ISSN: 1863-5598

ZKZ 64717
01-07

Bodo´s Power Systems

Systems Design Motion and Conversion

January 2007

Integration. Flexibility. Power. Find your architecture strategy.

FAIRCHILD
SEMICONDUCTOR®

Inverter motor designs: half the energy, cost and time.

Meet energy usage regulations with SPM

Satisfy government energy requirements for home appliances with Fairchild's Smart Power Modules (SPM) for variable speed motor drives. One highly integrated package, with up to 16 discrete components, provides space savings, ease-of-use and greater reliability.

Our SPM portfolio covers inverter motor designs from 50W to 3kW, all with adjustable switching speeds, superior thermal resistance and low EMI. We're also the only company to offer a module for partial PFC switching converters.

Smart Power Modules: where energy is critical, SPM is there.

Fairchild Smart Power Modules are the optimal solution for variable speed motor drives in home appliance designs.

For more information on our SPM products, evaluation boards, and all of our design tools, visit www.fairchildsemi.com/spm.

www.fairchildsemi.com

the power franchise™

Bodo´s Power Systems

Bodo´s Power Systems

A Media
Katzbek 17a
D-24235 Laboe, Germany
Phone: +49 4343 42 17 90
Fax: +49 4343 42 17 89
editor@bodospower.com
www.bodospower.com

Publishing Editor
Bodo Arlt, *Dipl.-Ing.*
editor@bodospower.com

Creative Direction & Production
Repro Studio Peschke
Repro.Peschke@t-online.de

Free Subscription to qualified readers

Bodo´s Power Systems magazine is available for the following subscription charges:
Annual charge (12 issues) is 150 € world wide
Single issue is 18 €
subscription@bodospower.com

Printing by:
Central-Druck Trost GmbH & Co
Heusenstamm, Germany

Events

APEC 2007
Feb. 25-March 1, Anaheim CA
www.apec-conf.com

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

ELECTRONICA China 2007, March 21-23, Shanghai, www.global-electronics.net

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

Hannover Fair, April16-20, Hannover, www.hannovermesse.de

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

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

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

Dreams and Reality of Power

Energy is not for free, as we know. In wintertime heating is the most important use of energy – needed to stay alive. Of the various forms of energy, electricity is the easiest to transport and convert to our needs. There was a time when waterpower was widely used to run mechanical systems, like the Tower Bridge in London. I remember when it was converted to an electro-hydraulic system. In the past, systems to save energy were mostly applications at higher power levels – but now efficiency is the focus at all power levels. Variable speed electric motor drives can save a lot of energy. And the larger the motor, the more an efficient design is a good choice. Using electric motors for rail and automotive has the advantage of saving energy in the braking mode. Efficient mass transportation is one of the opportunities we have to limit pollution - global warming cannot be solved by more air conditioners.

Renewable energy, like solar and wind power, will help to develop a clean future. The P in Bodo's Power Systems has become green. I am committed to give attention in my magazine to solar and wind power activities worldwide. These areas will develop our future - important as we take a look into events in 2007.

The upcoming events are APEC in Anaheim, PCIM China, and EMV-2007 in Stuttgart. The PCIM China Conference is a major platform for presenting and discussing state of the art developments in Power Electronics. The PCIM China section in this issue has the conference program to let you to plan ahead. My publication takes the world as one global market place, with English the engineering language. Industry receives my support in any place that has power electronic related subjects. EMC has strong connections to power electronics. Reduced electro magnetic interference always results in a more efficient system. EMV-2007 in Stuttgart in March will be the place to meet the experts. We have to design for EMC and not just test to comply with legislation.

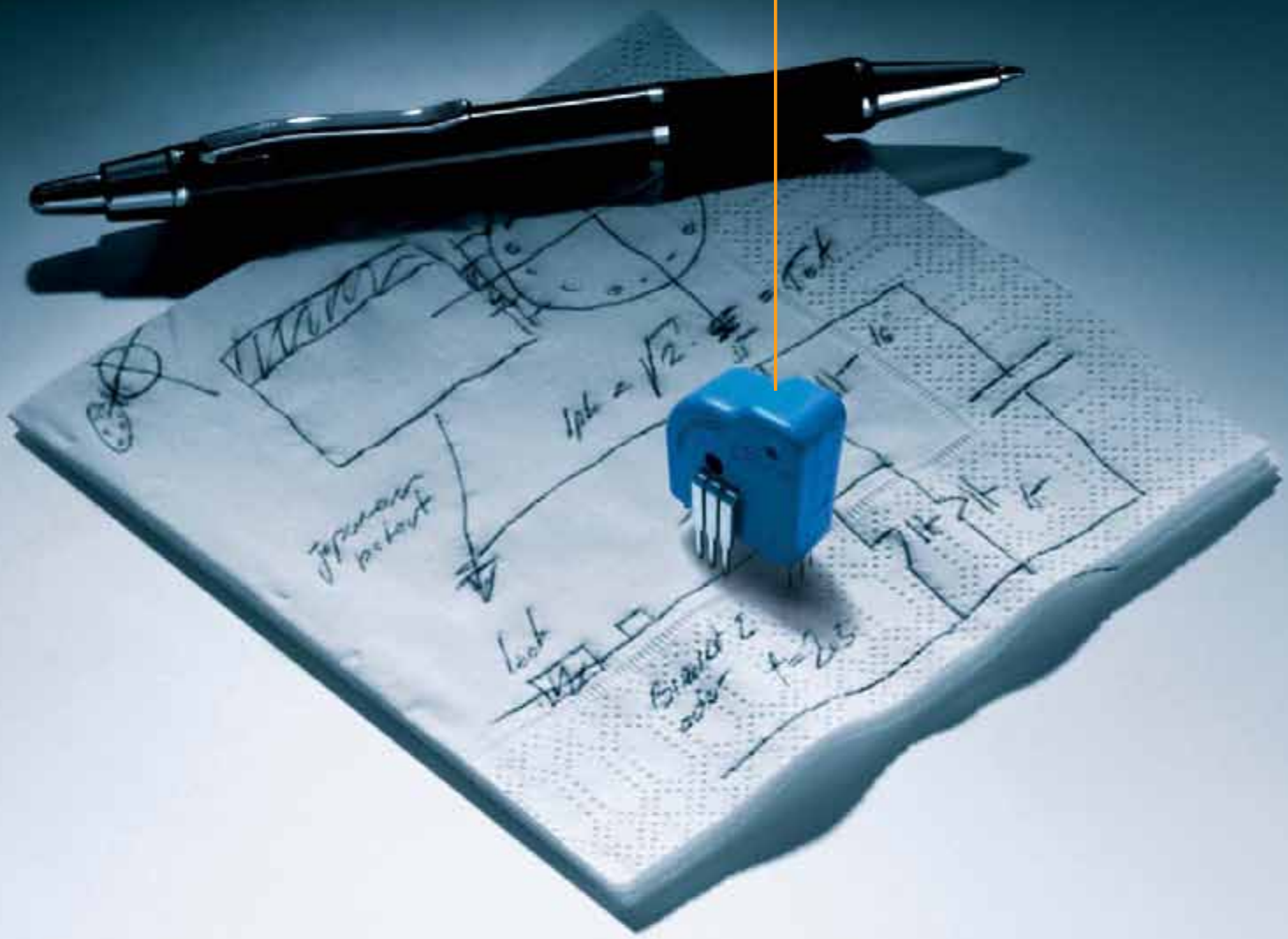
Anaheim demonstrates that a dream can become a reality. Walt Disney had made the dream real. Power Electronics has helped a lot - the illumination at Disney World, with modern lamp ballast designs, reduces energy consumption without any loss in the brilliance of the lighting. Engineering is not a magic thing, but the Disney world is pure magic. The children who will be the Engineers of tomorrow will be close to the APEC Conference, but with their attention on the magic world just next to the reality of power. So what is a dream and what is reality – possibly just our point of view.

Let us take a lesson from Mr. Disney – dream a little – and make our dreams reality.

Looking forward to see you in Anaheim discussing progress in Power Electronics.

Best Regards

Already part of your vision.
LEM.



Whatever you invent, imagine or develop, LEM's transducers are at the heart of your power electronics applications from the very start. LEM's products, R&D, and people provide knowledge intensive solutions to keep up with your changing industry, allowing your visions to come to life.

www.lem.com

At the heart of power electronics.

LEM®

Eric Lidow Receives Lifetime Achievement Award

International Rectifier announced that the Reed Electronics Group has selected IR chairman and founder Eric Lidow as this year's recipient of the Lifetime Achievement Award.
The award is presented to an individual who has made a profound and lasting impact on the electronics industry. Chairman of the Reed Electronics Group, Stephen Moylan, said, "This year's winner of the Elektra '06 Lifetime Achievement Award is a truly worthy recipient. He has been a pioneer of a technology which has had a profound and lasting impact on power electronics and founded a company whose name is now instantly recognized around the globe as a leader and innovator in the power semiconductor market."
Lidow founded International Rectifier in 1947 and was an early pioneer of a then rare global enterprise business model. Under his leadership, International Rectifier developed a number of key power management technologies now pervasive in the industry, among them the HEXFET power MOSFET. The lifetime achievement award, part of the European Electronic Industry Awards, was presented at the Elektra '06 gala in Munich on November 15. Past recipients include Pasquale Pistorio, Dr. Hermann Hauser, and Professor Hugo De Man.

www.irf.com

Consumers to Drive Stalled Power Semiconductor Market

Consumer applications will drive future growth in the power semiconductor market according to the latest annual study on the global market by IMS Research and the long term outlook for this key semiconductor product sector is bright.
The IMS Research study found that the market remained flat in 2005 at $11.3 billion following 2004's massive 25% expansion. However, data provided by suppliers to the market and analysis of the key applications consuming power semiconductors provide very encouraging signs for the next five to ten years.
The power discretes market (including transistors, thyristors and rectifiers) is predicted to nearly double in size over the next ten years, whilst the power module market is forecast for even stronger growth. Report analyst Ash Sharma revealed that "one of the factors behind this strong growth is the consumer market. Fast growing markets such as flat panel displays, together with ongoing technical advancement within products such as white goods, will provide significant additional revenue potential for power semiconductor suppliers". "Relatively small but rapidly growing sectors, such as renewable energy and hybrid-electric vehicles will also help drive the market" added Sharma.

www.imsresearch.com

Bright Future for the Indian Electronics Industry

STMicroelectronics hosted a special event, "ST DAY in India", in New Delhi, which took place in the presence of Thiru Dayanidhi Maran, Minister of Communication and Information Technology, and Shir Jainder Singh, the IT Secretary. During the event, senior managers of the company presented strategic overviews of the world and the regional electronics and semiconductor markets, with particular emphasis on the rapidly growing Indian electronics market.
With industry analysts expecting electronics manufacturing in India to grow at a rate some 5.5 times greater than the overall worldwide growth rate, India is poised to become a major player in the worldwide electronics manufacturing industry and ST emphasized the depth of support and the breadth of products, platforms and technologies that it offers customers in India.
During the event ST unveiled the first set-top box chip entirely designed in India. The STi5107 MPEG decoder, along with its accompanying software, was designed and implemented at the Greater Noida R&D center, using state-of-the-art design tools and application software integration techniques. The chip includes advanced security features designed to provide a secure and low-cost solution for the standard definition Pay-TV market.

www.st.com

Solar Energy Cooperation

Three of the world's leading experts in power management technologies have signed a Memorandum of Understanding in the field of photovoltaic power generation. Under the terms of the MOU, Delta Electronics, Inc. of Taiwan, its majority-owned subsidiary DelSolar Co. Ltd. (Taiwan), and STMicroelectronics NV (NYSE:STM) will explore strategic cooperation opportunities with the intention of concluding a strategic partnership in areas such as increasing solar cell production, and developing photovoltaic inverter and power supply applications. ST is supplier of semiconductor solutions for power conversion applications. DelSolar is a solar cell manufacturing. Delta, provider of switching power supplies, is focusing on photovoltaic inverter design and production and desires to become a major player in the fast growing solar energy system market.
Solar power accounted for only 0.024% of the total amount of electricity produced globally in 2004. By 2010 this may grow by a factor of 10, as solar power is predicted to supply 0.25% of the world's electricity.
Beyond that, solar energy has huge growth potential as global demand for clean, renewable energy increases. Solar power's advantages include low environmental pollution, solar cells with long product life cycles, and an unlimited supply of raw energy — the earth receives more energy from the sun in just one hour than the world uses in a whole year.

www.deltaww.com

www.st.com

The Best-Selling 2-Channel IGBT Driver Core

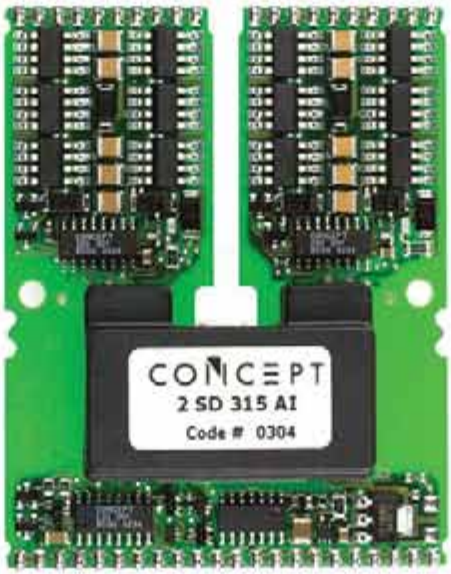
The 2SD315AI is a 2-channel driver for IGBTs up to 1700V (optionally up to 3300V). Its gate current capability of ±15A is optimized for IGBTs from 200A to 1200A.

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

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

Chipset Features

- Short-circuit protection
- Supply undervoltage lockout
- Direct or half-bridge mode
- Dead-time generation
- High dv/dt immunity up to 100kV/us
- Transformer interface
- Isolated status feedback
- 5V...15V logic signals
- Schmitt-trigger inputs
- Switching frequency DC to >100kHz
- Duty cycle 0...100%
- Delay time typ. 325ns



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

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

Isolated DC/DC power supply with 3W per channel

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

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

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

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

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

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

CONCEPT

CT-Concept Technologie AG
Renferstrasse 15
2504 Biel-Bienne
Switzerland

Tel +41-32-341 41 01
Fax +41-32-341 71 21

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

Let experts drive your power devices

IMEC Strengthens its Position in India

IMEC, Europe's leading independent nanoelectronics and nanotechnology research institute, engages to expand its R&D collaborations with Indian semiconductor companies and institutes. As a first step, a memorandum of understanding (MOU) was signed on November 5 with SemIndia. The company is planning to build a semiconductor fab in Hyderabad (India) and wants to take up research with IMEC on the next generations of semiconductor process technologies.
Today, IMEC has also signed an MOU with the Indian Institute of Science (IISc) in Bangalore to perform joint research on various nanoelectronics process steps.
IMEC's initiative to strengthen its position on the Indian semiconductor market comes in the wake of India's plans to give a major boost to the semiconductor industry by expanding nanotechnology R&D at the international science and technology centers and by setting up modern semiconductor fabrication facilities.
SemIndia intends to set up a semiconductor foundry in 2007 with production ramp up beginning of 2009 and with IMEC as a strategic fab technology research partner. Initial collaboration would focus on developing foundry-compatible 130nm and 90nm CMOS processes for logic and mixed-signal products for e.g. the cellular market. To this end, SemIndia will build on IMEC's long-term expertise in developing and transferring advanced CMOS processes. In a second phase, SemIndia intends to collaborate with IMEC on the 65nm and 45nm semiconductor processes.
The Indian Institute of Science in Bangalore has recently set up an international nano-science centre for R&D projects in nanotechnology applications. IMEC and the IISc intend to perform joint research on new materials for (sub-)45nm CMOS technologies as well as nanotechnology for the post-CMOS era. In addition, RF-CMOS and MEMS have been identified as potential joint research topics. PhD students and researchers will be exchanged and the use of facilities will be shared between the two institutes.

www.imec.be

Providing Russian Language Website

Instruments announced today that it is providing new levels of support to Russian-speaking markets to extend its local customer service. The enhanced technical service and support structure includes a local representative office in Moscow, a dedicated website and live technical information and support on a local phone number from its European Product Information Center (EPIC) – all in Russian language.
With current growth levels in the electronics industry reaching 20 percent in Russian-speaking markets according to WSTS, countries such as Russia, Ukraine, Belarus and Kazakhstan promise sustained business opportunities for the semiconductor industry. TI has already been supporting these markets for over nine years, and is now taking its commitment to the next level with local-language resources and support specifically targeted at design engineers in the region.
TI has created a Russian-language website at www.ti.com/ru to offer the Russian-speaking engineering community information on TI's digital signal processor, high-performance analog, logic, linear and microcontroller products and solutions as well as details of Russian-language training sessions. The website also provides information on specific application solutions and the list of TI distributors throughout the region from whom customers may obtain technical support services, as well as from TI's representative office in Moscow.
For the past ten years, through its University Program, TI has been supporting the most influential universities in Russia with access to leading-edge technologies such as Digital Signal Processing and ultra low-power microcontrollers. Today there are 46 "DSP Labs" in Russia, four in Belarus and ten in Ukraine. Last year, in Moscow and Novosibirsk, TI ran hands-on workshops for academic DSP users helping to support and accelerate the adoption of TI technology by the industry.
In 2007, TI will hold its industry-renowned Developer Conference in Moscow for the second time, dedicated to providing design engineers and managers in the region with targeted, technical training and information in a variety of application areas, and enabling them to find optimal solutions for their application designs.

www.ti.com

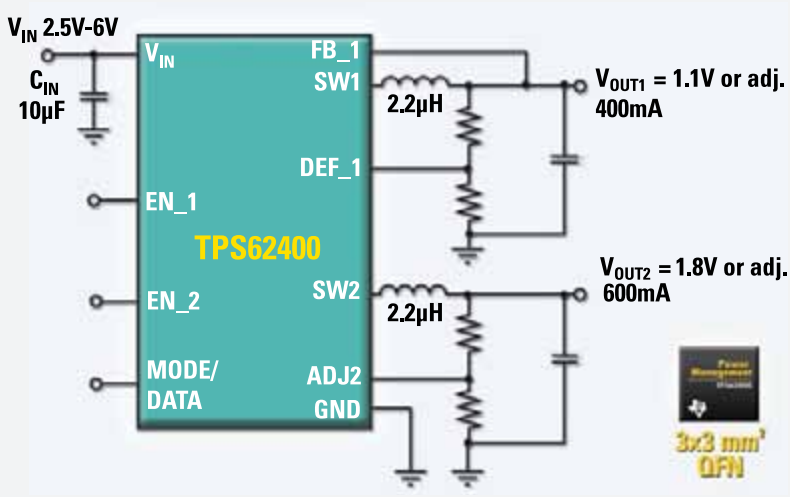
Maxwell Receives Largest-Ever Ultracapacitor Order

Maxwell announced that a leading European producer of wind energy systems has placed a purchase order for 3 million BOOSTCAP BCAP0350 E "D cell" ultracapacitors to provide backup power for wind turbine blade pitch systems.
Alain Riedo, senior vice president and general manager of Maxwell's Swiss subsidiary, Maxwell Technologies SA, noted that the order, which is expected to be drawn down over two years, is for double the quantity of the company's previous largest D cell order, a 1.5 million-cell order for a wind energy application in February 2006.
The ultracapacitors are used for backup energy storage and power delivery in wind turbines ranging in output up to 2.5 MW. Each of the turbines' three blades has an independent braking and pitch adjustment mechanism incorporating a bank of from 200 to 700 BOOSTCAP cells for backup power to ensure continuous operation in the event of a power failure.
"Strong global demand for wind energy systems is driving increased demand for ultracapacitors, and we are pleased that one of the world's largest and most innovative wind turbine producers has selected our BOOSTCAP products to enhance the performance and reliability of their systems," Riedo said.
Industry sources reported that approximately 11,400 MW of new wind energy generation capacity was installed in 2005, an increase of more than 40 percent from 2004. The worldwide installed base now stands at approximately 60,000 MW, and industry sources estimate the value of the wind energy market is expected to exceed $130 billion over the next five years. Riedo noted that MW class installations are expected to account for an increasing share of new capacity, and said that ultracapacitors' high reliability, robustness and long operating lifetime have now been proven in daily operation over the last three years in wind farms around the world.

www.maxwell.com

POWER MANAGEMENT

Dual Buck Converter with 1-Wire Interface



EasyScale™ Interface Enables Digital Control

The **TPS62400** synchronous, step-down switcher with integrated FET features a unique, one-pin EasyScale serial interface, which adjusts the output voltage dynamically during operation. The patent-pending feature gives the dual-channel TPS62400 complete, on-the-fly digital control when powering TI's TMS320C5000™ DSPs and OMAP™ processors for portable applications.

Additional Portable Power Solutions

Device	Topology	I_{OUT} (mA)	V_{IN} (V)	V_{OUT} Adjustable (V)	Switching Frequency (kHz) (typ)	Package	Price (1k)
TPS63000	Buck/Boost	1200	1.8 to 5.5	1.2 to 5.5	1500	10-pin SON	$2.75
TPS62350	Buck	800	2.7 to 6.0	0.75 to 1.537	3000	12-pin WCSP	$2.15
TPS717xx	LDO	150	2.5 to 6.5	0.9 to 6.2	—	5-pin SC70	$0.45
TPS799xx	LDO	200	2.7 to 6.5	1.2 to 6.5	—	5-pin WCSP	$0.35

▸Applications

- Processor core and I/O rail supply
- OMAP processor and low-power DSP supply
- Mobile phones, smartphones, PDAs
- Portable media players
- WLAN

▸Features

- EasyScale interface (1 pin)
- Dynamic voltage scaling, step size 25, 50 or 100mV
- Up to 95% efficiency (max)
- 2.25MHz fixed frequency
- Quiescent current: 32µA (typ)
- Input voltage: 2.5V to 6V
- Output voltage: 0.6V to 6.0V
- Output currents
  - TPS62400: 400mA/600mA
  - TPS62420: 600mA/1000mA
- Pricing:
  - TPS62400: $2.70 in 1k units
  - TPS62420: $2.95 in 1k units

Evaluation Module Now Available

www.ti.com/portablepower-e ○ +44 (0) 1604 66 33 99

Technology for Innovators™

Texas Instruments

Soft-starters with SEMiSTART modules boast six times less volume

SEMiSTART, the anti-parallel uninsulated thyristor module that was designed specifically for use in soft-start devices, boasts one main advantage: compact dimensions. A 400 kW soft-starter featuring SEMiSTART has just one sixth of the volume of the same device with conventional capsule thyristors. Plus, due to pressure contact technology and double-sided chip cooling, these new modules can withstand overload currents of up to 3000 A for a 20 s duration of overload.

SEMiSTART, the anti-parallel thyristor module (W1C switch) from Semikron, was designed specifically for overload conditions and comes in three different module sizes and a total of 5 different current classes. The smallest module sizes are for overload currents of up to 560 A, while the largest can withstand up to 3000 A with an overload duration (during start-up phase) of 20 seconds; the maximum blocking voltages are 1400 V and 1800 V.

Unlike in conventional designs with capsule thyristors, in SEMiSTART modules the thyristor chips are directly pressed between two heat sinks using pressure contact technology. This allows for highly compact designs and robust and reliable systems with optimized chip cooling. What's more, the heat sinks double as electrical connectors. With the use of SEMiSTART modules soft-starters can be more compact. The result: systems with a much better cost-to-benefit ratio.

The much lower thermal resistance Rth(j-s) in these modules is achieved due to the fact that the thyristor chips are pressured directly between the heat sinks. The new modules have fewer contact layers overall, meaning that they have less thermal contact resistance than conventional solutions - for instance, the thermal contact resistance between the flat thyristor case and heat sinks in conventional solutions. The total thermal contact resistance in these modules is more than half that of insulated semiconductor modules with similar sized thyristor chips because there is no electrical insulation that can hinder heat dissipation from the chip to the heat sinks.
SEMiSTART modules are also easily mounted as no mounting clamps are needed as is the case for capsule thyristors and no thermal paste as in semiconductor modules.
This new product family is compliant with the provisions of the EU Directives RoHS and WEEE.

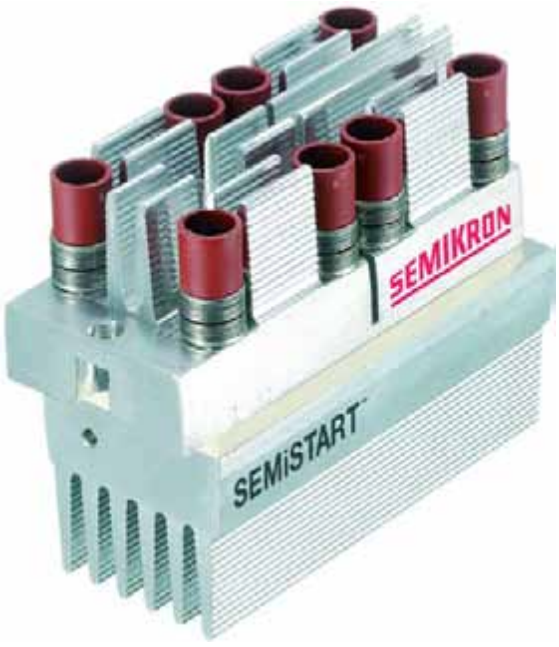


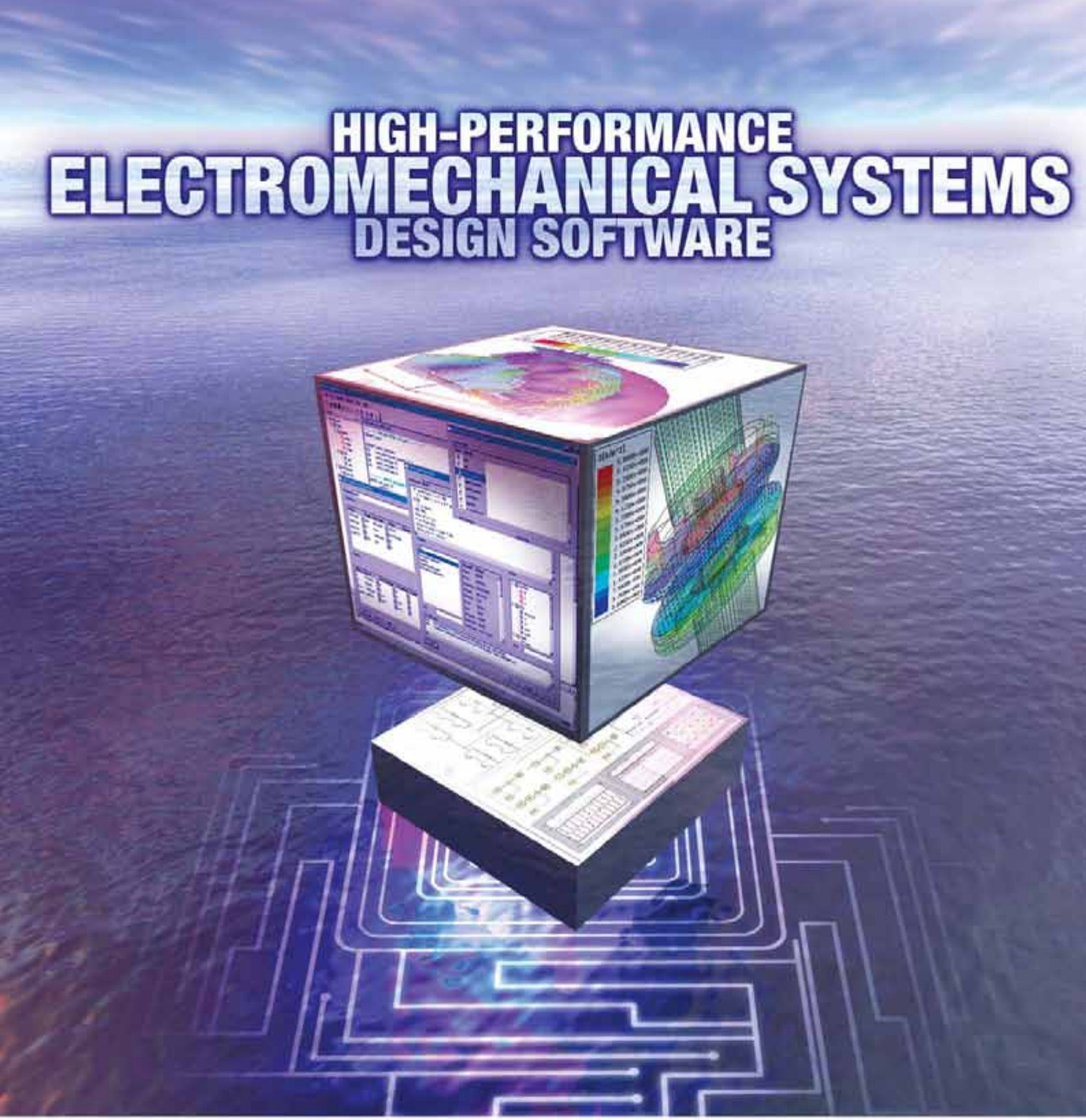
Figure 1. SEMiSTART, Anti-parallel thyristor module for soft-starters

Founded in 1951, German-based Semikron is a family enterprise that employs 2,500 people worldwide. Semikron comprises of a global network of 45 companies that guarantees a fast and competent on-site customer care. According to a study carried out by IMS, a leading Market Research Institute, Semikron is the market leader in the field of Diode/Thyristor modules, enjoying a 27% share of the worldwide market.

Semikron's product range consists of 21000 different power semiconductors including chips, discrete diodes/thyristors, power modules (IGBT / MOSFET / diode / thyristor), driver and protection components and integrated subsystems. "Semikron inside" has become a trade mark for industrial applications such as electric drives, wind power generators, solar, electric vehicles, welding machines, lifts, power supplies, conveyor belts and trams. As a significant innovator in the power electronics sector, many of Semikron's progressive developments have been accepted as industrial standards. The expertise of the Solution Centres from each continent are combined into a unique network, to develop and manufacture subsystems designed for specific applications and requirements.

www.semikron.com

HIGH-PERFORMANCE ELECTROMECHANICAL SYSTEMS DESIGN SOFTWARE



MAXWELL®
3D electromagnetic-field simulation and parameter extraction for component design and optimization

SIMPLORER®
System/circuit simulation and statistical analysis for multi-domain, mixed-technology design

ePHYSICS™
Thermal and stress analysis for electromechanical components

OPTIMETRICS™
Parametric, optimization, sensitivity analysis

ANSOFT
ANSOFT.COM

UK / EUROPEAN HEADQUARTERS
TEL: +44 (0) 1256 347788
EMAIL: uksales@ansoft.com

COPENHAGEN, DENMARK
TEL: +45 32 88 22 90
EMAIL: nordic@ansoft.com

MUNICH, GERMANY
TEL: +49 89 68 086 240
EMAIL: info_de@ansoft.com

PARIS, FRANCE
TEL: +33 01 39 56 67 99
EMAIL: info@ansoft.com

ROME, ITALY
TEL: +39 06 591 6845
EMAIL: italy@ansoft.com

Power Semiconductors in 2007:
Demand stays higher than Supply!

By Arunjai Mittal, Senior Vice President and General Manager, Power Management and Drives Infineon

Global economy is estimated to have grown by over 3% in 2006 & predictions for 2007 are also one of growth.

Between 1850 and 1970, world population grew by a factor of 3. However, per capita use of industrial energy increased by about 20 times! By the year 2000, consumption had grown by another 30%, driven to a great extent by the rapidly developing economies of the BRIC (Brazil, Russia, India and China) nations. Added to that, the use of energy globally puts enormous pressure on the availability and cost of energy.

About 30% of the energy consumed by us is utilized in the form of Electricity. About 60% of this electricity follows through Motors, Lighting applications & Power supplies. Replacing electromechanical/conventional systems with Power Electronic based systems increases the overall efficiency and holds the promise of saving enormous amounts of power, lost normally in the form of heat. By using power semiconductors, we can make the problem a lot less serious in the near term. And demand for Power Semiconductors therefore has reached record levels.

Classical applications

Most of the electric power is consumed by electric Motors. By utilizing Variable Speed Drive (VSD) techniques, it is possible to use this energy in a more efficient manner. This starts to now happen at a much faster rate than before. In Europe alone the penetration of VSD in AC Motor drive applications went up from 10% in 1996 to nearly 30% in 2004. Added to that, the desire & ability of developing nations to leap frog the technology curve & utilize/install latest technologies considering the total-cost-of-ownership, also drives the proliferation of these new technologies further.

With IGBTs optimized for lowest saturation voltage (VCEsat) and for switching losses, it is possible today to reduce the total losses in an inverter significantly. Operating them at Tjmax. of 175°C, combined with their higher temperature stability, means not only lower losses, but also higher system reliability. Innovative packaging concepts like the PressFITTM module technology, lead to simplification in the mounting techniques. Standard PCBs can be used and scaleable contact current leads to higher current density possibilities, all while being suitable for logic interfaces as well. And finally, robust gate drive ICs based on Coreless Transformer technology can easily be combined with innovative functions such as active Miller clamping, two-level turn-off or rail-to-rail outputs in one Integrated Circuit (2ED020I12-F), helping design engineers to meet their targets in terms of system cost, reliability, and time-to-market.

About 15% of the electrical energy is used for Lighting applications. Most of the loss is generated at the filament! But with the advent of fluorescent lamps & until recently LEDs, the focus shifts to the system as a whole for efficiency improvements. Price-performance ratio at system level is KEY. With Digital power management techniques (like those incorporated in the FL controller, it is now possible, not just to extend the life time of Fluorescent lamps, but also to detect end-of-life. All while offering the same or even higher amount of luminous intensity thro' the life time of the lamp for given power consumption.

It is estimated that about 6% of electricity in the USA flows thro' Power Supplies of all sorts. Assuming average power of 1200W per Server, estimations show that by simply increasing the efficiency by 1% for the next 30 million servers to be produced in the coming 4-5 years, it is possible to save up to 360MWatts of power (approximately one Hydro electric power plant). This is today possible by use of CoolMOSTM/Super junction MOSFET technology in conjunction with thinQTM / SiC based components. The introduction of the 80 PLUS regulation will surely help in accelerating the use of higher efficient power supplies in computers.

Emerging applications

In addition to the standard applications of motor drives, lighting & power supplies, new applications are adding demand to power semiconductor capacities.

Although inverters have been used for quite some time in Microwave ovens, it now offers economic gain, in addition to efficiency gains. With the increasing price of Cu, it is today cheaper to replace the "old" transformer based high voltage excitation circuitry, necessary to trigger the Magnetron, by a much smaller inverter based circuit working at several tens of kilohertz. Utilizing soft switching technique with low electromagnetic interference (EMI) and automatic Power factor correction (PFC), leads to lower System cost.

Last but not least, the Hybrid Electric Vehicle is also an application which intends to help reduce the consumption of fossil fuel. Estimations range from anywhere between 4% and 10% of new cars made by 2015, will be HEVs. Considering that about a €100 to €300 of additional Power Semiconductors are used in this application, the growth in the Power Semiconductors market is anticipated well beyond 2010.

Summary:

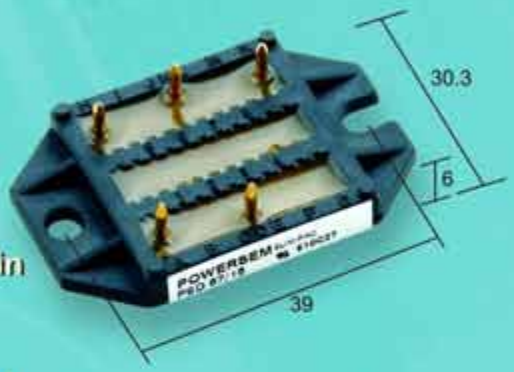
Demand for Power Semiconductors is expected to remain high in 2007, with a positive outlook beyond! With raw material prices on the rise (Cu, Si raw wafer), it is only going to get more challenging, before it becomes easier! Infineon maintains the number ONE position in the field of Power Semiconductors (as reported by IMS in their September 2006 report) and continues to invest not only in innovative new technologies such as for Insulated Gate Bipolar Transistors (IGBTs with Trench FieldStopTM technology), Super junction based High Voltage MOSFETs, Trench based Low Voltage MOSFETs (OptiMOSTM 3) and Silicon Carbide based components (thinQTM); but also in capacity build up. With start of production at our newly built 8" power technologies dedicated wafer fabrication facility in Kulim, Malaysia, we are well under way to fulfilling the demands of our customers, be it for the classical Industrial business or for the emerging high volume applications.

Once again, we thank our customers and wish you all a very happy & prosperous new year 2007.

www.infineon.com

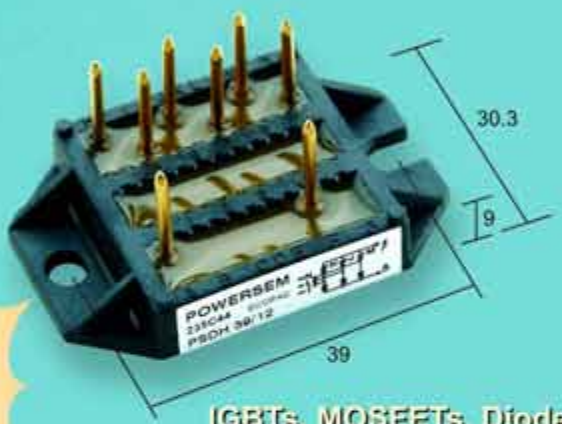
POWERSEM

Lowest Profile Package for Power Modules with Highest Performance and Widest Choice of Customized Circuit Configurations



Rectifier Bridges in **SLIM-PAC™**

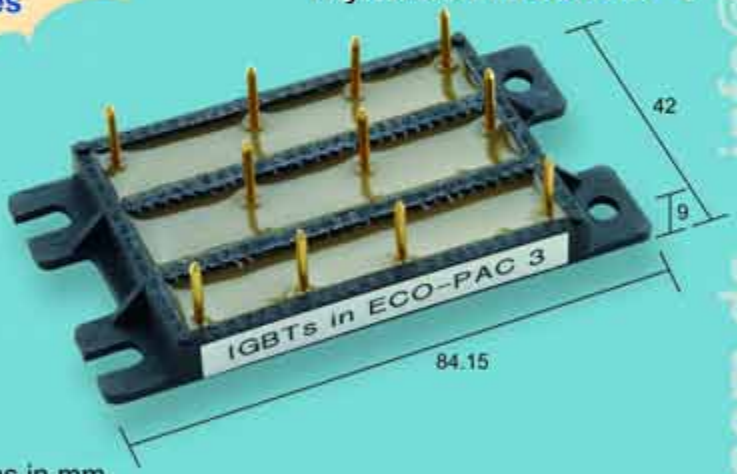
AC Controllers, Diodes, Thyristors, IGBTs in ECO-PAC™ 1



Two different pin heights are available with all ECO-LINE™ - Modules

IGBTs, MOSFETs, Diodes, Thyristors in ECO-PAC™ 2

IGBTs, MOSFETs, Diodes, Thyristors in ECO-PAC™ 3



all dimensions in mm

- Customized choice of Circuit Configurations
- High - Tech Integrations of Diode, Thyristor, IGBT and MOSFET Chips
- One Package Concept for Current Ranges from 29 A - 200 A and Blocking Voltages from 600 V - 1800 V
- Two different pin heights are available with all ECO-LINE™ - Modules

Visit us at :

PCIM China 2007 March, 21-23, Shanghai

Powersem GmbH, Headquarters
Walpersdorfer Str. 53
D-91126 Schwabach, Germany
Ph : + 49(0) 9122-9764-0 Fax : 49(0) 9122-9764-20

www.powersem.de info@powersem.de

ECO-LINE™

innovation and reliability with DCB Technology

THE LENNOX REPORT

ELECTRONIC COMPONENTS INDUSTRY

GENERAL

A survey by Transparency International of corruption perception rates Finland as "highly clean" with a 9.6 score out of 10 with other European countries ranking among the top 20 including Denmark, Sweden, Switzerland, Norway, Netherlands, Austria, Luxemburg, UK, Germany, France, Ireland and Belgium, in that order.

With much attention focused on China growth in India tends to be overlooked such as its automotive electronics industry worth $ 1.6 B last year and forecast by iSuppli to increase at a CAGR of 21.8% to nearly $ 5 B by 2010. Safety, control and power train systems are expected to account for over two-thirds of the market. Favorite for technology outsourcing due among others to English language capabilities India has fallen behind industrially due to a lack of infrastructure, excessive bureaucracy and shortage of highly qualified engineers though graduating 400 000 each year. In 2007 the EU will enter negotiations with India to facilitate commercial relations.

SEMICONDUCTORS

SICAS semiconductor fab capacity and utilization statistics for the third quarter of 2006 showed a decline in utilization from the previous quarter's 91.4% to 88.9% with ICs down from 91.2% to 88.6% and Discretes flat at 94.2%. MOS utilization declined from 91.8% to 89.1% while Bipolar dropped to 77.4% from 79.2%.

The ZVEI reports October semiconductor sales in Germany (in Euros) down 3% compared to prior year after –10% in September and –8% in August. Thus the first ten months showed a decrease of 3%, a decline also estimated for the entire year 2006 to result in a € 11.3 B market made up of about 35% information technology, 29% automotive, 20% telecom, 12% industrial and 3% consumer. By product group ICs should account for about 80%, discretes and optos 15% and sensors 5%.

National Semiconductor is attempting to broadening licensing of its with ARM developed Powerwise power management technology after Samsung took a license. Goal is to establish a standard. The firm's dedicated regulators are seen a key in LED semiconductor technology. The firm's European VP John Phelps bets on analog as presenting the optional trade-offs between power dissipation, I/O impedance, analog speed, noise linearity, gain, supply voltage and voltage swing.

NXP's executive VP Marc de Jong is quoted as saying that the new owners are committed to a seven-year plan involving acquisitions and partnerships including in set-top box chipsets, mobile phone silicon and automotive electronics. Goal is to increase the segments, now 60% of total, where NXP is number one or two, so its CEO Frans van Houten.

Infineon reported fiscal year ended September 30, 2006 revenue of € 7.9 B, +17% while the automotive and industrial business gained 13% and communications declined 13%.

Texas Instruments, which sees slower growth in mobile semiconductors, has introduced a single-chip with processors for multiple functions called "eCosto" aimed at low-cost phones in markets like China and India.

Toshiba's first half net profits more than doubled to ¥ 38.8 B on higher revenues of ¥ 3162 B in part due to semiconductors. The firm will sell its 40.4% stake in wafer fab Toshiba Ceramic to a management buyout backed by private equity groups, sees increased profits (+22%) over its earlier annual forecast and is optimistic for DVD sales with ICs accounting for 54% of material costs, so iSuppli.

PASSIVE COMPONENTS

According to the China Electronic Components Association (CECA) Mainland China film capacitor output was $ 380 M, or 12.6 B units in 2004 forecast to increase to 16.8 B units this year fueled mostly by power supplies, lighting systems and industrial equipment. There are about 100 producers versus only twenty in Taiwan who however have been focusing on high-end applications such as automotive, so Paumanok.

Japan's production declined 18% in 2004 to 3.08 B units with em-phasis now on miniaturization to recapture market share.

CONNECTORS

The connector technology "roadmap" has benefited from global standards freeing up customer development time and creating innovation driven by density, cost and speed, so 3M's Adrian Hyner with fiber optics gaining as copper cannot support anticipated higher speeds though USB and Ethernet are likely to extend the life of copper connections. But WiFi and WiMAX will continue to replace connectors and cables in PC/LAN and handset applications.

AUTOMATION COMPONENTS

A study by the Automated Imaging Association revealed that in North America smart cameras experienced the strongest growth in 2005 with +19.1% in units and +14.4% in revenue while application-specific machine vision systems rose 13.6% and 6.4% respectively.

Carlo Gavazzi increased half year ended September 30, 2006 revenue 4.6% to SFr. 107 M with Automation Components up 9% to SFr. 87.8 M compared to an estimated 4% market growth. Production of automation components in Denmark was transferred to Malta and Lithuania for cost-reduction.

OTHER COMPONENTS

MEMS technology is increasingly employed in electroacoutics due to improved voice quality in microphones. It accounted for 5% of the roughly $ 120 M microphone market last year expected to grow to $ 680 M by 2010, so The International Networks, with MEMS accounting for an increased share. France's Cabasse, recently bought by Canon, and the USA's Akustica are examples of small voice specialists. Given the price competition in the car industry no wonder that suppliers are restructuring such as Valeo to sell its electric motor business, a possible acquisition of Bankrupt Delphi by an investment group and personnel reduction by Bosch including in its Mondeville, France, plant.

CONCEPT

Wir sind ein 20 Jahre junges, international erfolgreiches High-tech Unternehmen im Bereich Leistungselektronik und Gewinner mehrerer Technologiepreise. Im Bereich IGBT-Treiber sind wir Technologie- und Marktleader und definieren die wegweisenden Standards von heute und morgen.

Im Rahmen unserer Expansionsstrategie suchen wir für unseren Standort Biel-Schweiz:

Entwicklungsingenieur / Projektleiter Entwicklung IGBT-Treiber

Anforderungen
- Abgeschlossenes Studium der Elektrotechnik
- Fundierte theoretische Kenntnisse und praktische Erfahrungen mit IGBTs, IGBT-Treibern und deren Anwendungen
- Mehrjährige Berufserfahrung auf dem Gebiet der Leistungselektronik
- Ausgezeichnete Kenntnisse der deutschen und englischen Sprache in Wort und Schrift

Zu Ihrem primären Aufgabenbereich gehört
- Erarbeitung von Analysen und Konzepten für neue Produkte
- Durchführen und koordinieren von Entwicklungsarbeiten
- Ausarbeiten von Lastenheften und technischer Dokumentation

Sie unterstützen im Rahmen von Pre-/Aftersales Aktivitäten
- Technische Unterstützung der Marketingabteilung
- Erarbeitung/Mitarbeit von technischen Produktpräsentationen

Wir bieten Ihnen
- eine ausbaufähige Position mit attraktiven Anstellungsbedingungen
- einen angenehmen Arbeitsplatz mit einer Top-Infrastruktur
- die Möglichkeit zur Entfaltung Ihrer Kreativität in einem Top-Team

Fühlen Sie sich angesprochen? Wir freuen uns auf Ihre Bewerbung!
Unser Herr H. Rüedi steht Ihnen gerne telefonisch oder per Mail unter Jobs@IGBT-Driver.com für weitere Auskünfte zur Verfügung.

CT-Concept Technologie AG
Renferstrasse 15, 2504 Biel - Schweiz
Telefon +41 - 32 344 47 47
www.IGBT-Driver.com

CONCEPT

Wir sind ein 20 Jahre junges, international erfolgreiches High-tech Unternehmen im Bereich Leistungselektronik und Gewinner mehrerer Technologiepreise. Im Bereich IGBT-Treiber sind wir Technologie- und Marktleader und definieren die wegweisenden Standards von heute und morgen. Im Rahmen unserer Expansionsstrategie suchen wir für unseren Standort Biel-Schweiz:

Support- /Applikationsingenieur

Anforderungen
- Abgeschlossenes Studium der Elektrotechnik
- Fundierte theoretische Kenntnisse und praktische Erfahrungen mit IGBTs, IGBT-Treibern und deren Anwendungen
- Mehrjährige Berufserfahrung auf dem Gebiet der Leistungselektronik
- Ausgezeichnete Kenntnisse der deutschen und englischen Sprache in Wort und Schrift

Zu Ihrem primären Aufgabenbereich gehört
- Technische Unterstützung unserer Distributionspartner und Kunden
- Adaptierung bestehender Basisprodukte an neue Anforderungen
- Ausarbeitung von Applikationsvorschlägen und praktische Verifikation
- Dimensionierung von Leistungsteilen
- Analysen und Erarbeitung von Problemlösungsvorschlägen
- Ausarbeiten von technischer Dokumentation

Sie unterstützen im Rahmen von Pre-/Aftersales Aktivitäten
- Technische Unterstützung der Marketingabteilung
- Erarbeitung/Mitarbeit von technischen Produktpräsentationen
- Kundenbesuche, Verkaufsförderungs- und Messeaktivitäten

Wir bieten Ihnen
- eine ausbaufähige Position mit attraktiven Anstellungsbedingungen
- einen angenehmen Arbeitsplatz mit einer Top-Infrastruktur
- die Möglichkeit zur Entfaltung Ihrer Kreativität in einem Top-Team

Fühlen Sie sich angesprochen? Wir freuen uns auf Ihre Bewerbung!
Unser Herr H. Rüedi steht Ihnen gerne telefonisch oder per Mail unter Jobs@IGBT-Driver.com für weitere Auskünfte zur Verfügung.

CT-Concept Technologie AG
Renferstrasse 15, 2504 Biel - Schweiz
Telefon +41 - 32 344 47 47
www.IGBT-Driver.com

CONCEPT

Wir sind ein 20 Jahre junges, international erfolgreiches High-tech Unternehmen im Bereich Leistungselektronik und Gewinner mehrerer Technologiepreise. Im Bereich IGBT-Treiber sind wir Technologie- und Marktleader und definieren die wegweisenden Standards von heute und morgen.

Im Rahmen unserer Expansionsstrategie suchen wir für unseren Standort Biel-Schweiz:

Entwicklungsingenieur Analog / Smart-Power ASIC Design

Anforderungen
- Abgeschlossenes Studium der Elektrotechnik oder Physik und 3-4 Jahre relevante Berufserfahrung (Industrie oder universitäre Forschung)
- Fundierte theoretische Kenntnisse und experimentelle Erfahrung in analog oder mixed-signal full-custom ASIC-Design, insbesondere Design von Smart-Power Funktionen, idealerweise auch IGBT- oder Mosfet-Treiber
- Kenntnisse in mixed-signal und mixed-language Schaltungssimulation
- Ausgezeichnete Problemlösungs- und Kommunikationsfähigkeiten
- Ausgezeichnete Kenntnisse der deutschen und englischen Sprache in Wort und Schrift

Zu Ihrem primären Aufgabenbereich gehört
- Identifikation, Entwicklung und Verifikation neuer Konzepte zur Integration von Smart-Power Funktionen zur Ansteuerung von IGBTs und Leistungs-MOSFETs
- Entwicklung von Smart-Power ASICs von der Definition bis zur Serienreife
- Ausarbeiten von Lastenheften und technischer Dokumentation

Wir bieten Ihnen
- eine ausbaufähige Position mit attraktiven Anstellungsbedingungen
- einen angenehmen Arbeitsplatz mit einer Top-Infrastruktur
- die Möglichkeit zur Entfaltung Ihrer Kreativität in einem Top-Team

Fühlen Sie sich angesprochen? Wir freuen uns auf Ihre Bewerbung!
Unser Herr H. Rüedi steht Ihnen gerne telefonisch oder per Mail unter Jobs@IGBT-Driver.com für weitere Auskünfte zur Verfügung.

CT-Concept Technologie AG
Renferstrasse 15, 2504 Biel - Schweiz
Telefon +41 - 32 344 47 47
www.IGBT-Driver.com

CONCEPT

Wir sind ein 20 Jahre junges, international erfolgreiches High-tech Unternehmen im Bereich Leistungselektronik und Gewinner mehrerer Technologiepreise. Im Bereich IGBT-Treiber sind wir Technologie- und Marktleader und definieren die wegweisenden Standards von heute und morgen.

Im Rahmen unserer Expansionsstrategie suchen wir für unseren Standort Biel-Schweiz:

Entwicklungsingenieur Testsysteme für ASIC-Tester und/oder LabView

Um die hohe Qualität unserer Produkte gewährleisten zu können, testen wir alle ASICs und Endprodukte auf modernsten Testsystemen. Die Testadaptionen und Testprogramme entwickeln wir bei uns im Haus.

Anforderungen
- Abgeschlossenes Studium der Elektrotechnik
- Fundierte theoretische Kenntnisse und praktische Erfahrungen mit Entwicklung von Testkonzepten, Testadaptern und Software für Testsysteme
- Erfahrungen mit ASIC-Testsystemen und/oder LabView
- Eventuell Erfahrung mit Reinhardt-Multifunktionstestern
- Ausgezeichnete Kenntnisse der deutschen und englischen Sprache in Wort und Schrift

Zu Ihrem primären Aufgabenbereich gehört
- Erarbeitung von Analysen und Konzepten für neue Testprojekte
- Durchführen und koordinieren von Entwicklungsarbeiten ggf. im Team
- Ausarbeiten von Lastenheften und technischer Dokumentation

Wir bieten Ihnen
- eine ausbaufähige Position mit attraktiven Anstellungsbedingungen
- einen angenehmen Arbeitsplatz mit einer Top-Infrastruktur
- die Möglichkeit zur Entfaltung Ihrer Kreativität in einem Top-Team

Fühlen Sie sich angesprochen? Wir freuen uns auf Ihre Bewerbung!
Unser Herr H. Rüedi steht Ihnen gerne telefonisch oder per Mail unter Jobs@IGBT-Driver.com für weitere Auskünfte zur Verfügung.

CT-Concept Technologie AG
Renferstrasse 15, 2504 Biel - Schweiz
Telefon +41 - 32 344 47 47
www.IGBT-Driver.com

Ultra-Low Power Defines the "New Portable" Market

Standby power consumption of a few micro-amps

Most ULP devices include battery back-up, with battery life of >5 years with no replacement or charging. Frequency bands include 300MHz to 6.6GHz, with most emerging markets and applications targeting the 2.4GHz and 5.8GHz Industrial, Scientific and Medical (ISM) bands.

By Linnea Brush, Senior Research Analyst, Darnell Group

The ultra-low-power (ULP) wireless component market is still considered "emerging" by the predominantly wired industrial, commercial and residential automation industries. The recent proliferation of consumer, computer and communications equipment has brought data communications into these arenas, where devices can now "talk" to each other and perform intelligent functions without manual instructions. Although most of these communications protocols are still based on wired standards and technologies, the opportunity for remote, wireless communications is becoming increasingly attractive.

Darnell Group defines ultra-low power as <50mA for a wireless communications device, such as a radio IC, transceiver IC, and so on. It depends on the application, however. One company said that the definition of ULP "depends on how you do the comparison. For a microprocessor running at full speed, 10mA may be low power. I would claim ultra-low power at less than 2 or 3mA. On the other hand, the processor should have a standby power consumption of not more than a couple of micro-amps. This is where most processors have problems claiming low power. They eat up their batteries while they are in standby doing nothing."

Most ULP devices include battery back-up, with battery life of >5 years with no replacement or charging. Frequency bands include 300MHz to 6.6GHz, with most emerging markets and applications targeting the 2.4GHz and 5.8GHz Industrial, Scientific and Medical (ISM) bands. Distance range includes <10 meters to >100 meters. Ultra-low power, extended battery life and miniaturization are critical in the <10 meter range.

The applications that utilize ULP devices frequently employ an architecture known as "sensor networks." These include transmission and receiving ends, often with multiple "nodes." Some new systems are employing an alternative powering solution caled "energy harvesting," wich uses light, vibration, thermal gradients, pressure differential, motion and piezoelectric to produce energ. Darnell defines the following classes of applications:

Remote/Sensors – Sensors are installed and information is transmitted to a receiving end, where ac power exists. No energy harvesting occurs at this receiving end, but it may be used on the transmitting end.

Remote/Energy Harvesting – Energy harvesting is at a point of transmission, such as a device where a button is pushed on a switch that sends power to the device being monitored or operated.

Mesh Networks (also known as "reconfigurable" networks) – Nodes are at either end (as described above), as well as nodes in the middle.

ULP wireless technologies are primarily employed in "stationary" applications, such as industrial process monitoring and control, building automation, security, fire safety, structural monitoring, and so on. While the applications are stationary, the power needs closely mirror the needs of portable devices such as mobile phone handsets and MP3 players. As a result, emerging ULP applications are expected to provide substantial growth opportunities for power management technologies traditionally associated with portable devices. In addition, ULP devices are often used in "critical" applications that will provide opportunities for greater value-added compared with many of today's portable devices. The worldwide ULP market is projected to reach over 200 million units by 2010.

Mobile phones, laptops, digital cameras, and so on are huge markets. Unfortunately, they are also mature markets. ULP stationary applications could be the "new portable." What ties these markets together in a portable fashion is the increasing use of wireless networks. As noted above, sensor mesh networks have transmitting and receiving ends, often with multiple nodes in the middle. A single device can be monitored and controlled, like lighting in a house. More complex systems can include temperature and humidity monitoring in harsh, industrial environments. Since wiring is often costly or impractical, wireless solutions are gaining popularity, although such technologies still have robustness and security problems.

There are three areas of portable overlap: technical requirements, applications, and business models. The degree of overlap defines a market that is: (1) established enough to be real; (2) emerging enough to have potential growth; and (3) broad enough to provide numerous opportunities.

The powering that ties this market together is ULP wireless components and ICs. In many ways, this market is in the same place digital power management and control was three years ago. There is a lot of overlap between the technical requirements of ULP and portable power. The obvious overlap is that the applications for both use low power, usually with batteries. Both have wired and wireless implementations, but the market is in wireless applications. Both rely on standards and protocols that vary by region. And both have to establish range and data rates. The degree of overlap is enough to make market entry relatively painless for portable

power component and IC makers. It produces more competition and less room for differentiation, however.

The area where there is the least amount of overlap is applications. The mobile phone market and the industrial control market are very different. This provides more opportunities for companies to differentiate themselves and find niches for their products. That is already happening with the home automation and industrial control markets. For example, the ZigBee™ is a standard is being pushed to the industrial side, while Insteon was developed for residential applications. The number of ULP applications is highly fragmented, and each has its own frequencies (often regionally based), data rates, ranges, power needs, and so on.

The business models for ULP and portable overlap in part, and the opportunities can be found where they don't overlap. For instance, portable applications like laptops are used for business purposes, which in turn produce revenue for a company. This is a second-order revenue benefit. ULP applications have immediate revenue-generating potential in the form of building automation. In medical applications, ULP can have life-saving benefits in the field. Remote security applications don't have the luxury of a "blip" the way a cell phone might.

Skipping wiring altogether saves cost upfront. For example, use of a piezoelectric-based energy harvesting ULP wireless lighting control device in a new warehouse saved $32,000 in construction costs. Wireless silicon is cheaper than copper in large buildings, which makes it highly attractive as a first-order benefit.

Both ULP and portable applications are based on remote communications with a host system, and ICs are used for monitoring various functions. Customers want small form factors and reduced power consumption. Network data security is important. Both focus on high-volume manufacturing. And, like most applications, batteries are a major problem.

The latter point has led to the emerging opportunities in ULP, such as energy harvesting. One microgenerator company even said, "Batteries are holding back wireless sensor network adoption." Like portable, batteries need to deliver long life, but customers don't like the maintenance and replacement problems they present.

The portable power market, as it is traditionally defined, is large and lucrative for many IC companies, component manufacturers, and battery makers. This market has reached saturation, however, and the unique characteristics of portable power solutions need to be positioned elsewhere. ULP could be the "missing link" between portable and stationary applications.

The convenience of wireless capability is balanced by concerns about security and robustness. As a result, ULP is being aimed at small, difficult-to-access applications that can benefit from remote monitoring and control, often over short distances. The challenge is finding niche markets that aren't already being targeted by companies adopting the dominant standards, such as ZigBee™.

Having the best technology does not guarantee success in any market; having the best business model does. This includes having a competitive price and knowing the commercial traction of the existing technology. As a rule, system makers and end users will stick with the cheaper, established, "known" technology – in this case, wired solutions. A compelling business case needs to be made for a wireless solution, regardless of its technical merits.

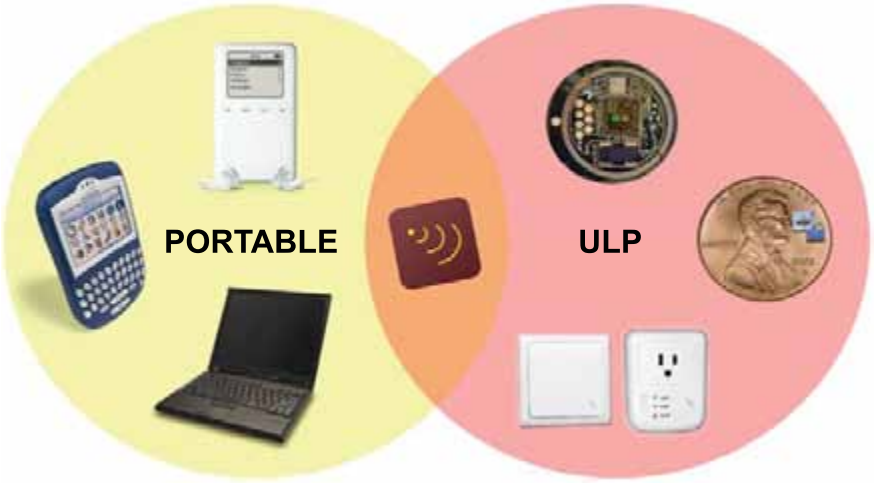


Figure 1: ULP Represents Incremental Opportunities

Interview on Power Module Technology

with Bernhard Eschermann, Senior Vice President, ABB Switzerland Ltd Semiconductors

By Bodo Arlt, Editor BPSD

Bodo Arlt:
What end markets will drive ABB's power module technology?
Bernhard Eschermann:
Clearly, our markets today are driven by an accelerated need for efficient energy usage. Whether for environmental concerns, energy-cost reduction or better process control, the necessary electricity passes more and more through power electronics. Technology has evolved to a point where power control can be performed at tens to hundreds of megawatts, efficiently and cost-effectively, providing solutions to such diverse areas as conversion of renewable energies like wind power, reducing the energy consumption in pumps through industrial drives or meeting mobility needs more efficiently, as in traction, ships or even cars, for which hybrid drive systems are evolving.
A strong common trait in all of these high-power applications is the need for a very high reliability in addition to a high power density/low cost and low losses.

Bodo Arlt: How do you see ABB Semiconductors' market position?
Bernhard Eschermann:
ABB has historically been known for high power and high voltage and is the clear market leader for high power bipolar devices. We are proud to be the world's largest manufacturer of high power thyristors, GTOs and GCTs and we still see a lot of potential in these devices, particularly in the further development GCTs. Thus, unlike some other power semiconductor manufacturers, we continuously invest into our technology position for bipolar devices, besides our investments in BiMOS technology.
In BiMOS, we have a rapidly growing portfolio in the standard HiPak product range. However, ABB is probably better known for pioneering the use of StakPak (press-pack) IGBT technology, which allows the reliable stacking of many IGBTs in series. It is based on years of research in order to achieve uniform pressure on all chips despite heat-sink tolerances, along with the ability to assure redundancy (i.e. failed devices being able to maintain a stable short-circuit). Learning from these experiences, we now also see significant success with our standard HiPak modules, even though ABB was certainly not the first company to enter this market.

BodoArlt:
What are the technologies that can offer innovation for leadership?
Bernhard Eschermann:
In the areas that we are active in, further reducing losses and increasing SOA and power densities is certainly one way to create sustainable advantages for our customers. To this end, for example, we have developed SPT+ IGBT technology. Higher SOA, even if not utilized by design, translates into improved component reliability, because it increases the tolerance against unexpected stress in normal operation. Furthermore, it can compensate for ageing effects, where some long-term behaviour patterns, e.g. of thermal greases, are not yet fully understood scientifically.
A trend that goes hand in hand with this is the ability to handle higher power ratings and higher voltages than before. This development is spearheaded on the bipolar side, where we'll launch higher-power IGCTs this year. In the future we see 6" monolithic HV thyristors and 10 kV IGCT device ratings.

Bodo Arlt: Are these technologies more in silicon, or is it part of packaging technology?
Bernhard Eschermann:
That is a good question, with an obvious answer: It needs both. We have to reduce losses and achieve a higher SOA in the silicon, but we also have to more efficiently transfer heat away from the silicon, through the package and on to the outside world. Thus, I'd actually extend "packaging" even further to the world outside the power module, because with further improvements we have in store for the module itself, the interface between the module and the coolers will become more and more the limiting factor for heat removal in the future.

Bodo Arlt: What makes ABB Switzerland Ltd Semiconductors different from traditional module suppliers?
Bernhard Eschermann:
In one way, we did everything backwards: we always started with the highest powers and voltages, like in high-voltage DC power transmission, and then moved the proven technologies to smaller modules and lower voltages. In our high power domain, just consider traction as an example, customers may expect up to 30 years service life from our devices, frequently in harsh environments. Obviously, using technologies that were already proven for higher power and voltage ratings provides safety margins that help to satisfy those expectations.
Also, as discussed earlier, we continue with our investments in bipolar press-packs in addition to further developing our IGBT packages and thus can offer customers the best of both worlds, providing the best fit for the application in question. Being the biggest GTO manufacturer, we accumulated a vast experience base in traction applications, which we can use to the benefit of our IGBT modules for traction.

Bodo Arlt: What makes ABB Switzerland Ltd Semiconductors different from traditional discrete suppliers?
Bernhard Eschermann:
We deliberately limit our scope to high power/voltage and do not aspire to the mass LV market (though that is clearly the largest market).
This is partly because we belong to ABB, which has a strong need for advanced devices for Energy Management, Transmission and Industrial Control because it is itself a leading manufacturer in these fields. Thus, we've got high-end and demanding in-house customers as well as support from ABB's global corporate

Raychem
CIRCUIT PROTECTION

How to get overvoltage under control

In today's wired universe, sensitive communications equipment can be exposed to devastating electrical hazards. Raychem Circuit Protection overvoltage devices are in use around the world, helping equipment designers and manufacturers meet safety and performance standards and improve the reliability of network and customer premises equipment. Our extensive line of thyristor surge protection devices, gas discharge tubes, MOVs, PESDs, and integrated overcurrent/overvoltage protection devices offer you a wide range of solutions, and the innovation, quality and value you expect from the leader in circuit protection

Please visit **www.circuitprotection.com/order/** to request a copy of our new Circuit Protection Product and Application Catalog.

COMMITTED TO A
GREENER PLANET

Diestsesteenweg 692
3010 Kessel-Lo Belgium
Tel +32 16 351321 Fax +32 16 351319
www.circuitprotection.com

a vital part of your world

tyco Electronics

research organisation to develop innovative solutions. But our leading position in high power semiconductors has made us an attractive supplier to companies world-wide such that today, the clear majority of our sales are outside the ABB group.
This strategy has an interesting side effect: our IGBT chip business is booming because we are an interesting supplier to those who do target these markets.

Bodo Arlt: How much is ABB Semiconductors involved in the end customer's application?
Bernhard Eschermann:
Quite extensively. It is the nature of our power business that our support is solicited by our customers since, as mentioned earlier, many of them expect our devices to operate for decades. To this end we have a large Applications Department involved not only in applications support for individual customers but who qualify our products specifically for a customer´s application.

Bodo Arlt: How much is ABB Switzerland Ltd Semiconductors involved in motion applications using the advantage of IGBTs?
Bernhard Eschermann:
Well, most of our IGBTs wind up controlling a motor. However, we are not involved in Intelligent Power Modules and have no plans to move into this field.

Bodo Arlt: What will be the target to introduce new power module products?
Bernhard Eschermann:
We aim to introduce about 6-8 new modules per year for the next few years. In parallel our research organisation also thinks about technological improvement for future module platforms, and we believe that there are significant opportunities for high-power applications.

Bodo Arlt: What will be the future for modules at high voltage and for driver technology?
Bernhard Eschermann:
We see a big potential for high-voltage modules, e.g. 6.5 kV HiPaks – we just got a major order for a traction application.
Moving to even higher voltages, however, would require a 10 kV module. Knowing the technological challenges for both IGBT module and bipolar solutions, we feel that a 10 kV GCT will be available much earlier than a 10 kV IGBT module. Thus, for those customers interested to tap the market in the range of 6 to 7.2 kV supply voltage with a device that does not need series connection, we expect solutions based on GCT technology to take the lead.

As far as driver technology is concerned, I don't want to make any predictions. We don't produce our own IGBT drivers, since with IGBTs, the gate drive is either generic (and readily available from third parties) or very specific, in which case *how* you control the device is an integral part of the circuit design and is best done by the user. We *do* market gate drives for GCTs and they are factory-fitted to the device tested and shipped as complete IGCTs. This is because the proper interaction of the GCT semiconductor with the driver circuit is essential to ensure performance and reliability of the GCTs, i.e., the design of a suitable GCT driver requires in-depth knowledge of the GCT's physics.

Bodo Arlt: Do you expect to introduce monolithic solutions for power modules?
Bernhard Eschermann:
Our IGBT modules are high power and consist of multiple chips. We do not see any commercially viable development with significantly increased IGBT chip sizes, hence do not expect any monolithic IGBTs at our power levels. We also don't intend to enter the business of integrated power modules.

Bodo Arlt: Do you expect to see high voltage IC technology in the high voltage range?
Bernhard Eschermann:
Well, remember that for us HV may be up to 6.5 or even 10 kV and there will be no HVICs at that level (and no one wants any) but for low power LV modules, I think this will ultimately be generalised.

Bodo Arlt: Who are your competitors, who you believe will stimulate the race for leadership?
Bernhard Eschermann:
Again in our domain, we feel we are the leaders and the main challenges come from our customers requiring lower losses, higher power densities and higher powers, all at high levels of reliability. Clearly Infineon and Mitsubishi have good capabilities but may not be focussing on the same markets.

Bernhard Eschermann is responsible for ABB's power semiconductor business since mid 2006. Before taking over this responsibility, he has been with ABB for 13 years, working on a wide range of assignments. For 5 years he was heading ABB's corporate research in power technologies with operations in Switzerland, Sweden, Finland, Poland, US and China. In addition, he was managing ABB's Corporate Research Center in Switzerland. Other assignments included developing ABB's ultra-high voltage power transmission business in Asia, managing its R&D in power-electronic systems, spearheading software process improvement in ABB's Swiss operations or heading ABB's R&D for high-voltage substation automation and protection.

He is on the board of Hasler foundation, a Swiss non-profit association promoting research in IT and telecommunications. He was a member of the Investment Committee of Venture Incubator AG, a venture fund for early-stage investments. He is also secretary and Swiss representative of IFIP TC 10. During many years he served on industrial advisory boards at ETH Zurich, Carnegie Mellon University, MIT and Electric Power Research Institute (EPRI). In the field of computer systems dependability and electronic design, he served on the program committee of numerous conferences and authored and co-authored around 50 technical publications. He was teaching at EPF Lausanne, University of Siegen and TH Karlsruhe.

Eschermann studied electrical engineering and got a Dipl.-Ing. degree at the TH Karlsruhe, an MSc. degree in electrical engineering and computer sciences from the University of California in Berkeley and a PhD degree in computer science from Karlsruhe. He also completed studies in economics at the University of Hagen.

Bodo Arlt: Are you ready for 2007?
Bernhard Eschermann:
I think in the history of our company, we have never been as ready for the next year as we are for 2007 in terms of being on top of market developments. As we are more than fully loaded with orders, my immediate focus is on capacity expansion with all the investment planning that this demands.

Bodo Arlt: Thank you Bernhard for your time and we look forward to a successful future for power modules.

www.abb.com/semiconductors

Intersil Battery Charger ICs

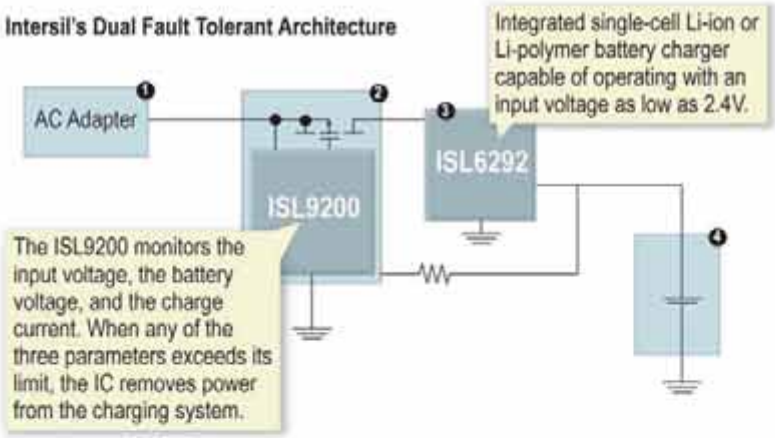
High Performance Analog

The Scariest Thing Inside Your Handheld Should Be Your Pictures

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

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

Intersil's Dual Fault Tolerant Architecture



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

Dual-Fault FMEA (Failure Mode and Effects Analysis)

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

Datasheet and more information available at **www.intersil.com**

Intersil – Switching Regulators for precise power delivery.

intersil®
HIGH PERFORMANCE ANALOG

Integration and Flexibility

The Path toward an Optimum Power Management Architecture

Developers of power management solutions for modern portable devices currently face a variety of challenges. Not only must the designs be smaller, less expensive and more energy-efficient, they must also be highly flexible. A single platform must fit a wide range of end products across different market segments with a few small, rapid modifications.

By Dr. Carsten Oppitz, Texas Instruments

This article highlights three different solution concepts for power management using the example of a portable navigation system, illustrating that all of the concepts have their uses and benefits, depending on the underlying priorities. The strategies can best be described as the full integration concept, the thermally optimized partial integration concept and the layout-optimized discrete concept. The optimum architecture for each individual scenario depends on the general technical, application and commercial framework.

Portable navigation systems, also known as PNAs (personal navigation assistants), is one of the fastest growing segments in the consumer electronics marketplace. These devices meet basic user demands for a sense of direction and navigation. The use of portable navigation systems to deliver local-based services (LBS) is still in the early stages of development. Rapid growth in this segment up to and beyond the year 2010 is therefore to be expected – this is certain to be further driven by the new European commercial system 'Galileo'. Portable navigation functionality can also be transferred to other portable end-user devices, which is why the underlying power management architecture challenges apply to many portable devices.

This article focuses on a typical commercial portable navigation system for the after market. Figure 1 shows a block diagram of a system of this kind.

The system comprises the actual GPS satellite receiver, which supplies its raw data to a processor, which then compares the data with the information of a digital map (usually supplied on a storage card) and shows the results graphically and numerically on a 6 to 12-cm large, illuminated TFT display. A USB interface is usually also provided for data exchange; the interface sometimes also serves as a power source for the rechargeable battery. The control interface generally comprises a touchscreen and some buttons; the power supply is provided by a Lithium-Ion rechargeable battery and a connection to the vehicle's electrical system. The rechargeable battery enables the device to be operated portably for a few hours – for example, for use by pedestrians in locating a destination. Exceptions to this are devices for pure outdoor use – for hillwalkers or cyclists, for example, who have to be able to spend a day outdoors with a single battery charge. Spoken directions for the navigation are emitted through an integrated loudspeaker. Most manufacturers use a single technological platform, which is then adapted by adding appropriate features for the different market segments.

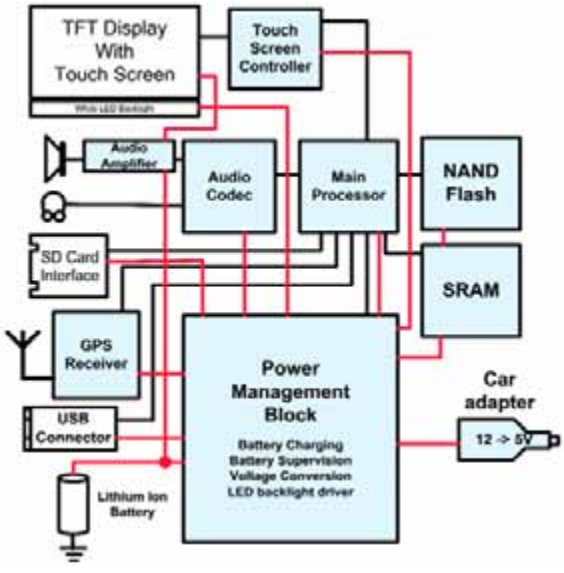


Figure 1: Block diagram of a navigation system (power flow in red)

Requirements for power management

The application scenarios described here essentially dictate the priorities for the design of a power management system. More than just the voltages and currents needed for the different consumers shown in Figure 1 must be provided. In addition, measures must be taken to ensure that the rechargeable battery is securely charged and monitored, the display illumination must be controlled and, since the available space is very limited, the solution must be very compact. The position on the dashboard demands low self-heating since a relatively high ambient temperature must be assumed under direct exposure to summer sunlight. The receiver sensitivity is a particularly important criterion that directly affects the user. The overall system must therefore emit only low levels of radiation in order to avoid internal interference that would reduce the signal-to-noise ratio at the receiver. The architecture of a common platform for different market segments also requires the greatest possible flexibility to support hardware and software adaptations and add-ons.

In summary, the priorities for the power management architecture are as follows:

- Small design size, low number of components
- Low EMI
- Flexible design
- High level of power efficiency, low self-heating

How can these priorities now be implemented in an optimum architecture? In principle, there are three different strategies, each with its own particular focus. These strategies are described in detail using commercially available components, followed by a discussion of their advantages and disadvantages.

Full integration concept

An obvious solution is to integrate all active power management functions into a single chip. Figure 2 illustrates the concept using the TPS65820 from Texas Instruments as an example. This chip not only contains two Buck converters for supplying power to the processor core, the program and flash memories, but also includes the linear regulators for storage card power supply, low noise supply of the satellite receiver and audio codecs. With the integration of the battery charge circuit and step up converter for the display background illumination, all power management functions are covered in one chip.

The TPS65820 has a 7x7 mm QFN housing. Small inductors and capacitors can be used due to the high switching frequency of the

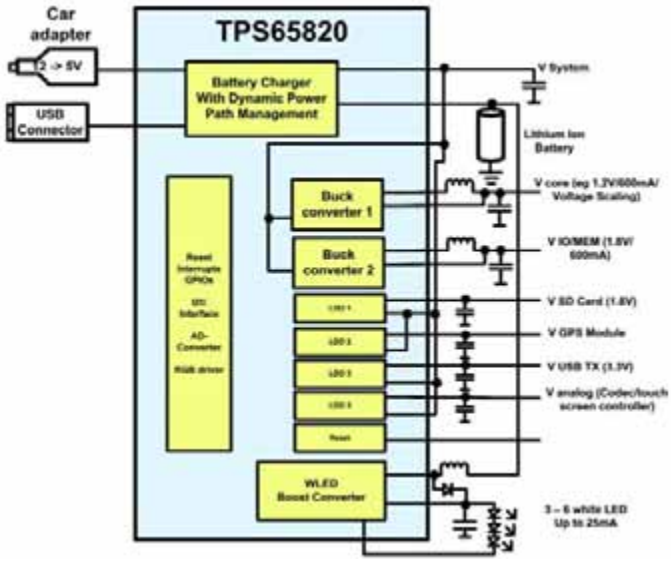


Figure 2: Fully integrated power management using a TPS65820 as an example

converters. Attention was also paid to the maximum height of the chip in the concepts shown here. Consequently, there are no active or passive components higher than 1 mm on the circuit board.

The compact design layout of the entire module is evident. This can be an advantage, but requires an approximately square space on the

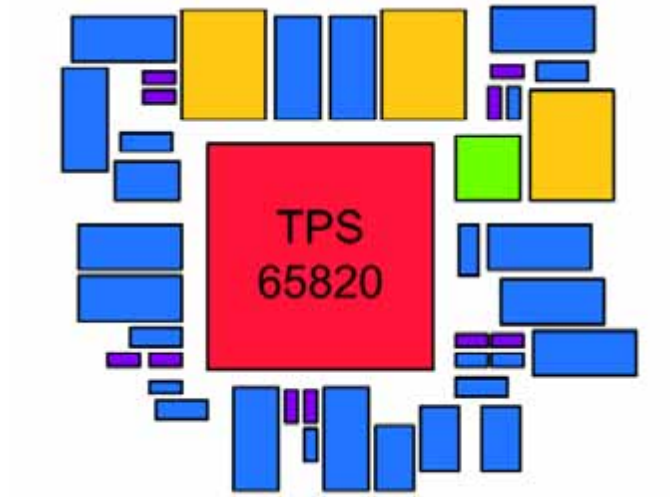


Figure 3: Possible placement of the components in a fully integrated concept (ICs in red, inductors yellow, capacitors blue, resistors brown, diode green). The board area is approximately 170 mm².

circuit board. However, if the layout is very irregular, problems can be encountered in selecting this variant. Another disadvantage of a fully integrated solution is its lack of flexibility. In different market segments, for example, the battery charger can be oversized for the low-end version, or in high-end systems with very large displays the driver circuit can be undersized for the background illumination. The decision to use a fully integrated system can, for example, limit the application to cost-driven, preferably high-volume market segments.

Thermally optimized partial integration concept

This concept is focused more on the need for flexibility. The power supplies that are identical in all models of a platform are combined in a single chip. Figure 4 illustrates this using the TPS65050 from Texas Instruments as an example. It supplies the processor core, the external memory areas, the storage card and the analog areas of satellite receivers and audio codecs.

The white LEDs are supplied with discrete components for the dis-

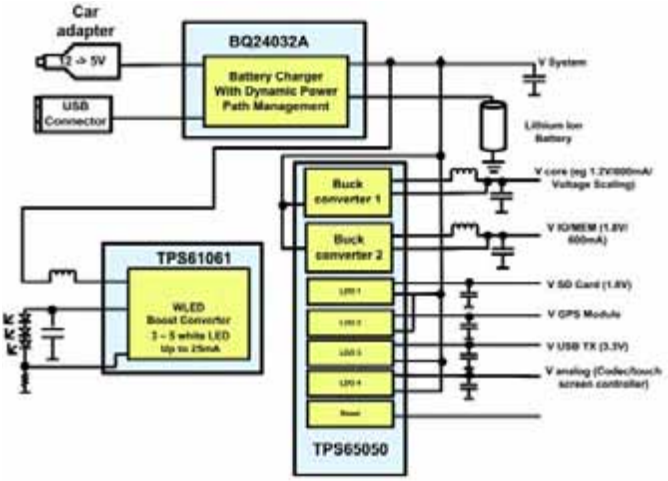


Figure 4: Partial integration of the power supplies close to the processor with the TPS65050, discrete battery charger IC BQ24032A and TPS61061 as discrete driver for white LEDs

play background illumination. This paves the way for diverse display types for different models belonging to the same platform – for example, also displays whose LEDs are not connected in series, but in parallel. In this case, the discrete LED driver TPS61061 would have to be replaced by a charge pump-based solution, like the TPS60230.

The name 'thermally optimized partial integration' is particularly self-explanatory due to the use of a discrete battery charger IC BQ24032A. The charge currents can be up to 1.5 A in large batteries with capacities of greater than 2 Ah. Since the end device must continue to function while a fully discharged battery is being charged with this concept, the operational currents are accumulated with the charging current and lead to considerable power loss in the battery charger IC due to the voltage drop between the external energy source and battery power. The relocation of this function in the described concept to a separate chip with a thermally optimized housing ensures in the event of very large power losses that only the charging current is reduced without incurring a thermal shutdown and without the power losses in the Buck converters and particularly the LDOs causing further heating, which would be the case in the fully integrated solution concept. Moreover, the discrete use of battery charger ICs enables this function to be adapted to different models in the platform. Consequently, models with large and small batteries with and without the option to charge via the USB are conceivable.

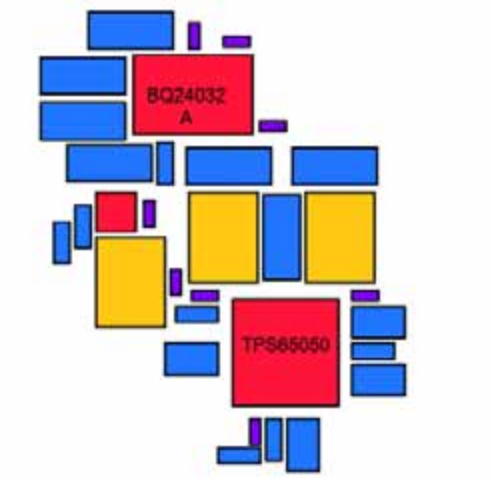


Figure 5: Possible placement of the components in the thermally optimized partial integration concept. Color coding from figure 3. Board space around 165 mm². Heat generated mainly in BQ24032A and TPS65050 which can be separated.

No compromise has to be made regarding space with this concept – the solution is approximately as small as in the case of the full integration concept. The placement of the components is considerably more flexible, which can be very helpful in the case of difficult circuit board shapes. Furthermore, thermally hot ICs can be favorably placed and the hot spots optimally distributed throughout the circuit board.

Layout-optimized discrete solution concept

If the step from full integration to thermally optimized partial integration can be regarded as a partial disintegration, it is therefore also possible to create a solution fully comprising discrete components. This solution certainly has the greatest number of individual components, which not only complicates the parts lists and warehousing, but is usually also the most expensive architecture. Nonetheless, this solution also has justifiable reasons for its use.

In our example of a portable navigation system the battery charging regulator BQ24032 and the TPS61061 for the display background illumination known from the previous concept are used. The power supplies close to the processor are generated by two Buck converters (TPS62300). For the discrete solution to achieve a similar design

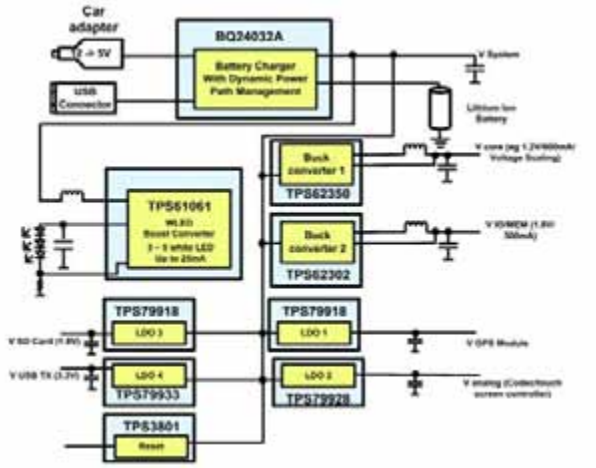


Figure 6: In a discrete solution every voltage type is provided by its own power supply IC

size to the fully integrated and thermally optimized partial integration solutions, cutting-edge miniaturized packaging technologies must be employed, such as a Wafer Level Chip Scale Package (WCSP) in this case. Owing to the small package size and its low parasitic impedance values, it is possible to implement switching frequencies of up to 3 MHz, which enable small chip coils and output capacitors to be used. This solution also specifies chip scale packages for the linear regulators – in our case, the TPS799xx from Texas Instruments.

When selecting optimum components in miniature packages, the necessary circuit board area is competitive with highly or fully integrated solutions.

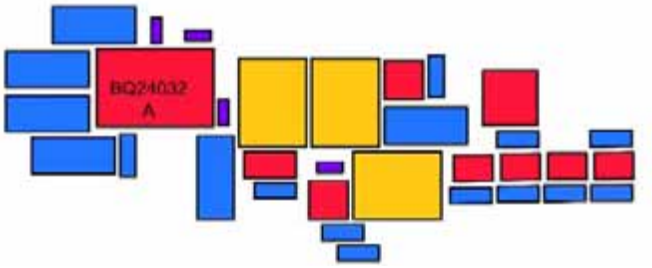


Figure 7: Possible placement of components in a discrete solution. Color coding like figure 3. Required board space around 175 mm². The shape of the design can vary according to the shape of the board.

When are discrete solutions preferred? There are two main reasons that might prompt designers to opt for discrete solutions. On the one hand, many circuit boards, particularly, in portable, battery-powered devices, are quite irregularly designed. They have breakouts for batteries, control elements, antennas or even for the display. The growing trend toward flat modules provokes the “jaggedness” of the circuit boards and at times blocks the possibility of a highly integrated solution. The switching frequencies in the voltage converters of 2 MHz and higher demand placement of the passive components near the pins in order to avoid instability and reduce interference radiation. In fully integrated solutions, there is almost no freedom to place the components differently without risking functional impairment of the system. By definition, the block for power management will always have a square-shaped to slightly rectangular structure.

If a decision is taken for a discrete solution instead, a functionally uncompromising design can be accommodated even on an extremely irregularly designed circuit board. The second potential reason for a discrete design is optimization of the interference radiation. The receiver sensitivity in a navigation system is a key user-relevant factor that demands a good signal-to-noise ratio at the antenna. It is possible in a discrete design to position potential noise and interference sources far away from the antenna, while at the same time leaving non-critical functions, such as linear regulators or battery charging functions, nearby. Moreover, particularly critical components can be more easily replaced in the event of design problems without having to rework the concept from the very start again. A particularly critical function in this context is the background illumination, since the most commonly used boost converters for driving white LEDs have a leaking current characteristic, and therefore emit interference radiation under certain circumstances. In fully integrated devices the radiation of the backlight driver is a very critical feature since it might cause the additional use of a discrete driver in the case of problems, leading to cost disadvantages.

Outlook

The article thus far focused on the most popular form of portable navigation devices today, the PNAs. It is advisable at this stage to consider the outlook of each concept for their future prospects. Convergence between navigation systems and portable multimedia applications, for example, is both conceivable and desirable. The integration of a MP3 player needs no additional components for power management and can therefore be implemented in a navigation system without bigger modification of the platform. Integration of a video player is a different ball game. The storage medium (usually a hard disk) generally requires a buck-boost converter to generate the operating voltage. Large displays need more LEDs for background illumination and therefore a considerably more powerful converter. If high-quality video applications are planned, the entire processor concept may have to be fully revised in certain circumstances since this calls for other processor blocks with greater calculating power, resulting in an immense rise in the overall current consumption. The battery size will likewise increase if longer operating times without direct power connection in the vehicle are required. In this case, the full system would then be more a portable video player with extended functionality to include navigation. Corresponding concepts with portable gaming applications are also conceivable. The best solution in such converging systems is that of thermally optimized partial integration since this solution enables standardization of the power management regarding the processor-related functions, while retaining complete flexibility in the design of the peripheral functions. Optimum conditions will also apply here in regard to system costs as incorrect dimensioning of individual converters, as is often encountered in fully integrated chips in convergent systems, can be avoided.

Summary

All three presented concepts are able to complete the design task without making any board space compromises. While the fully integrated solution has advantages for high-volume applications that require little flexibility, the discrete solution helps to implement difficult circuit board layouts and meet challenging EMC requirements. The thermally optimized partial integration solution often represents a balanced compromise between the other two concepts and is particularly suitable in modular designs for different market segments.
The choice of concept for a particular situation depends on the system design priorities. The overall requirements reflect a combination of factors, including market segment demands, technical possibilities and the commercial context. The optimum result calls for cooperation across different departments during the concept phase. Fortunately, the major semiconductor manufacturers, like Texas Instruments, now provide a wide range of suitable components for all concepts and offer assistance through their application engineers, who are specially trained in power management.

References:

www.power.ti.com (devices, block diagrams, design tools, simulation, webcasts, samples, power seminar materials)
http://focus.ti.com/general/docs/techsupport.jsp (knowledge base, design support, hotlines)
I. Buchmann, Batteries in a portable world, 2000. ISBN 0-9682118-2-8. (overview of battery chemistries)
Maniktala, S., Switching Power Supply Design & Optimization, Mac Graw Hill, 2004. ISBN 0071434836 (basics of switch mode power supplies, topologies and passives)

www.power.ti.com

Motor Control Current Sensing Applications

Isolation Amplifiers with Shunt Resistors vs. Hall-Effect Devices

The current sensor is an essential component in a motor control system. Recent progresses in sensor technology have improved the accuracy and reliability of sensors, while reducing their cost. Many sensors are now available that integrate a sensor and signal-conditioning circuitry into a single package

By Chew, Ming-Hian, Applications Engineer,
Optical Communication Solutions Division, Avago

The three most popular isolated current sensors for feeding current information to a microcontroller or digital signal processor in motor control applications are:

- Isolation amplifier and shunt resistor
- Hall effect current sensor
- Current-sensing transformer

In this article, we'll be discussing and comparing the first two types.

Figure 1 is a typical motor control block diagram using low-value shunt resistors for current sensing and a high-value parallel resistor as a voltage sensing element.

One of the more difficult problems in designing a current shunt sensing circuit is providing either galvanic isolation or dynamic level shifting of a precision analog signal in an extremely noisy environment such as that found in a motor phase current. The difficulty arises from the large common mode voltage, the high degree of variability of the common mode voltage, and the transients that are generated by the switching of the IGBT inverter transistor. These transients are equal in amplitude to the DC supply voltage or higher, and can exhibit extremely fast rise times (greater than 10 kV/µs), making it extremely difficult to sense the current flowing through each of the motor phases.

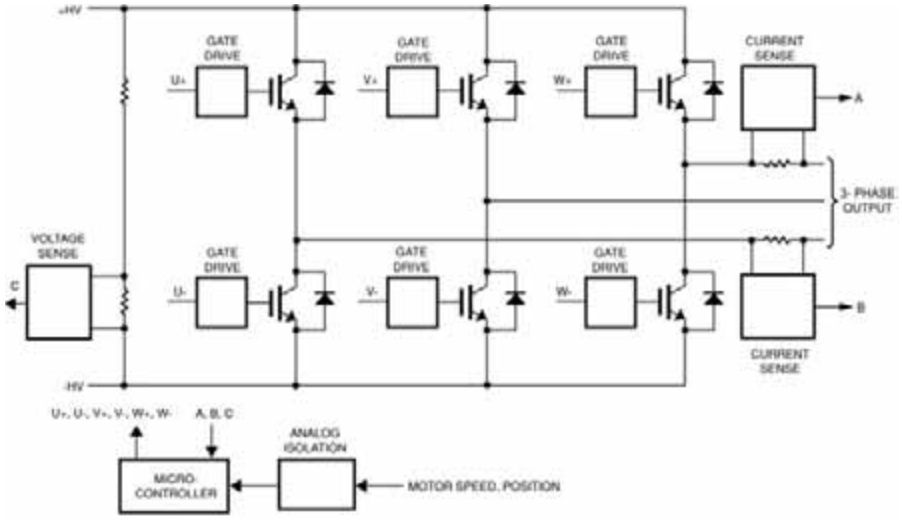


Figure 1. Typical motor control block diagram using resistors for both current and voltage sensing elements.

Isolation Amplifier and Shunt Resistor

Shunt resistors are the prevalent current sensors because they provide an accurate measurement at a low cost. The voltage drop across a known low-value resistor is monitored to determine the current flowing through the load. A circuit, such as an optically-coupled amplifier or level-shifting high voltage IC is then used to translate the differential voltage to a usable level while providing any required galvanic isolation between the resistor and control circuitry.

Optical isolation amplifiers are not affected by external magnetic fields, and do not exhibit the residual magnetization effects that can affect offset in Hall effect current sensors. Optical isolation amplifiers can be easily mounted on a printed circuit board and can be very flexible in performance, allowing the same circuit and layout to be used to sense different current ranges simply by substituting shunt resistors.

Amplifiers using linear optocouplers can suffer from linearity drift over the operating temperature range and reduced operating life because of current transfer ratio (CTR) degradation over time. This can be overcome by using negative feedback circuits consisting of matched photodiodes in the input and output side of the amplifier to make the transfer function is virtually independent of any degradation in the LED output as long as the two photodiodes and optics are closely matched. Another approach uses a voltage-to-frequency converter (analog-to-digital circuit or ADC) at the input, with the optically-isolated path transmitting digital rather than analog information. On the other side of the isolation, a digital-to-analog converter (DAC) develops the proportional analog output signal.

A sigma-delta (also known as oversampling, or 1-bit) architecture consists of a 1-bit ADC and filtering circuitry, which oversamples the input signal and performs noise shaping to achieve a high-resolution digital bit stream, the average of which is directly proportional to the input signal. The sigma-delta converter is comprised of two op-amp integrators and a clocked comparator, driven by a high frequency non-overlapping two-phase clock at about 6 MHz. The 6 MSPS (million sam-

ples per second) inherent in the operation of the sigma-delta converter eliminates the need for input sample\hold or track\hold circuits. A significant benefit of this coding scheme is that any non-ideal characteristics of the LED (such as nonlinearity and drift over time and temperature) have little, if any, effect on the performance of the isolation amplifier.

The advantage of using an ∑-Δ converter for analog-to-digital conversion is two fold:

1. The conversion accuracy is achieved mainly by virtue of the high sampling rate and is not very dependent upon IC process device matching.

The ∑-Δ modulator shapes amplifier noise to allow it to be efficiently filtered out.

Understanding Isolation Amplifier Parameters
Isolation amplifier specifications which are key for motor drive current sensing applications include:

Input-Referred Offset Voltage – this is the input required to obtain a 0 V output. All isolation amplifiers require a small voltage between their inverting and non-inverting inputs to balance mismatches due to unavoidable process variations. The required voltage is known as the input offset voltage (V_{OS}).

Data sheets for ∑-Δ amplifiers indicate another parameter related to VOS: the average temperature coefficient of input offset voltage. This parameter, $|\Delta V_{OS}/\Delta T_A|$, expressed in µV/°C specifies the expected input offset drift over temperature. V_{OS} is measured at the temperature extremes of the part, and $|\Delta V_{OS}/\Delta T_A|$ is computed as $\Delta V_{OS}/\mu°C$.

Gain Tolerance – this is especially important especially in multiple-phase drives where accurate gain tolerance is required for ensuring that precise phase-to-phase accuracy is maintained. For an isolated modulator such as the HCPL-7860/786J/7560, the important specification is the reference tolerance of the D/A, VREF.

Avago's data sheets show another parameter related to G: the average temperature coefficient of gain. The average temperature coefficient of G, $|\Delta V_{OS}/\Delta T_A|$, with units of V/V/°C, specifies the expected gain drift over temperature. G is measured at the temperature extremes of the part, and $|\Delta G/\Delta T_A|$ is computed as $\Delta G/\Delta°C$. For isolated modulators, it will be $|\Delta V_{REF}/\Delta T_A|$, with units of ppm/°C.

Nonlinearity – this gives an indication of the device's accuracy over the input current range. It is the deviation of the device output voltage from the expected voltage expressed as a percentage of the full-scale output range. A smaller percentage is better (closer to perfectly linear).

Avago data sheets show another parameter related to NL: the average temperature coefficient of nonlinearity. The average temperature coefficient of nonlinearity, $|\Delta NL/\Delta T_A|$, with units of %/°C, specifies the expected nonlinearity over temperature. NL is measured at the temperature extremes of the part, and $|\Delta NL/\Delta T_A|$ is computed as $\Delta\%/\Delta°C$.

Common-Mode Rejection (CMR) – in electronic motor drives, there are large voltage transients generated by the switching of the inverter transistors. These transients are at least equal in amplitude to the DC rail voltage, and can exhibit extremely fast rates of rise (as high as 10 kV/µs), making it difficult to sense the current flowing through each of the motor phases.

Propagation Delay and Bandwidth – device speed should be fast enough to ensure that the input signal is accurately represented and system stability is not compromised. The device should also be fast enough to protect against a short circuit.

Accuracy of an Isolation Amplifier
The typical isolation amplifier has an overall accuracy of a few percent. There are a number of error terms that combine to create this error, both at a nominal temperature (+25 °C) and across the operating temperature range.

The accuracy is limited by the combination of:
- DC offset at zero current
- Gain error
- Linearity
- Bandwidth limitations

Temperature changes also create drift in:
- DC offset
- Gain
- Linearity

Tables 1 through 3 demonstrate the performance of three ∑-Δ isolation amplifiers (Avago parts are used as examples) and shunt resistors.

Error due to reference voltage	1%
Error due to non-linearity	0.01%
Error due to shunt resistor	1%
Error at +25°C	2.01%
For operating ambient up to +85°C:	
Error due to offset voltage temperature drift	0.75%
Error due to reference voltage temperature drift	0.36%
Error due to non-linearity temperature drift	0.14%
Error due to shunt resistor temperature drift	0.3%
Error due to temperature drift	1.55%
Total uncalibrated error over temperature range	3.56%
Total calibrated* error over temperature range	2.56%

Table 1: HCPL-7860 Isolation Amplifier and Shunt Resistor Performance

Error due to offset voltage	0.5%
Error due to gain tolerance	1%
Error due to non-linearity	0.0037%
Error due to shunt resistor	1%
Error at +25°C	2.50037%
For operating ambient up to +85°C:	
Error due to offset voltage temperature drift	0.75%
Error due to gain temperature drift	0.19%
Error due to non-linearity temperature drift	0.35%
Error due to shunt resistor temperature drift	0.3%
Error due to temperature drift	1.59%
Total uncalibrated error over temperature range	3.60%
Total calibrated* error over temperature range	2.01%

Table 2: HCPL-7800A Ó-Ä Isolation Amplifier and Shunt Resistor Performance

** calibrated error refers to error when the gain tolerance or reference voltage (Δ_{Gain} or V_{ref}) and/or offset voltage (V_{OS}) of the device is calibrated out.*

Error due to offset voltage	0.25%
Error due to V_{ref}*	1%
Error due to gain tolerance	3%
Error due to non-linearity	0.06%
Error due to shunt resistor	1%
Error at 25°C	5.31%

* assume V_{ref} has 1% tolerance.

For operating ambient up to +85°C:	
Error due to offset voltage temperature drift	1.5%
Error due to gain temperature drift	1.8%
Error due to non-linearity temperature drift	0.55%
Error due to shunt resistor temperature drift	0.3%
Error due to temperature drift	4.15%

Total uncalibrated error over temperature range	9.46%
Total calibrated* error over temperature range	6.21%

**calibrated error refers to error when the gain tolerance or reference voltage (Δ_{Gain} or V_{ref}) and/or offset voltage (V_{OS}) of the device is calibrated out.*

Table 3: HCPL-7510 ∑-Δ Isolation Amplifier and Shunt Resistor Performance

A Note on Shunt Resistor Selection

The selection criteria for a shunt current resistor requires the evaluation of several trade-offs, including:

- Increasing R_{SENSE} increases the V_{SENSE} voltage, which makes the voltage offset (V_{OS}) and input bias current offset (I_{OS}) amplifier errors less significant.
- A large R_{SENSE} value causes a voltage loss and a reduction in the power efficiency due to the I^2R loss of the resistor.
- A large R_{SENSE} value will cause a voltage offset to the load in a low-side measurement that may impact the EMI characteristics and noise sensitivity of the system.
- Special-purpose, low inductance resistors are required if the current has a high-frequency content.
- The power rating of R_{SENSE} must be evaluated because the I^2R power dissipation can produce self-heating and a change in the nominal resistance of the shunt.

In order to maximize the accuracy of current measurement with isolation amplifiers, it is important to choose a shunt resistor with good tolerance, low lead inductance, and low temperature coefficient. Many resistor manufacturers offer such resistors.

Choosing a particular value for the current resistor us usually a compromise between minimizing power dissipation and maximizing accuracy. Smaller-value current-sense resistors decrease power dissipation, while a larger-value current-sense resistance can improve accuracy by utilizing the full input range of the isolation amplifier.

Two-terminal current-sense resistors are usually appropriate for lower-cost applications, while precision applications are better served with four-terminal resistors. Four-terminal current-sense resistors provide two contacts for current flow and two sense contacts for measuring voltage by making a Kelvin connection from the sense terminal to the isolation amplifier input. With a four-terminal current-sense resistor the voltage that is sensed is the voltage appearing across the body of the resistor (and not across the higher-inductance resistor lead.) Furthermore, four-terminal current-sense resistors typically have very low-temperature-coefficient and thermal resistance.

Hall Effect Current Sensors

Hall effect current sensors measure current flowing in a wire by measuring the magnetic field created by that current with a Hall effect IC and produce an output voltage (known as the Hall voltage). Hall effect current sensors are widely used because they provide a non-intrusive measurement. Several vendors offer devices that combine the magnetic sensor and conditioning circuit in a single package. These IC sensors typically produce an analog output voltage that can be input directly into the microcontroller's ADC.

Generally, Hall effect current sensors can be classified as either open-loop or closed-loop. Open-loop Hall effect current sensors consist of a core to magnify the magnetic field created by the sensed current, and a Hall effect IC, which detects the magnetic field and produces a voltage linearly proportional to the sensed current. Like all ferromagnetic material, open-loop Hall effect current sensors have hysteresis error, which contributes significantly to offset error.

Closed-loop Hall effect current sensors integrate additional circuitry and a secondary winding nulling the flux and improving the accuracy significantly, but at a higher cost than open-loop versions. They also tend to consume substantial current from the secondary power supply (which must provide the compensation and bias current)

In general, the comparatively large profile and footprint of Hall effect current sensors poses a challenge for incorporation onto high-density circuit boards. The larger profile also means that auto-insertion is difficult or impossible with standard pick-and-place machines. A second disadvantage of Hall effect sensors is that their accuracy varies with temperature.

Accuracy of Hall effect Current Sensors

The typical Hall effect current sensor has an overall accuracy of a few percent. There are a number of error terms that combine to create this error, both at nominal (+25 °C) temperature and across the temperature range.

The accuracy is limited by the combination of:
- DC offset at zero current
- Tolerance of measuring resistor, RIM (for closed-loop Hall effect current sensors)
- Gain error
- Linearity
- Bandwidth limitation

Temperature changes also create drift in:
- DC offset
- Gain
- Drift of measuring resistor, RIM (for closed-loop Hall effect current sensors)
- Linearity

Generally, ∑-Δ isolation amplifiers and open-loop Hall effect current sensors are comparably priced and closed-loop Hall effect current sensors are relatively more expensive. The higher cost of closed-loop Hall effect current sensors is due primarily to the additional core winding and the flux-nulling servo-amplifier.

At room temperature, both closed- and open-loop Hall effect current sensors have better accuracy than isolation amplifiers. A comparison of over-temperature accuracy between Hall effect current sensor and isolation amplifiers reveals a pronounced performance difference.

Error due to offset voltage	1%
Error due to primary current accuracy	1%
Error due to linearity	1%
Error at +25°C	3%
For operating ambient up to +85°C	
Error due to offset voltage temperature drift	2%
Error due to gain temperature drift	6%
Error due to temperature drift	8%
Total uncalibrated error over temperature range	11%
Total calibrated* error over temperature range	10%

**calibrated error refers to error when the gain tolerance or reference voltage (Δ_{Gain} or V_{ref}) and/or offset voltage (V_{OS}) of the device is calibrated out.*

Table 4: Open-Loop Hall Effect Current Sensor Typical Performance

This is because isolation amplifiers do not share the same sensitivity to temperature that affects Hall effect current sensors.

With calibration, isolation amplifiers show a clear accuracy advantage. Hysteresis error on Hall effect current sensors is always present and cannot be calibrated.

www.avagotech.com

Error due to offset voltage	1%
Error due to tolerance of R_{IM}	0.5%
Error due to number of secondary turns	0.1%
Error due to non-linearity	0.1%
Error at +25°C	1.7%
For operating ambient up to +85°C	
Error due to R_{IM} temperature drift	0.3%
Error due to offset voltage temperature drift	2%
Error due to temperature drift	2.3%
Total uncalibrated error over temperature range	4%
Total calibrated* error over temperature range	3%

**calibrated error refers to error when the gain tolerance or reference voltage (Δ_{Gain} or V_{ref}) and/or offset voltage (V_{OS}) of the device is calibrated out.*

Table 5: Closed-Loop Hall Effect Current Sensor Typical Performance

Coreless Transformer Provides Innovative Features

The expansion of the EiceDRIVER-family

Coreless transformer technology was introduced in the market by Infineon Technologies in 2003 [1, 2] as a core technology for IGBT gate drive ICs. Coreless transformer technology may be either used to replace half-bridge drivers, which use level shifters, or to replace optocouplers.

By Wolfgang Frank, Bernhard Strzalkowski, Uwe Jansen; Infineon Technologies Germany

Since coreless transformer technology provides a total galvanic isolation, negative transients at the high-side floating supply return are not a concern any more. The technology has been improved this year to make it even more resistant to system-level burst stress. Two new parts incorporating new innovative functions for cutting down system cost have been released.

Basics of coreless transformer technology

Coreless transformer technology uses semiconductor manufacturing processes to integrate a transformer consisting of metal spirals and silicon oxide insulation (Figure 1). The transformer is placed on the receiver chip in this example, but it may also be located on the transmitting chip without a change in functionality. Bond wires connect the upper winding with IC 1.

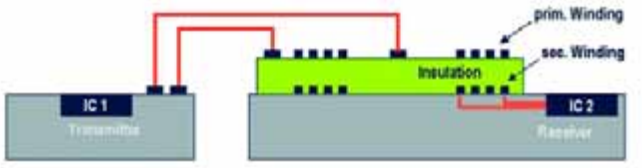


Figure 1: Cross-section of a coreless transformer

It is important to note that this technology is able to transmit pulse information at a rate of several MHz. This is a very big advantage, because it is useful for a wide variety of applications.

Advantages of coreless transformer in comparison to level-shift technologies

Level-shift technologies do not provide galvanic isolation. Therefore, it is impossible to enable features such as reinforced isolation directly with these technologies. Further current paths via the substrate material may lead to malfunction of the IC at specific operating points, if the semiconductor technology does not prevent this by using dielectric isolation or by separating the circuit onto two chips. A critical point is, for example, when the high-side reference potential runs below the potential of the low-side output reference. Then, the high-side output becomes insensitive to control signals. This means that short circuits can be actively triggered repetitively. Excessive power dissipation and system breakdown may result. These kinds of malfunctions can be avoided by using a coreless transformer due to their galvanic isolation.

Since level-shift topologies use high-voltage transistors in pulsed operation to transmit the signal to the high side, there is considerable power dissipation during transmission. This power dissipation is proportional to switching frequency and DC-link voltage. Therefore the applicability in systems with higher switching frequency is limited. Coreless transformer technology does not have this sort of power dissipation. The transmission of the control signal takes place with very low power dissipation in the transmission section. This allows coreless transformer technology to be used in high-frequency switching applications.

Improvements regarding EMI and package: 2ED020I12-FI

The 2ED020I12-FI is a half-bridge driver IC that is fully operational up to 1200 V. Its driving capability is 1 A sourcing and -2 A sinking, which makes this device suitable for IGBT with a current rating of up to 100 A without an additional booster circuit. Figure 2 shows the block diagram of this IC.

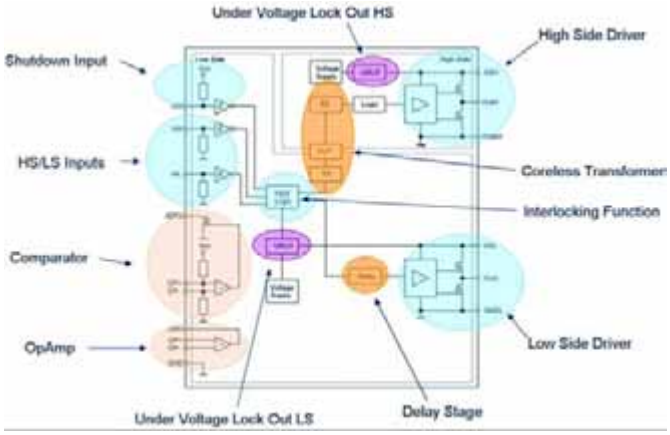


Figure 2: Internal block diagram of 2ED020I12-FI

The non-inverting control input pins for the high-side and the low-side IGBT are compatible with 3.3 V and 5 V TTL logic levels, and contain internal pull-down resistors. The integrated pull-down resistors reduce the number of external components. A dedicated shut-down function at pin /SD can inhibit the transmission of control signals to the high- and low-side drivers. This makes it possible to design a fast shutdown capability in case of a malfunction such as a short circuit.

Your Quality Partner for Power Solutions

New DualPACKs

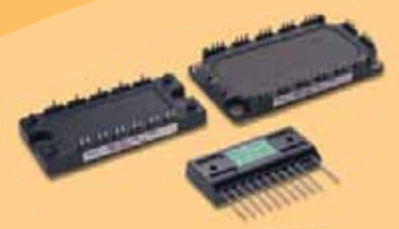
with Soldering Pins
1200V : 225A - 450A

with Spring Contacts
1200V : 225A - 450A

New High Power IGBT

1-Pack
1200V : 1200A - 3600A
1700V : 1200A - 3600A

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



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

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

New TMD Modules

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

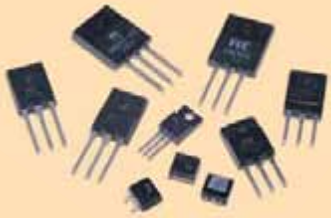
PIM IGBT
600V : 5A - 20A
1200V : 5A - 25A

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

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

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

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



Discrete IGBT
600V : 5A - 75A
1200V : 3A - 25A

FUJI ELECTRIC
DEVICE TECHNOLOGY
e-Front runners

Fuji Electric Device Technology Europe GmbH
Goethering 58 · 63067 Offenbach am Main · Germany
Fon +49 (0)69 - 66 90 29 0 · Fax +49 (0)69 - 66 90 29 56
semi-info@fujielectric.de

www.fujielectric.de

The propagation delay times with respect of the high-side gate drive signals are very small due to the high frequency transmission of the coreless transformer. However, an additional delay circuit is designed for the low-side gate drive section in order to compensate for the delay time of the coreless transformer of the high side. The delay circuit assures a maximum difference of 10 ns between the propagation delay times.

With an improved transmission protocol compared to the 2ED020I12-F, inverters that use the new 2ED020I12-FI are now able to manage high positive as well as high negative voltages in respect to bus bar ground. Power inverters including the 2ED020I12-FI pass the system-level burst test requirements according to level 4 of IEC 61000-4-4.

An advanced package now allows the 2ED020I12-FI to meet RoHS specifications and mass- production requirements for lead-free soldering.

A unique feature of the 2ED020I12-FI is the integrated comparator and operational amplifier (OpAmp), which can be used, for example, for current sensing by using a shunt according to [3]. Furthermore, the OpAmp and comparator can be used for general functions such as monitoring of the DC link voltage or triggering the start of the chopper, etc.

1ED020I12-S single-channel driver IC with innovative features

The 1ED020I12-S is an advanced, galvanically-isolated IGBT gate driver IC, which was designed to provide reinforced isolation. However, the process to define standards for the reinforced isolation of inductive couplers has just started. A preliminary standard from "Verband der Elektrotechnik Elektronik Informationstechnik e.V." (VDE) for reinforced isolation for magnetic and capacitive couplers is scheduled for publication in December 2006.

Due to the use of a state-of-the-art BICMOS process, control and protection functions superior to those in optocoupler-based drivers could be included. This allows the designer to build highly-reliable designs with fewer components. These functions and features are:

Active Miller clamp
Two-level turn-off
Rail-to-rail output
Desaturation protection with high precision
High-side status signalling with FAULT and READY

The effective active Miller clamp function avoids the need for negative gate driving in most applications. The lack of negative gate bias voltages lowers the system cost effectively, but it is important to avoid parasitic turn-on of the IGBT. High dv_{CE}/dt rates lead to a displacement current through the reverse capacitance ("Miller capacitance") C_{res} and the input capacitance C_{ies} according to the red path in Figure 3. This raises the gate voltage according to the transfer characteristic of the capacitive voltage divider. If the voltage shift is higher than the Miller voltage of the IGBT, parasitic turn-on of the IGBT is caused. This leads to a short-term short circuit of the half-bridge, and increases switching losses significantly. The gate resistor Rg actually decouples the gate-drive stage of the IC from this effect [4]. The active Miller clamp (pin CLAMP) now connects directly the gate pin of the IGBT module with an integrated, low-ohmic FET and pulls it down effectively, so that the IGBT is kept off. The integrated FET is able to sink up to 1 A.

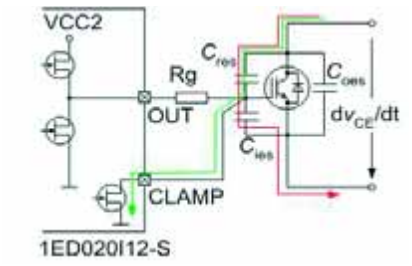


Figure 3: Application circuit using the active Miller clamp function of 1ED020I12-S

The two-level turn-off optimizes the switching of the IGBT in case of short circuits or severe overcurrents. By activating two-level turn-off, the gate voltage prior to turn-off is reduced to a programmable level in order to reduce the carrier density in the IGBT. This action avoids a dangerous excessive overvoltage across the IGBT during short-circuit turn-off. The intermediate level of reduced gate voltage is defined by the voltage of the external Zener diode D_{TL} as shown by a) in Figure 4. The turn-off delay T_{TL} shown in b) of Figure 4 is programmable through an external capacitor C_{TL} for accurate timing. The turn-off delay T_{TL} is also used to delay the turn-on signal to prevent distortion of the input-pulse width. The overvoltage with two-level turn-off activated is significantly lower compared to short-circuit turn-off without this protective feature. This considerably increases the reverse bias safe operating area (SOA) of the IGBT and the module, respectively. Although two-level turn-off is also in operation for normal switching events, it does not have an adverse effect on switching losses.

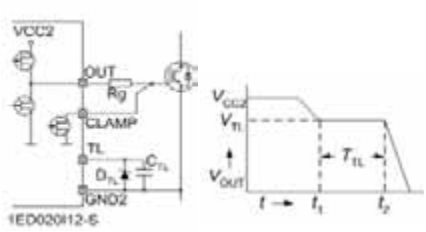


Figure 4 Two-level turn-off
a) Application schematic
b) Timing

Another new feature is the rail-to-rail output. This means, that the gate-drive voltage reaches the supply voltage V_{CC2} according to Figure 5. A rail-to-rail driver output enables the user to provide easy clamping of the IGBT gate voltage during short circuit of the IGBT via a Schottky diode from the gate pin of the IGBT to the high-side supply of the 1ED020I12-S. Thus, an increase of short-circuit current due to the feedback via the Miller capacitance can be avoided. Common gate-drive ICs do not offer this feature. Therefore, the supply voltage of the output stage is increased to 17 V or 18 V in order to obtain a gate-emitter voltage of V_{GE} = 15V. As a result, effective gate clamping with a diode to the supply is not possible with common gate-drive ICs that do not provide a rail-to-rail output.

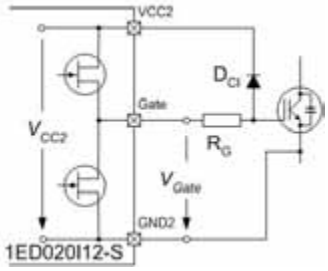


Figure 5: Rail-to-rail output and effective gate-voltage clamping

These features are important steps toward building very reliable, high-performance, high-power drive systems. They reduce the component count dramatically by comparison with standard approaches using optocouplers. Figure 6 shows two gate-drive PCBs for half-bridge modules, each with the same functionality.

The upper photo shows the evaluation board of 1ED020I12-S for a half-bridge driver design, which supports all functions of the 1ED020I12-S. This design saves four optocoupler and a large number of discrete components that would be necessary to provide the same features. The evaluation board is available from December 2006 onward.

Conclusions

The coreless transformer technology is very attractive for gate-drive ICs. Infineon's existing portfolio with the 2ED020I12-F has been expanded by adding the new half-bridge driver 2ED020I12-FI and the single-channel driver 1ED020I12-S. Coreless transformer technology is very robust and can easily be combined with innovative functions such as active Miller clamping, two-level turn-off or rail-to-rail outputs. These functions help design engineers to meet their targets in terms of cost, reliability, and time-to-market.

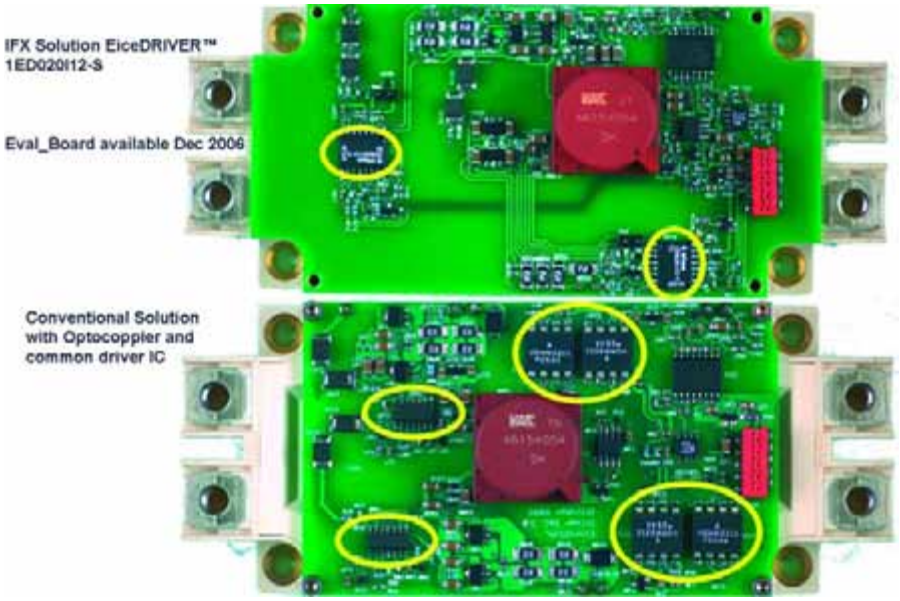


Figure 6: Fewer components in a PCB designed with 1ED020I12-S (upper design)

References

[1] B. Strzalkowski: "A monolithic integrated transformer in control circuitry of power electronics"; EDPE 2001 Kosice/Slovak Republic
[2] M. Münzer, et al.: "Coreless Transformer a new technology to drive power semiconductors the intelligent way"; Proceedings of PCIM 2003; Nürnberg, 2003
[3] A. Volke, et al.: "IGBT/MOSFET Applications based on Coreless Transformer Driver IC 2ED020I12-F"; Proceedings of PCIM 2004, Nürnberg, 2004.
[4] Infineon Technologies: "Driving IGBTs with unipolar gate voltage"; Application Note AN-2006-01, Infineon Technologies, Germany, 2005.

www.infineon.com/gatedriver

Loop Stability of Switch Mode Power Supplies

A practical measurement approach with the use of a network analyser

Knowing the stability criteria's of a switching power supply and measuring its close loop gain and phase over a certain frequency range helps the designer to understand potential risks of instability of the analysed design.

By Werner Berns, Application Design Centre Manager Europe, National Semiconductor
Michele Sclocchi, Principal Application Engineer Power Management Europe, National Semiconductor
Gianpaolo Lisi, University of Salerno/Italy

This article shows how to use a network analyser to measure the loop stability and gives guidance on how to interpret the results.

Mathematical model enough?
Beside the fact, that mathematical models of switching power supplies are getting better, they still have some limitations about the accuracy. The main reasons for those limitations are unknown details about the system. For example: component parasitics, PCB layout, temperature effects, propagation delays, non linearity's of all semiconductors. A real measurement almost always differs from the mathematical prediction and the efforts to get good models can be extremely high and time consuming. Therefore, it's always a good idea to actually measure the transfer function. Of course a mathematic model is very useful to calculate the compensation network (R-C values) before one actually build it and then cross check by doing a real loop measurement and do a fine tune. Just to clarify, it's not a question of whether to use a mathematical model OR a real loop stability measurement. An expert in power supply designs will always do both.

The feedback loop
The figure 1 shows a simplified block diagram of a typical switching power supply.

- The power stage is typically the pulse width modulation (PWM) controller with a power switch transistor, output filter (inductor/transformer and 1 or more capacitor connected in parallel).
- The error amplifier controls the output voltage of the power supply by sensing the output voltage and comparing it with a fixed voltage reference.
- The compensation network is G(s) and H(s), which typically is part of the circuitry which the designer can adjust in order to make the power supply stable.

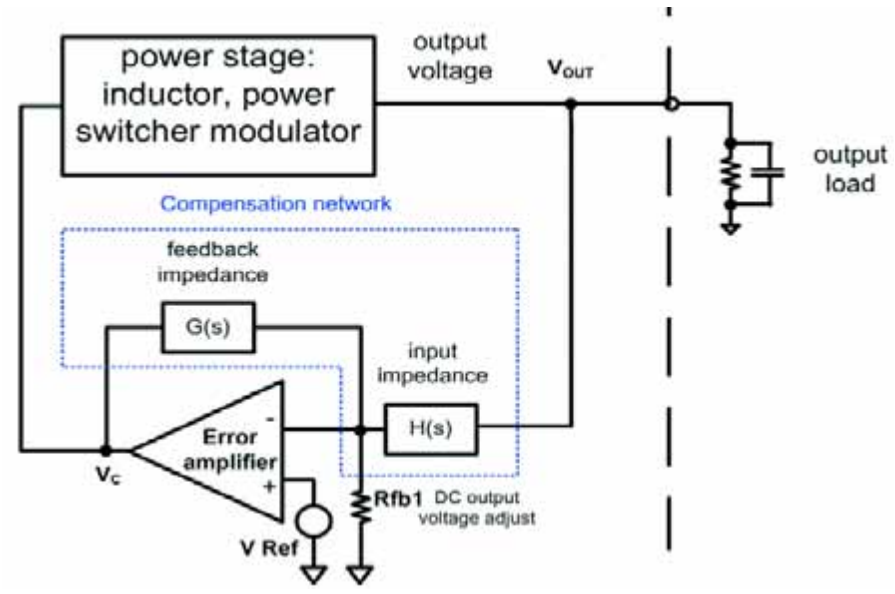


Figure 1: Simplified block diagram of a typical switching power supply

The gain of the error amplifier network is the ratio of the feedback impedance to the input impedance. The voltage adjust resistor (Rfb1) does not effect the AC gain calculation since it does not carry AC current. The feedback loop is the path through the input impedance, the error amplifier, the power stage and back to the input impedance.

Phase shift and loop gain
A feedback is used in all voltage regulators to keep the output voltage constant. The output voltage is sampled through a resistor divider and that signal is fed into the negative input of the error amplifier. Since the other input of the error amplifier is tied to a reference voltage, the error amplifier will supply current as required to the pass transistor to keep the regulated output at the correct DC voltage.

It is important to note that for a stable loop, negative feedback must be used. The response of the loop will opposes any change at the output. This means that if the output voltage tries to rise (or fall), the loop will respond to force it back to the nominal value.

SEMIKRON
innovation + service

SEMiSTART™

for compact soft-starters

- Overload current: 560 A – 3000 A @ 20 sec.
- Max. blocking voltage: 1400 V, 1800 V
- Low thermal resistance
- Heat sink for double-sided cooling
- High load cycle capability
- Pressure contact technology

☎ **Australia** +61 3-85 61 56 00 ■ **Belgium** +32 23 00 07 93 ■ **Brasil** +55 11-41 86 95 00 ■ **Cesko** +420 2 22 82 91 80 ■ **China** +852 34 26 33 66 ■ **Danmark** +45 70 27 12 22 ■ **Deutschland** +49 911-65 59-0 ■ **España** +34 9 36 33 58 90 ■ **France** +33 1-30 86 80 00 ■ **India** +91 22-27 61 97 45 ■ **Italia** +39 06-9 11 42 41 ■ **Japan** +81 3-56 39 50 75 ■ **Korea** +82 32-3 46 28 30 ■ **Mexico** +52 55-53 00 11 51 ■ **Nederland** +31 55-5 29 52 95 ■ **New Zealand** +64 9-4 14 29 70 ■ **Österreich** +43 1-58 63 65 80 ■ **Polska** +48 22-6 15 79 84 ■ **Russia** +7 38 32 55 40 95 ■ **Schweiz** +41 44-9 14 13 33 ■ **Singapore** +65 62 98 85 66 ■ **Slovensko** +421 3 37 97 03 05 ■ **Suid-Afrika** +27 12-3 45 60 60 ■ **Suomi** +358 9-7 74 38 80 ■ **Sverige** +46 8-59 4768 50 ■ **Türkiye** +90 216 4 10 30 22 ■ **United Kingdom** +44 19 92-58 46 77 ■ **USA** +1 603-8 83 81 02

sales.sknl@semikron.com, sales.skb@semikron.com, www.semikron.com

If a sinusoidal waveform (or noise) is injected into the loop, the signal will go through the loop and it will come back multiplied by the loop gain with a certain lag phase respect to the injected signal. The phase shift is defined as the total amount of phase lag, referred to the starting point of -180° (negative feedback loop) that is introduced into the feedback signal as it goes around the loop. The loop gain is defined as the ratio of the amplitude of the signal that goes through the loop divided by the amplitude of the injected signal: Loop Gain [dB] = 20*log(Va/Vb)

Lets assume we inject a sinusoidal signal into the loop across a wide frequency range. At low frequencies, the signal comes back with a larger amplitude and at high frequencies it is attenuated. All measured values, the gain and the phase, will be recorded. The result of the measurement is the so called bode plot (see example in figure 2). The shown graphs say a lot about the loop stability and certain points are of special interest.

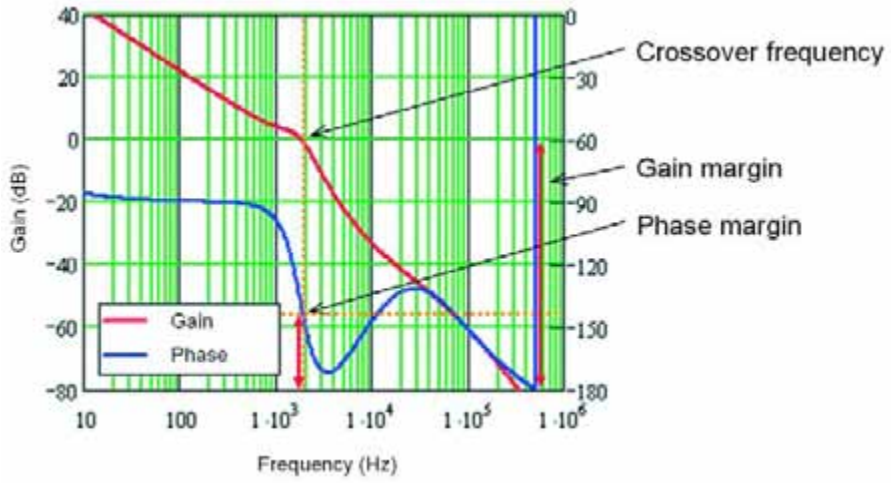


Figure 2: Bode plot for loop stability

Crossover Frequency (f_c)
The point at where the injected signal comes back at the same amplitude (0dB), is called cross over frequency or unity gain frequency.

Phase Margin (φ_m)
The phase margin is defined as the difference (in degrees) between the total phase shift of the feedback signal and the -180° measured at the cross over frequency.

Gain Margin (G_m)
The gain margin is the amount of negative gain (attenuation) where the total phase shift is 180 degree.

What do we like to achieve?
The compensation network needs to be optimised in order to meet the static and dynamic performance requirements while maintaining stability.

An ideal loop gain should have the following attributes:
- Fast loop response, achieved by a high bandwidth (high cross zero frequency)
- Loop gain slope of 20dB/decade from low frequency to half the switching frequency
- Large DC gain to achieve high DC accuracy over load and line variations
- Good noise immunity, with low gain at high frequencies, close to the switching frequency.
- Flat phase curve near crossover frequency
- Good phase margin in order to have a good stability with minimum overshoot.

The bandwidth of the control loop determines the speed of the loop in responding to a transient condition. Higher crossovers are preferred but there are practical limitations.

As a rule of thumb, 1/10 of the switching frequency is a good starting point. But more than 1/5 is not recommended. The higher the bandwidth is, the faster the load transient response speed will potentially be. However, if the duty cycle saturates during load transient, further increasing the small signal bandwidth will not help. There are also other practical limitations that depends on the type of control loop used, and topology, for example:
In voltage mode control, the LC filter will ring at the resonance frequency, the control must eliminate this by having a reasonable gain at the resonance frequency.

In flyback and boost topology the main limitation is the RHP zero, where the cross over frequency has to be 1/3 lower than the RHP zero frequency.
Also, if the main performance is step load, there are no practical benefits in raising the cross over frequency above the output capacitor ESR cross over limits (fc < 1/ 2 πCRc)

Sufficient phase margin is required to prevent oscillations. The step response

can be seen in a second order system where the damping factor is $\zeta \approx \varphi_m /100$. Optimal phase margin is at 52 degrees (blue graph). Lower phase margin leads to under damped system response (red graph) and higher phase margin leads to over damped system response (green graph).

As mentioned before, there are two main parameters that give a figure of merit of how stable the system is: Phase margin and Gain Margin.
In Theory even 20° of phase margin in worst case condition could be enough for a stable

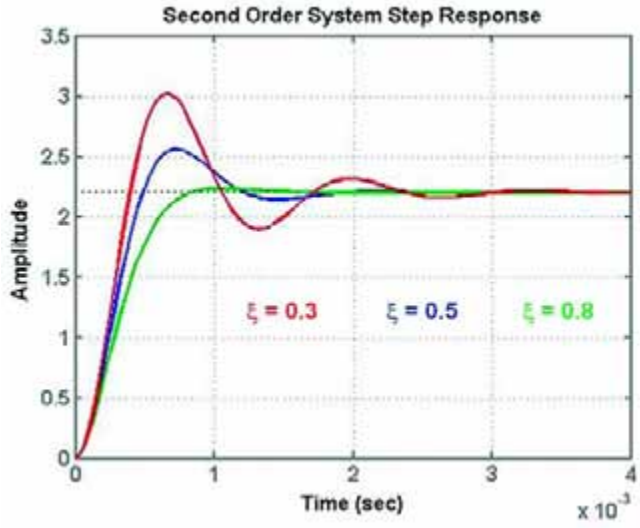


Figure 3

design, however more degrees of margin will ensure a stable loop in any conditions.
When we specify and measure the phase margin we also have to consider how much it will degrade in worst conditions, since line load and temperature changes will tend to degrade the phase margin from nominal value.

It is also important to monitor the minimum phase shift at frequency below the cross over frequency. If the phase shift gets close to 0, the system can oscillate when the gain decreases, for example with an increase of load or decrease of line voltage.

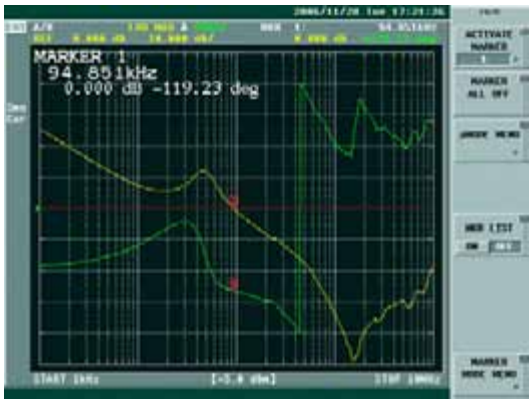


Figure 5: Network analyser screen shot

Implementation of a close loop measurement
A network analyser is used for this measurement, by injecting the sinusoidal output signal into the control loop, with a sweep frequency from few tens of hertz to above the operating switching frequency and measuring two signals A and B as shown in figure 4.

The sinusoidal signal is injected through an isolation transformer. In order to not distort the close loop system too much, the injected signal has an amplitude of few tens to hundred of mV. A resistor is connected in parallel with the output of the transformer.
The two output channels of the network analyzer are connected at the connection points of the transformer to measure the loop input (ch B) and loop output (ch A). Gain and phase of the function chA/chB is plotted in a logarithm scale over frequency.

The isolation transformer is needed to ensure a floating sinusoidal voltage injected to the feedback loop across an inserted resistor of few ohms. The resistor connected in parallel with the output of the transformer is in series with the feedback resistor divider and should have a resistance value much lower than the feedback resistors in order to not change the DC output voltage.
The transformer should have low primary to secondary capacitance and flat frequency response. Transformers designed for this purpose are available in the market and are typically sold for few hundred Euros. However, a simple transformer can be self-made by winding two strands of wires in a toroid core. Figure 5 shows an example of a network analyser screen shot.

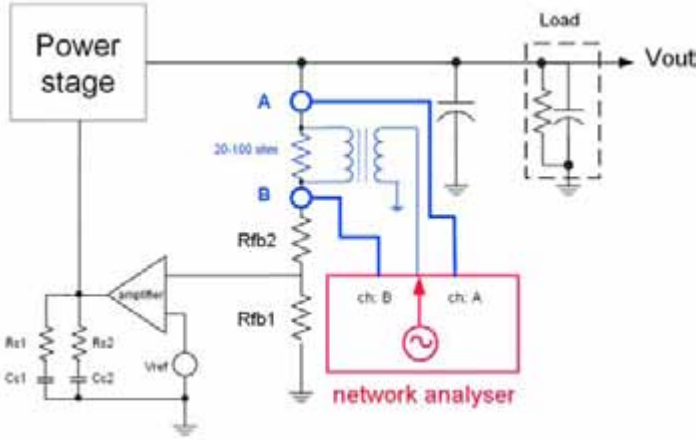


Figure 4: Close loop measurement.

Yellow graph represents the gain and the green graph represents the phase. The red line marks 0dB and 0° and the scale it 10dB respectively 45° per division. The switching frequency in this example was 1.5MHz.

Reading the results, we get the following values:
The crossover frequency is 94,8kHz (marker1) and the phase margin is about 60°.

The gain margin is about 16dB and the gain at the switching frequency is below -40dB (good noise immunity).

6 th International Conference & Exhibition for POWER ELECTRONICS in China

21 – 23 March 2007

PCIM China Conference - Hotel Holiday Inn Pudong, Shanghai, China
PCIM China Exhibition - Shanghai New International Expo Centre SNIEC, Pudong, China

The PCIM China Conference is organized by Mesago PCIM GmbH, Germany. Technical Conference Director is Prof. Leo Lorenz, Infineon Technologies, supported by a Board of Specialists for evaluation of all incoming abstracts. Out of a large number of abstracts the best papers were selected and will be presented in the PCIM China 2007 Conference.

Bodo's Power Systems magazine is one of the official Media Partners of PCIM China.

As a member of the PCIM Europe advisory board I like to encourage as many as possible to participate in the PCIM China conference. The attached conference program is giving the flavour what we can expect from the upcoming event.

Conference Program:

The registration form and all general information including accommodation and PCIM Exhibition are also available under

www.pcimchina.com

Wednesday, 21 March 2007 Morning Sessions Start: 8.30

Hotel Holiday Inn Pudong Dong Fang Road 899, Shanghai

8.30 – 8.40 **Opening**

Session 1 (parallel running to Session 2)
New AC/DC Power Converter Topologies
Chairman: Dr. Ying Jianping, Delta Electronics, China

8.50 – 9.10 1.1 **Environmental Stewardship: How Semiconductor Suppliers Help to Meet Energy-Efficiency Regulations and Voluntary Specifications in China**
Robin Clark, ICF International, USA, Andrew Fanara, US Environmental Protection Agency, USA, Aizhen Li, China Standard Certification Center, China, David Fridley, Lawrence Berkeley National Lab, USA, Louise Merriman, Jeff Ju, Fairchild Semiconductor, USA

9.10 – 9.30 1.2 **CE2QS01 Provides a New Solution for Quasi-Resonant Flyback Converters**
Yi He, Infineon Technologies Asia Pacific, Singapore

9.30 – 9.50 1.3 **Analysis and Design of a 1MHz LLC Resonant Converter with Coreless Transformer Driver**
Mingping Mao, Fraunhofer Institute, Germany

9.50 – 10.10 1.4 **An Open Load Solution for the LLC Resonant Converter**
Yan Chao, Delta Electronics, China

10.10 – 10.30 Coffee Break

10.30 – 10.50 1.5 **Topologies for Standby Power and its Performance Evaluation**
Eric Kok, Infineon Technologies, Singapore

10.50 – 11.10 1.6 **ZVS and ZCS High Efficiency Low Profile Adapter**
Bogdan Tudor Bucheru, Delta Energy Systems, USA

11.10 – 11.30 1.7 **Power Conversion and the New Business Model**
Jaspar Lim, American Superconductor, Singapore

11.40 – 12.20 Key Note Presentation
State of the Art and Future Trends in Electronics controlled Lighting Systems
Prof. Dian Guo Xu, University Harbin, China

12.30 – 13.15 Lunch

13.30 Bus Shuttle to SNIEC – Shanghai New International Expo Center

Session 2 (parallel running to Session 1) Advanced Motor Drive & Motion Control Systems
Chairman: Prof. Dian Guo Xu, University Harbin, China

8.50 – 9.10 2.1 **How to choose the Right Integrated Power Module for Appliance Application**
Zhou Chen, International Rectifier, USA

9.10 – 9.30 2.2 **To be defined**

9.30 – 9.50 2.3 **The Key Points of BLDC Type Compressor driven for Inverter Aircon**
Wang Rendong, Renesas System Solutions, China

9.50 – 10.10 2.4 **High Efficiency and Low Cogging Torque Motor Design for Hermetic DC Compressors**
Chih-Chung Lo, Yu-Choung Chang, Industrial Technology Research Institute,Taiwan

10.10 – 10.30 Coffee Break

10.30 – 10.50 2.5 **The IPMSM Position Sensorless Vector Control System for the Home Appliance**
Fukumoto Tetsuya, Aoyama gakuin University, Japan

10.50 – 11.10 2.6 **Enhanced Field Sensors used as a very simple Current Sensor**
David Jobling, Marc Schaerrer, Brian he Bo, LEM Group, Switzerland

11.10 – 11.30 2.7 **A new IGBT Module for Matrix Converter and AC application**
Norbert Pluschke, Semikron International, Hong Kong

11.40 – 12.20 Key Note Presentation
State of the Art and Future Trends in Electronics controlled Lighting Systems
Prof. Dian Guo Xu, University Harbin, China

12.30 – 13.15 Lunch

13.30 Bus Shuttle to SNIEC – Shanghai New International Expo Center

Thursday, 22 March 2007 Morning Sessions Start: 9.00

Hotel Holiday Inn Pudong Dong Fang Road 899, Shanghai

Session 3 (parallel running to Session 4)
Future DC/DC Converter Concepts – Part I
Chairman: Prof. Xu Dehong, Zhejiang University, China

9.00 – 9.20 3.1 **Very High Efficiency Power Conversion using a Novel Current Shaping Technology**
Dan Jitaru, Delta Energy Systems, USA

9.20 – 9.40 3.2 **Digital Control Techniques enabling Power Density Improvements and Power Management Capabilities**
Per-Johan Wiberg, Ericsson Power Modules, USA

9.40 – 10.00 3.3 **An Accurately Regulated Multiple Output ZVS DC-DC Converter**
Yanjun Zhang, Dehong Xu, Zhejiang University, Yu Han, Zhong Du, Emerson, China

10.00 – 10.20 3.4 **True Digital Solutions Simplify Full Featured Cost Effective Buck Converters**
Hasmukh Modi, Primarion, USA

10.20 – 10.40 Coffee Break

10.40 – 11.00 3.5 **New Approaches to build Jitter Free High Voltage, Small Size Power Supply**
Winter Cheng, National Semiconductor, China

11.00 – 11.20 3.6 **Reducing Power with Dynamic Voltage Scaling**
Scot Lester, Texas Instruments, USA

11.30 – 12.10 Key Note Presentation
Power Supply Technology - Present and Future
Milan M. Jovanovic, Delta Products, USA

Technology for power systems of modern computer/telecom equipment is facing extremely tough challenges because of continuously increasing power-density and efficiency requirements. Meeting these requirements will require significant technology advancements in system architectures, devices and materials, topology optimization, and packaging/thermal area. In this presentation, major technology challenges and future trends in each of these key technology areas are identified and briefly discussed.

12.15 - 13.15 Lunch

13.30 Bus Shuttle to SNIEC – Shanghai New International Expo Center

Session 4 (parallel running to Session 3)
Advanced Power Semiconductors – Part I
Chairman: Norbert Pluschke, Semikron Internat., Hong Kong

9.00 – 9.20 4.1 **The Development of new IGBT Module with the Unified Package Parts**
Manabu Matsumoto, Mitsubishi Electric, Japan

9.20 – 9.40 4.2 **Influence of Thermal Cross Coupling at Power Modules**
Daojie Chen, Tyco Electronics (Shanghai), China

9.40 – 10.00 4.3 **PrimePACK - The new High Power IGBT Module Concept**
Zhi Hong Liang, Zhen Bo Zhao, Infineon Technologies, China

10.00 – 10.20 4.4 **Soft Start Control**
Norbert Schaefer, Semikron, Germany, Wenrui Zhang, Semikron, Hong Kong

10.20 – 10.40 Coffee Break

10.40 – 11.00 4.5 **High Power Density in Power Modules**
Alan Elbanhawy, Fairchild Semiconductor, USA

11.00 – 11.20 4.6 **An Innovative Hybrid Approach for Next-Generation Off-Line SMPS High Power IC Converters**
Lorenzo Maurizio Selgi, Fabio Cacciotto, Luigi Arcuri, Fragapane Leonardo, STMicroelectronics, Italy

11.30 – 12.10 Key Note Presentation
Power Supply Technology - Present and Future
Milan M. Jovanovic, Delta Products, USA

Technology for power systems of modern computer/telecom equipment is facing extremely tough challenges because of continuously increasing power-density and efficiency requirements. Meeting these requirements will require significant technology advancements in system architectures, devices and materials, topology optimization, and packaging/thermal area. In this presentation, major technology challenges and future trends in each of these key technology areas are identified and briefly discussed.

12.15 - 13.15 Lunch

13.30 Bus Shuttle to SNIEC – Shanghai New International Expo Center

Thursday, 22 March 2007 Afternoon Sessions Start: 13.30

Hotel Holiday Inn Pudong Dong Fang Road 899, Shanghai

Session 5 (parallel running to Session 6)
Future DC/DC Converter Concepts – Part II
Chairman: Dr. Xinbo Ruan, Nanjing University, China

13.30 – 13.50 5.1 **Powering Portable Photographic Flash Lighting**
Scot Lester, Texas Instruments, USA

13.50 – 14.10 5.2 **Application of a 6kw Soft Switching DC-DC Converter in Rectifier Module**
Chengqun Yin, North China Electric Power University, China, Lisheng Shi, University of Missouri-Rolla, USA

14.10 – 14.30 5.3 **A new Compact Monolithic Step-Down Synchronous Regulator manages High Current Conversions**
Massimiliano Merisio, STMicroelectronics, Italy

14.30 – 14.50 Coffee Break

14.50 – 15.10 5.4 **Dual SmartRectifier™ - DirectFET Chipset Solution Overcomes Package Induced Sensing Limitations Allowing High Performance Synchronous Output Rectification in LCD TV Power Supplies**
Adnaan Lokhandwala, International Rectifier, USA

15.10 – 15.30 5.5 **A Simple and Flexible Non-Inverting Buck-Boost Converter for MCU Based Battery Charger Applications**
Nikhil Gupta, STMicroelectronics, India

15.30 – 15.50 5.6 **Low Qgd 200 to 250V UltraFET Trench MOSFETs with low Trr and Qrr for Synchronous Rectification, AC/DC and DC/DC Applications**
Praveen Shenoy, Bob Brockway, Fairchild Semiconductor, USA

Session 6 (parallel running to Session 5)
Advanced Power Semiconductors – Part II
Chairman: Prof. Leo Lorenz, Infineon Technologies, China

13.30 – 13.50 6.1 **Reverse Conducting (RC-)IGBTs from 900V to 1600V**
Oliver Hellmund, Stephan Voss, Wolfgang Frank, Infineon Technologies, Germany, Simon Zijing Chen, Infineon Technologies, China

13.50 – 14.10 6.2 **Elimination of Secondary MOSFET Avalanche Failure in DC Bus Converters**
Weidong Fan, International Rectifier, USA

14.10 – 14.30 6.3 **Universal, High Brightness LED Driver IC offers increased Flexibility and Higher Efficiency**
Ravi Bhatia, Mansion Lui, STMicroelectronics, Singapore

14.30 – 14.50 Coffee Break

14.50 – 15.10 6.4 **Impact of Mounting Height Variation on DC-DC Converter FET Peak Ring Voltage**
Arthur Black, Fairchild Semicondutor, USA; Carlo Ocampo, Santa Clara University, USA

15.10 – 15.30 6.5 **Offline Power Supply Topologies for LED lighting**
Donald Ashley, John Jovalusky, Power Integrations, USA

15.30 – 15.50 6.6 **CAL4: The next Generation 1200V Freewheeling Diode**
Volker Demuth, Semikron International, Germany

15.50 – 16.10 6.7 **From New Driver Concepts to Intelligent Modules**
Hui Wu, Infineon Zhi Hong Liang, Infineon Technologies, China, Wolfgang Frank, Infineon Technologies, Germany

Friday, 23 March 2007 Morning Sessions Start: 9.00

Hotel Holiday Inn Pudong Dong Fang Road 899, Shanghai

Session 7 (parallel running to Session 8)
Power Electronics in Cars
Chairman: Prof. Zhihong Wu, Tongji University, China

9.00 – 9.20 7.1 **Driving High Brightness LEDs for Wide Input DC to DC Applications**
Dennis Solley, ON Semiconductor, USA

9.20 – 9.40 7.2 **Laminated Bus Bars for the Power Electronics In Cars**
Reuven Koter, Eldre, USA

9.40 – 10.00 7.3 **A Novel Varied Frequency Control Method used in Hybrid Electric Vehicle**
Qingbo Hu, Zhejiang University, China

10.00 – 10.20 7.4 **1500W Automotive Bi-Directional Battery Charger**
Lucian Hriscu, Delta Energy Systems, USA

10.20 – 10.40 Coffee Break

10.40 – 11.00 7.5 **Reliable IGBT Modules for (Hybrid) Electric Vehicles**
Andreas Volke, Zhen Bo Zhao, Infineon Technologies, China

11.00 – 11.20 7.6 **Automotive Buck Regulator with Enhanced Load Range**
Winter Chen, National Semiconductor, China

11.40 – 12.20 Key Note Presentation
Hybrid Propulsion System: "GM March to Zero Emissions"
Vanessa Paladini, Maurizio Cisternino, Giovanni Cipolla, General Motors Powertrain Europe, Italy

The continuous petrol cost increase jointly to the always more stringent legislation for emissions pave the way for the introduction on the market of hybrid technology. However, the on costs still represent a major drawback of this technology. According to the specific region requirements a trade-off between costs and vehicle features is

required. The paper describes the GM global strategy, going through the most promising hybrids architectures with particular focus on Asia-Pacific market.

12.30 – 13.15 Lunch

13.30 Shuttle Bus to SNIEC – Shanghai New International Expo Center

Session 8 (parallel running to Session 7)
Power Quality Solutions
Chairman: Jean-Paul Beaudet, MGE UPS Systems, France

9.00 – 9.20 8.1 **New Trench-Field-Stop IGBT in UPS Applications**
Yizheng Zhou, Ziying Chen, Infineon Technologies, China, Wolfgang Frank, Infineon Technologies, Germany

9.20 – 9.40 8.2 **Improvement Current Sharing of Paralleled UPS System**
Yu Wei, Chao Yang, Yi Chen, Dehong Xu, Zhejiang University, China

9.40 – 10.00 8.3 **Transformerless 3-Phase UPS: A Natural Evolution toward better Performances**
Jean-Paul Beaudet, MGE UPS Systems, France

10.00 – 10.20 8.4 **Disturbance Rejection Control for Autonomous Wind-Diesel Power Systems**
Anastasios Pouliezos, Technical University of Crete, Greece

10.20 – 10.40 Coffee Break

10.40 – 11.00 8.5 **A Nonlinear Method of Detecting Sags for UPS Application**
Raj M. Naidoo, University of Pretoria, South Africa

11.00 – 11.20 8.6 **Optimum Harmonic Elimination Control Method for Multilevel Inverters using Artificial Neural Network**
Seyyed Hossein Hosseini, Hassan Taguizadeh, Hamed Latafat, Kaveh Razi, University of Tabriz, Iran

11.40 – 12.20 Key Note Presentation
Hybrid Propulsion System: "GM March to Zero Emissions"
Vanessa Paladini, Maurizio Cisternino, Giovanni Cipolla, General Motors Powertrain Europe, Italy

The continuous petrol cost increase jointly to the always more stringent legislation for emissions pave the way for the introduction on the market of hybrid technology. However, the on costs still represent a major drawback of this technology. According to the specific region requirements a trade-off between costs and vehicle features is required. The paper describes the GM global strategy, going through the most promising hybrids architectures with particular focus on Asia-Pacific market.

12.30 – 13.15 Lunch

Shuttle Bus to SNIEC – Shanghai New International Expo Center

Preliminary List of

Manufactures exhibiting at PCIM China 2007

A	Aavid Thermalloy Taiwan Inc.	www.aavid.com	TW	Taipei Hsien 221
	Atherm	www.atherm.com	F	38420 Domène
B	Beijing LEM Electronics Co., Ltd	www.lem.com.cn	RC	101300 Beijing
C	Ceramics Process Systems	www.alsic.com	USA	Chartley, MA 02712-0338
	CT-Concept Technologie AG	www.igbt-driver.com	CH	2504 Biel/Bienne
D	Diotec Semiconductor AG	www.diotec.com	D	79423 Heitersheim
E	Eldre Corporation	www.busbar.com	USA	Rochester, NY 14623
	Electrovac curamik GmbH	www.electrovac.com	D	93059 Regensburg
	Ericsson Power Modules	www.ericsson.com /campaign/powermodule	S	14175 Kungens Kurva
F	Fairchild Semiconductor Hong Kong Ltd.	www.fairchildsem.com	HK	Tsimshatsui, Kowloon
H	Hitachi Ltd.	www.hitachi.com	J	Tokyo 101-8608
I	Idealec S.A.S.	www.idealec.com	F	25300 Pontarlier
	Infineon Technologies China Co.	www.infineon.com	RC	Shanghai 201-203
M	Methode Electronics - Network Bus Products		RC	Beijing 100-086
	Microsemi	www.microsemi.com	RC	Shenzhen 518-040
	Mitsubishi Electric Corporation	www.mitsubishichips.com	RC	Shanghai 200336
P	Payton Group	www.paytongroup.com	IL	75140 Rishon Le Zion
	POLOVODICE a.s.	www.polovodice.com	CZ	14221 Praha 4
	Powersem GmbH	www.powersem.de	D	91126 Schwabach
R	Richardson Electronics Trading Co. Ltd.	www.richardsonelectronics.com	RC	Shanghai 200051
	Rogers Corporation Busbar Division	www.rogerscorporation.com	B	9000 Gent
S	Semikron (Hong Kong) Co. Ltd.	www.semikron.com	HK	Hongkong
	Shanghai Ericsson Simtek Electronics		RC	Shanghai 201-818
	Shenzhen Sunfly Electronics Technology Ltd.	www.sunfly.com	RC	Shenzhen, Guangdong 518031
	Speedy-Tech Electronics (Jiaxing) Co. Ltd.	www.speedy-tech.comsg	RC	Jiaxing, Zhejiang 314001
	STMicroelectronics (Shanghai) Co. Ltd.	www.st.com	RC	Shanghai 200-241

Registration Form for Participants from outside China

Use one copy of this form for each participant and fax it

Conference Registration for participants from outside China has to be booked with Mesago PCIM GmbH, Germany, Fax: +49 - 711 - 619 46 90

Last Name: _____

First Name: _____

Company: _____

Function: _____

Street/P.O. Box: _____

Zip Code: _____ City: _____

Country: _____

Email: _____

Phone: _____ Fax: _____

Conference Fee:

The Conference Fee includes Conference Proceedings, Lunch after the respective session*, Coffee Breaks per session, entrance to the PCIM China 2007 Exhibition with electronica & ProductronicaChina Exhibition on all days from 21 – 23 March 2007 and the daily bus-shuttle from the conference hotel Holiday Inn to SNIEC – Shanghai New International Expo Centre.

Please mark your participation.

21 March 2007	22 March 2007	23 March 2007	Participation Fee:	
☐ Session Unit A	☐ Session Unit B ☐ Session Unit C*	☐ Session Unit D	Register for 1 Unit Register for 2 Units Register for 3 Units Register for all 4 Units	Euro 160,00 Euro 280,00 Euro 360,00 Euro 420,00
**In case of registration for Session Unit C on 22 March, you are invited to attend the Key Note Presentation after Session B and Lunch before the session.*			Total Amount	Euro _____

Method of Payment – from outside China:

☐ **Charge to my Credit Card:** ☐ Visa ☐ Euro/Master Card

Card Number: _____

Cardholder's Name: _____

Expiry Date: _____

☐ **Bank Transfer**
Account Bank: Commerzbank Erlangen, Germany
Account No.: 821 5881
Bank Code No.: 763 400 61
S.W.I.F.T. Code: COBA DEFF 763

☐ **Cheque to be sent together with the Registration Form to Mesago PCIM GmbH**

_____ _____

Date **Signature** (legally binding)

Mailing Address (for participants from outside China):

Mesago PCIM GmbH
Rotebuehlstraße 83 – 85
70178 Stuttgart, Germany

phone: +49 - 711 619 46 821
fax: +49 - 711 619 46 90

Contact Person: Tanja Kaufmann
email: kaufmann@mesago.de

MESSE MÜNCHEN INTERNATIONAL

2007

China's platform for the electronics community

Components and Assemblies & Production Technologies

electronica & Productronica China 2007

With PCIM China

Featuring LASER. World of Photonics China

Collocated with Semicon China and CPCA Show

March 21–23, 2007

Shanghai New International Expo Centre SNIEC

Contact:
Messe München GmbH
Tel. (+49 89) 9 49-2 03 25
Fax (+49 89) 9 49-97 2 03 25
info@global-electronics.net

www.global-electronics.net

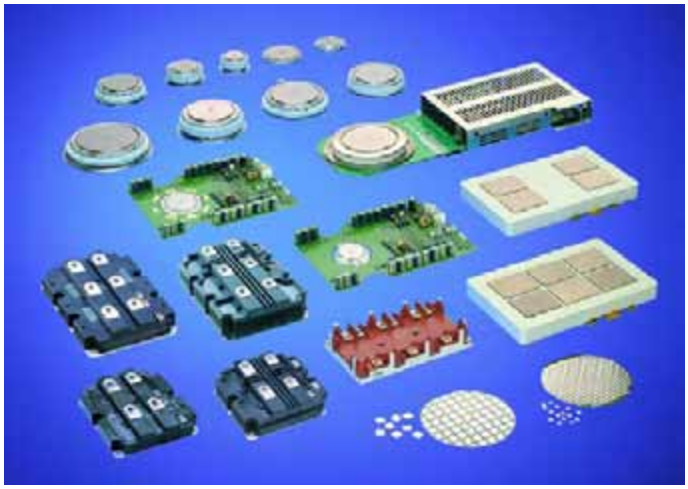
Global electronics

ABB

For a power semiconductor company, ABB in Lenzburg, Switzerland, is a rather young enterprise though from venerable parents. Established in 1991 as the result of the 1988 merger between the Swedish ASEA and the Swiss BBC, the company in Lenzburg, Switzerland celebrated its 15th anniversary in 2006 with record sales and an expanding workforce.

A Power Background

Because of ABB's background in Industrial Automation, Power Transmission and (historically) Transportation, it was clear at the outset, that the newly formed semiconductor company would have its focus primarily on these fields and thus HV thyristors from Sweden (HVDC) and GTOs from Switzerland (traction) were the initial cornerstones of the business. But times were changing in 1991 and a 10-year old device, the IGBT, was coming of age and aspiring to greater things than washing machine controls. The talk was of 2 MW locomotive drives and even of 50 MW transmission systems using IGBT modules and press-packs and so began an intense development and investment programme which culminated in the construction, in 1997, of the world's most modern dedicated power-IGBT wafer fab alongside the existing bipolar factory and only 500 metres from the IGBT module factory.



Competing technologies

In parallel to these "bimos" efforts, a then little-known turn-off device, the IGCT, invented by ABB in the early '90s, went into production. Many in the industry doubted the wisdom of investing in two, "competing" technologies but today it is clear that both devices have their preferred markets as witnessed by today's dominant position of IGCTs in industrial applications and that of IGBTs in traction. The success of these new devices has in no way eclipsed that of traditional products, such as diodes, GTOs and thyristors, which combined, enjoy 10% CAGR and generate the same revenues as IGBTs and IGCTs together.

Rebirth of an Industry

Following years of low growth and overcapacity in high power semiconductors, the industry is experiencing something of a come-back. This "reversal of fortune" is the result of increasing energy costs and environmental concerns. The simultaneous availability of powerful inverter devices has both met and further fuelled the demand for efficient power electronics, especially at medium voltage levels where "the big stuff happens".

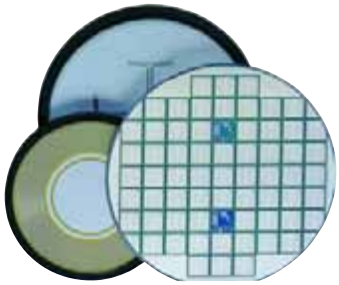
Confident that it is not experiencing a "transient phenomenon", ABB continues to invest in product developments and capacity expansion. 2006 saw the conversion of the above mentioned bimos fab from 5 to 6" wafers which allowed a >40% increase in IGBT capacity. A 6" line has also been decided upon for the bipolar factory and this will be operational in late 2008, initially for 8.5 kV thyristors but later also for other devices.

New Products

ABB has a full development portfolio for devices through to 2010. New products will include extensions to the popular HiPak standard modules (1.2 to 6.5 kV) with 6 products introduced in 2006 and at least 6 per year scheduled till 2010. In bipolar, six new symmetric and asymmetric IGCTs will go into production throughout 2007 and 2008 in 4.5, 5.5 and 6.5 kV ratings with a 10 kV device planned for 2010 to meet the urgent needs for efficient conversion on the 6.9 kVRMS line. New HV thyristors and diodes are also planned.

New Technologies

Increased power density and efficiency have become the goals of the industry in recent years and to this end, ABB has put great emphasis on loss reduction and extended Safe Operating Area. In 10 short years, switching power densities have gone from 150 kW/cm2 to 1.5 MW/cm2. The IGCT has been able to halve semiconductor losses compared to IGBTs but ABB's recent SPT+ technology, launched in 2005, reduces IGBT conduction losses by 20 - 30% while still conserving the outstanding SOA of standard SPT (Soft Punch Through). SPT+ matches Trench technology for loss reduction but it



has the considerable benefits of being applicable "across the board" from 1200 to 6500V while further increasing SOA. The SOAs achieved have given rise to a completely new concept in device turn-off, namely SSCM (Switching Self-Clamping Mode), a mark of outstanding robustness which is now being extended to IGCTs and perhaps, in the future, to fast diodes.

A Brave New World

Armed with new devices and technologies, ABB is energetically serving its traditional markets in Traction, Industry and Power Transmission while also supporting customers in the developing fields of Wind Power, FACTs, VSC-HVDC, Co-Generation, Magnetic Levitation and may other systems from 50 kW to 5 GW.

As such, ABB's three semiconductor factories in Lenzburg can confidently look to busy times ahead.

International Rectifier

International Rectifier is a pioneer and world leader in advanced power management technology. Founded in 1947, the company designs, manufacturers and markets a comprehensive set of power management products from digital, analog and mixed-signal ICs to advanced circuit devices, power systems and components. With worldwide operations, IR recorded revenues of $1.17 billion for FY06.

International Rectifier concentrates on solving two of the most important issues facing the world today, saving energy and powering an increasingly digital society. With each successful step toward these goals, IR's power management advancements help to raise the standard of living and improve the quality of life around the world. Today, IR innovations can be found in a variety of end applications, including computers, communications networking, consumer electronics, energy-efficient appliances, lighting, satellites, launch vehicles, aircraft and automotive.

Figure 1 – International Rectifier's fabrication facility in Newport, Wales

To deliver the greatest value to its customers, International Rectifier focuses on the most difficult power management challenges confronting system designers and then brings together architecture, silicon, thermal management techniques and packaging to advance the power management performance in a given application. In computing, one of most challenging applications today is presented by next-generation game stations which, from a processing standpoint, rival supercomputers. Inside, you'll find the company's iPOWIR™ integrated power modules and analog ICs helping to provide reliable, efficient, high performance power. In appliances, the key to energy efficiency rests with the adoption of variable-speed motion, where IR's industry-acclaimed iMOTION™* integrated design platform is helping appliance makers expand the feature sets they are able to offer consumers while driving down energy use. Already, people are saving more than half the energy needed just a decade ago to wash their cloths, refrigerate their food, and air condition their homes, the result of new appliances with variable-speed technology enabled by the simple and integrated approach delivered on IR's iMOTION platform.

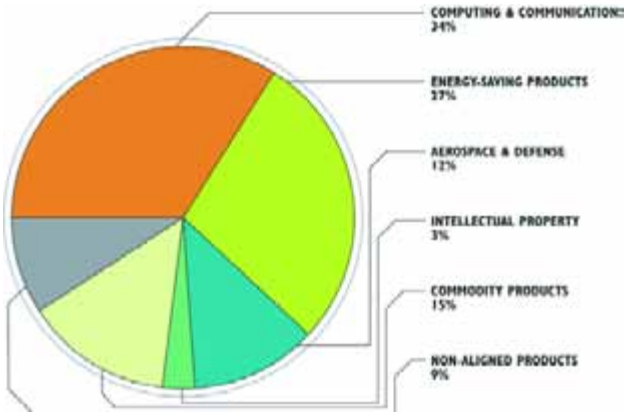


Figure 2 – International Rectifier's Business Segments FY06

In total, with the help of power management technology, it is possible to save about 30 percent of the energy consumed in the world, more than all the power currently used by nuclear power plants. Beyond motion control savings, two more opportunities exist to save vast amounts of energy - lighting and automotive.

In lighting, it is estimated that we could save about ten percent of the world's energy through the adoption of advanced and readily-available lighting alternatives such as electronic linear fluorescent ballasts, compact fluorescent light bulbs, and LED. By simply replacing incandescent bulbs with compact fluorescent lighting, consumers can save about 75 percent of the electricity needed to light their homes. Inside, International Rectifier's high-performance analog ICs form part of the solution.

In automobiles, another ten percent savings is achievable where IR's power management devices are helping designers put hybrid and diesel vehicles on the road capable of traveling twice the distance on a gallon of fuel than their standard counterparts.

In addition to saving energy, IR power management technology is making life better by extending performance in computing, communications, and entertainment devices. Some of these technological advancements are hidden away in infrastructure such a telecommunications base stations and enterprise servers while other innovations are "front and center" in the next breed of game stations, laptops and digital TVs. With the rapid pace of change enabled by power management technology, our entertaining and business services are becoming more ubiquitous, on-demand and mobile. These on-demand and mobile services are expected to drive a growth cycle, and at the same time, challenge traditional approaches to power management. Products like IR's XPhase, DirectFET, iPOWIR, DCBus™ and µPFC®, along with IR innovations in development, will stand ready to meet the challenge.

Figure 3 - IR's iMOTION integrated design platform showing the latest pump application

*IR's iMOTION (ai mo shan), representing the intelligent motion control, is a trademark of International Rectifier

www.irf.com

Danfoss Silicon Power

Danfoss Silicon Power is located in Schleswig, Northern Germany.

Danfoss Silicon Power is a customer-oriented global supplier of power modules within the industrial, automotive and appliances as well as in the area of alternative energy business areas. We are specialized in developing and producing customized power modules. Our customers can also choose from a wide range of existing Econo type standard packages.

Our customized modules are characterized by an individual chip assembly and heat sink design. The packaging can also be individually designed - to meet the exact requirements of our customers.

The company is located in new and modernized buildings with a light and friendly atmosphere with modern production facilities, promoting a competitive development and production of power modules as well as optimal working conditions for the people at Danfoss Silicon Power.

Danfoss Silicon Power possesses great knowledge of the design and manufacturing of power modules - the kind of knowledge, we invite our customers to draw upon in the engineering process.

The task of creating outstanding products requires the best employees and processes. More than 100 motivated and highly qualified Danfoss employees are dedicated to generating the best solution for the customers - with the aim of meeting their exact requirements.

At Danfoss Silicon Power, we design, manufacture and market integrated power modules for use in inverters, in a power range from a few amperes, to large modules with several thousand amperes for traction drives.

We are committed to manufacturing with the lowest possible consumption of raw materials and energy, with least possible impact on our surroundings and the most efficient exploitation of resources.

Therefore, we are continuously adapting our management of environmental and quality issues to the newest requirements specified in the international standards of ISO. As a result, we have been certified to ISO 9001, 14001 and ISO/TS 16949.

Core Competencies -
The Key Steps to a reliable Production of Power Products

- Void free vacuum soldering technology controlled by x-ray
- Lead free solders for every soldering step
- Test lines for isolation, static and dynamic parameter tests
- All important processes are monitored by SPC
- Latest packaging technologies
- Full traceability
- Capacity to supply any quantity

Danfoss Silicon Power GmbH
Heinrich-Hertz-Straße 2
24837 Schleswig
Germany
Phone: +49 4621 - 9512-0
Fax: +49 4621 - 9512-10
Email: dsp-info@danfoss.com
Homepage: http://siliconpower.danfoss.com/

Electrovac curamik

is a globally active group specializing in compound materials enabling high power density in electronic engineering processes. Electrovac products are also utilized in photonics and for temperature-resistant sensors. The technological core competence behind all developments and products is the combination of different materials (metals, ceramics, glass, carbon nanofibers) into components reliably resistant toward high-pressure gradients, extreme fluctuations of temperature, and extreme centrifugal forces while retaining long-term productive efficiency.

Another industrial core competence of Electrovac curamik is reflected in development cooperations whereby Electrovac curamik develops unique selling propositions for customers or enables the maintenance of existing USPs while simultaneously developing new solutions. Electrovac curamik commands a wealth of expertise in the fields of automation and in-house manufacturing and offers quick and cost-efficient production of prototypes and pilot series.

In Eschenbach/Oberpfalz (Germany) and in Klosterneuburg (Austria), Electrovac Power Cooling manufactures ceramic printed circuit boards for power converters and intelligent power modules and cooling systems. In Salzweg/Passau (Germany) and in Klosterneuburg Electrovac Hermetic Packages produces moisture-proof casings for pressure sensors, components of airbag release systems, and optoelectronic packages ensuring productive efficiency of microprocessors even in extreme environmental conditions. These high-performance components are also used in transmission control units of vehicles such as in the new 5 and 7 series of BMW. The first and second generations of ESP casings for Mercedes were manufactured exclusively by Electrovac curamik.

Efficient POWER for your applications

INFINEON TECHNOLOGIES offers a broad range of leading-edge power semiconductors for standardized and application-specific industrial applications such as industrial drives, renewable energies, transportation, power supplies and medical instruments. Our proven chip expertise combined with many years' package know-how enable our customers to select the right solutions for their applications.

eupec
An Infineon brand

www.infineon.com

infineon

Never stop thinking

LEM

innovates to meet market developments

LEM is a global company with approximately 700 employees worldwide. It has production plants in Geneva (Switzerland), Machida (Japan) and Beijing (China), and adaptation centres in Milwaukee (USA) and Tver (Russia). It also has ten regional sales offices, offering a seamless service to customers across the globe.

The company is a global market leader, designing and manufacturing transducers for measuring electrical parameters such as current and voltage. Starting with products for locomotives in the 1970s, LEM expanded into a vast area of industrial applications, including variable speed drives for motors, and power supplies. Today, LEM's current and voltage transducers are used in AC/DC converters, uninterruptible power supply systems for computers as well as in innovative energy applications such as micro-turbines and wind and solar power generation.

New opportunities have recently been developed in the automotive market for battery management and electrical motor controls for steering and braking systems. This evolution underscores the company's skills in leading industrial trends, which include:

Miniaturisation – Transducers have become smaller and cheaper. This trend has opened up new markets and opportunities to the leading players as the range of potential application has grown in step.

Greater degree of application integration and complexity – Given the trend of miniaturisation, the increasing demand for extended functionality requires a higher level of integration of LEM's products and opens up new markets. LEM has added functionality in many ways, including the addition of intelligent microelectronics.

Enhanced performance – Smaller and more integrated current and voltage transducers can provide improvements in performance in an increasing number of applications. This may come in the form improved comfort for end users and/or reduced energy consumption of equipment.

Process control and automation place particular demands on the need for increased intelligence, and LEM has formed a division dedicated to developing these macro components. LEM's unique manufacturing systems and in-house development of custom mixed-signal silicon chips also give the company an unmatched capability to meet the challenging requirements of customers across the wide range of power electronics applications.

Innovation is the basis for sustainable growth. LEM's long track record in the industry allows it to better understand its customers' needs and requirements. Furthermore, its transducer technology delivers clear and recognisable added value to customers:

by offering a comprehensive range of standard products as well as customised products;
by providing unique quality and reliability – guaranteed;
by isolating low power applications from high voltage;
and strategically by linking power electronics to 5V microelectronics.

The company invests a considerable amount of its financial resources in research and development. It also improves and optimises its manufacturing processes, e.g. accelerating the time to volume production. LEM's leading market position is assured through a number of key patents in technical design as well as trade secrets.

LEM offers a wide variety of transducers based on different technologies:

- Hall effect transducers, which include closed-loop, open-loop and Eta™ transducers;
- fluxgate transducers;
- air-core transducers, including Rogowski and PRiME™ technologies;
- Other voltage transducers, including the AV product family as well as devices based on Hall effect and fluxgate technologies.

The most suitable product and technology for an application will depend on many factors, predominantly the electrical requirements, mechanical requirements, thermal conditions and the environment in which the transducer is to be used. More complex applications may add criteria, such as electromagnetic interference, mechanical disturbance (vibration, shock, etc), special isolation or compliance with industry-specific standards. Although the requirements of most applications are met with standard devices, LEM also develops customised products.

For high-volume products, LEM's automated production lines include custom-developed equipment that optimise quality, with failure rates as low as 1ppm. In-house six-sigma training and support for employees to study for the Swiss Association for Quality (SAQ) diploma create a culture of quality, and all production follows the OHSAS 18001 model. Every LEM plant is certified to recognised standards, with certifications including ISO 9001, TS 16949 and ISO 14001. LEM's commitment to quality is demonstrated by the five-year warranty offered on all its industrial products.

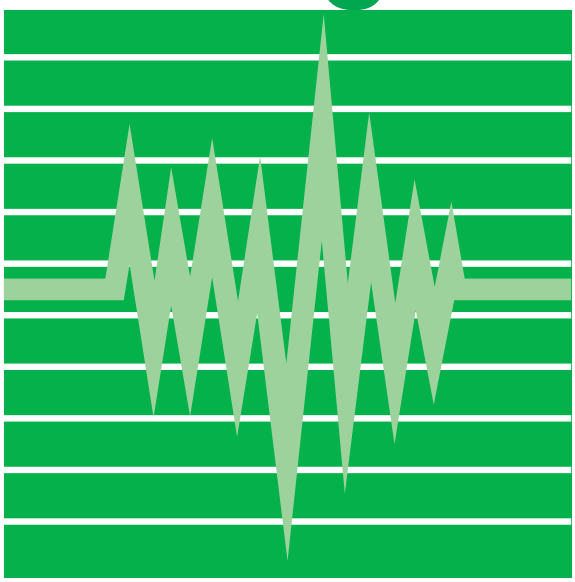
www.lem.com

e-emv.com

Europe's leading EMC event!

For complex challenges in all aspects of Electromagnetic Compatibility –
the answer is EMV 2007 Stuttgart!

EMV 2007 Stuttgart



International Exhibition
with Workshops
on Electromagnetic Compatibility (EMC)

6-8 March 2007
Messe Stuttgart

www.e-emc.com

Including:

- Measurement & Testing
- Filters and Filtering Components
- Lightning and Overvoltage Protection
- Shielding
- ESD-Protection
- Services and others

EMC EMC EMC EMC EMC EMC

Face-to-face communication at its best – plan your participation today!

Organizer:
Mesago Messe Frankfurt GmbH
Rotebuehlstraße 83-85
70178 Stuttgart / Germany
Phone +49 711 61946-0
Fax +49 711 61946-93
emv@mesago.de

Maxwell Technologies

Maxwell is a leading developer and manufacturer of innovative, cost-effective energy storage and power delivery solutions.

Our BOOSTCAP® ultracapacitor cells and multi-cell modules and POWERCACHE® backup power systems provide safe and reliable power solutions for applications in automotive, industrial electronics, transportation, renewable energy and the UPS market..

We also develop and manufacture CONDIS® high-voltage grading and coupling capacitors for electric utility switchgear, CVT and laboratory applications, and radiation-mitigated microelectronic products for space and military requiring high reliability.

Founded in 1965, the company's headquarters and principal operations are in San Diego, California, USA with a European base of operations in Rossens, Switzerland. Manufacturing takes place in the USA, Switzerland and China.

Maxwell has licensed its ultracapacitor technology to Shanghai Power Utility And Manufacturing Group, granting it a license to manufacture and market ultracapacitor products based on Maxwell's proprietary large cell and multi-cell module technology under its own brand in mainland China. Maxwell has also formed an offshore manufacturing alliance for large-scale production Of ultracapacitor cells and multi-cell modules in China with Belton Technology Group.

Maxwell's ultracapacitors are available from a worldwide network of business partners. In Europe, this includes representatives in Germany, UK, France, Austria, Benelux, Scandinavia, Spain, Poland, Italy, Israel, Czech Republic, Slovakia and Russia. In Asia, Maxwell handles sales in China directly, with partners in South Korea, Australia, Singapore, Taiwan, Japan and India.

Maxwell employs approximately 300 people worldwide. The company's market capitalization is currently about US$250 million.

Leader in ultracapacitors

Maxwell's BOOSTCAP® ultracapacitors are designed for energy storage and the delivery of rapid bursts of power for applications ranging from consumer and industrial electronics to hybrid electric buses, trucks and autos.

As the leader in ultracapacitors, and recognized by Frost & Sullivan as a pioneer in the technology, Maxwell Technologies is helping to change the way energy is stored all over the world.

Available in a range of sizes and modular configurations, our BOOSTCAP® products bring new levels of efficiency and power to everything from consumer electronics to hybrid cars and renewable energy sources.

Our proprietary electrode and global manufacturing facilities allow us to deliver unsurpassed value, keeping costs down while tailoring performance to specific applications.

Maxwell's ultracapacitors have a demonstrated lifespan of one million recharge cycles, even in extreme environments, reducing maintenance costs and adding value to other power sources.

Available in two distinct types of ultracapacitor—the exceptionally affordable Energy Line, and the high performance Power Line—our wide range of cells and custom modules ensures an ideal solution for virtually any application.

Maxwell's ultracapacitors provide higher energy density than electrolytic capacitors and higher power density than batteries. They offer a valuable set of features:

- Reliable operation in harsh environments
- Virtually maintenance free
- Tailored solutions
- Competitively priced
- Exceptional efficiency
- Compact design
- Extended operating life
- Environmentally safe
- UL-recognized
- RoHS compliant
- 10-year life capability
- Ultracapacitor product range

The BOOSTCAP® product range is divided into three families:

- The PC family of small 'energy' cells offers a 2.5V operating voltage and a lifetime of over 500,000 duty cycles in a low profile prismatic design. Cells are available with capacitances of 5F or 10F.

- The BC family of medium 'energy' and 'power' cells offers a 2.5V operating voltage, ultra-low internal resistance and a lifetime of over 500,000 duty cycles in a round, double-ended design. Cells are available with capacitance from 120F to 350F.

- The MC family of large 'energy' and 'power' cells offers a 2.7V operating voltage, ultra-low internal resistance and a lifetime of over 1,000,000 duty cycles in threaded terminal or weldable post versions. Cells are available with capacitance from 650F to 3000F.

A wide range of ultracapacitor modules is also available, including the new HTM 125V module aimed at transportation and industrial applications. The modules provide a rugged, enclosed system with individually balanced systems, which makes system design as easy as possible for our customers.

www.maxwell.com

info@maxwell.com

All the power you need...

For a better environment

IPM Modules

IGBT Modules

DIP-CIB Modules

Mitsubishi's service-proven product ranges with the latest chip and production technologies for best efficiency, highest reliability and, needless to say, good environmental compatibility.

Mitsubishi offers a large variety of RoHS compliant series for your industrial application. And compatibility with previous product generations is always assured.

MITSUBISHI ELECTRIC

Changes for the Better

semis.info@meg.mee.com · www.mitsubishichips.com

Technology and Market Leader in the Sector of IGBT Drivers

CT-Concept Technologie AG is worldwide technology and market leader in the sector of IGBT drivers for mid to high powers. We can look back onto more than 20 years of successful experience.

CONCEPT offers an unequalled selection of IGBT drivers for the most varied requirements. All our products are distinguished by top technology, outstanding functionality, unrivalled quality and a first-class price/performance ratio.

Our SCALE IGBT drivers have defined the pioneering standards against which our competitors have to measure themselves. These SCALE drivers are based on the unique SCALE ASIC chipset (ASIC = Application-Specific Integrated Circuit).

As an innovative company from the power electronics sector, we focus not only on research and development of innovative products but also on customizing and implementation projects in direct cooperation with our customers.

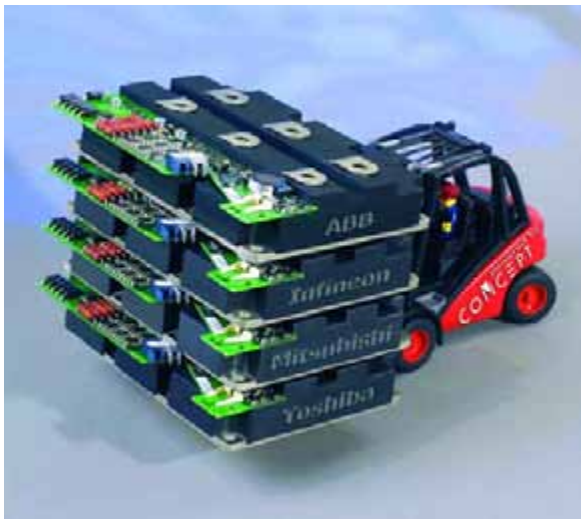
SCALE IGBT driver cores

We are market leader in an increasingly tough market with our SCALE driver cores. SCALE driver cores are modules containing all basic driver functions such as electrical isolation, protection functions, DC/DC converter etc. The user may place the cores onto a circuit board that accommodates all the components required for matching to specific IGBTs or other applications.

One to six-channel SCALE driver cores are available for IGBTs with reverse voltages from 600 to 3300V. We offer cores with output currents from ±6A to ±48A so that between 1W and 15W is available for each channel. SCALE driver cores are also suited for driving power MOSFETs.

SCALE plug-and-play drivers

In the sector of drivers for high-power and high-voltage IGBTs, we offer a comprehensive, sophisticated and unrivalled product range of SCALE plug-and-play IGBT drivers.



Plug-and-play drivers are complete ready-to-use IGBT drivers that have been perfectly matched by CONCEPT to a large selection of IGBTs. SCALE plug-and-play drivers are available for high-power and high-voltage IGBT modules with reverse voltages of 1200V to 6500V. All SCALE plug-and-play drivers are complete solutions and contain DC/DC converters, short-circuit protection, active clamping, supply monitoring etc. The user merely needs to mount these drivers onto the corresponding IGBT module. The system can then be immediately put into operation – with no development effort.

Applications

Our products are used worldwide in all conceivable sectors and applications including drives, traction, railway applications, wind, solar and power technology, medium-voltage converters (two level and multilevel), medical engineering, industrial process technology, RF technology, inductive heating and welding technology, military applications, telecoms and research.

Technology awards

CONCEPT products have repeatedly won first prizes in technology and innovation competitions: these have included the prestigious Swiss Technology Award for exceptional performance in the R&D sector as well as the special ABB prize for the best project in power electronics. These awards underscore our leading position in the sector of power electronics.

Next generation of IGBT drivers

The backbone of the next generation of IGBT drivers will be the SCALE II chipset, a central platform that will be introduced onto the market in 2007. The experience we have gained over 20 years, but specifically also our know-how in matching drivers to IGBTs of the latest generations have all flowed into this highly integrated chipset. The second SCALE generation will embody further massive improvements in functionality, scalability, space requirement and cost/benefit ratio. The modular chipset allows flexible matching to customized requirements. A variant for driving power MOSFETs will also be available.

Contact CONCEPT

We are aware that our success is based on the high flexibility and reliability of our products in conjunction with our many years of experience in working together with our customers. So our daily motivation is to offer them the optimal solution for their needs.

We will be pleased to let you have detailed information about our products and services.

CT-Concept Technologie AG
Intelligent Power Electronics
Renferstrasse 15
2504 Biel
Switzerland
T: +41 32 344 47 47
F: +41 32 344 47 40
Info@IGBT-Driver.com

The Website for Power Electronics Professionals
http://www.IGBT-Driver.com

www.IGBT-Driver.com

The Information Tool to Meet the Information Age

Navigating through constantly changing websites in search of data

We don't know what we don't know. Business strategies, be they marketing or product development, require awareness. To be aware one needs to be meaningfully informed.

BY Stef Prina, CEO, correlec.com

Correlec was created to offer professionals in the electronic industry an efficient and comprehensive online working tool to simplify or even eliminate many of the tedious aspects involved in the search for data. We are daily flooded by data, but it is time consuming and absorbs valuable resources to search through numerous websites, collate data and present it in a meaningful format.

For this, Correlec was born. Correlec transforms disperse data into correlated information, ready for use.

Figure 1: Search by Part Number.

Figure 2: Search by Product Type.

How? Supported by substantial investment from the private sector, we merge in-depth knowledge of the industry sectors we cover with cutting-edge IT technology. Our own specialists from the electronic industry, some with more than thirty years experience, work side by side with IT specialists to provide in-depth and qualitative information. The IT platforms at our disposal allow our senior programmers to create targeted, customized and very efficient search engines which, daily, search the web and collect data, then classify it as directed by our industry specialists. Our data banks, in continuous expansion and updated constantly, can then be queried by our customers who, with only a few clicks, can filter, group and sort the data they require and, ultimately, compile a document in the format of their choice, ready to use, present or distribute.

CorrelecPro™ is a unique online interactive tool for professionals in the electronic industry, who prefer evaluating results to searching innumerable websites for information.

It is designed to serve a wide variety of requirements: marketing, product development, sales, supply management, risk management, design engineers of equipment, distributors, spare parts providers, design centres, Universities …

Subscribers can filter our entire data base by simply inputting a part number, or part thereof, in the apposite "Search by Part Number"

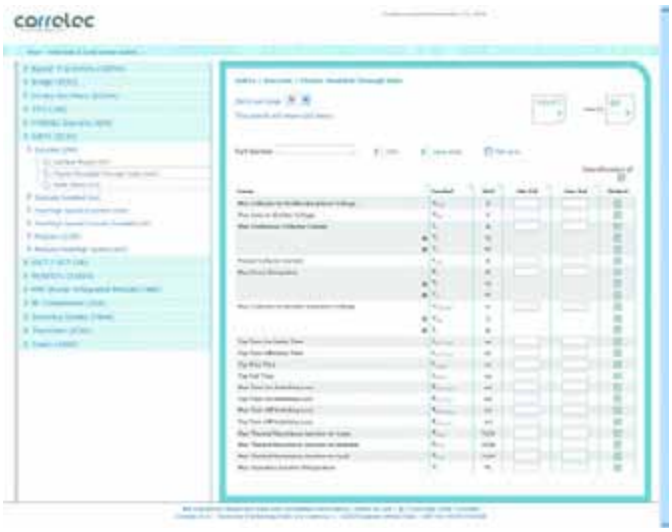


Figure 3: Using the apposite parametric query module.

module (Figure 1), or by navigating the product tree in the "Search by Product Type" module (Figure 2).

The "Search by Part Number" results in a table which includes the original manufacturer's name, the most significant electrical parameters, case type, circuit, and a direct link to the manufacturer's data sheet. One click extracts automatically all similar products in our data banks, or by using the apposite parametric query module (Figure 3), full filtering options are available.

Figure 4: Output of the Search, ready for further sorting, comparing data, printing final report

The same parametric query module is obtained by choosing the "Search by Product Type" module and by navigating the product tree to refine the filtering according to chosen criteria. The output of the search, (Figure 4), which contains by default all parameters or, at the user's discretion, only those pre-selected in the query module, can then be sorted in innumerable ways, with data shown in horizontal or vertical format.

Very powerful yet easy to use, CorrelecPro™ does not require the installation of any software, does not interfere with any existing IT internal infrastructures or business processes, produces immediate results. Correlec is not associated to any manufacturer, distributor or association thus guaranteeing its autonomy and impartiality.

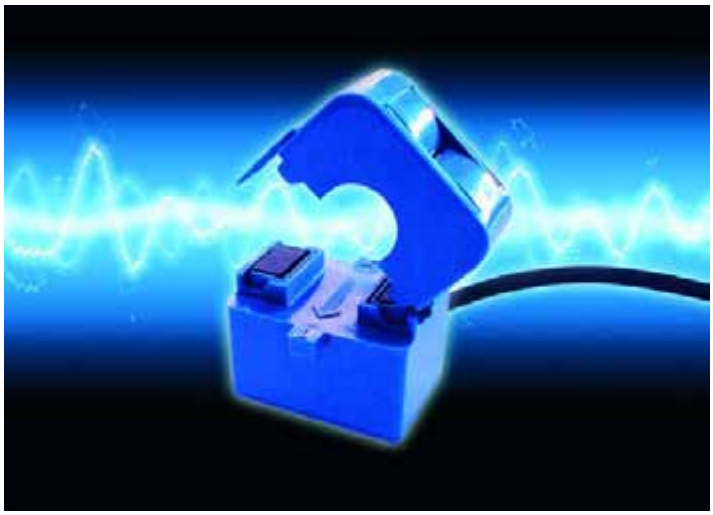
There are no limits to the potential of this product, both as an online tool or as a means to provide custom products. Content and functionalities are being added on a continuous basis and, very soon, product status, availability and pricing will be a feature of our offering. The semiconductor sector is rapidly being completed by adding PICs and components for the microelectronic industry, but our vision is to eventually cover a wide variety of sectors of the electronic industry, to include active and passive components, sensors, electro-mechanical components as well as equipment and electronic/electrical systems.

Now navigating through constantly changing websites in search of data, downloading it, collating it in a format you need, is a thing of the past.
Now there is Correlec, your partner for enhanced productivity.

www.correlec.com

Split-Core Current Transformers

LEM has introduced the TT series of compact split-core AC current transformers.



These new devices feature an innovative type of core material, enabling this technology to be the first to offer high performance coupled with an attractive price.
The core material used in the transformers is a new type of ferrite with improved magnetic permeability, allowing the accurate measurement of AC signals in a extended frequency range that includes 50/60Hz. The new transformers feature an absolute accuracy better than 1 percent at the nominal current and even better for lower primary currents. The ferrite material provides an excellent linearity of better than 0.1 percent even at very low levels, and the transformers have a particularly low phase shift between measured voltage and current of 1.5° ±1°.
The hard and dense core allows very small air gaps to be achieved and is virtually insensitive to ageing and temperature changes, in contrast to laminated FeSi or FeNi materials.
Two ranges of primary current measurement are available: 50A and 100A.

www.lem.com

pcim.de

PCIM Europe 2007

International Exhibition
& Conference for

POWER ELECTRONICS
INTELLIGENT MOTION
POWER QUALITY

22 – 24 May 2007
Exhibition Centre Nuremberg

Power On!

Mesago PCIM

Organizer:
Mesago PCIM GmbH
Rotebühlstraße 83-85
D-70178 Stuttgart

Exhibition:
Linda Raidt
Tel. +49 711 61946-56
E-Mail: raidt@mesago.de

Conference:
Lisette Hausser
Tel. +49 711 61946-85
E-Mail: hausser@mesago.de

High-Side Intelligent Switches

International Rectifier has introduced the IR331x family of high-side intelligent power switches (IPS) devices with accurate current-sensing and built-in protection circuits for 14V automotive applications. The new IPS devices enhance reliability in integrated lighting modules, intelligent glow-plug controls, auxiliary positive temperature coefficient (PTC) heaters for HVAC systems, engine cooling fan drivers and interior fan controllers.

The IR331x family provides accurate current feedback to ±5% at maximum load current over the entire operating temperature range and demonstrates improved accuracy at low load current. In pulse width modulated (PWM)-controlled applications, the accurate current-sensing feature provides the required feedback that enables a microcontroller or ASIC to control the load current. The current feedback bandwidth is 100kHz, also suitable for topologies where a low-side switch provides high frequency PWM, and enabling protection and load-current sensing for unidirectional DC motor drive applications.

The current-sensing feature also enables precise monitoring of load current in order to provide additional data to the microcontroller for diagnostic applications. Typical examples include open-load detection for defective bulbs and lamps or early warning of overload conditions. In addition, the IR3316S provides a slow-switching version of the IR3310S, which can help minimize noise in EMI-sensitive automotive applications.

In addition to the current-sense feedback, the IR331x family devices integrate over-temperature and over-current shutdown as well as reverse polarity protection, simplifying wiring harnesses and increasing reliability. In many applications, additional protection devices such as fuses can be eliminated.

The over-current shutdown protection feature is programmable, which allows optimization according to the requirements of the load or the application. A soft-start mode is included for low-frequency switching.

In case of a reverse battery condition, an integrated protection circuit turns the main MOSFET switch on, helping to relieve the intrinsic body diode, reducing or eliminating thermal problems. Additional features such as ESD protection and an active clamp circuit guarantee safe operation and protection under harsh automotive operating conditions.

www.irf.com

Design Software for Transformer

Würth Elektronik “WE Flex Designer” is a practical design program for selecting WE-FLEX Transformers. It allows straightforward and fast selection of transformers for your application to facilitate the desired switching.

The product range of the transformers WE-FLEX from Würth Elektronik has 6 windings which can be individually switched according to requirements. You can implement about 500 transformer circuits with the 25 transformers in this product range.

To select an appropriate transformer configuration you simply enter your input and output parameters and the switching frequency.

After entering these parameters you will be recommended a suitable component with individual switching of the windings clearly explained.

Additionally to every component winding combination the input and output currents are indicated as maximum and rms values.

This function is fully adjustable for you to tailor the setup to your requirements.

WE-FLEX Designer – a must have for design engineers and everyone designing in transformers. Available free at:

www.we-online.com

1700V A-Series for Drives, UPS and Welders

Mitsubishi 1700V A-series combining 5th generation CSTBT (Carrier Stored Trench Bipolar Transistor) chip technology with LPT (Light Punch Through) wafer offers a low VCE(sat) (typical 2.4V at rated collector current and junction temperature of 125°C), low E(on) and E(off) and delivers a high short circuit robustness. This 5th generation IGBT Module has a low inductance package. Due to the use of AIN isolation substrate superior thermal resistance is achieved as compared to existing 1700V series in the market. The new series features improved temperature cycling capability by controlling the solder thickness between the base plate and AIN substrate. It has an enhanced power cycling capacity by new wire bonding technology.

1700 V A-Series, an extended voltage range of 1200V A-Series IGBT module, is available with a rated voltage of 1700V and rated current range of 75A to 400A in dual module.

RoHS compliance is achieved without affecting the temperature cycling and the power cycling capabilities of the device.

The new 1700V A-Series maintains the greatest possible compatibility with the 1200V A-Series generation and is targeted for 575V and 690V line voltage operated equipments.

www.mitsubishichips.com

PCIM China 2007
同期召开
electronica & ProductronicaChina 2007

SHANGHAI NEW INTERNATIONAL EXPO CENTRE

6. International PCIM Conference & Exhibition in China for POWER ELECTRONICS

第六届中国国际电子功率元器件研讨会暨展览会

PCIM China 2007

热诚欢迎

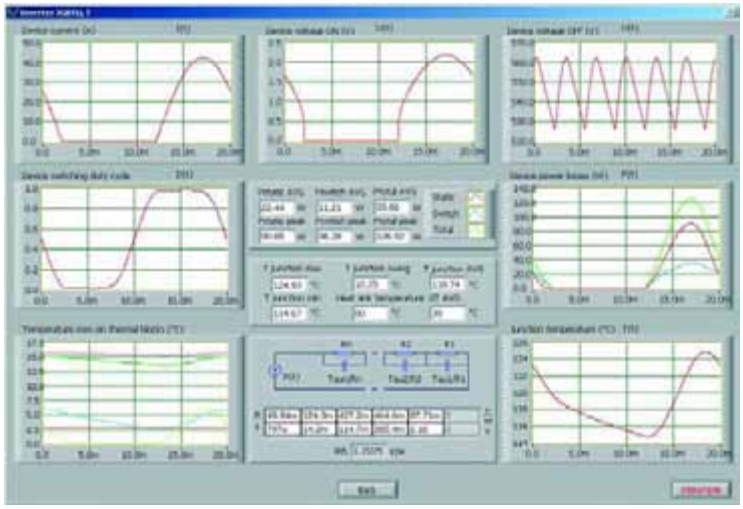
- 参加国际高层次会议
- 会见世界级著名专家
- 参观国际专业展览会

联系人：
韩彦
上海对外科学技术交流中心
电话：021-64712180
021-64311988-112
传真：021-64712001
E-mail:hanyan@sstec.com.cn

2007年3月21日—23日
中国·上海浦东

www.pcimchina.com

flowSIM Power Module Simulators



Tyco Electronics Power Systems releases the new flowSIM simulator for its Power Module products. This LabView based tool allows the simulation of three and single phase outputs as well as three and single phase input stages and PFC circuits, supporting applications like motor drives, solar inverter, UPS and switch mode power supplies.
flowSIM uses real measured data gathered during the characterization of the power modules for the calculation of the power losses providing access to up to 2 million data points per module. Previously this tool was only partly available for engineers in the application notes. This combination of simulation for the application output wave forms and calculation of the power component losses based on real measured data provides an industry-unmatched simulator performance in terms of accuracy and speed.
The picture shows the inverter stage detail information including power losses and dynamic thermal behavior of the simulated component which is also taken into account for the simulation. The detailed power loss information allows the designer to confirm the part selection in terms of switching speed and conduction losses. It also enables the calculation of total losses and therefore the validation of the selected heat sink.
Tyco Electronics will support all new standard products with the new flowSIM simulator, which can be downloaded free of charge from www.flowPIM.com.

www.tycoelectronics.com

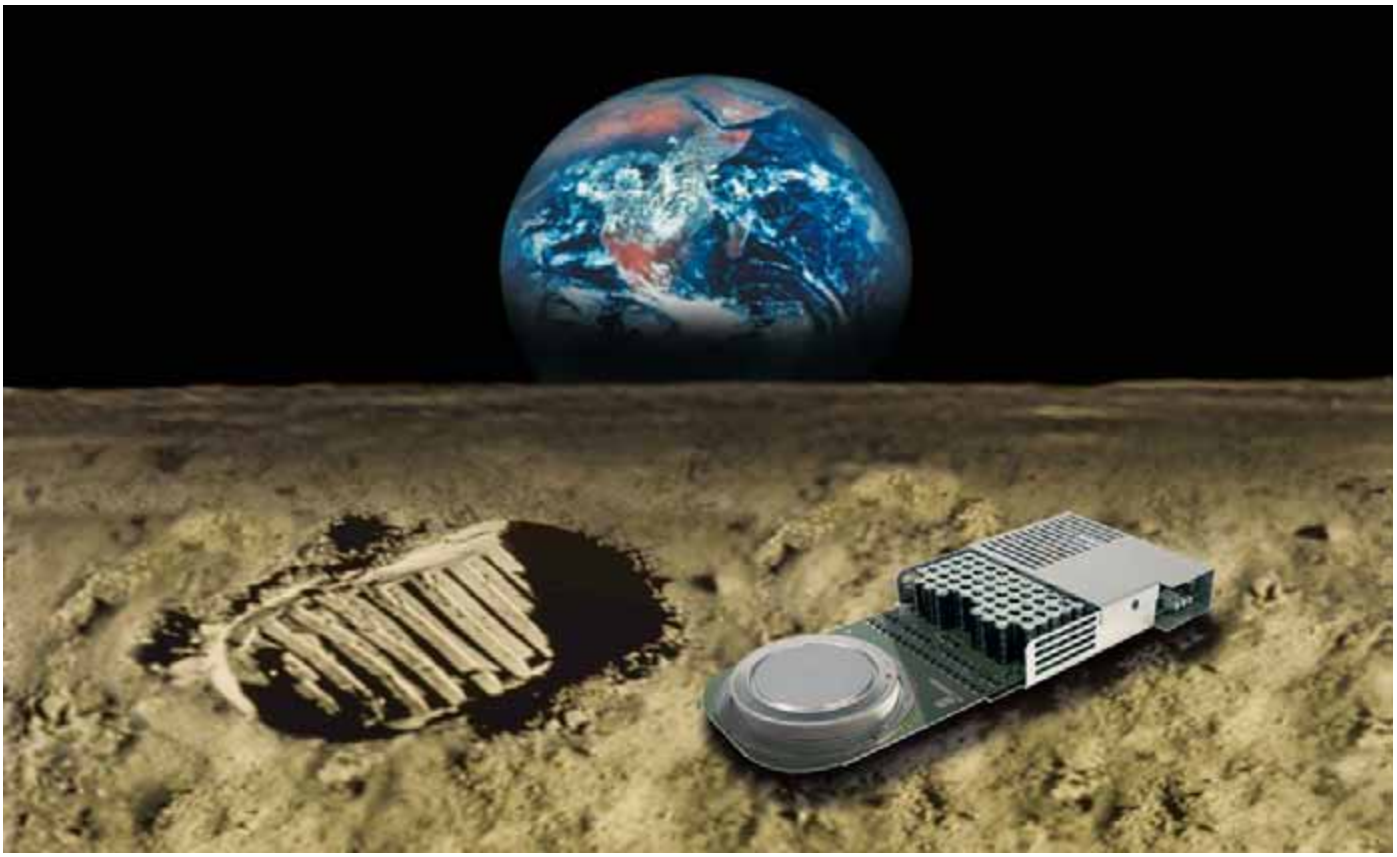
Optocouplers with Industry's Highest CMR Ratio

Avago Technologies introduced three new gate drive optocouplers optimized for reliability and performance. As equipment manufacturers in industrial automation and data center power supply markets transition to developing more energy efficient products which require fast switching operation, Avago has engineered new optocouplers with the industry's highest common mode rejection (CMR) ratio (40 kV/µs @VCM=1500V). Avago is a leading supplier of innovative semiconductor solutions for advanced communications, industrial and commercial applications.
CMR is the maximum slew rate of common mode voltage (VCM) which can be sustained, keeping the output in the correct logic state. CMR failure results in glitching on the output as either a positive or negative pulse. This key specification guarantees the reliable transfer of drive information at very high DC-link voltage and over fast switching operations.
Avago's new ACPL-3130, ACPL-J313 and ACNW-3130 gate drive optocouplers are ideal for applications such as isolated IGBT/MOSFET-gate drives for industrial inverters, switching power supplies (SPS) and uninterruptible power supplies. The optocouplers deliver 2.5 A maximum peak output current. Additionally, the products support a wide operating voltage range (15 to 30 volts) required by gate-controlled devices.
As part of Avago's extensive range of high-performance, isolated, gate drive optocouplers, the ACPL-3130 contains a GaAs LED while the ACPL-J313 and ACNW-3130 contain an AlGaAs LED. The new optocouplers have received approval in accordance with the following safety standards: UL (pending), CSA (pending) and IEC/EN/DIN EN 60747-5-2.

www.avagotech.com/optocouplers.

29 Palms

One small step for man…



… one giant leap for mankind!

HPT-IGCTs with astronomic SOA:

- 4500 V / 5500 A
- 5500 V / 5000 A
- 6500 V / 4200 A

Powerful efficiency – keeping our planet blue

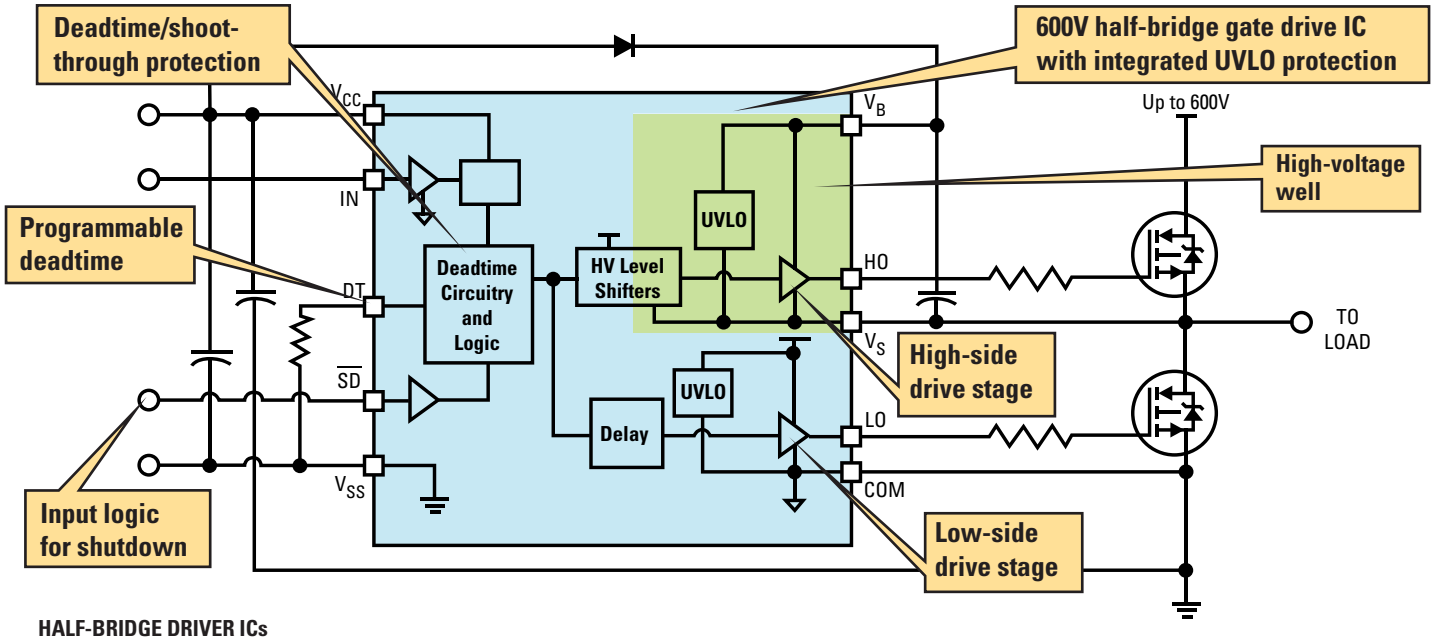
ABB Switzerland Ltd
Semiconductors
Tel: +41 58 586 1419
www.abb.com/semiconductors

Power and productivity
for a better world™

ABB

IR SETS THE STANDARD FOR 600V ICs

Rugged, Reliable, Highly Integrated



HALF-BRIDGE DRIVER ICs

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

INDEPENDENT HIGH- AND LOW-SIDE DRIVER ICs

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

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

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

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

Features:

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

**select models*

For more information call +44 (0)1737 227215
or +49 (0) 6102 884 311 or visit us at
www.irf.com/product-info/hvic

International
IOR Rectifier
THE POWER MANAGEMENT LEADER