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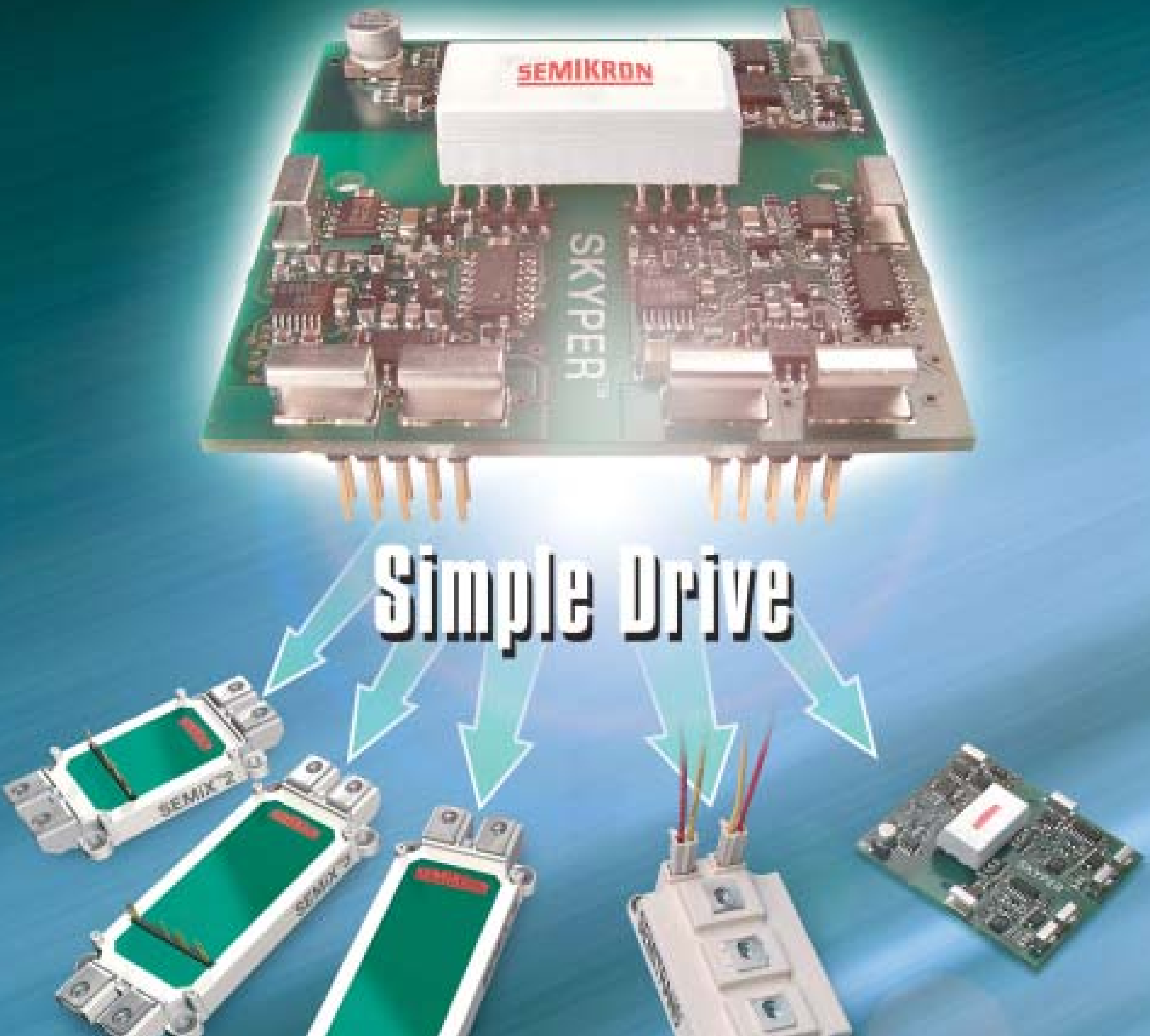
Power Systems Design EUROPE

Power Control Intelligent Motion
May 2004



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PCIM Nuremberg

IGBT Modules

AC Drive Systems

Air Cooling

SMD Microcoupler

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Power Systems Design EUROPE

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Volume 1, Issue 4

25 Years of Power Competence at PCIM

All engineers are on their way to Nuremberg to have their most important event throughout Europe. Their interest is focused on power. Power is and has been the heartbeat of any electronics. We see the demands on power in our own homes that surges until the lights turn off and we have to use candles. A candlelight dinner is always fine, but most of our kitchen equipment runs on electricity today.

PCIM started originally as a conference and show in the US by Myron Miller. PCIM was taken to Europe and organized by Gerd E. Zieroth. Not many events like this can have a summary of such good history. It is nice to see Christine Zieroth together with Gerd E. Zieroth at the 25 anniversary fueling in the spirit of a big family day.

The technology for size and weight of a motor drive or of a power supply is influenced by other circuit requirements beside the power electronics. Power management starts at the device level with controller ICs that conserve energy by putting non-required functions to sleep or by slowing clock cycles, followed by the distributed power at the board level. Additionally, more and more system solutions are being incorporated to boost the design to higher levels of performance.

Modern controllers using C-MOS logic run at extremely low voltages. You need to consider the load and its conversion to obtain the correct voltage at the proper peak current. MOSFETs are the semiconductor elements that serve that purpose today. The controller serves for efficient handling in DC/DC conversion.

In motion IGBTs are the preferred switches at line voltage and above. We have regularly the IGBTs as discretes or modules in our editorial plan. Motion is one of the european topics in applications. The tooling machinery needs the drives. Tooling machinery is strong in Europe.

What does embedded technology do for power at that point? It depends upon the application. Individuals working on automotive controllers have seen the benefits quite clearly. Our vehicles continue to increase in the amount of control established with electronic functions. Likewise, the motor drive industry is a fertile applications arena for embedded solutions.

We in our magazine cover the entire gamut of applications in order to supply the power designer with up to date crucial information that can help to facilitate the design being considered. Articles contained in the magazine cover varied subjects in order to reach a wider audience. Today's availability of web-links makes it easy to follow up with more details such as data sheets and applications notes.

The PCIM conference has a platform to provide a future view into technology. The strength of this technology can conserve our rapidly depleting natural resources. It can improve our lives and it can be a means of ensuring future generations of a better world to live in. My association at PCIM Europe for more than one and a half decades as a board member of PCIM conference will focus strongly for technology and application in power.

I am again looking forward to seeing you at PCIM in Nuremberg, the place to meet the power experts. Nuremberg the heart beat in power electronics!

Best regards

Bodo Arlt
Bodo.Arlt@powersystemsdesign.com

Zetex Semiconductor Appoints Marketing Chief

Zetex Semiconductors has appointed Frank Marx as Chief Marketing Officer.

He takes responsibility for advancing the company's range of signal processing, power management and high performance power switching components. He also heads up global business development.

Mr. Marx brings with him 15 years of marketing management experience gained with leading semiconductor manufacturers including SGS-Thomson Microelectronics, National and Fairchild. He comes to Zetex from Fairchild Semiconductor where he was Director of Worldwide Marketing.

Mr. Marx holds a degree in Industrial Engineering (Dipl. Wirtschaftsing) from Munich University.

www.zetex.com

APEC 2005 Announces Call for Papers

The Applied Power Electronics Conference (APEC), the leading worldwide conference and exhibit for practicing power electronics professionals, is calling for papers for the APEC 2005 event to be held in Austin, Texas here, March 6-10, 2005.

APEC, jointly sponsored by the Institute of Electrical and Electronic Engineers (IEEE) Power Electronics Society (PELS), the IEEE Industry Applications Society (IAS) and the Power Sources Manufacturers Association (PSMA), is noted for presenting top-quality, peer-reviewed, non-commercial papers of practical importance related to the design and application of power electronics. During the APEC 2004 conference in February, nearly 300 papers were presented.

For APEC 2005, papers are being solicited in the following technical areas:

- Emerging Applications of Power Electronics in energy conservation, automotive, telecommunications, medical and other electronic systems
- AC-DC Power Supplies; DC-DC Converters; Uninterruptible Power Supplies; Motors, Drives and Inverters; Lamps, Ballasts and Lighting
- Power Factor Correction
- Topics related to Powering Electronic Equipment including system architecture and design issues, fault tolerance, stability and regulatory compliance
- Power System Design Tools and Techniques; Modeling & Simulation
- Manufacturing processes, quality systems, procurement and qualification
- Components for Power Electronics; Packaging of Power Electronics

In addition, papers are solicited covering topics related to The Business of Power Electronics, including new market developments, e-commerce, business models, and techniques for marketing, selling and qualifying electronic products.

Deadline for submission of paper abstracts is August 9, 2004. Authors will be notified of acceptance no later than October 18, 2004.

www.apec-conf.org

NPL Determines A Faster Route To Reliability

National Physical Laboratory has just completed a three year project investigating the impact of thermal cycling regimes on the shear strength of lead-free solder joints.

The purpose of this work was to undertake a comparison of accelerated test regimes for accessing the reliability of solder joints, in particular those made using lead-free solders. Samples were subjected to six different cycling regimes to investigate the effect of thermal excursions, ramp rates and temperature dwells. The most damage to joints per cycle was found to be caused by thermal cycling between -55 and 125 degrees C, with a 10 degree C/min ramp rate and 5 minute dwells.

Similar degrees of damage in the lead-free solder joints were experienced from thermal shock regimes with ramp rates in excess of 50 degrees C/min. However, these regimes, although faster to undertake, appeared to cause different crack propagation paths than observed with the thermal cycling regimes, although importantly still remaining within the solder. Since this is a small difference thermal shock testing may still be used to differentiate between, or enable ranking of, the effects of changes to materials or processes on the reliability of the solder joints. Hence, it is envisaged that if a wide range of conditions are to be tested a first sift can be completed using thermal shock, with the final work using more typical thermal cycling conditions. The difference between the SAC (95.5Sn3.8Ag0.7Cu) and SnAg (96.5Sn3.5Ag) solder alloy results across all types of cycles showed very little difference in rates of joint degradation. The thermal shock cycle will typically be at least a third of the time, so you will get there more than three times quicker. So, if you are cycling, typically up to 2000 cycles, significant time can be. NPL Report MATC(A)156.

For more information contact: Dr. Chris Hunt chris.hunt@npl.co.uk

Fairchild names Dr. Izak Bencuya Chief Strategy Officer

Fairchild Semiconductor announced the appointment of Dr. Izak Bencuya as chief strategy officer and Dr. Bencuya, currently executive vice president and general manager of Fairchild's Power Discrete Group, will drive the direction and development of the company's power products across all business units and target market segments while retaining his current responsibilities. Dr. Bencuya has more than twenty-five years experience developing leading edge power solutions and holds numerous patents. Izak has a BSEE from Bosphorous University in Istanbul, Turkey, an MS and PhD in Engineering and Applied Science from Yale University and an MBA from the University of California-Berkeley.

www.fairchildsemi.com

Bergquist acquires Design-Mark Industries

The Bergquist Company has announced its acquisition of Design-Mark Industries, a leading supplier of graphic overlays, labels and decals. Design-Mark was founded as a screen-printed label manufacturer in 1971. The company has earned a reputation for excellence in the design and manufacture of printed industrial nameplates, graphic overlays and pressure-sensitive labels. Today, Design-Mark has one of the largest libraries of UL/CSA-approved label constructions in the industry.

Bergquist is recognized as a world leader in the design and manufacture of membrane switches. The company's HeatSeal technology results in a chemical bond between the switch layers that resists fluid ingression (a common cause of switch failure), even in the harshest industrial environments. Because of its extensive experience with industrial-grade overlays, Design-Mark is an excellent strategic addition to Bergquist's HeatSeal membrane switch business.

In addition to HeatSeal membrane switches, The Bergquist Company designs and manufactures high performance thermal management materials used to cool electronic components. Bergquist supplies the world with some of the best-known brands in the business: HeatSeal membrane switches, Sil-Pad thermally conductive interface materials, Gap Pad electrically insulating and non-insulating gap fillers, Hi-Flow phase change grease replacement materials, Bond-Ply thermally conductive adhesive tapes, and Thermal Clad insulated metal substrates.

www.bergquistcompany.com

Adiabatic Logic and IMEC

Adiabatic Logic a Cambridge-based company focused on creating and licensing intellectual property (IP) in the low power technology arena, has signed a co-operation agreement with IMEC, Europe's largest independent microelectronics and nanotechnology research center, which will lead to its patented low power Intelligent Output Driver (IOD) technology being used by IMEC in radiation hardened environments, such as in space applications, where power optimi-sation is imperative.

Adiabatic Logic's IOD IP cell is designed to replace the conventional pad drivers in an inte-grated circuit (IC) and uses a patented energy recycling technique, which delivers 50-75% power savings in chip I/O for portable devices such as laptops, smartphones, handheld com-puters, digital cameras and MP3 players.

IMEC's design against radiation effects (DARE) library consists of 60 core cells, 32 in-put/output cells (including low-voltage differential signalling (LVDS)) with enhanced electro.

www.imec.com

SmartDrive appointed as UK distributor for Tamagawa motors and encoders

SmartDrive, the Cambridgeshire based supplier of motion control solutions, has been appointed as the exclusive UK distributor for the Motortronics (ranges of stepper motors, servo motors, resolvers and encoders from Japanese manufacturer Tamagawa).

Founded in 1938, Tamagawa is one of the world's leading suppliers of precision motion control systems, and its products are widely used in industries as diverse as automotive, factory automation, scientific instrumentation and arcade games.

Commenting on the new agreement, Jon Bentley, Business Development Manager of SmartDrive, said: 'Tamagawa has a world-wide reputation for quality and reliability, and their products fit very well into our overall portfolio. When combined with SmartDrive's own engineering expertise in the development of stepper and servo drive systems, they will enable us to offer a complete package of precision motion control solutions for a variety of industries.

An important feature of the Tamagawa approach is that the company is happy to produce 'specials' in relative small quantities - something that fits in very well with SmartDrive's philosophy of producing complete motion-control solutions for customers in areas such as scientific equipment and laboratory instrumentation—where smaller production runs of relatively high value are typical.

"The requirements of this relatively new—but expanding—market create new demands in terms of precision, accuracy and smoothness on motion control systems", adds Jon Bentley: "and Tamagawa's market-leading resolvers and encoders are ideally suited to the requirements of this sector."

Pictured following the signing of the SmartDrive/Tamagawa agreement are (left) Dennis Murphy, Managing Director of SmartDrive and (right) 'Mac' Masaki, Overseas Sales Director of Tamagawa.

www.smartdrive.co.uk

Power Events

- ***PCIM 2004***, *May 25-27, Nuremberg, Germany; www.pcim.de*
- ***Fisita 2004***, *May 23-27, Barcelona, Spain; www.fisita2004.com*
- ***SMT/HYBRID 2004***, *June 15-17, Nüremberg, Germany; www.mesago.de*
- ***PESC 2004***,*June 20-25, Aachen, Germany; www.pesc04.org. Jointly organized with VDE/ETG CIPS 2004*
- ***EPE-PEMC 2004***, *September 2-4, Riga, Litvia; www.rtu.lv/epe-pemc2004*

Smart Power to the World

What it is the definition

Smart power starts at the device level based on controlling functions as a single chip approach handling power switches. Smart stands for intelligent functions to protect also the device from failures. The most critical failure is to destroy the device.

By Bodo Arlt, Power Systems Design Europe Editor-in-Chief

Smart Power by definition being monolithic has limits by technology and the cost for alternatives in design. A frequently asked question is; what is Smart Power? We see a certain amount of driver ICs that work in the lower voltage range covering handheld equipment and automotive. IC process technology allows control functions and switches like MOSFETs on the same die. ICs need more than double the amount of wafer processing steps than a MOSFET. Producing a MOSFET in the IC process technology will require the IC cost for the die space so the technology must benefit for doing things like that. Higher operation frequency can be one point.

There has been examples in the past for DCDC convertion shown by the GE-solid state later on Harris for custom design at IBM. Heat dissipation has been one major topic beside cost to make that product widely usable. Breakdown voltage for these processes are running at and below 100 volt. The amount of masks that are needed makes the MOSFET very costly. So what we see is a limitation of max current in most applications. Often we have the option to add an external MOSFET as the switch for extended power range.

Automotive applications have a strong interest to have a monolithic device to reduce the failure rate in systems that require reliability at higher temperature. The range of Smart Power solutions had a wide promise in the past. People from a major semiconductor manufacturer proposed MC controller fully integrated with protected MOSFET switches about decade ago. These products had been targeted for automotive. The world is still waiting for that unicorn.

The reality is that substantial functions for self protection and overload conditions get more and more integrated in the switch side. Current limiting MOSFETs have been serving the automotive needs. 60 to 80 volt breakdown with active clamping gives extended ruggedness inductive clamping requirements. The bipolar transistor between gate and source pulling the gate down was a very smart introduction by RCA a while ago. A number of people followed this economic approach and we see a volume market driven from volume applications in automotive. Ignition IGBTs in combustion engines have also active clamping and gate zener diodes to protect them from damage. These products are more or less known as intelligent discretes.

So automotive shows up as one of the most important Smart Power areas today.

Looking into motion and having electrical drives we learned by talking with experts in the lower end of the motor drives that we have a long way to go to get monolithic solutions. Trial and error in the washing machine drive has shown that more work has to be done to have a product that withstands inductive clamping. We are back to thermal management. Any losses will generate elevation of temperature in the device. As monolithic solutions concentrate the heat to small area in worst case conditions. Quickly the maximum junction temperature is reached and every thing above it starts to destroy the device. Integration of IC technology and IGBT switches is still not a common subject for the market.

IGBTs have break down voltages at 600 and 1200 volt for variable speed three phase motor drives. Most IC technology is below 100 volt. Only very few semiconductor manufactures have IC technologies that allow to match the IGBT voltages. Mostly these ICs at high voltage are used to build the driver for the switch on a multiple die approach.

On a multiple die approach we see a number of products that also use the smart power phrase having multiple die in one package. To a certain extent modules like six-packs or full motor stage having intelligent drivers included are possible to be counted as smart power. I remember statistics that had counted the level of power dissipation of an IC to be rated for smart power. What happened was bipolar digital logic ICs with poor performance became smart power ratings. The market study showed a digital logic maker as the leader in smart power. That is only about a decade ago before CMOS logic had taken over any logic for power dissipation reason.

Like we look into power management, it depends upon the application. Individuals working on automotive controllers may define 42 volts as being a high voltage, high power. Conversely, those in Europe operating at 240 volts or 420 volts, consider any value of voltage below these values as low voltage. However, this voltage region is the most commonly used in industrial and commercial electronics.

The IC manufactures are looking to applications in communications, computer and the portable and wireless portion of that business. Here we have the strong demand to use the give energy at the best performing efficiency. IC makers like Lattice, TI and others playing here are using complex structures to have parts of the IC put to sleep when they are not needed and have algorithms to wake them up if they have to contribute to the process. Here we have smart power if switches have significant current capability at the outputs.

Coming back to the roots means that thermal management is regulating the design of smart power. To distribute the power switches across a wider area allows a better thermal management. Anyone in power needs to realize this and design in multiple packages makes sense. The driver may count for smart power while the switches remain discrete devices. That is true for motion as mentioned before.

Power supplies may have portions of MOSFETs in half bride configurations together with an driver IC. All are single chips mounted together in special packages to build a smart power device.

Finally it is up to you to define your application need to look for a solution. Most of the smart power solutions are custom designed volume products that get a second chance as a standard product.

Simulation had made a significant contribution to smart power. Nowadays we have the product virtually ready to go for production with very close to reality results. The more advanced software and the extraction of data from devices in semiconductors including thermal details provides the platform that allows to work straight ahead. The simulation starts on semiconductor design level and goes step by step to include the surrounding elements to simulate total systems.

The computers of today have increased calculation speed together with “unlimited memory space”. Working with these tools today have much more detailed information to describe all elements more complex and have much more accuracy in the model. That includes today thermal behavior, something very crucial to smart power.

The main property of high density MOSFETs is below 100 volts breakdown. MOSFETs are today robust switches with a repetitive avalanche capability to make them safe in rough applications. Most of them have a very dense structure and use trench design. Something hard to use optimized in both the IC design and the MOSFET design in one process.

Smart power is wide area to understand and everyone has their own interpretation.

www.irf.com
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www.toshiba-europe.com

Quenching the Thirst for Information

By Dean Henderson, Intersil

How much do we take technology for granted? Reflect back a decade ago and think about your environment. A typical PC was a desktop 486DX2 50MHz based with 8MB main memory, 340MB hard drive, floppy drive and a CRT color monitor. Doom was voted game of the year. By the end of that same year our pride of ownership in such a system melted to embarrassment as newer systems more than double the processor speed. System memory of 32MB was available and hard drive storage affordability of 1.2GHz was commonplace. Surfing the Internet was taking off but content was limited, so were the number of web sites. There were less than 3,000 websites in early 1994.

The thirst for information has fueled an insatiable appetite, which is instantly available via the Internet. Growing at a logarithmic rate, there are over 100 million web sites today. Desire for more content, including a much richer user experience of audio and graphics content has been the market driver shaping information technology and high-speed data access.

Personal computers are the primary portal to this information and processors are the heart of the PC. In 1994 Intel introduced the DX4 processor with16KB of cache. The processor incorporated 1.6 million transistors, and operates on 3.3 volts with power consumption less than 5 watts. Linear regulators effectively powered the system where just a few voltage rails were needed. They were cost effective, power dissipation was very manageable and the average digital designer felt at ease designing with them.

Keeping pace with the information thirst, today's CPUs clock at over 3GHz with three levels of cache memory, 800MHz system bus and an endless stream of micro architecture advancements. Now comprised of over 400 million transistors, CPU cores operate over programmable voltage levels in the 1V range. Currents of 40 to100A are the norm. Voltage regulation in terms of absolute value has become much tighter at these low voltages and much more difficult to obtain. Compounding this is the need for dynamic response able to keep up with the rigors of severe step load changes that within a matter of a few clock cycles may slew 10 to 20, or more, amps. Dedicated power engineers have long since replaced the digital designer working with linear regulators. Multiphase converters have replaced single-phase converters years ago. A parallel story can be told regarding the tremendous evolution and associated power challenges for dedicated graphics processors.

At Intersil we led the efforts in PC power management since 1996 where we've shipped over 1.5BU of power management products. We've shipped more multiphase controllers than all others combined. Serving notebook, desktop and file servers our focus has been on CPU & GPU controllers, ACPI, DDR and system regulators. In the near future we will be sampling technology advancements that eases the design burden while meeting the performance challenges. Beyond PCs, smart information appliances will quickly surpass the former in terms of user access to the information highway. We are well positioned in battery management with some of the best battery charger products in the industry and products in development that address accurate fuel gauging.

Whether it is 48V DC-DC converters that are powering the internet infrastructure, POL power in switchers & routers or more consumer oriented with home gateways and WiFi, Intersil is focused on fresh ideas for solving the power problems of today and tomorrow with committed R&D focusing on challenges in desktop PCs and servers, notebook PCs, handheld Internet appliances, and a wide range of consumer products.

Have we hit a power plateau? Has the thirst for information been quenched? Hardly! Meeting the future power needs will require continued innovation.

www.intersil.com

SKYPER - Modern and Simple Driver

Flexible interface between IGBT modules and the controller

A driver is the core element of any power electronic system solution. For this reason, the choice of driver is closely linked to the degree of reliability of any such system. This in turn means that, in addition to system flexibility and user friendliness, quality is one of the main demands for modern drivers.

By Markus Hermwille und Thomas Graßhoff, Semikron

The SKYPER concept from Semikron constitutes a flexible and expandable interface between the different IGBT modules and the controller. Because of its sheer simplicity it is the perfect driver solution for any converter. It is a new driver family based on a driver core concept. This core is a half-bridge driver which compromises all basic driver function. Thus it can be directly used to build up a driver solution for any IGBT module. The SKYPER circuit is based on the established technology used in the SKHI 22A driver from Semikron, which has been used successfully in hundreds of thousands pieces in all kind of different applications.

Simple & Functional (Standard Version)

Besides the basic driving function and electrical isolation, this solution also includes VCE monitoring, undervoltage monitoring, short pulse suppression and TOP-BOTTOM interlock, the latter functions being integrated into an ASIC on the primary side (Figure 1).

Pulse transformers (with 4kV isolation voltage) are used for electrical isolation and are applied bidirectional in order to transfer the driver signals and status signals on the secondary side. Potential-free power supply is integrated via a DC/DC converter. That means it needs only one none-isolated +15V power supply.

Besides electrical isolation, further functions are integrated into the primary and secondary sides of the drive to ensure safe system operation. The primary side features signal processing for the CMOS-compatible signals and includes an interlock function which prevents the TOP and BOTTOM IGBTs of the same leg from being turned on simultaneously.

On the secondary side, an integrated V_{CE} monitoring function detects short circuits or shoot through conditions. The V_{CE} monitoring makes use of the relationship between collector current and forward voltage. The collector-emitter voltage is detected by a fast high-voltage diode and compared to a reference value. If the reference value is exceeded, the error memory will be set and the transistor will be turned off. The fast desaturation process in the transistor manages fast detection of short circuits. To guarantee safe turn-on of the IGBT during normal operation, V_{CE} monitoring is delayed until the IGBT is fully saturated.

If the driver supply voltage drops, the secondary control, protection and transmission functions may fail. Moreover, the power transistors can no longer be fully controlled or blocked. In order to detect this critical state in time the power supply of the driver is monitored. In case of a failure all IGBT switches are being turned off in a safe mode and an error signal is set.

If an error is detected, it is stored in the error memory on the primary side, where it is then passed on to the external system controller (Open-Collector output).

Extended Monitoring & Protection (Premium Version)

Figure 1 shows a block diagram of the premium version. In addition to the features included in the standard version, this version offers new functional blocks with extended driver and protection functions.

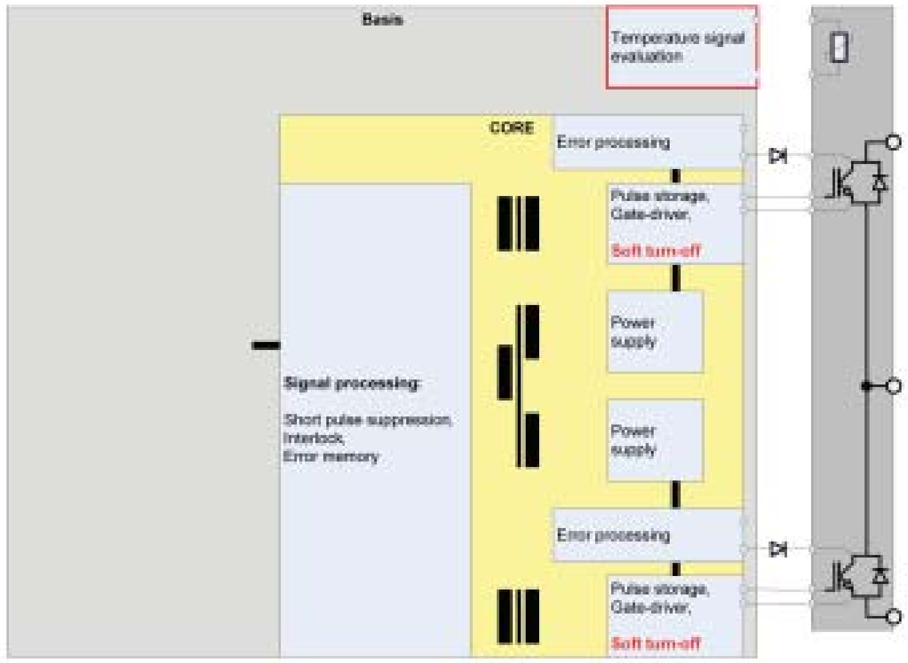

Figure 1. Block diagram driver core (premium features in red).

The secondary side of the premium driver core has an additional error input, which can be used for external overtemperature or overcurrent protection.

In case of a short-circuit, even at higher DC link voltages, an additional protection circuit turns-off the IGBT at lower speed (soft-turn-off). This produces a smaller overvoltage spike at short circuit turn off so that the device is protected even under extreme conditions. Additional monitoring circuits for power supply on primary side and secondary side were also integrated to achieve maximum protection levels.

Interface

Semikron has defined a new, future-oriented interface between driver and controller that meets every requirement. All of the signals have a clearly defined and very specific function. Great importance was placed on simplicity in operation. The signals in the interface were arranged in such a way that their logical connection can be assigned to different groups. These group allocations (segments) are mirrored in the signal arrangement in the plug. Although the interface includes all the features required for an expanded driver, the driver can also only be controlled and operated with very few base signals (TOP, BOT, HALT).

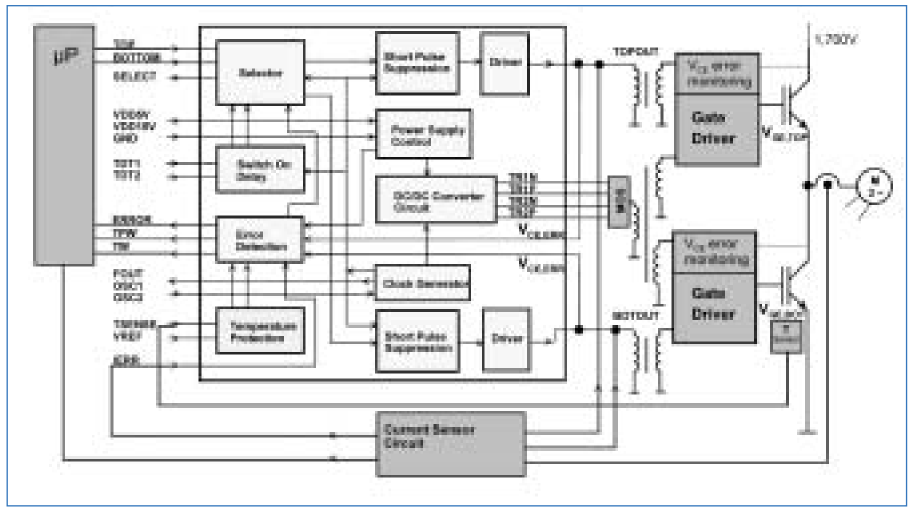

Figure 2. Block diagram ASIC.

Monolithic Integrated Circuit

The driver core is based on a monolithic integrated driver circuit developed by SEMIKRON. Fig. 2 shows the corresponding block diagram. The IC contains the following integrated functions:

- Short pulse suppression
- Pulse shaper
- Undervoltage monitoring
- Error detection, storage and output
- Interlock
- DC/DC converter driver

The above mentioned functions are available for two channels (half-bridges) on the primary side. If an integrated driver circuit (ASIC) is used, fewer discrete components are required for the driver core. At the same time, this reduction in discrete components means improved driver reliability and, consequently, better overall system reliability.

Simple Flexible

The driver solution for SEMiX power modules comprises a module-specific basis board and the universal driver core in standard or premium version. The driver core and basis board are connected using a plug and socket system, the result being an intelligent power module. The SKYPER has a complete end stage whose purpose is to drive the SEMiX IGBT module. Depending on the power semiconductor element to be driven, switching rates of up to 20 kHz and any duty cycle are possible. Module adaptation is carried out via the gate resistors on the basis board.

SEMiX & SKYPER – Modular IPM Solution

Conventional IPM (Intelligent Power Module) solutions for a power range of 2kW to 10kW feature integrated driver stages in one module. In these drivers, "quasi"-potential isolations such as level shifters are used instead of a galvanic isolation. Power module solutions also exist for the power range >10kW and feature integrated driver electronics. These IPMs fall short in that they have

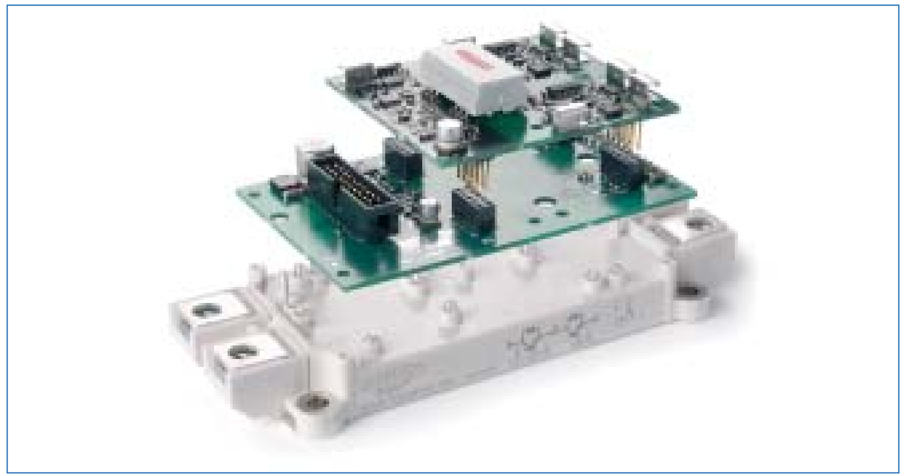

Figure 3. SEMiX & SKYPER.

no electrical isolation at all, meaning that additional external electrical isolation is needed and an interface and power supply board has to be developed.

In modular IPMs the driver is not a fixed integrated element. Instead, the driving element is mounted onto the power module to form what is known as an intelligent system. Unlike conventional IPM solutions, the SKYPER (drivers for modular IPMs) based on the SEMiX platform have integrated elements (DC/DC converters and pulse transformers) for complete electrical isolation.

Figure 3 shows a SKYPER assembled on a SEMiX3 half-bridge module. Soldered connections, cable connections and plug connections are not required for assembly. Instead, SEMiX spring contacts and the well-established snap-on technology are used for the electrical connection between the SKYPER and the SEMiX3 module. With a suitable basis board, an IPM in six pack topology is also possible.

Due to the simplicity of the driver and the flexibility to adapt the driver core to any IGBT platform (e.g. SEMITRANS, SEMiX), this solution from SEMIKRON is a excellent power electronic solution with technical support from a team of application engineers in over 50 SEMIKRON branches across the globe.

www.semikron.com

HiPak High Voltage IGBT Modules with SPT Chips

They are setting new standards in SOA performance

For the first time, the record-breaking SOA (Safe Operating Area) of these HiPak modules using ABB's newly developed HV SPT IGBTs and diodes is demonstrated. The devices have excellent overall electrical characteristics and are capable of withstanding extreme conditions during turn-off and short circuit operation thereby setting new standards in SOA capability for a given voltage class.

By M. Rahimo, A. Kopta,and E. Carroll, ABB Switzerland

This article presents the new high voltage HiPak IGBT module family with voltage ratings ranging from 2.5kV to 6.5kV. Trends for the development of IGBTs and diodes aimed for wide SOA limits are fuelled by many applications with operation under hard-switching conditions such as Traction, Industrial Drives, and HVDC. Compared to low and medium voltage devices (rated below 2000V), HV devices formerly exhibited lower SOA capability. This was due to physical constraints in the device structure and the high-stress operating conditions, mainly in terms of higher DC link voltages. Furthermore, the compromise between loss optimisation and SOA capability imposed additional restrictions in the design window of high voltage devices. To ensure that high voltage devices did not exceed their SOA limits, device manufacturers and system designers resigned themselves to a number of operational limits such as high gate resistances or voltage clamping. This required an increase in component count (for protection, control and de-rating) resulting in sub-optimal designs in terms of performance, size and cost of high Power Electronic Systems (PES). Figure 1 shows the two standard outlines of the current HiPak family of HV IGBT modules. As will be demonstrated later, this product range sets new standards of robustness for high-reliability applications such as Traction. Robustness translates to higher operating safety margins and low gate-drive resistance at turn-off, which, in turn, allows lower turn-off losses. SPT (Soft Punch Through) chip technology with its smooth switching behaviour, allows users the greatest freedom of design by not imposing dv/dt or peak-voltage restrictions at turn-off.

Figure 1. The new HiPak industry standard packages with 2500V-6500V SPT IGBT and diode technology.

It will be shown for the first time that the critical, formerly unsustainable, phase of dynamic avalanche is now not only the state-of-the-art for high voltage SPT IGBTs but that it can even be followed by a static avalanche previously known only in the case of low voltage MOSFETs. These newly available modules offer the ease-of-use long awaited by designers of high power, high voltage converters, by extending the device SOA limits as illustrated in Figure 2.

Table 1

Voltage	Current	Type	Part Number	V_{ce} 125°C	V_f 125°C	Eoff 125°C	Eon 125°C	Vdc
2500V	1200A	Single	5SNA 1200E250100	3.1V	1.8V	1.25J	1.1J	1250V
3300V	1200A	Single	5SNA 1200E330100	3.8V	2.35V	1.9J	2.0J	1800V
6500V	600A	Single	5SNA 0600G650100	4.7V	4.0V	3.5J	4.0J	3600V

Table 1. Typical characteristics under nominal conditions single-switch IGBT HiPaK modules.

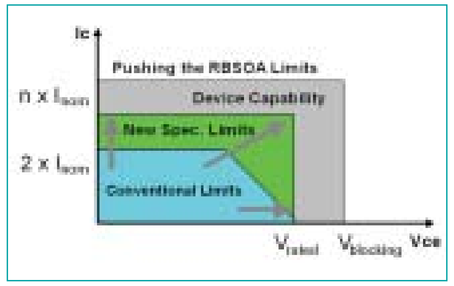

Figure 2. Extending the SOA limits of HV-IGBTs and Diodes.

The new module SOA capability shown in the grey area has a two-fold advantage for users compared to conventional available modules: First it will translate into larger operational safety margins for the system, and secondly, it will provide a new and extended specification limit for the SOA performance as illustrated in the green box.

High Voltage Chip-Set Technology

In order to achieve unrivalled static and dynamic characteristics for the IGBT and diode, the latest IGBT and diode technologies exploit the Soft-Punch-Through concept. This approach has allowed considerable reduction of overall device losses as compared to previous technologies.

The addition of a deep, low-doped SPT buffer region realises a reduction of 20% of the total device thickness when compared to an NPT design. The SPT buffer then ensures that such a device maintains soft turn-off characteristics. This is all the more necessary when the chips are employed in very high current modules such as the HiPak. High power, high voltage circuits inevitably have high parasitic inductances, which will cause voltage spikes and large oscillations at device turn-off, provoking Electro Magnetic Interference (EMI). In addition to these more obvious advantages of SPT, it will be shown here that SPT technology, allows significant increases in SOA for both the IGBT and the diode. The HV-IGBT design platform utilises an advanced and extremely rugged planar cell design developed for enhanced latch-up immunity for wide SOA performance. The input capacitance of the SPT IGBT has been designed to provide good controllability of the turn-on di/dt as a function of gate resistance while eliminating any need for an external capacitance across the gate-emitter terminals. This results in faster turn-on voltage decays for the IGBT, substantially reducing IGBT turn-on losses.

The IGBT chips are accompanied by a family of HV fast and soft recovery SPT diodes to complement the inherent advantages of the SPT IGBTs. The superior SOA performance of the HV-diodes was achieved through a highly doped P+ anode; resulting in extremely rugged performance compared to diodes with low P anodes. This is due to the elimination of the "reach-through" effect during reverse recovery under extreme dynamic avalanche conditions. The higher P+ doped anode also eliminates high fields and current crowding at the anode periphery during reverse recovery resulting in robust junction termination. By using a combination of local and homogenous lifetime control methods, the electron-hole plasma distribution is optimally tailored for controlled recovery and high SOA. Finally, good current sharing of the paralleled die in the high current module is ensured by a positive temperature coefficient of the on-state voltage drop for both the IGBT and diode.

The HiPak Module Range

The HiPak modules are high-power IGBTs in industry-standard housings with the popular 190 x 140 mm footprint. The initial ABB offering is for devices using Aluminium Silicon Carbide (AlSiC) base-plate material for excellent thermal cycling capability as required in Traction applications and Aluminium Nitride (AlN) isolation for low thermal resistance. Devices with copper base-plates and Aluminium Oxide substrates (Al2O3) are also planned for later introduction. Two housing types are offered: one with isolation voltage up to 6kVRMS and one with isolation to 10.2kVRMS.

To achieve the high reliability required by its targeted applications (e.g. Traction) the HiPak™ SPT chips have been optimised for reliable operation in harsh environments. This has been achieved through smooth switching characteristics an rugged performance - essential in the high-inductance environments of Power Electronic Systems (PES). Proprietary internal wiring and layout were used to minimise oscillations or current unbalance that might occur between the chips. Finally, the design was confirmed by standard HTRB (High Temperature Reverse Bias), HTGB (High Temperature Gate Bias), THB (Temperature Humidity Bias 85°C/85% relative humidity), APC (Active Power Cycling) and TC (Temperature Cycling) reliability tests.

HiPak Electrical Performance

The modules were extensively tested for their static and dynamic characteristics and SOA and an extract of the dynamic results is presented below. Typical characteristics under nominal conditions are summarised in Table 1 for the (140mm x 190mm) single-switch IGBT HiPaK modules.

Figure 3 shows the smooth ("soft") turn-off waveform of the 3300V/1200A HiPak (5SNA 1200E330100) at twice nominal current (2400A) and high DC voltage for the IGBT. Figure 4 shows the corresponding turn-off of the Diode under similar conditions. In both cases, the smooth, monotonic return to zero of the current should be noted. Equally smooth turn-off can be seen in Figure 5 and Figure 6 for the 2.5kV and 6.5kV modules respectively, also turning off twice nominal currents at high DC link voltages. No active clamps or snubbers were employed in any of the tests.

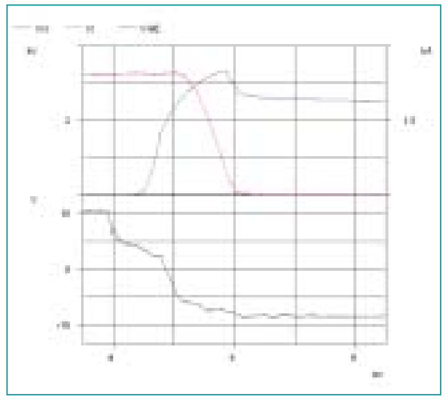

Figure 3. 3300V/1200A HiPak IGBT RBSOA during turn-off (V_{CC}=2500V, I_C=2400A) R_{Goff}=1.5ohm, L_S=170nH, T_j =125°C, no clamps.

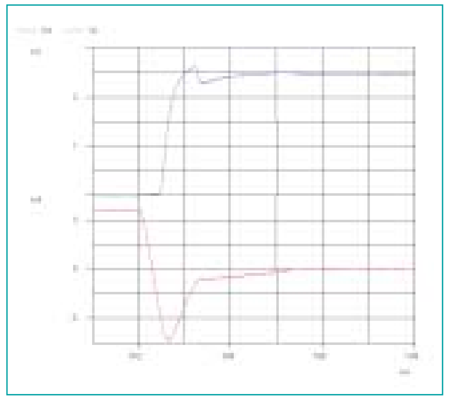

Figure 4. 3300V/1200A HiPak diode RBSOA during reverse recovery (V_{CC}=2500V, I_C=2400A) R_{Gon}=0.27ohm, L_S=170nH, T_j =125°C.

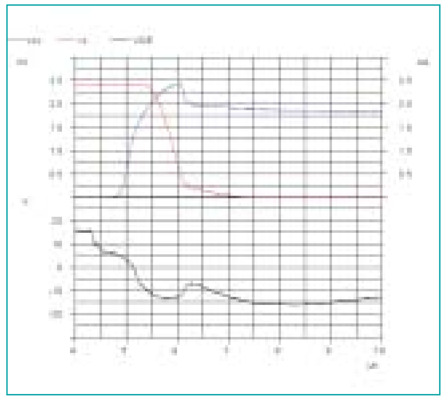

Figure 5. 2500V/1200A HiPak IGBT RBSOA during turn-off (V_{CC}=1800V, I_C=2400A) R_{Goff}=1.5ohm, L_S=110nH, T_j =125°C, no clamps.

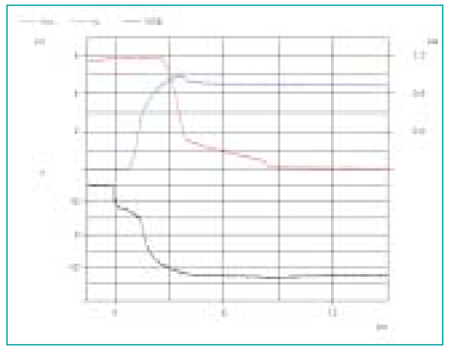

Figure 6. 6500V/600A HiPak IGBT RBSOA during turn-off (V_{cc}=4400V, I_C=1200A) R_{Goff}=2.7ohm, L_S=280nH, T_j =125°C, no clamps.

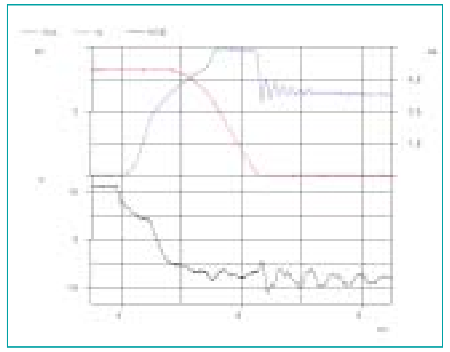

Figure 7. 3300V/1200A HiPak IGBT RBSOA during turn-off (V_{cc}=2600V, I_C=5000A) R_{Goff}=1.5ohm, L_S=280nH, T_j =125°C, no clamps.

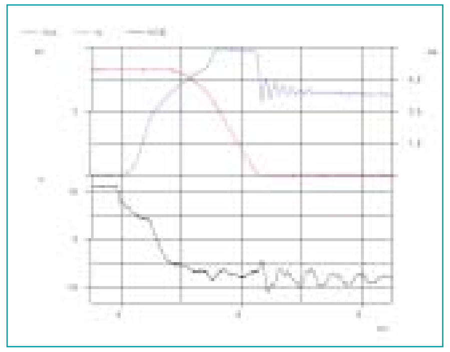

Figure 8. 3300V/1200A HiPak SCSOA characteristics V_{cc}=2500V, R_G=1.5ohm, V_{GE}=15V, T_j =-40°C.

A further advantage of an extremely rugged SPT IGBT, is that a lower gate-resistance can be employed which results in lower losses and shorter delay times during device turn-off. A conventional HV IGBT would have required a significantly higher gate resistance to safely turn-off the rated current. The new 6.5kV/600A HiPak module takes full advantage of this feature and as such is the first ever 6.5kV module capable of operating in the same way as lower voltage devices: full SOA is achieved without dv/dt or peak voltage limitations.

HiPak New Benchmark SOA Performance

As previously mentioned, not only is inherent smooth switching desirable for predictable (reliable) behaviour in inductive environments (large stray inductances) but also, the ability to absorb the resulting stored energy is essential. An inability to meet either requirement would necessitate costly de-rating of the equipment or (equally costly) special gate-units and construction. Figure 7 shows the turn-off of the 3300V module type 5SNA 1200E330100 at over four times its nominal current and at high DC link voltage with neither active nor passive clamping and without snubbers. The initial fast rise of collector voltage is followed by a reduced dv/dt indicating dynamic avalanche (normally a critical condition for snubberless turn-off devices) after which, the voltage rises quickly once more and is finally limited to the static avalanche voltage of 4kV. The collector current can be seen to fall to zero without snap or oscillation. The small oscillation in the voltage waveform occurs as the device voltage “leaves static avalanche” and jumps back to its DC link level resulting in resonance between the stray inductance and the device junction capacitance. A peak power of up to 14MW is dissipated during this turn-off event. Figure 8 shows the excellent Short Circuit Safe Operating Area (SCSOA) of a 3.3kV module at a low temperature of –40°C.

The high voltage HiPak industry standard module range using the newly developed high voltage SPT IGBT and diode chip-sets presents a clear breakthrough in SOA performance especially for higher voltage devices up to 6.5kV. Both IGBTs and diodes were designed to exhibit very wide SOA limits even under extreme test conditions, while still maintaining lower conduction and switching losses compared to previous HV designs. The establishment of this benchmark in SOA performance will provide new degrees of freedom for system designers.

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A One-Chip Solution for High Performance AC Drive Systems

Designed for industrial AC servo motors

Fast computation directly influences the dynamic performance of torque and speed of a servo system. The faster the update rate of closed loop current control is, the higher the bandwidth of torque control. This will in turn affect system turn around time or cycle time of the machine.

By Toshio Takahashi, International Rectifier

The motion control design process

Designing high performance servo control systems is a complex and time-consuming task involving many design engineers. Among the key design factors to be considered are control algorithms that critically influence the final system performance. These algorithms include various elements that interface to sensors closely coupled with power electronics circuits and elements. Position, speed and current are essential variables that need to be fed back from the appropriate sensors.

In addition to an open loop control, a three-phase AC motor requires Field Orientation Control (FOC). The FOC senses 3-phase motor current and transforms it into two variables: torque current and field current to simplify torque control. The closed loop current control contains two separate current control loops, one for torque current and the other for field current. Each loop is identical and consists of several control elements. Vector rotator, Clark transformation, Proportional plus integral, PWM, and current sensing are the essential control elements in each closed loop current control.

Traditional DSP and microprocessor solutions

Traditionally, with the exception of the PWM and current sensing functions, all control elements have been implemented by software code in a motion control DSP or microcontroller. In a real-time control environment using a DSP or microcontroller, these current control loops are implemented in high priority tasks that require intensive knowledge of real-time control to make sequential execution of each control element to complete computation within a specified time frame. These tasks, often driven by specific hardware events/interrupts, require precise execution timing of software, requiring sequencing of instruction coding to manipulate hardware at specific time in order to control a motor.

The FOC for servo application and sensorless control is written in assembly language rather than a high level language due to the fact that these applications often demand fast computation and update rate in order to satisfy growing demand for higher dynamic performance. Moreover, special coding techniques are sometimes required to achieve fast computation to overcome classic computation power sluggishness making programming a highly complex and time-consuming task. Therefore, developing a motion control algorithm quickly while achieving high performance is still a challenging job for high performance servo system and sensorless AC motor drive system development.

A new one-chip solution

To overcome these design issues, International Rectifier has developed two integrated circuit devices, the IRMCK201 and IRMCK203, that provide one-chip solutions for complete closed loop current control and velocity control for high performance servo and sensorless control applications. These digital ICs require only an inexpensive crystal resonator to feed the 33MHz clock and, unlike traditional microcontrollers or DSPs, do not require any programming effort to complete complex AC servo algorithm development, so once hardware is realized with the IC, motor tuning, for example, becomes readily available without spending the time and effort of programming because all functions are implemented in the hardware.

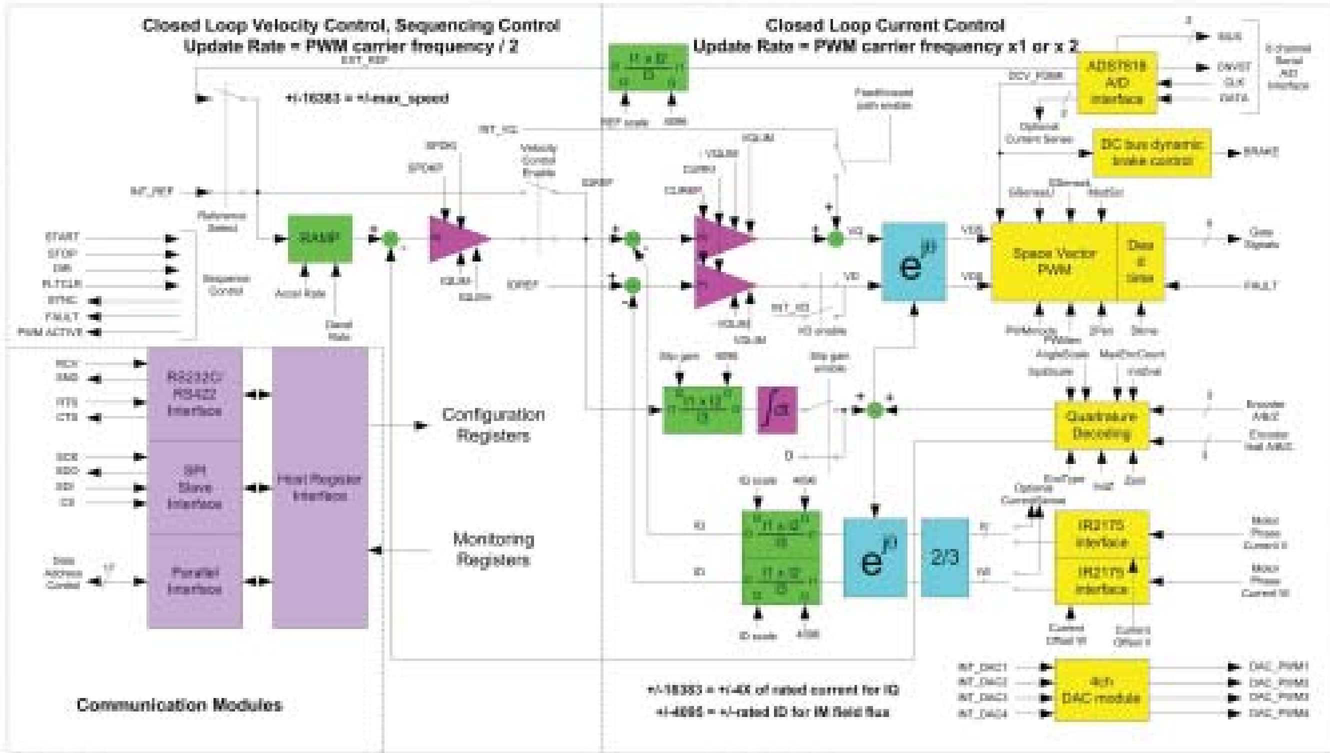

Figure 1. Detailed Block Diagram of IRMCK201.

No multi-tasking is required as these digital integrated circuits feature a Motion Control Engine (MCE) which comprises all the control necessary to perform closed loop controls elements including Proportional plus integral, Vector rotator and Clark transformation, motion hardware peripherals (i.e. Space Vector PWM, motor current feedback interface, encoder feedback), and flow control logic, that enable parallel multi-loop control. A synchronous execution mechanism of closed loop velocity control and closed loop current control is included in the logic hardware.

Designed for industrial AC servo motors, the IRMCK201, which is implemented on a 100-pin QFP package, implements all necessary functions of the encoder-based servo control in hardwired logics (Figure 1). As this IC does not require any programming and/or coding, it can be easily converted to a fixed function and hardwired logic IC as a stand-alone servo controller without requiring any PC interfaces at all. The configuration process to adapt a new motor and tuning is simple. It provides host registers that can be read or written by either a PC or a mating microprocessor through RS232C serial interface or SPI serial interface or parallel interface. Writing specific on the path can enable this control configuration.

Enabling and disabling the induction motor control can be done by simply closing or opening the switch, more precisely by writing a “1” or “0” value to the associated write register by the PC. The IRMCK201 also supports other structural changes such as interfacing with a different type of current sensors rather than IR2175 current sensing IC, enabling/disabling feed forward gain path in the current control, enabling/disabling velocity closed loop control, and selecting source of velocity command.

One significant advantage of the Motion Control Engine is the very short computation time required to complete closed loop control algorithm with deterministic timing. Fast computation directly influences the dynamic performance of torque and speed of a servo system. The faster the update rate of closed loop current control is, the higher the bandwidth of torque control. This will in turn affect system turn around time or cycle time of the machine. For example, a surface mount component insertion machine requires fast pick-and-place time to shorten the total cycle time to complete component assembly.

A digital servo drive, although very flexible, has not yet come close to analog servo drive when it deals with high bandwidth performance, especially high bandwidth torque control. This has been due mainly to DSP and microcontroller throughput limit stemmed from sequential computation mechanism of executing thousands of instructions one-by-one.

The Motion Control Engine removes this barrier and can run at even 40kHz PWM update rate or greater frequency update rate that is similar to an analog servo drive counterpart.

Figure 2 shows the step response of torque control loop. Two traces are torque current reference (“Iq reference” in the blue color trace) and torque current feedback (“Iq feedback” in the red color trace). The data was taken at a stalled rotor with 40kHz PWM frequency and 40kHz current control loop update configuration. The reference amplitude is 50% of the rated motor current.

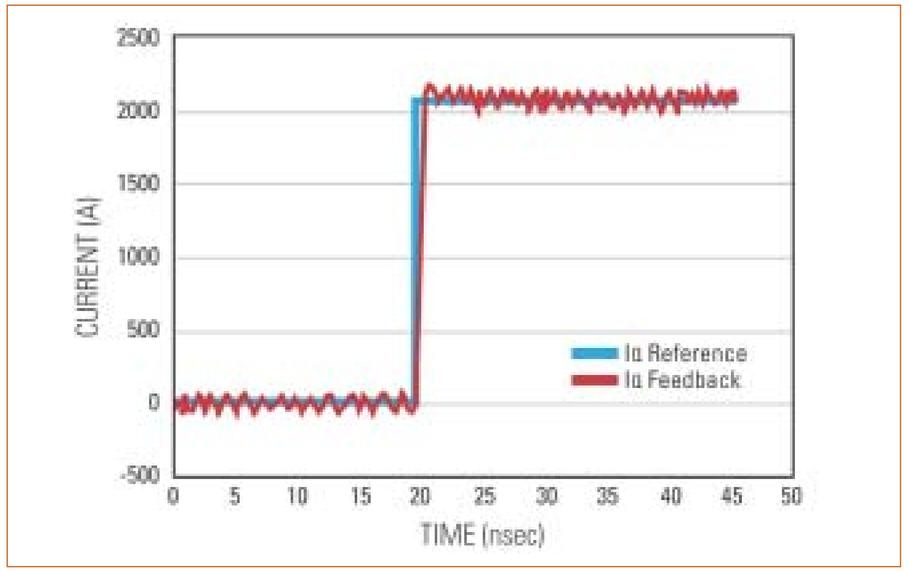

Figure 2. Step Response of Torque control loop.

As shown, it only takes approximately 350 microseconds for torque current to reach the reference.

The IRMCK201 can operate in a "stand-alone" mode without the host controller. A serial EEPROM can be utilised to load motor-specific parameters into the IC. The IC also provides direct interface to an inexpensive serial 12-bit A/D converter so that the system solution using IRMCK201 accepts industry standard +/-10V input for speed or torque reference. A 100-pin QFP small IC package together with the SO-8 packaged IR2175 current sensing IC enables significant size reduction of the final servo amplifier for cost sensitive application.

The MCE structure is also implemented in the IRMCK203, an 80-pin QFP package, to perform a complex sensorless control algorithm for permanent magnet motor. The permanent magnet (PM) motor has recently become a major power source in the appliance industry due to a greater energy efficiency focus and motor size reduction requirement.

Today's PM motor control still employs position sensors such as a hall effect sensor, and trapezoidal commutation. However, in order to achieve more efficiency while eliminating as many sensors as possible to meet cost reduction and increase system reliability, more advanced sensorless control scheme is required. The new level of advanced control requires sinusoidal commutation as opposed to trapezoidal commutation without incorporating position sensors. Computational power required to perform sinusoidal sensorless control pushes new envelope of the traditional DSP or microcontroller in terms of memory size and MIPS. Rotor angle estimation algorithm needs to be added in addition to the FOC algorithm.

For example, the new trend of air conditioner application uses a 32-bit RISC machine to achieve sinusoidal sensorless control [1]. In this example, the computation time for FOC together with sensorless control reaches already 60 microseconds and the memory usage is 128kbyte of ROM and 6k byte of RAM due to 32bit length of each instruction.

The IRMCK203 solves this bottleneck of additional computational power requirement by the MCE. Complete sinusoidal sensorless control algorithm run in 10 microseconds. This chip employs unique starting/ramping algorithm, and low loss energy efficient Space Vector PWM control (Figure 3).

Figure 4 shows two scope waveforms of the IRMCK203 controlling a PM motor. At the left scope picture, the motor phase current is shown from starting to ramping to steady state transition, where sinusoidal current control is

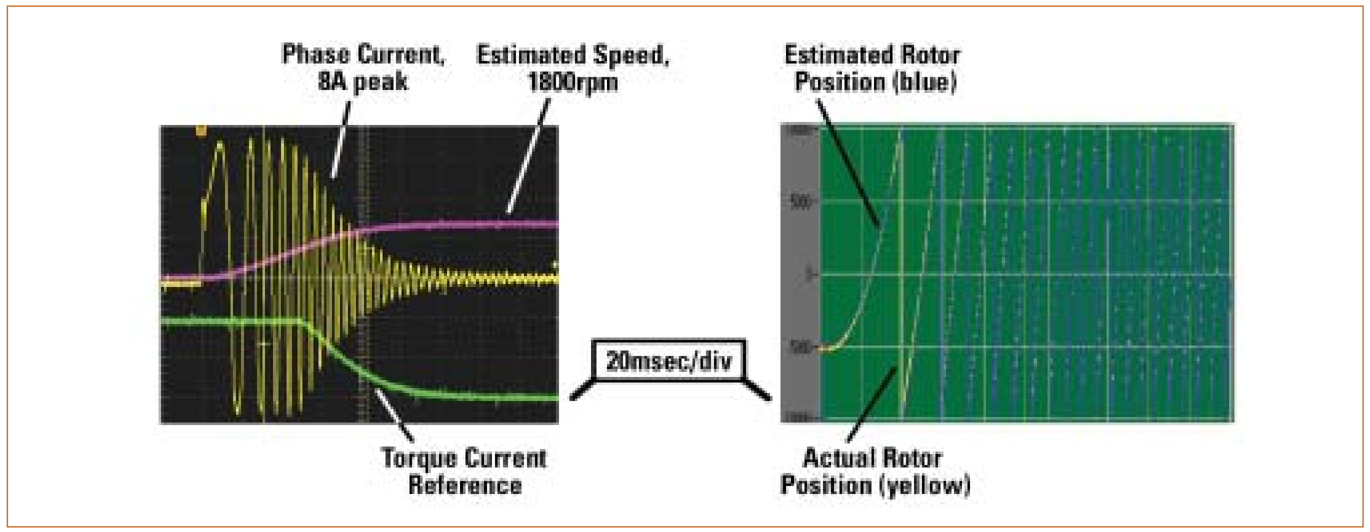

Figure 3. Sinusoidal sensorless control waveform.

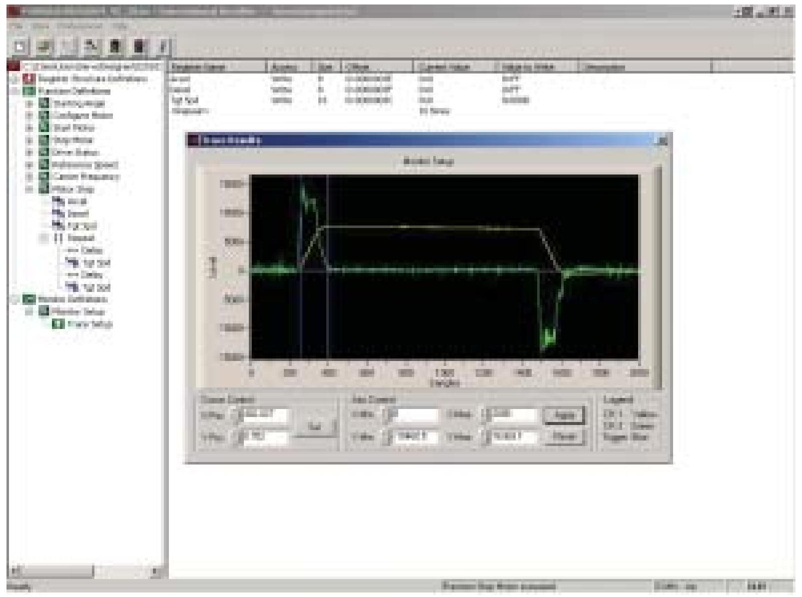

Figure 4. ServoDesigner tool.

clearly seen during acceleration with 200% of current control along with the internal data traces, namely the estimated speed and the torque current reference. At the right hand picture, there are two traces are superimposed each other showing the real rotor angle position versus the estimated rotor angle position. The test result shows that the rotor angle position error is less than 2 degrees.

Support tools

Although configuring the host registers is a simple process and does not require any programming or coding effort, it still requires writing specific values into each associated registers. ServoDesigner is a Windows®-based configuration tool, that maps the internal registers to configure motor type, motion peripherals, control mode, tune control parameters, and monitor and diagnose internal signal waveforms.

Conclusion

IR's digital ICs provide a dedicated solution for motor controls, reducing time to market by simplifying traditionally complex AC servo algorithm development and improving performance for sinusoidal sensorless control using a motion control engine.

The IRMCK201 is a one-chip solution for high performance precision motion control for industrial and automation applications. The digital IC eliminates complicated software programming, minimizes component count and reduces time-to-market. Alternatively, the IRMCK203 is a one-chip solution for complex sensorless control for light industrial application including pumps, fans, spindle, and dental drills, where energy efficiency and high dynamics of torque control is required.

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Air Cooling of High Power IGBT Packages

Cooling is a major limiting factor

High Power IGBT modules are currently used in power electronics systems due to their high performances and easy driving modes. The growing in terms of integration and compactness is resulting in an increase of power density dissipated at the case of the module. As a consequence, cooling is becoming one of the major limiting factor in designing modern Power Electronics systems.

By Pierre Lecocq, Ferraz Shawmut

Considering the latest three phase inverter module technology (1200V, 300A for example) with its standard package (162 x 122 mm_ contact surface), the maximal thermal resistance of the heat sink can be plotted versus the power losses, considering the following hypothesis :

Power losses :
- 2/3 dissipated in the IGBT
- 1/3 dissipated in the diodes.

Temperature :
- Tj = 125°Cmax
- Tfluid = 40°C.

Thermal resistance :
- Rjc = 85°C/kW per transistor
- Rc = 5°C/kW per module

This curve shows that with the above conditions:

Up to about 2500 W, an air heat sink or heat pipe can be used.
A liquid heat sink solution is needed above about 2500 W.
The maximal dissipated power for the "ideal" heat sink is equal to 5880 W.

Ferraz Shawmut Thermal Management, recognized as a leader in cooling systems for Power Electronics, is designing, manufacturing and marketing high performance heat sink solutions like cold plates, heat pipes and air heat

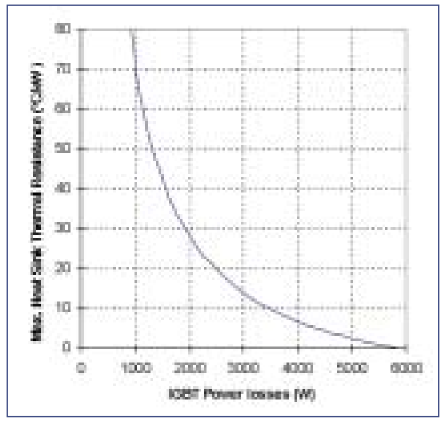


Figure 1. Maximal Heat sink Thermal Resistance versus dissipated power.

Figure 2. FABFIN air-cooled mixed-materiel heat sink technology.

sinks answering to this problem. The topic of the present discussion concerns the air heat sink optimization Thermal resistance, pressure drop, mass, volume, noise levels and cost are the main parameters to optimize following the application constraints. As needed before, a low thermal resistance for high power IGBT dissipation can only be achieved with heat sink having a high heat exchange surface/ base surface ratio R. R-Theta, a Canadian company, distributed by Ferraz Shawmut in Europe, offers such performances with its FABFIN heat sink family, using the patented swaging technology for the fins assembly onto the base plate (see Figure 2).

The problem, as in many applications is evidently 3 dimensional: the free in line R-Tools thermal code allows to compare the different solutions, avoiding costly experimental tests to our customers. A results example is given in figure 3. R-Tools is a registered trademark.

Figure 4 summarizes the simulation results, given the thermal resistance and pressure drop ranges for different air heat sinks :

A classical one piece extrusion heat sink (1) gives a thermal resistance

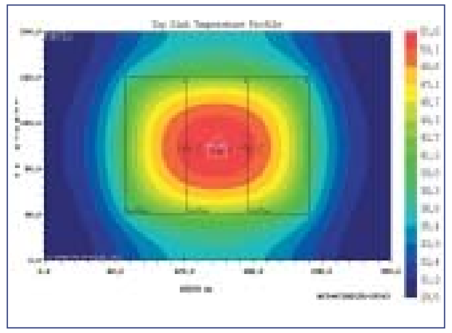
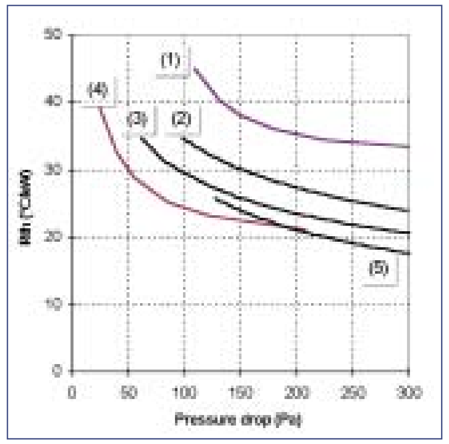


Figure 3. R-Tools thermal simulation results. (MF Fins heat sink - Pigbt=1000W - 100 l/s).

which cannot be lower than 35 °C/kW even at high flow rate due to a low heat exchange surface ratio R. (Rmax # 15)

The MF fins (2) offers an important gain in term of thermal resistance compared to (1) at a lower mass and compactness and consequently its maximal performance is limited by a high pressure drop due to a low air front section.
Increasing the heat sink width (3) increases by 50 % the flow rate for the same pressure drop and gives a 4°C/kW additional gain on the thermal resistance.

Another way to have a more important heat exchange surface is to increase the fin height instead of the base plate surface



Pressure drop (Pa)

n°	Fin Type	Base (WxLxT) in mm	Fin Height in mm
1	Classic Extrusion	200x200x17	60
2	MF Fins	200x200x13	49
3	MF Fins	300x200x13	49
4	Hollow Fins	200x200x13	118
5	MF copper Fins	200x200x13	80

Figure 4. Thermal resistance of different FABFIN air heat sinks for cooling a standard 162x122mm_ IGBT module.

by using copper or Hollow fins.

The Hollow fins (4) gives about the same thermal resistance than (3) but with an important gain on the pressure drop due to a large air front section even for a quite small base plate surface.
Using copper or a material with equivalent conductivity fins (5) on an aluminum base offers the best compromise in terms of compactness and thermal resistance due to a high fin efficiency, but with a weight penalty .Solutions 4 and 5 present also the advantage to have a lower temperature difference under the IGBT module, compared to solution with higher base plate surface, for a better uniform chip temperature.

The simulation results, given by R-Tools, shows that the FABFIN air heat sink technology offers a panel of solutions which all presents their pertinence and flexibility following the most important parameters retained for the application at a competitive cost. A thermal resistance as low as 18 °C/kW can be reached allowing to dissipate up to 2500W on a 3 Phase inverter 1200V-300A IGBT module for a 125°C maximal chip temperature. Using the FABFIN technology allows to keep the heat sink compact with 1 single unit module instead of 3 separated ones.

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SMD Microcoupler Package

Application is in switching mode power supply

Using conventional substrate and processes in the industry it is possible to construct a very low profile surface mountable optocoupler package. From the package design it is possible to eliminate a set of particularly capital intensive process steps: molding, deflash trim and form.

By R. Joshi, Chung-Lin Wu, M. Narayanan, K.Ramdass, Fairchild Semiconductor Corporation

An optocoupler, also known as an optoisolator, is a semiconductor device that permits the transfer of electrical signals between circuits or systems, while ensuring that those circuit or systems are electrically isolated from each other. The typical optocoupler mounted in a Dual in Line Package (DIP) incorporates three basic elements —an infrared (IR) light emitting diode (LED), an output photodetector and coupling medium which are critically linked to each other.

When a forward current (If) is passed through the LED, electrons are converted to photons. The radiant energy is transmitted through an optically coupled medium and falls on the surface of the detector where the photons are converted back to electrons. The photodetectors (phototransistors in many of the cases) are designed to have large base areas and hence a large base-collector junction area, and a small emitter area. If the base and the emitter are grounded and a positive voltage is applied across the collector of the phototransistor, the device operates as a photo-diode. Thus a current flows from collector to the base causing a voltage drop across a load resistance (RL). The junction capacitance (Ccb) results in an output circuit time constant (RL x Ccb) with a corresponding output voltage rise time. The output current in this configuration is small and hence this connection is not normally used.

The coupling medium optimizes the transfer of light emitted by the LED to the photodetector. The coupling medium must be optically transparent to the emitted wavelength and have a high index of refraction. A reflective coating is sometimes placed over the transparent coupling medium to optimize coupling efficiency. Coupling medium and reflecting coatings must be selected carefully to limit thermo-mechanical stresses on the connecting wires and the GaAs or AlGaAs based LED.

The most common circuit application is to leave the base connection open. As a result, the total collector current is much higher than the photo generated current and is about several hundred times greater than for the previous configuration. The gain comes with a penalty of slower operation. The output time constant for this connection would be (b x RL x Ccb). The ratio of output current from the phototransistor to the input current of the Gallium Arsenide Diode is known as the Current Transfer Ratio (CTR).

A common application of an optocoupler is in switching mode power supply. It provides isolated feedback from the secondary low voltage side to the primary high voltage side for control purposes, while maintaining signal integrity and safety. The optocoupler, besides providing a high degree of electrical isolation, also enhances the ratio of differential-mode to common-mode signals.

A number of improvements could be made to the P-DIP optocoupler package. For example, the optocoupler package requires an expensive and time consuming overmolding process. In the overmolding process, the molding compound encapsulates the other parts of the optocoupler package. In addition to the overmolding process itself, mold material removal processes (e.g., dejunk and deflash processes) are used to remove excess molding compound, thus adding to the time and expense of manufacturing an optocoupler package. In addition, the tooling that is needed to create moldings of different “form factors” (e.g., 4, 6, or 8 pin packages) requires a significant capital investment. Accordingly, if the overmolding process could be eliminated, the time and costs associated with producing optocoupler packages could be reduced. In addition, the DIP optocoupler package does not lend itself well to surface mount attachment to the PCB - leads have to be formed to allow for surface mount reflow often at the danger of causing micro-cracks, compromising component reliability. Further, the height of the so-formed DIP package still poses a problem for users whose other components are low profile surface mount components like TSSOP or TQFP.

The Microcoupler addresses advantages by the nature of its design. A low profile miniature surface mount component is described up to 1.20 mm in height having a footprint smaller than the current PDIP form factors. The

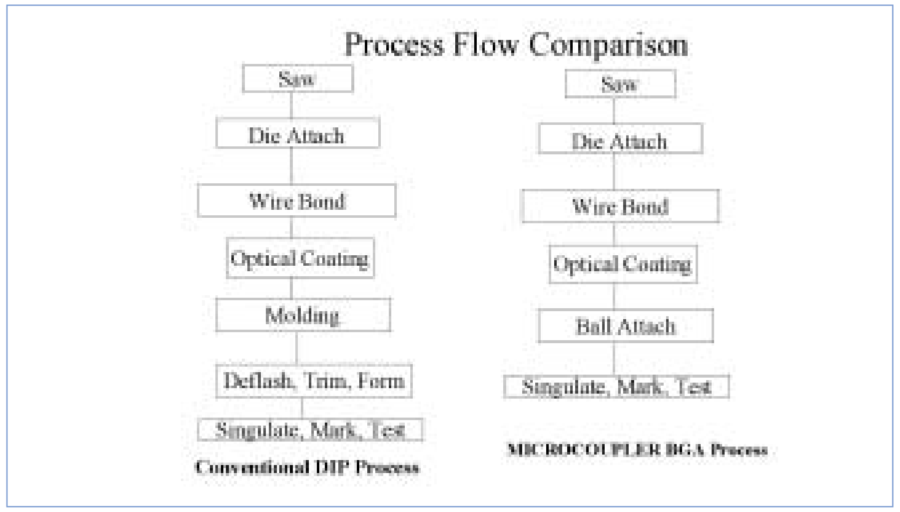

Figure 1. Microcoupler Assembly Process Flow vs. Conventional DIP Optocoupler Process Flow.

Microcoupler does not need encapsulation (mold compounds) and its manufacturing tooling is form factor independent. Its design also lends itself to improved reliability performance in accelerated tests such as thermal cycling. Using Pb-free solder balls an all Pb-free package can be constructed.

Construction Details

Figure 1 compares a typical process flow of a conventional molded DIP type optocoupler with the Microcoupler.

The Microcoupler consists of a substrate on which are patterned traces and paddle for die attach of the Gallium Arsenide light emitting diode (LED) and the photodetector silicon. The LED is bonded out to allow it to be biased and the photodetector connects to the output. The LED and the photodetector are coupled using an optical coating which allows for high transmission between the medium. Further the optical coating is covered with a reflective coating to maximize radiation transfer to the photosensitive die. Solder balls form the level 2 interconnect (package to the printed circuit board). Figure 2 provides a closer view of the Microcoupler.

Figure 2. Close up view of Microcoupler

Using conventional substrate and processes in the industry it is possible to construct a very low profile surface mountable optocoupler package. Moreover, from the uniqueness of the package design it is possible to eliminate a set of particularly capital intensive process steps: molding, deflash trim and form. Singulation of the microcoupler is accomplished by using a conventional dicing saw.

Characterization

Microcoupler devices built with a PT504 emitter and a OI1523 detector were compared with 4-pin DIP packages incorporating the same pair of emitter and detector. Insulation Test measurements of CTR at 1mA input current and 5V bias, Iceo at 80V Vce and Insulation Voltage for a duration of 1 second were carried out. Figure 3 compares the results of the study:

Test	Microcoupler Package	DIP Package
CTR (typical) (1mA, 5V)	320-380%	50-300%
I_{CEO} (80V=Vce)	20-40 nA	N/A
Insulation Test (3.5kV, 20 nA)	Passed	Passed

Figure 3. Characterization Results for Microcoupler compared to conventional (DIP) Packages.

Comparative measurements of the CTR degradation from 25°C to 125°C were also made of the two packages. Figure 4 shows that the high temperature degradation (at 1mA, 5V) was only around 30% for the Microcoupler as compared to 60% for the 4-pin DIP package.

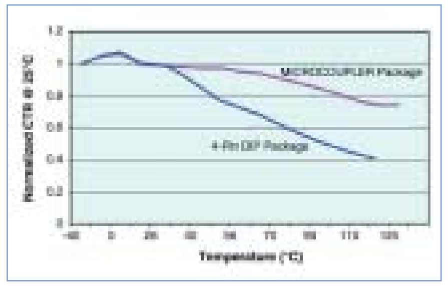

Figure 4. CTR degradation from 25°C to 125°C for Microcoupler and 4-Pin DIP Packages.

The Microcoupler's CTR performance over temperature at low input currents can be seen in Figure 5.

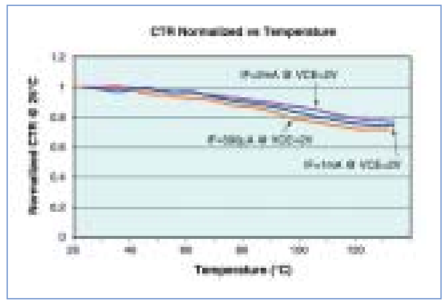

Figure 5. CTR performance over temperature at low If and Vce.

Package Reliability

Figure 6 gives the results of preliminary reliability stressing of the Microcoupler package.

The FEA analysis indicates a maximum stress of 131 MPa which is significantly below the critical stress of silicon (~ 700 MPa). The solder balls and the reflective coating are under low stress. The results would indicate that the package is robust under 260°C reflow as validated from empirical testing.

A unique construction for a surface mountable Microcoupler package has been described. The construction of this package as well as its assembly flow

Test	Conditions	Result
3X IR reflow	260°C peak	Passed
96 hrs HAST	110°C, 85% RH	Passed
500 cycles TC	-40°C to +125°C	Passed
1000hrs HTOL	100°C, If=20mA Ic=20mA	Passed
1000hrs LTS	-40°C	Passed
1000hrs HTS	+125°C	Passed
1000hrs H3TRB	85°C, 85% RH, Vce=30V	Passed

Figure 6. Preliminary reliability results of the Microcoupler package.

lend itself to a low profile surface mountable component with a simplified assembly process relative to the current packages of choice.

The FEA analysis indicates that the package could be expected to be under little or no stress under a severe 260°C (Pb-free) reflow profile, validated by empirical testing conducted independently. Using Pb-free solderballs, an all Pb-free optocoupler package can be constructed. Preliminary characterization results of key parameters such as current transfer ratio (CTR) indicates no degradation due to this package form factor. Early reliability results show encouraging results of these unique/novel materials and the design, indicating a good likelihood of a robust package and assembly process.

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Perfect Punch Through Prevents Poor Performance

Trench-LiPT offers a fast and low loss cell structure

As the next generation of 1700V and 3300V IGBT die development continues, Hitachi's latest modules balance the strengths of today's technology with tomorrow's demands. Power density and efficiency are up. What can Low injection Punch Through (LiPT) do for you?

By Neil Markham, Hitachi Europe

Today's billion dollar inverter market is an exciting place to be with opportunities for manufacturers to land significant contracts. Incumbent with this is a natural development of competitive pressures, with customers demanding more from their suppliers in terms of cost efficiency, service and support. The market for IGBT is no exception.

If we consider the development of IGBT, a conventional 1st Generation would have utilised local lifetime control to the speed up recombination of holes at the collector in addition to the expensive use of expitaxially grown silicon. As process technology advanced, the main collector (p region) transferred to diffusion techniques which brought in cost and performance improvements.

For an application engineer the key benchmark parameters are the static and dynamic losses or on-state ($V_{ce(sat)}$) and switching losses (Err, Eon & Eoff). To improve these, manufacturers set out a migration path from Punch Through (PT) to new Non Punch Through (NPT) and Trench gate technology. The Trench gate was quickly recognised as the technology that offered the biggest step function gains and, as a result its benefits made it the defacto standard for IGBTs 1700V and lower. Whilst the Trench gate structure has had the biggest impact on Vce(sat) this solved only one half of the engineers' needs. This can be expressed as follows:

Low Power Loss = Energy Saving = Simplifying Cooling = Cost Efficient

The challenge is to handle the switching losses more efficiently, particularly given that these losses have a major impact as switching frequencies increase. As a principle structure, LiPT has addressed fundamental switching losses by decreasing Eoff by as much 60% with similar reduction levels for Eon. LiPT has a low injection p collector layer made of a thin p+ layer or low concentration p- layer. This low injection production technique used by Hitachi's LiPT creates a lower carrier density at the collector side, thereby reducing switching losses. Comparing the cross sections shown in Figure 1, their relative carrier density's can be compared during device switch off.

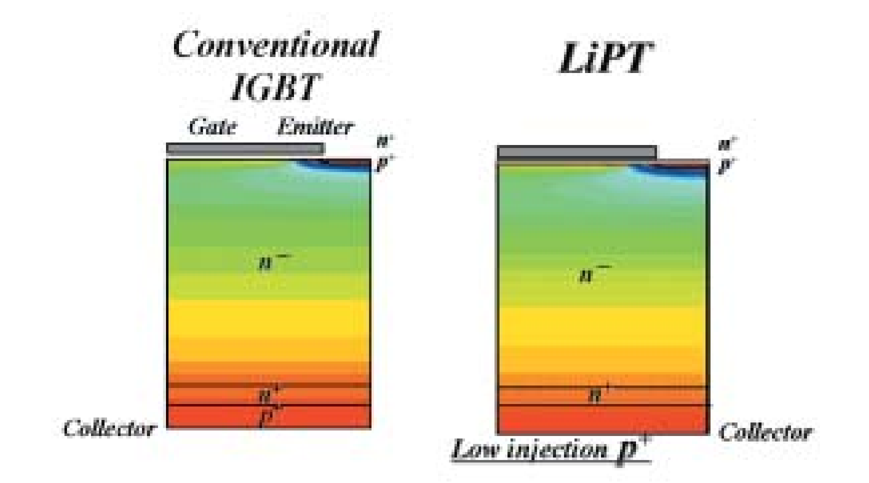

Figure 1. Comparison of on-state carrier density between conventional IGBT and LiPT.

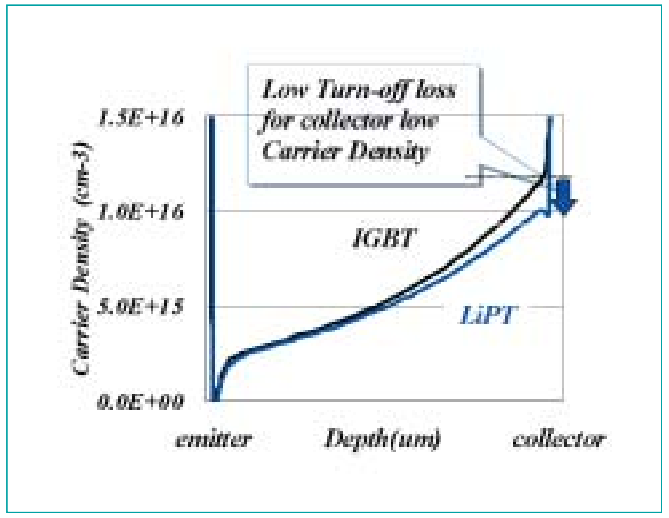

Figure 2. Carrier density comparison.

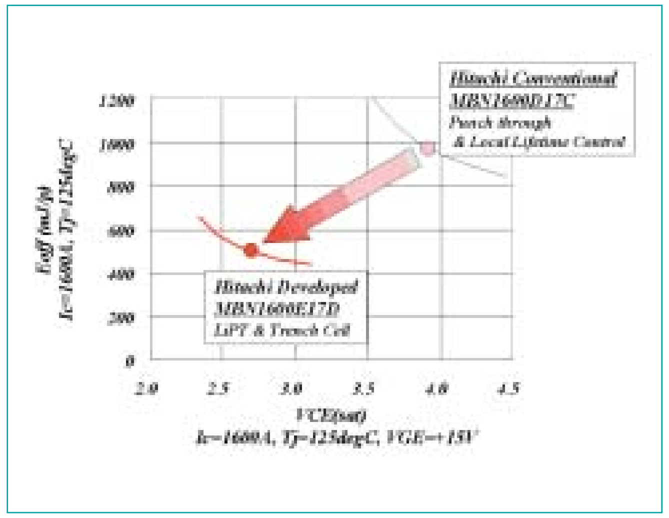

Figure 3. Improvement of VCE(sat)-Eoff relation.

The resulting difference is highlighted in Figure 2. This shows a profile of the relative carrier densities between conventional and LiPT structures. Energy saved during recombination is visible as the area in between the two respective traces. During the IGBT turn-off stage the depletion region spreads from emitter to collector side. A lower on state carrier density results in smaller carrier storage at the end of the spreading depletion region. This in turn generates less tail current during turn-off, which allows LiPT to achieve small turn-off losses.

The amalgamation of the two technologies, Trench and LiPT, sets the scene for the next generation series of high voltage, high power and high reliability modules. As described above, individually the benefits are certainly clear. Together key parameters affecting

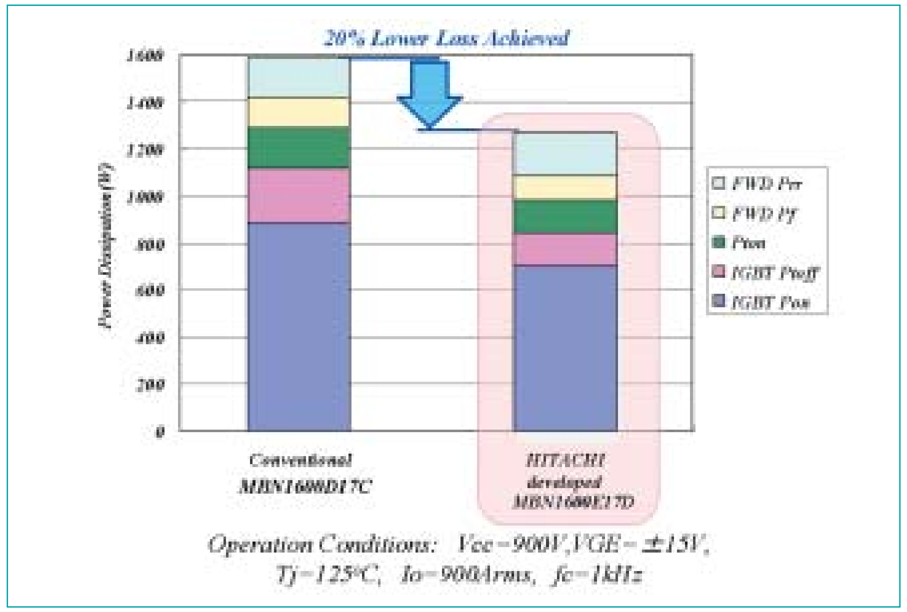

Figure 4. Comparison of power dissipation by inverter operation.

how much cooling will be required or just how much more power can be output from an existing platform become apparent. Greater flexibility is offered with these two technologies. For example cooling and output power can be maintained to improve long term reliability. They can also be used to reduce active cooling and save costs, and so on. Importantly choices can be made. Under simulated inverter conditions simplified in Figure 4, total power losses can typically see a 20% reduction.

With such combined technology the question may be asked whether the fast turn-off behaviour of Trench LiPT requires the application engineer to utilise special laminated bus bar technology? The short answer to this is no. As seen in figure 5, conventional bus bar systems allow Trench-LiPT operation. Even in a high inductance bus bar system or under high DC voltage, existing dynamic clamping gate circuits can adequately suppress spike voltages—just as the gate circuit designer intended.

Trench-LiPT retains a formal positive temperature coefficient, shown in Figure 9 using 25°C and 125°C Tj data collated from a 2400A single switch. As such easy paralleling of several modules with stable current sharing can be achieved.

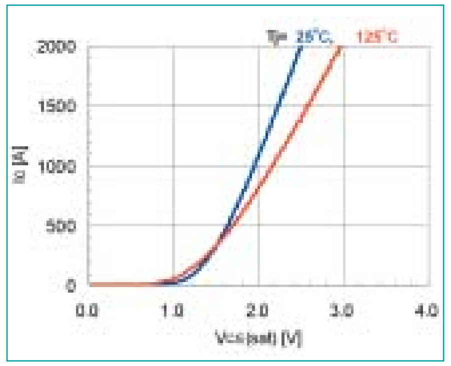

Figure 6, Positive temperature coefficient (25ºC blue, 125ºC red)

To conclude then, Trench-LiPT offers a fast and low loss cell structure and is an impressive IGBT partner for high power high reliability inverter solutions. Delivering greater flexibility and choice, it achieves the critical objectives of reduced power loss, improved energy saving, reduced cooling and more efficient operation. A 1700V Trench-LiPT product portfolio is available from Hitachi Europe in various circuit configurations up to 2400A.

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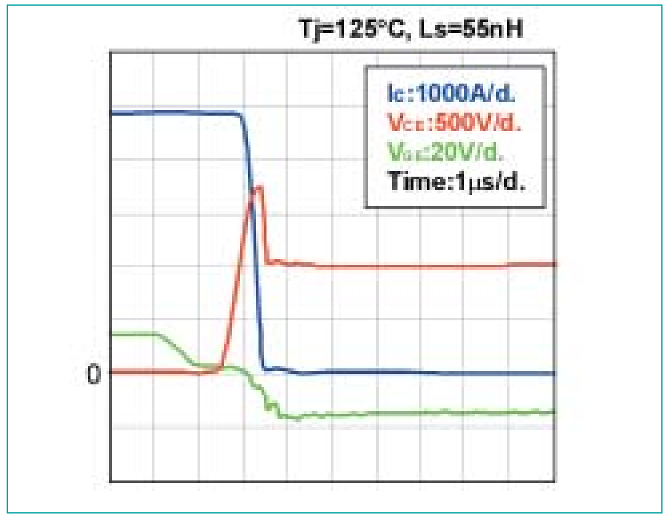

Figure 5. Turn-off waveforms.
(a) Small inductance turn-off waveforms.

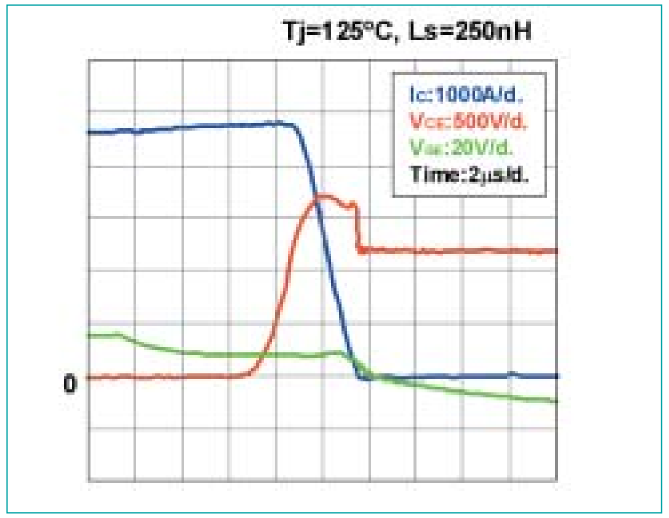

Figure 5. Turn-off waveforms.
(b) High inductance, high DC voltage turn-off waveforms.

Power Capacitors

Reshaping converter design

IGBT converter technology makes tough demands on link circuit capacitors. With the PCC LP series (Power Capacitor Chip, Low Power), Epcos is meeting this challenge and opening up new dimensions in converter design.

By Harald Vetter, Epcos

In comparison with conventional converters, the circuit inductance L of IGBT converters must be lower by a factor of ten. At the same time, the thermal current Ith and the peak current Ip are at least twice as high. New control concepts make it possible to use link circuit capacitors with a lower rated capacitance and correspondingly higher thermal current load. Film capacitors such as PCCs from Epcos are therefore superseding aluminum electrolytic capacitors. Extreme thermal and mechanical stresses prevailing in the engine and engine compartment present further challenges to automotive electronics design.

For low-power converters, the PCC concept is based on the new MPM (metalized polymer multilayer) wound film technology, i.e. a stacked winding in power capacitor format with plane surfaces. All the advantages of the tried and tested MKK (metalized plastic film) technology, e.g. compact and dry design, have been retained. Structured as well as unstructured metalized polymer films with edge reinforcement are used. A combined wavy/smooth cut maximizes the effective contact area through the MPM windings that are wound precisely with a small offset. The feared pinch effect at the film edge of plastic windings is avoided and high current handling capability achieved. The rated voltage of PCC LPs extends from 42 V DC for automotive electrical systems up to 1000 V DC for industrial applications. Depending on system requirements, the rated capacitance ranges from 50 to 4000 µF. The capacitors are available in various sizes and in bare and cased versions. The bare version is designed for integration into a converter package. The version enclosed in a plastic or metal case filled with resin is designed for standard applications or customized solutions. Versions featuring an integrated busbar, for example, with special fixing holes are also available so that PCCs can cover all design demands. In the new MPM wound film technology developed by Epcos, flat stacked windings are implemented in power capacitor format using polymer films such as PET or PP with thicknesses up to 1.5 or 2.8 µm respectively. The trend toward PCC LPs is particularly obvious in applications that require not only easy-to-integrate design but also the high pulse and thermal current-handling capability, constant capacitance and long service life unique to MKK technology. EPCOS is the only manufacturer to master both wound and stacked film technology. Opportunities for optimization of capacitor design should be considered at an early stage of converter development. This is the only way to achieve optimum system solutions (Figure 1 and Table 2).

MPM winding for flexible capacitor design

The photograph in Figure 1 shows the variety of shapes and sizes in which the MPM windings come. Based on a standard length of 300 mm, widths of 150, 70 and 30 mm are available. Geometrical data is listed in Table2.

Key technical data is listed in Table 3. A key technical parameter in these applications is equivalent series inductance ESL, which is exceptionally low in PCC LPs. For instance, for a capacitor rated at 1.1 mF/900 V DC and measuring 380 _ 80 _ 50 mm, ESL is only 5 µH at 64 kHz.

The examples in Figure 2 to 4 illustrate the variety of customer specific solutions that can be implemented with corresponding system benefits. Screw holes or integrated busbars can help optimize converter design even further.

A PCC LP should be connected to the IGBT by a busbar. The capacitor design can include a variety of terminal options to ensure an optimum solution for every application Table 4.

The PCC LP is ideally located at the rear of the water-cooled heatsink (Figure 5) and connected by a busbar to the IGBT module. The bare PCC is enclosed in a hermetically sealed converter package.

Parameter	Under the hood	At engine
Temperature range	-40 ... 125°C	-40 ... 165°C
Vibration	≤3 g	≤30 g
Shock	≤20 g	≤100 g

Table 1. Electronic components are exposed to extreme stress in automotive applications. That calls for the highest standards in component design.

Figure 1. The variety of shapes and sizes in which the MPM windings come.

Parameter	L[mm]	W[mm]	H[mm]
Max.	300	150	50
Min.	50	30	5

Table 2. Key dimensions for PCC capacitors with MPM windings. The capacitors can be made in different sizes to match design requirements.

Rated voltage	V_R	40 ... 1000 V DC
Rated capacitance	C_R	50 ... 4000 µF ± 10% or ± 5%
Rated current	I_R	≤ 250 A RMS
Inductance	L_s	3 ... 30 nH
Dielectric loss factor	$\tan \delta_0$	$2 \cdot 10^{-4}$ (PHD) ... $15 \cdot 10^{-4}$ (PET)
Peak current	I_s	≤ 100 kA
Temperature range	T_0	-40 ... +125 °C [1]
Test voltage B/B	V_{BB}	$1.5 \cdot V_R$, 10 s
Test voltage B/G	V_{BG}	>2500 V AC
Failure rate	$\lambda_{\lambda 0}$	300/10⁹ h
Service life	t	5000 ... 50 000 h
Humidity rating		up to class C
Self-discharge time constant	τ_{SE}	$R_{is} \cdot C$ >10 000 s
Standards		IEC 1071, IEC 68, NFF 16-101/102, UL 94-0

[1] Depending of Design

Table 3. Technical data of PCC LPs

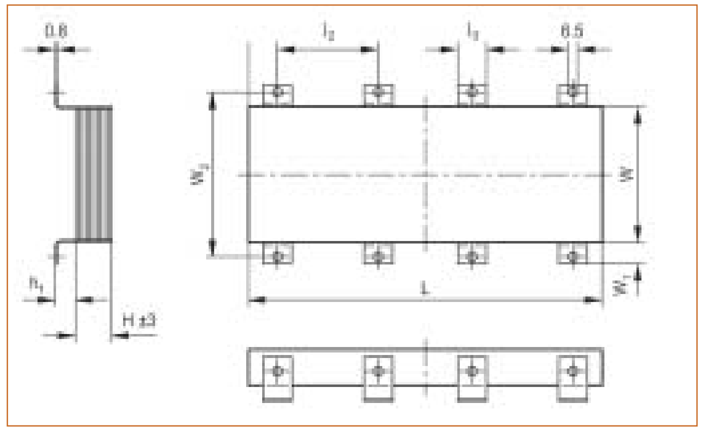

Figure 2. Standard-PCC LP. All dimensions are in millimeters. When no dimensions are given, a wide range of customized solutions is available.

Figure 3. PCC with radial screw holes. This design simplifies assembly, and the capacitor is pressed against the cooling surface.

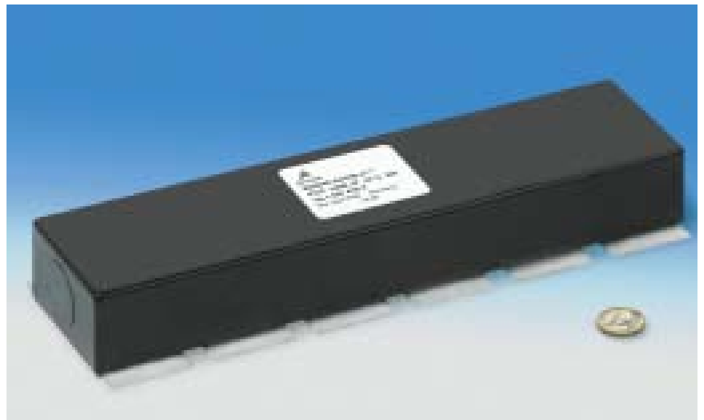

Figure 4. PCC in plastic case. This design is particularly rugged and immune to ambient influences thanks to its plastic case and resin filling.

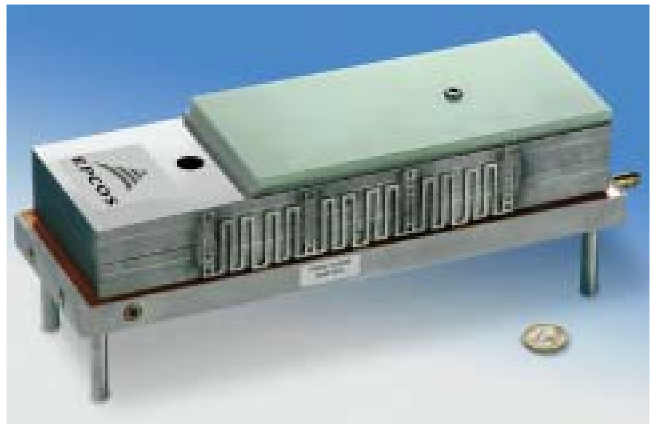

Figure 5. Compact IGBT converter. In this design study, the PCC with integrated busbar is located at the rear of the water-cooled heatsink. From top to bottom: pressure plate with fixing screws through the PCC; spring plate; bare PCC comprising two MPM windings; cooling plate with coolant tube connections.

Terminal type	$I_{th}[A_{rms}]$
Solder pin	10
Strap (0.8 mm)	10 ... 30
Plug	10 ... 30
Threaded stud M6	40 ... 60
Integrated busbar	50 ... 300

Table 4.Terminals and current-handling capability

The trend in low-power converters is toward miniaturization of components right up to system integration with modular design. PCC LPs support this trend. As the PCC product family grows, more new applications will be opened up. Metalization is an important aspect of development. The goal here is to increase thermal currenthandling capability and field strength under operating conditions. But the properties of polymer films are also being constantly improved. Thermally stabilized PET (CHT) or polypropylene PP (PHD) films, for example, can now be used at temperatures up to 125 °C.

PCC capacitor technology offers considerable design flexibility and excellent electrical properties that are ideal for IGBT converters. The benefits are listed: Low-inductance capacitor results in low circuit inductance; High permissible ambient temperature; High thermal current-handling capability; High pulse strength; High peak voltage strength; Rugged, self-healing and reliable design with long service life; Low space requirement (Vphys/ Vtech = 1); Low functional weight; Universal mounting; Ease of integration into converter package; Low fire hazard thanks to oil-free MKK technology and no additional decoupling capacitors needed.The MPM wound film technology provides more degrees of freedom for design-ins.

www.epcos.com/capacitors

Fastest POL Converter Modules

Artesyn Technologies has launched a series of 15A non-isolated point-of-load DC/DC converter modules that set a performance benchmark for the industry. Developed specifically for applications demanding exceptionally fast transient response capabilities, the Typhoon SMT15F modules can accommodate step load changes in excess of 300A/µs, which is several orders of magnitude faster than any comparable point-of-load (POL) converter on the market. A further unique advantage of SMT15F series modules is that they are completely self-contained, drop-in power solutions, requiring no additional components to achieve their unprecedented transient response performance. Virtually all competitive POL converters have a hidden cost element, demanding a relatively large number of bulk storage capacitors and a variety of high-, mid- and low-frequency decoupling capacitors to improve dynamic performance.

The SMT15F series initially comprises four models with nominal output voltages of 1.0, 1.2, 1.5 and 1.8V. The output voltage can be trimmed by ±10% of nominal to suit the exact needs of the load, and each converter is capable of delivering up to 15A output current. The converters have a wide input voltage range of 10.8 to 13.2V, and are designed primarily for use on boards employing intermediate bus architectures (IBA). They use a synchronous buck regulator topology and a very high switching frequency of 1MHz to maximise conversion efficiency. The 1.8V output model, for example, has a typical efficiency of 88%. This results in extremely low internal power dissipation and high levels of useable power, and is exceptional for a DC/DC converter capable of operating over such a wide input/output voltage ratio. Artesyn's SMT15F POL converters carry a full set of international safety approvals—including EN60950 (TÜV Product Service) and UL/cUL60950.

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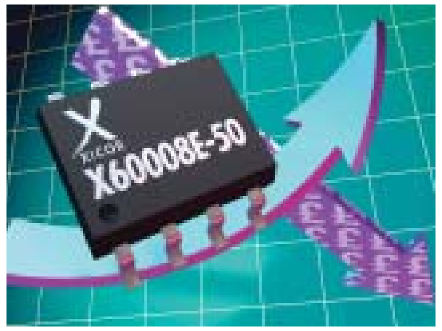
Ultra-Small DC-DC Regulators



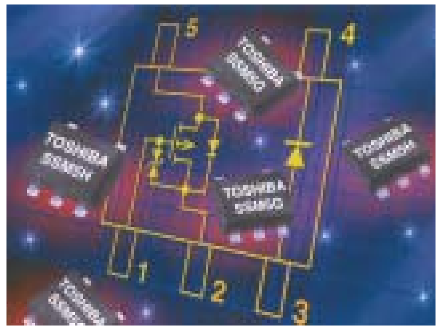
Intersil announced two new single-chip synchronous buck DC-DC regulators with integrat-ed power FET transistors. The EL7530 and EL7531 are target-ed at digital cameras and other portable products—such as test instruments and PDAs—that are powered from a single Li-Ion or multiple NiMH or alkaline battery cells. The devices operate and switch automatically from pulse frequency mode (PFM) to pulse width modulation (PWM) modes to offer outstanding effi-ciency over the full low-to-high load current range.

The tiny 0.145 square-inch total BOM footprint combined with up to 94 percent efficiency makes these regulators ideal for powering space-critical applica-tions in portable, battery-operat-ed devices. With only 120 µA quiescent current in PFM mode and internal soft-start, they pro-vide the performance required for the standby mode and inrush current conditions for a variety of USB-powered applications. Using an integrated oscillator, the EL7530 and EL7531 operate at a high 1.4 MHz switching fre-quency, thus needing smaller inductors and external compo-nents than do other regulators. Additionally, a sync pin al-lows for synchronization to an exter-nal clock at up to 12 MHz, enabling placement of the switching noise outside of bands critical to the application.

They deliver 600 mA and 1 A continuous output current, respec-tively, and operate from input voltages of +2.5 V up to +5.5 V over an ambient tempera-ture range of –40 degrees C to +85 degrees C. The devices are available in a compact MSOP10 and 3x3 mm DFN10 packages and require only eight components to provide a complete DC-DC step-down (buck) converter. A simple resistor divider sets the output voltage from a minimum of 0.8 V to a maximum of nearly Vin. Other features include a shut-down mode in which the device only draws 1 µA of supply current, an external en-able control to turn the device on or off, and a 'power good' output signal, which can in-dicate to another IC that the supply voltage has reached the desired level.

www.intersil.com

MOSFET and Schottky diode



Intersil announced two new single-Toshiba has launched a family of high-current discrete components that integrate a small signal MOSFET (SMOS) and a Schottky barrier diode (SBD) in a single ultra-miniature 5-pin surface mount package.

The new SSM5G and SSM5H series small signal MOSFETs are ideal for reducing the com-ponent count and the space required to implement high-effi-ciency DC/DC converter circuitry in portable electronics equip-ment and other space-limited applications. The SMOS/SBD integrated devices comprise SSM5G01TU, SSM5G02TU, SSM5G04TU and SSM5G09TU as P-channel devices and SSM5H01TU, SSM5H03TU and SSM5H05TU as N-channel devices in a small UFV package with dimensions of 2.0 x 1.7 x 0.7mm.

Drain source voltage (VDS) of the P-channel parts is rated at –30V for the SSM5G01TU, and –12V for the remaining devices. The N-channel devices have respective voltage ratings of 30V, 12V, and 20V. Drain current ratings (ID) for P-channel types SSM5G01TU, SSM5G02TU and SSM5G04TU are specified as –1A and, in the case of the SSM5G09TU, -1,5A. For N-channel types SSM5H01TU and SSM5H03TU an ID of up to 1.4A can be used, while the SSM5H05TU is rated at 1.5A.

Toshiba has also developed lower power versions of the integrated MOSFET/diode devices. Supplied in a smaller ESV 5-pin package measuring 1.6x1.2x0.5mm,these devices have ratings of 0.1A at 20V as N-channel or P-channel parts. The Schottky barrier diodes integrated alongside the small signal MOSFETs have maximum forward voltage ratings of between 0.3 and 0.45V and offer low loss operation. As a result, they allow designers to implement flyback diode designs for high-efficiency DC/DC converters without the need for additional components.

www.toshiba-europe.com

Voltage Reference

Xicor has announced the X60008EIS8-50, the latest addition to its family of precision voltage references manufactured using the company's proprietary Floating Gate Analogue (FGATM) technology. Offered at an extremely competitive price, the X60008EIS8-50 allows designers to improve system performance whilst lowering overall system cost. Since the X60008EIS8-50 is pin-compatible with many of the industry voltage references, no board layout changes are required and therefore, a faster time-to-market release can be achieved.

The device is a 5V reference featuring ± 0.1% accuracy, a very low 20 ppm/°C maximum temperature coefficient, and an ultra low power supply current of just 500nA. Able to run from a supply voltage range of 5.1V to 9V, the reference has a long-term stability of 10ppm/1000hrs and features a very low dropout voltage of 100mV at no load. The X60008EIS8-50 allows designers to achieve a performance range previously not available in its price range. Previously, systems requiring this level of performance were constrained by cost burdens.

The range of applications for the X60008EIS8-50 is wide and includes high resolution A/Ds and D/As, precision current sources, smart sensors, digital meters, precision regulators, strain gauge bridges, calibration systems, precision oscillators, threshold detectors, V-F converters battery management systems, and servo systems.

The X60008EIS8-50 is able to operate in an ambient temperature range of –40 to +85°C, and is available in 8-lead SOIC packaging.

www.xicor.com

SMD Power Inductor

Epcos has further extended its range of power inductors with the introduction of two new series: the B82464-A4 (unshielded) and B82464-G4 (shielded). With a footprint of 10 mm x 10 mm, the B82464-** version has an insertion height of 4.8mm. It can be used in ambient temperatures ranging from -55 °C to +125 °C. Available inductance values for the new B82464-A4 are from 1µH to 47µH with rated current up to 7A. With inductance values from 0.82µH to 47µH, the B82464-G4 has a rated current up to 7.6A. Epcos produces a wide and varied range of power inductors that are ideal for all automotive applications. Other application areas include: telecommunications, consumer and industrial electronics. In order to handle high rated current, SMD power inductors must have a low ohmic resistance and minimal losses at high frequencies. The power inductors are wound around a ferrite core and are particularly suitable for cost-critical mass applications thanks to their surface-mounting capability.

These material saving power inductors are ideal for applications such as storage chokes in DC/DC converters as well as in the EMC sector. Epcos offers its SMD power inductors in several heights and footprints. Ranging from 4.8mm square and 1.2 mm height, the different 20 options go up to 18.54 mm x 15.24 mm and 7.62 mm height. Depending on version, the inductance values of these SMD inductors range from 1µH to 1000µH. If EMC considerations are an important factor, shielded versions are available which guarantee excellent EMC characteristics.

www.epcos.com

Synchronous Step Down DC-DC Converter IC

The XC9510/XC9511 series from Torex Semiconductor Europe is a highly integrated solution combining step-down DC-DC converter, high speed, low noise LDO voltage regulator and an internal comparator for low voltage detection. The XC9510/XC9511 offers designers a cheaper, smaller and more reliable alternative to current discrete solutions and is supplied in a SOP-8 package. The XC9510/11 is an ideal partner for the latest DSPs and microcontrollers which require 1.8V for the memory. The device's 0.6Ω P-channel driver transistor and 0.6Ω N-channel switching transistor means that efficiencies over 90% can be achieved without the need for an external Schottky diode. The XC9510/11 is designed for use with low ESR ceramic capacitors and small chip inductors making it the ideal choice for designs where space is at a premium. Output current is 800mA (DC-DC converter), 400mA (voltage regulator). Operating voltage range is 2.4 to 6.0V. DC-DC output voltage is factory set in 0.1V steps between 0.9 and 4.0V (XC9511) and between 1.6 and 4.0V (XC9510). Voltage regulator output range is between 0.9 and 4.0V and voltage detector range is 0.9V to 5.0V, again in 0.1V steps. Three switching frequencies are available: 300kHz, 600kHz or 1.2MHz. A choice of switching control method is provided: either synchronous-rectified PWM switching control, or synchronous PWM/PFM auto switching, selectable via the XC9510/11's MODE pin. This gives the designer fast response, low ripple output and high efficiency over a broad range of output loads. The voltage regulator's dropout voltage is 80mV at 100mA (typ) while ripple rejection is 60dB at 1kHz. (Vout = 2.8V). Other features include a built-in current limit, an internal soft-start (set to 10ms) and an under voltage lock-out circuit.

www.torex.co.jp

NV-Power Supply without Compromise

NV-Power is based around a configurable planar transformer, and employs Multiple Efficiency Gain (MEG) technology to achieve its class leading efficiency for multiple output PSUs. The Lambda approach is essentially a unique use of synchronous rectifiers in a resonant topology. The patented Multi-Resonant-Topology (MRT) that lies at the heart of the new design gives a 5% improvement in efficiency over more traditional methods. AC/DC products commonly use magamp post regulators and two-stage conversion. The MRT however uses closed loop control of the main outputs, a single conversion stage and auxiliary channels employing high efficiency DC/DC post regulation. All outputs are fully isolated from each other allowing them to be floated either positive or negative Improvements in multilayer ceramic capacitors and functional organic polymer capacitors allows the implementation of much simpler inductorless filter circuits, again lowering losses, increasing efficiency and reducing size. Finally, the use of silicon carbide Schottky diodes in the PFC circuit provides another 4% efficiency improvement. The superior EMI performance of NV-Power enables it to achieve 601 medical compliance (with earth leakage current down to under 300µA) and meet EN55022 Curve B requirements with a typical 6dB margin which is unique for this class of product.

www.lambda-europe.com

TI Introduces New Power Management ICs to Enhance OLED Color Displays, White LED Backlighting

OLED, CCD sensor power converter and white LED charge pump provide flexible power control, efficiency to next-generation display designs. Extending efforts to support every power requirement for next-generation portable color displays, Texas Instruments announced its first organic light emitting diode (OLED) display power conversion integrated circuit (IC) and a new white LED charge pump for backlight applications.

TI's TPS65130 is a dual-output, DC/DC converter optimized to generate a positive output voltage up to 15 V and a negative output voltage down to -12 V with programmable sequencing. With a power conversion efficiency up to 89 percent, the new driver supports advanced OLED and charge-coupled device (CCD) sensor bias supply applications in battery-powered equipment such as cellular phones, PDAs, digital cameras and camcorders. The TPS65130 supports an input voltage range of 2.7 V to 5.5 V, which allows it to be powered directly from a single-cell lithium-ion (Li-Ion) battery or multi-cell nickel-metal hydride (NiMH), nickel-cadmium (NiCd) and alkaline batteries. Meeting designer's need for board space reduction, the TPS65130 features a small 4 mm x 4 mm QFN package and a minimum number of external components. The TPS65130 operates at a low quies-cent current and with a fixed frequency pulse width modulation of minimum 1.25 MHz, which allows the use of tiny 4.7-uH inductors. Independent enable pins allow power-up and power-down sequencing for both outputs. Furthermore, load-disconnect during shutdown conserves battery life.

www.ti.com

Companies in this issue

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

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SATISFY CONTROL REQUIREMENTS WITH MAXIMUM DESIGN FLEXIBILITY

International Rectifier's New 600V Half-Bridge Control ICs

Part Number	Drive Current (mA)	V_{OUT} (V)	Input Logic	VIH/ VIL (V)	Typical. Dead time (ns)	Delay Matching (ns)	Turn On (ns)	Turn Off (ns)
IR2304	60/130	10-20	HIN/LIN	2.3/0.8	100	50	220	200
IR2308	120/250	10-20	HIN/LIN	2.9/0.8	540	46	220	200

IR's IR2304 and IR2308 600V half-bridge control ICs give circuit designers the ability to select the best control IC for their lighting ballast, appliance and SMPS applications.

The IR2304, with a high pulse current for minimum driver cross conduction, is an optimized solution for low drive current MOSFETs or IGBTs. The IR2308 is a rugged IC with two non-inverting inputs for larger MOSFETs or IGBTs in high frequency applications.

Features

IR2308

- Cross conduction prevention logic
- Rugged negative transient voltage tolerance
- Under-voltage lockout for both channels

IR2304

- Cost-effective, 600V half-bridge control IC
- Optimized gate drive for smaller MOSFETs
- Logic compatible

Benefits

- Improved time to market
- Reduced board space
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- High noise immunity
- Maximum design flexibility
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