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Bodo´s Power Systems

Systems Design Motion and Conversion

August 2006

An Even Brighter Idea...

IGBT Modules

Battery Charger

Power Management

Capacitors in Automotive

FAIRCHILD SEMICONDUCTOR®

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Bodo´s Power Systems

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EVENTS

Power Integrations Seminars,
www.powerint.com

EPE-PEMC 2006:
Aug. 30–Sept.1, Portoroz, Slovenia,
www.ro.feri.uni-mb.si/epe-pemc2006

Digital Power Forum (DPF '06)
September 18-20, Richardson, Texas
www:darnell.com

H2Expo,October
25-26, Hamburg,
www.h2expo.de

ELECTRONICA 2006,
Nov. 14 – 17, Munich,
www.electronica.de

SPS/IPC/DRIVES 2006,
Nov. 28 – 30, Nuremberg,
www.mesago.de

SPS/IPC/DRIVES 2006,
Nov. 28 – 30, Nuremberg,
www.mesago.de

Fall is Showtime

Most of us have had a summer break, my strawberries tasted wonderful, and now we can look forward to autumn. You have the third issue of Bodo's Power Systems in your hand and we are moving on quickly, as the industry suggests.

With the fall season fast approachng, we look forward to many shows - always an exciting time. The last big show was PCIM Nuremberg - totally focused on Power Electronic applications. Now we anticipate more specialized events and more global ones – but all have a strong tie to Power Electronics. I am supporting them all, and as well, they will have my magazine for distribution. The science driven conference in Europe is EPE-PEMC 2006, this time in Portoroz, Slovenia, at the end of August. Darnell will have their Digital Power Forum in September in Richardson, Texas. In October, the H2Expo in Hamburg is focused on hydrogen usage. Electronica in Munich is the first event in November and is followed by SPS/IPC/DRIVES covering industrial highlights in Nuremberg towards the end of the year. This certainly represents quite a busy schedule for anyone attempting to attend all these events. Fortunately, I am collecting and presenting the information so you may concentrate on what is important for you and your designs.

Power Electronics is integral to economical and efficient solutions, as we learn in this issue. Modern IC's together with power semiconductor switches make up the basic platform and optimized passives are the spices that give your design recipe a final kick. Optimized switches are the key to efficient applications - MOSFETs dominating at lower voltages and IGBTs the workhorse at line voltages and higher. IGBT technology still continues to improve with development into the kilovolt ranges of breakdown capability. ABB with IGBTs in module packages up to 6,5kV will surely impress Frank Wheatley, who can look back to his work in the '80s getting the "Comfet" patent (now the IGBT).

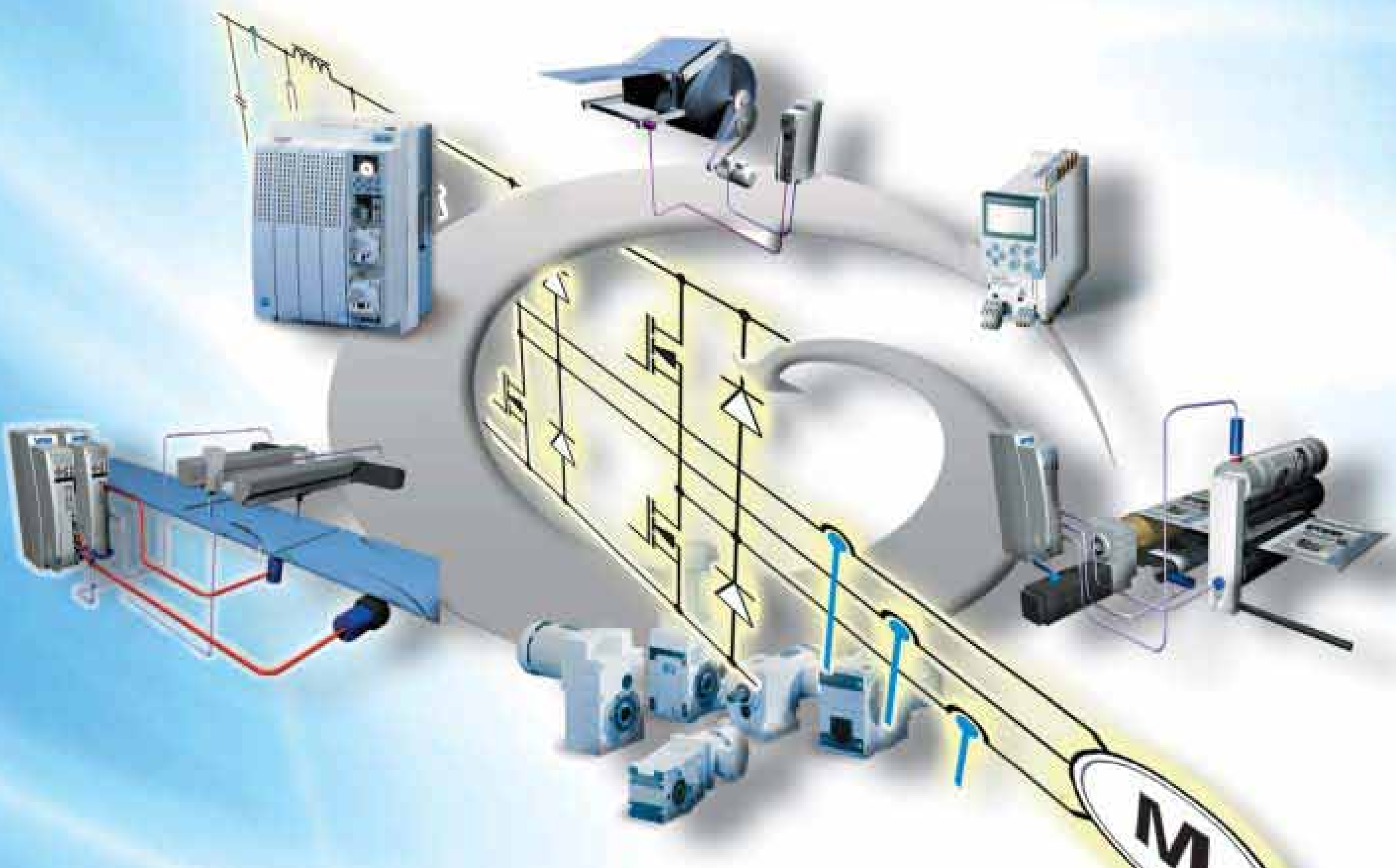
Also, it is impressive to contemplate the wide use of electronics in today's automobile – for instance, the use of intelligent ignition IGBTs for internal combustion engines. Not to overlook the passives - Epcos gives us a full introduction to what capacitor technology can do for automobile electronics.
Hybrid vehicles are getting more attention due to regenerative braking, which improves fuel consumption in urban areas where stop and go is normal. The buzz surrounding the 42 volt bus in automobiles seems to have totally disappeared. Remember the past conferences promoting 42 volts and the need for 85% efficient 2kW converters adapting to 12volt systems in the vehicle ? I was thinking during the presentations that 15% of 2kW would be great for seat heating. Semiconductor manufacturers are now happy if they sell the 75 volt MOSFETs designed for the 42 volt applications to industrial users who like an extra margin of safety.

Finally, in this issue we will learn more about Communication over Power - as I called it "CoP" - the unique way of using power lines for communication.

The magazine covers the critical subjects and gets them up front for you. I am looking forward to meeting you at one of the shows and chatting about technology and trends.

Best regards

MULTIRANGE COMPACT CURRENT TRANSDUCER



Low profile (only 16.35 mm high)
Simplified integration with power modules

- Excellent accuracy (less than 1 % of I_{PN})
- High dynamic performance
- Closed-Loop Hall effect technology
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LAX 100-NP

UP TO 100 A_{RMS} ON PCB

LEM
At the heart of power electronics

Patrick Zammit President of Avnet Electronics Marketing


Patrick Zammit

Avnet Electronics Marketing, an operating group of Avnet, Inc. announced the promotion of Patrick Zammit to president, Avnet Electronics Marketing, Europe, the Middle East and Africa (EMEA), effective October 1, 2006. Zammit will succeed Axel Hartstang, who has decided to step down from his current position after almost 30 years in the industry. Hartstang will continue with Avnet as an advisor to the EMEA team. New Avnet Electronics Marketing, EMEA President Zammit began his career at Avnet in 1993, and currently serves as president of EBV Elektronik, the largest division of Avnet Electronics Marketing, EMEA. Prior to his senior leadership role at EBV, Zammit's management positions included finance director of Avnet France, and both director of operations and chief financial officer of Avnet Electronics Marketing, EMEA. Zammit was elected a corporate officer of Avnet, Inc. in 2000. As president of Avnet Electronics Marketing, EMEA, Zammit will report to Harley Feldberg, president, Avnet Electronics Marketing worldwide, and become a member of his global leadership team.

http://www.avnet.com.

Silica Northern Europe wins Micron Award

Semiconductor distribution specialist Silica an Avnet company, won Micron Europe Ltd.'s distribution award for excellent support, sales performance and pro-active market approach throughout 2005.
"SILICA's commitment to create new opportunities and develop new markets for Micron is impressive," said Brian Purdom, Distribution Account Manager for Micron Northern Europe. "Their UK sales and engineering teams are highly skilled and understand customer needs and the environment they compete in. This is key support for Micron when it comes to discovering new business," Purdom continued.
Gerard Braybrooke, Regional Vice President Northern Europe, adds: "We're pleased to receive this award and eager to continue working at this level of excellence both for Micron and our customers. Our success has been due to the way we interact with the customer, every project has very individual demands and our team has shown how seriously we take our obligation to customer orientation and individual support."
SILICA, number one distributor for Micron in Northern Europe, markets the entire product range and supports customers with innovative technologies on a European base.
The companies have worked together since 2001.

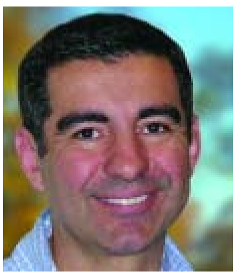
www.silica.com.

Alain Riedo, senior VP and CO Maxwell

Riedo, 48, joined the company's Swiss unit, formerly known as Montena Components, in 1988 as director of sales, and was promoted to general manager in 1994. Maxwell retained Riedo as general manager of Maxwell SA when it acquired Montena in 2002. He negotiated the divestiture of several non-core product lines in 2002 and 2003, and continued to oversee management of the CONDIS line of high voltage capacitor products as well as BOOSTCAP ultracapacitor manufacturing in Switzerland. In November 2005 his role was expanded to include overall responsibility for Maxwell's global ultracapacitor sales organization.

www.maxwell.com.

C&D Tony Abrantes Global Sales and Marketing



C&D Technologies Power Electronics Division has appointed Tony Abrantes to the position of VP Global Sales and Marketing. The vacancy was created by the recent appointment of Brian Crowe, formerly VP Global Sales and Marketing, to the role of General Manager for the company's Tuscon / Nogales Business Unit. A graduate of Boston University, Tony will be based at C&D's Mansfield, Massachusetts facility. He has an extensive background in the sales, marketing and management of power electronics products. He also has comprehensive knowledge and experience in the area of power semiconductors. Before joining C&D Technologies, Tony was employed as a Sales Director for International Rectifier. Prior to that, he held senior level sales positions at both Artesyn Technologies and Power One.

www.cd4power.com .

The Best-Selling 2-Channel IGBT Driver Core

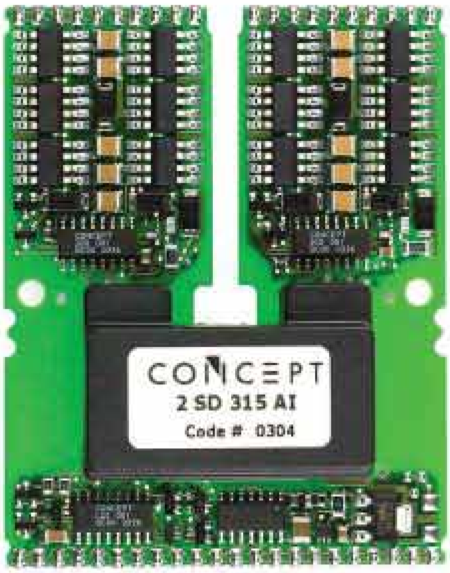
The 2SD315AI is a 2-channel driver for IGBTs up to 1700V (optionally up to 3300V). Its gate current capability of ±15A is optimized for IGBTs from 200A to 1200A.

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

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

Chipset Features

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



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

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

Isolated DC/DC power supply with 3W per channel

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

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

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

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

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

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

CONCEPT

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Fax +41-32-341 71 21

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

Let experts drive your power devices

Avnet Memec Stuart Edwards Country Manager

Stuart Edwards

Stuart Edwards has been announced as the new Avnet Memec Country Manager for Great Britain and Ireland. Stuart joined Avnet in 2005 following the acquisition of Memec and heads up a team of 18 people. He brings over 12 years experience in strategic account management and European product marketing positions with companies including Memec Unique and Kudos Thame.

'I am particularly pleased to take on this role at the current time. We have established a fantastic team to help achieve our goals, and we are offering a comprehensive technology road map fully supported by our technical specialists.' commented Stuart as he took up his new role at the company UK headquarters in Aylesbury, Bucks. 'And I passionately believe in the demand creation model that we have established here.'

'The new line card supports 31 suppliers and serves our UK customers with a unique portfolio of semiconductor technologies from world-renown suppliers such as NEC, Marvel, Lattice and Silicon Laboratories.'

Stuart has ambitious plans for the UK market approach ' We are already helping our customers to find the right innovation for their newest applications in industry segments such as embedded solutions, medical, wired and wireless communications to name but a few.'

Steve Haynes, President of Avnet Memec 'Stuart made the decision easy for us as he brings with him a background of both sales and technical support to fill this demanding position.'

http://www.avnet.com.

Nu Horizons Partnership with Micrel into Greater China

Nu Horizons Electronics Corp. announced the expansion of their North American distribution agreement with Micrel, Inc.into Greater China. In addition to North America, this partnership now includes demand creation and fulfillment of Micrel's analog, high bandwidth and Ethernet products in Hong Kong, China and Taiwan."We are very pleased to expand our relationship with Nu Horizons into Greater China," states Mark Lunsford, vice president of worldwide sales for Micrel Semiconductor. "Since our partnership inception in 1991, Nu Horizons has successfully demonstrated the ability to create demand for Micrel's products through their motivated team of FAEs who are supported by Nu Horizons' leading-edge global design tracking software. They possess all the key attributes we seek in a global distributor - world-class fulfillment, engineering support and in-depth product and solutions expertise. This expansion strengthens our partnership and compliments Micrel's global growth strategy."

"Nu Horizons looks forward to adding Micrel to our focused line card in Greater China" adds Wendell Boyd, president of Nu Horizons Asia Pte Ltd. "Micrel delivers high performance products in rapidly growing end markets, providing customers with technologically-advanced solutions necessary to remain competitive in our fast-paced industry. In addition, Micrel's fierce commitment to their customers' success makes our partnership expansion a very valuable addition to Nu Horizons Asia Pte Ltd."

www.micrel.com

Director of Sales Richard Ford at Powerstax

Richard Ford

Powerstax plc, the Farnborough UK based manufacturer of high efficiency DC:DC converters and application rich power solutions announces the appointment of Richard Ford to the new post of Director of Sales.

Continuing sales growth, with exports now accounting for some 70% of business has created the requirement for a senior management appointment to manage direct sales and distribution channels.

Richard has been a major influence in the growth of power supply sales with a leading UK distributor and will now bring his expertise to Powerstax's international business.

Tim Worley, CEO of Powerstax plc, comments, "It have been clear for some time now that we needed a senior manager to run our growing day to day business and allow me to spend more time on strategic management and defining our development plans for the future. We are very pleased to have found the right person in Richard and are looking forward to him making a great contribution to our next phase of growth."

Richard Ford has had close to 25 years experience in the electronics industry beginning in manufacturing and progressing to senior buyer positions with a battery charger manufacturer, a manufacturer of video monitors and one of the largest electronics OEM's in the UK.

sales@powerstaxplc.com

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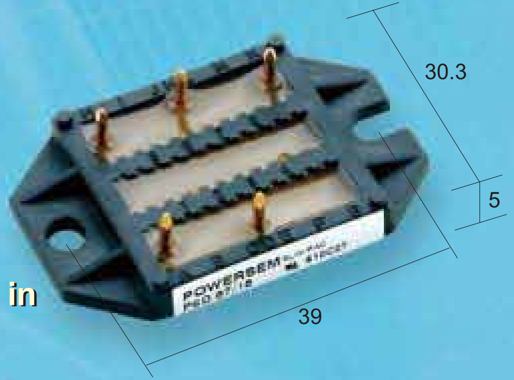
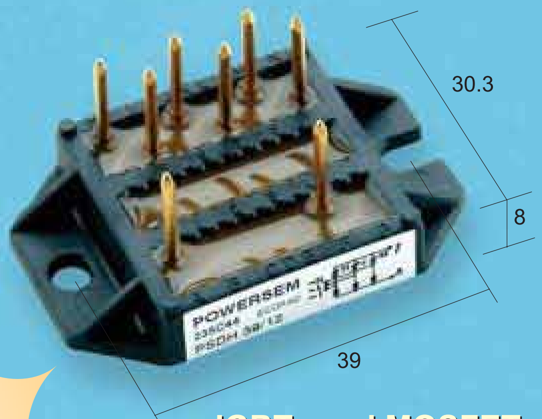
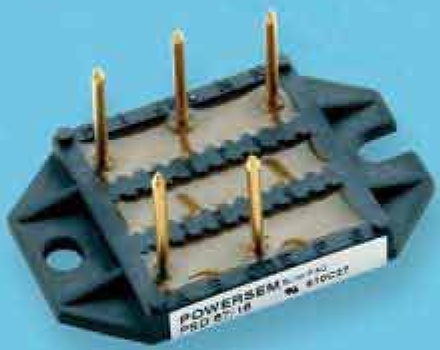
Lowest Profile Package for Power Modules with Highest Performance and Widest Choice of Customized Circuit Configurations



AC Controller in ECO-PAC™ 1

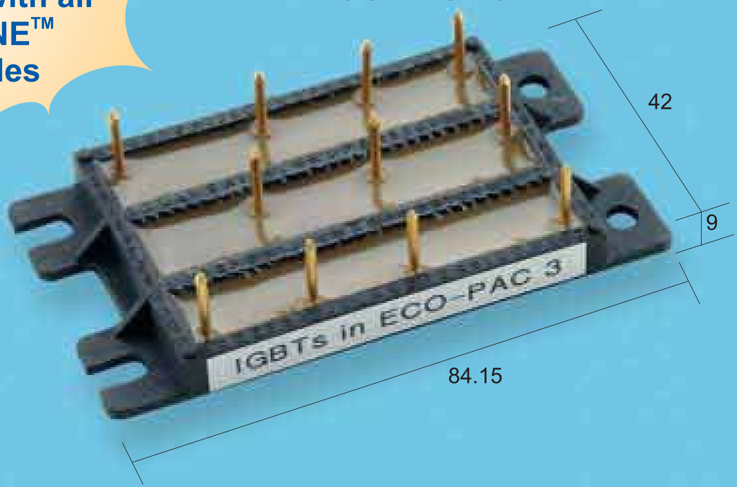


Rectifier Bridges in SLIM-PAC™



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

IGBTs and MOSFETs in ECO-PAC™ 3



IGBTs and MOSFETs in ECO-PAC™ 2

all dimensions in mm

- Customized choice of Circuit Configurations
- High - Tech Integrations of Diode, Thyristor, IGBT and MOSFET Chips
- One Package Concept for Current Ranges from 29A - 200 A and Blocking Voltages from 600 - 1800 V

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innovation and reliability with DCB technology

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New Modules in Standard Housings

HiPak1 expands the HiPak Range

ABB launches a new family of high power IGBTs in an industry standard module with the popular 140 mm x 130 mm footprint.
ABB thus joins an established fraternity of suppliers of similar devices but brings, with the presently launched HiPak™ family extension, unprecedented electrical robustness thanks to the SPT^{+} chip technology (Soft Punch Through), as well as the heightened efficiency of the new SPT^{+} technology.
HiPak1 complements the larger HiPak2 series of standard 140 x 190 mm foot-print housings launched two years ago.

Figure 1: HiPak™ Family

This expansion to a lower calibre will add some 15 new part numbers to the HiPak family over the next 12 months, more than doubling ABB's current IGBT module offering. The move is in response to the popularity of the SPT^{+} chips, which have brought exceptionally high Safe Operating Area (SOA) to high power IGBT modules.

Product Range:
HiPak is now offered in all the standard voltage classes, namely: 1.2, 1.7, 2.5, 3.3, 4.5, 6.5 kV but whereas the HiPak2 is offered in only two configurations (Single-Switch and Chopper), the HiPak1 will cover the latter and additionally the Dual-IGBT and Dual-Diode configurations.

Chip Technology:
Last year's introduction of SPT^{+} chip technology, which allows 15 - 30% $V_{CE\ SAT}$ reduction at constant switching losses, has further increased demand for the smaller modules as these can now replace the larger 140 x 190 mm modules in some current categories while enabling the HiPak2 to be rated to 1500 A and 3600 A for 3300 V and 1700 V types respectively. HiPak™ modules exclusively use SPT chips for their smooth switching and robustness. In particular, the high voltage chip-sets (2.5 – 6.5 kV) allow much higher SOA than conventional modules because they are able to withstand dynamic avalanche under overload conditions. The ability to withstand full rated voltage at twice rated current under all switching conditions (square SOA) obviates the need for snubbers and external or active clamps and allows efficient fast ("hard") switching.

Housing Technology: The HiPak family exclusively uses the metal matrix composite material Aluminium Silicon Carbide (AlSiC) for its base-plate and Aluminium Nitride (AlN) as the isolating ceramic substrate on which the chips are mounted. AlSiC conducts heat almost as well as a metal (e.g. aluminium) but has a thermal expansion coefficient close to that of ceramic thus closely matching that of the isolating AlN substrates. These, in turn, closely match the expansion coefficients of the silicon chips. This technology minimises the stresses between the base-plate and the ceramic substrate during thermal cycling, allowing the modules to be used in demanding applications such as Traction Drives. Special terminals are used for the very high current (3600 A) modules to minimise I^2R losses.

Applications: The growing demand for efficiency and performance is forcing the adoption of inverters in ever more applications. Transportation is always a driving force for product innovation because of the concurrent demands for power, compactness, reliability and longevity and it is not surprising that this has been the main application of the Hipak2 to date. However, the widespread use of industrial motor drives and the development of Renewable Energy Sources (e.g. wind power converters) is placing similar demands on industrial systems requiring more diverse configurations (e.g. Double-Diodes for 3-level inverters). Traction auxiliary supplies increasingly operate directly from the main-drive DC link (eliminating the intermediate chopper) which requires HV modules (e.g. 6.5 kV) of modest current ratings (200 – 400 A) for which the HiPak1 is ideally suited.
HiPak™ meets all the demands of today's power electronics industry in terms of chip performance, package technology and range of configurations and voltage classes.
Reliability and longevity are quantified in published cosmic ray withstand specifications and power-cycling capabilities for production devices.

www.abb.ch/semiconductors

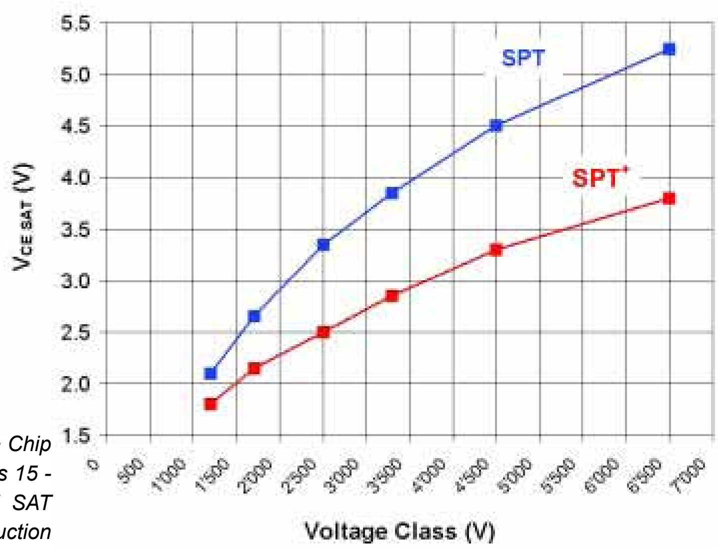
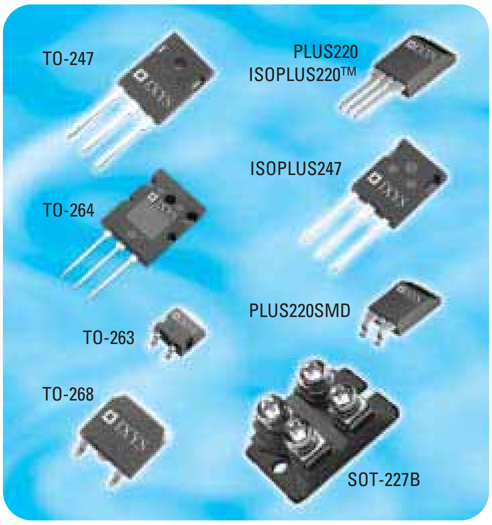


Figure 2: SPT+ Chip Technology allows 15 - 30% VCE SAT Reduction

Combine Cool Performance with Ruggedness

PolarHV™ HiPerFET™ Power MOSFETs



www.ixys.com

Advantages

- Best-In-Class current control at 500V and 600V
- Current range: 2A – 80 A
- $R_{DS(on)}$ as low as 65 mΩ in PLUS247 package
- Cool performance due to low $R_{DS(on)}$ and thermal resistance
- Fast intrinsic diode
- Commutating dV/dt capability greater than 20V/ns
- Electrically isolated tab and surface mountable packages available
- Additional Standard and HiPerFET Power MOSFETs from TO-252 to SOT-227 shown at www.ixys.com

Example Products

Part Number	V_{DSS} Min. V	I_{D25} Tc=25°C A	$R_{DS(on)}$ Tc=25°C Ω	Qg (typ) nC	R_{thJC} °C/W	Package Type
IXF(1)12N50P(2)	500	12	0.50	30	0.75	P, A
IXF(1)30N50P(2)		30	0.20	72	0.27	V, H, T, R
IXF(1)64N50P		64	0.09	150	0.15	X, K, N
IXF(1)14N60P(2)	600	14	0.55	40	0.42	P, A, H
IXF(1)22N60P(2)		22	0.33	60	0.31	V, H
IXF(1)26N60P(2)		26	0.27	72	0.27	V, H, T

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Thermal Management and the Power Sipping Future

By Nico Bruijnis, Area Sales Manager, The Bergquist Company

Upward pressure on energy prices is here to stay. With the unstable outlook for oil prices and increasing levies on carbon output, it is even intensifying. In this context, the need for energy efficiency is a growing imperative. Fortunately, electronic technology has allowed us to respond, for example through innovations at junction level, component level and system level. These have reduced the amount of energy wasted as heat in electronic systems to a fraction of the quantities recorded even just a few years ago.

Yet thermal management is continually coming to the fore in an increasing range of applications. One reason is miniaturisation. Dissipation is down, but power density is up. Hence designers have to plan for much better utilisation of the small thermal masses available to quickly transfer heat from silicon to ambient. The thermal characteristics of some of the energy efficient new devices also differ from those of traditional technologies. The latest power LEDs provide a good example.

Power LEDs now deliver comparable light output to incandescent light sources. Designers of end products ranging from automotive lighting to roadway and public signage, architectural lighting and escape route illuminations are switching over en masse. Advantages include improved performance, higher longevity, versatile control modes, easier assembly, and lower overall power consumption. As an example, replacing a European traffic light signal with an LED array can more than halve the power consumed and extend replacement rates from a few months to several years. But despite their overall energy savings, LEDs produce a high quantity of heat relative to their dimensions. This characteristic must be effectively addressed in LED signage or lighting applications, which usually comprise many individual LEDs mounted close together to achieve sufficient light output intensity;

this may be specified by applicable standards such as EN12368.

Failure to adequately remove the heat produced will impair performance from individual LEDs and shorten the lifetime of the assembly. Excessive temperature leads to a reduction in intensity and produces variations in colour resulting from changes in the emitted wavelength. In a red stop signal such as a traffic light or centrally mounted high level brake light in a vehicle, for example, colour variations across the face of the light will translate into low perceived quality, and may also be distracting or confusing for road users. With white power LEDs now targeting vehicle headlamp applications, thermal management to ensure colour fidelity will become even more important. This can be achieved without using large and expensive heatsinks, for example by using an insulated metal substrate technology such as single layer or multi-layer Thermal-Clad, which is well suited to surface mount assembly.

Staying with the automotive theme, electrical technology is increasingly important to fuel economy. Compact, lightweight electric motor assemblies are replacing bulky mechanical implementations in major components such as power steering and transmission controls. Inside the cabin, electronically controlled electric motors produce smoother motion and allow lower rated motors to be specified for seat adjusters, HVAC controls, and door mirror and window adjusters. Again, although the power normally viewed as being wasted within a vehicle is actually reducing quite quickly with each successive new model, the thermal energy produced is increasing relative to the size of the assembly.

Designers must assess the thermal challenges and determine appropriate countermeasures early in development. However, another factor coming into play is the increasing requirement for standardised electrical subsystems that can be used across multiple vehicle platforms, to meet market demands for low prices and frequent new models. Versatile thermal management products are essential, such as the latest two-part gap fillers that are applied in liquid form to create a low stress, thermal filler conforming to any shape of enclosure. Dispensing techniques are also becoming easier and more cost effective.

As electronic technologies provide the tools to micro-manage energy resources, precision thermal management is key to maintaining performance, longevity and cost-effectiveness.

www.bergquistcompany.com

THE LENNOX REPORT

ELECTRONIC COMPONENTS INDUSTRY

GENERAL

The ZVEI forecasts a 5% increase to € 18.3 B of the 2006 German electronic component market, after a 2005 growth of 2%, predicts an increase of over 6% for next year. Semiconductors are to grow 6% to € 12.2 B, 9% next year to € 13.4 B while passives will increase 2.1% in 2006 to € 1.28 B and electromechanicals 2% to € 2.7 B. PCBs are to add 2% for € 1.37 B. As concerns the European market it is estimated at € 50.1 B in 2006, up 4% which would make Germany by far the largest single market at about 36% of total.

SEMICONDUCTORS

The WSTS has up-graded its earlier forecast of the 2006 world semiconductor market from 8% to 10.1% followed by 11% next year and 12.8% in 2008 with Asia/Pacific being the largest and fastest growing region. Europe is to add 3% this year, 9.5% in 2007 and 10.6% in 2008. By product line, analog ICs are expected to grow 16.9% this year worldwide with memories +14%, sensors +13.7% and optoelectronics up 10.1%. According to SEMI semiconductor capital equipment spending declined 11.3% last year to $ 32.9 B with Japan down 1.1% to $ 8.18 B, Korea +26.3% to $ 5.83 B, Taiwan –26.3% to $ 5.72 N, North America –1.9% to 5.70 B and Europe –$5.3% to $ 3.26 B. But continuing strong demand and high capacity utilization are, so VLSI Research, pushing equipment sales this year to a record rate of 23% after a 7% decline last year to $ 43.4 B (a broader definition than SEMI's), test and assembly even 16.8% to $ 5.6 B (Advantest $ 1.9 B sales, Teradyne $ 658 M, Yokogawa $ 461 M and Agilent $ 384 M). The assembly business shrunk 13.5% to $ 2.8 B (ASMI – whose shares have been rising on hopes of a breakup promoted by an investment fund – $ 327 M, Kulicke & Soffa $ 268 M, Skinkawa $ 192 M, BE Semiconductor $ 183 M). ASML maintained its lead last year in the $ 4.3 B lithography market with a 48.4% share, so The Information Network, ahead of Nikon's 33.1% but lead in the number of units shipped.

News from Intel includes the official opening of its Fab 24-2 in Leixlip, Ireland, operating on a 65 nm process and representing a $ 2 B investment out of $ 7 B the firm has invested in four production centers in the country employing 5500. Fabs in Oregon and Arizona are already using the 65 nm process and a move to 45 nm is planned for next year and should double the number of transistors per chip and increase speed by 20%. Intel is introducing a Core2 Duo design for servers with versions for desktop Intel still led the graphic IC market in the first quarter with a 39.1% share, so Jon Peddie Research, ahead of ATI's 28.7%, all measured on the basis of a 74.9 M unit market. AMD's VP of global marketing Patrick Moorhead is quoted as saying that "price competition doesn't scare us"
though the firm still produces only at 90 nm levels but the new Dresden fab will use 65 nm processes and is being rushed into production to meet capacity required to serve recent new customer Dell.

National Semiconductor which already has six design centers in Europe employing close to 300 engineers plans to open another one dedicated to devices for the signal path such as high speed buffers. The firm has managed to boost gross margin to 60.7%, so CEO Brian Halla, with growth driven not so much by end equipment but rather ist contents, that is increasing number of applications. The firm claims market share increases in standard linear, power, amplifiers, data conversion and interface, last fiscal year sold 47% in Asia-Pacific, 20% each in America and Europe and 13% in Japan. The firm has been conducting power management seminars in several European cities, is pushing its distributors to support the design-in process with reference designs as the market looks for system solutions and sees advanced power management critical for converged voice and data applications.

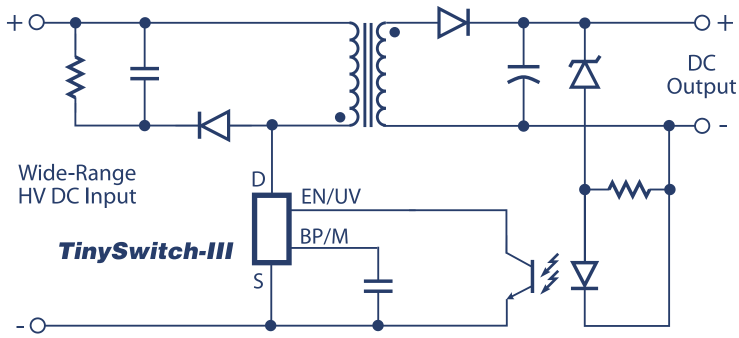
As previously reported Philips now made it official that it plans to reduce its ownership share in its semiconductor division, 2005 sales € 4.6 B, pre-tax income € 307 M, to a minority stake through either an IPO and/or sale of shares to financial investors. This "is a further step away from high volume electronics to a strategy to build a Healthcare, Lifestyle and Technology company". The changes are to be completed before the end of this year.

Texas Instruments, the N° 3 semiconductor producer with 2005 sales of $ 10.12 B, +4.3%, is revising its second quarter revenue estimate upwards to between $ 3.63 B and $ 3.73 B, up from $ 3.46 to $ 3.75 B with net profit to increase 17% over the prior estimate. TI is betting on immersion lithography for its 45 nm process to get into production by mid-2008 as it focuses on size and power consumption reduction, key requirements in all phones. Silicon will be the preferred technology for decades where cost is an issue, so TI's Gene Frantz.

editor@bodospower.com

TinySwitch-III®

High-Voltage Switcher IC for Power Supply Design
Enables Lower Total System Cost, Greater Design Flexibility



Typical TinySwitch-III Application

Features:

- Selectable current limit for greater flexibility
- Tight parameter tolerances reduce system cost
- On-time extension reduces input bulk capacitance
- Supports designs up to 36.5 W

Applications:

- Accurate CV/CC chargers/adapters
- PC Standby and other auxiliary supplies
- DVD/PVR and other consumer products
- Supplies for appliances, industrial systems, metering

EcoSmart® Energy Efficiency:

- Easily meets all global energy efficiency regulations
- No-load consumption:
  - <50 mW with bias winding
  - <150 mW without bias winding
- Meets 1 W standby requirements

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DC-DC Market Cycles

POL modules will remain a large share of the market

DC-DC converter market dynamics are an amalgam of technological, economic and business trends. The traditional pattern in this market is that as technological shifts occur, such as a new form factor or a new architecture, the market experiences growth that lasts for a few years.

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

Over the course of dc-dc converter technology cycles, business dynamics take an increasingly important role in determining the overall growth in the market. This trend was true following Vicor's introduction of bricks during the mid-1980s, is true today, and will remain true in the future.

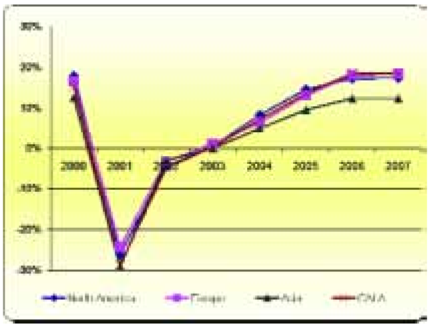

Figure 1: Worldwide DC-DC Converter Market by Rgion (year - to - year revenue growth)

The dc-dc converter market's current cycle began at approximately the same time that the dotcom boom was ending. Bricks had become a commodity product and production had already begun shifting to Asia. As a result, dollars-per-Watt was in decline. Then the economic downturn associated with the dotcom-bust occurred and dc-dc converter sales plummeted.

However, dc-dc converters bounced back faster than the larger ac-dc power supply market. The primary driver for this growth was the emergence of the Intermediate Bus Architecture (IBA). Sales of point-of-load (POL) converter modules and bus converters lifted unit sales higher than their pre-bust days, even as revenue remained relatively low due to heightened price pressure. While this look back is interesting, the truly important take-away from this trend is to see how it might be reapplied to the current situation.

The IBA is maturing as new product introductions of POLs and bus converters are slowing. This architecture has grown quickly from its inception, with new product introductions peaking in 2004, according to Darnell's PowerPulse daily newsletter. In 2005, new product announcements started tapering off, and that trend is continuing in 2006. This is partially due to the strong growth in the point-of-load market, which is not sustainable at the high growth rates of recent years. As a result, bus converter market growth is expected to continue slowing down, with a flattening of growth over the next few years.

IBA adoptions will slow down as a result of normal market dynamics. Of the potential market adopters, the early adopters and even the early majority have already switched to the IBA, so the potential growth is coming from those few remaining applications that may switch. This does not imply that the IBA will see sales declines, just that it cannot continue to outpace sales in the overall dc-dc converter market.

Since any continued adoption of the IBA will not be large enough to ramp up dc-dc converter sales on its own, business trends will be the primary driver of the dc-dc converter market over the next two years. Three related business trends standout as the largest market drivers of the dc-dc converter market: 1) continued emergence of discrete POL solutions; 2) industry consolidation; and 3) rising pricing pressure.

One of the most commonly discussed threats is the continued rise of discrete semiconductor solutions eroding the market for POL converters, which is a result of the maturing of the IBA. Semiconductor makers are attempting to provide solutions at a reduced cost. If this occurs, makers of bus converters may see fast growth even as POL sales slip away. However, this does not imply that the POL module market is going away.

Clearly, the discrete market is growing, but it is not encroaching too much on the dc-dc module market. Many system makers still find POL modules to be a cost-effective solution that can yield faster time-to-market and save board space, while being easier to test and replace, should problems arise.

The exact power level where modules gain an advantage is a moving target. Currently, based on OEM feedback, Darnell Group estimates this break at 6A. While semiconductor companies are challenging this advantage with products such as Linear Technology's 10A LTM4600 Module™, POL modules will likely remain a large share of the >6A market.

However, while many dc-dc converter companies are lamenting the rise of discretes as the largest threat to continued dc-

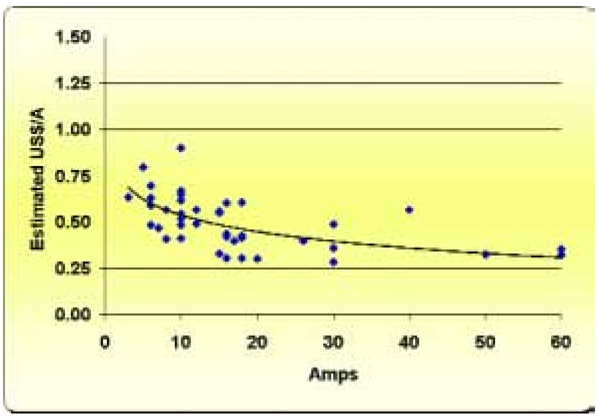

Figure 2: POL Pricing in US Dollars-per-amp

dc converter growth, there is currently a larger threat—industry consolidation.

When industry consolidation is mentioned in context with the dc-dc converter market, the first thing that likely comes to mind is Emerson's acquisition of Artesyn. While this is clearly a large part of the consolidation, as it brings together two of the top ten companies in this space, it is only the tip of the iceberg.

Delta Electronics is practically consolidating this industry on its own. Delta has pegged its annual sales growth at over 40% for the last two years. During the first quarter of 2006, Delta's sales grew 48.5% to reach $680.5 million. While this growth is impressive, Delta's growth in the dc-dc converter market is even faster. Over the same time period, Delta's PS2 division, which is primarily made up of dc-dc converters, jumped 93.1% to $88.5 million. If Delta can put together four quarters of revenue at this level (just revenue, not growth), it will jump from the eighth largest dc-dc company to the largest as it surpasses the combined Artesyn/Astec.

Since the market is not growing nearly this quickly, Delta's growth stems from cannibalizing others' market share. As this has occurred, Delta has brought the production volumes, margins and pricing strategies that made it the largest ac-dc power supply company to the dc-dc market. While this will have only a modest effect on the dc-dc converter market overall, it will have an effect on which companies rise and fall within the market.

Industry consolidation is also occurring in the communications market, which may hamper potential dc-dc converter growth. The mergers of Alcatel with Lucent and Nokia with Siemens are reducing the number of customers in the communications market. Over the next few years, as the companies work out their preferred suppliers, some dc-dc converter manufacturers will see sales gains, while others will slowly lose once-large customers. This, combined with intra-industry consolidation, will significantly lessen many companies' opportunities in the dc-dc converter market, even as the top-line market revenue projections remain rosy.

The combined maturing of the IBA, industry consolidation and the threat of increased penetration of discrete solutions has helped to lower average selling prices throughout the market. Only a few years ago, POLs were selling at an average dollars-per-amp of US$1. Currently, that dollars-per-amp price has fallen much closer to US$0.50-per-amp. So even if POLs can maintain unit sales growth, the ever-increasing price pressure that they face will make revenue opportunities harder to find.

Currently, it appears that two trends may drive further growth in the dc-dc converter market. The most obvious of these is the adoption of digital control and management techniques. Darnell expects the digital dc-dc converter market to reach its growth inflection point during 2008 and 2009, which is shortly after digital control techniques are expected to reach price parity with analog solutions. However, while digital control will be implemented in dc-dc converters, the largest opportunity that digital control presents are in other markets.

This leads to the second opportunity—increased efficiency. The embedded and external ac-dc power supply markets are seeing a surge of activity, which will lead to revenue growth associated with increasing power supply efficiency. While dc-dc converters are typically more efficient than ac-dc power supplies, efficiency gains can still be made, which will lead to a surge in spending. Server OEMs, and more importantly their customers, are beginning to demand greater efficiency. This is necessary as energy costs continue to rise, which raises the costs of inefficiency.

A number of independent design houses already have what they claim are cost-effective and possibly cost-neutral technologies that can enhance the efficiency of dc-dc converters. One of these design houses is California Power Research. The company claims to have taken a bill-of-material very similar to those used for a comparable Point-of-Load Alliance POL and cut the losses in half, while maintaining the same footprint. As more efficient dc-dc converters come to market, the market will see another batch of longer-term sustained growth.

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Powering LED Arrays in Backlight Applications

32 LEDs are driven from a 12V supply

LEDs are becoming an increasingly popular backlighting option for all types of LCD displays, large and small, as more efficient and more cost-effective white LEDs become available on the market.

By David Sorlien, Applications Engineer, Intersil

Advantages of LED backlighting include low cost, high reliability, low voltage, low EMI, high immunity to vibration, wide operating temperature range, and wide dimming range. These features make LED backlighting particularly suitable for handheld applications, such as cellular phones, portable media players, digital still and video cameras, and GPS receivers, among others.

An LED backlight has two basic configurations: edge-lit or array-lit. Edge-lit displays use one or many side-emitting LEDs along the sides of the display. Array-lit displays employ multiple LEDs arranged in a grid pattern directly behind the display. In both configurations, the LED light source is coupled with light guides and diffusers that distribute the light evenly behind the display.

Intersil's EL7801 is a high-power LED backlight driver with integrated 36V FET, capable of driving 1 to 8 high-power LEDs in a series from a wide range of input voltages. The 1 MHz PWM converter can be configured in boost or buck topologies, supporting a wide variety of LED backlight applications.

LED light level may be controlled by adjusting the DC bias via the LEVEL pin, or by applying an external PWM signal to the EN/PWM pin. Since LED color temperature varies with bias current, PWM dimming offers better control of color temperature because current through the LEDs is kept constant. The EL7801 provides a 5V gate driver synchronized to the EN/PWM pin that can be used to control an external FET that disconnects the LED stack during the PWM dimming signal-off period. A voltage applied to the LEVEL pin then sets the output current of the converter during the PWM on period.

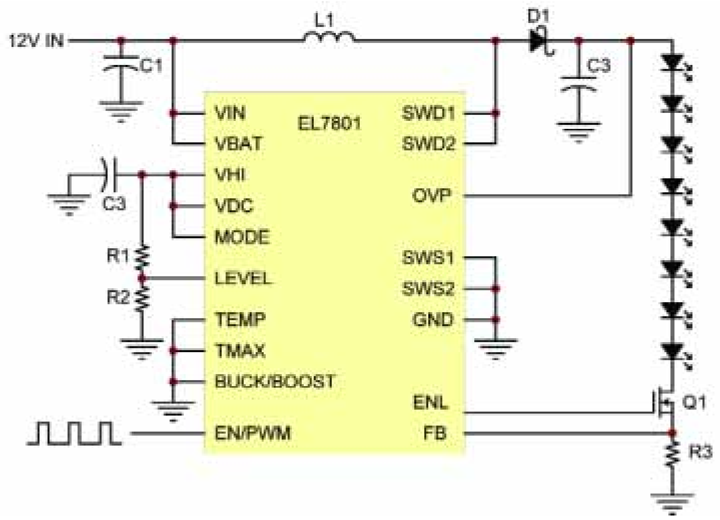


Figure 1. Typical EL7801 Circuit

A minimal BOM LED backlight application using an EL7801 in boost configuration to drive a string of eight series-connected LEDs is shown in Figure 1.

In this application, eight series-connected LEDs are driven from a 12V supply. A logic-level PWM dimming signal is applied to the EN/PWM input to control average LED current. Current in the LED load during the PWM on-time is determined by the value of the feedback sense resistor R3, and the target feedback regulation voltage (V_{FB}). With MODE tied to VDC, voltage across the feedback resistor is set by V_{LEVEL}.

$I_{LED} = V_{FB} / R_{SENSE}$
$V_{FB} = V_{LEVEL} / 5$

The value of VFB should be kept in the 50mV to 450mV range for linear operation. With MODE pin tied to ground, V_{FB} is set to 400mV via an internal reference, and resistors R1 and R2 can be omitted.

For applications that require more than 8 series connected LEDs, multiple strings of series-connected LEDs can be controlled using a single EL7801 device. If one simply connects the LED strings in parallel, there can be noticeable mismatch in brightness between the strings, due to variations in LED forward voltage. To illustrate this concept, the forward voltage versus forward current variation of eight white LEDs taken from the same reel is shown in Figure 2.

In this example, LED current at a specific forward voltage can differ by as much as 10mA. When two such LEDs are connected in parallel, and driven by a constant current source, the variability of the individual LED forward voltage will likely result in one LED receiving significantly more current than the other.

An additional source of LED forward voltage versus forward current mismatch is introduced by temperature variations

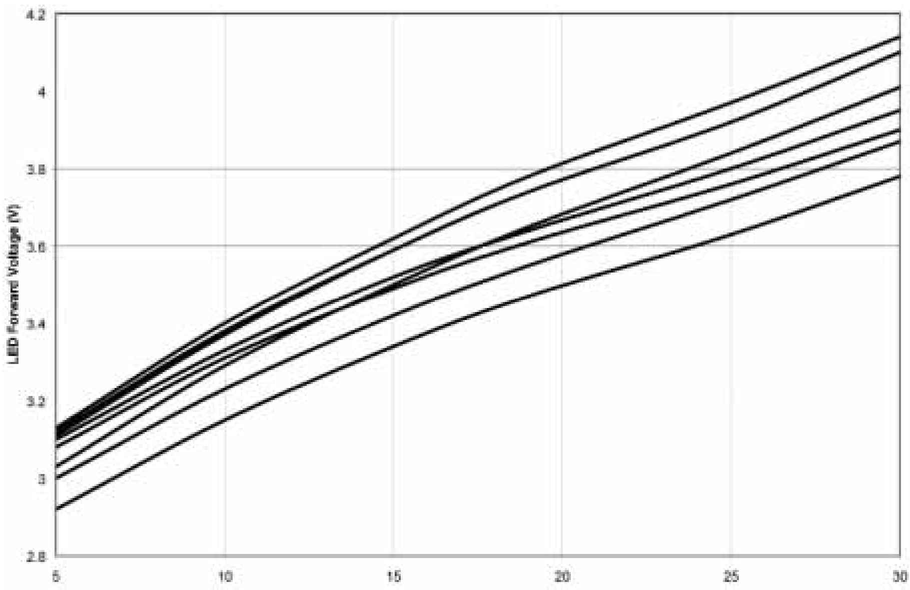


Figure 2. Forward Voltage vs. Forward Current for eight white LEDs from same reel

between the individual LEDs. White LEDs of the type used in backlight applications typically have a temperature coefficient of -2 to -4mV/ºK. Thus, as temperature increases, the forward voltage decreases. This effect will contribute to the current mismatch between LEDs or LED strings connected in parallel.

A better method of driving multiple LED strings from a single LED driver IC is required. One solution to provide equal current to two LED strings involves the use of a simple current mirror, constructed with a matched transistor pair. Such an application is shown in figure 3.

In this application, Q1-Q2 is a matched pair of transistors. It is important to keep Q1 and Q2 at the same temperature to provide good current matching in each LED string. Devices that include two or more thermally-coupled matched transistors in a single package are available for this purpose.

A logic-level PWM dimming signal is applied to the EN/PWM input to control average LED current. Total current in the LED strings during the PWM on-time is controlled by the value of R4 and the target feedback voltage (V_{FB}), which is controlled by applying a DC voltage at LEVEL.

The value of R3 must be carefully selected to guarantee that under all operating conditions, the voltage between points A and C in this circuit is greater or equal to the voltage between points B and C. If this relationship is not maintained, the LED strings will receive unequal current.

To calculate the required value at R3, the maximum (V_{f_MAX}) and minimum (V_{f_MIN}) forward voltage of the LEDs must first be determined. It is important to consider all sources of forward voltage variation, as described in the sections above. The worst-case voltage difference between the two LED strings (ΔV_{f_string}) is then calculated.

$$\Delta V_{f\_string} = \text{(\# of LEDs in string)} \cdot (V_{f\_MAX} - V_{f\_MIN})$$

The minimum current in either LED string is then determined. This is nominally one-half of the total output current, set by R4 and V_{FB}. The accuracy of the current mirror circuit at Q1-Q2 should be considered, as well as the gain and offset error in the EL7801 internal circuitry that translates the voltage on LEVEL to the target feedback voltage V_{FB}. When minimum LED current is known, the ideal value of R3 can be determined.

$$R3 = \Delta V_{f\_string} / I_{LED\_MIN}$$

It is important to not violate the absolute maximum power rating of the components, therefore R3, Q1, and Q2 must be selected to handle the worst-case conditions, and PCB layout must be done with thermal considerations in mind.

The application circuit depicted in figure 3 has a few drawbacks. The circuit is rather inefficient, since worst-case LED forward voltage variations must be accommodated. Furthermore, driving additional LED strings while maintaining tight string-to-string current matching may be difficult due to the unavailability of suitable matched transistor arrays. For such applications, a better solution is required.

A more efficient backlight application using the EL7801 to drive four strings of eight series-connected LEDs is shown in figure 4.

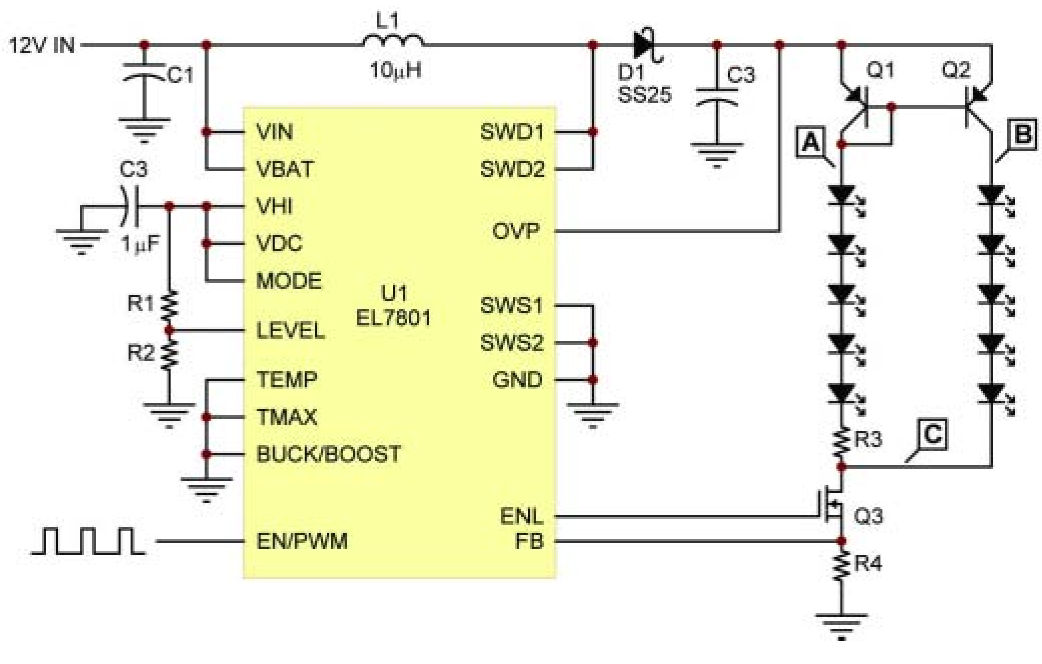


Figure 3. Multi-Leg EL7801 Circuit, with Simple Current Mirror

In this application, a total of 32 LEDs are driven from a 12V supply. Similar to the application depicted in figure 1, LED brightness is controlled by applying a logic-level PWM signal on the EN/PWM input. The LED current during the PWM on time is controlled by the voltage at LEVEL.

U2 and U3 are single supply dual op amps, configured as voltage-controlled current sinks. Examining the leftmost leg, we see that current flowing through the LED string also flows through Q1 and R3. The op amp will adjust the gate drive of Q1 to force the voltage across R3 to equal V_{FB}. LED current during the PWM on time is determined by the voltage on the LEVEL pin.

$$I_{LED} = V_{LEVEL} / (5 \cdot R3)$$

With the 10 ohm current sense resistors shown in figure 4, a voltage of 1V applied to LEVEL will result in 20mA current per LED leg. LED current can be increased by reducing the value of the current sense resistors, or by increasing V_{LEVEL}.

The op amps selected for this application must be able to function with input voltages near ground. The op amps will typically be single-supply type, powered from the EL7801 VDC output, therefore a rail-to-rail op amp is suggested (for instance, Intersil EL5220CY). With this circuit, leg-to-leg current matching is primarily a function of the op amp input offset error, so an op amp with a low VOS specification is preferred. The op amp output slew rate is also an important consideration to maximize system efficiency and dimming linearity, and becomes increasingly important as the frequency of the PWM dimming signal increases.

Diodes D2 though D5 identify the LED string that exhibits the greatest combined forward voltage drop. The voltage at the bottom of this LED string also appears at the cathode of D6. During the PWM dimming signal on-time, ENL is driven to 5V, turning Q5 on. The control loop of the EL7801 will then increase switching duty cycle until the VFB reaches the desired voltage level. At this time, the voltage across R8 becomes equal to the minimum drain-source voltage of the four current sink MOSFETS (Q1 through Q4). Therefore, the value of resistor R8 determines the minimum voltage that will appear across any of the current sink MOSFETs.

To increase efficiency of the system, the value of R8 can be reduced. However, the ratio of R8 to R9 must be greater than the ratio of the current sink MOSFET $R_{DS(ON)}$ to the current sense resistors (10 ohms in this example), in order for the circuit to generate equal current in each LED string.

Since the voltage across each of the 10 ohm resistors at R3-R6 is equal to the FB voltage, the legs that exhibit a lower combined LED forward voltage drop will see an increased drain-source voltage at the current sink MOSFETs. The designer should consider the LED forward voltage tolerance across the operating temperature and desired LED current ranges, and select current sink MOSFETs capable of handling the worst-case power dissipation condition.

During the PWM off time, the ENL signal is driven low, turning off Q5. Voltage across R9 then becomes zero. The voltage controlled current sink circuits respond in turn by driving the gate of the connected MOSFETs low, disabling the current flow through the LEDs.

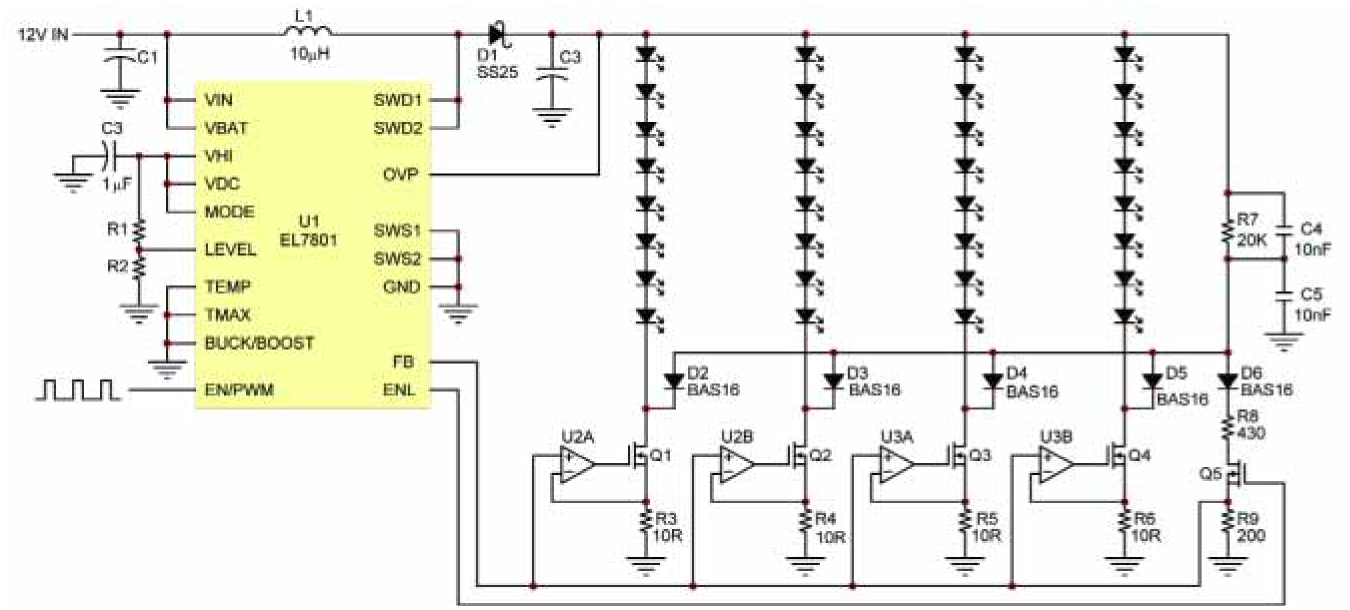


Figure 4. Multi-Leg EL7801 Circuit, with Active Current Mirror

Capacitors C4 and C5 allow some of the output voltage ripple to appear at the FB circuit node, and help stabilize the EL7801 control loop. The EL7801 employs a direct summing control loop with current feedback. No error amplifier is used in the system. This arrangement provides fast transient response and makes use of the output capacitor to close the loop. A combination of ceramic and low-ESR electrolytic capacitors can be used to minimize implementation costs. Generally, the higher numbers of LEDs, lower VFB voltages, and smaller values of current sense resistors will require smaller value output capacitors to achieve loop stability. In the circuit depicted above, with 20mA LED current per leg, a total of 40ìF of capacitance at C3 is recommended.

It may be desirable to sense the actual light output of the LEDs, and adjust the LED current to maintain a precise level of luminous intensity. A method of controlling LED current with a light sensor IC is shown in figure 5.

The circuit shown above can replace the fixed voltage divider on LEVEL depicted in figure 4, to provide a method of maintaining a constant light output. The EL7900 is a light-to-current optical sensor combining a photodiode and current amplifier on a single monolithic IC. Output current is directly proportional to the light intensity on the photodiode.

$EL7900\_I_{OUT} = E_V \cdot (60\mu A / 100Lux)$
Where E_V is illuminance in Lux

The op amp at U5 is configured as a current-to-voltage converter. The voltage divider formed by resistors R10 and R11 sets the output voltage when no light is present at the EL7900 sensor. With the values of R10 and R11 shown, the output of U5 is 1.5V when there is no light present. Resistor R12 is selected to provide the desired gain of the system.

$V_{OUT} = V_{REF} - (E_V \cdot R12 \cdot (60\mu A / 100Lux))$

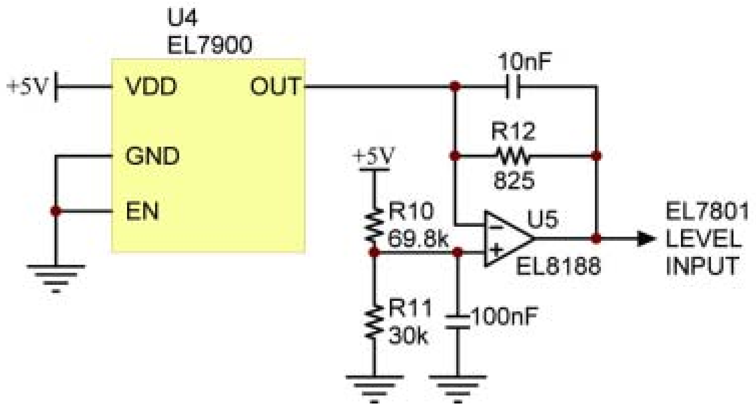


Figure 5. Controlling LED Current Using an EL7900 Light Senor IC

Where V_{REF} is the voltage at U5's non-inverting input

E_V (illuminance, in Lux)	V_{OUT}
0	1.500
100	1.451
200	1.401
500	1.253
1000	1.005
2000	0.510
3000	0.015

Table 1. Luminance versus Output Voltage

The component values shown in figure 3 were selected to provide a 1.0V output at 1000lux light input. When light intensity increases, the output voltage of this light-sensing circuit decreases, and the attached EL7801 circuit will respond by decreasing the switching duty cycle, thus reducing LED current.

In conclusion, the EL7801 is a highly versatile device, and can be used in a variety of applications, including those where more than 8 LEDs must be powered. When used in conjunction with an EL7900 light-to-current sensor, applications that require a constant light output can be easily implemented.


Come
together

HEV Converters Based on PCC Technology

Innovative Miniaturized System Solutions

The solution can be realized on the basis of the innovative and integration-friendly Power Capacitor Chip (PCC) technology. This technology was mainly developed for the DC link capacitor, one of the key components of an HEV converter.

By Harald Vetter, Epcos AG, PM Power Electronic Capacitors

The PCC, a newly developed power capacitor, will set a new standard for DC link capacitors for HEV applications. The challenge for PCCs in this field is the considerably higher requirements profile in comparison with well-known industrial loads. This means that most standard PEC solutions cannot be successfully transferred to these applications e.g. the total circuit inductance L_σ must be extremely small, approximately 10 to 30nH, to avoid oscillations at the switching frequency. Also, the thermal current carrying capability I_{th} must be up to $250A_{rms}$ /mF and the high peak current I_s rating at least twice the value usual in industry. These requirements are promoting a switch to self-healing solutions such as PCC in the domain previously covered by aluminum electrolytic capacitors. The capacitor should withstand harsh environments, various geometrical dimensions lead to space and weight restrictions depending on the current HEV development status and a strong design to cost management during the design-in phase is a must. The PCCs delivers outstanding performance and support innovative and cost-effective converter designs based on the goal of miniaturization and modularity.

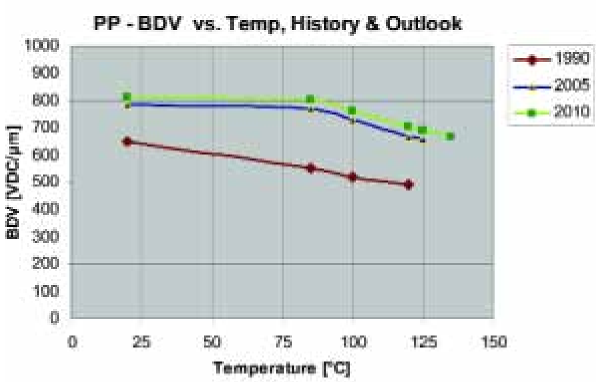


Figure 1: Breakdown voltage BDV vs. temperature history and outlook carried out to DIN 53481 (sheet test, ball-plate).

Polymer selection guide

PP (Polypropylene)
This dielectric, and particularly its high temperature grade, is competitive with the other common dielectric films within a wide range because of its superior electrical properties, such as breakdown voltage level, insulating resistance and self-healing.
PP is semi-crystalline, consisting of crystalline regions in an amorphous matrix. By optimizing the matrix structure, using ultra-pure homopolymer with extra-high isotactic content with a tailor-made molecular weight distribution (MWD), modified preparation of the catalyst and extreme process purity during film production, the BDV strength vs. temperature has been increased consistently in the past. In future, a limit will be reached at about BDV=700VDC/µm and T=120°C..

The development trend for the BDV field strength vs. temperature (for miniaturizing of V_C one of the key parameters) is shown in Figure 1. In fact, the temperature limitation rose from $T_{max} \approx 120°C$ in 1990 up to $T_{max} \approx 125°C$ in 2005. New Laboratory results indicate increase of this value in the future up to $T_{max} \approx 135°C$ at a BDV ≈ 670VDC/µm with optimised thermal shrinkage characteristics. The line for 2010 is a theoretical estimate, so this target remains uncertain in practice.

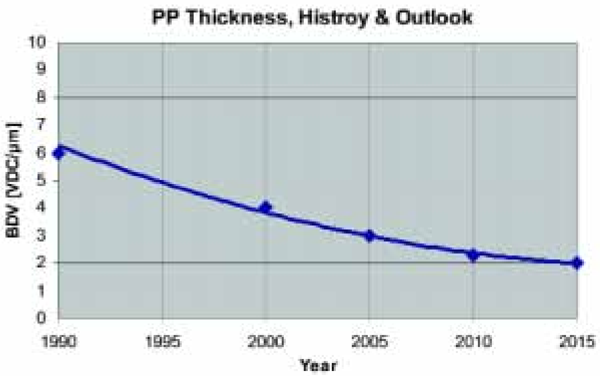


Figure 2: Thanks mainly to the MWD, the PP polymer can be converted to an ultra-thin capacitor grade film. The development history and road map of PP plays an impressive role in miniaturizing V_C.

The development trend for film thickness (the next key parameter for miniaturization) is described in Figure 2. Thanks largely to the tailor-made molecular weight distribution (MWD), the polymer can be converted to films with a thickness less than 3µm. The film thickness has been gradually reduced in the past but will also reach a limit in future, which is expected at about d=2µm.

The miniaturizing effect for V_C due to down-gauging is shown in Table 1.

Parameter	Unit	2005	2010	2015
d_{film}	µm	3,2	2,5	2
V_C	dm³	68	41	26
dV_C	%	0	-40	-62
$V_{C\ rel}$	%	100	60	38

Table 1: Miniaturizing effect for V_C

The PP parameter collection based on the outlook estimate described above can be summarized as:
- BDV=660VDC/Vμm at T=125°C satisfies the current HEV requirements for the DC link.
- The expected outlook of BDV≈670VDC/μm at T≈135°C is encouraging for the future.
- The expected down-gauging to 2μm [5] is helpful for future APE applications.

Design comments on alternative films

PPS (Polyphenylenesulphide)

Because of its high thermal resistance, a larger and more expensive PPS design is attractive as long as V_C is not at the focus and if T_{max} <=170°C is a requirement (e.g. with fully integrated HEV designs of the 3rd generation – this means an solution within the gear bell and without a second liquid cooling system). This expensive dielectric material seems to be a competitive alternative to the visionary solution discussed for this application: the ceramic capacitor.

PEN (Polyethylenenaphtalate)

This dielectric material is used in a small number of applications, such as automotive HID lamps, where the high heat resistance of T_{max} <=150°C offers a technical advantage over PET and is less expensive than PPS.

PET (Polyethyleneterephthalate)

For applications that operate at elevated ambient temperatures such as T_{max} <=135°C, a PET dielectric will often be selected. PET will be mainly “designed-in” at low to medium V_R values. An interesting example is the mild hybrid: metallized 1μm…2μm PEN capacitors operate in converter for integrated starter generator at $V_R \approx$ 42VDC. The design of a DC link capacitor with a medium voltage of V_R >100VDC and a capacitance C_R >100μF will be more difficult than small capacitors because of its more complex casing requirements designed to avoid overheating in large capacitor winding blocks or assemblies (e.g. with round or flat MKT windings). Special care must be taken to guarantee sufficiently high R_{ins} values and avoid effects such as hydrolytic degradation of the dielectric system.

Modern metallizing technology

The MKK-Technology for PCCs in HEV is working with a toolbox of metallization features like: Al, ZnAl, heavy edge, single or double side, flat or CSP, with or without structure, Figure 3.

Advanced coating techniques

An Acrylate coating on the metallized film is now available in production quantities. The thickness of the Acrylate layer ranges in between 0,1…0,3μm and delivers a high temperature protective effect for the dielectric substrate. The DC-BDV strength of PPS, PEN and PET has been improved by between +20…30% and superior self-healing properties of PPS have also been confirmed.

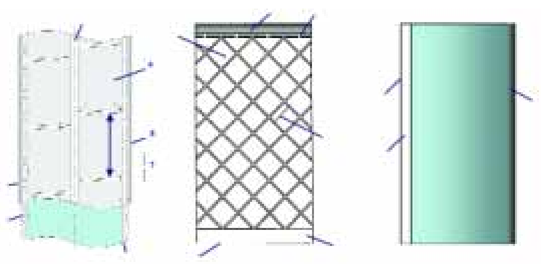


Figure 3: Metallization features for PCC, left to right: Smooth cut; Wavy cut; Free stripe; Partial capacitor; Free margin; Segment spacing; Protection fuse – for self protection function and Film, e.g. metallized with heavy edge, flat, wedge, step ore CSP, with or without structure

An Oil-coating technique is now also available. The thickness of this layer is in the range between 0.1…0.3μm. In addition to improved DC-BDV strength, greater insensitivity to climate can be implemented. This makes it significantly easier to work inside the converter casing with naked and cost effective PCCs.

These coating technologies will create new development targets, especially for innovative automotive applications. The most interesting substrate for coating apart from OPP will be high temperature grade films such as PPS, PEN and PET. The improved DC-BDV voltage strength and self-healing properties will increase the ER level and thus will minimize the physical capacitor volume V_C as already described.

Volume fill factor

The effect of the volume fill factor (VFF, the ratio $V_{Cphysical}$ / $V_{Ctechnical}$) is often underestimated because if the existing black box is filled with a sub-optimized winding shape, not all possible dielectric materials are activated inside the box. The necessary result is a reduced design-film thickness and reduced expected lifetime for the capacitor function (Figure 4) compared with a VFF≈1 solution with PCC.

A new winding technology for PCC

This newly developed winding technology can be used to implement absolutely flat and wrinkle-free stacked windings in “power cap dimensions” for PCC using metallized polymer films, starting with PP down to 2µm and PET 1.5 µm, Figure 5.

The result is an outstandingly high pulse-current-handling capability without the contact edge problem (a well-known and dangerous constriction effect at the film edges of low-cost MKP windings).

Figure 6 and Table 2 show the possible dimension range from a flat stack winding in PC dimension up to large diameter e.g. D≈260mm.

Requirements profile

The requirements profile in automotive APE engineering is characterized by the absence of a standardized mission profile. One first approach that may be used as a basis for the capacitor layout is filed in Table 3. The requirements for under-the-hood and on-the-engine installations are well known and extremely high, up to 125°C. Also, the upcoming short-term- / full operation requirements of up to 140°…150°C differs significantly from the standard specifications for industrial applications.

Thermal design

A thermal design for the overall system by taking into account the requirement on reliability and expected lifetime is therefore of central significance in these applications to be able to minimize the capacitor volume needed. The thermal loads on the capacitor can be classified into slow temperature changes and temperature shock. Thermal shock tests are typically performed over 100 up to some 1000 cycles between e.g. -40 and +105 / 125°C.
The applicable standards for road vehicles define no limits for the voltage disturbance on the traction battery system. However, a lower ripple voltage will represent an additional challenge for PCC R&D and will mean trying to increase the capacitance density in future

Advanced design aspects

If a PCC “design in” is taken into consideration at an early stage of the converter development, optimized system solutions can be implemented for maximum customer benefit. EPCOS is the only manufacturer to master all key winding technologies: round, flat and stacked windings in “power cap dimensions”. The rated voltage band-width extends from V_R=100VDC up to

Figure 4: Lifetime expectation vs. field strength ratio E_1/E_2 - caused due to different winding technologies Left: calculation based on a constant big casing.

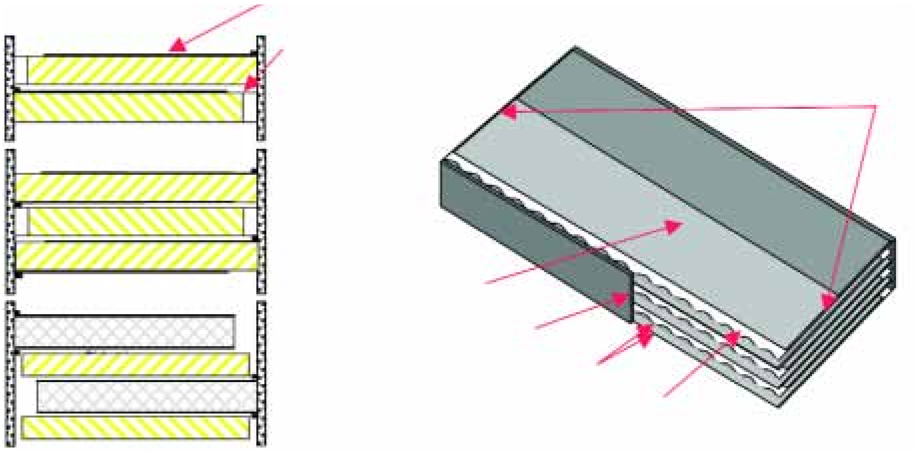


Figure 5: Design of flat and wrinkle free stack winding in “power cap dimensions” for PCCs. Left: cross section of different film/foil assembly. Right: stacked winding and Insulating area via saw cut. Free margin and “wavy-smooth” cut combination; Precise extension; Metal end spray layer and Film, e.g. metallized with heavy edge, flat, wedge, step ore CSP with or without structure.

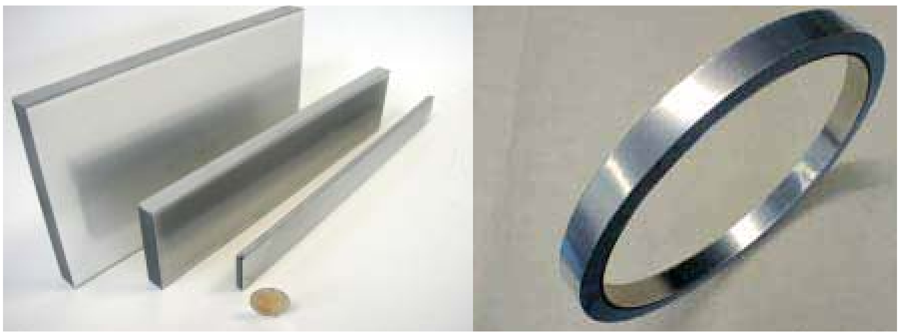
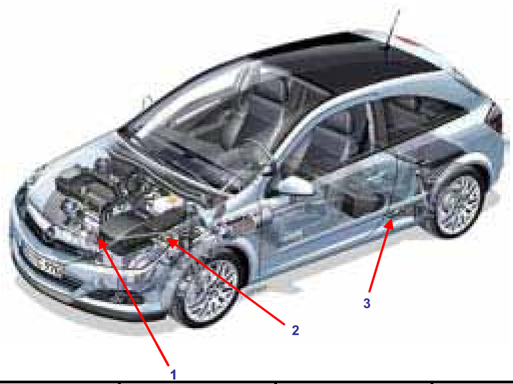


Figure 6: Examples for the dimensional flexibility
Left: LxWxH≈300x150…30x25…5mm³ Right: DxWxH≈260x30x20mm³

Parameter	L [mm]	D [mm]	W [mm]	H [mm]
Max	300	600	150	50
Min	50	150	30	5

Table 2: Possible dimension range from a flat stack winding



Parameter	1 on-the-engine	2 under-the-hood	3 chassis
Temp. range	-40 to +165°C	-40 to +125°C	-40 +70°C
Vibration	sinus < 30g	mixed < 3g	noise < 2g
Shock	up to 100g	up to 20g	-up to 5g

T [°C]	125	120	80	115	110	95	105	100
V / V_R [%]	100	138	138	113	138	113	113	100
t / t_{LD} [%]	1	2	3	6	7	8	31	42

Table 3 : Basis for the capacitor layout

V_R=1000VDC and the rated capacitance range from C_R=50µF up to C_R=3000µF depending on the system requirements. Custom-design solutions which generate additional benefits such as an integrated busbar will give the system designers additional scope to optimize their inverter layout in order to achieve: High volume fill factor ($V_{physical}/V_{technical} \approx 1$); Miniaturizing due to system integration; High design flexibility; Easy to integrate into a converter casing; Extremely low inductance; High permissible ambient temperature; Low functional weight; High over voltage strength;High pulse-current-handling capability; Long expected service life;High mechanical strength and Low fire hazard due to oil-free technology.

Application example:
The application benefits of the PCC concept will now be illustrated by some examples:

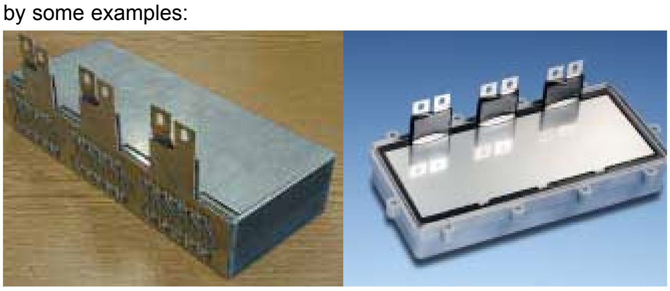


Figure 7: PCC, C_R=2mF, U_R=450VDC, LxWxH= 270x125x56mm³, water cooled, -40°C up to +125°C for the 1st generation HEV converter.

The PCC capacitor in a aluminum casing provides additional excellent EMC behavior together with the hermetic sealed converter.

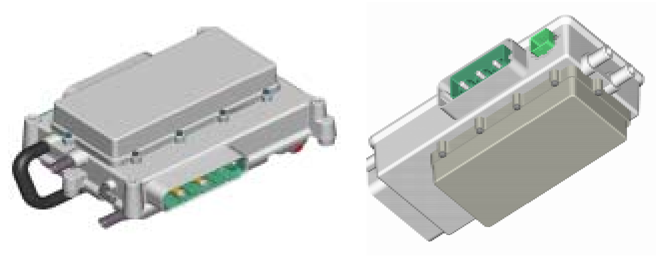
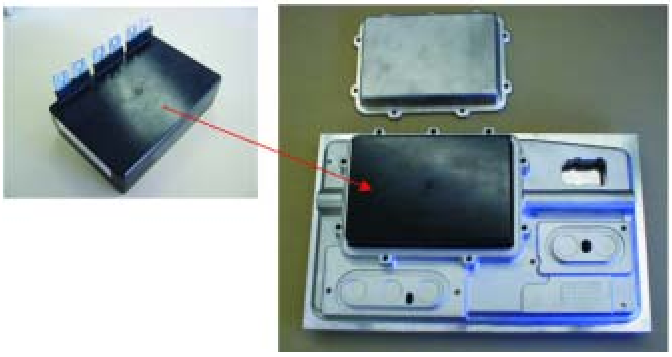


Figure 8: PCC with integrated bus bar in a plastic box ready for assembly up side down into the HEV converter casing. Left: CR=1mF, UR=450VDC, LxWxH=163x111x45mm³, -40°C up to +125°C, water cooled. Right: PCC in a pre-assembly stage



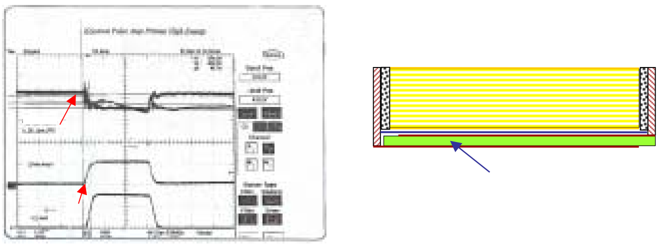


Figure 9: PCC designs with screw holes radial through the winding e.g. for mounting on cooling plate. Left: with integrated busbar, IGBT contacts and output terminals; C_R=1,8mF, U_R=450VDC, 3µm PP, LxWxH=370x60x50mm³.

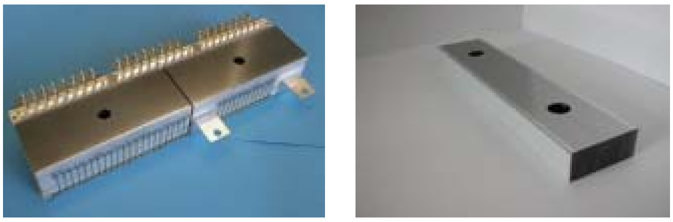


Figure 10: measured current and voltage waveforms, left and PCC mounted on a PCB busbar, right2xPCC with, C_R=200µF, U_R=450V, LxWxH=120x 73x28mm³, connected in parallel via a 2mm PCB busbar reached û=30V and di/dt=8kA/µs. The result calculated delivers an ultra-low loop inductance of Ls≈4nH.

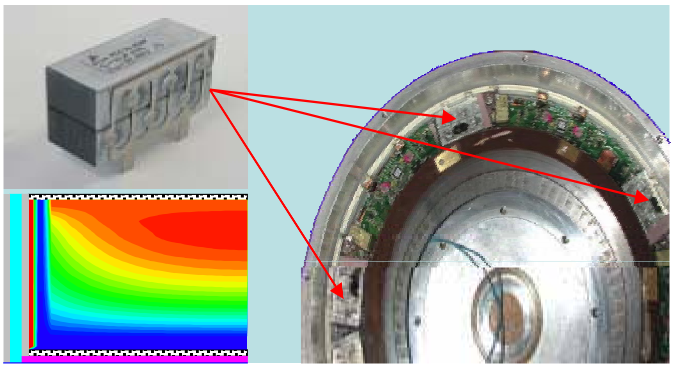


Figure 11: First motor-integrated circular converter for HEV, mounted in the stator and PCC with C_R=310µF, U_R=450VDC, I_{th}=200 Arms. Left: thermal simulation of PCC in operation.

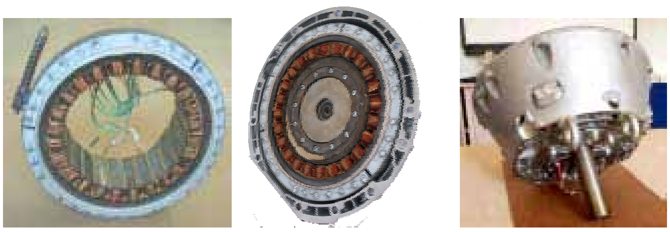


Figure 12: HEV converter 2nd generation used a circular shaped PCC with d=270mm and an integrated busbar with a Y-capacitor function.

For utility of the power semiconductors the stray inductance between the power semiconductors and the PCCs has to be minimized. Hence the DC-link capacitor is distributed between the power electronic modules around the circular converter assembly. To make full use of the available space the PCC were built in a circular form by winding the foils with a diameter corresponding to the diameter of the circular converter.

Trends

HEV motor output P rose from the level of 20...30kW in 2001 up to 120kW in 2006 and the rated voltage UR started at 100…300VDC and has reached now UR ? 700VDC. For film capacitor this trend is a good chance for future design in wins. The development trend characterized by the extreme requirements] of fully integrated next generation HEV converters will be supported by improvements in plain film performance data, the use of with new coating processed films, the upcoming down gauging of film thickness on the PP, and the reduction of power losses due to optimized metallization profiles. This requires a high-quality, cost-effective and complete production process with ultra-thin film (UTF) handling capability for boosting PCCs in industrial and mainly automotive.

Conclusion

The introduction and development of the process and production resources of PCC allow the DC link application of HEV converters to be optimized. This technology can be used also to replace electrolytic capacitors and it is evident that this ultra compact capacitor - often made in a single block - is a best-case design for an integrated and miniaturized system solution. This dimensional flexibility allows customized designs and satisfies hitherto unfeasible size requirements and PCCs delivers outstanding performance data like very low ESR and ESL values and should basically be able to operate up to 150°C.

Glossary

APE	Automotive Power Electronics
HEV	Hybrid Electrical Vehicle
PCC	Power Capacitor Chip
ECPE	European Center for Power Electronics
VFF	Volume Fill Factor of capacitor
BDV	Breakdown Voltage strength (DC or AC)
PP	Polypropylene
PPS	Polyphenylene sulphide
PEN	Polyethylene naphtalate
PET	Polyethylene terephthalate
HID	High Intensity Discharge lamps
MWD	Molecular Weight Distribution
PW	Polygon Winder
CSP	cross section profiled (metallization)
MKP	Metallized Kunststoff Polypropylene
MKK	Metallized Kunststoff Kompakt
UTF	Ultra thin film handling

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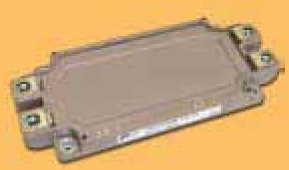


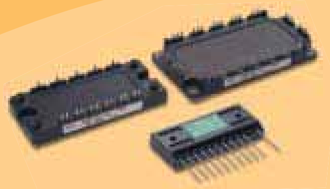
with Soldering Pins
1200V : 225A - 450A

with Spring Contacts
1200V : 225A - 450A

New High Power IGBT

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

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

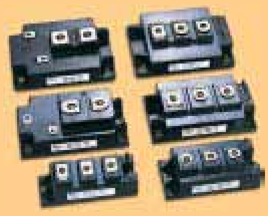


6-Pack IGBT
600V : 15A - 150A
1200V : 10A - 150A
1700V : 100A & 150A

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

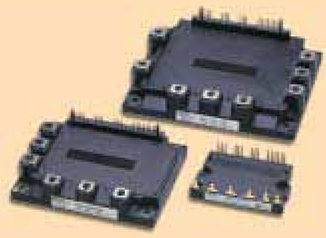
High Power 6-Pack
1200V : 225A - 450A
1700V : 225A - 450A

Special version available for rough environments



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

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



IPM-IGBT
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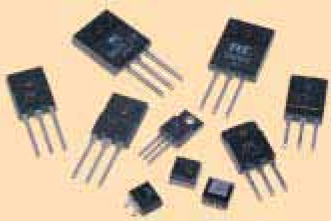

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Reduced Switching Losses and Higher Operating Temperature

IGBT4 chip generation enables efficient high current power modules

With the 1200V IGBT4 chips Infineon introduced a new generation of IGBTs. The goal of this innovative IGBT development was to reduce the saturation voltage and simultaneously decreasing the switching losses to improve the trade-off between static and dynamic losses.

By Marco Baessler, Peter Kanschat, Frank Umbach and Carsten Schaeffer, Infineon Technologies

The 1200V IGBT4 family offers optimized vertical structures for low, medium and high power applications. This article focuses on high power applications, namely modules with more then 1200A current rating. The related measurements were performed on a 2400A Infineon IHM single switch module.

Today state of the art IGBTs are Trench/Field-stop devices. In a Trench IGBT the MOS channel is rotated by 90° compared with a planar IGBT. Thus, a higher channel density can be realized at the chip top side which leads to a higher inundation of the top/emitter side with charge carriers. A good combination of a suitable trench density, a low backside emitter efficiency (collector doping) and a high charge carrier life time leads to a clear reduction of the saturation voltage without increase of turn-off losses [2].

In a Field-stop IGBT, an additional n+ layer is introduced close to the collector. This layer (field-stop) brings down the electric field within a very short spatial dimension. Therefore, it is possible to make the chips thinner and in such a way to reduce the static and dynamic losses. However, during switching events the silicon volume not affected by carrier extraction through the electric field is determining the amount of carriers contributing to the tail current. This tail carrier/charge is crucial for the softness of an IGBT. In case of high transient over voltages the space charge region reaches far into the field stop and the residual/tail charge is very small. For a critical voltage the tail current disappears and the current flow snaps off. Such a snap-off results in high and hardly controllable over voltages. This, so far, was a big challenge for the design-in of trench/field stop modules in high power applications.

Higher operation temperature

The new IGBT4 chip generation is balanced for the typical switching frequencies of the different power classes (low, medium and high, [1]). As a key advantage the 1200V IGBT4 chips allow a maximum operation temperature of 150°C (max. junction temperature of 175 °C) - compared to 125°C of the previous generation. The higher operation and junction temperature was introduced first by Infineon at 600V power semiconductors (IGBT3, [3], [4]).This results in the potential of a 20% higher output power, by use of the full temperature swing based on the same cooling condition. The higher temperature swing is supported by an improved power cycling reliability.

No snap-off currents

The tendency towards current snap-off is strongly dependent on the current rating of modules which are using the same IGBT chips. In today's high current modules as much as 24 150A IGBT dices are connected in parallel. Since the switching speed of the IGBTs is almost independent from the current rating, the current gradient dI/dt increases linearly with current rating to first order. As a consequence of parasitic stray inductances this leads to high dynamic over voltages favoring current snap-off. Moreover, even though the IGBTs in Infineon's high power modules are arranged in a highly symmetric manner any misbalance of current sharing boosts these effects. Consequently soft turn-off behavior of the IGBT is a major prerequisite for safe and controllable operation of high power modules. Due to low switching frequencies lowering conduction losses is the main development target. This also enables the optimization towards softness even if this is done at the cost of higher switching losses compared to chip optimizations for low power modules.

Investigations on the soft turn-off behaviour of the IGBT4 show the most critical case is switching of high currents at high over voltage. In contrast to the former trench/field stop generation, the new high power IGBT4 shows no snap off under operation conditions with working temperatures of 125°C or 150°C (Figure 1).

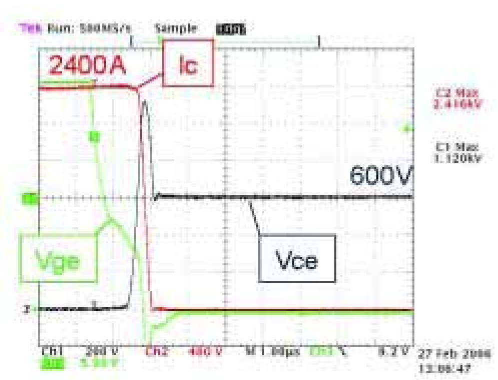

Figure 1: Soft turn-off behavior of an Infineon 2400A single switch IHM module with IGBT4 at 125°C, stray inductance of the capacity bank = 50nH.

Reduced losses

In addition to softness an easy controllability of the turn off dI/dt is crucial because in this performance category an active (dI/dt) control is generally present at least to limit the over voltage peak for inverter overload conditions. A simple active clamping was used as active control for the characterization of a 2400A single switch in Infineon's IHM module. The measurements (Figure 2 and Figure 3) show that the new chip is easily controllable which was formerly (with IGBT3) only possible with high Rg (> 1?) at the cost of drastically increased losses due to reduced dV/dt. At the nominal current of 2400A and 800Vdc, the improved softness leads to a reduction of the turn off losses of approximately 70mJ. On the other hand, there is a trade off relation between softness and current tail and therefore the optimization towards softness is linked with an increase of turn off losses at low current. At low collector currents the tail current influences the turn off losses more than the dI/dt- and dV/dt, where dI/dt and dV/dt is mainly determined by the gate resistor. Generally applications are thermally limited at high current levels and moreover the overall losses throughout a whole sine wave have to be considered (Figure 4). Here the IGBT4 shows a benefit of about 5% compared to IGBT3.

The diode behaviour is most decisive for optimized turn-on losses at tolerable EMC (electromagnetic compatibility). The IGBT4 high power devices come with a kind of EmCon4 diode which shows an extreme soft behaviour. Therefore the IGBT can turn on much faster. Taking benefit from the diode softness the turn-on losses may be reduced by up to 20%.

More output power

With the optimized high power IGBT4 Infineon introduced a trench/field stop component which provides an improved softness behaviour, so that large nominal currents up to 3600A can be controlled with a small gate resistor. During operation with an active gate control the total turn off losses in sum over the complete operation range decrease by 5% at a DC link voltage of 800V. Through the improved diode the turn-on losses decrease too by approximately 20 percent. Taking into account the 25°K higher operation temperature this means an approximately 20% higher inverter output power compared to an IGBT3 module assuming the same heat sink [1]. An optimization of the assembly technology furthermore ensures the same lifetime expectation in spite of increased operation temperature. On the other hand enhanced lifetime at comparable output power can be chosen by the customer.

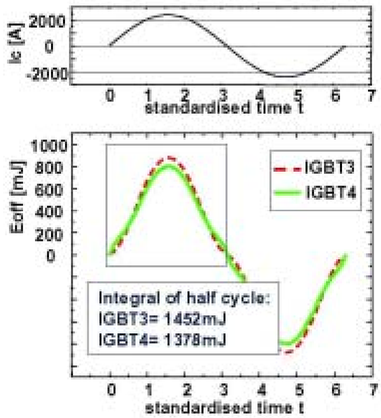

Figure 4: Turn-off losses of a sinusoidal current (Vce=800V; Tc=25°C; active clamping Vbr=900V; Rg(IGBT4)=0,47? and Rg(IGBT3)=1,2? are chosen for Vcemax<1150V); Eoff(IGBT4)<Eoff(IGBT3) for Ic>1000A. In sum the IGBT4 produces approximately 5% fewer turn-off losses than the IGBT3

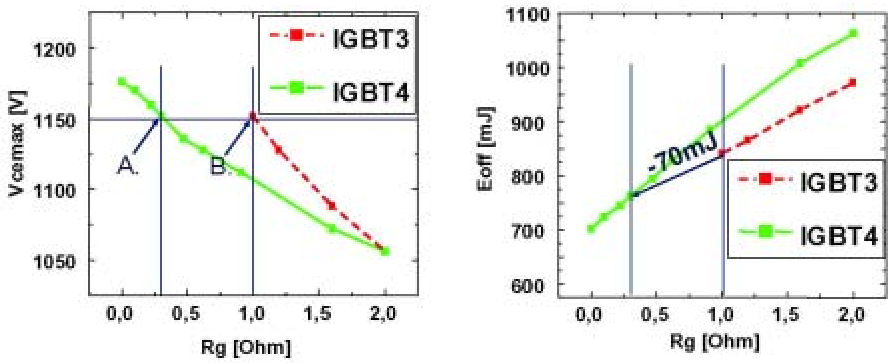

Figure 2: Controllability of IGBT 3 and 4 (Vce=800V; Ic=2400A; Tj=25°C; active Clamping Vbr=900V); 2a: over voltage peak vs. Rg - the over voltage of IGBT4 can handled with 0? for an IGBT3 a gate resistor > 1? is needed; 2b: Turn off losses vs. Rg - improved controllability leads to reduced turn-off losses (both characteristics apply only for driver circuits with an active clamping, where the collector voltage is coupled to the gate through a zener diode with a defined break-trough voltage of Vbr = 900V, for example).

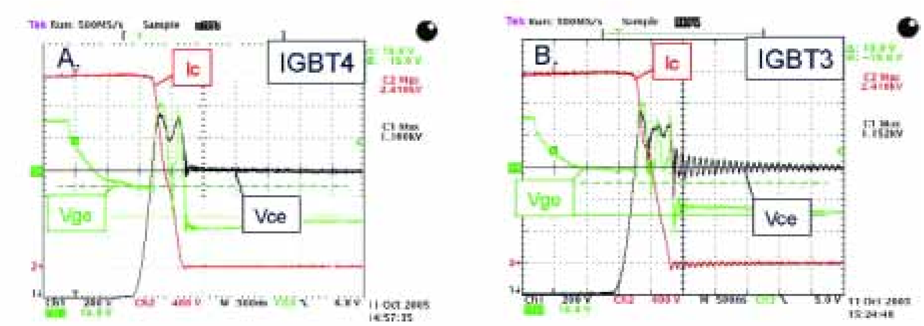

Figure 3: Turn-off behaviour with active gate control (V_{ce}=800V; I_c=2400A; Tc=25°C; V_{br}(active clamping)=900V) for IGBT4 and IGBT3

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IC Tailored for Battery Charging

Single Li-Ion/Polymer cells are in focus

Single cell Li-Ion/Polymer batteries are the preferred voltage source for various portable equipments such as PDAs, cellular phones and digital still cameras (DSCs) because they offer the highest energy density, the lowest self discharge rate and the thinnest profile.

By Merisio Massiniliano, STMicroelectronics

The biggest challenges in defining an IC for Li-Ion battery charging are the choice of the best charging approach and the ability to provide monitoring and control function to the host system in order to optimize the charging process and protect the battery from harmful conditions.

Considering a single Li-Ion/Polymer cell, the main recharge requirements are:

1 high accuracy voltage loop, (±1% or better) to regulate the fully charged battery
2 voltage (the voltage termination depends on the anode material)
3 medium accuracy current loop (±5%).
4 medium charge rate (approximately 1C, where C is the capacity of the battery expressed in A)

Additional useful features for the battery charger IC are:

1 the ability to pre-charge deeply discharged batteries
2 the ability to terminate the charge process based on a minimum current level or a safety timer
3 the management of a battery temperature sensor in order to stop the charge process if these parameters are out of a specified safety window

Until the battery voltage is lower than a specified threshold (and so it can be considered deeply discharged) it is charged with a light current. Then, the charge current abruptly increases to the fast-charge level (usually close to 1C, as already mentioned). Once the battery voltage is close to the regulated output voltage, the voltage regulation takes place and the charging current decreases. Finally, when the charging current goes lower than a set threshold Iend (usually approximately 10% of the fast charge current), or when a set timer expires, the battery charging process is terminated.

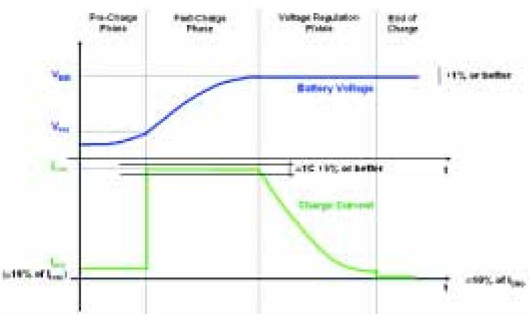

Figure 1: Recharge profile for single cell Li-Ion/Polymer batteries

Recharge Techniques for single cell Li-Ion/Polymer batteries

There are two main recharge control techniques for single Li-Ion/Polymer cells:

1 linear approach
2 pulse approach

Figures 2 and 3 describe the two different approaches. When operating in Linear mode, the device works in a similar way to a linear regulator with a constant current limit protection. During the Pre-Charge and Fast-Charge phases, the battery charger regulates the charge current to the set value. So, in these phases it works like a linear regulator in constant current limit protection. Its output voltage drops to the battery voltage.Once the battery voltage is close to the regulated output voltage VO, the voltage regulation phase takes place and the charging current is reduced. Finally, when the charging current goes below a set threshold or when a set timer expires, the charge process is terminated. The graph shows the current and voltage profiles during the different phases, as well as the power dissipated inside the charger.

As can be seen, the worst case in power dissipation occurs when the device starts the Fast-Charge phase. The battery voltage is at its minimum (which means maximum voltage drop across the charger) and the charge current is at its maximum.

When operating in Pulse mode, the device works in a similar way to a controlled switch. When the battery voltage is low, the switch is completely closed and directly connects the power source to the battery. Once the battery voltage is close to the regulated output voltage VO, the charger starts turning the switch ON and OFF, thereby charging the battery by current pulses. The voltage control loop gradually reduces the duty cycle of the pulses so that the average charge current is reduced as well. The charge process terminates when the duty cycle of the pulses goes below a set value or a set timer expires.

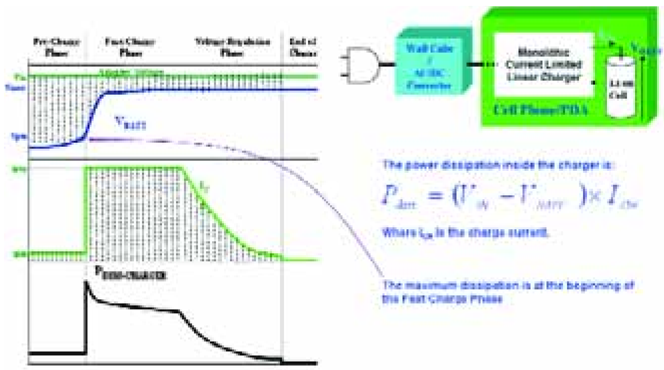

Figure 2: Linear recharge approach for single cell Li-Ion/Polymer batteries

The period of the pulses is much shorter than the chemical time constants of the battery, and so the low pass filter is provided by the battery itself. The graph shows the current and voltage profiles during the different phases, as well as the power dissipated inside the charger.

The great advantages of the Pulse approach are the very low power dissipation inside the charger and its simplicity. In fact, the power dissipation actually occurs only when the internal switch is closed, and it is only due to its Rdson conduction losses. The drawback is that the charger does not control the instantaneous current, and so the upstream adapter must behave like a constant current source when the switch is closed. Thereby, the upstream adapter must be matched to the battery characteristics and cannot be a cheap general purpose part. This is sometimes an unacceptable limit. For example, this kind of approach cannot be used to recharge batteries from a USB bus since it is not possible to rely on its current limit.

2 fast-charge current threshold
3 end-of-charge current threshold
4 pre-charge voltage threshold

as well as a flexible way to terminate the charge process, to implement a thermal battery protection, and to set a charge timer. The package is a small VQFN (3x3mm).
The next paragraphs will describe in more detail:

1 a new recharge approach
2 the closed loop thermal control
3 the charge process termination

To make the device operate in this mode, it is sufficient to set the charging current higher than the current limit of the upstream adapter. However, neglecting the voltage drop across the charger, its input voltage is equal to the battery one and so a very low operating input voltage (down to 2.5V) is required.

The main advantage of this approach is that it has the same simplicity of the Linear approach with lower power dissipation. The drawback is that like the pulse charger, during the Fast-Charge phase it does not control the current, and so it must rely on the current control of the upstream adapter.

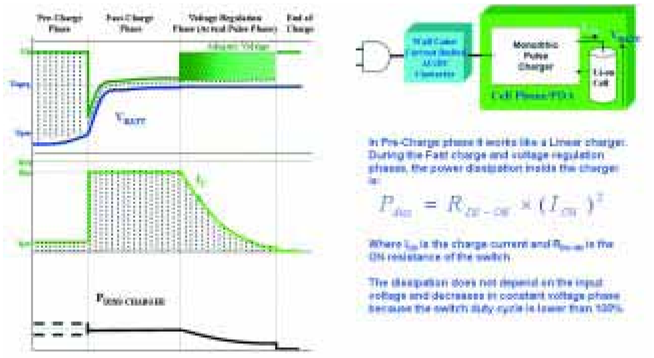

Figure 3: Pulse recharge approach for Li-Ion/Polymer batteries.

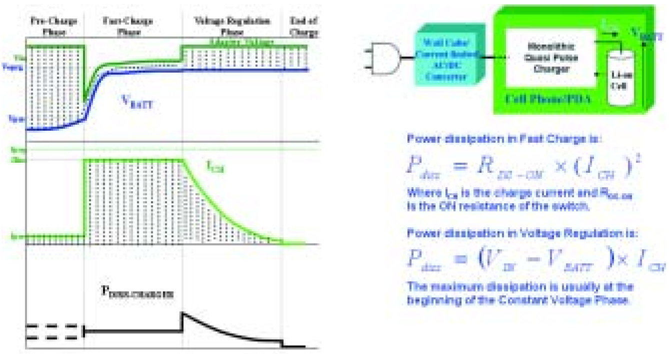

Figure 5: Quasi-Pulse recharge approach for Li-Ion/Polymer batteries

A new device for single cell Li-Ion/Polymer battery chargers

The L6924D is a new device dedicated to battery chargers for single Li-Ion/Polymer cells and it is designed with the advanced BCD6 (BiCMOS-DMOS version 6) fabrication. Figure 4 shows the simplified block diagram of the part. The device consists of a fully integrated solution, including the power pass transistor with reverse blocking structure and sense element. It is dedicated to linear battery chargers but can also be used in a different recharge approach (see the following paragraph). The device also includes a closed loop thermal control to avoid overheating.

Finally, it offers the possibility to adjust many parameters such as:

1 pre-charge current threshold

A New Charge Approach

Even if the device is thought to be used in Linear mode, it can also manage a different approach. This is a combination of the Linear and Pulse ones (for this reason here it will be called Quasi-Pulse). When the battery voltage is low, the internal switch is completely closed and directly connects the power source to the battery (like the Pulse approach). Once the battery voltage is close to the regulated output voltage VO, the voltage regulation phase takes place.
Figure 5 shows the current and voltage profiles during the different phases, as well as the power dissipated inside the charger. place. The charger takes the control of the current, and the charging current is reduced (as in a Linear approach).

As it can be seen, the worst case in power dissipation occurs when the device starts the Constant Voltage phase that is, when the charger starts behaving like a linear regulator. However, when this happens, the battery voltage is close to its maximum, and so the voltage drop is much lower than at the beginning of the charge process.

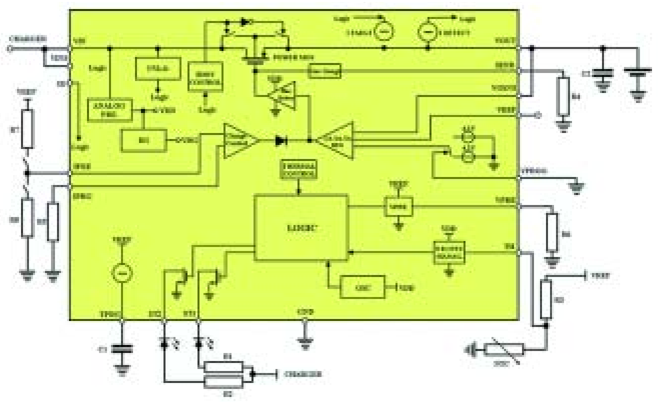

Figure 4: L6924D block diagram

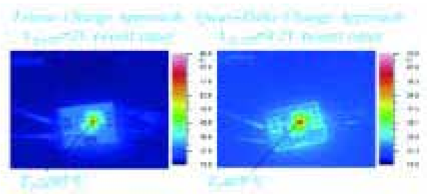

Figure 6: Thermal performance. VIN=5V, ICHG=500mA, TAMB=25C°

Performance Results

One of the most significant performance results in a linear battery charger is the thermal behaviour. As already mentioned, the device can manage a new recharge approach thanks to its very low minimum input voltage. Figure 6 shows the thermal benefit of this new approach (Quasi-Pulse). The picture shows the maximum device temperature when a battery is charged with a fast charge current of 500mA and an input voltage (output voltage of the upstream adapter) of 5V.
As explained, in Quasi-Pulse mode, the worst case from a thermal stand point is at the beginning of the constant voltage phase but even in this case, the junction temperature is much lower than in Linear charge approach.

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Next Generation 3.3kV IGBT Module

HVIGBT modules will provide lower power losses

High power applications require high voltage IGBT (HVIGBT) modules operating with low power losses and high reliability. However, these specifications are often in a reciprocal relationship to each other.

By S. Iura, A. Narazaki, M. Inoue and S. Fujita, Mitsubishi Electric Corp. Power Device Works and E. Thal Mitsubishi Electric Europe

Addressing exactly this challenge, Mitsubishi developed a new chipset combining an FP-LPT-HVIGBT (Fine Planar MOS-gate Light Punch Through HVIGBT and an SR-HVDi (Soft reverse Recovery HV-Diode with high robustness), which were combined into a single module. This new generation of 3.3kV HVIGBT modules will provide lower power losses at increased rated currents.

HVIGBT modules are used in many different high power applications including railway traction and large industrial drives. In addition to reduced losses and increased rated currents a wider operation junction temperature is required in these applications. Furthermore, the modules must be easily connectable in parallel while offering a good switching controllability in order to achieve low EMI levels.

The improvement of the IGBT chip performance strongly depends on MOS-gate structures such as planar and trench as well as vertical structures like LPT, FS and SPT. The secret of a good IGBT chip is a good balance between the correlative parameters on-state loss, off-state loss, robustness and leakage current as well as low power losses. Furthermore, a higher-performing free-wheeling diode and a highly reliable package are needed. Following these objectives, Mitsubishi developed a new generation of 3.3kV IGBT modules.

Chip Technology

According to the design concept of the new IGBT-diode chip set the IGBT provides lower losses as well as di/dt and dv/dt controllability while the diode offers a reduced reverse recovery current (Iπ). Furthermore, a higher SOA robustness and a positive temperature coefficient (PTC) were requested for easy paralleling.

The gate structures of planar and trench IGBTs are well known. The on-state voltage ($V_{CE(sat)}$) of a trench-gate IGBT can be reduced more than that of a planar-gate IGBT because of non-JFET regions. But this $V_{CE(sat)}$ reduction effect due to the trench-gate structure is smaller for high voltages.

For its new 3,3kV IGBT chip Mitsubishi adopted an advanced planar-gate design with a fine pattern MOS structure and in conjunction with the dense n-layer to the JFET region this significantly reduces the $V_{CE(sat)}$ of the new IGBT compared with conventional IGBTs.

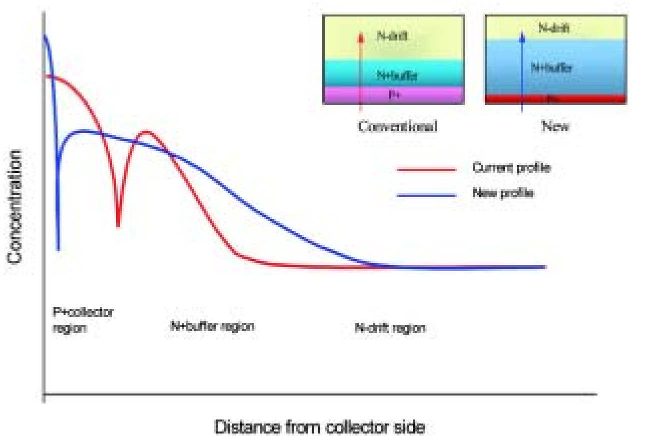

Figure 1: IGBT backside structure comparison: cross-section of the new IGBT backside doping profile compared with conventional IGBTs. Red and blue lines indicate the doping profiles of the new IGBT and conventional IGBTs, respectively.

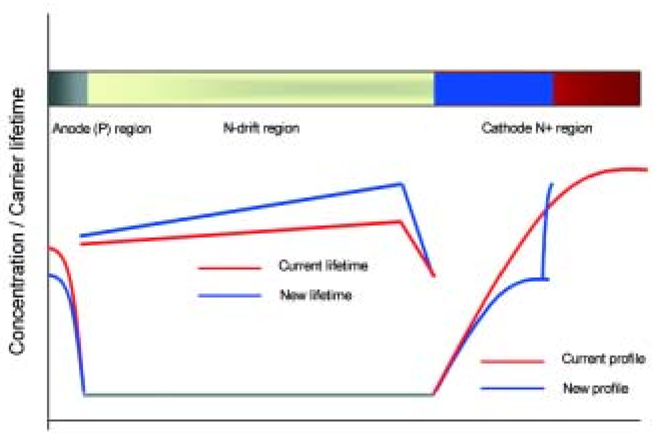

Figure 2: Diode cross-section structure comparison carrier concentration and carrier lifetime in n-drift region: Red and blue lines indicate a doping profile and lifetime of the new IGBT and conventional IGBT, respectively.

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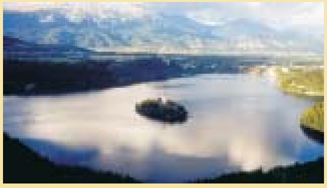

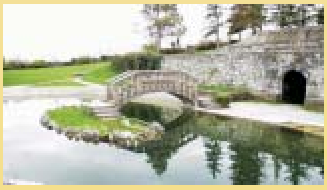
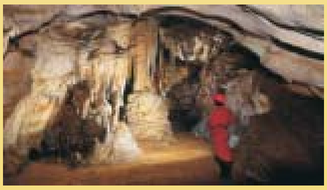


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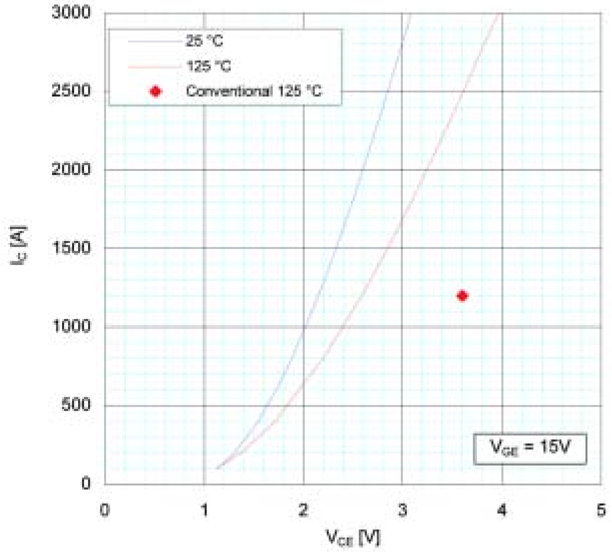

Figure 3:
IGBT output characteristics of 1200 A modules at 25°C and 125°C

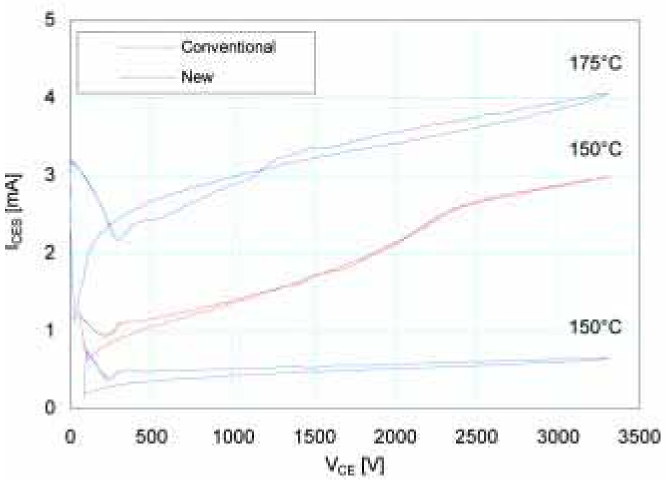

Figure 4: Leakage current characteristics of IGBT chips (between collector and emitter, AC60Hz half-sine wave)

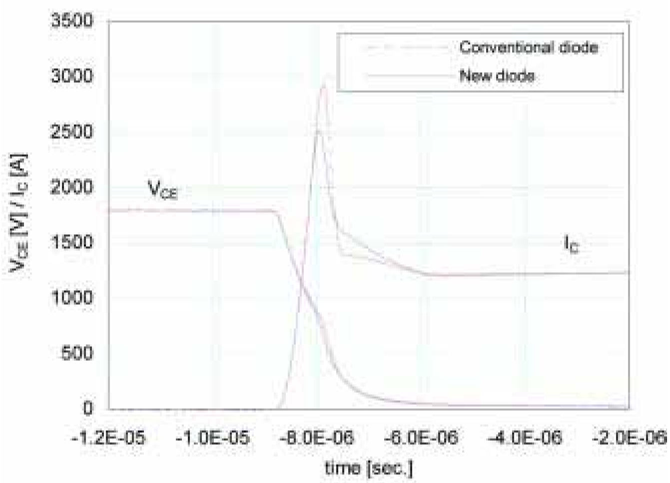

Figure 5: Turn-on switching waveforms at 125°C, V_{CC}=1800V, I_C=1200A, V_{GE}=15V, di/dt=3800A/µs, L_S=150nH

Static Characteristics

The current density of the new IGBT chip in Figure 3 is 94% compared with a conventional IGBT, and that of the new diode chip is the same as with a conventional diode. The $V_{CE(sat)}$ of the new IGBT is 30% less than with a conventional IGBT at rated current and 125°C conditions. Furthermore, Figure 3 shows that the new IGBT has a strong PTC. The forward voltage (V_{EC}) of the new diode is 7.5% less than the V_{EC} of a conventional diode under the same conditions and having a cross-point from NTC towards PTC at half rated current.

Figure 4 shows the collector-emitter leakage current characteristics in relationship to the forward blocking voltage up to 3300V and temperatures up to Tj = 175°C. The leakage current at Tj=150°C of the new IGBT is reduced by a factor of 4 compared to conventional IGBTs when a voltage of 3300V is applied. At Tj = 175°C no runaway has occurred so far.

Dynamic Characteristics

The evaluation results of dynamic characteristics of 1200A modules equipped with new the IGBT and the matching diode carried out the turn-on and turn-off switching under the half-bridge circuit with inductive load at 125°C, a DC-link voltage of 1800V and a collector current of 1200A.

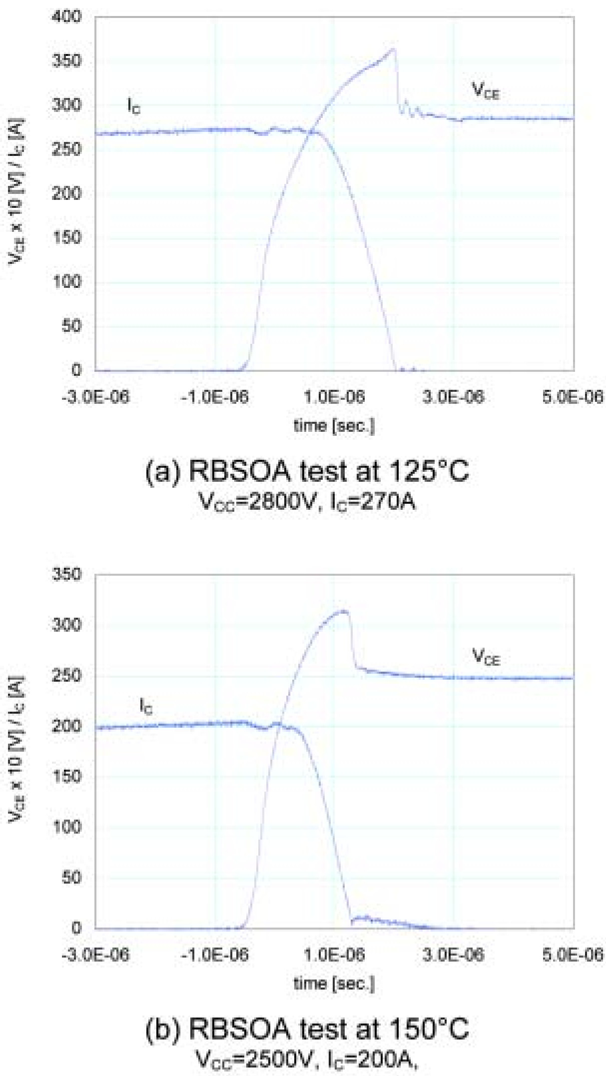

Figure 6: IGBT chip turn-off switching waveforms rated I_C=67A, V_{GE}=15V, R_G=75W, L_S=2.2µH

Figure 5 shows the turn-on switching waveform with different diodes and the identical new IGBT at identical di/dt conditions. Compared to using a conventional diode (red line in Figure 5) the new diode (blue line in Figure 5) shows 20% lower peak collector current (i.e. I_{π} of the diode) when using the new IGBT, resulting in a reduction of the IGBT turn-on switching energy (E_{on}) by 10%: 1.54J/pulse (new FWDi) versus 1.73J/pulse (conventional FWDi). Furthermore, the new diode displays a softer reverse recovery behaviour.

SOA Performance

Mitsubishi tested the turn-off switching SOA of the new IGBT chip (Figure 6) with junction temperatures of Tj=125°C and Tj=150°C. The test at Tj=125°C (Figure 6a) was carried out by gradually increasing the DC-link voltage up to 2800V at a turn-off current of four times the rated current (4x67A=270A), while the test at Tj=150°C was performed at a DC-link voltage of 2500V with a turn-off current three times as high as the rated current (Figure 6b). Tracing the voltage and the current of this test waveform explains that the specified SOA curve at 2 times the rated current can be fulfilled with a wide margin (Figure 7).

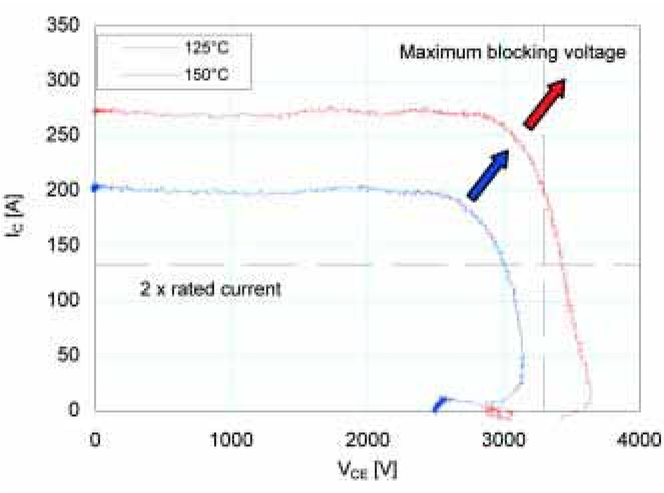

Figure 7: RBSOA V-I curve

The reverse recovery SOA test of the new diode chip (rated I_F = 67A) was also carried out and the peak power (Prr) was monitored by gradually increasing the di/dt at Tj = 125°C and a DC link voltage of 2600V. As a result a P_{π} withstand capability per diode chip of 360…380kW at di/dt of 700A/µs was confirmed. Therefore the P_{π} values of the module will be about 2.7 to 2.85 times larger than the currently specified P_{π} limit.

Inverter Output Performance

The RMS output current of the new HVIGBT module can be increased by approximately 200A assuming a maximum junction temperature of Tj = 125°C at fc = 400Hz. Besides, if the maximum operating junction temperature will be Tj = 150°C, the output current Io could be increased by another 550A.

Conclusion

This article describes the superior performance of a new generation 3.3kV HVIGBT module with FP-LPT-HVIGBT and SR-HVDi compared to conventional HVIGBT modules. The advanced new IGBT improves the trade-off characteristic between $V_{CE(sat)}$ and E_{off} by 25% without deteriorating the robustness.

Furthermore, the new diode improved E_{on} due to the reduced I_{π} while the soft reverse recovery behaviour maintains the robustness of conventional diode designs. Therefore the new generation 3.3kV HVIGBT module will reduce the power losses and increase the rated current by utilizing the improved new chip-set.

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USB Bus Powered Devices

Design Challenges for Consumer Electronics

How much room is there in a person's briefcase, really? It seems that every electronic component we purchase requires not only that we carry the device itself, but that we also carry its large, awkward, cumbersome wall plug to boot. Do we really have to?

By Steve Kolokowsky & Trevor Davis – Cypress Semiconductor

When are consumer electronics companies going to figure out that if they want us to buy their products, they are going to have to free up enough room in our briefcases, purses, and notebook carrying cases to allow us to shove yet one more component amongst the cracks? Help is on the way!

"Wall Warts" (the colorful name for our beloved device Power Supplies) may be a thing of the past for some consumer electronics devices thanks to the ubiquitous and versatile Universal Serial Bus (USB) port on your Desktop or Notebook PC. Traditionally, power hungry devices that connect over the USB cable also required a Wall-Wart for power. The market (all of us consumers), however, is demanding that we jettison Wall-Warts, and that USB connected devices use the power sourced through the USB cable to supply the power needed by our favorite mobile devices. The truth is, there are several design considerations that must be taken into account when designing a consumer electronics device needing to operate without a Wall Wart.

Figure 1. "Wall Warts" required for "Self-powered" PC peripherals

Many people don't realize that the USB cable attached to their PC is actually a power cable as well. In fact, in any given USB cable, there are only 4 wires: 2 for representing and carrying the data, one for power, and one for ground (see Figure 1)

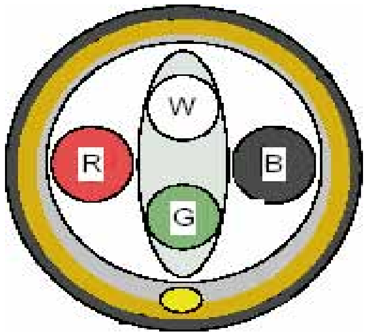


Figure 2. Cable Cross Section: White & Green carry Data, Black for Ground, Red for Power (VBUS)

Because of this fact, devices are able to use this power connection as a means of receiving the power necessary for proper operation. The key, however is that the USB bus is strictly regulated to ensure proper power management. To use a real word example: You get out of the shower and towel dry. You pick up your hair dryer and turn it on. Normally, it works fine…until you try to turn on the curling iron at the same time. Then, the lights go out. Why? Every system that supplies power must incorporate some kind of power limits. In your house, it's the circuit breakers between you and the power company. In a system connecting a peripheral device to your PC, it's the USB bus power specifications. You don't want your computer to go dark when you plug in a mouse or pair of speakers, do you? As a way of controlling potential misuses of power over the USB bus, power is limited by the specification and governed by software.

So what does a designer need to understand to take this into consideration?

According to the USB specification, USB devices can either be "Bus-powered", powered through the USB cable, or "Self-powered", powered by a battery or plugged into the wall (the Wall Wart!). In addition, USB has defined two potential power levels available to Bus-powered devices through a USB port: High Power Ports, and Low Power Ports. High power ports are capable of supplying 500mA to a downstream device. Low power ports can only supply 100mA to a downstream device. Why are there two different levels? The original intent of low-power ports was to enable bus-powered hubs. These devices draw 500mA from the upstream port, use 100mA internally, and distribute 100mA to each downstream port (See Figure 3).

So how does power control work in USB?

The very first power regulation a USB connected device encounters is the "enumeration" power consumption limit. When a device initially connects to a USB port, it must limit its current usage to 100mA so that it can identify itself to the host (enumerate) on either a high-power or low-power port. Provided the device connects at less than the 100mA, the host reads one or more configurations from the device using the GET_CONFIGURATION command. In the world of USB, each device will respond to

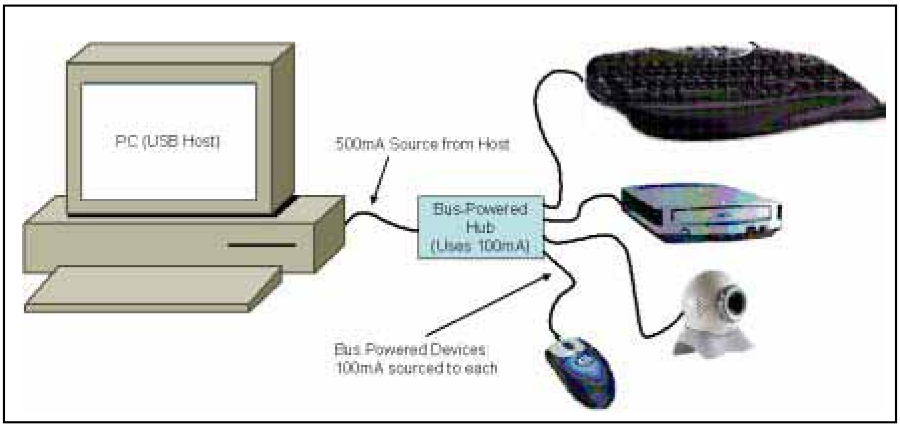


Figure 3. Power configuration provided by Host PC with Hub providing port expansion

the host with a listing of its required configurations. Generally, a USB device has three possibilities:

The device has only one configuration for low-power.

The device has only one configuration for high-power.

The device has two or more configurations with a mix of high and low-power.

In case 1, the host's decision is easy: issue the SET_CONFIGURATION command, confirming proper power configuration, to turn on the device. In case 2, the host will only issue the SET_CONFIGURATION command if the port is a high-power port. If it is not a high-power port, the host will notify the user with a message (See Figure 4)

In case 3, the host picks the configuration that is appropriate for the port's power level -- provided there are both High and Low power ports available. Once the port configuration has been negotiated and properly configured, it is up to the device to now behave properly on the port. If it does, the device is considered "USB compliant". If it doesn't, the device is "non-compliant" and can either cause system error issues or may not work properly at all under certain circumstances.

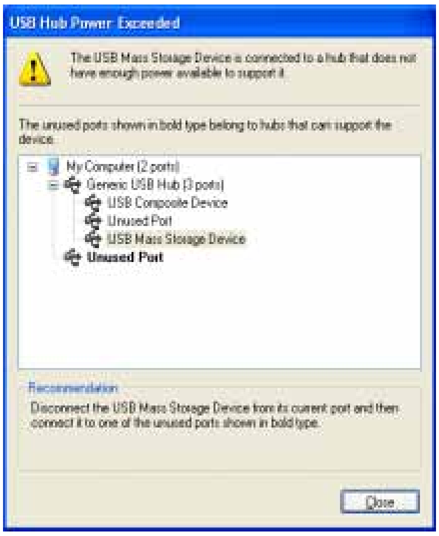


Figure 4. Port error by Windows XP when High Power port is unavailable

So why is this problem so difficult to solve?

Bus-powered USB devices have actually been around since the beginning of USB. However, when the USB 2.0 specification added High-Speed (480Mbps) data transfer, no USB silicon vendors could make a high-speed USB controller chip that would enumerate under the critical 100mA limit. In other words, when peripherals incorporating the new High-Speed USB devices attempted to connect, they exceeded the limit of 100mA and were not properly configured. Initially, this was not a huge problem since most of the early USB 2.0 devices were mass storage (external CD burners and external hard drives) which suffer from a separate power issue unique to rotating media (discussed below). As a result, bus power operation of high power devices was rarely a consideration. The times, however, have changed. In June 2004, Cypress Semiconductor introduced the first true high-speed USB 2.0 silicon that enabled bus-powered devices. The EZ-USB FX2LP chip draws 50mA in typical operation, leaving 50mA for the other pieces of the USB system even before the SET_CONFIGURATION message is received…the beginning of the demise of the Wall Wart?

Not so fast. Just when you think you have a start to solving the Wall Wart problem, unique power issues must be considered for some applications. For example, some of today's most popular USB mass-storage devices use a rotating media to store data. In CD-ROMs and DVDs that connect over USB, the media is the familiar shiny plastic silver disc. In the case of external hard drives like those made by Seagate, Maxtor, or Western Digital, the media is polished aluminum discs. For each of these devices, the media is rotated until the desired area is under the read or write head and then the electronics access the data. For USB power purposes, there are two main problem areas: the motor and the head. Both are issues for the same reason: they consume more power than USB allows – especially as they begin their start up process. In fact, Figure 5 shows a typical power profile for the startup sequence for a disc drive product. Note the problem area where, as the disc spins up, the drive consumes too much power.

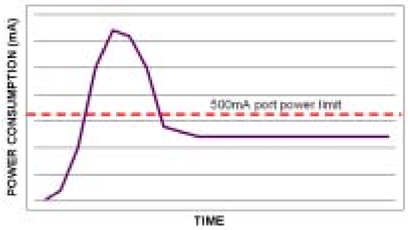


Figure 5. Disc Drive power consum ption curve

Several companies have successfully solved the puzzle of building a bus-powered device with rotating media. The first of such products was introduced by Iomega. Iomega's strategy was to re-engineer the entire drive mechanism so that it reduced the peak power used by the device. For example, they did not spin up the drive as fast as possible, but opted to limit the power used during spin-up. This sacrificed performance, but the bus-power feature made the device very portable and easy to use.

In-System Design took a different approach creating their bus-powered hard disk. They used an off the shelf disk drive and engineered a clever solution to limit the power drawn from USB. When the disk drive was idle, they stored power in a set of eight AA batteries. When the disk was in use, they drew down the batteries to power the drive. This approach had the advantage of allowing the use of any drive in the design, not just a specifically designed USB drive.

Additionally, as more drive manufacturers become aware of the desire to develop bus powered applications, and as more consumer product companies become USB spec savvy, they are employing creative solutions to solving this problem. In fact, Apricorn introduced the first USB compliant High Speed USB 2.0 Bus Powered Hard

Drive by using a 1.8” Hitachi harddrive and a Cypress Semiconductor low power USB chip. The combination of a lower power drive, with slower spin rates along with a power saving USB device, allowed the company to introduce true “Bus-power” 20GB and 40GB Hard Drives. As the USB external storage market continues to grow and drive power continues to shrink, it seems like it’s only a matter of time before your external hard drive backup system and your external DVD drive lose their wall wart.

Even the most common “bus-powered” USB 2.0 devices today suffer potential non-compliance because of power. These are the ubiquitous “thumb drives” that combine a USB controller with one or two NAND flash chips in a package the size of a stick of gum. The USB NAND market has exploded from next to nothing in 2000 to 63 million units shipped in 2004. All USB thumb drives appear to be bus powered, but many will not work properly in USB 2.0. The following graph shows laboratory measurements of commercially available “thumb drives”. Many of these devices are well above the limit for a low-power port. Some of these devices are subject to failure the moment they are plugged into a USB hub (with its low power downstream ports). The wise designer will anticipate power issues and make device choices that allow them to be USB compliant.

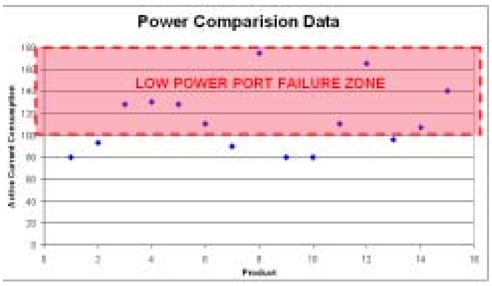


Fig.6.Thumb Drive operation above 100mA shows probability of choosing non-compliant device

Reset and power issues for bus-powered devices

Bus-powered devices don’t have the luxury of a stable wall-power supply or battery. As a result, designing them for fail-safe operation can be challenging. One area of particular concern is when power is quickly cycled on and off of a device (as is the case when you unplug and then re-plug a USB device quickly). According to the spec, bus powered devices can be hot-plugged and hot unplugged at any time. This means that VBUS (USB power) can be removed and reappear with very little delay when the user power cycles the device by pulling the plug.

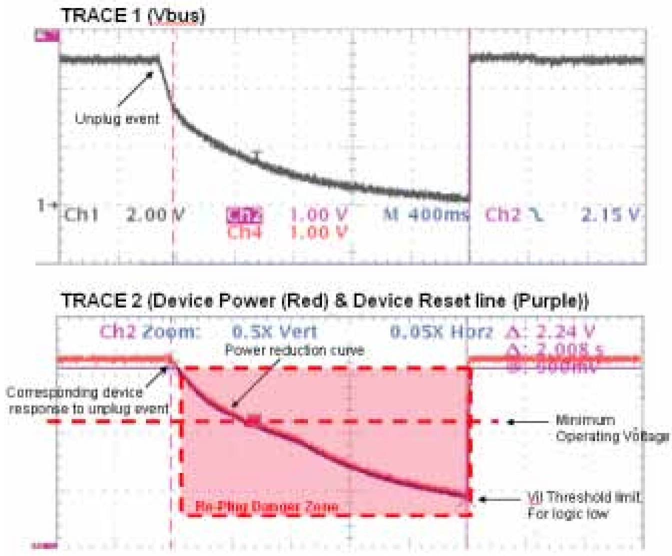


Figure 7. Bus Power reset issues

Unfortunately, this unplug and re-plug can confuse the system unless properly designed for.

In Figure 7, we will describe the power down sequence that can create system confusion. Trace 1 shows the RC RESET# line and 3.3v line during an unplug/re--plug event. VBUS (Trace 1) starts to drop as soon as the device is unplugged. Over 100ms later, the 3.3v line (Trace 2, red trace) begins to drop. The RESET# line (Trace 2, purple) tracks the 3.3v line’s drop towards ground. The unit under test is below minimum operating voltage at 300ms after the unplug, but the RESET# line is not below the Vil (TTL Input Level for Logic Low) threshold until almost 2 seconds after the unplug. Unfortunately, a Logic Low MUST be reached on the RESET# line in order for the system to recognize a bus reset. If you re-plug the device in the area of the curve depicted below as the 2 second Danger Zone, there is a very good chance that the Host PC will become confused as the device was not properly resent, and it will not recognize the re-plug.

Unfortunately, self-powered hubs will create even shorter pulses on VBUS when they are plugged into a host or when the host resets them – so if your product is plugged into a USB Hub, your design had better be prepared to contend with the short reset pulse.
Reset sounds like an infrequent event until you hear that your product doesn’t work after the PC reboots!
The best solution to these problems is to use an external POR (Power On Reset) chip. If economic constraints force your design to use an RC reset circuit, however, follow these hints:
Limit large capacitors on your board. This will allow VBUS and 3.3v to drop more quickly when your board is unplugged.
Add bleed resistors so your board is at the 500uA suspend current limit.
Delay suspend until the 10mSec limit.
RC reset circuits may be safely used in some self powered designs. Designers should make sure that the reset properly holds RESET# below Vil (800mV) for 5ms after Vcc has risen enough to supply Vcc(min) to your chips. Test your reset circuit in the following conditions:
Cold power-up, plugged into USB.
Cold power-up, unplugged from USB.
Hibernate/resume, plugged into USB.
Power cycle, plugged into USB.
Power cycle, unplugged from USB.
Power cycle, plugged into 5 tiers of hubs (connect 5 hubs together and plug into the furthest one from the host).
Unplug/replug the 5 tiers of hubs.
Repeat the above two tests with one tier of hub.

Conclusion

So Wall Warts may not be gone forever any time soon, but there sure are pressures from the mobile computing consumer base to get rid of as many as possible. Unfortunately, there are many consumer electronics companies not savvy enough (or creative enough) to solve the problem AND remain USB compliant. USB compliance assures end users are not confused, frustrated, or worse, damaging their PC or the peripheral device due to poor power management. It is the wise designer that considers the power constraints of USB, designs to meet the specification, and recognizes that the end market will reward them with greater sales due to reliable, effective, useful bus powered components. So get creative – and get rid of those Wall Warts!

The Next BIG Thing!

Whole-house Digital Media over AC Power Lines

Industry watchers are always asking, "What's going to be the next big thing"? They are asking what the next big wave in technology will be – the next big money maker, industry builder – the next big impact on society like that of the automobile, airplane, television, computer, Internet, cell phone and all other means of mobile personal communications.

By Mark E. Hazen, Senior Technical Writer, Intellon Corporation

Well, I have an answer for you – it's whole-house networking that enables instant digital media access from every and any location in the home. That includes whole-house access to the Internet, TV/IPTV/Video (both standard- and high-definition video), served-up streaming music, file sharing, security and more.

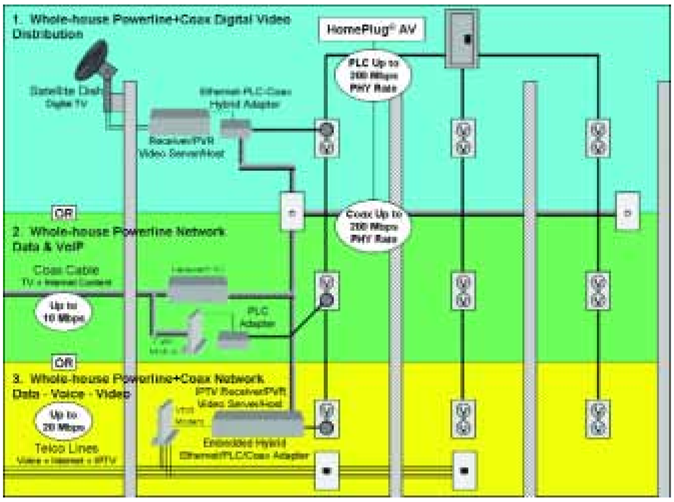


Figure1: Service Providers Deliver Whole-House Content Distrubtion

Advanced Wired Technology

Advanced wired technology is now making this possible. That's right, wired! It's a technology that uses the existing wired power and coax infrastructure in the home to form the network. While household coax has been used for digital video and Internet access, AC wiring has not, until now. New advanced Powerline Communications (PLC) technology converts every AC outlet in the home into a network connection point.

Each AC outlet now can serve double-duty as both a source of AC power and an access point for digital content. Powerline technology transforms AC power wiring into Ethernet lines. Modular or embedded Ethernet-to-powerline (bidirectional) adapters are used to accomplish this. There are no longer restrictions on where a TV or computer must be placed. There is no need for a cable jack or phone jack to be nearby. All multimedia and data content is available from any AC outlet.

'BIG Thing' Enablers

So, who is behind the 'Next BIG Thing'? It's a phenomenal list of industry who's who. United under the banner of the HomePlug Powerline Alliance standards organization (www.homeplug.org), the list includes semiconductor companies, consumer electronics companies, equipment manufacturers and major service providers around the world. The synergy of this complete market chain is making the 'Next BIG Thing' a reality. Customers will hear from their service providers regarding this new technology starting in the second half of 2006. Many field tests are underway now.

Vexing Problems and Costs

Until now, phone, TV and Internet service providers have been vexed with the problem of getting their service into the home in locations where the customer wants it. Trucks have had to roll with technicians to install both equipment and wiring to meet customer needs. The trend now is for service to be a 'self-install' proposition, in which the customer is shipped or collects the equipment from a central office, or even purchases the equipment from a retailer, and installs it without on-site assistance. Technology is not always easy to self-install and it still doesn't address the problem of being restricted to coax and phone jacks. For self-install to be truly successful, the customer should be asked to do little more than simply plug the devices in anywhere they want and start using the equipment and services.

Deployment

Figure 1 illustrates how PLC technology is starting to be deployed. Different service providers may have different approaches to enabling their customers. Satellite service providers are interested in making video content available at every AC outlet and coax jack in the house. Cable companies, who already offer broadband Internet access and digital TV with PVR, may take advantage of PLC to dis-

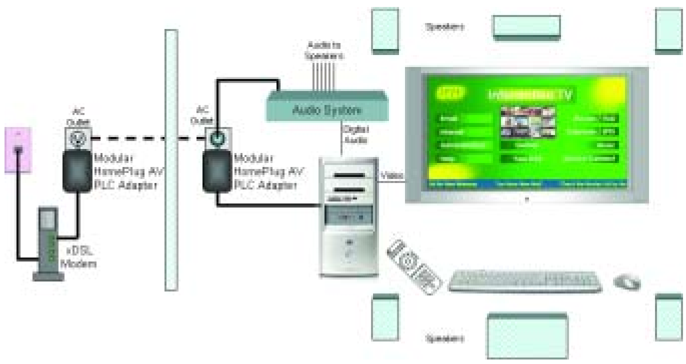


Figure 3: PLC-connected Media-enabled PC Brings Total Convergence

tribute live TV, Video on Demand (VoD) and stored video content throughout the home and to provide whole-house Internet access to customers. Telephone companies are starting to offer Internet Protocol TV (IPTV) using DSL technology and PLC to make Internet access, IPTV, VoD and other services available at every AC outlet in the home.

What is common here is that all service providers want their customers to enjoy television and video distribution to any location in the home. PLC and the AC outlets make that happen. Each service is based on a central host digital tuner/media server box, which receives, stores and distributes TV/video content.

Low-cost client boxes plug into any chosen outlet, or available coax jack, and are connected to TVs or monitors via standard video and audio interfaces. The remote control for the client box is used to select programming. Figure 2 shows the use of the client box.

Program content is delivered over the AC power lines to the client box. Optionally, a coax jack may be used if there is one nearby. Having the option to use existing coax is a hybrid PLC/coax approach. The client box includes the PLC adapter and control circuitry needed for channel selection and the retrieval of stored audio and video content.

Media-enabled PCs will also be part of the home network with the ability to surf the Internet, stream video and music, receive IPTV and serve as a Personal Video Recorder (PVR). Figure 3 shows how the media PC is added to the powerline network.

The 'Next BIG Thing' Rides on the Powerful PLC Backbone

Installing a home network that offers broadband Internet sharing but scales well to high-quality audio/video/IPTV content distribution requires a 'backbone' concept to be introduced into home networking. This concept allows the service provider to consider a hybrid network solution to serve the varied applications. A hybrid network that utilizes household AC wiring and installed coax cables provides the needed whole-house ubiquity.

Mobile applications such as Wi-Fi-enabled notebooks, PDAs and other devices, may require optimizing the wireless coverage by utilizing the PLC backbone and wireless solutions in tandem. Using the PLC backbone, wireless access points can be placed in any desired location in the home to create hotspots.

Table 1 compares the various technologies that may comprise the hybrid network and backbone. Home power lines are the most readily available physical medium for whole-house distribution. The average number of power sockets found in a typical home is over 40. These sockets are readily available in all areas of the home and do not require new wiring or the installation of jacks and signal splitters. With a powerful and reliable whole-house backbone, customers can fully enjoy freedom of mobility and freedom to locate their entertain-

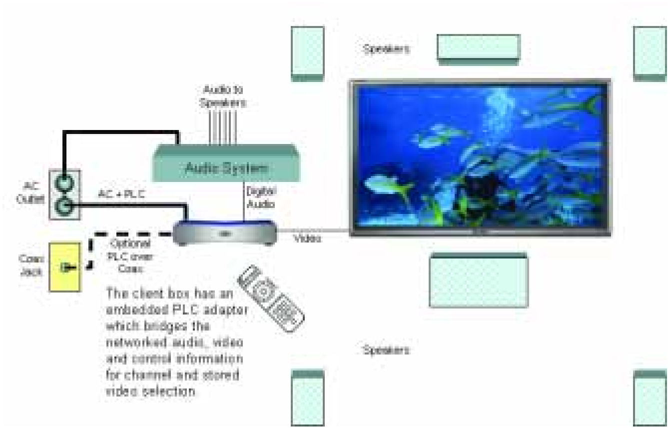


Figure 2: Use of the PLC Client Box

ment stations anywhere throughout the home. HomePlug AV provides the robust backbone that frees the service providers' customers to fully enjoy the services they provide without the expense of truck rolling and the negative affects of customer technophobia. Just plug-it-in technology is what customers and service providers want.

How does HomePlug PLC technology work? How is it possible to put digital information on wires that carry 120 or 240 volts AC power? Those questions and more will be answered in The Next BIG Thing Part 2: BIG Thing Technology. Coming in the next issue of Bodo's Power Systems magazine.

HomePlug Powerline Technology

Powerline Technology has been around for over a decade. The HomePlug 1.0 standard, ratified in 2001, supports extended powerline networking for data sharing at data rates up to 14 Mbps. The new Home-Plug AV standard, ratified in August 2005, is designed to support data sharing along with streaming audio and video, both standard- and high-definition, at channel rates up to 200 Mbps. This is what is enabling a massive rollout of the 'Next BIG Thing'.

HomePlug Powerline Alliance

Sponsors: Comcast, GE Security, Intel, Linksys, Motorola, Samsung, Sharp and Sony

Contributors:arKados, Conexant and Intellon Over 60 Participants and Adopters

Acronyms

AV Audio Video
ADSL Asymmetric Digital Subscriber Line
DSL Digital Subscriber Line (digital data service over phone system)
HDTV High-definition TV
IPTV Internet Protocol Television (TVchannels supplied digitally over the phone network)
Mbps Mega-bits per second (Millions of bits of data per second)
PLC Powerline Communications
PVR Personal Video Recorder (stores video digitally on a hard drive for replay on demand)
QoS Quality of Service
SDTV Standard-definition TV
VDSL Very high-data-rate DSL
VoD Video on Demand (video content viewed as desired from an IPTV source or an in-house video server)
VoIP Voice over Internet Protocol (telephone service over the Internet)

	HomePlug® PLC	*Coax-based Technologies*	*Wireless (802.11x)*	*Phoneline (HomPNA®)*
Customer Installable?	Yes	Not Always	Not Always	Yes
Whole-House Coverage?	Yes	Not Always	Not Always	Not Always
Enables Mobility?	Available	No	Yes	No
Cost Effective?	Yes	Yes	Yes	Yes
Reliable	Yes	Yes	Not Always	Yes
Number of Outlets (typically)	40+	3 to 5	N/A	3
Max. Data Rate (Mbps)	14 (HomePlug 1.0)		11 (802.11b)	1
	85 (Intellon´s Turbo)		54 (802.11a)	10
	200 (HomePlug AV)	270	108 (802.11n)	128

Table 1: Technologies that May Comprise the Hybrid Home Network

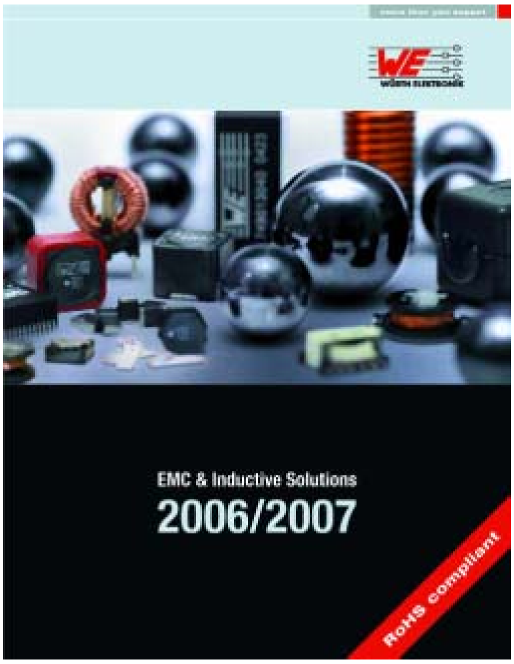
www.intellon.com
www.homeplug.org

Würth Product Catalogue

Find your EMC & Inductive Solutions in the latest product catalogue of Würth Elektronik. All products are lead-free and RoHS compliant. From now on Würth Elektronik offers you an extended product range of SMD flat wire wound inductors for high current applications up to 65A.
The WE-HC and WE-HCA series are optimized for applications where very low core losses are required. The WE-SD rodcore inductor series combines high current capability and high mechanical stability.The new current compensated choke WE-CMB with NiZn core material offers high suppression of asymmetric interferences even in medium and high frequencies. The miniature SMD line filter WE-SLM stays compatible to the 1812 standard. Applications for this common mode choke are USB, FireWire and CAN. Further new products are SMD & THT Disk Varistors to provide over voltage protection for electronic circuits and devices. Transformer for Power-over-Ethernet (PoE), design kits for PoE and switch mode power supplies. Würth Elektronik offers an extended range of conductive shielding gasket profiles for EMI absorption.

Order the free EMC & Inductive solutions catalogue.

www.we-online.com



140A Polar Power MOSFETs

IXYS announced the release of high-current PolarHT/HV Power MOSFETs that bring additional design flexibility to a broad range of higher power conversion applications based on IXYS PolarHT/HV technology. The PolarHT/HT platform incorporates IXYS proprietary cell-design technology that reduces on-resistance by 30%, enabling improved efficiency. IXYS provides a wide selection of these high-current PolarHT/HV Power MOSFETs. Voltages range from 300V to 800V and currents reach as high as 140A. These Power MOSFETS are offered in a number of different packages, including the standard TO-264 and a variety of IXYS ISOPLUS packages, which provides integral backside case isolation. These new devices are all HiPerFET processed, yielding Power MOSFETs with a fast intrinsic body diode for low Qrr and enhanced dV/dt ruggedness.

The IXFR140N30P (300 V, 70 A, 0.026 Ohms, Rth,jc of 0.42 K/W) and IXFL100N50P (500 V, 90 A, 0.052 Ohms and Rth,jc of 0.20 K/W) are just some example parts that offer great electrical and thermal performance when utilizing the ISOPLUS packages.

www.ixys.com

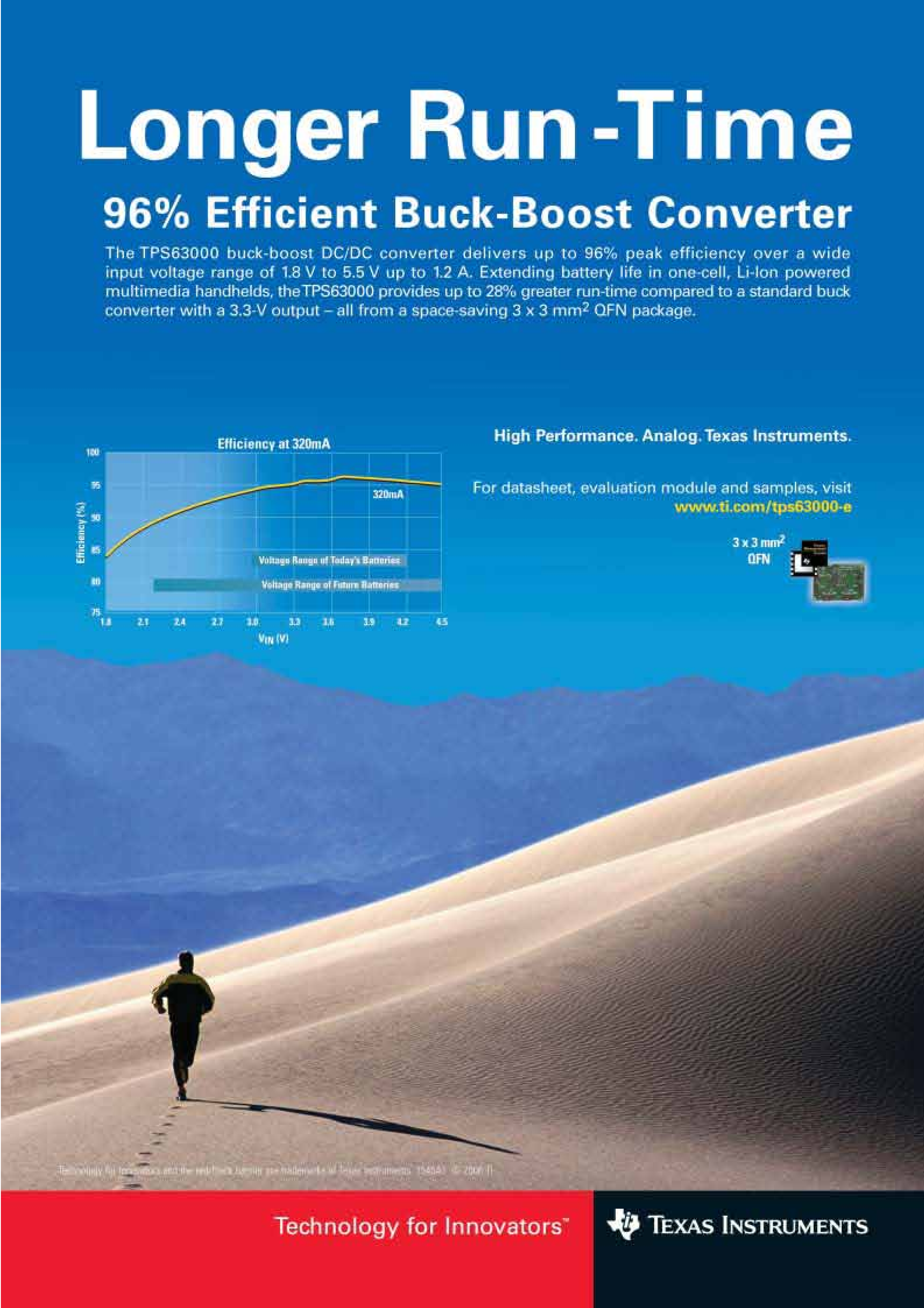
Military SMD Tantalum

Vicor announces the addition of Kemet has introduced three new ranges of established reliability, military standard qualified, Tantalum surface mount capacitors. The new devices complement the company's existing military approved products. The T409 series (CWR09

style) complies with MIL-PRF-55365/4, whilst the T419 (CWR19 style) and T429 (CWR29 style) series comply with MIL-PRF-55365/11. Typical applications for the devices include decoupling, bypass, filtering and R-C timing circuits. Parts are available with ratings of between four and 35 volts, and capacitance values of 0.22µF to 330µF. A wide operating temperature range of –55ºC to +125ºC allows the devices to be used to address a diverse range of applications, including those in harsh or difficult environments.

Offered in nine (A to X) case sizes, the reliability of T409, T419 and T429 military approved capacitors is enhanced by Weibull grading (B, C and D levels), and optional 100% surge current testing.

www.kemet.com



Longer Run-Time
96% Efficient Buck-Boost Converter
The TPS63000 buck-boost DC/DC converter delivers up to 96% peak efficiency over a wide input voltage range of 1.8 V to 5.5 V up to 1.2 A. Extending battery life in one-cell, Li-Ion powered multimedia handhelds, the TPS63000 provides up to 28% greater run-time compared to a standard buck converter with a 3.3-V output – all from a space-saving 3 x 3 mm2 QFN package.
Efficiency at 320mA
100
95
90
85
80
75
Efficiency (%)
320mA
Voltage Range of Today's Batteries
Voltage Range of Future Batteries
1.8
2.1
2.4
2.7
3.0
3.3
3.6
3.9
4.2
4.5
VIN (V)
High Performance. Analog. Texas Instruments.
For datasheet, evaluation module and samples, visit
www.ti.com/tps63000-e
3 x 3 mm2
QFN
Technology for Innovators™
Texas Instruments

Heat Sink Cases

Extracting the heat from electronic components which are mounted on PCBs and then pushed into cases or which have to be firmly installed is often rather difficult due to the fact that appropriate cases are not available.

Fischer Elektronik have developed various lines of cases, which ensure efficient heat extraction and functional handling combined with visually appealing design. There are many types of these small cases which are made from aluminium. They have differently designed cooling fins or heat sinks for efficient dissipation of heat, internal fittings for PCBs in the Euro format, etc. The cases are available for installation on “top hat” rails to DIN, on walls or on mounting plates and also as standalone versions. In addition to the standard range, surface treatment and coatings, black and natural anodising, prints and mechanical processing as well as special designs are provided, to meet customers' specific requirements.

http://www.fischerelektronik.de

Select Easy Data for Correlation

Correlec provides industrial professionals with the means to extract and correlate, easily and inexpensively, constantly updated information generated by multiple sources and to compile the extracted data speedily and efficiently in the format of their choice. We search, extract, update, classify data originating from a very wide variety of sources and group it into logical categories so that you may extract and regroup it as you require when you need it, in the format you want it, easily, rapidly and at low cost. We employ specialists and professionals in the electronic / electrical / electro-mechanical industry and IT professionals who have deep knowledge of the latest IT technology to ensure the most efficient and accurate compilation of data.

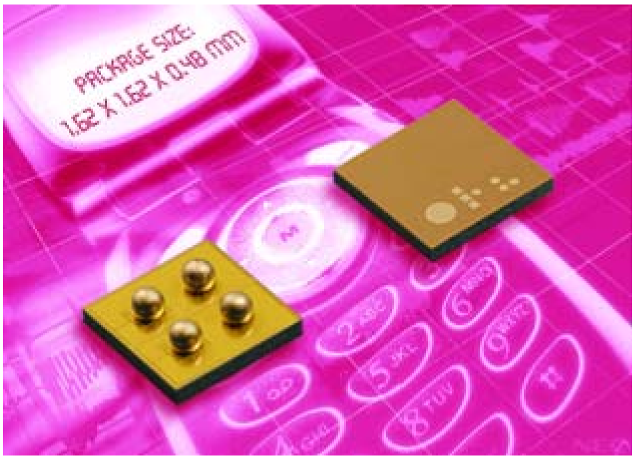
The peace of mind of knowing that you are, at any time, only a few clicks away from the data you often need in a hurry. The peace of mind of knowing that you are dealing at all times with updated information prepared by professionals who come from your field. The relief from the often gruelling and thankless task of searching, collecting and compiling information. We do it for you, daily, and on a scale way beyond most departments' resources. You can now concentrate productively on evaluating the results and using them profitably.

Correlec on a daily base, search, extract, update, classify data originating from a very wide variety of sources and group it into logical categories so that you may extract and regroup it as you require when you need it, in the format you want it, easily, rapidly and at low cost.

www.correlec.com

Smaller Battery Packs by MOSFETs

NEC Electronics announced it has extended its portfolio of low-voltage power management devices (PMD) to include two MOSFETs that boast the industry’s smallest-in-class footprint. The uPA2350 and uPA2351 power MOSFETs reduce the design footprint of traditional dual N-channel MOSFETs for Portable Systems battery-protection applications by as much as 86 % compared to current industry solutions such as the 8-pin thin shrink small-outline package (TSSOP) traditionally used, and are ideal for use in lithium-ion battery packs for portable battery-powered applications such as MP3 players, cell phones and other mobile wireless devices.



The devices combine NEC Electronics’ fourth-generation UMOS process technology with a chip-on-board packaging technique that results in low on-state resistances of 28 milliohms (uPA2350) and 32 milliohms (uPA2351) to extend battery life. The devices are housed in the industry’s smallest and thinnest package in their class, 1.62 millimeters (mm) square by 0.48 mm thick, which can reduce the size of battery packs in ever-shrinking consumer products such as cell phones, digital cameras and other mobile devices.

www.eu.necel.com

HV IC for Resonant Half-Bridge

STMicroelectronics introduced an advanced double-ended controller specifically designed for the series-resonant half-bridge topology. Rich in functions and robust in design, the new-generation high-voltage IC guarantees excellent performance, allowing the design of fully protected and highly reliable power supplies that are particularly suited for use in applications such as Liquid Crystal Display (LCD) and Plasma Display Panel (PDP) TVs, high-end AC-DC adapters for laptops and game consoles, 80+ initiative-compliant ATX silver boxes, servers and telecom SMPS.

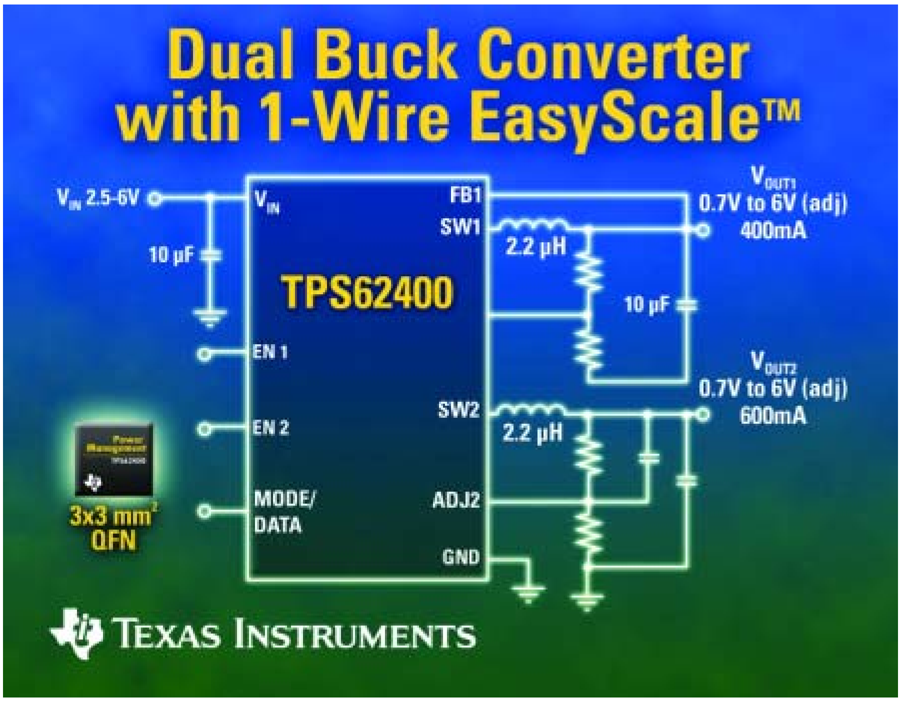
The L6599 includes additional features such as a dedicated output for direct Power Factor Corrector (PFC) connection, two-level Over-Current Protection (OCP), latched Disable input, burst-mode operation at light-load, and an input for power-on/off sequencing or brownout protection.

The device operates at 50% complementary duty-cycle with a fixed dead-time inserted to ensure soft-switching. It enables high-frequency (up to 500kHz) operation with high efficiency and low Electromagnetic Interference (EMI) emissions.

www.st.com

2.25-MHz Dual- DC/DC

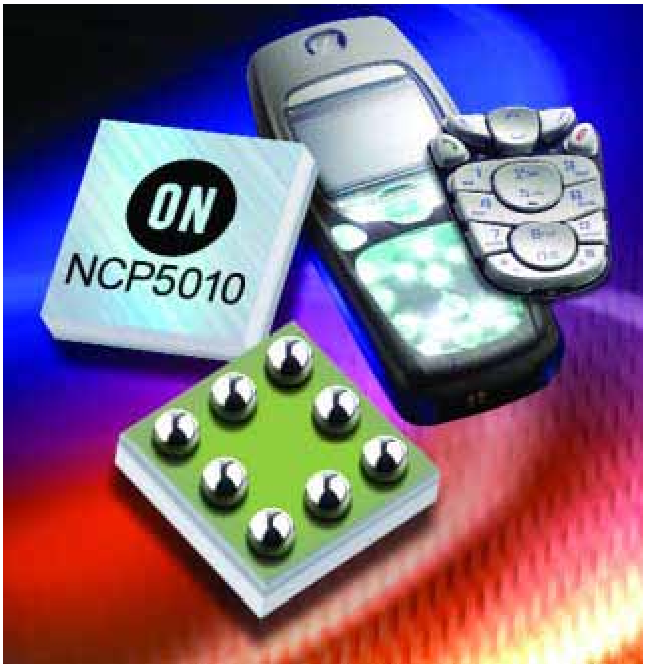
Texas Instruments introduced two dual-output, step-down DC/DC converters with a unique one-pin serial interface technology that allows simple digital voltage scaling. The 95-percent efficient, 2.25-Mhz devices help extend battery life in cell phones, portable media players and other portable electronics, as well as portable industrial and medical equipment. TI's new TPS62400 synchronous, dual-channel switcher with integrated FET technology supports up to 400mA of output current on the first output and up to 600 mA on the second output over an input voltage range of 2.5 V to 6 V. The converter features TI's one-pin EasyScale serial interface, which allows the device to adjust the output voltage dynamically during operation. The feature allows the TPS62400 to support dynamic voltage scaling when powering TI's TMS320C5000 digital signal processors (DSPs) and OMAP processors used in smart phones, PDAs and other portable equipment.



In addition to the TPS62400, TI introduced the TPS62420 dual step-down converter, optimized for portable industrial and medical equipment that deliver up to 600 mA on the first output and up to 1,000 mA on second output. They save valuable board space, while providing extremely efficient power conversion without the need for external compensation.

www.ti.com

LED Driver for Portables



Analog Devices unveiled the ON Semiconductor introduced three new white LED drivers designed to drive high brightness LEDs in backlighting applications for cellular phones, digital cameras, MP3 players, and other portable consumer electronics devices. With up to 90 percent efficiency and an ultra-thin 0.6 mm package profile, the devices help designers meet the stringent power and board space budgets of today's battery-powered portable electronics.

The NCP5010 supplies up to 22 volts (V) typical to power a series of two to five white LEDs for LCD backlighting applications. Delivering up to 84 percent efficiency and 1 microamp (?A) shutdown current, the NCP5010 operates on input voltages from 2.7 V to 5.5 V. It features true cut-off, short-circuit and overvoltage protection, and offers undervoltage lock-out.

This space-saving device is offered in a flip-chip package – which utilizes less than 3 mm2 of board space and requires only 0.6 mm of profile room. Both the NCP5604A and NCP5604B are offered in a thin profile QFN package (WQFN) that requires only 0.8 mm of profile room - making it ideal for ultra-slim phone form factor where space is at a premium

www.analog.com/isensor

Flat Chip Tantalium

NIC Components has introduced a range of flat chip surface mount solid aluminium electrolytic capacitors. The NPC series provides a highly competitive, space saving, high-performance solution, in a wide range of applications including replacing multiple tantalum chip devices in designs such as power supplies. The NPC series offers low impedance and low ESR at high frequencies, plus high ripple current ratings at 105°C. Parts are available with rated capacitances between 47µF and 330µF and working voltages of 2VDC to 6.3VDC. The range features a fused construction for greater safety and is compatible with EIA (7343) 'D' land patterns. Overall case dimensions are a compact 7.3mm x 4.3mm, with case heights ranging between 1.9mm to 2.9mm.The NPC series is fully RoHS compliant, includes gold termination plating and is compatible with Pb-free reflow soldering processes.A wide operating temperature range of –55°C to +105°C makes the NPC series suitable for applications in harsh and difficult environments. Parts are supplied taped and reeled ready for automated assembly processes.

www.niccomp.com

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