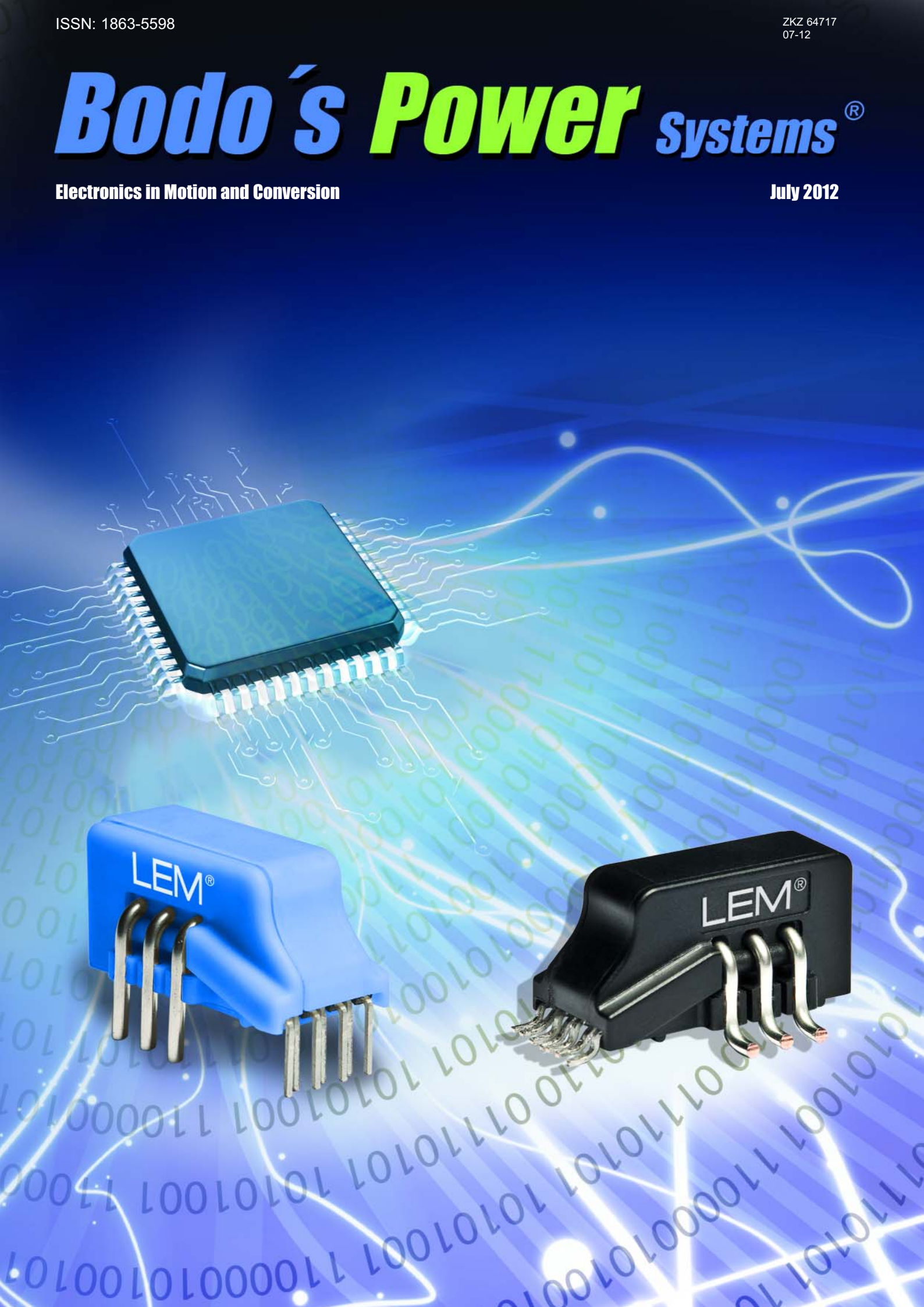
ISSN: 1863-5598

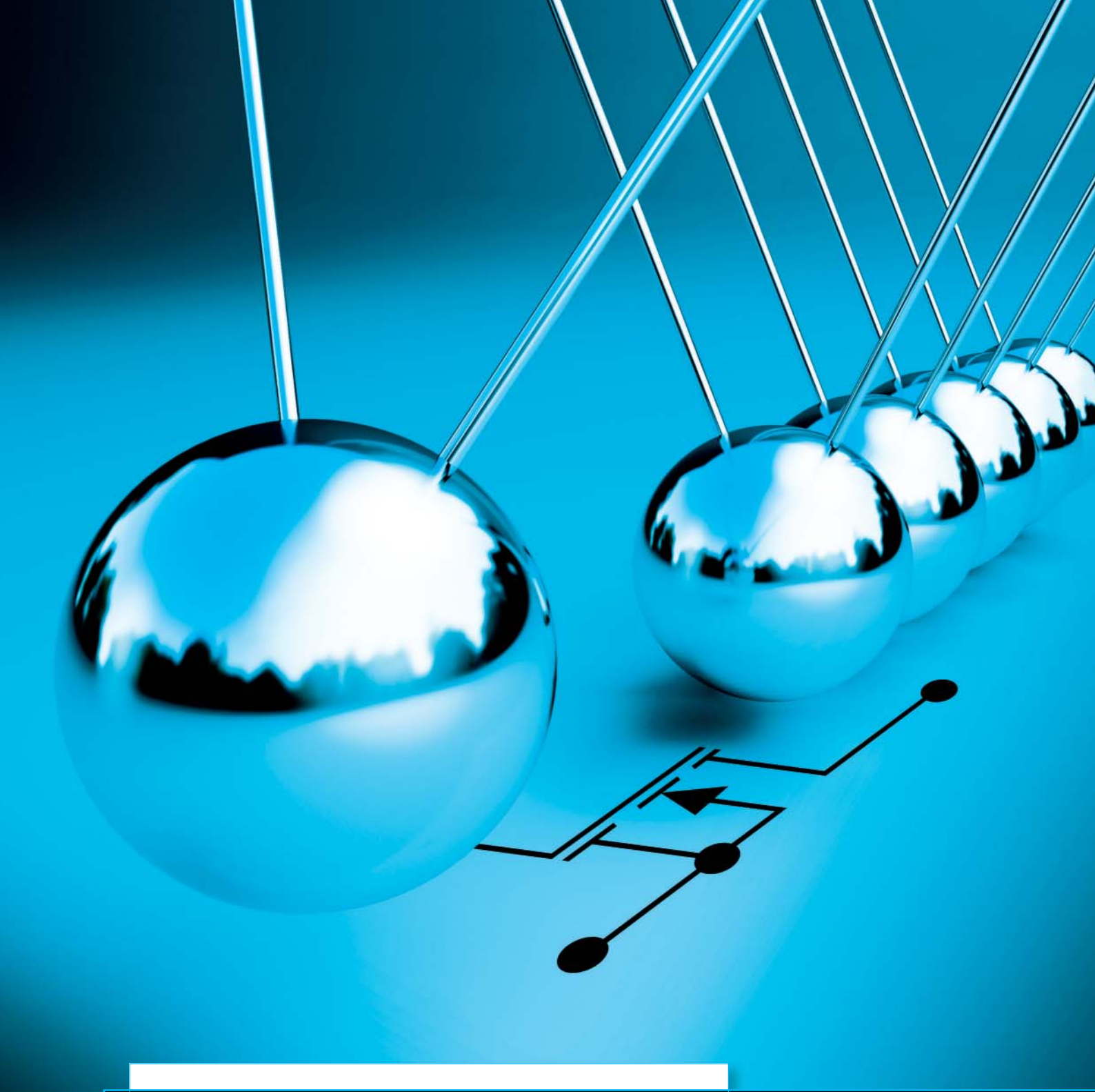
ZKZ 64717
07-12

# Bodo´s Power Systems®

Electronics in Motion and Conversion

July 2012





# INITIATING YOUR PROJECTS

GvA Power Electronics

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GvA is your expert in individual problem solutions for all sectors of power electronics – state of the art know how and profound experience as an engineering service provider, manufacturer and distributor.

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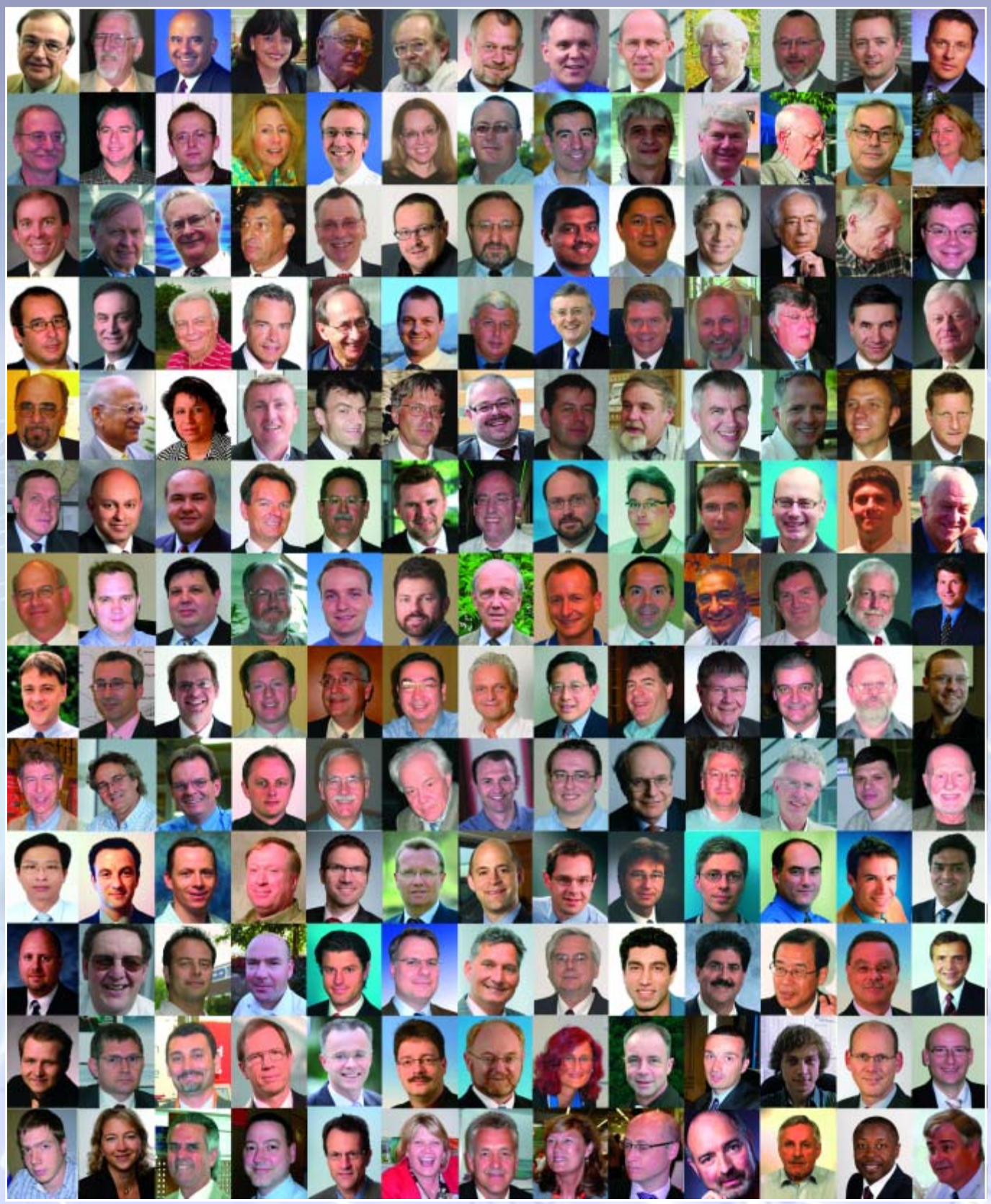
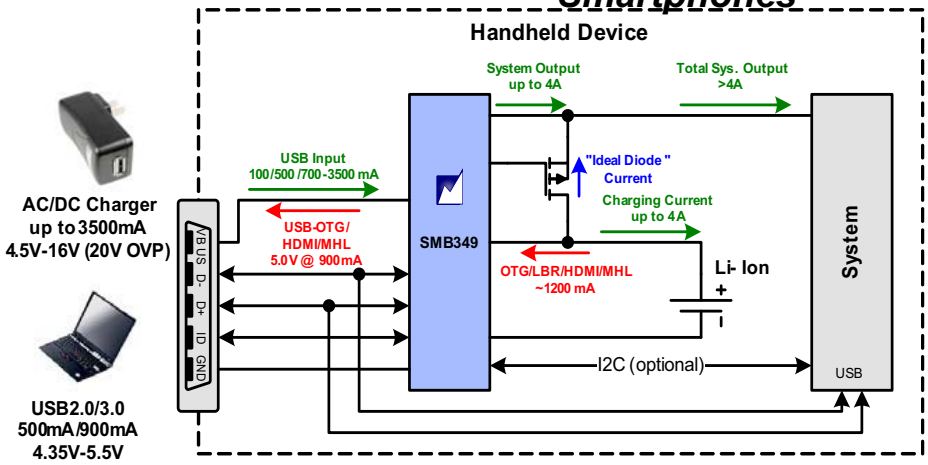
# The Gallery



# Finally! Charge Big Batteries Fast With 4A Chip-Scale Li-Ion Charger ICs

## *Flexible USB/AC Input from +3.6V to +16V, Tiny Solution Size, I²C Programmable Parameters and Built-In Safety – Ideal for Tablets and Smartphones*



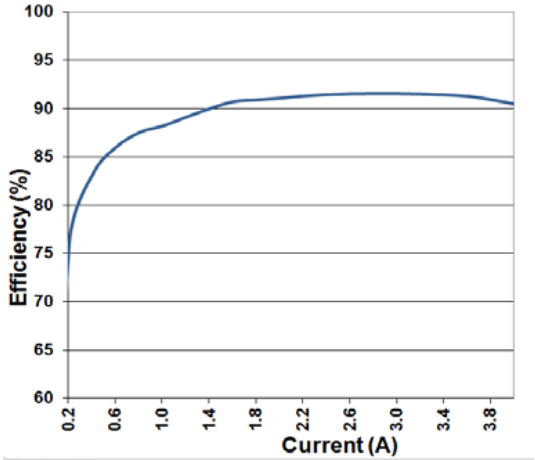

### *Applications*

- Tablets
- Smartphones
- E-Readers
- UltraBooks
- Battery "JuicePacks"
- Portable Gaming
- Portable Digital Video

### *Features*

- +3.6V to +16V Operating Input (+20V OV Protection)
- Fast-Charging, Flexible 4A Switch-Mode Architecture
  - *TurboCharge*™* current-multiplier cuts charge time by 30%-60%
  - *TurboCharge+*™* auto-float voltage control (AFVC) further reduces charge time by compensating for internal battery impedances
  - *CurrentPath*™ with dual outputs for system/battery (SMB349) supports instant-on with dead/missing battery
  - *FlexCharge/FlexCharge+*™* auto power source detection (APSD/AIVD) per USB2.0/3.0/BC1.2 to detect USB or AC/DC source +5V to +16V
  - *OptiCharge*™* auto input current limit (AICL) detects and adapts to source current limit to maximize available power
- I²C Programmable Parameters and Functions with NV Configuration
- *SafeCharge*™ safety features support JEITA/IEEE1725
  - Battery and IC over-voltage/current/temperature protection
  - Trickle charge for deeply-discharged cells
  - Safety timers and fault monitors/reporting
- Tiny 3.2 x 3.0 CSP and 52mm²/1.2mm z-height solution size

### *Industry's Highest System Efficiency*




| | SMB349 | SMB359 | SMB347 | SMB137C | SMB346 | SMB136C |
|---|---|---|---|---|---|---|
| Input Voltage Range (V)* | 4.35 to 16 (20) | 4.35 to 16 (20) | 4.35 to 6.2 (20) | 4.35 to 6.0 (18) | 4.35 to 6.2 (20) | 4.35 to 6.0 (18) |
| # of Inputs/Outputs | 1/2 | 1/1 | 2/2 | 2/2 | 2/2 | 1/2 |
| Maximum Charge Current (mA) | 4000 | 4000 | 2500 | 1500 | 1250 | 1500 |
| Maximum Input Current (mA) | 3500 | 3500 | 2500 | 1500 | 2500 | 1500 |
| CurrentPath™ Control | √ | | √ | √ | √ | √ |
| Charge Current Voltage Output | √ | √ | √ | | √ | |
| Low-Battery Recovery Mode | | | | √ | | √ |
| Automatic Power Source Detection ** | rev 1.2 | rev 1.2 | rev 1.1/1.2 | rev 1.2 | rev 1.1/1.2 | rev 1.2 |
| Package | 3.2x3.0 CSP-49<br>5x5 QFN-40 | 3.2x3.0 CSP-49<br>5x5 QFN-40 | 3.0x2.5 CSP-30 | 3.0x2.5 CSP-30 | 3.0x2.5 CSP-30 | 3.0x2.5 CSP-30 |
| Solution Size (mm2) | 52 | 52 | 32 | 38 | 32 | 35 |

All chargers have Battery Thermal Protection & JEITA Support, IC Thermal Protection, Auto Input Current Limit, Safety or Watchdog Timers, Programmable Charging Parameters, I2C Interface, USB On-The-Go, TurboCharge™ Mode*

**** Patent granted or pending***

*For more information see:*

***www.summitmicro.com/SMB349***

SUMMIT MICROELECTRONICS

*Programmable Power for a Green Planet™*

Bodo´s Power Systems®

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Free Subscription to qualified readers

Bodo´s Power Systems
is available for the following
subscription charges:
Annual charge (12 issues) is 150 €
world wide
Single issue is 18 €
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circulation ASC audit since 09/2006 print run 20 000

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



## Events

**SEMICON WEST,**
San Francisco CA, July 10th -12th
www.semiconwest.org

**EPE PEMC,**
Novi Sad, Serbia, September 4th-6th
http://epe-pemc2012.com/category/news

**Battery Power 2012,**
Denver Colorado, September 18th -19th
www.batterypoweronline.com

**Thermal Management 2012,**
Denver Colorado,
September 18th -19th
www.thermalnews.com/conferences

**LED Professional,**
Bregenz Austria,
September 25th -27th
www.led-professional.com/

**EU PVSEC,**
Frankfurt Germany,
September 24th – 28th
www.photovoltaic-conference.com

**Husum WindEnergy,**
Husum, Germany, September 18th-22nd
www.husumwindenergy.com

# China - a Challenge

The Chinese market challenges all of us in the industry to develop new relationships. Bodo's Power China has started by cooperating with i2i. Serving such a huge market in the local language only makes sense for reaching out to all engineers that need up-to-date technical information. Engineers, worldwide, are a rare breed; a point made by Alfred Hesener of Fairchild in his guest editorial in May. We must do our best to make technical careers attractive to young people and then provide the support necessary to have them focus on power electronics.

The PowerGuru internet platform will help students find articles, products and companies that support their goals for success at university. Bodo's Power Systems is partnering with Power Guru by providing the technical content published in our magazine to the visitors of their website. Roughly 700 articles are already available and this will continue for future issues.

I'd like to welcome Marisa Robles Consée who will, in the future, support us as a freelance journalist with a focus on press events in Bavaria. I am very happy to have such an experienced editor on my team. The magazine has progressed, along with the industry, and we must provide effective support for media service needs. Intersolar in Munich was the first event that Marisa covered for us.

Being in Shanghai for the PCIM Conference and Show has opened up my view of China. This strong and growing nation left a lasting impression of Asia as a region that moves very fast!

Communication is the only way to progress. We delivered twelve issues last year and will continue each month, on time, every time. So far this year we have published 508 pages and 84 technical articles. As a media partner, Bodo's Power Systems is internationally positioned. Don't miss our Chinese version: www.bodospowerchina.com.

**My Green Power Tip for July:**
Whenever possible, use the internet and phone calls instead of travelling. This will save some of the world's energy resources. Plan ahead and bundle your travel activity to maximize effectiveness and minimize energy consumption.

Best
regards

# Dawn of a new intelligence for current measurement


## HO

Conventional current transducers are over. The age of intelligent, interactive transducers begins with the dawn of the programmable HO. Set its operational characteristics using a simple microcontroller interface to meet your applications' needs. Its outstanding performance gives you better control and improves the efficiency of your system whilst minimising inventory with one configurable device.


The future starts now!

- Three programmable ranges: 8 $A_{RMS}$, 15 $A_{RMS}$, 25 $A_{RMS}$
- Single +5V or +3.3V power supply
- Through-hole and SMT packages
- Up to 8 mm creepage and clearance distances + CTI 600 for high insulation
- Half the offset and gain drifts of previous generation
- Overcurrent detection with programmable thresholds
- Programmable slow (6 µs) or fast (2 µs) mode
- Up to 4 programmable internal reference voltages
- Access to voltage reference
- -40 to +115°C operation

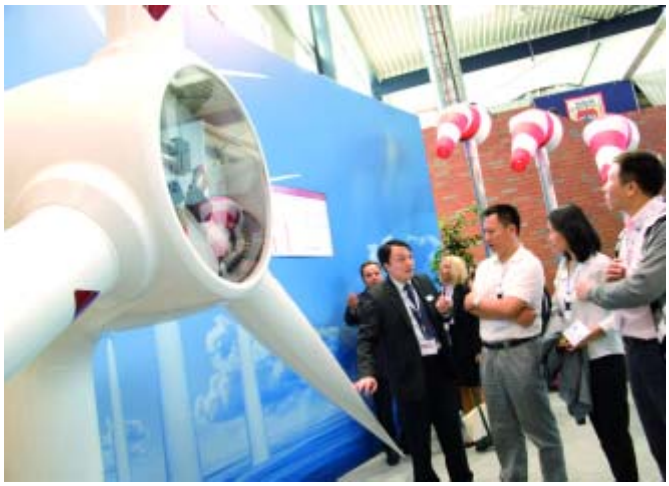
**www.lem.com**

**At the heart of power electronics.**

40 Years Anniversary 1972 - 2012 LEM

# HUSUM is the Natural Home of Wind

From 18 - 22 September, the global wind industry will once again be centred on HUSUM, the natural home of wind. This small town on the North Sea coast of Germany has been the shop window of the wind world since 1989, showing the latest wind technology, associated products and services from all over the world.



As the industry has developed over the last two decades, HUSUM WindEnergy has been the natural magnet for all those wanting to see the latest products the industry has to offer. Whether these are improvements in onshore technology aimed at improving performance and efficiency, new developments to ensure the stability of offshore turbine foundations, or flexible grid solutions, HUSUM remains the most important source of information for players at all levels.
Now heading towards its quarter century, HUSUM WindEnergy boasts 1,200 exhibitors from over 30 nations, and more than 36,000 visitors from over 90 countries.
When the first Husum Wind Days were held back in 1989, the pioneer turbine builders were not taken seriously by mainstream energy providers, and the number of politicians who were able to grasp what was going on could be counted on one hand, HUSUM showed the way ahead. And today, with a resurgence of the (onshore) wind power objectors in many countries, HUSUM is where the doubters can separate fact from fiction and then make qualified decisions about their energy future.
The HUSUM WindEnergy Congress is an established forum for presenting new technology and discussing the new challenges facing the industry. With fears of economic meltdown in the Eurozone, and the continued impact of the global banking crisis, it has never been more important for all wind industry actors to come together to help shape the future. The congress covers onshore and offshore developments, present and future challenges facing the industry, advice about funding communal and large-scale industrial projects, new developments in the fields of lubrication and weather prediction, and company innovations from well-established enterprises and young trailblazers.

**www.husumwindenergy.com**

# SemiSouth Garners 30th US Patent

SemiSouth Laboratories, Inc. is pleased to announce its 30th US patent granted by the US Patent and Trademark Office. SemiSouth is an industry leader in designing and manufacturing silicon-carbide (SiC) power semiconductor transistors and diodes, which are rapidly gaining market share in the solar, UPS, traction, wind, automotive, and aerospace industries for their superior performance in high-efficiency, harsh-environment power applications.
US Patent 8,169,022 was issued on May 1, 2012, and is entitled “Vertical Junction Field Effect Transistors and Diodes Having Graded Doped Regions and Methods of Making.” It was co-invented by Dr. Michael Mazzola, a co-founder of SemiSouth in 2000 when the company spun off of Mississippi State University.
“The underlying technology in this patent allows SemiSouth to fine tune their already performance-leading vertical channel junction field effect transistors and diodes to get ever closer to the unipolar theoretical limit. Customers can expect even better value from the products based on this patent,” said Mazzola. “We are excited to receive our 30th US patent,” said Dr. Jeffrey B. Casady, SemiSouth President & CTO and company co-founder. “Our technology is state-of-the-art in terms of performance per unit area. SemiSouth products deliver advanced, efficient, cost-effective power solutions that others cannot.” In addition to 30 US patents, SemiSouth possesses 24 patents internationally and has 204 applications pending worldwide.

**www.semisouth.com**

# CUI Launched New Website

CUI Inc announced the launch of its new website, www.cui.com. A main feature of the new site is a significantly advanced parametric search capability for the company’s Power, Motion Control, and Components product lines. Visitors to the new site are now able to dynamically filter, sort, and send searches based on a range of critical specifications. Access to technical resources has been greatly improved and now includes downloadable 3D models, videos, and application notes, with no registration required. The new site also highlights the latest news and social media feeds from CUI.


“We developed the new cui.com with the goal of making our product lines easy to navigate and our content simple to access for the engineering community.
We believe visitors will find our new site greatly improved while still maintaining some of the existing functionality that made our previous site successful,” stated CUI’s VP Marketing, Jeff Schnabel.

**www.cui.com**

# Does your digital power-supply design controller require high performance flexible on-chip peripherals?...

## Control complex Digital Power applications and save power


**Microchip's new dsPIC33F 'GS' Series DSCs provide on-chip peripherals including high-speed Pulse-Width-Modulators (PWMs), ADCs and analogue comparators, specifically designed for high performance, digital power supplies.**

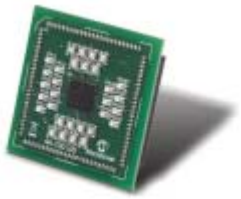
The powerful dsPIC33F 'GS' series is specifically aimed at power control applications and can be configured for a variety of topologies, giving power-supply designers the complete freedom to optimise for specific product applications. Multiple independent power control channels enable an unprecedented number of completely independent digital control loops. The dsPIC33F 'GS' series offers the optimal digital power solution supported by royalty free reference designs and advanced power design tools.

Typical applications for the new 'GS' series DSC include: Lighting (HID, LED , fluorescent), uninterruptable power supplies, intelligent battery chargers, AC-DC and DC-DC power converters, solar and pure sine-wave inverters, induction cooking, and power factor correction.

- Digital control loops with up to 18 high-speed, 1 ns resolution PWMs
- Up to 24 channels 10-bit on-chip ADCs
- 2 to 4 Million Samples Per Second (MSPS) ADC for low latency and high-resolution control
- Pin range: 18 to 64
- Up to 64KB Flash memory

### GET STARTED IN 3 EASY STEPS:

1. Purchase a 'GS' Series Plug-In Module
2. Download Digital Power Reference Design
3. Order samples and start designing!
   www.microchip.com/power



dsPIC33F 'GS' Series Plug-In Module (MA330024)

**For more information, go to: www.microchip.com/power**

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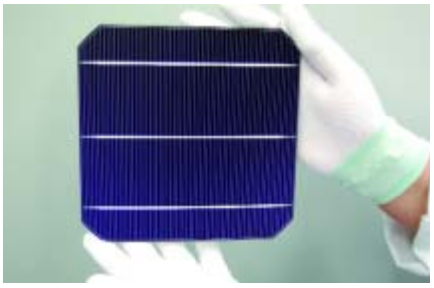
# High-Efficiency Bifacial Silicon Solar Cells

bSolar announced the availability of its high-power, high-efficiency, bifacial, photovoltaic (PV), crystalline silicon solar cells. Bifacial cells utilize the cells' rear side to collect reflected and diffused sunlight to generate additional electricity. bSolar cells are produced using p-type wafers, standard equipment and production processes, giving them a mass market appeal.

The new cells provide 10-30% higher energy (KWH) per KWp installed in standard applications and up to 50% in vertical installations, resulting in an equivalent cell efficiency of 21%-24% in standard applications and a total module power of 280-325 Watts for 60 cell modules. This unprecedented efficiency and power are amongst the industry



highest for mono crystalline silicon cells.

Applications for the new cells include flat rooftops and ground installations, as well as unique solutions for special BIPV applications such as solar sound barriers, car ports, facades and green houses.

The bifacial cells are produced in bSolar's industrial production line in Heilbronn, Germany and have been recently incorporated into bifacial modules by numerous producers worldwide. The current production capacity of bSolar is 30 MWp/year and the company is planning to rapidly expand production to meet customer demand.

"We are excited to introduce our disruptive bifacial cells, which will significantly improve the financial returns of solar projects.", commented Yossi Kofman, bSolar's CEO. "We are currently working with our commercial partners and customers to bring cutting-edge bifacial panels to the market."

**www.b-solar.com**

# New Manufacturing Facility in Rome, NY

Indium Corporation has acquired a new manufacturing facility, located at 5836 Success Drive, Rome, NY, USA. The plant is currently being outfitted to expand production capacities of Indium Corporation's range of compounds, including indium-, gallium-, germanium-, and tin-based materials.

The company's expansion addresses its growing global success with supplying materials to industries such as solar photovoltaic, flat panel display, semiconductor, optical fiber, LED, and others.

Indium Corporation is installing state-of-the-art manufacturing equipment, processes, and analytical capabilities to address the world's demand for high-performance materials. The enhanced capabilities will enable Indium Corporation to convert a wider range of feed materials into high-purity compounds and provide recycling of customers' reclaim streams.

According to Claire Mikolajczak, Indium Corporation's Director of Metals and Compounds,

"This major expansion enables us to simultaneously enhance our process efficiencies, product quality, and product range. We will soon be able to deliver a very large share of the world's demand for high quality compounds."

Greg Evans, Indium Corporation President, added,

"We have committed to our markets that we will raise the bar with regard to capacity, quality, and service. Our new facility addresses each of these issues and even allows us to partner with new customers on their challenging future requirements. We look forward to these new opportunities."

The new plant is sized to accommodate future expansion of upstream and downstream processes to improve its costs and performance.

**www.indium.com**

# 25 Years of Success

Syfer Technology are celebrating 25 years of successful electronic component development at their Norwich headquarters and are set to continue their innovation serving new markets.

Syfer Technology, which employs 240 people, is Europe's leading manufacturer of ceramic multilayer capacitors, which are widely used in telecommunications, automotive manufacture and other industrial applications.

Over the last 25 years Syfer have shown their skill and flexibility in being able to adapt their operations to meet new trends and emerging markets.

"We have successfully identified new customers in different areas like medical instrumentation, military applications, the aerospace industry and space exploration," says Howard Ingleson, Syfer Technology's Managing Director.

"Many of the products that are made with our electronics components are used in safety-critical environments, and so precision and quality are paramount," he says.

The company has pioneered several cutting-edge production techniques and component designs to meet global market requirements.


**www.syfer.com**

# Extension of the HelioProtection® Program Offering

Mersen has identified specific needs for universal and high-quality monitoring systems. These needs are related to PV installations in industrial and commercial fields and large solar farms as well. For such installation the investor is waiting quick and good return on investment. Mersen has designed a set of electronic cards for monitoring. At the core is the main electronic card capable of monitoring six strings making it possible to detect problems as they occur by spotting their precise location in the string. Auxiliary cards can be added in order to monitor up to 30 strings in total.

Edouard Guillaume, Product Manager states: “The main card and four additional auxiliary cards can be installed in Mersen's HelioProtection? junction boxes to monitor solar panel strings.The benefits include proactive maintenance, an increase in the power performance of the system (an improved rate of energy actually produced compared with theoretical energy production) and more secure return on investment, with greater profits and operational costs under control.”

Mersen's HelioProtection? junction boxes incorporating self-powered monitoring electronic cards enable various monitoring and diagnostic functions to be embedded in order to manage energy generation and equipment maintenance.

**PV Fire Shunt joins HelioProtection® Program**

Different national guidelines recommend that in solar PV installations the DC circuit be switched off the closest to PV modules so as to secure the intervention of emergency responders.

Mersen has designed an innovative solution to meet this requirement for safety. The PV Fire Shunt device designed by Mersen is based on a shunt technology in order to lower the voltage to almost 0V. This is achieved by pulling straight down one handle with a pike pole. This technology plus the product’s mechanical characteristics, thanks to materials guaranteeing good resistance to fire and flames, secure the area for emergency responders and fire fighters. One PV Fire Shunt secures 3 PV strings which is the case in residential PV installations.

**Extension of HelioProtection® gPV fuse links mapping**

Mersen pursues the development of its HelioProtection? gPV fuse links offering. Besides the gPV string fuse links: HP6M (10x38mm), HP10M (10x38mm), DC10 (10x85mm) Mersen launches new gPV main fuse links complying with the well renowned NH standard (square-bodied fuse links with blade-type connections).

Emmanuelle Delcambre, Product Manager states: “For 1000VDC we offer now a ‘short’ NH size 1 with ratings from 50A to 160A and a ‘long’ NH size 3 with ratings from 250A to 400A.”

The completion of the mapping will be achieved with the launch of the 1500VDC NH model at end 2012.

**Innovative fuseholder with screwless, spring pressure, wire termination technology**

Mersen launches a new UltraSafe™ fuse holder for 10x38 sized fuse links.

USGM1HEL fuse holder is easy to use and save time for installers. It’s a safe and reliable solution for PV installations market.

“Easy wiring is of course the key feature of this new product. Another key feature is the limitation of DC effects on the wiring provided by the Wago Cage Clamp® technology.”, states Franck Ageron, Product Manager.

**www.mersen.com**

# LED Component Business Keeps Growing

Luger Research, the organizers of the LpS LED professional Symposium +Expo 2012 announced that the exhibition that runs parallel to the symposium has already sold 2/3 of its exhibitor spaces with still 4 months left until the start of the symposium.

The exhibitor list is very impressive with many major players and specialist companies from the LED industry exhibiting in Bregenz for the second time running or participating for the first time this year. Among them are companies like e:lumix, Osram, Tridonic, Alanod, AT&S, Bergquist, Cree, Everlight and Zenaro, to name just a few.

A complete exhibitor list is available at: http://www.led-professional-symposium.com/exhibition/lps-2012-exhibitor-list

Visitors travel from around the world to meet in September at the famous Festspielhaus in Bregenz, Austria for this event. They come from a wide range of luminary and lighting industries. In 2011 20% of the visitors were involved in luminary & lighting system manufacturing, 12% came from research & education, 9% from distribution, 7% from LED manufacturing, 6% were involved in engineering & design services, 5% were driver & supply manufacturers, 4% each were electronic component manufacturers, lamp manufacturers and consultants.

The LED professional Symposium & Exhibition targets interest groups that are looking for information about LED lighting technologies and its applications in light modules and lighting elements. The symposium is technology oriented and therefore ideal for specialists from the research and industry. In 8 sessions 26 speakers cover a multitude of LED topics that attract an expert audience, bringing high quality leads to the exhibition. The exhibition is a perfect platform to present technologies and implementation solutions and to demonstrate products and services to global decision makers and to an extended circle of delegates from major industry players.


The Symposium and Expo will be held again at the Festspielhaus in Bregenz. For this year the exhibition area has been expanded to accommodate the increasing number of exhibitors. The presentations will be held in the “Grosser Saal” which is equipped with the latest presentation technology ensuring a high quality experience. Besides hosting the world renowned annual Bregenz Festival, scenes from the James Bond film, Quantum of Solace, were filmed here.

**www.lps2012.com**

# Peter Schiefer Appointed Head of Operations

Infineon Technologies announced that Peter Schiefer (46) will assume leadership of Operations at Infineon Technologies AG as of September 1, 2012. He will report to Dr. Reinhard Ploss, member of the Management Board, and be responsible for the company's Manufacturing, Supply Chain and Purchasing activities. Peter Schiefer will simultaneously give up his position as Head of the Power Management & Multimarket (PMM) Division, which he has led since January 1, 2012.

As of September 1, 2012, the new Head of the Power Management & Multimarket (PMM) Division will be Andreas Urschitz (40). As a member of the PMM management he is currently responsible for worldwide Sales, Marketing and Distribution of the division. He will continue these activities.

After studying business at the Vienna University of Economics and Business Administration and his teaching activities there, Andreas Urschitz began working in the semiconductor industry at Siemens and later Infineon in 1994. After holding senior management positions in production planning, marketing and strategy, he took over as Head of Marketing for power semiconductors. In 2005, he assumed worldwide responsibility for Power Management & Supply Discretes. Since January 1, 2012, he has been a member of the management of the Power Management & Multimarket (PMM) Division, where he is responsible for global Sales, Marketing and Distribution.

**www.infineon.com**

# Photo Voltaic Meets Manufacturing

Where do PV manufacturers go to meet up with equipment and materials suppliers to identify critical manufacturing needs? How do they determine meaningful action items to accelerate industry growth?

SEMI has created the best possible place to meet PV equipment and materials companies in one venue and network and collaborate on major issues facing the industry. At the Intersolar Europe, SEMI PV Group has organized a wide variety of special events, meetings, and exhibits geared for solar energy professionals involved in the manufacturing supply chain. From the 8th Advanced PV Manufacturing Forum to the PV Production and Technology Hall A5 & A6 to the PV Standards development meetings, it's the place to learn how to gain traction in the PV manufacturing.

The 8th Advanced PV Manufacturing Forum had been an excellent opportunity for PV technology leaders, managers, engineers and professionals from the manufacturing, supplier and R&D communities to share their most recent developments in the collective drive towards quality and excellence in PV manufacturing.

**www.semi.org/europe**

**www.pvgroup.org**

# James Doyle Appointed President and CEO

The Owners and Board of Directors of RF and microwave components manufacturer, XMA Corporation, announced today that they have appointed James Doyle as the company's new President and CEO.

"Our leadership committee considered many extraordinary candidates for this position during a nationwide search, but it became very clear to all that James Doyle was the right choice to lead the organization and create a new vision for the future," said Fred Goodrich, XMA's Board Chairman. "James is a leader, with in-depth knowledge and experience, and is highly results driven. He has an authentic passion for our mission to make XMA the premier supplier for highly complex RF termination and microwave interconnect systems. XMA Corporation is now poised for tremendous growth, and we are eager to welcome James to lead the organization in the next steps of our evolution."

Doyle is an accomplished leader with a proven track record of creating well-targeted strategies that achieve business objectives. Most recently he worked as the Congressional Affairs Liaison for Emerson Embedded Computing in Washington DC, a "Fortune 100" company. He is highly regarded in the technology industry and considered one of the leading authorities on the changing face of Washington, D.C. Previous to his appointment with Emerson he was the Vice President of Business Development and Strategy for Hybricon Corporation. He holds degrees from the University of Massachusetts and an MBA from Boston University.

"I am excited to have the opportunity to lead this world-class organization," said Doyle. "XMA has a tremendous reputation and a strong history thanks to the passion and expertise of past and present leadership. I am confident that we can create even greater value to our customers and stakeholders going forward."

**www.xmacorp.com**

# Ploessl Named Compounds Product Manager

Indium Corporation announces that Robert Ploessl, PhD, has been named Product Manager for indium, gallium, germanium and tin compounds.

Dr. Ploessl will work with Indium's global team of engineering, sales, operations, and research and development professionals to capitalize on the growth of LEDs, metal organic precursors, power storage systems, fiber optics, and the next generation OLED displays. He will develop Indium Corporation's marketing strategies, while bringing insights learned from their technical team to further product development efforts. Indium Corporation's compounds business includes indium trichloride ($InCl_3$), gallium trichloride ($GaCl_3$), germanium tetrachloride ($GeCl_4$), as well as a full range of oxides.

Dr. Ploessl joined Indium Corporation in 2010. He holds a doctorate in physics from the University of Regensburg in Germany and an MBA from the S.C. Johnson Graduate School of Management at Cornell University.

Dr. Ploessl is based at Indium Corporation's Global Headquarters in Clinton, NY, and resides in New Hartford.

**www.indium.com**

# Dr. David Reusch Joins Efficient Power Conversion

Efficient Power Conversion Corporation (EPC) is proud to announce that Dr. David Reusch has joined the EPC engineering team as Director, Applications Engineering.

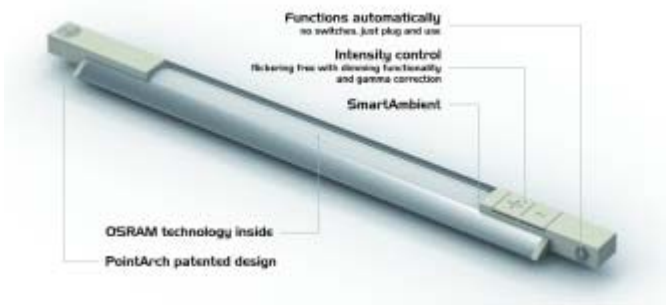
As a member of the EPC applications team, Dr. Reusch's focus will be on designing lower loss and higher power density benchmark circuits that demonstrate the benefits of using gallium nitride transistors. His initial focus will be on their use in higher voltage DC-DC converters and resonant, soft-switching converters. Dr. Reusch's research and experience in these applications will be shared with customers to accelerate their designs using high performance eGaN FETs. His designs will demonstrate GaN transistors' superior performance over MOSFETs.

Dr. Reusch earned a doctorate in electrical engineering from the Virginia Polytechnic Institute and State University (Virginia Tech), where he also earned his bachelor's and master's degrees. While working on his Ph.D. he was an NSF Fellow at the Center for Power Electronics Systems (CPES). Dr. Reusch is active in IEEE organizations and during the last several years has published papers at the Applied Power Electronics Conference (APEC) and the Energy Conversion Congress and Exposition (ECCE). In addition, he has first-hand experience designing with GaN transistors to meet the demands for lower loss and higher power density in power converters.

**www.epc-co.com**

# Smart LED Lighting Solution

FuturoLighting, company focused to LED lighting solutions, introduces extension to its range of Catherina lighting solutions. Catherina$^S$, a compact fully autonomous, motion detecting, lighting solution uses most recent Osram Duris E5 LED technology. Due to its immediate light output and no lifetime limitation due to switching, Catherina$^S$ offers advantages over traditional incandescent and fluorescent light sources as well as improved reliability due to its solid-state construction.




Similarly to long form version, Catherinav has a simple setup using built-in micro-controller provided by Microchip with integrated high resolution control over light output levels, ambient light threshold, dimming functionality, and Gamma correction which improves visual comfort. Once the desired settings are adjusted the Catherina$^S$ doesn't need to be adjusted again. It can be installed in any location that is dry and has low voltage distribution network or a standard wall outlet.

**www.futurolighting.com**

# Intersolar Europe Shows Solar Power and E-Mobility

The PV and E-Mobility special exhibit demonstrated for the first time how solar power and e-mobility complement each other. The combination of electric vehicles, PV carports and charging stations invites visitors to discover more about the future of mobility.

Exhibitors at the world's largest exhibition for the solar industry, Intersolar Europe, are presented the latest trends and technologies in the areas of photovoltaics (PV), PV production technologies and solar thermal technologies. For the first time, the topic of e-mobility is also taking center stage with the new PV and E-Mobility special exhibit unveiling mobile storage technologies and showcasing combinations of PV carports, charging stations and electric vehicles. In addition to presenting solutions individually, Intersolar Europe showed the most important ways in which they work together, providing information on how electricity storage and grid integration can be combined to ensure solar power is used effectively by those who generate it. The program also provided the opportunity to take an electric vehicle for a test drive in the outdoor exhibition area of Messe München, allowing visitors to experience the future of mobility first hand.

**www.intersolar.de**

# Circuit Material Solutions at Microwave Symposium

Rogers Corporation and representatives of its Advanced Circuit Materials Division will be at the upcoming 2012 IEEE International Microwave Symposium (IMS) to help attendees learn more about Rogers' wide range of high frequency circuit materials.

The 2012 IEEE International Microwave Symposium (www.ims2012.org), RF/microwave industry's largest event, featured a three day exhibition at the Montreal Convention Center in Montreal, Quebec, Canada, and a full week of technical sessions. Rogers' representatives highlighted two new additions to its proven lines of high performance circuit materials: the 2929 bondply system and low loss RO4835™ circuit laminate with enhanced oxidation resistance for excellent long term performance.

Visitors to the Rogers' booth can reviewed the new 2929 bondply, an unreinforced hydrocarbon based thin film adhesive system intended for use in high performance, high reliability, multi-layer circuit constructions. Its low dielectric constant (2.9) and low loss tangent (<0.003) at microwave frequencies make it ideal for bonding multi-layer circuit boards based on high performance composite dielectric materials such as Rogers RT/duroid® 6000, RO4000®, and RO3000® series laminates.

**www.rogerscorp.com**

# 230400000. Number of IGBT cells performing reliably to drive a highspeed locomotive.

The HiPak family of IGBT modules sets new standards of robustness for high reliability applications such as Traction, Medium Voltage Drives and Windpower. All modules feature ABB's Soft Punch Through (SPT™ and SPT$^{+}$) chip technologies, which combine low-losses with soft-switching performance and record-breaking Safe Operating Area (SOA).
HiPak modules are available in three standard isolation voltages (4, 6 and 10.2 $kV_{RMS}$) and a variety of circuit configurations. For more information please visit our website:
**www.abb.com/semiconductors**

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Power and productivity
for a better world™

# Delivers Optimal Intel® VR12 Solution

*Best in Class Reliability, Efficiency and Performance*

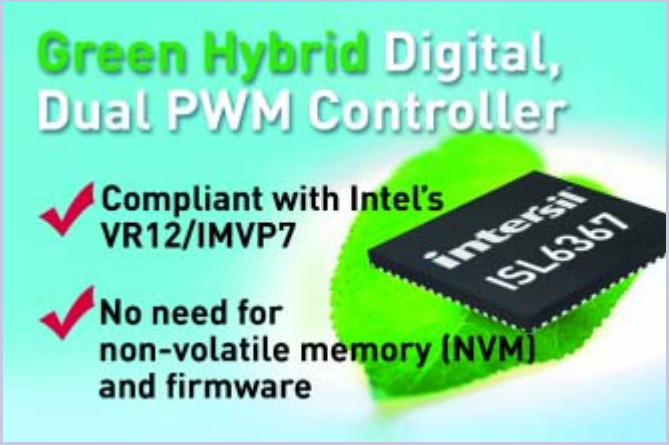
Intersil Corporation a world leader in the design and manufacture of high-performance analog and mixed signal semiconductors, introduced a green hybrid digital, dual PWM controller that is compliant with Intel's VR12/IMVP7 specification.

The ISL6367 incorporates a 6-phase PWM to control the microprocessor core or memory voltage regulator and a single-phase peripheral PWM voltage regulator for graphics, system agent or processor I/O. Additionally, the ISL6367 has simplified programmable functions and telemetry for optimal system flexibility. Intersil's proprietary hybrid digital approach eliminates the need for non-volatile memory (NVM) and firmware typically required by digital solutions, significantly reducing cost, design complexity, manufacturing control and inventory requirements.

**Features and Specifications Highlights:**

- External programmability to support different platforms and designs
- Best-in-class linear control loop architecture
- Proprietary EAPP control architecture provides excellent current balance during high frequency transients and eliminates beat frequency oscillation
- Feedforward architecture to achieve constant modulation gain with input voltage variation
- PMBus/SMBus/I2C compatibility for digital power management
- Robust system protection
- Optional input current sensing for true catastrophic failure protection
- Fast and accurate over-voltage and over-current protection
- Two output sensing points for protection against single point of failure
- Highest efficiency from light to full load
- Low quiescent current
- Auto phase dropping
- Diode emulation
- Compatible with phase doublers such as the ISL6611A and ISL6617, to double or quadruple the phase count (up to 24+4 phases)
- Up to 2MHz switching frequency per phase

"These green hybrid digital solutions truly bring value to end users," said LL Sheu, Chief Operating Officer at ASRock. "Intersil's hybrid digital technology does indeed outperform, providing invaluable balance of system performance and reliability within the digital power management landscape."




"The ISL6367 provides flexibilities of digital controllers without the learning curves required to design with it," said Majid Kafi, vice president and general manager, computing products group at Intersil. "Major customers like AsRock are already adopting this design approach."

**Pricing and Availability**

The ISL6367 is available now in 60-lead 7 x 7 QFN packages with prices starting at $3.75 each in 1,000-unit quantities. For more information please visit: http://www.intersil.com/products/ISL6367

Intersil Corporation is a leader in the design and manufacture of high-performance analog, mixed-signal and power management semiconductors. The company's products address some of the fastest growing markets within the industrial and infrastructure, personal computing and high-end consumer markets. For more information about Intersil or to find out how to become a member of our winning team, visit our website and career page at:

**www.intersil.com**

**Note**

# Need High Power Inverter Design Support?

## Components > Designs > Assemblies

From active and passive component selection to development of complete assemblies, Richardson RFPD can help find the best solution for every high power (>10 kW) inverter design.

**Specializing in:**

- Global engineering and technical support for high power design projects
- Design and assembly of power semiconductor assemblies, power passive assemblies and inverter subsystems

**Component design-in from industry-leading suppliers:**

CDE Cornell Dubilier — Capacitor Solutions for Power Electronics
CONCEPT — Intelligent Power Electronics
The Capacitance Company KEMET — Charged.
Kendeil
Maxwell Technologies
Microsemi — Power Products Group
Mitsubishi Electric
OHMITE
Priatherm
RECOM
TAMURA
Vincotech

Reduce development cost and time-to-market. Put Richardson RFPD's 30 years of high power assembly and design expertise to work for you.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# ProtectiCap™ Coating Saves on Production Stage

The latest innovation in Multilayer Chip Capacitors (MLCC's) from Syfer Technology is a range of compact devices, supplied with a built-in protective coating, designed to prevent flashover in high voltage applications. Typically, with standard high voltage capacitors, a special coating is applied after the devices are soldered onto the board in order to minimise the risk of flashover from one termination on the chip to another.

Syfer's ProtectiCap™ process applied to its high voltage range of MLCC's has been developed specifically to address this issue. The coating minimises the risk of flashover and avoids the need for the customer to apply conformal coating after soldering. The range increases the voltage capability of standard HV devices and provides the highest working voltages in the industry for each case size, allowing significant downsizing with no loss of performance.

Aimed at applications such as power supplies, lighting ballasts, inverters/DC link, and general high voltage circuits, the X7R dielectric ProtectiCap™ range of MLCC's combines high voltage capability with small package size. The capacitance range of devices in this series is 100pF to 33nF, package sizes range from 1206 to 2220, and voltages available include 2KV, 2.5KV, 3KV, 4KV and 5KV.

Typical devices include a 2KV MLCC in 1206 package with capacitance range of 100pF to 3.3nF, 2KV MLCC in 2220 package with capacitance range of 220pF to 33nF, 3KV device in 1880 package with 100pF to 3.3nF capacitance range, and 5kV mlcc in 2220 package with 220pF to 4.7nF capacitance range.

Additional specifications include operational temperature range of -55 to 125oC, temperature coefficient of capacitance typically at +/-15%, and insulation resistance of 100Gohms or 1000s, whichever is the least.

This range is fully compliant with the RoHS and WEEE directives and parts are compatible with lead free solders. The devices, manufactured at Syfer's Norwich, UK facility, are available immediately in sample packs or on standard 6 week delivery for production volumes. Pricing, on application, depends on value and volume.

For further technical and ordering information, see

**www.syfer.com**

Essential L i n k

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**PROTON-ELECTROTEX**

**Power semiconductor devices**

# Industry Lowest Operating Power 5MBd Digital Optocouplers

New Compact digital optocouplers consume less than 10 mW per channel while handling isolation voltages of up to 5 kV as compared to other 5MBd optocouplers in the market

Avago Technologies, a leading supplier of analog interface components for communications, industrial and consumer applications, today announced the ACPL-M21L/021L/024L/W21L/K24L optocoupler family . These optocouplers consume less power as compared to other similar 5MBd optocouplers in the market. The ACPL-x2xL optocouplers are designed to meet customer needs for lower power, higher isolation voltage, and better common-mode rejection (CMR) performance, thanks to the excellent performance of the new LED and detector IC design.

Avago Technologies' digital optocouplers are used in a wide variety of isolation applications ranging from power supply and motor control circuits to data communications and digital logic interface circuits.

The new ACPL-x2xL 5MBd digital optocouplers require minimum LED drive current of 1.6 mA, and detector IC power consumption of less than 1.1 mA. The detector IC contains a CMOS output stage with glitch-free output during power-up and power-down, and optical receiver input stage with built-in Schmitt trigger that provides logic-compatible waveforms, eliminating the need for additional waveshaping. An internal shield also guarantees high common-mode rejection (CMR) of minimum 25 kV/µs at 1000V common-mode voltage.




ACPL-x2xL optocouplers operate at 3.3V/5V power supply with guaranteed AC and DC performance from an extended temperature range of –40°C to +105°C.

The ACPL-M21L, ACPL-021L and ACPL-W21L are single-channel optocouplers in 5-lead small-outline (SO5), 8-lead small-outline (SO8) and stretched 6-lead small-outline (SO6) packages, respectively. Whereas, the ACPL-024L and ACPL-K24L are dual-channels optocouplers in 8-lead small-outline (SO8) and stretched 8-lead small-outline (SO8) packages, respectively.

All new optocouplers are compliant to industrial safety standards such as IEC/EN/DIN EN 60747-5-5 approval for reinforced insulation, UL 1577 and CSA.

**Availability**

The first available optocoupler, the ACPL-M21L is immediately available in sample quantities.

Avago Technologies is a leading supplier of analog interface components for communications, industrial and consumer applications. By leveraging its core competencies in III-V compound and silicon semiconductor design and processing, the company provides an extensive range of analog, mixed signal and optoelectronics components and subsystems to approximately 40,000 end customers. Backed by strong customer service support, the company's products serve four diverse end markets: wireless communications, wired infrastructure, industrial and automotive electronics, and consumer and computing peripherals. Avago has a global employee presence and heritage of technical innovation dating back almost 50 years to its Hewlett-Packard roots. Information about Avago is available on the Web at:

**www.avagotech.com**

CONCEPT
INTELLIGENT POWER ELECTRONICS


# Taming the Beast

## New 3.3kV SCALE-2 IGBT Driver Core

2SC0535T2A0-33

The new dual-channel IGBT driver core 2SC0535T for high voltage IGBT modules eases the design of high power inverters. Using this highly integrated device provides significant reliability advantages, shortens the design cycle and reduces the engineering risk. Beside the cost advantage resulting from the SCALE-2 ASIC integration, the user can consider to have a pure electrical interface, thus saving the expensive fiber optic interfaces. The driver is equipped with a transformer technology to operate from -55°..+85°C with its full performance and no derating. All important traction and industrial norms are satisfied.

**SAMPLES AVAILABLE!**

## Features

Highly integrated dual channel IGBT driver
2-level and multilevel topologies
IGBT blocking voltages up to 3300V
Operating temperature -55..+85°C
<100ns delay time
±4ns jitter
±35A gate current
Isolated DC/DC converter
2 x 5W output power
Regulated gate-emitter voltage
Supply under-voltage lockout
Short-circuit protection
Embedded paralleling capability
Meets EN50124 and IEC60077
UL compliant

**CT-Concept Technologie AG, Renferstrasse 15, CH-2504 Biel, Switzerland, Phone +41-32-344 47 47**

**www.IGBT-Driver.com**

# Adding Intelligence: Is this Enough to Create a Smart Grid?

*The obvious answer is: no! Let us see why.*

*Dr. Sergio Rossi, Vice President Smart Grid, Infineon Technologies*

Electric grids are the largest technical constructions in the world - but years behind compared with the innovations seen in other technical fields. According to the U.S. Energy Information Administration (EIA) energy demand more than tripled in the last 50 years, due to the increase both in world's population and gross product. Continued increases in energy demand through the next decade will create severe challenges for a grid infrastructure that cannot support additional loading without modernization. In addition complex problems like the reduction of CO2 emissions must be addressed to preserve our environment.

Infineon estimates that to deliver 85W to a typical home's load for appliances and lighting, we need to consume 220W of energy. The vast majority of losses are thermal losses happening during energy generation (which cause CO2 emissions), but also a significant amount of energy is wasted during transmission and conversion from AC to DC and vice-versa. Additional losses occur due to AC/DC and DC/DC conversion in home equipment. In the end, only 60W on average reaches the circuits which drive and control our home goods.

To address global warming and CO2 pollution, electricity can be generated with nearly no emissions when using renewable resources such as solar and wind power. However, integration of renewable energy sources creates additional challenges for existing grids. The main problems to overcome are:

- Energy generation varies strongly from day to night and according to weather conditions – causing high variations of the available energy in the grid;
- Production typically takes place far away from the places where energy is consumed, thus energy need to be transmitted over long distances;
- The overall paradigm of the electric grid shifts from a one-way energy flow (from big energy plants to users) to micro-grids integrating distributed energy generation sources (such as solar panels on roofs of houses).

To address the problem of fluctuations, new technologies need to be applied: energy storage, energy peak leveling and demand response infrastructure.

It is possible to reduce energy fluctuations by harboring excess power in batteries and storage power stations during peak production times. In times of low power generation, the stored energy is fed back into the grid. As all the energy storage process implies AC/DC and DC/AC conversion, efficient and highly innovative semiconductor solutions such as IGBT, CoolMOS and Silicon Carbide devices are needed to enable design of quasi-lossless converters with efficiencies exceeding 98%.

Energy grids must be sized to sustain peak consumption requests without incurring black outs. Outsize energy peaks happen seldom, but during such peaks up to 30% to 40% more energy needs to be delivered by the grid compared to normal operation.

In order to avoid energy peaks, the behavior of energy users must be influenced. Smart meters offer the potential to help control energy peaks and to balance the smart grid and micro grids. Two-way information flow via smart meters allows energy utilities to develop methods to work with consumers to control equipment use and decrease power consumption to prevent peaks (or in extreme cases disconnect the load). Utilities can also influence the behavior of consumers by dynamically changing tariffs.

Since energy needs to be transported over long distances, High Voltage DC transmission is an important tool to reduce transmission losses and to maximize the capacity of existing networks, DC current also makes it more practical to transport energy from offshore wind parks to in-land stations with minimized losses in submarine cables. In both cases very efficient and reliable power semiconductors utilized in the voltage conversion from AC to DC and vice-versa are key devices.

Grids need to be monitored in a constant and efficient way. Important information such as line load, temperature and humidity must be provided continuously from a vast number of nodes to a control station which manages the line and, in case of a failure, activates backup energy paths to prevent massive blackouts. Reliable sensing technology and communication is needed to allow effective grid monitoring.

The increasing need for distributed grid monitoring and control creates new problems in terms of cyber security. Smart Meters are cash counters which can decide to turn off energy to our homes. Privacy and protection against frauds and malicious attacks must be ensured. To make sure a proper security level can be implemented in any smart grid device and thus avoid any weak backdoor to the grid, Infineon integrates a sophisticated cryptography engine in all its smart meter ICs and provides certified hardware security modules dedicated to smart grid security– implementing the same security level used for credit cards and electronic passports.

Intelligence is an important ingredient to move from a traditional grid to a smart grid. But intelligence by itself is not enough. Efficient and reliable power semiconductors, security devices and sensors are

equally necessary and important. Infineon offers a broad range of MCUs and ICs allowing cost effective implementation of smart meters and grid communication and leading power semiconductors sized for any power application, from a few Watts to high Megawatts. Sensors and a complete portfolio of security devices complete our semiconductor solutions for smart grids.

Thanks to the smart grid, an important milestone can be realized: The energy we need to deliver 85W to a home can be reduced from 220W to less than 100W. Great! But this is still not enough. The next step is to make sure we consume energy in more efficiently, so that the needed load can shrink to 50W instead of 85W. This will automatically turn in an even higher saving in energy generation. There are a large number of initiatives with the aim of decreasing the average power consumed. Those are generally known as Smart Cities or Smart Homes. Efficient lighting, electro mobility, public transportation and security are the most relevant technologies enabling Smart Cities. This will be the next challenge and the next area of innovation where Infineon is committed to enable further power saving.

More information can be found at:

**www.infineon.com/smartgrid**

# Electronics Industry Digest

*By Aubrey Dunford, Europartners*

**GENERAL**

More than 12 million parts have been involved in counterfeit incidents during the period spanning the start of 2007 through April 2012, so IHS. Reported incidents of counterfeited parts amounted to 1,363 in 2011. However, each incident can include thousands of separate parts, adding up to 12 million over the past five-and-one-quarter years. This equates to slightly more than 1 counterfeit part every 15 seconds. Companies in two countries accounted for two-thirds of counterfeit incident reports in 2011: China was actually No. 2, while the United States was No. 1. The two countries were neck and neck, with China at 32 percent and the U.S. at 33 percent. For many companies, particularly those in the defence and aerospace industries, much of the counterfeit risk lies in obsolete parts.

**SEMICONDUCTORS**

The top 20 semiconductor suppliers showed a 4 percent decline in Q112 sales as compared to Q111, at $ 52.28 billion. This growth rate is 10 points less than IC Insights' full-year 2012/2011 worldwide semiconductor market growth forecast of 6 percent.

Sitelesc, the French semiconductor association, reports Q112 semiconductor sales in France were up 13.7 percent on a euro basis compared to Q411, and down 2.7 percent compared to Q111. Particularly, sales to the OEMs were sequentially up 11.5 percent in integrated circuits and down 9.1 percent in discretes, optoelectronics and sensors.

Intersil announced a restructuring plan that includes a reduction of approximately 11 percent of Intersil's worldwide workforce and a reduction of approximately $ 40 M in annual operating expenses. Intersil's net revenue for the first quarter of 2012 was $ 156.0 M, a 21.6 percent decrease from the first quarter of 2011, and a 5.9 percent decrease from the fourth quarter of 2011.

Zentrum Mikroelektronik Dresden (ZMDI), a semiconductor company focused on energy efficiency, is establishing an R&D design centre in Limerick, Ireland. The company will create 35 engineering positions for graduates and technicians over 5 years, with the support of government, through IDA Ireland. The R&D centre will focus on the development of products for the smart power management sector. Headquartered in Dresden, Germany, ZMDI has 280 employees worldwide.

Based on imec technology, the start-up EpiGaN has opened its new production site in Belgium for the volume production of their gallium nitride epitaxial material.

Gallium Nitride on Silicon (GaN-on-Si) is a key technology enabler for clean energy generation and more efficient power conversion. EpiGaN focuses on providing III-nitride epitaxial material solutions for key market segments such as power supplies for consumables, hybrid electric vehicles, solar inverters, RF power for base stations, smart grid... EpiGaN has been incorporated in 2010 and is currently offering GaN epitaxial layers deposited either on Si up to 150 mm or, for specific applications, on SiC. Wafer diameters of 200mm are under development.

**OPTOELECTRONICS**

Large-area (9"+) TFT LCD shipments fell by 3 percent Q/Q in Q112 to 170.2 million, reflecting adjustments in supply chain inventories, so NPD DisplaySearch. However, the report forecasts that shipments are expected to make a strong recovery in Q212 to 189.6 million, up 11 percent Q/Q and 4 percent Y/Y.

**PASSIVE COMPONENTS**

February sales for Germany's PCB industry was flat month-on-month, so the ZVEI. However, sales were down 6 percent compared with the same month last year. Incoming orders for the month, meanwhile, were 7 percent lower year-on-year. Book-to-bill ratio is at 0.95. In terms of workforce, the number of employees fell by 3.4 percent, attributed to weaker demand in some specialized areas.

**OTHER COMPONENTS**

Diversified industrial manufacturer Eaton and electrical equipment supplier Cooper Industries have entered into a definitive agreement under which Eaton will acquire Cooper in a total transaction equity value of approximately $ 11.8 billion.

**DISTRIBUTION**

EBV Elektronik, an Avnet company, was awarded "European Distributor of the Year 2011" by Atmel for highest growth in demand creation and revenue.

Easby Electronics has added ultracapacitors to its product portfolio, with its appointment as franchised distributor for the UK and Ireland by the Canadian company, Nesscap Energy, a manufacturer of ultracapacitors.

Digi-Key announced the launch of its new website for Israel. The Israel website can be viewed in both Hebrew and English. Customers placing orders using the Israel website may do so in the local currency, the Israeli Shekel (ILS). Digi-Key also announced the signing of a global distribution agreement and will now distribute Maxwell ultracapacitor products worldwide. Dig-Key has also signed a global distribution agreement with T-Global Technology, a supplier of advanced thermal management solutions. The distributor was also named TDK-EPC's Top Distributor for Fiscal Year 2012.

This is the comprehensive power related extract from the « Electronics Industry Digest », the successor of The Lennox Report. For a full subscription of the report contact:
eid@europartners.eu.com
or by fax 44/1494 563503.

**www.europartners.eu.com**

# POWER MADE SIMPLE, MADE SMALLER

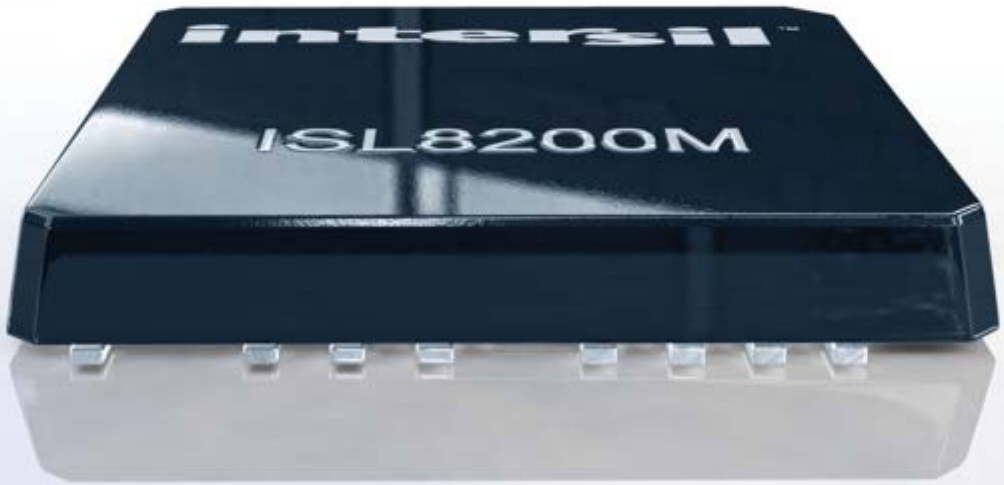
Let's face it – thin is in. Intersil's ISL8200M, the world's thinnest 10 Amp power module at just 2.2mm, is so thin it can be mounted on the backside of most PCBs. And our ZL9117M (17 Amp) and ZL9101M (12 Amp) are the industry's thinnest digital power modules at 3.5mm.

Whether you're looking for analog or digital power solutions, the only name you need to remember is Intersil. That's just one more way we've made your design job simpler.

intersil™

## Ultra thin. Yet fully loaded.

At just 2.2 mm, Intersil now has the world's thinnest 10 Amp power module. Go to intersil.com/powermodules for design resources for analog and digital power modules, including videos, samples, eval boards, software, drivers and gerber files.

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# The Time for Power & Energy Measurement is NOW

*By Jeff Shepard, President, Darnell Group*

Market developments are driving demand for power and energy measurement across a growing variety of applications. It began with the emerging smart grid and is now proliferating across numerous sectors. For example, starting next year tax rebates for reduced energy consumption in Germany will only be available to companies equipped with an energy management system that provides detailed reports of power consumption. According to a statement from the Fraunhofer Institute, "This won't be an easy task for the companies concerned, because it means they will have to install individual auxiliary meters to monitor the power consumption of individual loads such as presses and welding machines, or bakers' ovens, or electric motors."

Darnell Group' first-edition report, "Power and Energy Measurement: Worldwide Forecasts" provides power management IC and power converter makers with a roadmap for growth and value-added opportunities. Measuring real-time energy consumption, and adjusting power delivery at critical loads (as opposed to simple "on-off" functions), are becoming increasingly important in today's commercial, residential and industrial environments. The ability to "fine-tune" energy usage requires sophisticated power monitoring and measurement techniques.

Many companies and organizations are busy developing products and technologies to address this growing need. Recent announcements have come from the Fraunhofer Institute for Integrated Circuits IIS, Silicon Laboratories, Analog Devices, Maxim Integrated Products, Cirrus Logic, and others.

According to Fraunhofer, in many cases the metering instruments currently available on the market are too large to fit into existing power distribution cabinets. To remedy this situation, researchers at the Fraunhofer Institute for Integrated Circuits IIS in Erlangen have developed a novel, space-saving metering unit that can be simply clipped onto a power cable like a laundry peg, without even having to disconnect the load. The new "energy analyzer" was developed in collaboration with Rauschert GmbH – a manufacturer of advanced ceramic products that require energy-intensive production processes. The device is based on the HallinOne® 3-D magnetic field sensor originally developed by IIS for use in Bosch and Siemens branded washing machines, where it monitors the position and orientation of the rotating drum. "This new device is the first application in which we have used our 3-D magnetic-field sensor technology to measure the magnetic field generated by an electric current as a means of determining the energy consumed by the connected load. As such, it is an entirely novel approach," stated IIS research scientist Michael Hackner.

To build the device, he and his team of engineers mounted eight sensors, in the form of application-specific integrated circuits (ASICs), on a flexible, flat circuit board. What sets these sensors apart from more conventional designs is that they measure the magnetic field not only perpendicular to the surface of the chip but also in tangential directions, which improves measurement accuracy.

"Our power sensor is quick to install and can be integrated online," said Hackner, citing one of the advantages of the new product. He went on to emphasize another unique design feature, namely the fact that it functions in the same way as a Rogowski coil, a component incorporated in many standard instruments used to measure electrical currents. "But the Rogowski coil only measures alternating current, whereas the IIS sensor can also measure direct current – an important consideration when measuring the power consumption of photovoltaic systems that include solar inverters for converting DC output into AC power."

Silicon Laboratories Inc. introduced what it says is the industry's first isolated 10-bit analog-to-digital converter (ADC) products designed specifically for the demands of mains line monitoring. The new Si890x family combines Silicon Labs' patented CMOS-based digital isolation technology and its proven ADC technology to create a robust line voltage monitoring and protection solution for power management applications such as solar power inverters, switched-mode and uninterruptible power supplies, and industrial applications with sensors in high-voltage areas requiring isolated data acquisition. Silicon Labs engineered the Si890x isolated ADCs to meet the needs of the mains monitoring market in ways no other vendors have addressed. The Si890x family provides a much smaller and thinner footprint solution than transformer solutions. Since the Si890x devices integrate the ADC and isolation function, they can transmit power measurements through an isolated serial port for processing by the system controller. The Si890x family features 2.5 and 5 kV isolation ratings that meet critical safety requirements for high-voltage systems such as IEC 60950-1, 61010-1 and 60601-1 standards and UL, CSA and VDE certifications. The family's 5 kV rating enables the devices to be used in demanding industrial and medical applications and universal-powered systems with 120/220 Vac mains supplies.

Analog Devices recently introduced a single-chip energy measurement AFE (analog front end) that monitors the energy consumption and power quality of up to six electrical circuits. The ADE7816 energy measurement AFE is designed for data center power distribution units, energy monitoring and management systems, and multi-channel electricity meters. Able to measure one voltage and up to six current channels, the new AFE provides high-accuracy energy usage and power quality data for each circuit. Since it interfaces to standard microcontrollers, the ADE7816 energy measurement AFE is specifically suited for applications that require more processor flexibility and peripheral options than is offered by fixed-configuration SOC (system-on-chip) devices. Additionally, multiple ADE7816 energy measurement AFEs can interface with a single application processor resulting in scalable and cost-effective solutions.

In February of this year, Maxim introduced the 78M6631, a Teridian 3-phase power measurement system-on-chip (SoC) that embeds power monitoring into high-load applications. This fully self-contained and customizable energy measurement system offers a full range of measurement and diagnostics, and results in ease of design and reduced costs. The 78M6631 is suited for a wide variety of applications requiring 3-phase power and quality measurements, including industrial panels and motors, solar panel inverters, storage power supplies, and data centers.

The self-contained energy measurement system features an embedded metrology engine and includes a full range of embedded energy

diagnostics, including power factor, harmonic distortion, voltage sag, and dip. The 78M6631 also provides better than 0.5% system accuracy across a wide 2000:1 dynamic range. This enables the use of the lowest value shunt for the current sensor, thus reducing heat and parasitic power loss. The device's integrated flash provides application flexibility, on-chip calibration, and field upgrade capability. Furthermore, the 78M6631 is available with preloaded firmware that supports both Delta and Wye 3-phase applications, which reduces both development costs and time to market.

Featuring what the company describes as the highest energy measurement accuracy in the industry, Cirrus Logic states that its CS5484/80/90 family of analog front end (AFE) ICs gives designers of single and polyphase utility meters and smart energy products a superior combination of proven energy calculations, flexibility, performance and cost.

The CS548X/9X family is well suited for today's smart utility meter applications, as well as the growing market for new generations of smart energy products that provide consumers and enterprises with more precise information about their electricity consumption. By better understanding how much electricity their products are using, consumers can make more informed decisions about how, or when, to operate their products. Emerging applications such as smart meters, white goods, smart appliances, smart powerstrips/plugs, and energy efficient power supplies for enterprise applications (e.g., servers), are critical components to global Smart Grid initiatives designed to maximize efficiency of the electric grid.

Darnell's groundbreaking analysis has identified four markets that will benefit from advanced power and energy measurement functions: Embedded AC-DC Power Supplies, Power Distribution Units; Motor Drives; and Telecom Rectifiers. Embedded AC-DC power supplies are a strong unit market with healthy sales between 2012 and 2017 with annual growth rates above 30%/year and sales of hundreds of millions of units annually.

Digital power management is part of almost all energy management solutions, since "intelligent" data communication is an essential feature of these systems. Accuracy of data acquisition and power measurement is challenging from a number of perspectives, and its importance (and how precise it needs to be) determines, in part, the market penetration rates used to derive a forecast.

At the front end, digital controllers are being designed with an integrated power factor correction function to provide more accurate input power metering. At a broad level, so-called "energy management systems" are being implemented in a variety of facilities, but not all of these systems are "critical" or complex enough to require dynamic power measurement and control.

Advanced power and energy measurement is already providing opportunities for certain functions in certain power supplies in certain applications. For example, "Zero net energy" and "demand-response" smart meters are among the emerging applications that are driving the need for accurate power and energy measurement. This report highlights where these functions, power supplies and applications converge, and when they are likely to offer the greatest commercial prospects.

Details about "Power and Energy Measurement: Worldwide Forecasts" can be found at: www.Darnell.com/pwrmeas

Power and Energy Measurement will also be a featured topic at the 2012 edition of Darnell's Power Forum in San Jose, California, in September,

**http://dpf.darnell.com/**

# Intersolar Europe 2012: Facing the challenges with latest technologies

*2011 was a record year for the international solar industry, with the expansion of newly-installed photovoltaic capacity reaching a new high. With 18 billion kilowatt hours (kWh) of solar power generated during the year, 2011 saw photovoltaics overtake hydropower in the German energy production market for the first time. The increasing market share occupied by solar power highlights the opportunities of the technology for future energy supply. However, all the euphoria cannot hide the fact that the market is going through a consolidation phase.*

*By Marisa Robles Consée, Corresponding Editor, Bodo's Power Systems*

Even though 2011 was a record year, the global solar industry is focusing on its negative qualities. Primarily, a collapse in profitability in solar photovoltaic (PV) manufacturing led to companies restructuring, layoffs, plant closures, and even a number of bankruptcies. Big names like Solar Millennium, Solon, Spectrawatt, and Evergreen Solar were hit by the wave of bankruptcies in 2011, and were followed this year by SolarTec, SunConcept, Centrosolar, Pairan, Sovello and Q-Cells SE. The situation remains tense especially in Germany, where small and medium-sized enterprises dominate the market. Due to a sharp decline in orders, some thousand jobs were lost over the past few weeks. Furthermore, many solar companies suffer from a tense investment climate caused by worldwide overcapacities, massive competitive pressure and worsening production conditions. In this context, Mr. Carsten Körnig, general manager of BSW-Solar (German Solar Industry Association), addressed the federal government with a demand for supportive action: "The future of photovoltaics is in the hands of politics. Without quick corrections, the fate of hundreds of small and medium-sized solar companies is at stake".

Anyway, the market wasn't too good in the US either. Late in 2011, a vicious trade dispute sharply divided the US PV industry which also saw significant negative press, most notably the fabricated scandal of the Solyndra DOE loan guarantee.

**Sun drives energy transition**

However, all of this obscures the fact that global PV, concentrating solar power (CSP) and concentrating photovoltaic (CPV) industries continued to grow in 2011, at some times and in several regions dramatically. But perhaps more significant in the long run were a number of technological and political breakthroughs during the year which promise to pave the way for the future growth of these industries, and the greater transformation of our global industry infrastructure. In the long view, 2011 may be seen as a much better year than we might think.

In 2011, solar plants with a total capacity of at least 26.5 gigawatts (GW) were installed across the globe. In Germany alone, around 7.5 GW of new photovoltaic capacity was added, exceeding even the previous record year of 2010. This takes the total capacity installed in Germany to 24 GW. With 18 billion kilowatt hours (kWh) of solar power produced during the year, 2011 saw photovoltaics conquer a larger share of the German energy production market than


*Hustle and Bustle during the Intersolar Europe*
*Picture: Solar Promotion*

hydropower for the first time – and this share is set to grow further. According to estimates from BSW-Solar in Berlin, solar power production will see a further 70% rise in the next four years. This would mean that by 2016 7% of the German energy mix will be supplied by PV systems. In order to take full advantage of this capacity in future, the industry needs to address grid stability, intelligent solutions for on-site consumption and efficient, economical storage as a matter of priority.

**Innovative solutions for future energy supply**

As the demands on infrastructure increase, the industry gains new potential for value creation. Only recently, with the latest amendments to the Renewable Energy Sources Act (EEG), the route was paved for improving the grid integration of photovoltaics. The new Low Voltage Directive has come into effect on January 1, 2012. Inverter manufacturers played a significant role in developing both this directive and corresponding solutions that have integrated mechanisms for controlling effective power. Thanks to the new standard, it will be possible to install significantly higher numbers of PV plants in future and integrate them into the low voltage grid. Even the on-site consumption of solar power and new storage technologies may, in future, also play their part in easing the burden on the grid and boosting photovoltaics' contribution to energy supply.

There is also potential for small, efficient, distributed battery storage systems to assist in optimizing on-site consumption in residential homes. And for industry and commerce, which have highly consump-

tion-dependent electricity costs mainly throughout the day, it is possible that intelligent all-in-one solutions using efficient storage technologies could allow for substantial cost savings. The options for doing so are many and varied, as almost all types of storage open up enormous potential for lowering costs, which in turn makes the use of energy storage systems increasingly attractive. Current battery technologies, for example, require an investment of at least 15 euro cents per kWh of stored energy that the installation is intended to generate. Over the next five to ten years, as the mass production of these technologies increases, it is expected that costs will drop to a level of around seven to ten euro cents per kWh.

**Intersolar Europe 2012 depicts the industry**

The Intersolar Europe 2012 trade show that took place in Munich from June 13 to 15, 2012 cleary represented the market. On 170,000 square meters of exhibition space in 15 halls and an outdoor exhibition area, 1909 exhibitors showed their inventions – a small decline compared to 2011, when 2286 companies demonstrated products and solutions. Markus Elsässer, director of Solar Promotion GmbH (organizer of the Intersolar Europe), reasons that “the industry is going through a consolidation phase, characterized by overcapacity and a lack of reliability concerning political decisions”. This political laxness reduces planning reliability. He nevertheless remains optimistic – even the slightly lower number of exhibitors signifies the second best result in the 20 year long history of the show. Mr. Elsässer emphasized that the solar crisis was not a German crisis but happened worldwide. This year, 54% of exhibitors at Intersolar Europe came from abroad – from a total of 49 countries. Germany is home to 871 (2011: 988) of the exhibitors, followed by China with 388 (2011: 523), Italy (2011: 106) with 78, Spain with 48 (2011: 72), and Taiwan (2011: 67) and Austria (2011: 50) with 46 companies each.

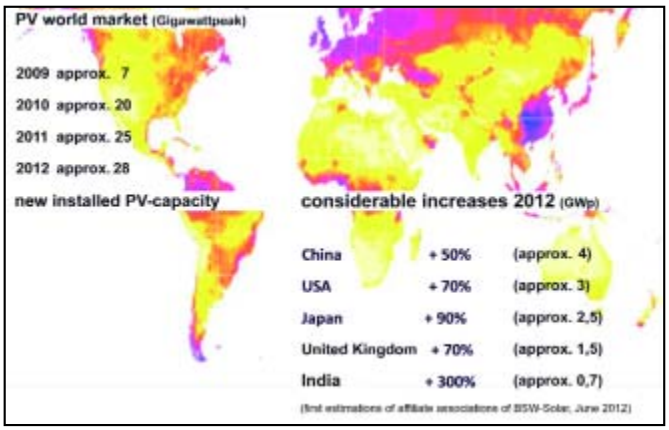
About 66000 visitors from 160 countries filled the showfloor in those three days. Around 40% of the visitors came from outside Germany. The Intersolar Europe Conference took place in parallel from June 11 to 14, 2012 and boasted approximately 400 speakers. About 2,000 attendees took part in the conference and its side events. The main focus lied on “Stability of power grids” as well as “new storage technologies and “large PV plants”. The area of solar heating brought the topics “process temperature”, “solar cooling” and “solar heating concepts”. Another important topic this year was the international market situation and its development which was dealt with in different sessions.

The special exhibit “PV and e-mobility” caused a lot of interest. Thousands of visitors crowded around the combinations of PV carports, charging stations and modern electric cars presented on the open-air exhibition ground of Messe München. With 11 partners the trade fair demonstrated state-of-the-art technology and delivered hands-on experience with the future of electric mobility. The program was completed by test drives with different vehicles, from e-bikes to roadsters.

Electric vehicles play an important role in our future energy supply, thanks to their batteries storing electricity which in turn stabilizes the grid. Intelligent control technology charges the batteries when sufficient cheap power is available. At peak times, when electricity demand is high among grid users, the stored power can be used as a short-term backup. As private vehicles spend 90% of their time parked and not in use, this opens up enormous potential to compensate for peaks in demand. These intelligent systems are the most effective and sustainable when the vehicles are “filled” with solar power from, for example, the energy produced by the user’s own roof-mounted PV installation or carport. In addition to protecting cars

*Electric vehicles like the Renault Z.E. Twizy play an important role in our future energy supply*
*Picture: Marisa Robles Consée*

from rain and snow, PV carports are also able to deliver the energy needed for e-vehicles. Part of the solar power is used to charge the vehicle battery, while the rest is consumed for a different purpose or fed into the grid. Special charging stations for PV carports synchronize the charging times of the electric vehicles with electricity generated by the photovoltaic installation. An installation with a capacity of three kilowatts (kW) can supply enough power for a vehicle to travel around 15,000 km per year. The combination makes sense because electric vehicles have significantly greater levels of efficiency than vehicles with combustion engines, and generating power from renewable sources is much more efficient than producing biofuel. On the other hand, the fluctuating ‘renewables’ need storage facilities like this.




*The worldwide PV market as seen by the German Solar Industry Association BSW Solar: There is still a huge potential of growth.*
*Source: BSW Solar*

Researchers at the Fraunhofer Institute for Solar Energy Systems ISE have developed a three-phase charger with 97% efficiency and high power density to be used in charging stations and in vehicles. With a rated power of 22 kW, the charger is able to load a typical electric vehicle battery to 80% in 45 minutes. Through the use of novel silicon carbide transistors (SiC JFETs), which are characterised by low conduction losses and good switching performance, the Freiburg researchers achieved a maximum efficiency of over 97%. Special semiconductor modules and gate driver circuits were developed and optimised specifically for the charger. The new semiconductor technology allows for a switching frequency of 80 kHz. This significantly reduces the size of the filters on the side of the grid and battery which enabled a power density of 2.8 kW/l for the complete

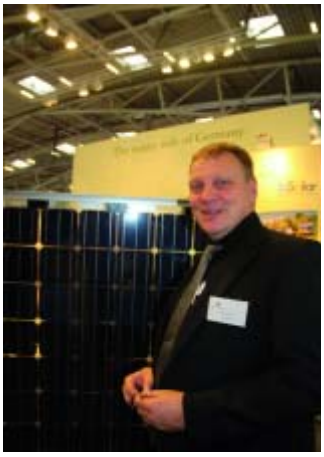
converter. This extremely compact charger, including of all filter chokes and heat sink, measures just 340 x 230 x 100 mm³. By comparison, commercially available chargers for electric vehicles achieve efficiencies of around 90%, are usually single phase, have a maximum power of only 3.3 kW and a power density in the range of 0.5 kW/l. The charger is a two stage converter. The first stage converts the three phase grid voltage of 400 VAC into a DC voltage. A DC/DC converter is used as the second stage in order to adjust for the varying battery voltage of 300 to 500 VDC. To save weight, volume and cost while increasing the efficiency, a transformerless circuit topology with extra electrical safety measures, was used. The charger is bidirectional and is thus not only able to take energy from the grid for charging, but also to feed the energy stored in the battery back into the grid.

**Raising efficiency**

Unfortunately, efficiency decreases on the way from solar cell to PV module. The increase of unused surface area together with glass reflexions and absorption in the covering layers cause optical losses. Additionally, serial resistors in the cell and string connectors are responsible for electrical losses. Gains from encapsulation effects can't compensate for these losses, so the module efficiency typically is 10 to 15% lower than cell efficiency. Of all the commercially available PV technologies, copper indium gallium diselenide (CIGS or CIS) PV technology stands out in 2011 for advances in efficiencies, manufacturing capacities, and market adoption.

The race for higher efficiency factors continues to drive PV technology. bSolar claims that the bifacial, PV crystalline silicon solar cells, which use both the front and rear sides to collect sunlight, provide 10 to 30% more kWh per kW in standard applications and 50% in vertical installations. The company estimates that this provides an equivalent cell efficiency of 21% to 24% in standard applications, translating to a total module power of 280 to 325 watts for a 60-cell module. "We

*The bifacial PV crystalline silicon solar cells of bSolar (right) use both the front and rear sides to collect sunlight*
*Picture: Marisa Robles Consée*



*Friedhelm Klee from bSolar in front of the rear side of the bifacial PV crystalline silicon solar cells*
*Picture: Marisa Robles Consée*

are excited to introduce our disruptive bifacial cells, which will significantly improve the financial returns of solar projects," commented Friedhelm Klee, Managing Director of bSolar Germany. bSolar states that its PV cells have already been incorporated into bifacial modules by several module manufacturers. Applications for modules incorporating the new cell design include both flat roofs and ground installations, as well as building-integrated photovoltaic (BIPV) designs such as sound barriers, carports and facades. The company can produce 30 MW of PV cells annually at its plant in Heilbronn, Germany, and bSolar states that it is planning on expanding production "rapidly". bSolar is on track with a four-year target of reaching a bifacial cell production capacity of 500 MWp/year worldwide.

# Pre-Applied Thermal Interface Material (TIM)

## The Infineon-qualified solution

With the ongoing increase of power densities in power electronics the thermal interface between power module and heatsink becomes a larger challenge. A thermal interface material, especially developed for and pre-applied to Infineon's modules outperforms the general purpose materials available.

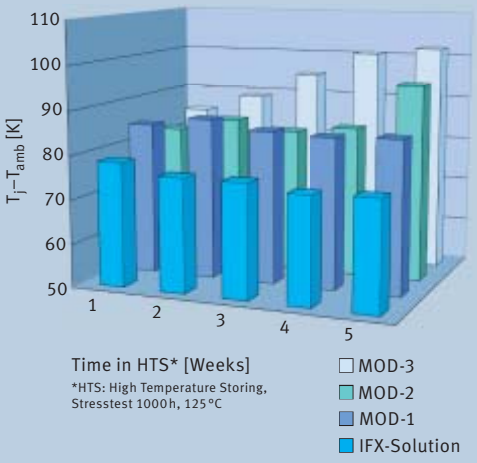
TIM does not only provide the lowest thermal resistance, it also fulfills the highest quality standards given for power modules to achieve the longest lifetime and highest system reliability.

**Main Features**

- Best in class thermal resistance
- Pre-applied to Infineon Modules
- Dry to the touch
- Optimized for dedicated Infineon Modules

**Benefits**

- Reduced process time in manufacturing
- Simplified mounting
- Increased system reliability
- Increased system lifetime
- Optimized thermal management
- Improved handling in case of maintenance




www.infineon.com/tim

# Current Transducers with Advanced ASIC Technology

## *Intelligent and Interactive functions implemented in an Open Loop Current Transducer*

*This article describes a new Open Loop Hall effect based current transducer series in which a new generation of ASICs contributes to fast response time, low temperature drifts and extra Over Current Detection functionality.*

*By Yo Makita, Ph. D, D&E Manager, LEM Japan and*
*Stéphane Rollier, Product & MarCom manager, LEM International SA*

Any logistic's manager will appreciate the value of a single stock item that covers two or more part numbers: in the case of a current transducer, having one type that can cover several current ranges, offer various response times, and provide several choices for the internal reference voltage, all configurable by the engineering team. Achieving that flexibility has been the key motivation for LEM engineers in their most recent development.

Particular objectives for the new transducer series were to meet industry trends in power electronics for optimization of cost and reduction of size, together with performance improvement. Special effort has been focused on a new Application Specific Integrated Circuit (ASIC) to help achieve these goals, resulting in a new generation of ASIC specific to current transducers based on the Open Loop Hall effect technology. This technology was combined with a new mechanical design, leading to the development of the new HO current transducers series.

The HO series provides nominal current measurement in the range $8A_{RMS}$ up to $25A_{RMS}$, with additional features such as over current detection (OCD) and a completely new level of programmability in parameters such as gain, response time, reference voltage level and OCD threshold.

**Working Principle**

Open-loop transducers use the simplest implementation of the Hall-effect. They provide the smallest, lightest and the most cost-effective current measurement solution whilst also having very low power consumption. A current flowing in a conductor creates a magnetic field around the conductor. This field is concentrated by a magnetic core. The core has a gap cut through it and a Hall cell is used to sense the magnetic flux density in the gap.

*Figure 1a: Open-Loop Hall-effect based current transducer, HO series, using LEM's new generation ASIC, HO xx-NP & -NPPR (Through-hole mounting)*

*Figure 1b: Open-Loop Hall-effect based current transducer, HO series, using LEM's new generation ASIC, HO xx-NSM & -NSMPR (SMD mounting)*

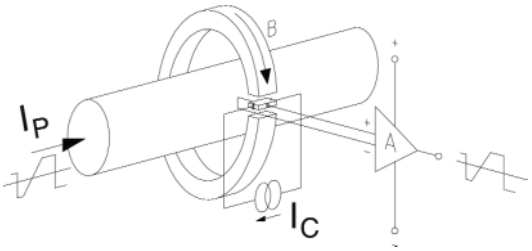



*Figure 2: Working principle of the Open loop Hall effect based current transducer*

The output from the Hall device is then signal conditioned so that the transducer output is an exact representation of the primary current.

**LEM's intelligent and interactive new Open-Loop Hall-effect transducer, HO series, based on new generation of ASIC**

In many areas of electronics technology, where there is a market demand for size and cost reduction, along with accuracy and reliability improvement, the answer is integration, and when no off-the-shelf integrated circuits exist that meet the specification, a custom-designed Application-Specific Integrated Circuit (ASICs) must be created, to replace all the discrete circuitry in a transducer with an "all in one" chip solution [1]. While the impact of an ASIC in terms of size reduction may be obvious, the challenge is to make the best use of an ASIC's capabilities to improve accuracy.

LEM has developed a new generation ASIC specifically for Open-Loop Hall-Effect Technology [2]. Target performance gains of at least 2x improvement in critical parameters, over the previous generation, were set, and those targets were achieved. At the same

# Fuji's Chip Technology

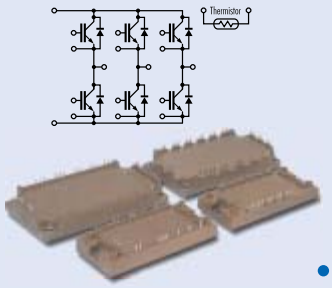
## The Independent Way

## V-Series IGBTs

- Trench-FS IGBT
- High thermal cycling capability
- Low spike voltage & oscillation free
- Excellent turn-on $dI_C/dt$ control by $R_G$

# Econo IGBTs

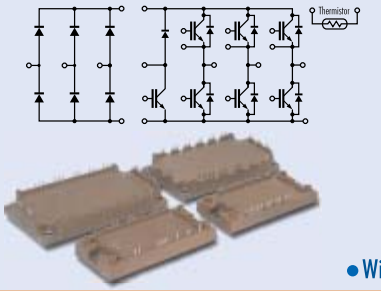
## The 6-PACKs




| Package | $I_C$ | 600V | 1200V | 1700V |
|---|---|---|---|---|
| 45x107.5 mm | 50A | ● ■ | ● ■ | |
| | 75A | ● ■ | ● ■ | |
| | 100A | ● ■ | ● ■ | |
| 62 x 122 mm | 100A | | ● ■ | ● |
| | 150A | ● ■ | ● ■ | ● |
| | 180A | | ● ■ | |
| | 200A | | ● ■ | |

● With solder pins ■ With PressFit contacts

## The PIMs




| Package | $I_C$ | 600V | 1200V |
|---|---|---|---|
| 45x107.5 mm | 25A | | ● ■ |
| | 35A | | ● ■ |
| | 50A | ● ■ | ● ■ |
| | 75A | ● ■ | |
| | 100A | ● ■ | |
| 62 x 122 mm | 50A | | ● ■ |
| | 75A | ● | ● ■ |
| | 100A | ● ■ | ● ■ |
| | 150A | ● ■ | ● ■ |

● With solder pins ■ With PressFit contacts

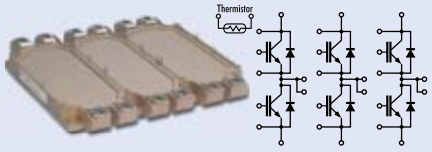
## The 2-PACKs


● With Solder Pins

● With Spring Contacts

| Package | $I_C$ | 1200V | 1700V |
|---|---|---|---|
| 62 x150 mm | 225A | ● ● | |
| | 300A | ● ● | ● |
| | 450A | ● ● | ● |
| | 550A | | ● ● |
| | 600A | ● ● | |

## The High Power 6-PACKs




| Package | $I_C$ | 1200V | 1700V |
|---|---|---|---|
| 150 x 162 mm | 225A | ● | |
| | 300A | ● | ● |
| | 450A | ● | ● |
| | 550A | ● | |

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time new levels of programmability, and new functions such as an Over Current Detection (OCD) output, have been added: the final circuit configuration can be chosen at any time in the process, up to and including by the end user in the final application.

A die photograph of LEM's new generation ASIC "HG2" is shown in Figure 3: the eight Hall cells are placed in an optimized symmetrical arrangement, which can be seen at the centre of the die, in order to achieve the required improvements in measurement performance.

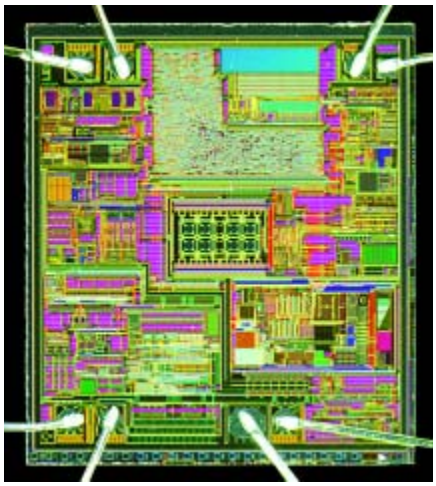


*Figure3: New ASIC die, a complete Open Loop Hall effect current transducer on a single chip*

**HO series**

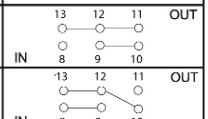
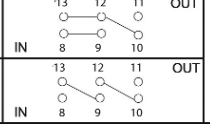
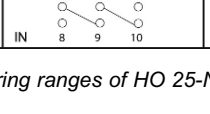
With this ASIC at its heart, a new model, the HO series, of Open-Loop Hall-effect current transducer has been developed. The device is designed for current measurements from 2.67 $A_{RMS}$ to 25 $A_{RMS}$ nominal, with nine possible current ranges selectable either by digital programmability or by multi-range PCB configuration.

**Their main benefits are the following:**

- Three programmable current ranges: 8 $A_{RMS}$, 15 $A_{RMS}$, 25 $A_{RMS}$ (25 $A_{RMS}$ set by default),
- A broad range of programmable functions (including Low power mode, Standby mode, and EEPROM control),
- Single + 3.3V or + 5V power supply (in two different HO versions),
- Offset and gain drifts a factor of two better than the previous generation,
- Programmable over-current detection function provided on a dedicated pin (up to 5x $I_{PN}$, the nominal primary current),
- Programmable slow or quick response time (2 to 6 µs) by choosing specific output filters.
- Four programmable internal reference voltages: 2.5 / 1.65 / 1.5 / 0.5V,
- External access to voltage reference,
- Measuring range up to 2.5 x $I_{PN}$,
- -40 to +115°C operating temperature range,
- High accuracy at +25°C: 1% of $I_{PN}$ and at +85°C: 2.8% of $I_{PN}$,
- Creepage & clearance distances: 8 mm + CTI 600,
- Small device outline: 12 (W) x 23 (L) x 12 (H)mm,
- Through-hole and SMT packages.

The new ASIC has memory locations that determine three predefined sensitivities which can be selected at any time. Also, in the HO series, primary current is carried on three bus bars which can be connected either in parallel or in series to cover three nominal measuring ranges. The combination of these options gives nine possible measuring current ranges from a single product. Table 1 shows the possible measuring ranges for the HO 25-NPPR with the various primary bus bar configurations.

This high degree of **programmability and flexibility** of the HO series means that designers can use a single part in a wide range of circuit configurations, simplifying designs and reducing parts stock holdings. Logistics need only handle one part number instead of nine unique types; the EEPROM memory used in the ASIC can be re-written as many times as required.

| Number of primary turns | Primary current | | | Recommended connections |
|---|---|---|---|---|
| | Range 1 $I_{PN}$ = 8 [A] | Range 2 $I_{PN}$ = 15 [A] | Range 3 $I_{PN}$ = 25 [A] | |
| 1 | 8 A | 15 A | 25 A |  |
| 2 | 4 A | 7.5 A | 12.5 A |  |
| 3 | 2.67 A | 5 A | 8.33 A |  |

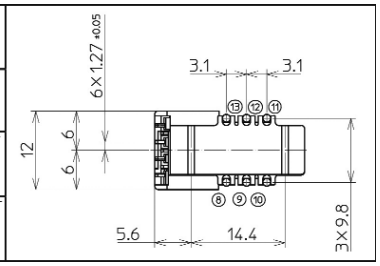



*Table 1: possible nominal measuring ranges of HO 25-NPPR with the various primary bus bars configurations*

Temperature drift, in terms of both offset and gain drifts, have been improved by a factor of over two in comparison with the performance of a transducer built with a previous-generation ASIC. Over a temperature rise of 50°C, the offset drift reaches a maximum of 0.5% of the nominal value. The gain drift, defined as a percentage of the measurement value, reaches 1.0% in the worst case. These are excellent values for Open-Loop Hall-effect current transducers.

To achieve this accuracy level, once again the ASIC is fundamental to the performance of the HO series. The ASICs are individually tested at cold and hot extremes before a final test at ambient temperature: this allows drifts of gain and offset to be measured, and a correction factor to be stored in the chip's EEPROM. In operation, this data is combined with the output of an on-chip temperature-measurement function; digital to analogue converters generate precise analogue corrections for the gain and offset drifts that are unavoidable in a standard silicon process.

Another parameter that is user-configurable in the HO series is the response time in reaction to an incoming transient with high di/dt (A/µs). The user can set this value to between 2 µs and 6 µs, corresponding to different frequency responses of an internal noise filter. A filter value of 600 kHz corresponds to less than 2 µs, 250 kHz to under 3.5 µs, and 100 kHz to under 6µs.

A new feature of the ASIC is the **Over Current Detection (OCD) function**. An over-current event is signaled on a dedicated pin, and the OCD threshold level can be set by the user over 16 programmable levels up to 5.2 x $I_{PN}$. The OCD output turns on within 2 µs when programmed overcurrent occurs, switching from a high (5V) to a low level (0 V). The overcurrent detection threshold is detected with 10 % accuracy; the user can set a minimum duration of the OCD output pulse of 1 ms if required, to ensure that a short overload can still be detected by an external micro-controller. The waveforms of OCD output, $V_{out}$ of the transducer and primary current are shown in Figure 4.

The over-current detection is separate from the main current measurement. Using a single measurement range (for both detection and measuring functions), if the transducer is called on to detect an over-current condition at (say) five times the nominal full-scale value, the measurement range must extend up to the over-current limit: this effectively reduces the available accuracy within the nominal range. Separate over-current detection, with programmable threshold, ensures maximum resolution is maintained up to the nominal full-scale value.

The HO series delivers its output as a scaled analogue voltage; in most systems this will be converted to a digital value by an analogue/digital converter (ADC) which requires a reference voltage. The designer can program the LEM HO-series transducer to output a reference of 0.5, 1.5, 1.65 or 2.5V on a dedicated pin: these levels are suitable for 3.3V A/D converters. Alternatively, the HO-series can be configured to make measurements relative to an external reference between 0.5 and 2.65V.

Using an external reference voltage at 0.5 V provides the option of a higher range when unidirectional measurement is employed. In that mode of operation, only one of the two measuring spans (negative or positive) is used and the second one is available to expand the first.

Another programmable parameter for the user, is the possibility to switch off the internal reference completely, to reduce the $V_{REF}$ power consumption when an external reference voltage is used, decreasing the total transducer consumption, as shown in Figure 5.

Other programmable functions provide the option to activate or deactivate the standby mode (for low power consumption if the application is also in standby mode), and to access the ASIC's EEPROM, to verify if the contents of the EEPROM have been correctly loaded during the programming procedure.

Users program the HO through a connection to a host microcontroller: if the VREF pin of the HO transducer is forced to the supply voltage, the output pin becomes the I/O port of a single wire bus interface. Over this interface, serial data comprising a 12-bit word signals the user's configuration choices, such as among others range selection, the internal reference voltage, and the over-current threshold. Data is sent over this interface to the transducer at 10 kbits/s, and programming takes a few hundred milliseconds. This programming procedure may be carried out at any time, so the operating parameters of the HO transducer may be re-assigned, even during operation of the device in its application.

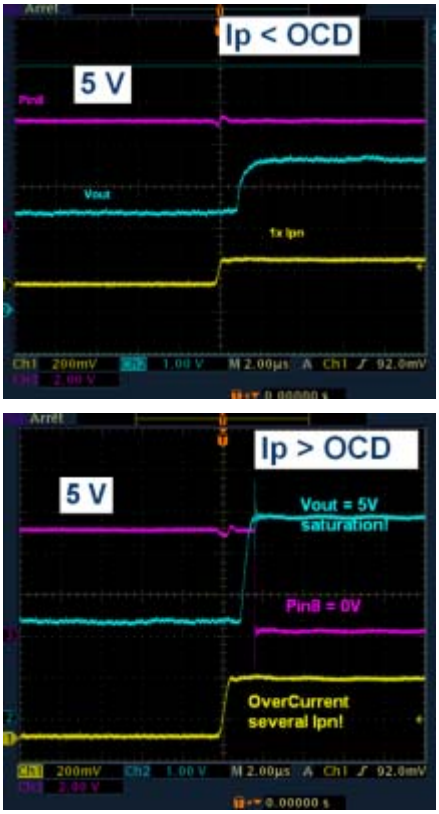



*Figure 4: OCD function*

Table 2 shows the key parameters of HO 25-NPPR/-NSMPR. As shown in Figure 1, the transducers are available on both through-hole and SMT packages.

The HO series of current transducers therefore set a new standard of performance, programmability and ease-of-use for designers of the latest generation of motor drives and inverters. Several parameters and functions are user-programmable by a simple serial digital bit-sequence, generated by the system's host microcontroller. Improving the offset and gain drifts by a factor two, the HO current transducer achieves a typical accuracy of 1% and 2.8%, at +25°C and +85°C, respectively, without offset, and with a high level of insulation between primary and measurement circuits (8 mm creepage and clearance distances + CTI 600), bringing the device very much closer to the performance of a traditional Closed Loop Hall effect current transducer, but at a lower price.

It operates from a single supply voltage at 3.3 or 5V, is lightweight (5g) and occupies a very small area on the PCB (12 mm wide x 23 mm long x 12 mm high). Its extended operating temperature range from -40°C up to +115°C brings many new opportunities in industrial applications, as well as in home appliances, solar inverters (MPPT) together with servo drives, variable speed drives, UPS, SMPS, Forklift trucks, air-conditioners, current monitoring and welding applications, all of which will benefit from improved efficiency in operation.

Thanks to the new programmability feature enabling the user to configure exactly the transducer he needs in both performance and functionality from only one product, the HO provides a cost benefit to the user who is then managing many fewer references in stock. In addition to cost saving, this also a gives a high level of flexibility to the user for the availability of the product.

| | | | |
|---|---|---|---|
| Programmable Rating $I_{PN}$ (ARMS) | 8 or 15 or 25 | Accuracy @ +25°C (% of $I_{PN}$) | 1 |
| Measuring range $I_{PM}$ (A) | +/- 2.5x$I_{PN}$ | Accuracy @ +115°C (% of $I_{PN}$) | 3.7 |
| Linearity (% of $I_{PN}$) | 0.5 | Programmable internal Reference VRef OUT (V) | 0.5 / 1.5 / 1.65 / 2.5 |
| Supply Voltage (VDC) | +3.3 or +5 +/- 10% | Frequency Bandwidth (kHz) (3 dB) | DC..100 to 600 |
| Analogue Voltage Output (V) @ $I_{PN}$ | 0.8 | Offset drift (mV/K) | +/-0.075 |
| Programmable Response time @ 90 % of $I_{PN}$ tr (us) | 2 - 3.5 - 6 | Gain drift (ppm/K) | +/- 200 |

*Table 2: Key parameters of HO 25-NPPR/-NSMPR models*

For users who require transducers already programmed to a single set of operating parameters, LEM can also offer models with performance and function already set at the factory.

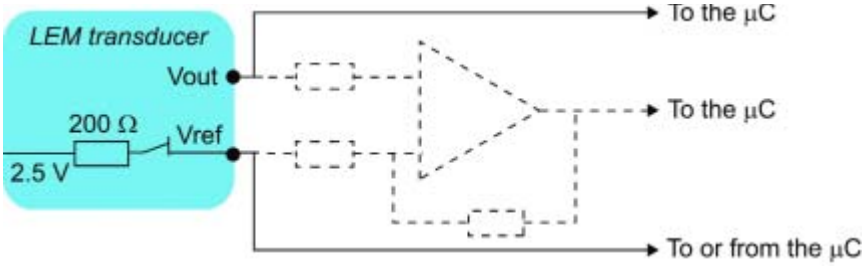



*Figure 5: Connection of the HO output and reference with power electronics. Switch on or off of the internal voltage reference by programming to reduce the $V_{REF}$ consumption*

**References**

[1] S. Rolllier , "Current Transducers with ASIC Technology", Power Systems Design Europe – December 2004

[2] D. Jobling, "Advances in ASICs for Open Loop Hall-Effect Based Current Transducers", Bodo's Power Systems®, May 2012.

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# Stacked Substrates for High Voltage Applications

## *Solving the problem of high electric fields at sharp corners by multilayer structures*

*Modules with a blocking voltage above 1700V are based on Si3N4 or AlN substrates. Special effort is required to manage the high electric fields that occur at the sharp edges of the metal layers on both sides of these ceramic layers. Simulations show that stacking substrates can significantly reduce the peak electric fields that are generated. This allows cheaper isolation solutions by replacing above materials by Al2O3.*

*By O. Hohlfeld, R. Bayerer, Th. Hunger, H. Hartung, Th. Schütze, Infineon*

**Prevention of flashover and partial discharge**

In high voltage modules sharp edges of substrates result in high field strengths that require special consideration such as the use of high performance potting materials. Insulation defects in combination with high electric field strength may lead to flashovers or partial discharge. The probability of such events can be minimized by a suitable substrate design. Target is to minimize peaks of the electric field and to create a homogeneous field distribution.

The same requirement can be found for chip designs. Guard ring structures or field plate designs are common measures to spread the field. Field plates have also been proposed for module design. Since these structures require a lot of space they are not used in today's modules. In older diode and thyristor disk designs, the field is stretched and homogenized by a vertical design. With respect to this construction the idea was born to get a similar effect by stacking a number of thin substrates on top of each other.

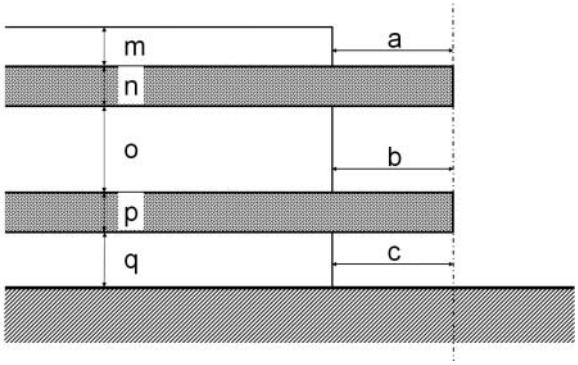


*Figure 1: Schematic of the simulated stack with ceramics in grey and white metal layers. The variables show measures that have been investigated due to influence to the electric field.*

**Simulations**

To find an appropriate structure, the number of ceramic layers was varied between one and three. The schematic of Figure 1 shows the investigated stacks. The distance of metallization to the ceramic rims a, b and c was varied from 0.25 to 1 mm. The uniformity of this distance was also investigated using a uniform and pyramid shape as well as a recess in the middle. The total ceramic thickness (sum of n and p) and the metallization thickness m, o and q were modified too (0.3 & 0.6 mm).

The comparability of the finite element simulations with ANSYS was obtained using a special structure technique illustrated in Figure 2. The first step was to investigate the complete stack, using coarse mash neglecting details like rounding's at sharp edges. Using fine meshing and potential from coarse model as boundary we calculated the field at the edges. The local mesh size in the fine model was chosen in a way that the element lengths are significantly smaller than the smallest radius modeled. Care was taken to use the same mesh for all structures in regions of highest field strength. These detailed model areas are highlighted in red.

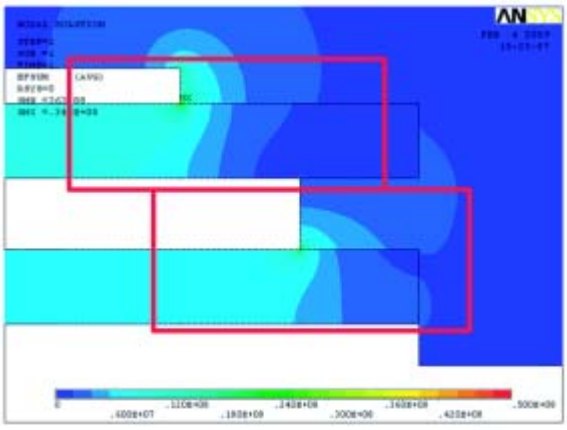

*Figure 2: Electric field strength [V/m] of a stack with two substrates. The red highlighted areas were investigated again with a fine mesh.*

**Results**

The effect of stacking is presented in Figure 3. The voltage distribution of a single Si3N4 substrate is compared with that of a two substrate layer stack. From the spacing of the equipotential lines one can clearly see that the electric field in potting and ceramics is significantly reduced in the stack assembly.

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Highest field strengths are found at edges of the metallization. The maximum field strength is located at the edges between ceramic top sides and metallization. One can see the much higher electric field strength at the upper edge of the single substrate compared to that of the stack. In this assembly the potential of the metal layer between both ceramics can float nearly symmetric. The field maximum is nearly devided by the factor of two compared to the single substrate. A comparison of the maximum electric field strength at upper ceramic of different stack designs is given in Figure 4.

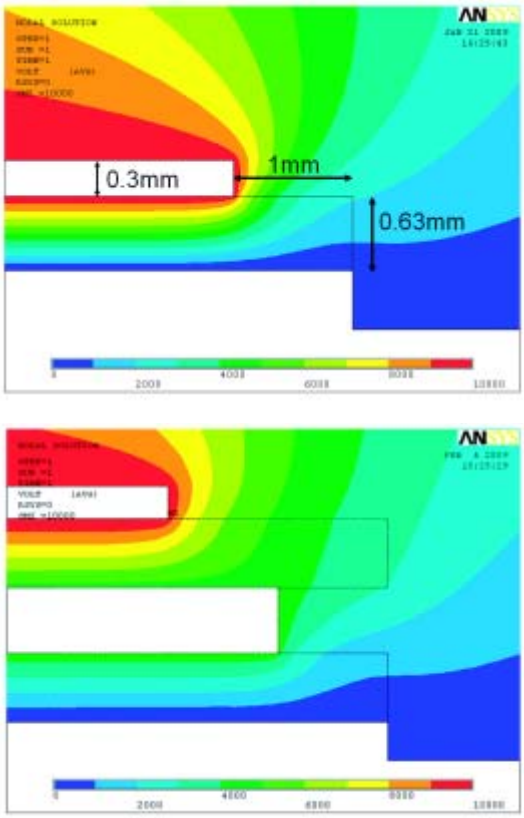


*Figure 3: Electric potential [V] at an applied voltage of 10kV on a single 0.63mm Si3N4 substrate (a) and two 0.63mm Si3N4 substrates (b).*

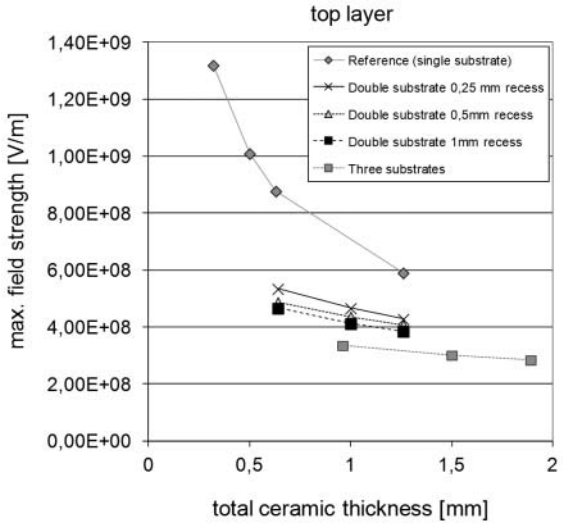


*Figure 4: Maximum electric field strength at the edge of top ceramic and top metallization as a function of total ceramic thickness, number of ceramic layers and recess of the metallization.*

The upper curve is the max. field strength of a single substrate. Below one can find the results of various stack designs. As assumed the maximum field strength is reduced remarkably. Looking at a total substrate thickness of 0.63mm it is nearly divided by half at the top edge. At the edge of the lower ceramic and the related metallization it is still reduced by around 30%. The distance of metallization to the ceramic rim has a remarkable influence on the electric field but the effect is much smaller than stacking. The strongest effect can be found in this simulation with a recess of 1 mm. As this effect is based on the homogenization of the field it is assumed to improve further with an increased recess or increase of the metal layer thickness.

The lowest curves represent the effect of using a third ceramic layer. Theoretically the field strength should be divided nearly equally between the three ceramics. The simulation shows that the additional effect of the third layer is small. At the top edge it is below 15% and in the middle and low layer it is nearly insignificant. The same effect can be reached by increasing the metal recess in a two ceramic layer stack.

The reason for this effect is the influence of the base plate. The potential distribution in a two layer stack is not really homogeneous and results in higher field strength in the bottom ceramic. In a module without base plate there is no overlapping metal and the field distribution will be more homogeneous. However the metal of a cooler will act similar as a base plate. Therefore a stack without base plate will finally not deliver a better effect.

The simulations show that a three ceramic layer stack has just a limited benefit compared to the two layer version. Experiments were undertaken only with two layer stacks. The stacks can be joint by soldering, sintering or by direct bonding (DBC). An influence of the joint on the electric properties could not be found.

**Measurement of partial discharge**

The electric field strength of different assemblies can easily be compared measuring the partial discharge. In Figure 5 the PD inception voltage of various single ceramic assemblies are compared to a stack made of two 0.32mm Al2O3 ceramics.

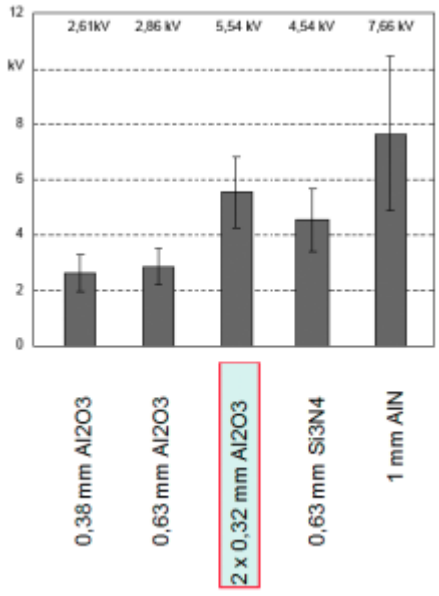


*Figure 5: Partial discharge inception voltages of various assemblies at a partial discharge level of 10pC*

The samples were tested in an isolation fluid with a MPS equipment. The applied voltage was increased by 1kV/sec and the inception voltage was defined by a PD level of 10pC.

The inception voltage of a stack is nearly two times higher than that of a single Al2O3 ceramic with the same total thickness. Even the inception voltage of a Si3N4 ceramic is 1kV lower than that of the Al2O3 stack with the same total thickness. This is an effect of the homogenized electric fields.

Due to the high inception voltage it is possible to realize 4.5kV modules with an Al2O3 assembly which is impossible with today's single layer substrates.

In a phase resolved partial discharge chart of the Al2O3 stack the PD events happen around 270°. This gives a hint on the PD mechanism. It indicates a coronary discharge normally caused by metallic edges at the border between potting material and ceramic layer. In a following insulation measurement a flashover occurred at 15kV from metallization edge through the potting material. The ceramic did not show any alteration. Even at this high voltage the Al2O3 stack with 0.32mm thick ceramic layers was not the limiting factor but the potting material or irregularities in the joint between potting material and ceramic like delaminations or voids in combination with high electric fields at sharp metallic edges. It should be mentioned that voids were not visible even under a microscope.

The investigations were repeated with a stack made of two 1mm thick AlN ceramics. PD started between 9-10kV and quenched at 8-9kV. The weak point could be found again in the combination of potting material and metal edges.

**Conclusion**

Simulations show that stacking two substrates in high voltage modules can significantly reduce the peak electric fields that are generated at sharp edges of the metal layers of these ceramics. Equal recess of the metal layers and doubling the middle and lower layer in thickness results in a reasonable homogenization of the electric field. The use of a third ceramic layer just causes a small benefit compared to the dual layer solution.

Stacking allows cheaper isolation solutions by replacing today's Si3N4 or AlN substrate materials by Al2O3. These stacks are suitable for applications up to 4.5kV fulfilling both insulation and partial discharge requirements.

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# Silicon Holds Key to ERP Legislation for Fans and Pumps

*The European Union's Energy-Related Products (ErP) directive will see new efficiency standards for fans and circulator pumps come into force from 2013. Here we consider the impact of the new legislation on fan- and pump-based designs and look at how the latest semiconductor advances are helping designers to address the challenges of meeting the new efficiency targets.*

*By Alberto Guerra, International Rectifier*

A wide variety of domestic appliance and light industrial applications rely on circulator pumps and fans – and whether its the compressor drive in a refrigeration system, a pump for heating and water circulation or a fan for an air conditioning unit, the majority of these applications will be driven by a low-to medium-power motor. Indeed, it is estimated that, globally, there are over 200 million motors with powers below 750W, many of which are sub-450W 'fractional HP' motors deployed in pump and fan designs. And now, thanks to new European legislation that will come into force from 2013, the efficiency criteria that these applications must meet are becoming more rigorous, driving designers to seek out new, more efficient motor control implementations for their designs.

**ERP Directive**

In Europe the key legislation that is driving the move to increasingly efficient fan and pump applications is Directive 2009/125/EC, or the European Energy Related Products (ERP) Directive. Designed to minimise energy consumption and support lower carbon emissions by improving energy efficiency, this legislation replaces the Energy Using Products (EUP) Directive and provides a framework for establishing minimum eco-design requirements for energy-using and energy-related products.

The Directive is implemented in the form of product-specific regulations that cover items ranging from finished units (e.g. domestic lighting and set-top boxes) to sub-assembly elements of a finished unit, such as fans and circulator pumps. The Directive is being implemented in various stages, with the key dates for fans and circulator pumps being January 1st 2013 and January 1st 2015, as defined in regulations EU 327/2011 and EC 641/2009 respectively.

The impact of this new legislation should not be under-estimated. For example, experts suggest that between 30% and 50% of fans currently in the market will not be compliant with the ERP requirements. And the situation could be even worse for the glandless circulators employed in heating and air conditioning systems, with some commentators claiming that over 90% of those circulators currently on the market will soon be prohibited for sale. As a result, OEMs will have to replace their products with more energy-efficient systems if they are to achieve the all-important CE mark.

**Variable Speed Drives and IPMs**

Moving their designs away from inefficient, uncontrolled motors to variable speed motors will play a vital role in helping manufacturers meet the efficiency levels demanded by the latest legislation. By optimising the speed of the load based on specific operating conditions, variable speed drives can deliver energy savings of as much as 70% when compared with their uncontrolled counterparts. However, they also require much more sophisticated drive electronics. Implementing these drive schemes with discrete designs has the potential to lead not only to longer development times but also to increased component counts, both of which can impact cost. The latter can also create challenges for designs where space is at a premium, as well as increasing the possibility of EMI effects.

To address these issues recent years have seen a growth in the market for 'intelligent power modules' or IPMs. These IPMs minimise the component count for variable speed drive electronics by integrating into a single device all of the analog and power circuitry needed to drive a motor. However, while this sounds like the ideal solution, combining sensitive control electronics and power circuitry into a single package is not without its challenges, especially where cost/performance factors are critical.

Many 'traditional' gull wing lead and DIP IPM solutions for the 30W – 200W inverterized motor drive market have either used a relatively inefficient large construction or required an external heat sink to achieve satisfactory thermal performance. As a result, the complete integration of the motor controller within a space-limited system can be difficult and, sometimes, even commercially unviable. What's more, the addition of a heatsink increases susceptibility to vibration and other mechanical stresses. Add in the fact that the single or dual in-line through-hole packaging formats that many of these products employ will require some manual assembly during manufacture and there is clearly an opportunity to re-think IPM design.

And it is just such a re-think that is behind the launch, in May this year, of a new generation of ultra-compact, highly integrated power modules. Known as µIPM™, these new modules will play a key role in helping manufacturers of the fans and pumps deployed in heating, ventilation and circulation applications meet energy-efficiency obligations resulting from the new ERP legislation.

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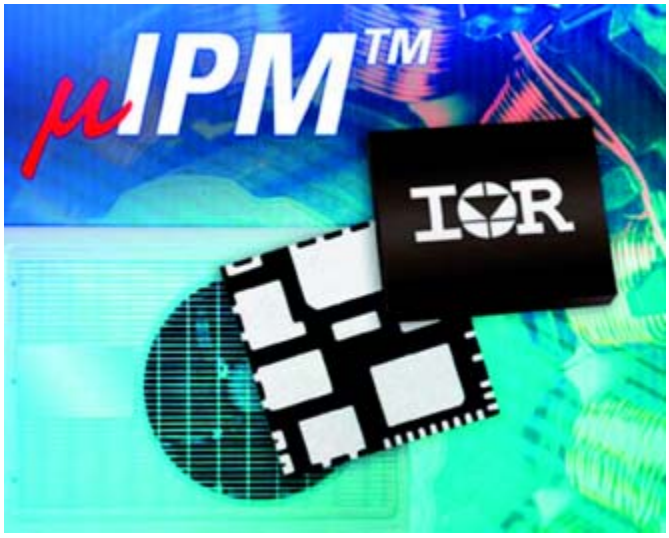



*Figure 1: Ultra-Miniature µIPM*

The family comprises a series of fully integrated three-phase or single-phase half-bridge motor control circuits (Figure 2) with DC current ratings from 2A to 4A and voltage ratings of 250V or 500V. Features such as an open-source topology for leg-shunt current sensing help to further simplify motor control designs (common source options are also available) while optimized dV/dt characteristics minimize losses and the need for EMI trade-offs. The devices also incorporate propagation delay matching circuitry, ensuring that the response at the output to a signal at the input requires approximately the same time turn-on and turn-off time durations for both the low-side and the high-side channels.

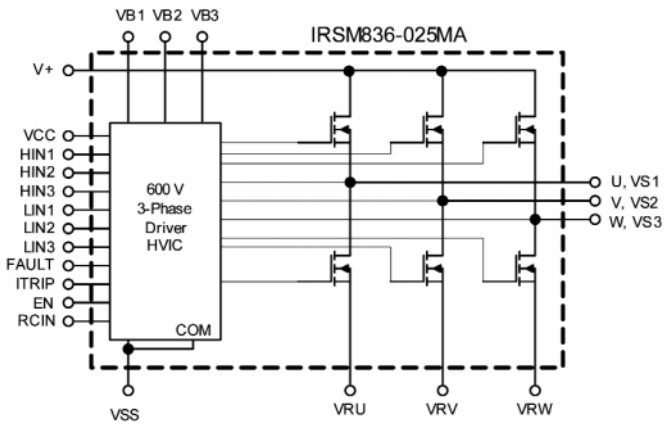



*Figure 2: µIPM Internal Schematics*

Despite their current and voltage ratings and high levels of integrated functionality, each of the new devices is supplied in a miniature 'QFN-like' package, which until now has been more commonly associated with lower voltage parts. Indeed, with dimensions of just 12mm x 12mm x 0.9mm the new devices are the smallest IPMs currently on the market and can help designers to achieve space savings of up to 60% compared to alternative devices. And this is all without compromising isolation safety requirements – the µIPMs meet the creepage distance requirements of the UL standards.

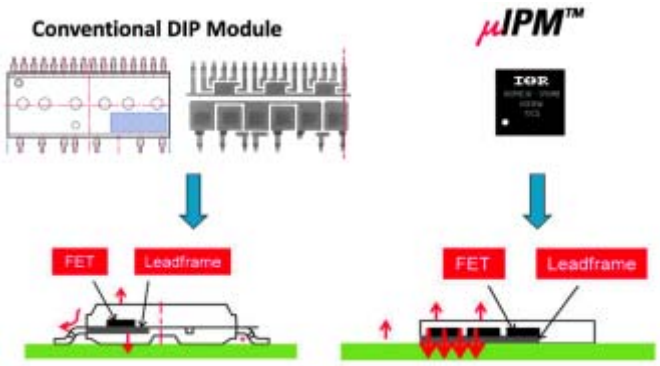
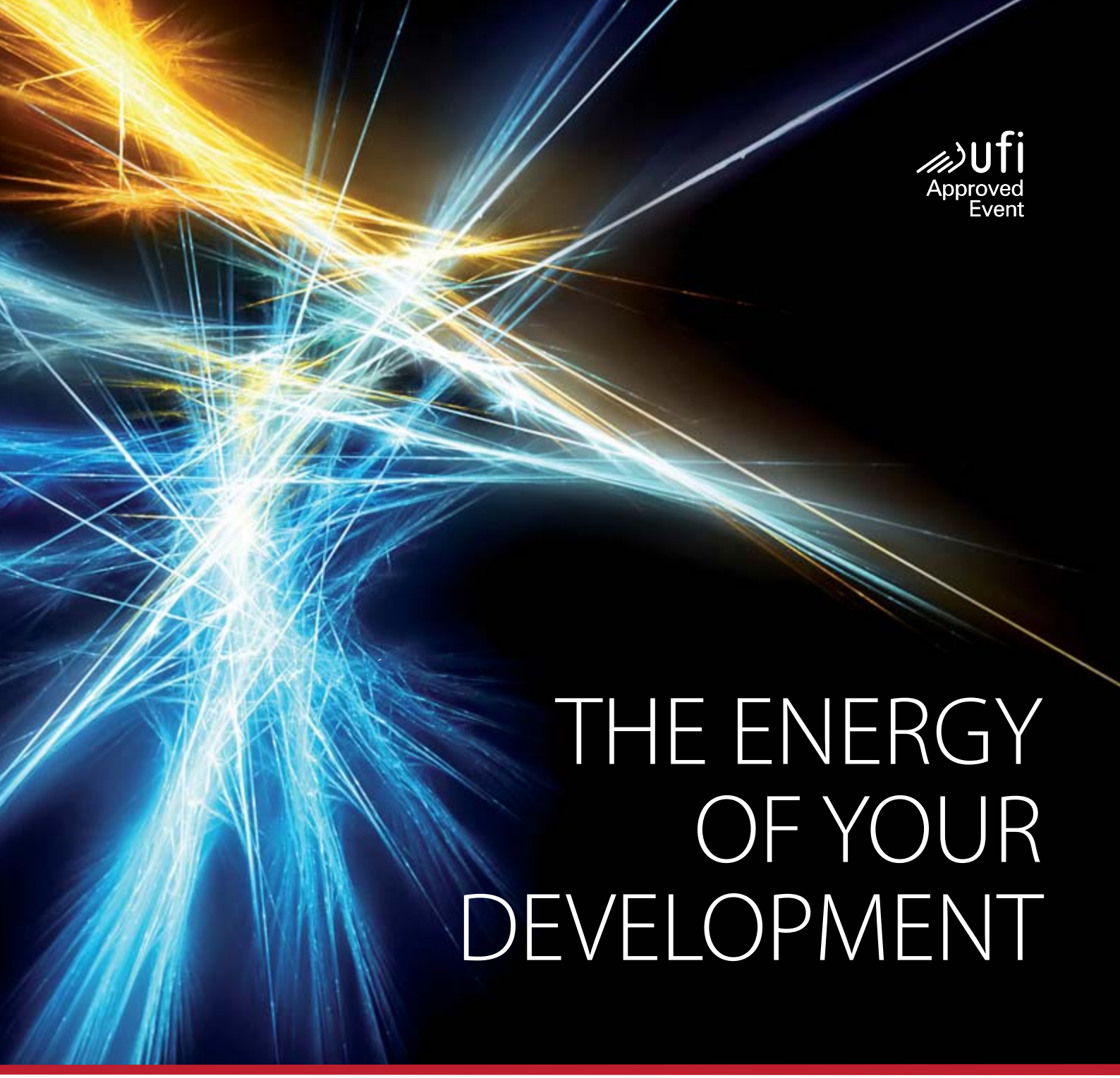



*Figure 3: PQFN Design uses PCB as Heatsink*

Among the factors that have led to these significant space savings is the approach taken to device cooling. In particular, unlike the poor die-to-PCB heat dissipation characteristics of gull-wing lead and DIP packages, the µIPMs achieve high die-to-PCB heat dissipation, allowing them to actively use the PCB as a heatsink. This is a similar approach that point-of-load (PoL) or VRM QFN-based packages use. As Figure 3 shows, the power semiconductors (500V FredFETs) and the HVIC die are bonded to the lead-frame, which is exposed and then soldered to the PCB.

This solution to effective heat dissipation means that the approach taken to PCB design and layout (in terms of, for example, PCB copper thickness or the deployment of copper wires/jumpers on thermally conductive traces) can be used to 'tune' thermal performance. As a result, under the same application and load conditions the new µIPM devices can be used to deliver improved current capabilities and load efficiencies than IPM solutions housed in more traditional packages at the same ambient temperature.

Alternatively, they can be used to achieve 'cooler running', placing less stress on the device, leading to longer term reliability – a particularly important issue for designers of fans and circulation pumps that are expected to deliver maintenance-free operation for many years.

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# New Symmetric Voltage Suppressor with Peak Pulse Power and Increased Power Capacity

*By Alexey Surma, Yury Loktaev, Alexander Stavtsev and Anatoly Chernikov, Proton-Electrotex JSC*

Typical element of symmetric avalanche voltage suppressor of "conventional" structure is shown in figure 1. The basis for such devices is high voltage "symmetric" p-n-p transistor with lightly doped n-base and two identical smooth p-n junctions. High blocking voltages of p-n junctions at the periphery of the element are ensured by special profile of edge beveling protected by silicon compound. Devices with such structure have low production costs, though may ensure high values of discharge voltage (up to several thousand volts), symmetric voltage-current characteristics, and also have high admissible pulse power and power capacity, because the active area of semiconductor element can reach up to several tens of square centimeters.

For devices with conventional structure the problematic area, separating maximum pulse values of dissipated power and avalanche current as well as maximum admissible energy loss, is the edge area adjacent to the bevel. In this area, as shown in figure 2, with any polarity of applied voltage, concentration of current density occurs; moreover, conditions of cooling is worsened, because the size of the upper contact of the housing is smaller than semiconductor element.

To remove the above mentioned disadvantages an improved semiconductor element is suggested, which contains hidden n' – layers with decreased resistivity constant, localized in active area of semiconductor element, where a full double-sided heat-sink cooling is possible. Herewith, avalanche breakdown occurs only within the area of that part of the element, where hidden n' – layers are localized.

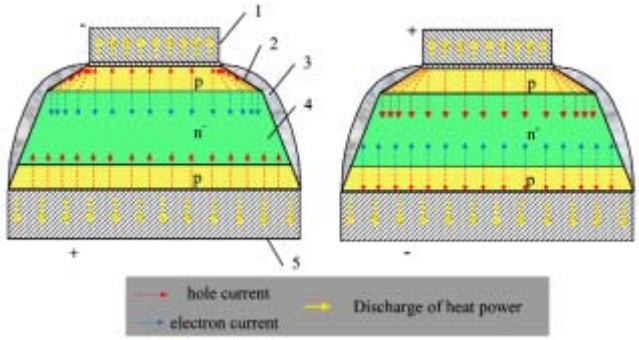


*Figure 1: Symmetric avalanche voltage suppressor with "conventional" structure. 1- upper contact of the housing; 2- edge bevel of the silicon element; 3- compound; 4- silicon element; 5- thermal compensator.*

**Structure and Technology of Production of Improved Semiconductor Element**

Hidden layers in improved semiconductor element can be located in different ways. In particular, it's efficient to consider the variants of disposition of two identical layers adjacent to p-n junctions, or one hidden layer in the center of the base as it's shown in figure 2.

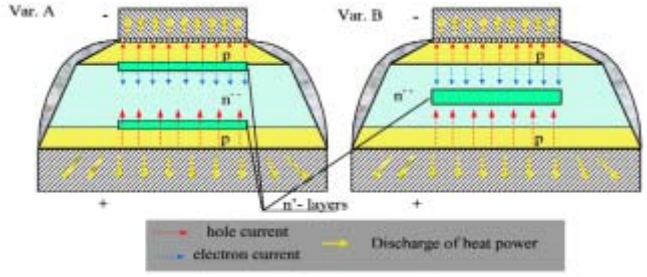


*Figure 2: Symmetric avalanche voltage suppressor with improved structure.*

Both these variants of hidden layers disposition enable to receive symmetric voltage-current characteristic and remove conduction of avalanche current in peripheral area of semiconductor element. Below there'll be described the influence of hidden layers disposition on important characteristic of voltage suppressor - dynamic resistance of voltage-current characteristic during avalanche breakdown.

An effective technology that can be used to produce deep hidden n' – layers is proton irradiation. It's well-known that [1-4] during proton irradiation of silicon, implanted atoms of hydrogen induce appearance of connected with them doping centers similar in characteristics with conventional dopants (phosphorus, arcenic, stibium). Unlike the atoms of the mentioned chemical elements, hydrogen can be easily implanted into silicon on depth up to several hundred microns. This gives an opportunity to create in n – base hidden n' – layers with precisely correct regulation of their depth and concentration of additional dopants. As a result, precise regulation of voltage of avalanche breakdown is possible. Also a highly precise homogeneousness of breakdown voltage is achieved, even within the spots of big area.

**Simulation of Voltage Suppressor Characteristics with Different Disposition of Hidden n' - layers**

Characteristics calculation of voltage suppressor semiconductor element was made with the help of computer program of physic and topologic simulation "ISTOK".

Initial variant of semiconductor element without hidden n' – layers was a symmetric p-n-p transistor with total thickness of the silicon wafer 450 μm. The depth of p-n junctions was 80 μm from the surface, atoms concentration of donor impurity in n – base - 9.4*1013 cm-3. Impurity distribution in p – layers is shown in figure 3.

Modified semiconductor elements with hidden n' – layers had identical with initial variant thickness of the silicon wafer and distribution of acceptor impurity. The following variants of modified semiconductor element were examined: A1, A2, A3 – two layers adjacent to p-n junctions, the thickness of layers varied; B1, B2 – one layer in the

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middle of n' – base, the thickness of layer varied. For variants: A1, A2, A3, B2 concentration of "initial" evenly distributed in n' – base donor impurity was $6*10^{13}$ $cm^{-3}$, for variant B2 - $9*10^{13}$ $cm^{-3}$. Distribution of "additional" donor impurity in hidden layers conformed to Gaussian function, maximum concentration of "additional" donor impurity was picked in such a way that initial stress of avalanche breakdown was close to this characteristic for initial variant. Distributions of donor impurity for different variants of semiconductor elements are shown in figure 4.

Voltage-current characteristic of voltage suppressor on the basis of three-layer p-n-p semiconductor element has a number of features comparing to characteristics of avalanche diode. Like in high voltage diode generation of electron-hole pairs during avalanche breakdown occurs in relatively narrow layer with maximum values of electric field intensity.

In the main part of the area of p-n junction volume charge located in high-resistivity n – layer avalanche generation of electron-hole pairs doesn't occur, though there's an electron current in this layer as well as holes, injected by the second p-n junction of p-n-p element as a result of transistance. Herewith the electron current, occurred as a result of avalanche generation, for p-n-p element is similar to base current. During above mentioned current flows in the area of volume charge an additional charge with bulk density Qv occurs:

$$Q_v = \left( \frac{\alpha}{v_{ps}} - \frac{1-\alpha}{v_{ns}} \right) \cdot J$$

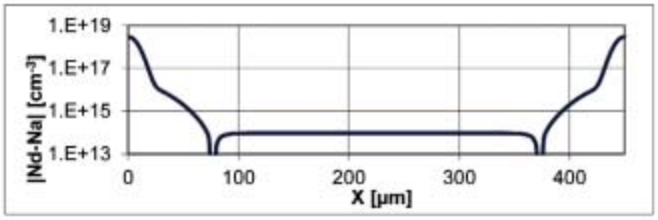


*Figure 3: Distribution of dopant impurity in semiconductor element (initial variant).*

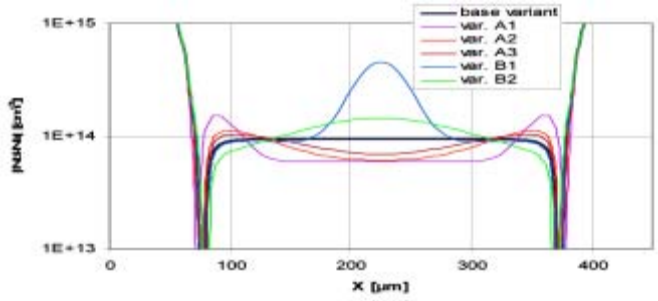


*Figure 4: Distribution of donor impurity for different variants of semiconductor elements with hidden n' layers in n base.*

$v_{ps}$, $v_{ns}$ – saturated (maximum) speed of holes and electrons with high electric field intensity,
J – current density flowing through the limiter,
$\alpha$ – current amplification factor (in scheme with common base) of transistor p-n-p element.
Presence of the additional charge influences the electric field gradient and as a result the value of voltage. Herewith, if

$$\frac{\alpha}{1-\alpha} > \frac{v_{ps}}{v_{ns}} \approx 0.8$$

then $Q_v$ is positive and with increase of J voltage in the semiconductor element decreases, i.e. voltage-current characteristic has an area with negative dynamic voltage. In other case, voltage of the semiconductor element increases monotonically with increase of current density as in avalanche diode, though the value of dynamic resistance of voltage-current characteristic can be substantially lower.

Value $\alpha$ can be easily regulated by changing carriers lifetime in n – layer of element. In case of using such elements as protective overvoltage suppressors it's recommended to have voltage-current characteristics with possibly lowest dynamic resistance, but with no area of negative voltage. During simulation of characteristics of semiconductor elements described earlier, the value of carriers lifetime in n – base was considered 0,4 µs, at which for all variants of voltage-current characteristics there was no area of negative differential resistance.

The voltage-current characteristics of semiconductor elements, which were received during simulation are shown in figure 5.

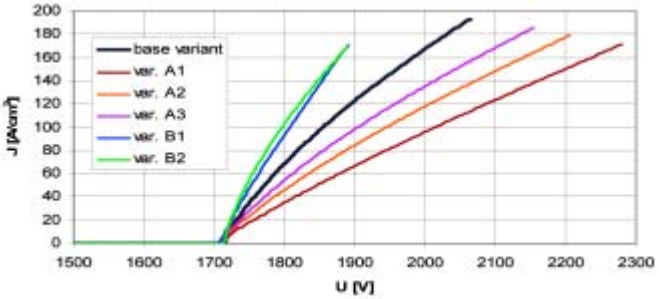


*Figure 5: Voltage-current characteristics in the area of avalanche semiconductor element for different variants of structure.*

As seen in the figure, the disposition of two hidden n' – layers on the edges of n – base leads to increase of slope resistance in the area of avalanche breakdown with current density at least up to 200 A/cm². This negative effect increases with decrease of thickness of hidden layers and increase of maximum concentration of dopants in these layers.

Disposition of the hidden layer in the center of the base enables to decrease the slope resistance approximately 1,5 times comparing to the initial variant. Essential dependency of slope resistance and thickness wasn't noticed. Probably it's connected with presence for variant B1, higher than in other variants with hidden layers, "initial" concentration evenly distributed in n – base of the donor atoms. Increase of this concentration was necessary to receive close to the other variants breakdown voltage. Thus, this question requires further studies.

Transfer of the holes through the basic layer of the p-n-p element has some persistence, that's why the question of speed of voltage suppressor on the basis of such element is quite important. In the figure 6 the dependencies of voltage and current density on time for the semiconductor element with hidden n' – layer in the center of the base (variant B2) are shown. The semiconductor element was applied with voltage pulse of 3000 V amplitude with rise speed of 60000 V/µs (rise time is 50 ns) form the supply with inner resistance of 10 ?. It's clear that time during which the voltage in the semiconductor element differs from "quasi-stationary" value doesn't exceed 100 ns, which is the result of small delay of holes current rise. The dependency of current density time of the holes in the area of volume charge of p-n junction (out of the area of avalanche generation) is also shown in figure 6.


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Dependency of maximum pulse voltage in semiconductor element (variant B2) on voltage rate of rise is shown in figure 7. It's clear that in actual for power electronics range of dV/dt up to 10000 V/µs difference of maximum pulse voltage from "quasi-stationary" is less than 5%.

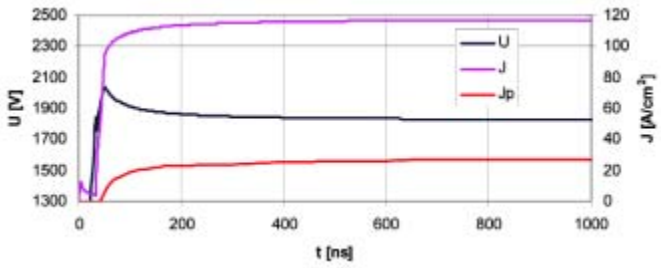


*Figure 6:Dependencies of voltage, general current density and current density of the holes on time during influence of voltage pulse on semiconductor element (var. B2). Parameters of voltage pulse: peak value 3000 V, rise speed 60000 V/µs, inner resistance of supply 10Ω.*

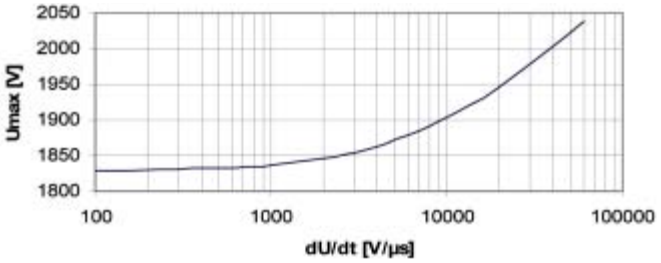


*Figure 7: Dependency of maximum peak voltage in the semiconductor element (variant B2) on rate of voltage rise of the applied impulse. Parameters of the applied impulse: peak voltage 3000 V, rate of rise 60000 V/µs, supply inner resistance 10 Ω.*

**Experimental Results**

Experimental voltage suppressors were produced on the basis of initial bedding of neutron transmutaded silicon with resistivity constant 80Ω*cm with thickness 450 µm. P – type layers were formed with simultaneous double-sided diffusion of barium and aluminium on depth ~ 30 and 80 µm accordingly. Molybdenum thermal compensator was attached to the contact surfaces of the semiconductor element from one side by high temperature vacuum soldering on silumin. From the other side of the silicon element contact metallization was formed by evaporation of aluminium layer with 10 µm thickness. The diameter of the silicon element of prepared voltage suppressors was 32 mm, diameter of the active structure after formation and edge bevel protection about 27 mm. In n – base of the semiconductor elements a hidden n' – layer was formed, topologically the distribution area of this layer was like a circle with diameter about 26 mm. The hidden layer was formed with the help of proton irradiation. After irradiation theelements were annealed for activation of H-induced donors and regulation of carrier life time.

Values of avalanche brealdown voltage at current 10 µA before irradiation were 2100-2300 V, after irradiation and annealing 1650-1750 V.

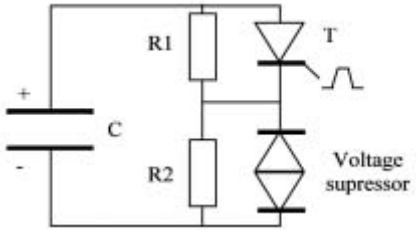


*Figure 8: Voltage suppressor testing scheme*

Testing of the experimental samples was made according to the scheme shown in figure 8. Voltage pulse commutation on the tested voltage suppressor was made at switching-on of thyristor, rate of voltage rise was about 100 V/µs. Initial direct voltage on voltage suppressor was formed by replicator R1-R2 and was about 700 V.

During testing the experimental samples of voltage suppressors commutated current pulses with peaks about 200 A with duration (with level 0.1 of peak value) about 1000 µs. Peak dissipation power was over 300 kW (over 60 kW per cm² of active surface). Full power dissipated by voltage suppressor per one impulse was about 250 J (or 50 J per 1 cm² of active surface).

Typical time dependence of current and voltage on experimental samples during tests is shown in figure 9.

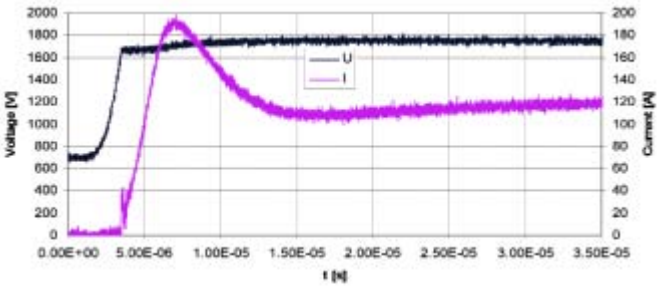


*Figure 9: Typical dependencies of current and voltage on time.*

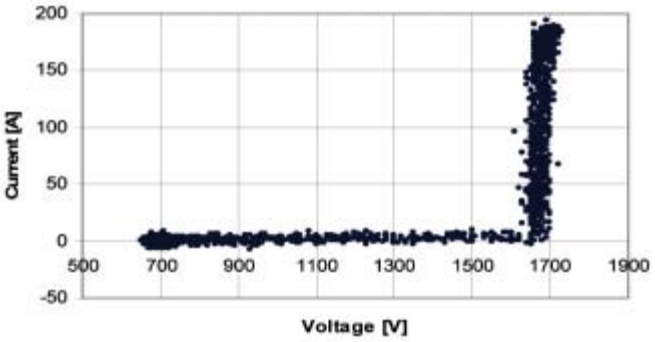


*Figure 10: "Quasi-isothermal" voltage-current characteristic of experimental voltage suppressor.*

During the first several microseconds after commutation of voltage pulse, when current increases, temperature change in semiconductor element is insignificant. This enables to build "quasi-isothermal" voltage-current characteristic of the semiconductor element shown in figure 10. Then the temperature change starts influencing the voltage breakdown leading to its increase and as a result to some current decrease. After that current stabilization occurs and then its slow decrease during capacitor C battery discharge (out of the limits of time interval shown in figure 9).

An improved power silicon voltage suppressor is developed on the basis of p-n-p transistor, base of which contains hidden n' – layers with decreased resistivity constant, localized in active area of semiconductor element, where double-sided cooling is possible.

By methods of computer simulation it's shown that disposition of hidden n' – layer in the middle of the base enables decrease slope resistance of voltage-current characteristic of the semiconductor element during avalanche breakdown in the area of high current density. It's experimentally proved that new devices have low dynamic resistance of voltage-current characteristic, admissible pulse dissipation power over 60 kW per 1 cm² of active surface and power capacity at least 50 J per 1 cm² of active surface.

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# Higher Performance for Neodymium Magnets

## *High-Anisotropy field Layer (HAL) production process*

*A new method for producing neodymium magnets that takes dysprosium-saving to the extreme. Since they were commercialized in 1983, neodymium magnets (sintered neodymium-iron-boron magnet, TDK product name: NEOREC) have maintained their position as the most powerful type of magnet known to industry.*

*Ba Takahiro Minakuchi, TDK Corporation*

Demand for these magnets continues to grow in many fields, for example actuators that drive magnetic heads on hard disk drives, motors used in industrial equipment and energy-saving appliances, and more recently in the drive motors used in HEVs and EVs. Neodymium magnets are made of two rare earth elements, Nd (neodymium), and Dy (dysprosium) — which is particularly scarce and expensive; to increase a magnet's coercive force TDK has newly developed its HAL (High-Anisotropy field Layer) production process which achieves dramatic reductions in the amount of Dy used, and still improves magnetic properties. We have succeeded in improving the performance of these magnets by optimally diffusing minimum amounts of Dy into substrates consisting of neodymium magnets that are among the best in the world.

**Neodymium magnets were created in the pursuit of compositions with no samarium or cobalt**

The first rare earth magnet, the samarium-cobalt magnet developed in the 1960s, made an impressive debut as a revolutionary and innovative type of magnet that considerably outperformed alloy magnets; these alnico or alloy magnets were the most powerful magnets of their day, and were the enabling force behind lighter and more compact electronic devices, and the portable audio players that became a global sensation. However, because the supply of these elements was unstable — samarium was a rare earth element that was in scarce supply, and cobalt could be mined only in certain regions — scientists around the world carried out research on rare earth magnets with different compositions.

As a result of these efforts, a neodymium magnet was developed that used iron, an inexpensive element, instead of samarium, neodymium, or cobalt. Neodymium is the third most abundant rare earth element in the earth's crust after cerium and lanthanum, and more than 10 times as much of the mineral is mined as samarium.

Ferromagnetism refers to the characteristic of elements which attracts them to magnets. And while the most representative of these ferromagnetics are the iron group of elements (iron, cobalt, and nickel); some rare earth elements also exhibit ferromagnetism. The source of a magnet's magnetism is the magnetic moment of its electrons. In iron group elements, the magnetic moment of electrons in the 3d orbit carry the magnetism, while in rare earth elements, electrons in the 4f orbit are involved. Rare earth magnets are based on an ingenious combination of the functions of 3d electrons of iron group elements, and that of 4f electrons of rare earth elements.

A neodymium magnet is a three-element intermetallic compound that contains neodymium, iron, and boron at a basic composition ratio of 2 : 14 : 1. The nonmagnetic element boron is used to increase the interatomic distance of iron by a slight amount. By achieving this exquisite interatomic distance, the orientation of the electrons' magnetic moment becomes fixed, making the metal a powerful magnet.

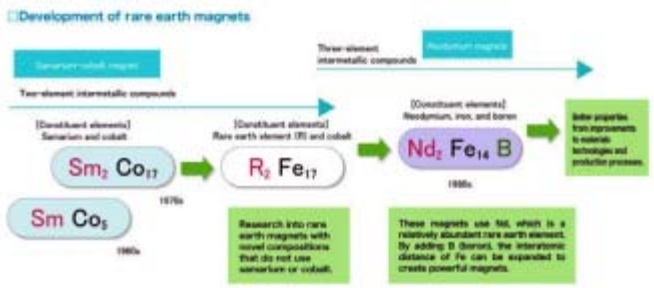


*Figure 1: Development of rare earth magnets*

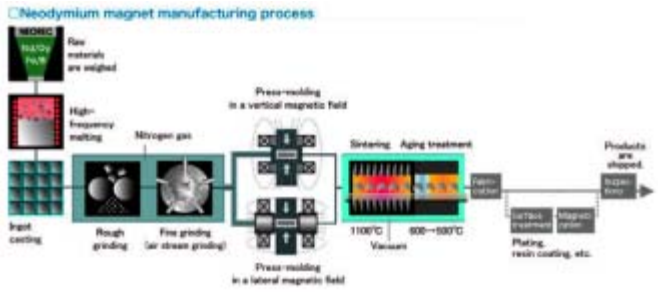


*Figure 2: Neodymium magnet manufacturing process*

**Manufactured in a ppm-order, low-oxygen process to eliminate oxides**

Similar to electro-ceramic materials, sintered neodymium magnets are manufactured by forming and baking highly pure raw materials. Therefore, a neodymium magnet constitutes a polycrystalline body which is a collection of a large number of fine Nd2Fe14B crystalline particles.

Since they were first commercialized in 1983, the properties of neodymium magnets have continued to improve every year. The highest maximum energy product (BHmax) — one of the indices of magnet performance — of these magnets when they were first invented ranged from 30 to 40MGOe. Current magnets are capable of 59MGOe in the lab, with production neodymium magnets delivering 55MGOe or more. These advances are a result of improvements to material technologies and production technologies.

Before they are baked, neodymium magnets are press-formed in a magnetic field. Uniform powder granularity results in better orientation, which leads to a more powerful neodymium magnet. Controlling the microstructure in the baking process is another key technological area. The polycrystalline body of neodymium magnets consists of three phases: Nd2Fe14B crystalline particles which make up the main phase, an Nd-rich phase which is produced around these crystalline particles, and grain boundaries or the boundaries between the crystalline particles.

Because it is the Nd2Fe14B phase which produces the magnet's magnetism, the relative proportion of Nd2Fe14B must be increased by eliminating impurities as much as possible. Thanks to technological advances, this proportion, which was at around 90% in 1990, has now been improved to 97% or more.

Additionally, we must thoroughly eliminate impurities that segregate into the grain boundaries. The primary impurity is an oxide of Nd (Nd2O3) that is created when Nd oxidizes in the manufacturing process. Not only does this Nd oxide not contribute to the magnetic properties of these magnets, it is actually a major factor that diminishes magnet performance. What is more, such impurities cannot be removed once the magnet has been formed.

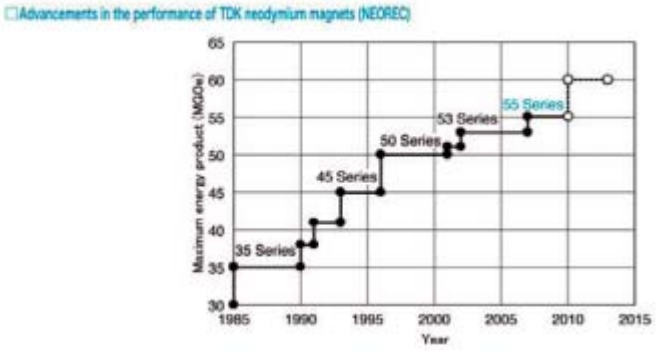


*Figure 3: Advancements in the performance of TDK neodymium magnets (NEOREC)*

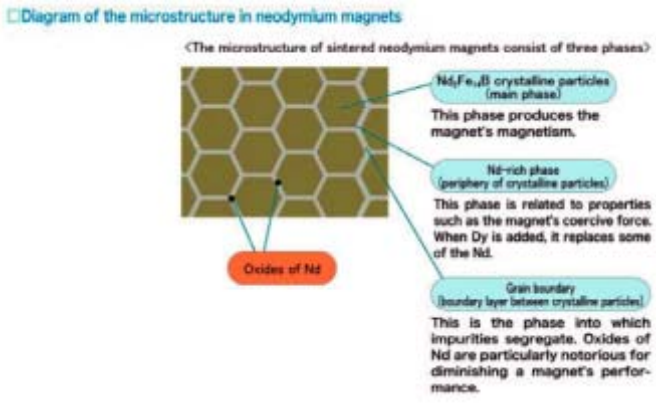


*Figure 4: Diagram of microstructure in neodymium magnets*

This is why our magnets are made in a low-oxygen environment where oxygen levels are maintained at the ppm level. As you can see, the levels of technology that are required for manufacturing neodymium magnets are significantly more demanding than those required for the simple casting of alloy magnets.


*Figure 5: SEM images of a neodymium magnet manufactured using a conventional process, and one made in TDK's low-oxygen process*

**Dysprosium is added to improve the coercive force of magnets**

Dy (dysprosium), a rare earth element, is added to improve the performance of neodymium magnets. Dy replaces some of the Nd on the periphery of crystalline particles to improve the magnet's coercive force. However, because Dy is a rare earth element and its price is unstable, researchers have been exploring technologies for reducing the amount of Dy used. TDK's HAL process provides a solution to this issue.

HAL stands for „High-Anisotropy field Layer." Magnetic anisotropy refers to the magnetic moment of electrons which produce the magnetism being aligned in a certain direction, resulting in a particular orientation at which the magnetic material can be readily magnetized.

It has been well known that replacing some of the Nd with Dy has the effect of increasing a magnet's coercive force. An analogy for this would be how the sweetness of oshiruko, a sweet bean soup, can be made more intense by adding a small amount of salt in addition to sugar. In the same way, the adding of Dy in neodymium magnets is analogous to the exquisite salt seasoning of oshiruko; although to add Dy does require rather more sophisticated technology. By

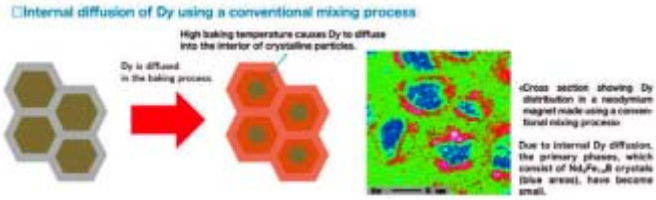


*Figure 6: Internal diffusion of Dy using a conventional mixing process*

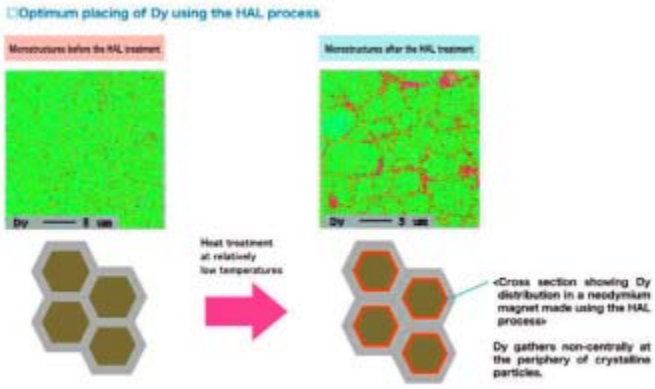


*Figure 7: Optimum placing of Dy using the HAL process*

increasing the amount of Dy to increase a magnet's coercive force, its residual flux density is diminished; flux density is key to the strength of the magnet.

Also, in the past, a mixing method based on Dy addition was used to create high-anisotropy field layers (HAL structure). This is a process of mixing two alloys in appropriate amounts, one with a low Dy content, the other with a high Dy content, and baking the mixture to uniformly diffuse Dy throughout the formed polycrystalline body of the neodymium magnet. However, as the material had to be baked at high temperatures, a drawback of this process was the Dy would diffuse deep into the crystalline particles. TDK's HAL process provides a solution to this problem. Through a relatively low-temperature heat treatment, this new technology means Dy uniformly gathers noncentrally at the periphery of the crystalline particles, improving the magnet's properties.

**The HAL process achieves better properties while reducing the amount of Dy used**

In TDK's HAL process, a Dy source for diffusion is applied to the surface of a sintered neodymium magnet substrate, and then heat treated.

The Dy diffuses throughout the entirety of the material through the Nd-rich phases that surround the crystalline particles. And because the heat treatment used in the HAL process is performed at relatively low temperatures, Dy does not diffuse into the interior of the crystalline particles, and the Nd2Fe14B phase that has replaced Nd gather non-centrally so as to cover the surface of the crystalline particles. Therefore, the roles of the Nd2Fe14B phase which produces the magnet's magnetism, and that of the Dy2Fe14B phase which is related to magnetic properties are clearly distinguished, paving the way for greater improvements to the coercive force.

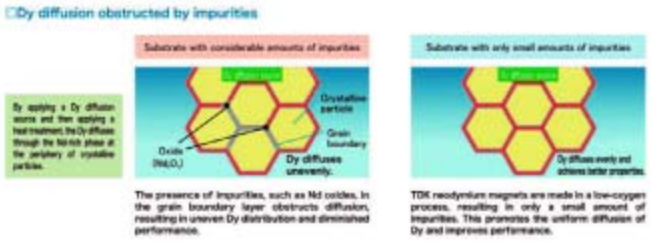


*Figure 8: Dy diffusion obstructed by impurities*

A good substrate containing only small amounts of impurities is needed to implement the HAL process and achieve uniform Dy diffusion. Dy diffusion can be obstructed by impurities such as Nd oxides that segregate in the grain boundaries, causing uneven Dy distribution.

TDK neodymium magnets are made in a process which maintains extremely low oxygen levels. As a result, these magnets contain only small amounts of those impurities such as Nd oxides that can obstruct diffusion. They are therefore well suited for the HAL process, and enable ideal and uniform Dy diffusion.

Additionally, sophisticated film-forming technologies accumulated by TDK over the years in the manufacture of magnetic tapes and chip components are applied to make the Dy diffusion source. While coercive force can be improved by replacing Nd at the periphery of crystalline particles with Dy, if this area becomes too Dy-rich, it can result in diminished residual flux density, which is related to the strength of the magnet. This is because the coercive force and residual flux density are in a quid pro quo relationship where an improvement in one results in a diminishment in the other.

By achieving optimum Dy diffusion using a Dy diffusion source that is evenly applied with only the required amount of Dy, TDK's HAL process has succeeded in dramatically improving on the properties of NEOREC55, a top-class conventional magnet. The HAL process — a marriage between advanced materials technologies and process technologies — enables smaller and higher-performing motors, and will contribute to the advance of energy savings and more environmentally friendly products.

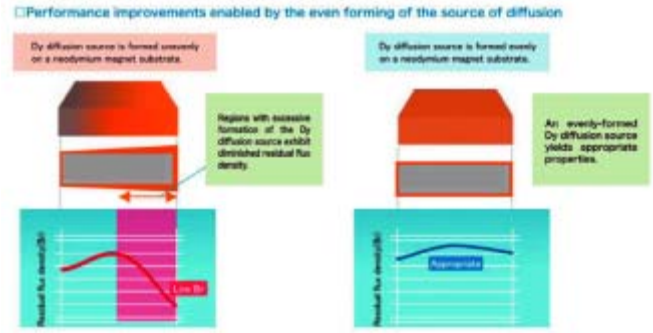


*Figure 9: Performance improvements enable by the even forming of the source of diffusion*

**Main Features**

- TDK's HAL (High-Anisotropy field Layer) process diffuses Dy — a scarce and expensive element that is added to improve performance — only to those areas in neodymium magnets (TDK product name: NEOREC) where they are needed.
- Magnets with top-class performance are made by optimally diffusing Dy into a neodymium magnet substrate that is made in a low-oxygen process and contains only small amounts of impurities.
- These improvements in magnet performance enable smaller motors and greater efficiencies, and ultimately help achieve dramatic energy savings.
- Remanent magnetic flux density has been improved by 3-5%.
- Uses 20-50% less Dy, a rare earth element.
- By optimizing magnetic field orientation to suit specific applications, designers can achieve both superior magnetic properties and cost benefits.

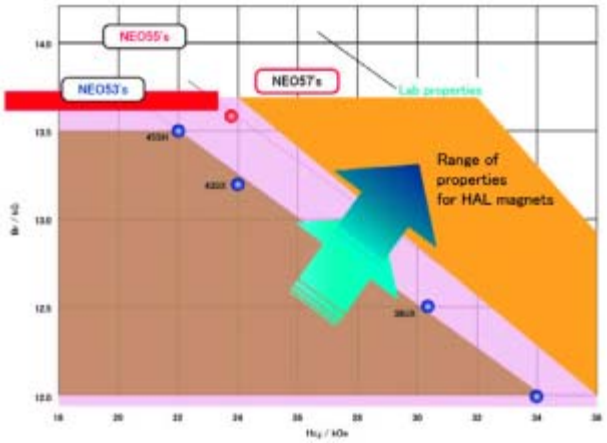


*Figure 10: Range of properties for HAL magnets*

**Main Applications**

Optimum for driving/generator motors for HEVs and EVs, as well as a broad range of other highefficiency motors.

**www.tdk.eu**

# Repetitive Learning Harmonic Current Control in a Load Emulation System

*In an active energy feedback unit of an electronic load emulation system harmonics in the grid currents are compensated by using a repetitive control algorithm*

*By Michael Hausmann, Dominik Dorner, Dr. Norbert Graß and Dr. Bernhard Wagner, Georg Simon Ohm University of Applied Sciences Nuremberg, Germany*

**Introduction**

For power electronics development the availability of power electronic load emulation systems can be very beneficial for testing, particularly for the verification of the system performance under real load conditions. Such test equipment has been developed for dedicated applications like motor inverters [1, 2] and complex systems like electrostatic precipitators [3] or escalator systems [4]. In low power applications, the power consumed by the emulator is usually converted into heat, e. g. by using a brake chopper. This strategy is not applicable for high power load emulations, where the electric power has to be recovered by the emulator. In such applications, the power is mostly fed back to the device under test (DUT) using a coupled DC-link or by feeding back into the mains. Feeding the power to the grid has the advantage, that the complete DUT (grid side and load side converters) can be tested in the original system environment.

In an ideal load emulation setup, the energy is fed back from the emulation system directly into the DUT. Thereby, only the power losses of both converter systems need to be provided by the power grid (see Figure 1).

Harmonics in the current $i_L$ are generated by the DUT e.g. by using a B6 rectifier as a grid side converter. These harmonic currents have to be provided either by the emulation system or by the power grid. The harmonic currents are directly related to the circulating power in the test loop and therefore they can exceed the current capability of the grid by factors. For grid side power quality reasons, the harmonics in the grid current $i_N$ need to be compensated by intelligent control of the energy feedback unit of the emulation system. With appropriate modification of the energy feedback unit output current $i_A$, all harmonics are provided by the emulation system.

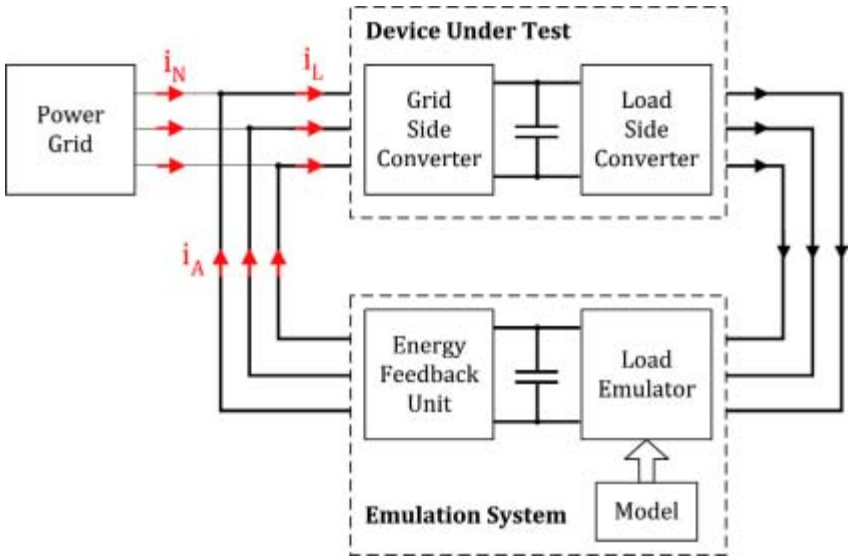


*Figure 1: Schematic of the device under test and the emulation system*

The harmonic current control can be realized using various control techniques. In this contribution, a repetitive learning controller (RC) is presented to suppress the harmonics in the grid current $i_N$.
For demonstration purpose, the algorithm is implemented and evaluated in a 150 kW load emulation system of an electrostatic precipitator.

**The Repetitive Learning Controller**

In general, repetitive learning control is used to improve the attenuation of periodic disturbances. The principle of a repetitive control system is shown in Figure 2.

The repetitive learning control (RC) applies the internal model principle [5], which states that zero steady state error can be achieved if a generator is inserted in the closed control loop. Here, the error signal (calculated from the difference of the reference trajecto-

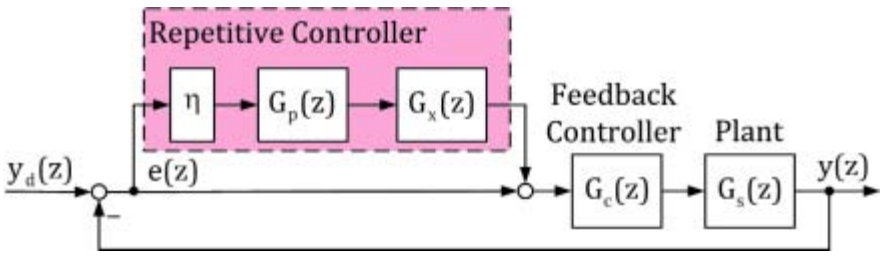


*Figure 2: Block diagram of a general repetitive control system*

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"The Future of Solid State Lighting in Europe"
*An overview of EU initiatives launched under the Digital Agenda for Europe in the area of Solid State Lighting.*

**Dr. Hans Nikol**
VP LED Technology Strategy, Philips Lighting, Netherlands

"LED Technology Overview & Trends"
*Summary of recent LED technology trends and strategies for future lighting system developments.*

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*Demonstrating state-of-the-art technology for LED lighting designs using the example of a museum project.*

**Prof. DDr. Sergei Ikovenko**
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ry $y_d(z)$ and the output $y(z)$) is compensated by the output of the repetitive signal generator $G_P(z)$. The repetitive learning gain $\eta$ is responsible for the velocity of the error compensation. The loop filter $G_x(z)$ in Figure 2 is designed by using a system inversion of the plant shown in [6] and [7] and generates a compensation signal out of the error signal. Therefore, a mathematical model of the controlled system is necessary.

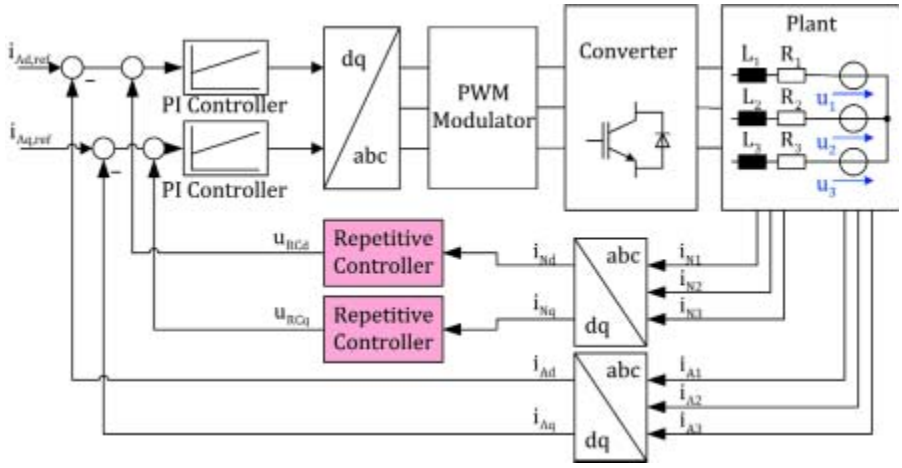


*Figure 3: Block diagram of the control system*

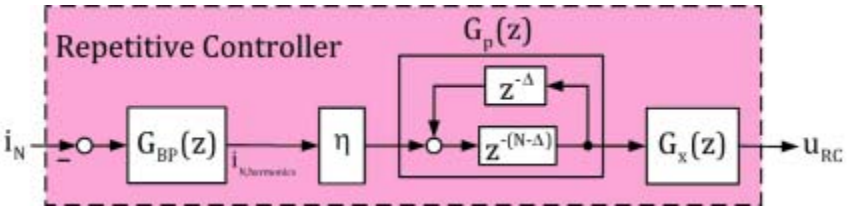


*Figure 4: Block diagram of the repetitive controller for the harmonic compensation*

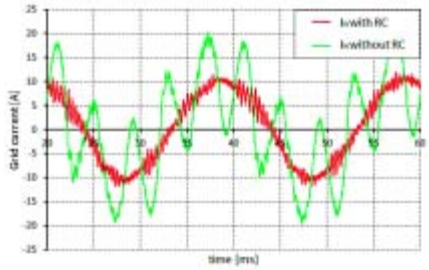


*Figure 5: Grid current with and without the repetitive controller (RC)*

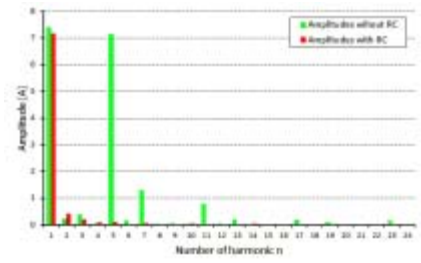


*Figure 6: Amplitudes of the harmonics with and without the repetitive controller (RC)*

In the given application, the periodic disturbances are the harmonics of the grid current produced by the DUT. A compensation strategy for harmonic current control by using selective current controllers is mentioned in [8]. In the paper, for each harmonic component a specific harmonic controller is implemented. Using RC, a large number of harmonics can be suppressed with a single algorithm.

Repetitive learning controllers are mentioned in [9] and [6] for the compensation of harmonics. In these papers, the harmonics are compensated in the inverters output currents $i_A$ where the harmonic controller supports the fundamental controllers to generate sinusoidal currents. As described earlier, in the given application the RC must compensate fairly high harmonics in the grid current $i_N$ while the output current of the energy feedback unit $i_A$ is controlled by the fundamental feedback controller. This application requires different behavior of the RC. The implemented block diagram of the control system is shown in Figure 3.

PI controllers are used in the energy feedback unit for feeding constant power to the grid. This function should not be influenced by the repetitive control algorithm. This is realized by placing a high-pass filter at the input of the RC for decoupling the control variables of the different controllers. To specify a certain number of harmonics to be controlled, also a low-pass filter is used. Both filters are combined in a band- pass filter ($G_{BP}(z)$) in Figure 4. For this application, finite impulse response (FIR) filters are used because of their linear phase. They cause a constant time delay $\Delta$ which has to be compensated to get an overall delay of one cycle. After filtering the grid current, the error signal at the input of the repetitive signal generator $G_P(z)$ is equal to the negation of the grid current harmonics $i_{N,harmonics}$, because the desired value is zero.

The choice of the learning gain $\eta$ is essential for the stability of the RC and depends on the uncertainties of the model, which was taken for the system inversion. The sampling rate of the system is 100µs and the fundamental grid frequency in the demonstrator is 50Hz, which results in N=200 delay steps. In addition of the time delay $\Delta$, the repetitive signal generator $G_P(z)$ has to be adapted as shown in Figure 4. All controllers are calculated in a rotating reference frame with a fundamental frequency of 50Hz. Thereby the fundamental frequency of the grid current is transferred into a DC value using the park transformation.

**Measurement Results**

The repetitive current controller is implemented in the energy feedback unit of an electrostatic precipitators load emulation system. The DUT has a B6 rectifier on the grid side converter and produces n = m·3±1 (m=1,2,3...) harmonics. The 260th order band-pass filter has a lower cutoff frequency of 200Hz and an upper cutoff frequency of 1500Hz. Without harmonic current control there are several harmonics in the grid current $i_N$ (time domain signals in Figure 5 and Fourier spectrum in Figure 6).

After activating the harmonic cancellation with the RC, the harmonics in the grid currents are reduced significantly. The measured grid current $i_N$ with a RC algorithm in the energy feedback unit is shown in Figure 5 and 6. The signal quality is characterized by the total harmonic distortion (THD):

$$THD = \frac{\sqrt{\sum_{\gamma=2}^{40} I_\gamma^2}}{I_1}$$

The THD of the grid current $i_N$ without RC is $THD_{without}$ = 98,8% and with the RC it is $THD_{with}$ = 7,0%.

The Fourier spectrum of the two measured currents and the THD show, that the repetitive controller is able to cancel almost all harmonic components above the 50Hz first harmonic.

**Conclusion**

The article shows a harmonic current control with a repetitive learning controller (RC) which operates besides a fundamental frequency PI current controller. Both controllers have two different control variables while influencing the output current of the emulator's energy feedback inverter.

The presented control algorithm could also be used in grid stabilizing functions like active power filters in e.g. PV inverters for future grid stabilization and harmonic suppression.

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## High-Current/High-Temperature Linear Hall-Effect Current Sensor IC

The ACS759 from Allegro MicroSystems is a high-current/high-temperature linear Hall-effect current sensor IC that provides an economical and precise solution for AC or DC current sensing in 3.3 V supply applications.

The device consists of a precision, low-offset linear Hall sensor circuit with a copper conduction path located near the die. Applied current flowing through this copper conduction path generates a magnetic field which is sensed by the integrated Hall IC and converted into a proportional voltage.

Device accuracy is optimised through the close proximity of the magnetic signal to the Hall transducer. A precise, proportional voltage is provided by the low-offset, chopper-stabilised BiCMOS Hall IC, which is programmed for accuracy at the factory.

High-level immunity to current conductor dV/dt and stray electric fields, offered by Allegro proprietary integrated shield technology, guarantees low ripple at the output and low-offset drift in high-side high-voltage applications. The output of the device has a positive slope when an increasing current flows through the primary copper conduction path used for current sensing.

The internal resistance of this conductive path is typically 100 microhms, providing low power loss. The thickness of the copper conductor allows for 200 A continuous current sensing applications and survival to much higher transient currents.

The terminals of the conductive path are electrically isolated from the sensor leads, allowing the ACS759 family of sensors to be used in applications requiring electrical isolation without the use of opto-isolators or other costly isolation techniques. The device is fully calibrated prior to shipment from the factory.

This device is targeted at the automotive and industrial markets. Typical applications include motor control, load detection and management, power supply and DC/DC converter control, inverter control, and overcurrent fault detection.

**www.allegromicro.com**

## AC Rack Mount High Voltage Power System

UltraVolt, Inc. announced its newest high-voltage power systems – the HV Rack Advanced AC and HV Rack Advanced AC 3Phase Series. These unique systems are fully adjustable AC sources with up to three phases, offer currents up to 600A per phase, provide a digital display of all parameters, and include features such as user interface control and flicker simulation.

The HV Rack Advanced AC and HV Rack Advanced AC 3Phase Series are fully adjustable AC sources with up to three phases. The manually adjustable frequency range is between 0.1Hz and 2000Hz, which includes the often-used frequencies of 50Hz, 60Hz and 400Hz (including line sync) with the push of a button. The standard model provides a voltage range of 0-300VAC (425DC) at a power range of 250VA to 45kVA. The currents reach up to 80A per phase, wherein a high-current, controlled-current version of 600A is available. Alternatively, voltages up to 500VAC (700DC) or 700VAC (1kV DC) are available, where peak output currents are reduced by 40% and 50%, respectively. Both series have excellent control, provide data in a control accuracy of 0.1%, have a very low total harmonic distortion of 0.1%, and exhibit a programming voltage change with an accuracy of 100mV.

**www.ultravolt.com**

## "Green" Gate Drive Transformer

As we continue to learn more about the importance of making better use of our energy resources, companies are striving to come up with innovative product designs that will use energy more efficiently and help reduce our "carbon footprint". Renco Electronics is no exception to this trend. The Rockledge, Florida, based electronic manufacturer has announced the addition of the RL-9500, the company's latest green gate drive transformer.

The RL-9500 boasts a low cost design with isolated primary winding, a 1:1:1 turn ratio and 3,000 volt Hi-Pot. At only 18mm tall, the RL-9500 conserves space with a slim profile. In addition, the 9500's rugged construction allows for a wide operating temperature range of -40°C to +130°C.

Ideal for use in push-pull converters and half and full bridge circuits, Renco Electronics' RL-9500 gate drive transformer is packaged in quantities of 50 units per tray and has a list price of $0.65 per unit.

**www.rencousa.com**

# High Power Tx/Rx Switches from M/A-COM Tech

Richardson RFPD, Inc. announced immediate availability and full design support capabilities for two high power Tx/Rx switches from M/A-COM Technology Solutions Inc. (M/A-COM Tech). Both devices are well-suited for high power LTE, TD-SCDMA, WiMAX, and military radio applications, and are offered in compact, surface mount 4mm PQFN Packages.

The MASW-000932 is an SPDT high power, broadband, high linearity, common anode, PIN diode Tx/Rx switch for applications from 10 MHz to 4.0 GHz. This broadband switch is ideal for use in WiMAX and WiFi Customer Premises Equipment (CPE), as well as Software Defined Radio (SDR), picocell and femotcell Tx/Rx switching applications. The device incorporates a PIN diode die fabricated with M/A-COM Tech's patented Silicon-Glass HMIC process. The process also provides full top side polymer passivation to ensure robust performance with excellent Isolation to loss ratio on both the transmit and receive states. This switch provides 80.0 Watts of CW power handling with 72 dBm IIP3 at 2010 MHz for outstanding switch performance.


**www.richardsonrfpd.com**

# Flexible 4A Charger ICs Offer Universal Input

Summit Microelectronics has introduced the industry's first monolithic 4A Li-Ion battery charger integrated circuits (ICs). The SMB349 and SMB359 are fully configurable and can deliver up to 4A charging/system current while accepting a wide +3.6 to +16V input voltage range. The SMB349 incorporates CurrentPath™ technology with dual system/battery outputs (for instant-on with discharged or missing battery), while the SMB359 provides a single output. Both products include Summit's FlexCharge™ automatic power source detection and patented FlexCharge+™ automatic input voltage detection technologies to support universal USB/AC battery charging and comply with industry standard like USB2.0/3.0/BC1.2. Also Summit's patented TurboCharge™ high-efficiency switch-mode charger, TurboCharge+™ automatic float voltage compensation and OptiCharge™ automatic input current limit technologies, combined with SafeCharge™ JEITA/IEEE1725 battery safety support, optimize the solution and provide the industry's fastest, safest battery charging. Like all of Summit's battery charging solutions, these devices are highly integrated and highly flexible. Digital I2C control and nonvolatile configuration allow for host-based control while maintaining the simplicity of stand-alone operation. Parameters and functions are easily reconfigured for various applications or system modes. High integration keeps external components to a minimum while high-frequency operation and CSP packaging contribute to a tiny solution size.


The SMB349/359 are the ideal charging and system power solutions for virtually any portable application that utilize high-capacity batteries, require reliable and fast charging and feature very compact industrial designs. Target portable devices include smartphones, tablets, ultrabooks, digital camcorders, portable media players, and portable game consoles/controllers.

**www.summitmicro.com**

# 2x2 mm MOSFETs with Tin-Plated Solderable Side Pads


NXP Semiconductors introduced the industry's first MOSFETs in a 2-mm x 2-mm low-profile DFN (discrete flat no-leads) package with tin-plated, solderable side pads. These unique side pads offer the advantage of optical soldering inspection, as well as a better quality of solder connection compared to conventional leadless packages.

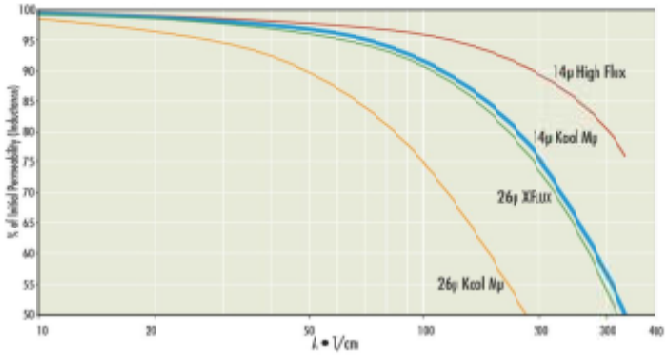
Available immediately, the PMPB11EN and PMPB20EN 30V N-Channel MOSFETs are the first of more than 20 devices housed in the DFN2020MD-6 (SOT1220) package from NXP. Both MOSFETs have a maximum drain current (ID) of >10 A, and very low Rds(on) values of 12 mOhm typ and 16.5 mOhm typ at 10V respectively for reduced conduction losses, which enable lower power consumption and longer battery life.

Only 0.6 mm in height, the new DFN2020 MOSFETs are also thinner than most 2-mm x 2-mm products on the market today, making them ideal for ultra-small load switches, power converters, and charger switches in portable applications such as smartphones and tablets. The MOSFETs are also well suited for other space-constrained applications including DC motors, server and network communications, as well as LED lighting, where power density and efficiency are critical. Eight times smaller than standard SO8 packages, DFN2020 offers comparable thermal resistance, and can replace many larger MOSFET packages such as SO8, 3x3 or TSSOP8 with the same Rds(on) value range.

**www.nxp.com/ultra-small-mosfets**

# Kool Mu® Powder Cores Available in14 Permeability

Magnetics® has expanded the permeability range of our popular Kool Mu® powder alloy by developing this material in 14 permeability. The excellent DC bias performance of 14 permeability Kool Mu makes it an outstanding choice for use in very high current inductors needed in inverters for Photovoltaic, UPS, Welding, and Traction markets.




With the combination of high DC bias and reasonable AC losses, 14 permeability Kool Mu can provide the optimal solution when the design challenge is to achieve a target inductance at maximum current load in a high current power choke. In addition to the DC bias performance, 14 permeability Kool Mu provides additional benefits such as no thermal aging concerns, low magnetostriction, soft saturation, and relatively low cost.

Since this ultra-low permeability material will be most beneficial in high current applications, the initial sizes available will be large outside diameter (OD) toroids. While any size can be made, samples are available in toroids ranging from 47 – 165 mm OD. E cores, U cores, and blocks for building large inductors will also be available in 14 permeability Kool Mu.

Technical data for 14 permeability Kool Mu, including datasheets, is available at:

**www.mag-inc.com**

# EN2300 Family of 12 Volt Integrated Power IC Solutions

Enpirion announced the availability of the EN2300 family of fully integrated 12 Volt DC-DC converters, implemented in the company's industry leading power MOSFET technology with double the power density over alternative solutions. As the leader of integrated power IC solutions, this introduction underscores Enpirion's continued focus on miniaturizing DC-DC power systems in applications such as telecommunication, enterprise, industrial, embedded computing, and storage systems. The addition of the EN2340QI 4 Amp, EN2360QI 6 Amp, EN2390QI 9 Amp, and EN23F0QI 15 Amp devices further broadens Enpirion's extensive PowerSoC (power-system-on-chip) portfolio. These devices capitalize on Enpirion's field proven PowerSoC technology, which integrates the controller, power MOSFETs, high frequency input capacitors, compensation network and inductor. The EN2300 family offers small solution sizes with uncompromised performance, highest reliability, and a 45 percent reduction in time to market. Customers have already validated these benefits with more than 50 design wins ahead of the official market release.

Enpirion's proprietary high-speed transistor structure implemented in 0.18u LDMOS process achieves the industry's best Figure of Merit (FOM = Gate Charge x On-state Resistance in units of milli-ohm nano-coulombs) to operate at high frequency while reducing switching losses. "Enpirion focuses on driving high speed, low-loss power MOSFET technology as the key enabler for delivering the highest efficiency solutions with leading power density," says Dr. Ashraf Lotfi, Enpirion Chief Technology Officer. "Our technology FOM of 20 provides a 40% improvement over alternative LDMOS, 73% versus VDMOS, and 33% better than high performance GaN."

**www.enpirion.com**

# Half-Pitch Package Option for General Purpose Transistor Couplers

Toshiba Electronics Europe (TEE) has expanded its family of general purpose transistor photocouplers with its first devices in a small, low-profile SO4 half-pitch package. The TLP290 and TLP291 can be used up to the maximum permissible operating isolation voltage of 707Vpk defined by EN 60747-5-5, and provide guaranteed operation between -55°C and 110°C.


Featuring the same reference pad dimensions as Toshiba's previous TLP280 and TLP281, the new TLP290 and TLP291 allow designers to replace their predecessors in existing circuits without system redesign. Target applications include AC adaptors, switching power supplies, programmable logic controllers and inverter circuits.

Toshiba's TLP290 consists of a photo transistor that is optically coupled to two GaAs infrared LEDs, which are connected in an inverse parallel configuration. The device can operate directly from an AC input current. The TLP291 comprises a photo transistor and a single GaAs LED. Both of the couplers have a minimum rated isolation voltage of 3750Vrms.

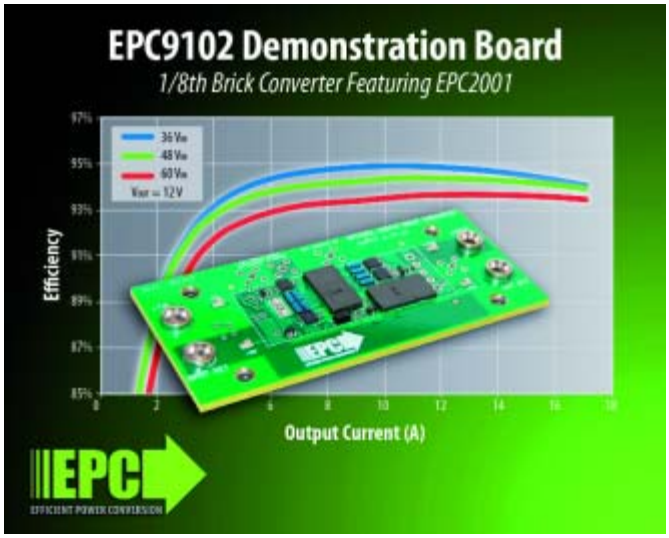
Despite board mounting dimensions of just 7mm x 2.6mm, and a profile of only 2.1mm, the new transistor couplers offer guaranteed creepage and clearance distances of 5mm and a guaranteed insulation thickness of 0.4mm. As a result they meet the reinforced insulation requirements of international safety standards.

The new devices have a minimum collector-emitter voltage rating of 80V and offer current transfer ratios from 50% to 400% (IF = 5mA, VCE = 5V, Ta = 25°C).

**www.toshiba-components.com**

# Eighth Brick DC-DC Converter Featuring (eGaN®) FETs

Efficient Power Conversion Corporation (EPC) introduces the EPC9102, a fully functional eighth brick converter. This board is a 36 V – 60 V input to 12 V output, 375 kHz phase-shifted full bridge (PSFB) eighth brick converter with 17 A maximum output current.
The EPC9102 uses the 100 V EPC2001 eGaN FETs in conjunction with the recently introduced LM5113 100V half-bridge gate driver from Texas Instruments. The LM5113 is the industry's first driver to optimally drive and fully release the benefits of enhancement mode gallium nitride FETs. The EPC9102 demonstrates the performance capabilities of high switching frequency eGaN FETs when coupled with this eGaN driver.
The whole converter is constructed within the standard eighth brick footprint and height (2.300" x 0.900" x 0.400") requirements. Despite its small size, the board has a peak power efficiency of 94.8% while delivering 10 amps of current with a 36 V input.
The EPC9102 demonstration circuit was designed to showcase the size and performance that can readily be achieved at 375 kHz operation using eGaN FETs rather than to optimize the design for maximum output power. The operating frequency is roughly 50% - 100% higher than similar commercial eighth brick DC-DC power converters. To assist the power system design engineer, the EPC9102 demonstration board is oversized to allow connections for bench evaluation. There are various probe points to facilitate simple waveform measurements and efficiency calculation. The board is intended for bench evaluation with low ambient temperature and forced air cooling.




A Quick Start Guide, http://epc-co.com/epc/documents/guides/EPC9102_qsg.pdf, is included with the EPC9102 demo board for reference and ease of use.
EPC9102 demo boards are priced at $306.25 each and are available for immediate delivery from Digi-Key at http://digikey.com/Suppliers/us/Efficient-Power-Conversion.page?lang=en

**www.epc-co.com**



# 150 W LED-Driver Design with 93% Efficiency

Power Integrations announced a reference design kit for a 150 W, 48 V power supply for LED streetlights and other industrial/infrastructure lighting systems. The driver circuit described in RDR-292 is more than 93% efficient at 230 VAC input and above 91% at 110 VAC. The design delivers a system power factor of greater than 0.97, THD of less than 10%, and easily meets EN61000-3-2 C. Designs can be scaled from 75 W to 400 W, using the same platform, simply by choosing different HiperPFS™ (PFC) and HiperLCS™ (LLC) family members and sizing power components appropriately.
RDK-292 requires fewer than 125 components to implement the driver's PFC, LLC and standby power supply circuits, resulting in low BOM cost and exceptional reliability. The design utilizes a combination of Power Integrations' highly integrated HiperPFS power-factor-correction IC and the HiperLCS resonant converter IC, which together save up to 35 components compared with conventional LLC solutions. HiperLCS also permits the use of smaller magnetics and output filter capacitors than typical LLC designs. The design incorporates a Qspeed™ merged PIN-Schottky diode as well, boosting CCM PFC efficiency by delivering greatly reduced diode recovery losses when compared with conventional ultrafast silicon PFC diodes.

**www.powerint.com**

# Highest Power Planar Transformer is Introduced

Payton has introduced the highest Power Planar Transformer available for use in SMPS. The transformer is designed to accept 700 to 1000 Vdc input, and have multiple high voltage outputs with a max of 10 Amps for each output. The total output power is 90000 Watts provided the transformer is mounted on a 50C0 cool plate. Switching frequency is 70Khz and the topology is Full Bridge . The weight is under 30 pounds with the maximum dimensions of 9"x9"x5". The efficiency is better than 99.3% with more than 100 Amps in the primary. The dielectric strength is 10kVrms. Different models can be designed in this configuration based on specific technical requirements.
Payton America Inc., a Deerfield Beach, Florida company, designs, manufactures and markets Planetics®, a custom line of planar transformers and inductors to Original Equipment Manufacturers and their suppliers of power electronics. Payton's headquarter is in Israel, with manufacturing in Israel, Florida and China.

**www.paytongroup.com**

# W-Band Low Noise Amplifier from UMS

Richardson RFPD, Inc. introduces a new 80-105 GHz balanced low noise amplifier (LNA) from United Monolithic Semiconductors S.A.S. (UMS). The CHA1008-99F is a broadband, four-stage monolithic LNA designed for millimeter-wave imaging applications and is also well-suited for commercial digital radios and wireless local area networks (LANs). The device is manufactured on a 0.10im gate length pHEMT process, offering via holes through the substrate, air bridges and electron beam gate lithography. To find more information, or to purchase this products on the Richardson RFPD website, please visit the CHA1008-99F webpage. The device is also available by calling 1-800-737-6937 (within North America); or please find your local sales engineer (worldwide) at Local Sales Support. To learn more about additional products from UMS, please visit the UMS storefront webpage.

**www.richardsonrfpd.com**


# Precision Analog IC Offerings by Micross Components

Intersil Corporation announced the expansion of its precision analog die offerings through authorized distributor Micross Components. Newly available die products will include Intersil's ultra-precision, low power and/or low noise operational amplifiers; low power instrumentation amplifiers; and low power voltage regulators.
"We are thrilled by Intersil's desire to increase offerings within this line," expressed Tony Hamby, General Manager of US Distribution for Micross. "Like Intersil, many of the customers we support are leaders in their respective fields. By increasing their access to Intersil's precision products, we'll be enabling design innovations and enhancing product performance across multiple industries."

**www.micross.com**

**www.intersil.com**


# Ignition Coil Driver Reduces Power Dissipation

Fairchild Semiconductor has introduced the latest generation of ignition IGBTs that provide reduced power dissipation in a smaller footprint. The EcoSPARK® 2, FGD3040G2 and FDG3440G2 ignition coil drivers, deliver up to 20 percent reduction VSAT performance without a significant reduction of Self Clamping Inductive Switching (SCIS) energy. This optimized feature reduces power dissipation, lowers heat sink requirements and operating junction temperatures.
The EcoSPARK 2 ignition coil driver is also available in a DPAK, allowing for a D2PAK replacement solution that reduces form factor while achieving the same VSAT. Both devices support advanced multi-spark high-current ignition systems with lean burn requirements.

**www.fairchildsemi.com**

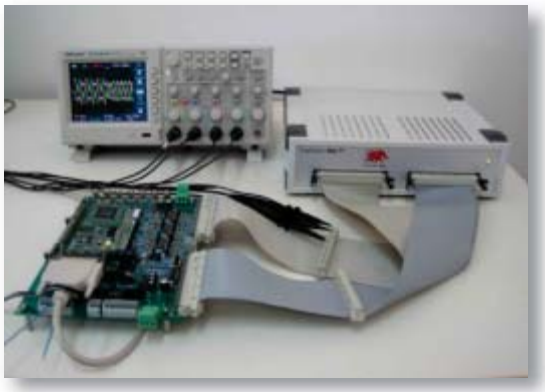

**WEB SITE: WWW.EPE-PEMC2012.COM | INVITATION (PDF VERSION)**

## Dear prospective industry partners!

It is our pleasure to invite you and your company to join us at the EPE-PEMC 2012 ECCE Europe conference an exposition. This conference and exposition gives your company an excellent opportunity to present its technology and its products to industry and academia.

In order to maximise the benefit to Industrial Exhibitorrs three related events are organised:

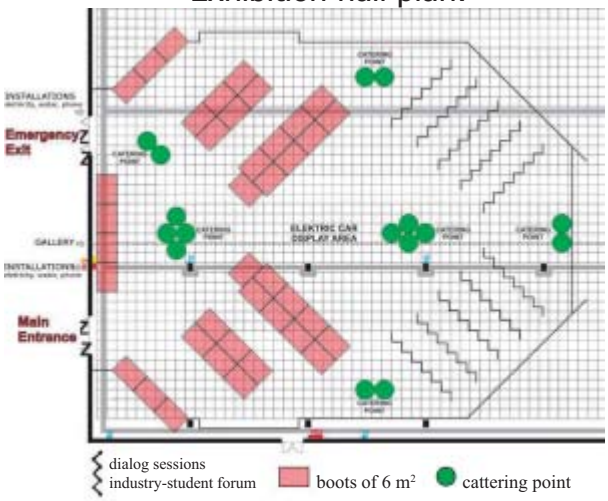
**Industry-Student Forum (Sep. 3, 2012):** The Industry-Student Forum at the EPE-PEMC 2012 ECCE Europe is a platform for bringing together companies looking for young, talented power electronics engineers and interested PhD/MSc students in the final phase of their studies. Participating students will present themselves with a poster with their CV. Companies will present their profile and employment opportunities to the students in the form of a booth. The Industry-Student Forum will be organized in cooperation with the European Center for Power Electronics (ECPE) and will be held together with the conference tutorials on 3. September 2012 (please see Tutorials and Industry-Students Forum schedule). This joint event provides a unique opportunity for students to learn about newest developments from the world-wide recognized power electronics experts and to meet young promising candidates.



**Industry Panel Sessions (Sep. 4-6, 2012):** The industry panel sessions provide an opportunity for companies to give a presentation about the latest technology achievements of their company. These sessions present a unique and much appreciated venue for highlighting new technological developments, products and services of the company in a classroom-style format. The sessions are held in the afternoons of the days of the conference.
The presentation time for each company will be 15-20 minutes.

**Exhibition (Sep. 3-5, 2012)**: The representatives from the industry, technical books & journals publishers, future conference organizers, will present their products and their programs, enhance exchange of idea between academia and industry, and meet potential clients and partners. With a limited number of conference supporting packages and a limited number of exhibition space available, we are recomending you to choose your exhibition package earlier. Priority for booth selection will be given on first come, first served basis. Please see exhibition hall plan and customize your package on the conference web site: www.epe-pemc2012.com

Exhibition hall plan:




### Why EPE-PEMC?

The conference is one of the most important of its kind in Europe. It brings together outstanding professionals in the field of Power Electronics and Motion Control from the leading research centers around the world. EPE - PEMC'2012 will be no exception and will create oportunities to renew and strengthen professional contacts of all participant, and it will highlight the multidisciplinary character of Power Electronics and Motion Control and show its vast scope of applications.
The EPE – PEMC'2012 conference in Novi Sad Serbia attracted over 400 high quality publications from 60 countries worldwide. The papers cover 15 topics important for the development of the filed of PE and MC and will be presented in more then 20 sesions. One of the important parts of the EPE-PEMC conference is the industry participation from the companies that conduct basic and applied research in cooperation with universities as well as the manufactures of power electronics components and systems, renewable energy technologies, mechatronics systems, adjustable speed drives, automation technology (hardware and software solutions), R&D companies specialisingspecializing in various fields of power electronics applications and end users of this technology.

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# Zero-Drift Operational Amplifier Portfolio

Microchip has broadened its portfolio of zero-drift operational amplifiers (op amps) with the debut of the MCP6V11 and MCP6V31 single amplifiers. Operating with a single supply voltage as low as 1.6V and a quiescent current as low as 7.5 µA, these ultra-high-performance devices offer some of the industry's lowest quiescent current for the given bandwidth without sacrificing the optimal performance essential for portable applications in the consumer, industrial and medical markets.


With an ageing world population in need of new therapies and early diagnostic tools, devices such as the MCP6V11/31 enable the development of portable medical products integrated with higher efficiency, and signal-conditioning hardware and software, which is critical to accommodate the continued push for lower costs and faster times to market. In addition, designers of industrial applications such as portable sensor conditioning and instrumentation which require low power, smaller form factors, simplified thermal management and cost control, can benefit from the optimised performance, low quiescent current and low operating voltage made possible by the MCP6V11/31 op amps.

**www.microchip.com/get/1L7G**

# Semipack 1.6 in New Protective Packaging

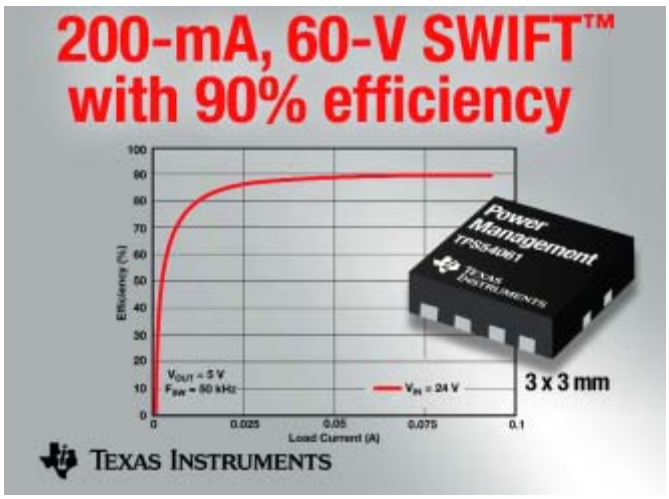
Semikron has reduced the amount of materials used in its 6th-generation SEMIPACK modules and improved module protection thanks to its new packaging concept.

The target applications for the thyristor, thyristor/diode or diode modules are input rectifiers (single-phase, three-phase, non-controlled, semi-controlled or fully-controlled) for frequency inverters or UPS systems, lighting control systems in theatres and temperature control systems in furnaces.


The thyristor-diode module Semipack 1.6 uses less material and includes a fundamental change to the design of the internal module structure. This module now features spring pressure contacts, meaning chips can now be freely positioned on the substrate and additional internal connections are no longer needed, improving reliability substantially. In addition, the heat management in the electronic packaging concept has been optimised, the result being the elimination of materials and solder layers and a clear reduction in thermal resistance Rth. This means that the maximum continuous current of the Semipack1.6 is greater than in the previous-generation Semipack 1.5. In thyristor modules the mean forward current was increased to 119A@TC=85°C, sin180° (+12%); in diode modules to as much as 134A@TC=85°C, sin 180° (+34%).

**www.semikron.com**

# Power Converter Conserves Energy in Smart Meter and Sensor Designs




Simplifying power design in smart grid and sensor control applications, Texas Instruments Incorporated introduced a 200-mA, 60-V SWIFT high-density, synchronous step-down regulator with 90-percent high efficiency and low noise performance. With a solution size of only 125 mm2, the TPS54061 integrates both high side and low side power MOSFETs, and improves efficiency in industrial automation and 4-mA to 20-mA sensor control applications, as well as smart meter, Power over Ethernet, computing and consumer designs.

The TPS54061 converter manages input voltages from 4.7 V to 60 V, and can withstand high-voltage transients up to 62 V, while saving energy – even under light load conditions. The converter supports various TI processors, including Stellaris® ARM® Cortex™-M MCUs, C5000™ DSPs and ultra-low power MSP430™ 16-bit MCUs.

**www.ti.com**

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http://DPF.Darnell.com

# Introduction of Li-ion Battery Protection ICs

ROHM Semiconductor introduces a broad line-up of ICs providing all functions needed for controlling, monitoring and protecting systems using multiple-cell series-connected Li-ion battery packs. These rechargeable battery packs are commonly used in hybrid electric vehicles or electric vehicles (HEV/EV), Power Tools and E-Bicycles, application areas which are expected to rapidly grow over the next few years. Li-ion batteries have proven to be an efficient high performance power source; however, safety functions such as voltage monitoring, over-/overdischarge detection, cell balancing and temperate measuring play a crucial role in order to secure stable and safe operation. ROHM provides a portfolio of different families exactly addressing the needs of the respective target applications, further offering chipsets for complete multiple-cell control and protection solutions:


ML5207, ML5208, ML5235 and ML5237 Li-ion Battery Management ICs for E-Bicycles & Power Tools

These are low consumption current protector ICs compatible with multiple-cell series-connected Li-ion battery packs (five to ten respectively 13 cells), detecting the over-charge or over-discharge and over-current of each cell. They also integrate the Gate driver for an automatic ON/OFF control of the external PMOS-FET or N-ch FET (depending on the version) for the charge and discharge.

**www.rohm.com/eu**

# Compact PowIRaudio™ Modules Reduce Component Count

International Rectifier has introduced the PowIRaudio™ family of integrated power modules for high performance home theater systems and car audio amplifiers. The new devices integrate a PWM controller and two digital audio power MOSFETs in a single package to offer a highly efficient, compact solution that reduces component count, shrinks PCB size up to 70 percent and simplifies Class D amplifier design.


The combination of an advanced audio controller IC with MOSFETs fully optimized for audio performance results in improved efficiency, THD, and EMI, allowing the IR43xxM family to operate without a mechanical heatsink over a wide power supply range on either a single or split power supply. High voltage ratings and noise immunity ensure reliable operation over various environmental conditions.

The single channel IR4301M and dual channel IR4302M offer the flexibility and convenience of building stereo amplifier and multi-channel designs in various channel configurations, while the devices' 5x6 mm and 7x7 mm PQFN packages enhance the benefit of utilizing a smaller size of Class D topology.

Other key features common to the family include over-current protection, thermal shutdown, internal/external shutdown and floating differential input. The IR4302M also offers clip detection.

A wide range of reference designs are available to further simplify the design of systems using these devices.

**www.irf.com**

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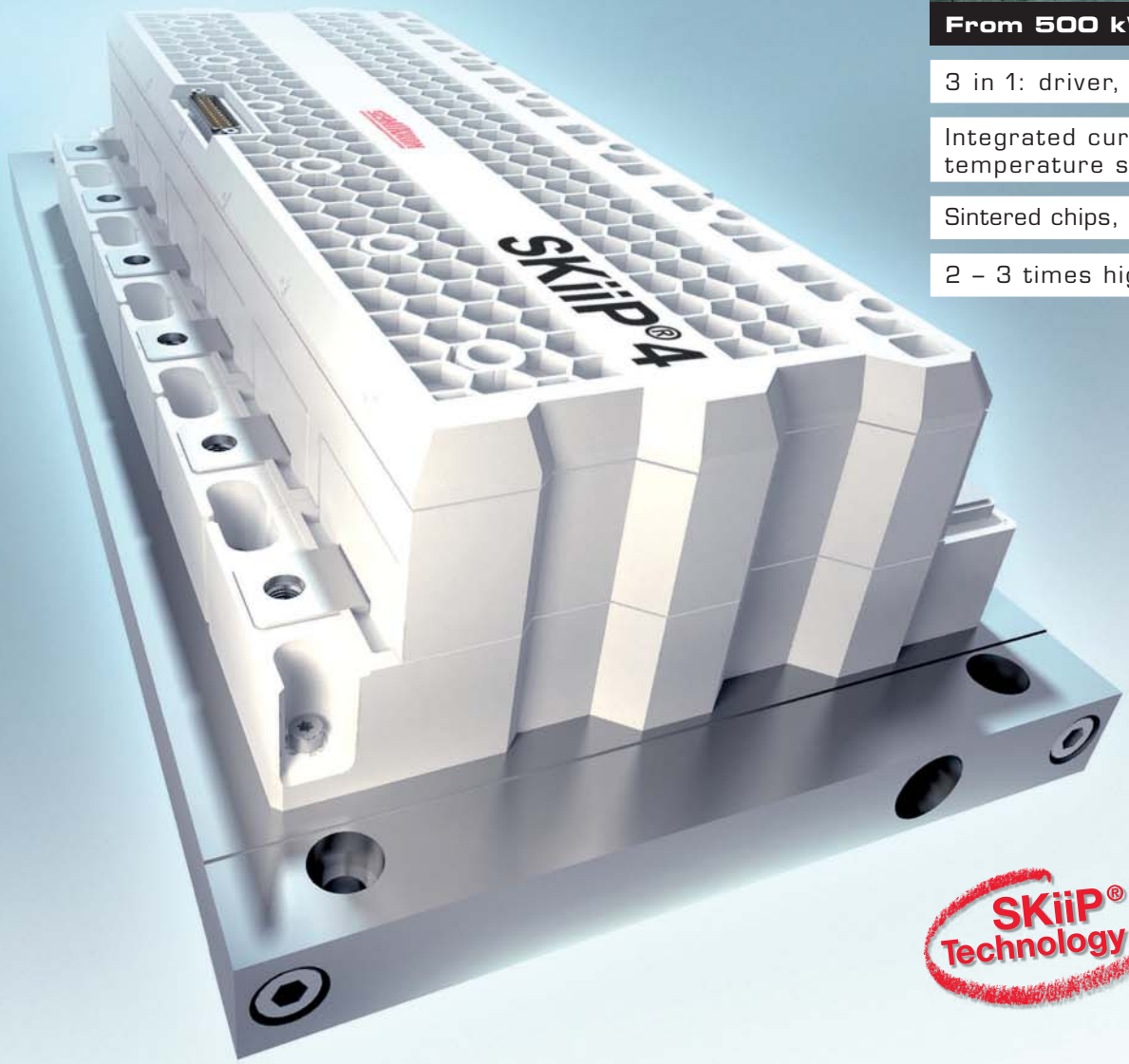


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# Introducing 40 V – 250 V MOSFETs in High Current Package

## Offering Optimized Performance and Cost for a Given Application

### Standard Gate Drive

| Part Number | Package | Voltage | Current | $R_{DS(on)}$ Max. @10V | $Q_G$ Typ @10V |
|---|---|---|---|---|---|
| IRFH5004TRPBF | PQFN 5x6mm | 40 V | 100 A | 2.6 mΩ | 73 nC |
| IRFH5104TRPBF | PQFN 5x6mm | 40 V | 100 A | 3.5 mΩ | 53 nC |
| IRFH5204TRPBF | PQFN 5x6mm | 40 V | 100 A | 4.3 mΩ | 42 nC |
| IRFH5006TRPBF | PQFN 5x6mm | 60 V | 100 A | 4.1 mΩ | 67 nC |
| IRFH5106TRPBF | PQFN 5x6mm | 60 V | 100 A | 5.6 mΩ | 50 nC |
| IRFH5206TRPBF | PQFN 5x6mm | 60 V | 89 A | 6.7 mΩ | 40 nC |
| IRFH5406TRPBF | PQFN 5x6mm | 60 V | 40 A | 14.4 mΩ | 21 nC |
| IRFH5007TRPBF | PQFN 5x6mm | 75 V | 100 A | 5.9 mΩ | 65 nC |
| IRFH5207TRPBF | PQFN 5x6mm | 75 V | 7 A | 9.6 mΩ | 40 nC |
| IRFH5010TRPBF | PQFN 5x6mm | 100 V | 100 A | 9.0 mΩ | 67 nC |
| IRFH5110TRPBF | PQFN 5x6mm | 100 V | 63 A | 12.4 mΩ | 48 nC |
| IRFH5210TRPBF | PQFN 5x6mm | 100 V | 55 A | 14.9 mΩ | 40 nC |
| IRFH5015TRPBF | PQFN 5x6mm | 150 V | 56 A | 31 mΩ | 33 nC |
| IRFH5215TRPBF | PQFN 5x6mm | 150 V | 27 A | 58 mΩ | 20 nC |
| IRFH5020TRPBF | PQFN 5x6mm | 200 V | 43 A | 55 mΩ | 36 nC |
| IRFH5220TRPBF | PQFN 5x6mm | 200 V | 20 A | 100 mΩ | 20 nC |
| IRFH5025TRPBF | PQFN 5x6mm | 250 V | 32 A | 100 mΩ | 37 nC |

### Logic Level Gate Drive

| Part Number | Package | Voltage | Current | $R_{DS(on)}$ Max. @4.5V | $Q_G$ Typ @4.5V |
|---|---|---|---|---|---|
| IRLH5034TRPBF | PQFN 5x6mm | 40 V | 100A | 3.2 mΩ | 43 nC |
| IRLH5036TRPBF | PQFN 5x6mm | 60 V | 100A | 5.5 mΩ | 44 nC |
| IRLH5030TRPBF | PQFN 5x6mm | 100 V | 100A | 9.9 mΩ | 44 nC |

### Features

- Low thermal resistance to PCB (down to <0.5°C/W)
- High Current Package – up to 100A continuous
- 100% RG tested
- Low profile (<0.9 mm)
- Industry-standard pinout
- Compatible with existing surface mount techniques
- RoHS compliant containing no lead, no bromide and no halogen
- MSL1, industrial qualification

### The IR Advantage

- Increased power density
- Increased reliability
- Multi-vendor compatibility
- Easier manufacturing
- Environmentally friendlier

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