user are minimal. The business drivers of functionality, cost, and schedule are not new to the industry, but the lines dividing successful and unsuccessful products are becoming finer and finer.

Since many of the costs of a product, such as materials, tend to be somewhat fixed, this means that manufacturers must increase focus on other areas they can control more directly, such as development tool selection, enhancements in data and process management - including increased efficiency within and between all of the various enterprise organisations involved in the design, manufacture, and delivery, of the final product.

One of the areas that is ripe for a change is the level of communication and cooperation between the electrical CAD (ECAD) and mechanical CAD (MCAD) organisations. Historically, these have been separate engineering organisations, with separate management chains and different goals. ECAD has been responsible for the design and performance of the printed circuit board(s) in the product, while MCAD has been generally more concerned with the physical aspects of the product in the form of enclosures, controls, and general look and feel. Each design team has its own tools and processes, and their design schedules overlap only occasionally.

In some cases, which fortunately are declining, the lack of forward progress toward mutual efficiencies is a function of management style or other social constraints in the company. More often it has been that there was not a common technology adequate to address the need and facilitate improved teamwork.

So if incremental enhancements are not enough, what can help? One method is to implement collaboration capabilities, which turn serial processes into parallel ones, change paper communication to electronic, and enable multiple organisations in the enterprise to negotiate proposed design changes in real time. A distributed company's ECAD and MCAD design organisations may not only be separated as described above, but also separated by time zones and language. Enabling close collaboration between these designers throughout the design process can significantly reduce design cycle times, reduce manufacturing re-spins, and generally improve the quality of the product.

Addressing the challenges

The first challenge with creating a collaboration capability between ECAD and MCAD is that these design solutions do not speak the same language. Each domain has evolved over the last 40 years to optimise the productivity of their designers. The result is that each solution's (ECAD and MCAD) database and constructs are tuned to that solution. When attempts are made to translate data back and forth, it is like two completely different languages (words, constructs, subtitles) trying to communicate with some commonality.

For several years, there has existed a data interface between ECAD and MCAD. This industry standard format, IDF, was typically used to import the board outline, mounting holes, etc. into the starting PCB database at the beginning of the design process. At the end of the PCB design process it was used to interface the PCB database (component placements, etc) back to the mechanical tool (see Figure 1).

Basically, the IDF format was designed and effectively used as a data dump. It had no method of identifying the changes that had occurred in either the PCB or mechanical enclosure design. In a sense,

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Many system designers choose to defer power supply and power management decisions until near the end of the design cycle. This is partly because it is easier to avoid over-budgeting on power - and therefore less expensive - once the system's actual power requirements are known, and partly because power supply selection often proves cumbersome and frustrating, and is therefore best avoided until the very last minute!

This approach might have made sense in the days when the only ac-dc power supply options available to designers were fixed-output analog designs. Whatever would be, would be. But nowadays there is little or no excuse for ignoring power in this manner - it is much better to choose a configurable power platform that can be programmed to suit the application.

The advent of modular switch-mode power supplies introduced a welcome level of flexibility by enabling designers to configure solutions more optimised for their systems. However, these modules invariably used analog control loops and therefore suffered from highly limited and fixed functionality, demanding expensive and time-consuming custom engineering to address issues such as special voltages and currents, output sequencing, particular cooling requirements, operating noise limitations and fan speed adjustments.

Latest-generation power supplies

One of the world's leading power supply manufacturers - Emerson Network Power - recently began introducing modular digitally programmable ac-dc power supplies, designed specifically to overcome the limitations of traditional analog power modules. The company's *i*MP™ series of power supplies, for example, feature microcontrollers in each module as well as the containment case, and their PC-based control software employs a highly intuitive graphical user interface (GUI) that enables designers to easily adjust a wide variety of operating parameters.

iMP series programmable power supplies are completely modular

This modular, digitally programmable approach provides unprecedented flexibility. Designers can configure the power supply to precisely match their application requirements - and can even change their mind later, to accommodate unforeseen or new power requirements - and can then set it up to do exactly what they want, when they want.

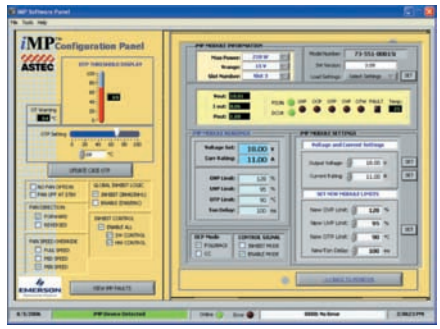
Intelligent digital control

All *i*MP series ac-dc power supplies are fully programmable. Both the case and the individual power modules feature integral microcontrollers to maximize control flexibility, with all communication between the host controller and the power supply handled via I²C bus, using the industry-standard PMBus™ protocol.

The control software supplied with every *i*MP series power supply runs under Windows® on any standard PC, using Microsoft's .NET™ framework. It uses a highly intuitive, easy-to-use graphical user interface.

Configuration made easy

Setting-up an *i*MP series power module is very easy - the same control screen is used for all modules and all operating parameters. So as well as defining a module's output voltage and current, users can just as easily adjust its OVP, UVP and OTP limits, change its OCP mode and control signal, and force fan speed override if required.



Powerful real-time monitoring

The *i*MP series control software offers exceptionally powerful real-time monitoring facilities. A single screen conveys all status information, to provide at-a-glance performance confirmation for the entire power supply, including the case and all its constituent modules. The monitoring screen displays correlated functions as sub-panels to ensure unambiguous visual interpretation, and data can be presented both numerically and graphically - at the same time, if required.

Wide-ranging applications flexibility

Emerson Network Power's *i*MP series power supplies are suitable for an extremely wide range of applications, including medical, laboratory and telecommunications equipment, test and measurement systems, and general industrial use. Their key features include:

- **6 types of power module - including single, dual & triple output units**
- **25 standard output voltages, from 2 Vdc to 60 Vdc**
- **Up to 1,500 watts & 21 separate outputs from one power supply**
- **Optional power hold-up (SEMI F47-compliant) and Oring modules**
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- **Advanced PMBus™ digital monitoring & control functions**
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- **Configurable output up/down sequencing**
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- **Processor-controlled PFC input with active inrush protection**
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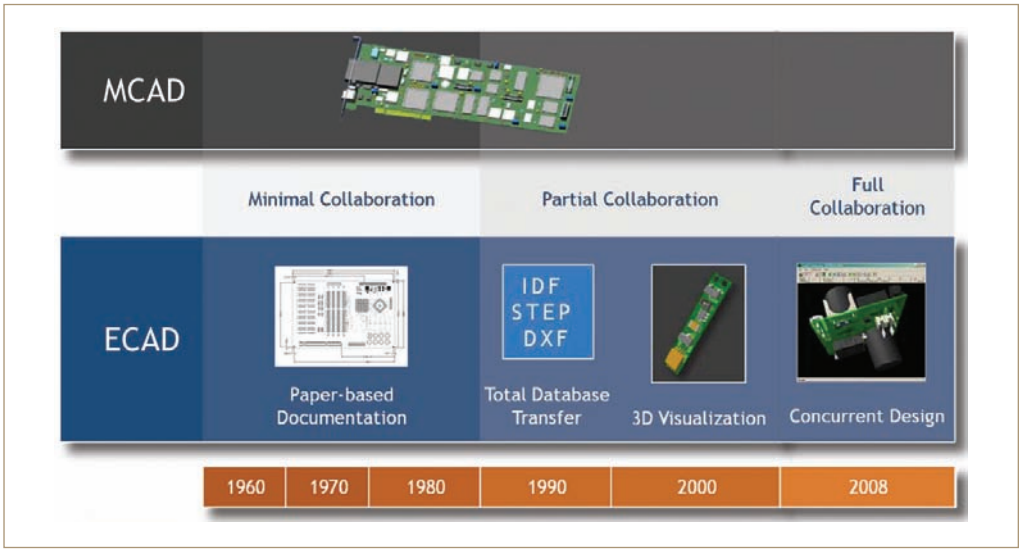

Figure 1: ECAD/MCAD collaboration evolution

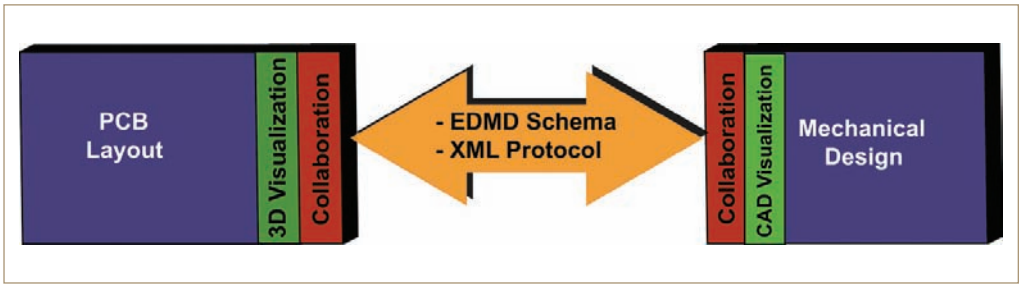

Figure 2: ECAD-MCAD collaboration architecture

any time parties communicate and exchange data towards reaching a common goal is a form of 'collaboration', even if not particularly efficient. In these early days, collaboration consisted of pieces of paper and oral communications between the disciplines. This methodology has proven to be very time consuming and error prone.

In addition to this massive data transfer between ECAD and MCAD, many ECAD solutions have incorporated 3D viewers that enable PCB designers to view their designs in 3D and even insert/view them in an enclosure supplied by the mechanical system. This form of communication could be considered collaborative, and is more effective than the mass exchange of data with IDF, but still leaves considerable room for improvement. Yes, it gives the PCB designer the opportunity to spot obvious errors (e.g., gross PCB interference with the enclosure) but does not create the opportunity for real time, bi-directional communication and incremental data transfer between the disciplines required for timely resolution of the problem.

Collaboration standard specification

Faced with the increasing needs of PCB systems design users, an effort was initiated in 2005 by Mentor Graphics, some select mechanical solution suppliers like Parametric Technology Corporation (PTC), mutual customers, and the ProSTEP iVIP Association to develop ECAD–MCAD collaboration capabilities. The first step was to solve the ECAD–MCAD language problem. Rather than attempting to completely change the basic data models of both domains, a subset of objects was chosen and prioritised that represented the most likely objects to be subject to change during the concurrent design of the mechanical enclosure and PCB. Examples include mounting holes, board outline, component placements, height restrictions, etc.

Each of these object's names, properties and constructs was specified to a mutually agreeable form so that both domains' systems could fully understand them. This was the beginning of a common language covering the most important collaboration objects, to be known as the EDMD (electrical design, mechanical design) scheme (see Figure 2). Also defined was the collaboration interaction protocol (XML), the common use cases to be supported, and the relationship of the collaboration tools with the native ECAD and MCAD tools. All of this was specified in a document and approved in early 2008 by ProSTEP iViP as the go forward communications standard open to all ECAD and MCAD suppliers.

Collaboration capabilities

To address the global nature of the electronics industry today, collaboration must include not only real time interactions, but also address the fact that the ECAD and MCAD organisations might be globally dispersed and not in the same time zones. To that end, one of the use cases applied is to provide both synchronous and asynchronous communication. For synchronous collaboration it is assumed that both designers are online and can respond to change proposals at their convenience, but in more or less real time. For asynchronous situations, the changes must be stored persistently and presented through the collaboration module at the appropriate time. Initial implementations provide for these scenarios.

Collaboration should not be an event, but an ongoing process. Seldom would a

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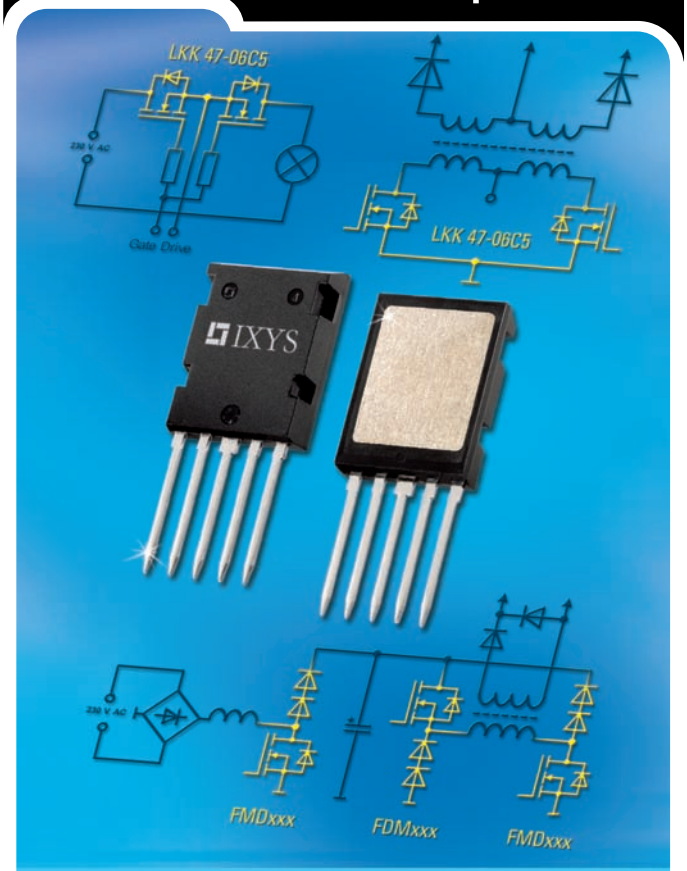

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• RoHS compliant	• AC switch	• Low gate drive power

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FMD 15-06KC5	600	15	0,165	40	ISOPLUS i4	Boost
FMD 47-06KC5	600	47	0,045	150	ISOPLUS i4	Boost
FDM 15-06KC5	600	15	0,165	40	ISOPLUS i4	Buck
FDM 47-06KC5	600	47	0,045	150	ISOPLUS i4	Buck
LKK 47-06C5	600	2 x 47	0,045	2 x 150	ISOPLUS 264	Dual
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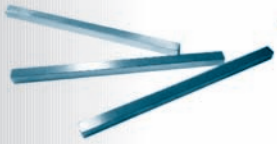
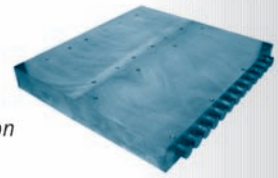
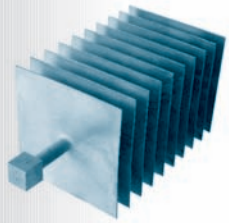


• Square heat pipe for better thermal contact to components



• Isothermal heat pipe plate for optimal temperature distribution



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designer propose a change that would be accepted outright. More often, a change would be proposed and either rejected by the other domain or a counterproposal made through a negotiation process. To facilitate this process, the collaboration tools need to have the capability to sandbox proposals. and only after the completion of the negotiation process, implement that change into the permanent database of each design. Figure 3 shows a typical collaboration process.

One of the design criteria for a collaboration solution was that neither ECAD nor MCAD designer should be expected to learn how to use each other's tools, or a new hybrid tool. They are both experts in their domains and that needs to be leveraged for optimal performance. The Collaborator implementation provides a communication layer between the systems, which enables each designer to do what they do best, in the environment they are used to. This aspect facilitates the adoption rate on both sides of the design cycle, and accelerates the solution into the industry (see Figure 4).

The ECAD-MCAD Collaborator allows for continuous, iterative design collaboration all through the design cycle to help avoid costly re-work and re-spin surprises at the end of the cycle; ECAD-MCAD conflicts are identified and resolved early in the process. Those same iterations also greatly reduce the probability that late cycle re-designs will negatively affect the product release schedule. And with the recent acquisition of Flomerics, mechanical design collaboration is enhanced by conduction and convection thermal analysis of PCBs in full enclosure.

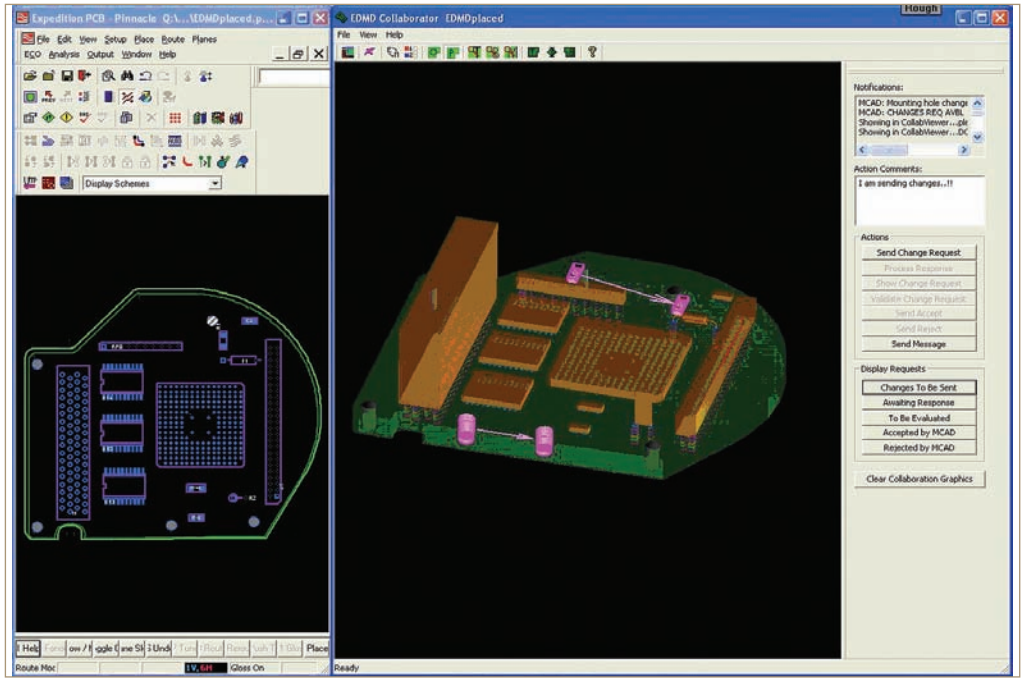

Figure 4: The Collaborator maintains user interface and terms familiar to PCB designers

Conclusion

While the ECAD-MCAD Collaborator may appear to be a technical solution, and does in fact facilitate improved communications and issue resolution between the development domains, it is the evolution of the design cycle processes, the 'left shift' of the design development and analysis activities that provides the real bottom line benefit to the product line and the company. The Collaborator itself is the key that opens the door to significant competitive advantage in the electronics industry.

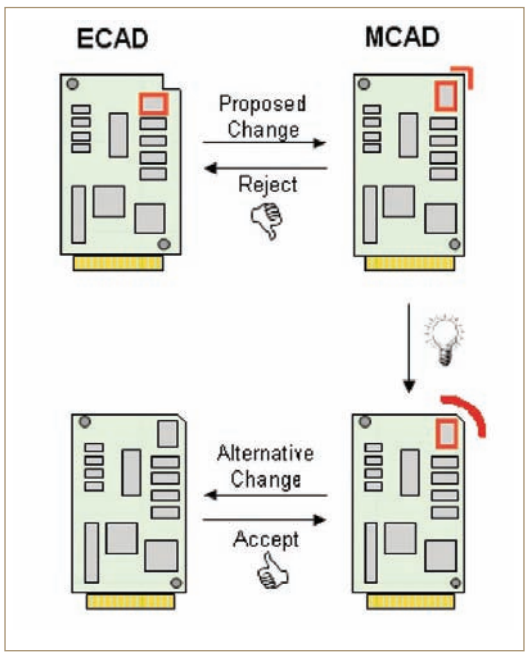

Figure 3: Typical collaboration process

Circuit Protection for 24V Systems in Buses

Tyco Electronics Raychem Circuit Protection has introduced a new line of PolySwitch circuit protection devices for the automotive market. The AHEF family of devices provide resettable overcurrent protection for bus and truck wire harnesses utilising 24V electrical systems. Key device parameters for the family of seven devices include hold-current ratings from 0.50 to 10A with a maximum fault-current rating of 100A. The maximum operating voltage rating is 32V for all devices, the same as for vehicle electronics in Europe. The maximum operating temperature for all the devices is 125°C, permitting their use in the passenger and in the engine compartment.

All the devices are housed in radial-leaded packages. The resettable devices are of through-hole construction. They don't need fuse holders to be installed, but can be directly installed onto PCBs with 'pick and place' equipment, giving system designers added flexibility. Next generation wire harnesses generally have a hierarchal structure with the main power trunks dividing into smaller and smaller branches with overcurrent protection at each node. This structure results in the use of smaller wires — which save volume, weight and cost — as well as maximum system protection and fault isolation.

www.circuitprotection.com

620V SuperMESH3 Power MOSFETs

STMicroelectronics has further increased the ruggedness, switching performance and efficiency of power MOSFETs for lighting ballasts, where they are used in the PFC and Half Bridge sections, as well as in switching power supplies. The first SuperMESH3 devices to be introduced are the 620V STx6N62K3, which will be followed by the STx3N62K3, also at 620V, as well as the 525V STx7N52K3 and STx6N52K3. The savings in on-resistance enabled by SuperMESH3 reduce $R_{DS(on)}$ in DPAK packages to 1.28Ω in the STD6N62K3 at 620V and 0.98Ω in the STD7N52K3 at 525V boosting operating efficiency in applications such as low-energy lamp ballasts.

The new technology also reduces reverse-recovery time, gate charge, and intrinsic capacitance, leading to improved switching performance and enabling higher operating frequencies. As a further advantage of SuperMESH3 technology, which combines strip topology with an optimised vertical structure, the new devices also exhibit one of the best-in-class dv/dt behaviours. This translates into increased reliability and safety in lighting and other consumer electrical applications.

All SuperMESH3 devices are 100% avalanche tested, and also incorporate zener protection to deliver all-round robust performance.

www.st.com

Extended Quarter Brick Line

TDK-Lambda has extended its line up of high power quarter brick modules with the introduction of the iQL Series. Covering the output voltage range from 1.2 to 28V and with a power rating up to 300W, this new family of wide input voltage range, fully regulated output DC-DC converters features the industry standard DOSA quarter brick footprint.

The iQL Series has been designed with confined space and demanding thermal environments in mind, as used in telecom, datacom, access, wireless and many other applications including test & measurement, broadcast and industrial. The single board open frame quarter brick converter offers up to 95% power conversion efficiency, 181W/in³ power density and 70A useable output current. Furthermore, the iQL converter's efficiency curve remains high and incredibly flat, staying at more than 92% efficiency, over a wide 25 to 100% load. With custom ASIC control device, ferrite cores and multi-layer capacitors, component count has been reduced significantly providing in a single board solution, the same levels of power formerly only available on two-board designs. The DC/DC power modules cater for two application areas. For conventional power rails, the 'standard' output voltages of 1.2, 1.5, 1.8, 2.5, 3.3, 5, 24 or 28V are equipped with both remote sense and trim suitable for powering a wide array of devices. The 8.3, 9.6 and 12V output products, featuring output trim and no remote sense are ideal for powering Intermediate Bus architectures. The iQL family also boasts a wide input range of either 36 to 75V or 18 to 36V.

www.emea.tdk-lambda.com

600V Super Junction Power MOSFETs

Toshiba Electronics Europe (TEE) has announced the first products from its DTMOS II family of power MOSFETs. These 600V power MOSFETs combine a very low on resistance and reduced gate charge to deliver an $R_{DS(on)}$ x Q_g 'figure of merit' that is 15% lower than that of the DTMOS I range and 68% lower than conventional MOSFETs (respective $R_{DS(on)}$ and Q_g ratings of 0.19Ω and 27nC, 0.3Ω and 17nC, and 0.4Ω and 14nC). Featuring 20A (TK20A60U), 15A (TK15A60U) and 12A (TK12A60U) current ratings, the three new DTMOS II power MOSFETs are suited for switch mode power supplies, lighting ballasts, motor drives and other applications requiring high efficiency, high-speed switching. The new devices are supplied in thea 13.5% reduction in PCB mounting height. This package uses copper connections rather than aluminium bonding wires, which leads to improved current and lower resistance ratings and aids heat dissipation.

www.toshiba-components.com

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