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Electronics in Motion and Conversion

April 2017

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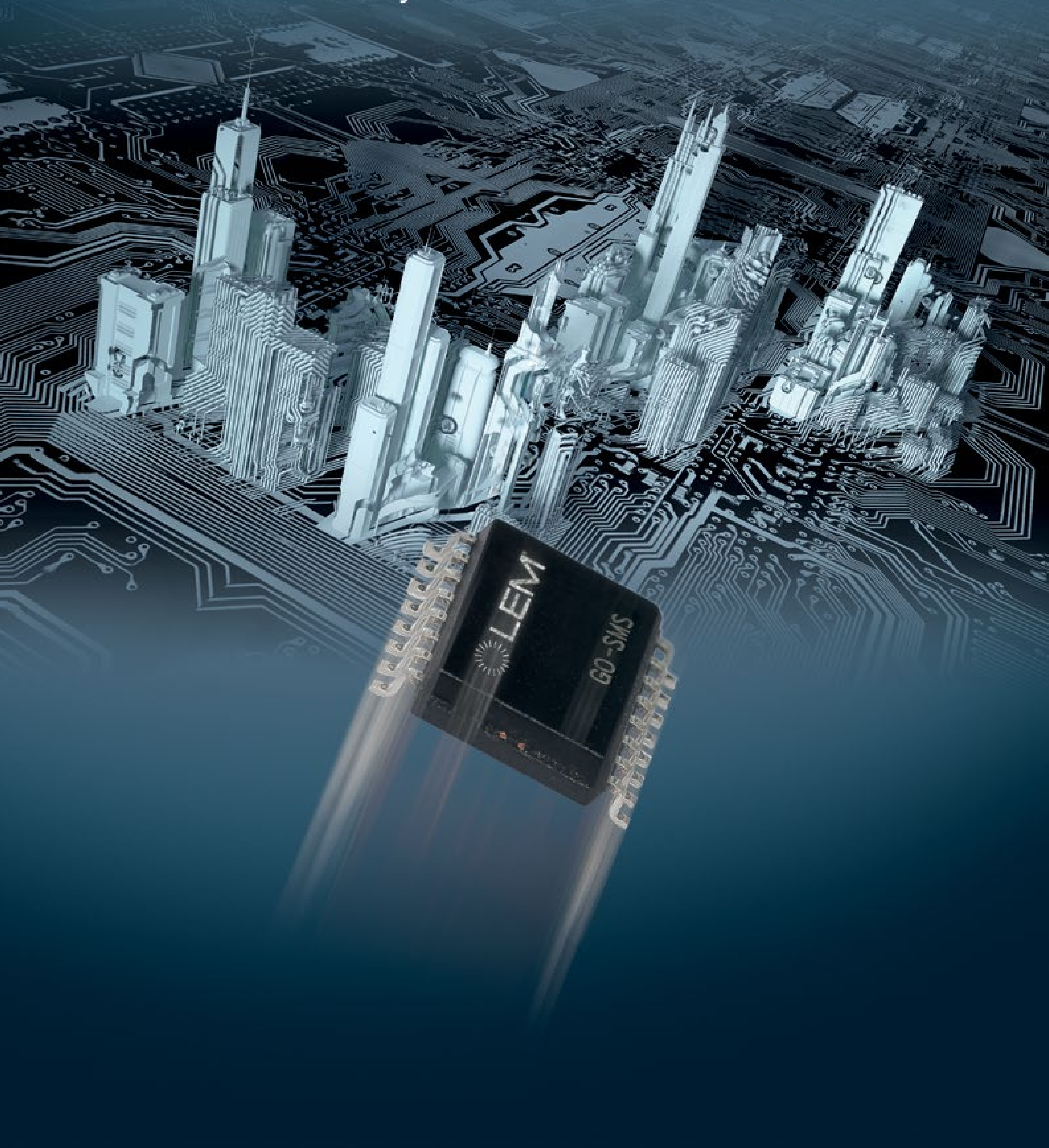

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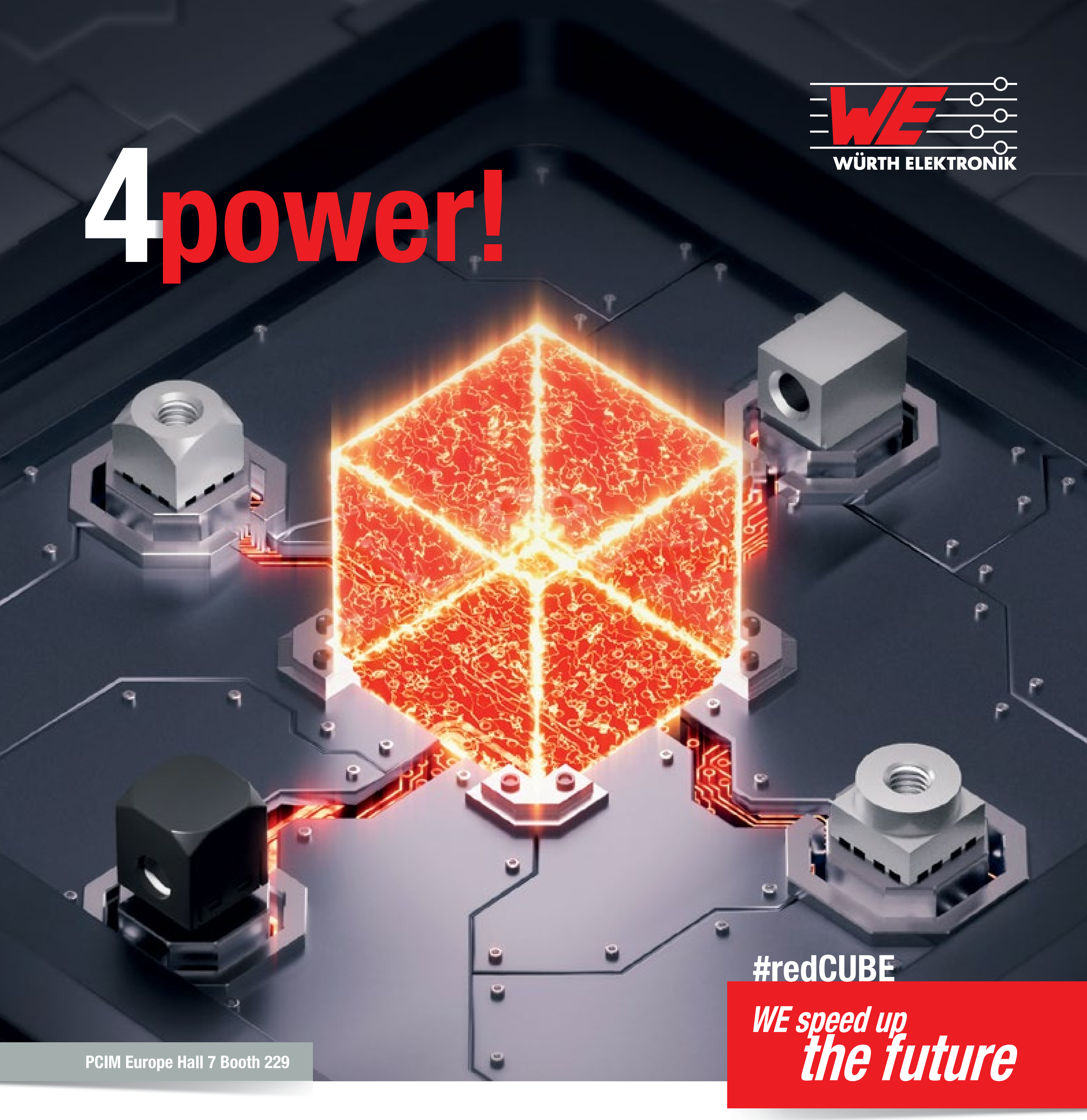
GvA Power Electronics

The Gallery



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Cape Canaveral Alligators,

As a little boy I was fascinated to watch black and white TV and see men land on the moon. It was far out in my imagination – indeed many people had trouble believing it. At that age, I was happy with my electric toy train. Many years later I visited Melbourne Florida frequently, as I worked at marketing and applications for Harris Power Products. I was again fascinated to see the Space Shuttle rising above Cape Canaveral. And for the first time I saw wild Alligators, Wildlife and Technology were in a precarious balance.

Now, back in Tampa for APEC, I realize that much of Space activity is history: no Apollo missions since 1972, 45 years ago. At that time I was a student just getting into electronics. By now, innovations in electronics have changed the world. Microcomputers have entered so many aspects of handling functionality. There was the IGBT invention of Wheatley and Becke, that enabled efficient, variable-speed, motor drives. Now most semiconductor vendors for Power Electronics have IGBTs in their portfolio. All that happened with conventionally silicon designs. But now we have wide band gap devices in SiC and GaN taking over.

It was nice to have a great time in sunny Florida and to see all my friends at APEC - working together on progress for a better world. Reducing losses and thus atmospheric emissions is important if we are to hand over to our Kids a world that is safe to live in. Our grandchildren should be proud of what we did for their future. The entire world must be great - if there is an imbalance, there will always be conflicts.

The Apollo Space program is history, but my grandchildren are still fascinated to play with my trains, now 55 years old. Electric motors have not changed too much in principal, but are they are more efficient. And in the 90's I provided Marklin little MOSFETs that helped digitize the control of their locomotives. So toys too joined the electronics world, without waiting for "Industry 4.0". It is always good to play around with toys and foster young minds for the next innovation.

Bodo's Power Systems reaches readers across the globe. If you are using any kind of tablet or smart phone, you will now find all of our content on the new website www.eepower.com. If you speak the language, or just want to have a look, don't miss our Chinese version: www.bodospowerchina.com

My Green Power Tip for April:
Don't feed the Alligators, they can run faster than you, so stay away. They like to eat whatever they can catch. We still may need your expertise for Power Electronics.

Best Regards

Events

Internat. Power Workshop on Packaging
Delft, The Netherlands, April 5-7
http://iwipp.org/

ETG Bauelemente der Leistungselektronik
Bad Nauheim, Ger., April 6-7
http://conference.vde.com/be2017

ExpoElectronica 2017
Moscow Russia, April 25-27,
http://expoelectronica.primexpo.ru/en/

SMT Hybrid 2017
Nuremberg, Germany, May 16-18
http://www.mesago.de/en/SMT/home.htm

PCIM Europe 2017
Nuremberg, Germany, May 16-18
http://www.mesago.de/en/PCIM/home.htm

ISiCPEAW 2017
Stockholm, Sweden, May 21-23
mietek.bakowski@acreo.se

Sensor + Test 2017
Nuremberg, Germany, May 30 June1
http://www.sensor-test.com/press

Intersolar 2017
Munich, Germany, May 31 June 2
www.intersolar.de/de/intersolar-europe.html

PCIM Asia 2017
Shanghai, China, June 27-29
http://www.mesago.de/en/PCC/home.htm

SEMICON West 2017
San Francisco, July 11-13
http://www.semiconwest.org/

EPE ECCE 2017
Warsaw, Poland, September 11-14
http://www.epe2017.com/

HusumWind 2017
Husum, Germany, September 12-15
www.husumwind.com

Prof. Dr. Leo Lorenz honored with Dr. HC of Valencia University

The ceremony took place on February 17th in the historical building of the University of Valencia in Spain. It is a special honor for his contribution in power electronics over several decades. The University of Valencia started its operation in 1499 with Humane Science and is today a full scale University with more than 40.000 Students.
Leo Lorenz is an honorary professor of the Ilmenau University in Germany and Tsinghua University of Taiwan in addition to several Adjunct Professorships at first class level Chinese Universities. As member of the Chinese Foreign Senior Fellow Program and German Academy of Science, he acted as a governmental technology consultant in Europe, the United States, Japan and China. Leo Lorenz started as an engineer from the Technical University of Berlin and his doctor degree is from the University of Defense in Munich Germany. His professional carrier started in the R&D Department of Power Electronics of AEG, Senior Director for the Power Semiconductors Division of Siemens, Senior Principal in Infineon Technologies, whose general direction is currently advised by him in the field of power semiconductors and advanced systems of the engineering of the future.
Doctor Lorenz is well known in the industry for power semiconductors. More than 400 publications in magazines and conferences, more than 50 key note presentations have been contributed and more than 50 international patents are registered by him.

www.ecpe.org

Dr.-Ing. Frank Osterwald is appointed to be Honorary Professor of University of Applied Sciences Kiel

Prof. Dr.-Ing. Frank Osterwald is Director Research at Danfoss Silicon Power GmbH in Flensburg, Germany.
Since eleven years Frank Osterwald is strongly involved in power electronics research and development in the institute of Mechatronics at the faculty of Computer Science and Electrical Engineering of University of Applied Sciences Kiel. With his knowledge of Microsystems as well as of power packaging & interconnection technologies he has been supporting research and teaching at the University. He had been the door opener for a number of funded research projects involving local as well as international partners. A broad range of students have been benefitting from his activities and numerous Bachelor, Master and Diploma theses have been resulting from the cooperation between the University and Danfoss Silicon Power.
Prof. Osterwald has been a member of the PhD committee of one of the PhD's from the institute of Mechatronics. Currently, he is the mentor for two more PhD students in Kiel.
His particular focus was on the transfer of technology from the University to Danfoss Silicon Power, which Frank Osterwald was driving together with the Technology Transfer Center as well as with the R&D Center of the University. About 30 master graduates from the University have had the chance to start their professional career at Danfoss Silicon Power. The close link between applied research and professional education is characteristic for the long term co-work between the University and Prof. Osterwald.

Picture: Prof. Dr.- Ing. Frank Osterwald (left) and Prof. Dr. Udo Beer, President FH Kiel, University of Applied Science (right).
Picture by Matthias Pilch

www.fh-kiel.de

www.siliconpower.danfoss.com

6th Power Analysis & Design Symposium

Symposium: April 26th, 2017 / 08:30 - 17:00
With lectures, practical examples and demonstrations presented by international power supply experts from: Biricha Digital, Microchip Technology, IDT, Kemet and Rohde & Schwarz.
Advanced Characterization, Simulation and Troubleshooting of Electronic Power Systems in Eching (near Munich), Germanytych
Open Lab: April 25th, 2017 / 15:00 - 19:00t trends in
Join our Open Lab after your daily work is done. We will have several measurement benches ready for you, where we can measure loop stability, PSRR, output impedance and more. Come whenever you want, have a beer, bring your power supplies and do some great measurements with us.
The participation in our symposium is free of charge and includes lunch and refreshments during breaks. The Symposium and the Open Lab take place at: Bürgerhaus Eching, Roßbergerstraße 6, 85386 Eching (near Munich), Germany. Please register online until April 11th, 2017.
Visit us at PCIM Europe in Hall 6 booth 244

www.omicron-lab.com/event

Final Regulatory Approval for Renesas' Acquisition of Intersil

Renesas Electronics Corporation, a premier supplier of advanced semiconductor solutions, and Intersil Corporation, a leading provider of innovative power management and precision analog solutions, announced that they received notification by the Committee on Foreign Investment in the United States on February 21, 2017 PST; February 22, 2017 JST that the investigation of the merger transaction under which Renesas will acquire Intersil is complete and that there are no unresolved national security concerns with respect to the transaction. All necessary regulatory approvals for the acquisition have now been received and the merger is expected to close on February 24, 2017 PST, subject to customary closing deliveries. Intersil stockholders have previously voted to adopt the merger agreement and approve the transaction at a special meeting of stockholders held on December 8, 2016.

www.renesas.com

www.intersil.com

Small Wind & Solar Hybrid Systems - Key to a Self-Sufficient Energy Future

The World Wind Energy Association (WWEA) and Intersolar Europe are pleased to invite the small and medium wind stakeholders as well as the Solar PV and Energy Storage industry to participate in the World Small Wind Conference (WSWC2017), taking place in Munich/ Germany on 1 and 2 June 2017, in parallel with the Intersolar Europe exhibition 2017 (31 May - 2 June 2017).
Participants from over 30 countries gathered in each of the seven internationals small wind conferences organised by WWEA in previous years - including top small wind manufacturers, representatives from international organisations like IRENA, national small wind associations, members of the academia and consumers.
The main theme of the conference is Small Wind & Solar Hybrid Systems - Key to a self-sufficient energy future. The conference is aimed at jointly exploring the current status and future developments of the wind & solar hybrid technology as well as to present new innovative business models that could exploit the market of self-supply electricity.
Abstracts are invited on issues within the scope of the topic of the conference:

www.small-wind.org

Announcing Collaboration Sales in Japan

ROHM and SEMIKRON will kick-off collaboration sales of SiC power devices and modules, to contribute to the innovative evolution of the Japanese power electronics market.

Photo: (left to right) Erwin Ysewijn, Managing Directror SEMIKRON Japan; Mr. Kazuhide Ino (Ph.Doctor), General Manager Power Device Division, ROHM Co.,Ltd.

ROHM has been a leading developer of advanced Silicon Carbide (SiC) products and SiC power devices in particular. It was the first company in the world to manufacture the SiC MOSFET in 2010 and offers SiC Schottky diodes as well. The wide range of ROHM SiC chips is suitable for an easy module integration.
SEMIKRON is one of the market leaders in power modules, covering a wide range of packages for all applications. It is well known for its cutting edge packaging technology that has set standards in power electronics. SEMIKRON offers SiC modules in six different packages covering 20A to 600A, which are widely used in the world-wide power electronics market, enabling energy savings in various applications.
Both companies together will synergize their joint knowledge (about Device, Control and Module technology) in the approach to the Japanese power electronics market, offering the perfect power solution.
Both companies will collaborate to widen the SiC power module lineup and contribute to energy saving and miniaturization.

www.rohm.com/eu

www.semikron.com

Respect for Journalists

Power Inductors and Capacitors Featured in Module Solutions

Wurth Electronics power inductors and capacitors are now featured in Monolithic Power Systems, Inc. Plug & Play Power Module Solutions.

MPS's open-frame modules provide easy-to-use, plug & play power solutions with pre-programmed output voltage options available. Using proprietary technology processes, MPS's mEZ products provide simple, high efficiency power solutions for DC/DC step down, step up, PoE, and USB charger applications. Customers can choose from ready-to-use products or 'Do It Yourself' solutions to build customized modules. All design files, including schematic, layout, and bill of materials are provided.

Learn more about these products at the Wurth Electronics Booth #811 at APEC 2017, in Tampa, FL. Yi Sun, MPS Module Product Line Manager, will conduct a free presentation Monday, March 27 at 7:00 pm and Tuesday, March 28 at 1:00 pm. For a full schedule, visit www.we-online.com/apec. For more information about MPS's mEZ products, email MEZsupport@monolithicpower.com

www.we-online.com/apec

Welcoming Twining as Vice President, Marketing

Indium Corporation has hired Tim Twining as the company's new Vice President, Marketing.

Twining is responsible for leading the development, implementation, and oversight of Indium Corporation's market strategies. Twining has extensive global sales and marketing experience in industrial, business-to-business, and manufacturing environments. As part of his extensive career, he has lived and worked in England, Russia, Singapore, and the USA.

Twining earned a bachelor's degree in Mechanical Engineering from the University of Minnesota and an MBA with a concentration in finance from the University of St. Thomas in Minneapolis, Minn.

www.indium.com

Reference Work on Battery Technology by Sven Bauer

No matter whether they're used in the automotive sector, electric bicycles, tools, energy networks, or industrial manufacturing: batteries play an ever growing role in our society, and are at the heart of many different devices and systems. They make mobile applications possible and drive innovation on all technologically-oriented markets. Only reliable energy storage systems that are lightweight and equipped with high storage capacities make it possible to use drones or other self-guiding robotic units, for instance.

The development of electrochemical energy storage systems is a field strongly characterised by dynamism and innovation. Increases in capacity are taking place almost every six months in lithium battery technology, and noticeable technological leaps occur roughly once a year. We can assume that numerous new markets will develop over the next few years where lithium battery technology can be successful: The potential for this technology is substantial.

With his book "AkkuWelt" (Battery World), Sven Bauer, Managing Director of the BMZ Group, is publishing a reference text that will become the new standard work for battery technology. The author communicates basic knowledge on battery engineering using state of the art technology, offering an overview of the development, construction, and use of batteries. Bauer is able to base his work on his exclusive knowledge as an industry leader and key innovator.

susanne.kaschub@bmz-group.com

Freedom for Journalists

Broadcom Optocouplers

Take the Risk Out of High Voltage Failure!

Optocouplers are the only isolation devices that meet or exceed the IEC 60747-5-5 International Safety Standard for insulation and isolation.

Stringent evaluation tests show Broadcom optocouplers deliver outstanding performance on essential safety and deliver exceptional High Voltage protection for your equipment. Alternative isolation technologies such as magnetic or capacitive isolators do not deliver anywhere near the high voltage insulation protection or noise isolation capabilities that optocouplers deliver.

IEC 60747-5-5 Certified

BROADCOM®

ICT Announce the Acquisition of CS&E

ICT Power USA, located in Saint Charles, Illinois is pleased to announce the acquisition of Capacitor Sales and Engineering (CS&E) of Sarasota, Florida. CS&E is a stocking distributor of motor run and motor start capacitors manufactured by Ducati Energia (Italy) & Yi-Card (Taiwan).
ICT Power USA and its sister company Iconopower Limited (both subsidiaries of the PECAS group of companies) have represented Ducati Energia for more than twenty years, focusing on their AC & DC power electronic capacitor product range. We are pleased to have the opportunity to expand the Ducati product offering to now include their high quality motor run and motor start capacitors. Collectively, the ICT / Iconopower sales team have over one hundred years of technical sales experience in AC/DC power capacitors and other power conversion components and applications.
The New Company will operate under the name “Capacitor Sales and Engineered Products“ and operations have been transferred to ICT Power USA’s facility in Saint Charles, Illinois.
ICT Power USA looks forward to assisting you with all your Power Conversion and Control needs.
Ray Ragonese – National Sales Manager, ICT Power USA

ray.ragonese@ictpowerusa.com

Call for Papers for the first Passive Component Networking Days Symposium

The European Passive Components Institute (EPCI) is pleased to announce a Call for Papers for the first Passive Component Networking Days Symposium (PCNS) jointly organised together with Technical University of Brno on Sep 12-15th in Brno, Czech Republic.
Passive components represent more than 80% of the parts used on a PCB. Therefore, they are one of key elements of electronic design. PCNS is a European technical conference that is totally dedicated to Passive Components. It is an exceptional opportunity to learn more about the latest advances in this field and meet recognized international experts from industry, academia and other agencies/organisations.
The aim of the PCNS event is to promote discussion of recent developments and trends and to encourage the exchange of technical expertise and information covering a broad range of passive electronic components. The PCNS proceedings will be ISBN-listed to validate the published papers. The papers presented will be also recommended to relevant magazines for publication in order to encourage the active participation of universities.
Hardware engineers, field application engineers, component engineers, procurement specialists and all other participants interested in passive components will also have a chance to attend one of the pre-event four hour capacitor, resistor or inductor seminars - from basics down to the depth of the technology. Abstract submission is open online at the conference website. Deadline is 2nd April 2017.

www.passive-components.eu/pcns

ECPE Tutorials and Workshops in 2017

- **ECPE Tutorial ‘Power Semiconductor Devices & Technologies’**
  26 - 27 April 2017, Berlin, Germany
  Chairmen: Dr. A. Mauder (Infineon),
  Prof. D. Silber (Univ. of Bremen)
- **ECPE Workshop ‘EMC in Power Electronics: From Harmonics to MHz - Design for EMC and Fast Switching’**
  3 - 4 May 2017, Berlin, Germany
  Chairmen: Prof. E. Hoene (Fraunhofer IZM),
  Dr. L. Dalessandro (Schaffner Group)
- **ECPE Tutorial ‘Power Electronics Packaging’**
  21 - 22 June 2017, Würzburg, Germany
  Chairmen: Prof. U. Scheuermann (Semikron),
  Dr. J. Popvic-Gerber (TU Delft)
- **ECPE Workshop ‘Condition and Health Monitoring in Power Electronics’**
  4 - 5 July 2017, Aalborg, Denmark
  Chairmen: Prof. F. Blaabjerg (Aalborg University), Dr. S. Mollov (Mitsubishi Electric R&D Centre EUROPE), Dr. A. Rojko (ECPE)
- **ECPE Tutorial ‘Thermal Engineering of Power Electronic Systems - Part I (Thermal Design and Verification)’**
  18 - 19 July 2017, Erlangen, Germany
  Chairmen: Prof. U. Scheuermann (Semikron), D
  . Malipaard (Fraunhofer IISB)
- **ECPE Tutorial ‘Thermal Engineering of Power Electronic Systems - Part II (Thermal Management and Reliability)’**
  10 - 11 October 2017, Nuremberg, Germany
  Chairmen: Prof. E. Wolfgang (ECPE),
  Prof. U. Scheuermann (Semikron)
- **ECPE Tutorial ‘Power Circuits for Clean Switching and Low Losses’**
  8 November 2017, Aalborg, Denmark
  Chairman: Dr. R. Bayerer (Infineon)

www.ecpe.org

Respect Free Press

Auxiliary Power Supply Evaluation Board for SiC MOSFET from Wolfspeed

Single-end flyback converter design delivers 48 W of power utilizing 1700 V SiC MOSFET in a low-inductance surface mount D2PAK to reduce total cost and simplify design

Richardson RFPD, Inc. announced the availability and full design support capabilities for a new evaluation board from Wolfspeed, a Cree Company.

The CRD-060DD17P-2 is a demonstration board for a single-end flyback converter design with built with Wolfspeed's commercially-available 1700 V SiC MOSFET.

The 48 W experimental reference design demonstrates how the 1700 V SiC MOSFET can reduce total cost and simplify the design of auxiliary power supply. It replaces the more common, but more complicated, silicon-based two-switch flyback topology, while successfully supporting a wide input voltage range (300 V to 1000 V). An active start-up circuit is also introduced to achieve less start-up losses with faster start-up time.

The design utilizes Wolfspeed's C2M1000170J, which is available in a 7LD2PAK surface mount package that combines a small footprint with a wide creepage distance—7mm between drain and source. By moving to the surface mount package, design engineers can achieve economical thermal designs without the need for heat sink on the MOSFET. The addition of a heat sink enables the same design to reach 58 W of output power.

The C2M1000170J features high blocking voltage with low RDS(on), low parasitic inductance, ultra-low drain gate capacitance, and a separate driver source pin. It is easy to parallel and simple to drive, and it is ideally suited for auxiliary power supplies, switch mode power supplies, and other applications involving high-voltage capacitive loads.

To find more information or to purchase these products today online, please visit the CRD-060DD17P-2 and C2M1000170J webpages. The devices are 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 about additional products from Wolfspeed, please visit the Wolfspeed storefront webpage.

About Richardson RFPD

Richardson RFPD, an Arrow Electronics company, is a global leader in the RF and wireless communications, power conversion and renewable energy markets. It brings relationships with many of the industry's top radio frequency and power component suppliers. Whether it's designing components or engineering complete solutions, Richardson RFPD's worldwide design centers and technical sales team provide comprehensive support for customers' go-to-market strategy, from prototype to production.

More information is available online at:

www.richardsonrfpd.com


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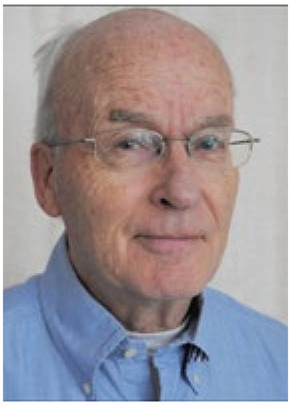
The dark Side of the Internet



It is still a common belief, that modern electronics and the Internet make our daily life more comfortable and safer. Online banking, email, social networks and endless search opportunities on the Internet eliminate paper checks, letters and faxes and offer us huge amounts of knowledge and connections. But that's only one part of our modern life.

Computer viruses, Trojan utilities and lately ransomware and the theft of millions of consumer data are not only reducing our productivity but costs us already a huge pile of money and lost time. If you are not subscribed to the newsletter of Brian Krebs (https://www.krebsonsecurity.com) please subscribe. It is an eye opener. Brian is a wellknown expert regarding cybercrime and cybersecurity. Just read his recent intro about ransomware:

"Among today's fastest-growing cybercrime epidemics is "ransomware," malicious software that encrypts all of your computer files, photos, music and documents and then demands payment in Bitcoin to recover access to the files. A big reason for the steep increase in ransomware attacks in recent years comes from the proliferation of point-and-click tools sold in the cybercrime underground that make it stupid simple for anyone to begin extorting others for money."

How many have paid and how many victims didn't get the promised key for decryption? Don't forget, we have to deal with criminals.

A few days ago, the 'Wall Street Journal' reported about a "Hack" by a 18 year old student, who created a link to a certain website, where all his followers of his social network infected their iPhones with a software routine, which caused on these smartphones endless calls to 911.

This kind of cyberattack spread fast to more than 12 U.S. states. It took IT specialists more than half a day to stop this attack. If convicted, the student faces more than 10 years in prison. According to this report, the teenager learned about this tool from a video on YouTube. And the damage had been done very easily.

But this case is not closed yet, since this incident (I hope nobody suffered through those hours) and countless other attacks show clearly, that our societies are still too complacent regarding online security.

Some time ago law enforcement people placed several memory sticks in a parking lot of a company. Almost 80 per cent of the sticks were picked up by employees, who just out of curiosity inserted those sticks into their computers. The IT people of that company were able to trace those prepared sticks. Beside phishing for IDs and passwords with emails, those attacks by memory sticks are unfortunately very successful.

Countless companies and individuals are tricked into handing over their valuables and important information. I even have to think about the worldwide online industrial espionage, which is almost untraceable.

Does your company store all its data in the cloud? How secure is this? I hope you know where the servers are, how they are protected against physical and cyberattacks and also against unauthorized access within the hosting company. Due to a simple typo by a programmer, a major cloud storage provider stopped serving his clients for hours. If you were one of those clients, is your company finished after such an incident?

Northeast Blackout

You may recall the blackout in August 2003, which hit a major part of the northeast of the U.S. and Canada (see picture). Most customers got their power back after six hours or so, people in remote areas were waiting almost two days.

According to reports, the main cause was a software bug in the alarm system at a control room in Ohio. Today I ask: Was it really a random freaking software failure? And when you look at this picture, how much damage, lost business and extra costs did this outage cause?

Experts agree, that the next outage disaster with a failing electricity grid could strike a whole country with unimaginable consequences. I'm very concerned about such a case, because news reports suggest, that those networks are not sufficient secured against cyberattacks.

Just imagine, that everybody can buy a 'ready-to-go' script kit on the dark Internet and ruin your day, your finances and your company.

My wish: Please stay alert all time in private and on the job - and don't underestimate these threats. We all already paid dearly.

Wish you well

A New Family of Miniature, Fast and Accurate Transducers for Isolated Current Measurement

The design of isolated current transducers has been continuously driven by cost and size reduction. Continuing this trend, a new family of transducers needing no magnetic circuit has been introduced in standard small-outline integrated circuit packages. Careful design results in their accuracy being similar to those of conventional transducers with only a modest reduction in isolation voltage. Some extra features have been added.

By David Jobling, David Barbagallo and Julien Feignon, LEM International SA Plan-les-Ouates, Geneva, Switzerland

Introduction

Current transducers in which isolation is required generally detect the magnetic field of the measured current; this has the additional advantage of allowing both AC and DC currents to be measured. There have been two aspects to the trend in LEM open-loop current transducers in recent years: cost and size have been continuously reduced, and by using custom proprietary CMOS ASICs as the sensing element the performance parameters such as accuracy and response time approach those of more complex closed-loop transducers (Ref 1). Usually the ASIC is placed in the air gap of a small magnetic circuit which gives noise-free amplification of the field and screening from external interference. Most of LEM's conventional open loop transducers measure currents in the range of 3 A to 100's of A, isolation levels are up to 8 kV and the response time from 2 us.

Some applications, particularly for motor drives, have the same need for speed but are less demanding of the current range and isolation levels while having strong pressure on price. In applications such as for example white-goods, window shutters and air-conditioning low cost and small size are particularly important. For these cases LEM has now introduced an additional family of sensors, the "GO" family, whose size is reduced even further by eliminating the magnetic circuit. Instead, the primary current is passed directly into a standard integrated circuit package where its magnetic field is measured by a

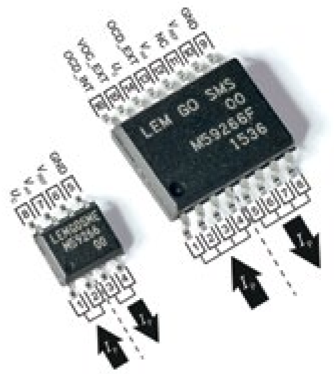


Figure 1: The GO series transducers and their pin connections in SOIC-8 and SOIC-16 packages

new ASIC derived from that used in conventional transducers. Figure 1 shows two such examples. One is in an SOIC-8 package and the 4 secondary-side pins are for the supplies, the output voltage Vout and a reference voltage Vref. The other is in an SOIC-16 package where 8 secondary pins are available so the opportunity has been taken to provide two different Over-Current Detect (OCD) warning levels; one very fast, and the other slower but more accurate. The speed and accuracy of the GO transducers are very similar to those of a transducer with a magnetic circuit. The absence of a magnetic circuit of course means that there is zero magnetic offset.

Architecture and features

The GO transducer ASIC is derived from that used in LEM open-loop transducers which have a magnetic circuit. There is considerable production experience with this ASIC, which has allowed introduction of some extra features around the well-known signal path blocks. In this section the design of the GO transducer is described and some contrasts are made with magnetic circuit transducers.

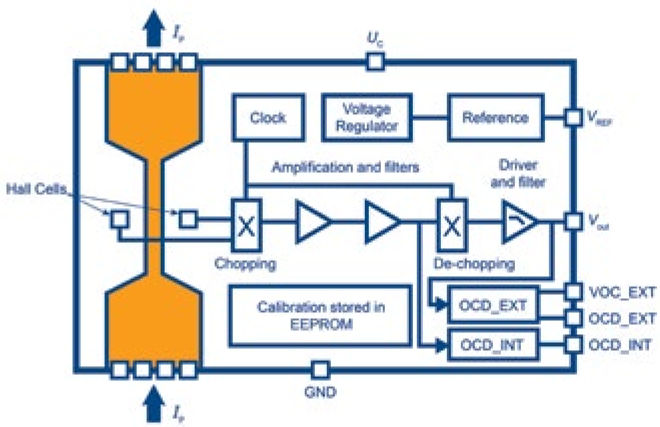


Figure 2: Block diagram of a GO transducer in an SOIC-16 package

Figure 2 shows a simplified block diagram of a GO transducer in a 16-pin package. Multiple Hall cells implanted in the ASIC are placed on both sides of the primary current to detect its magnetic field. Their offset, together with that of the input amplifiers, is eliminated with chopping techniques which modulate the Hall cell output to an AC

signal. After amplification the Hall signal is demodulated back to its original frequency before buffering and filtering at the output. The fast response time is achieved by using a high chopping frequency and internal filters which reduce the noise bandwidth of the system.

During production each transducer is individually calibrated. Tests are done at 3 temperatures; the drifts of sensitivity and output offset are measured and corrections stored in an EEPROM memory on the ASIC; this ensures that the transducer accuracy is maintained over temperature and aging.

The ASIC is separated from the primary conductor by a series of insulating layers – an optimum separation has been chosen for the best compromise between highest isolation with a wide separation and highest magnetic field at the Hall cells with lower separation. The Hall cells on opposite sides of the primary are sensitive to fields in opposite directions so the transducer is immune to uniform magnetic fields from sources other than the measured current. The exact lateral position of the Hall cells relative to the primary is not critical, since the difference between the outputs of the cells on the opposite sides is used. In other words, the Hall cells are configured as a gradient sensor.

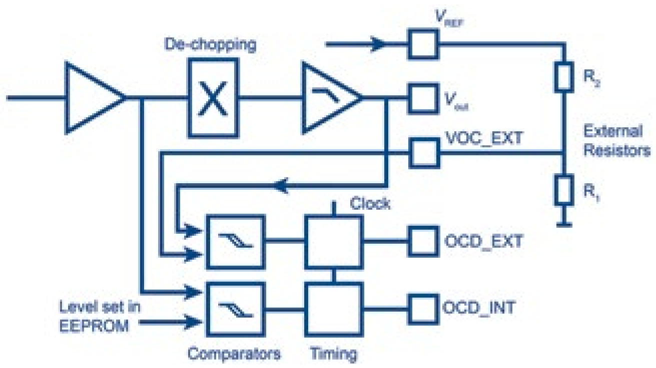


Figure 3: Block diagram of the Over-Current Detect (OCD) systems

The detail of the OCD implementation is shown in figure 3. The aim is to give two different levels of warning. The first level is for currents slightly higher than expected, to warn for example that a drive current is going out of the expected range. This OCD needs to be reasonably accurate, not especially fast, and each user may want to set a different level. The relaxed speed requirement allows the input to this first OCD to be taken from the transducer output, and the level is set by user-chosen external resistors, hence its name, OCD_EXT.

The second level is intended to warn of currents which are dangerously high, due to a short circuit for example. The response time must be extremely fast, but the value and accuracy of the detection level are not critical. To obtain a fast response time and to allow an OCD level outside the normal linear operating range the input to the second OCD is taken before the demodulation block. Its level is set internally by storing a parameter internally in the EEPROM – so it is known as OCD_INT. The level is typically set at 3x the nominal primary current, I_{PN}.

Figure 3 is slightly simplified: it omits the detail that ensures that both OCDs respond to both positive and negative over-currents.

Both OCDs check that the over-current condition is present for at least 1us approximately, to avoid false alarms, and both outputs, once triggered, are maintained for 10us to be sure that the condition can be detected. The outputs are open-drain, which conveniently allows OCDs from several transducers to be connected together. OCD_INT triggers in less than 2.1 us; the typical response time of OCD_EXT is 10 us.

The footprint of a GO series transducer in a 16-pin package is about 100 mm2, and in an 8-pin package it is half of this. The corresponding value for the smallest PCB-mounted transducer with a magnetic circuit is about 400 mm2. The heights are 2.5 mm and 12 mm respectively. However, for both types, in the higher current ranges some allowance must be made for dissipation of the heat generated in the transducer primary, which is greater in the GO series since the primary resistance is higher.

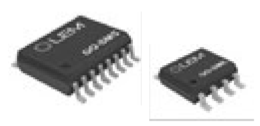
Parameter	**GO transducers**	**Magnetic circuit based transducers**
		
Nominal current range	4 A – 30 A	3 A – 50 A
Supply	3.3 V or 5 V; 19 mA	3.3 V or 5 V; 19 mA
External field immunity	Yes: gradient sensor	Yes: magnetic circuit screen
Insulation test, 50 Hz, 1 min	3 kV	4.3 kV
Impulse test voltage, 50 us	4 kV	8 kV
Creepage, clearance distances	SOIC-8: 4 mm; SOIC-16: 7 mm	>8 mm
Accuracy at 25°C	1.0%	1.0%
Accuracy over 25 - 105°C	3.0%	3.4%
Primary resistance	0.7 mOhms	0.2 mOhms
Out-of-range detection	Yes, 10 us response time	No
Short-circuit detection	Yes, 2.1 us response time	Some models, 2.1 us
Response time	<2.5 us	<2.5 us
Offset drift (10 A model)	0.9 mA/K	0.9 mA/K
Sensitivity drift	150 ppm/K	200 ppm/K
Magnetic offset	0	0.25 A after 10x I_{PN}
Footprint	50 – 100 mm^2	400 mm^2 or more
Height	2.5 mm	12 mm or more

Table 1: Comparison of key parameters of GO series and magnetic circuit based transducers

Key parameters and measured transducer performance

In Table 1 some of the key electrical parameters of the GO series transducers are presented. For comparison, the values of the same parameters for a small open-loop transducer with a magnetic circuit are also given – a small transducer has been chosen to give the most meaningful comparison, a larger transducer would have different parameter values.

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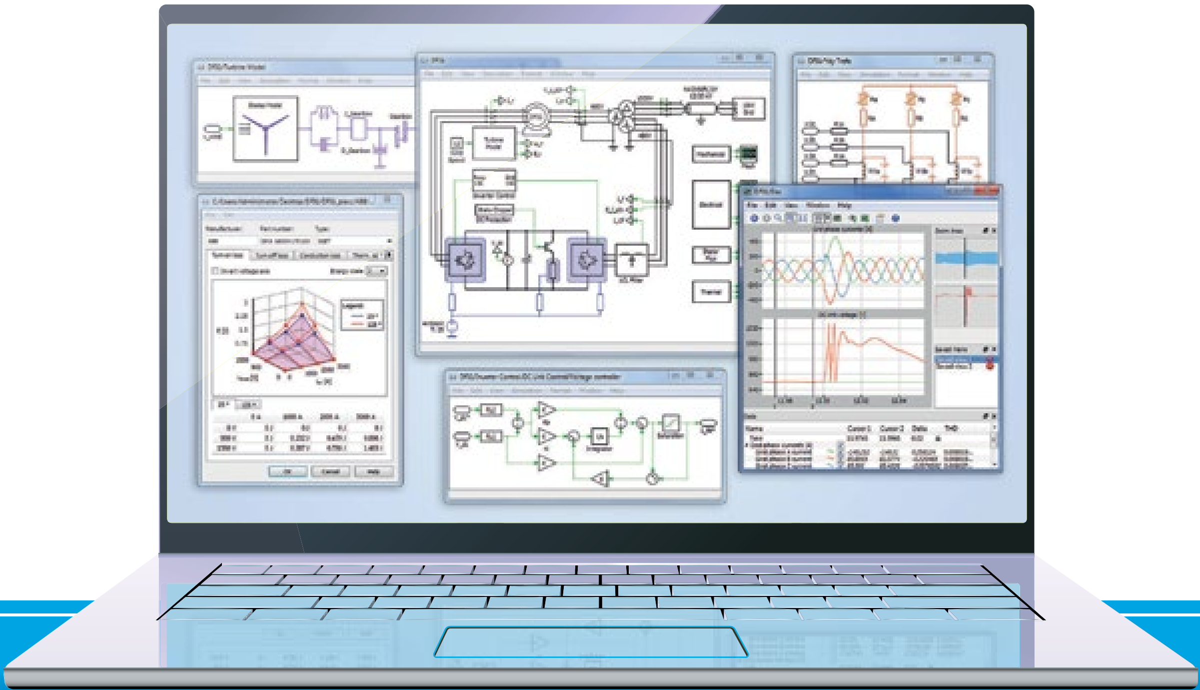

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Table 1 shows that many key electrical parameters have been inherited unchanged or slightly improved from the established sensors with a magnetic circuit, whereas others, such as size and insulation, are different, allowing the two transducer families to address quite different markets.

Figure 4 shows a measured response time after a primary current change in 0.3 us. The compact size and absence of magnetic components in the transducer gives a response with very little overshoot and ringing.

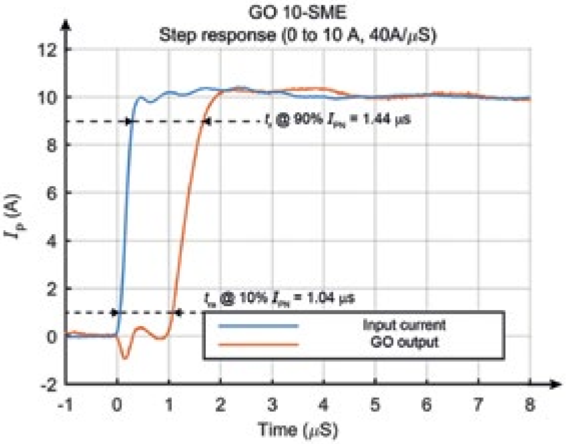

Figure 4: Response time measurement of a GO transducer

The assertion made previously that the GO transducers are not disturbed by external magnetic field will be true if the amplified electrical output of the Hall cells from both sides is the same, since the difference between the two outputs is used. To satisfy this condition:

(i) The sensitivity of the Hall cells on both sides of the primary (and the amplifiers to which they are connected) must be the same; that is, they must be well matched;

(ii) The magnetic field must be the same on both sides of the primary; it must be uniform.

Considering point (i), because the Hall cells and the amplifiers are made with large devices, their matching is excellent. When a uniform external magnetic field is applied to a GO transducer it is almost perfectly rejected.

However, for point (ii) the magnetic fields generated by conductors placed close to the transducer are not uniform and the outputs from the two sides of the primary will not be perfectly rejected. This has been investigated for conductors placed in 4 different positions near a GO transducer; see figure 5. The worst case is position 3 in which the external conductor is aligned with the GO primary. If the external conductor carries 10 A and the measured current is also 10 A the transducer output error due to the external current will be only about 1% of the measured current even with zero distance between the external conductor and the GO. This investigation shows that with a minimum of care in the design of PCB layout, external conductors will have negligible influence on the accuracy of GO series transducers.

Another important consideration in miniature transducers is the effect of a sudden primary voltage change on the transducer output. This is best handled at the ASIC level. Where internal signal levels are small they are always differential, and changes in their common mode level due to an external transient have little effect. Sensitive nodes can be protected by small grounded screens on the top metal layer. Screening is used only over the small areas where it is needed. This has many advantages over large screens: the top metal layer remains available for interconnect where screens are not needed; the ASIC die is not hidden and damaged parts can be analysed, and there are no Eddy currents which would slow the response time.

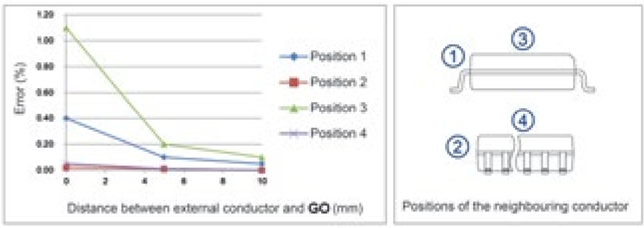

Figure 5: The effect of external conductors on the accuracy of a GO transducer. The error is shown when the currents in the GO primary and the external conductor are the same

Figure 6 shows the effect of a dv/dt of 5kV/us on the output of a 25 A GO (GO 25-SMS). The peak disturbance on the output is 4% of I_{PN} and the recovery time is about 3.6 us.

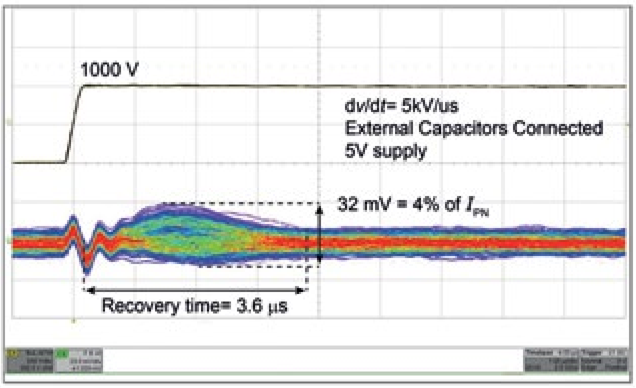

Figure 6: Response of a GO transducer (GO 25-SMS) after a dv/dt disturbance

Conclusion

This article has introduced a new series of miniature, fast and accurate transducers for isolated measurement of AC and DC currents. Some of their electrical parameters are similar to those of transducers with magnetic circuits and others are altered. Different transducers will be suited to different applications and the addition of this series to the LEM catalogue will extend system designers' possibilities for optimizing their systems with the most efficient cost effective means of isolated current measurement.

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Authors

David Jobling, David Barbagallo and Julien Feignon,
LEM International SA; Plan-les-Ouates, Geneva, Switzerland

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A Practical Study on Three-Level Hybrid SiC/Si Inverters

In today's PV, UPS and GPI systems, three-phase output inverters are often based on three-level topologies using Silicon IGBTs. This article demonstrates the potential of a hybrid inverter using CoolSiC™ MOSFETs and TRENCHSTOP™ 5 Silicon IGBTs.

*By Fabio Brucchi, Infineon Technologies Italia S.r.l. and
Klaus Sobe and Davide Chiola, Infineon Technologies Austria AG*

State of the Art Three-Level Inverter Topologies

Three-level inverters based on Silicon IGBTs are a common design solution giving an excellent cost/performance ratio. As explained in [1]-[3], the technical advantage over the classical two-level B6 inverter represented in Figure 1 (a) is a reduction of switching losses and filtering effort, at the expenses of higher circuit complexity. Two commonly found three-level designs in the low to mid power range are the Neutral Point Clamping Diode and the Neutral Point Clamping Transistor topology, illustrated in figure 1 (b) and (c), respectively.

As explained in [2], [4] and [5], both three-level topologies have their advantages and disadvantages. While T-Type inverters have fewer semiconductor devices on the current path and thus low conduction losses, I-Type inverters benefit from lower switching losses as there is no need for a relatively slow higher voltage device. Consequently, T-Type inverters are typically found at switching frequencies up to 20-30kHz, I-Type inverters above.

SiC Technology Changes the Picture

The unique features of Silicon Carbide (SiC) switches were described in [7] and [8] together with the potential impact on applications. With the emerging SiC semiconductor technology the degrees of freedom for the designer become higher, opening the path to new scenarios: fast 1200V SiC switches can make T-Type inverters attractive for higher frequencies and even the transition back to a two-level solution might be considered in order to achieve higher efficiency and reduce the bill of material [6].

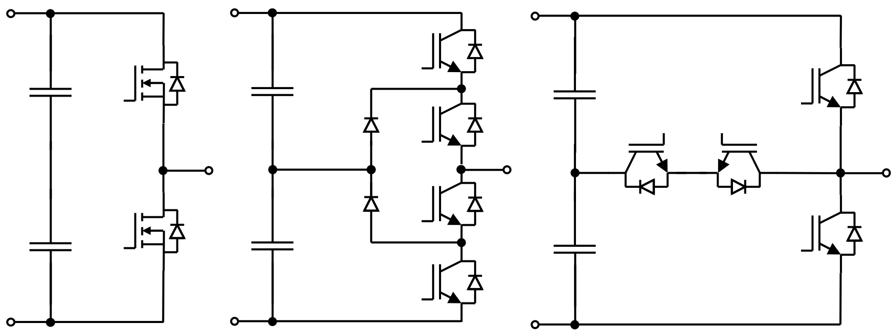


Figure 1: Commonly used inverter configurations: (a) two-level (B6, Six-Pack) inverter; (b) three-level neutral point clamping diodes (NPC-1, I-Type) inverter; (c) three-level transistor clamped (NPC-2, T-Type) inverter; for each topology only one out of three phases is shown.

In the following sections, the potential of a hybrid T-Type inverter using 1200V CoolSiC™ MOSFETs and 650V TRENCHSTOP™ 5 IGBTs is demonstrated experimentally. The key benefits of this approach are low conduction and switching losses, relatively low effort for output and EMI filtering and – compared to converters with more than three levels – moderate control effort.

Test Setup and Conditions

Since this article considers the influence of only the power semiconductors on the system efficiency, all measurements were carried out using a single phase test board and a fixed L-C-L output filter designed by Tecnologie Future S.r.l. and Infineon Technologies Austria A.G. The design goals for this platform were a simple component

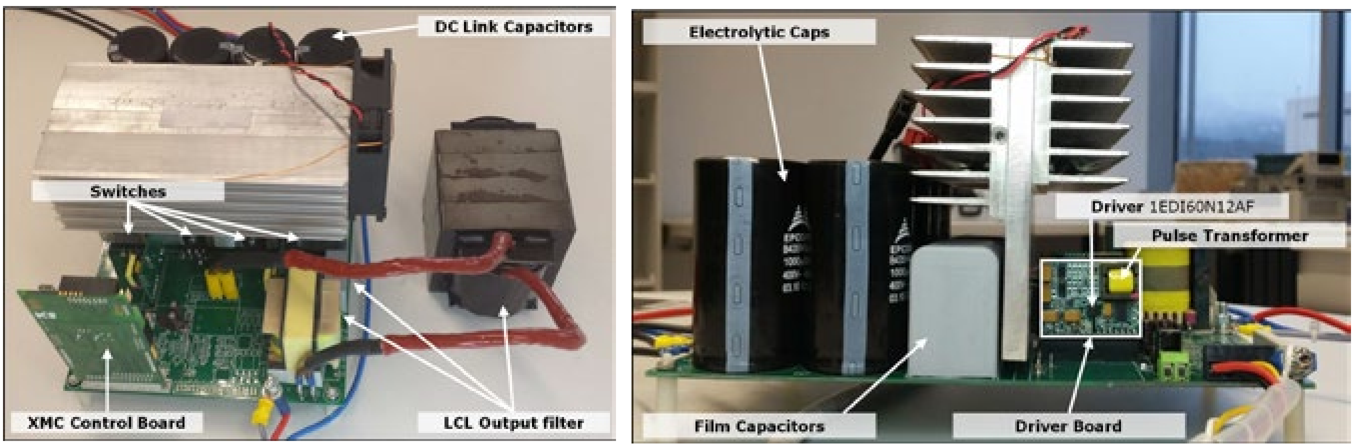
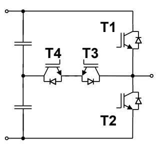
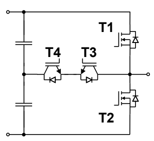
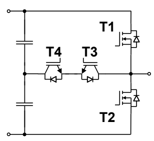


Figure 2: Single-phase test platforms in front and side view

replacement as well as an easy access for thermal and electrical measurements – not a demonstration of power density or a BOM cost reduction.

It should be noted that the absolute efficiency values obtained with a single-phase system do not correspond one-to-one to the values of a three-phase and three-wire system, i.e. a system without exposed neutral. First, the core losses of the filters are different and second the modulation scheme cannot use a third-harmonic injection technique.

All devices were operated using an Infineon 1EDI60N12AF driver. This compact, isolated, single channel driver is based on the coreless transformer technology, featuring a high common mode transient immunity – a major requirement when dealing with high speed switches. The output voltage of the drivers is provided using a local HF transformer close to the driver that is fed from one resonant AC link. Using the turn-ratio of the transformer, the gate voltages are set to +15V for turn-on and -5V for turn-off.

Circuit Schematics	3L-IGBT	3L-Hybrid-1		3L-Hybrid-2	
					
T1/T2 D1/D2	*IKW40N120H3* 1200V 40A Si IGBT (H3) 1200V 20A Si Diode	IMW120R045T1 1200V 45mΩ CoolSiC™ MOSFET		IMW120R045T1 1200V 45mΩ CoolSiC™ MOSFET	
T3/T4 D3/D4	*IKW30N65ES5* 650V 30A Si IGBT (S5) 650V 30A Si Diode (Rapid 1)	*IKW30N65ES5* 650V 30A Si IGBT (S5) 650V 30A Si Diode (Rapid 1)		*IKW30N65_S5 + IDH16G65C5* 650V 30A Si IGBT (S5) 650V 16A SiC SBD (Gen 5)	
f_{sw} [kHz]	24	24	48	24	48
P_{max} [kW](1)	4	5	4.2	5.5	5.2
η_{max} [%] (2)	98.5	99	98.5	99.1	98.8

(1) P_{max} refers to the output power that can be reached before exceeding 100 °C device temperature measured at thepackage case front side;
(2) η_{max} refers to the maximum efficiency value that is reached.

Table 1: Test scenarios and results for the single-phase test system at unity power factor

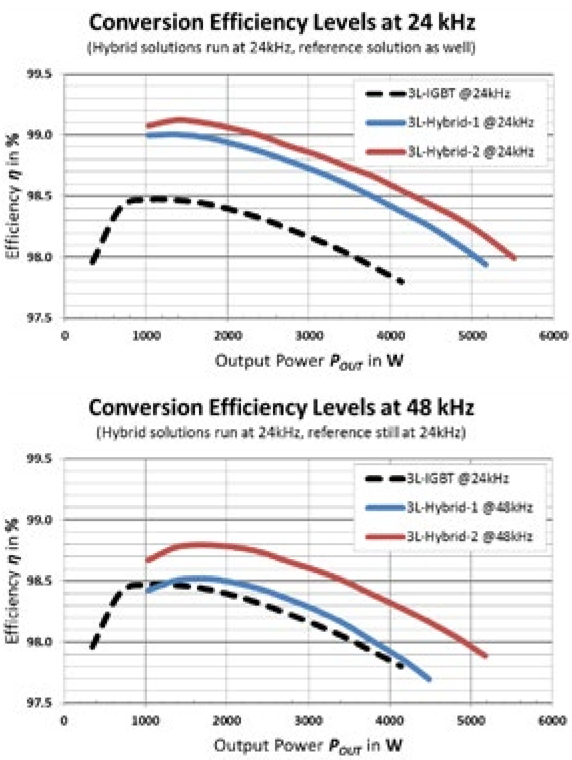


Figure 3: Conversion efficiency as a function of output power for the single-phase test system at unity power factor

The single phase inverter was operated at a constant DC link voltage of $720V_{DC}$ providing a voltage of $230V_{RMS}$ on the output. Using an electric AC load the output current of the inverter was increased in steps of $1{,}5A_{RMS}$ every 5 minutes in order to determine the conversion efficiency for different load situations.

Test results

A summary of all measurement results can be found in Table 1. For each scenario the circuit, the devices under test, the switching frequency f_{sw} as well as the maximum achievable output power P_{max} and efficiency η_{max} are given.

Figure 3 shows the conversion efficiency levels obtained as a function of the output power at 24kHz and 48kHz, respectively. The efficiency values consider the losses on the semiconductors and passives but not the power required for control and driving.

The loss distribution depicted in Figure 4 was estimated with an analytic calculation routine and verified using chip and heat sink temperatures. Minor deviations were considered to be caused by a deviation of switching losses and corrected according to the experimental data. Calibration measurements to determine the correlation of losses and temperatures were done upfront.

The selection of the 1200V devices is based on the DC current rating of the data sheet. The 650V switches were kept the same throughout all tests: S5 IGBTs with a trade-off of conduction and switching losses. For the diode, a fast Si diode as well as a SiC SBD – both with the same DC current rating at 100°C case temperature – were selected.

IGBT three-level solution: 3L-IGBT

As the three-level, pure silicon IGBT solution can be considered state-of-the-art, it serves as a benchmark within this article. As depicted in figure 3, 4kW output power per phase and a peak efficiency of 98.5% were reached at a switching frequency of 24kHz. A slight increase of efficiency and output power could be achieved with a lower switching frequency, at the expenses of a larger filter to maintain the same ripple and EMI figures.

Hybrid three-level solution: 3L-Hybrid-1

A more efficient way of reducing the switching losses is to replace the switches T1 and T2 of the T-Type inverter by CoolSiC™ MOSFETs, leading to the solution referred to as 3L-Hybrid-1. By keeping the same switching frequency of 24kHz the peak efficiency can be lifted by 0.5% and the output power can be increased by 25%. By doubling the switching frequency the output filter's size and cost can be reduced by keeping the original IGBT efficiency line. This hybrid solution can be considered relatively balanced, since it is always one SiC and one Silicon device involved in the commutation.

Hybrid three-level solution: 3L-Hybrid-2

A further performance improvement can be reached by replacing the Silicon Rapid 1 diodes D3/D4 with CoolSiC™ Schottky Barrier Diodes (SBD), leading to the third solution 3L-Hybrid-2. Although the SiC diodes do increase the conduction losses of D3/D4 by some watt, this is more than counterbalanced by the savings in switching losses of T1/T2 and D3/D4. Therefore, the benefits of this solution are increasing with the switching frequency. Apparently, a solution like that can be optimized towards frequencies that are even higher than the 48kHz shown above.

Summary and Conclusion

Results presented in this article demonstrate that the use of SiC devices allows unprecedented high degree of freedom in the design of a power electronic system.

When high efficiency and output power are the main design goals, an existing three-level T-Type topology might be adapted by simply replacing Si IGBTs with SiC MOSFETs ("3L-Hybrid-1") and maintaining a relatively low switching frequency.

For system-cost optimization, the switching frequency could be increased. In this case, both hybrid solutions might be an option. The selection will depend heavily on the efficiency and power factor requirements as well as the trade-off between magnetic component cost reduction vs SiC component cost adder.

Acknowledgements

The Authors would like to warmly thank the Design House Tecnologie Future S.r.l., in the name of Dr. Giovanni Pace and Ing. Fabio Angeletti for the great support and the important contribution to the implementation of the present project.

Figure 4: Distribution of the semiconductor losses in the single-phase test system at unity power factor

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Evaluating the Effect of High Switching Frequency on the Performance of an Active Front End Converter Results in Efficiency of 98.5%

Increasing the switching frequency of a power converter will bring a number of benefits; passive component size can be reduced as the requirements for stored energy decrease, and increasing control loop bandwidths will enhance dynamic performance. For commercial power converters operating in the 10s of kW though, the upper limit of switching frequency has tended to be in the 10 – 20 kHz region where IGBT switching losses start to become unmanageable without more complex soft switching techniques.

By Jon Woodhead, Converter Technology Ltd, Pangbourne, UK

Introduction

With the recent rise of wide-bandgap semiconductors, particularly Silicon Carbide (SiC), switching losses have once again taken a back a seat and the frequency of converters can be pushed further, but is there a point at which other system level challenges limit performance? The Converter Technology Hardware Stack™ has been used to explore the behaviour of a 10 kW active front end (AFE, Figure 1) as a function of switching frequency and highlight some of the challenges seen when running at high frequency with this topology.

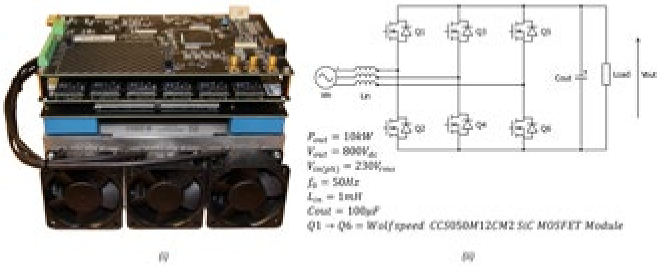


Figure 1: (i) Converter Technology Hardware StackTM Rapid Prototyping System (ii) 10 kW Active Front End Schematic and Parameters

Control of the AFE

An AFE is a natively bidirectional power topology which allows a three phase AC supply to be converted to a high voltage DC link whilst maintaining excellent power factor and low harmonic distortion. Rather than adhering to the methods used in single phase PFC, whereby the mains current is forced to follow the shape of the mains voltage, mimicking a perfectly resistive load, most three phase PFCs operate slightly differently. The central premise can be most readily understood if a single phase of the converter is analysed and imagined to be running as an inverter from a constant DC link. A duty cycle is chosen so that a sine wave of almost identical phase and magnitude to the mains is generated at the converter side of the input inductors. Adjusting the magnitude and phase of the converter voltage, VAFE, relative to the input voltage, VIN, will create a voltage drop across the inductor, forcing current to flow. By adjusting the amplitude and angle of the current relative to the input voltage, full bi-directional control of both active and reactive power becomes relatively simple to implement, opening up the converter to run in regenerative mode and/or carry out reactive power compensation. Figure 2 demonstrates the calculation of the converter voltage VAFE and phase angle ε (ignoring the impact of inductor ESR for clarity). For 10kW total power (3.3kW/phase, power flow from AC to DC link), 230Vrms phase voltage, 50Hz mains, unity power factor and a 1mH inductor, calculations show that VAFE will need to be around 230.05Vrms and lag the mains voltage by 1.13°.

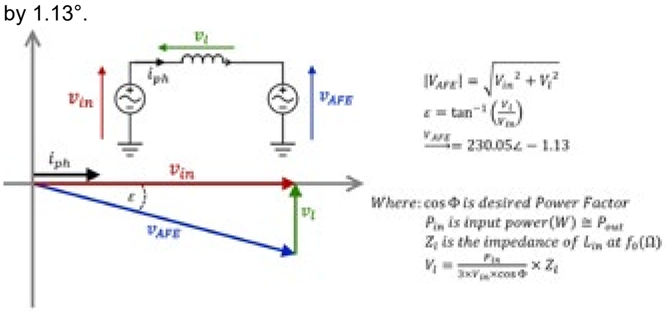


Figure 2: Calculating the Converter Voltage and Phase Angle

For this converter, Voltage Oriented Control (explained in some detail in [1]) is used to accomplish this. In brief, the three phase rotating values for input voltage and current are transformed into stationary values within a DQ reference frame aligned to the phase of the input voltage. In this way, simple PI controllers can be used to independently set the active and reactive current flow through the inductor. An outer loop is then closed around these to regulate the DC link voltage.

The Influence of the Inductor Value

In general, an increase in switching frequency allows for a corresponding decrease in inductor for a given ripple current, but there are there are other considerations when using an AFE. In assessing whether the inductor value can be reduced, one has to consider not only the current ripple but also the resolution of the measurement data available and the potential impact on system stability. As can be seen from the calculations in Figure 2, the required AFE voltage and angle are very close to the phase voltage, and both are directly related to the impedance of the inductor at line frequency. Whilst a simple voltage transducer with a measurement accuracy of 1 % would cause no issue when measuring the DC output voltage of the converter, it becomes significant when looking at the input voltage.

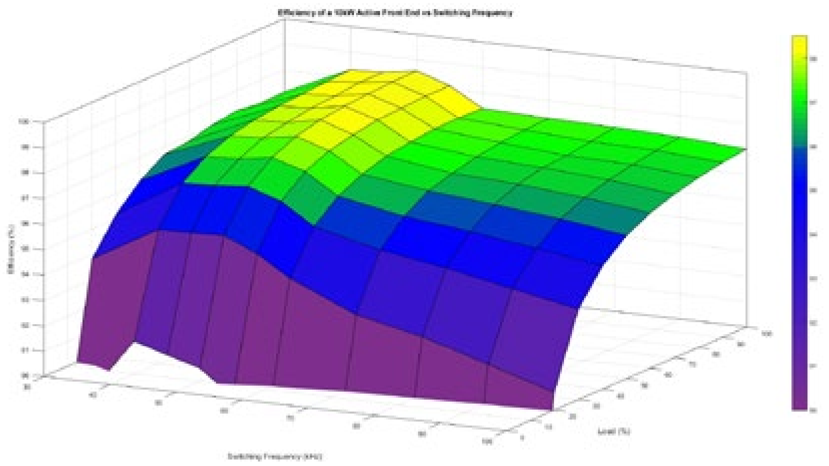


Figure 3: Efficiency of a 10 kW Active Front End vs Switching Frequency

It should also be considered that by setting the voltage VAFE relative to a measured input voltage to force current flow through the inductor, the current controller is essentially closing the loop around the inductor, so the gain of the system is inversely proportional to the inductor value. Combining the increased impact of measurement inaccuracies with extra sensitivity suggests that targeting very high frequency operation (100s of kHz) to use lower inductance at these power levels would likely require more complex control schemes.

Operational Data

The converter was run at switching frequencies from 30 – 100 kHz and at loads of 10 – 100 %. Input voltage was 230Vrms(ph) and output was 800Vdc. Input and output power were monitored to calculate efficiency whilst the power factor and THDi were directly available from the power analyser on the input. Figure 3 shows the variation of efficiency of the converter over the whole range of conditions. As can be seen, even in this prototyping setup, efficiencies above 98 % are achievable. The maximum full load efficiency was measured at 98.6 % when running at 50 kHz.

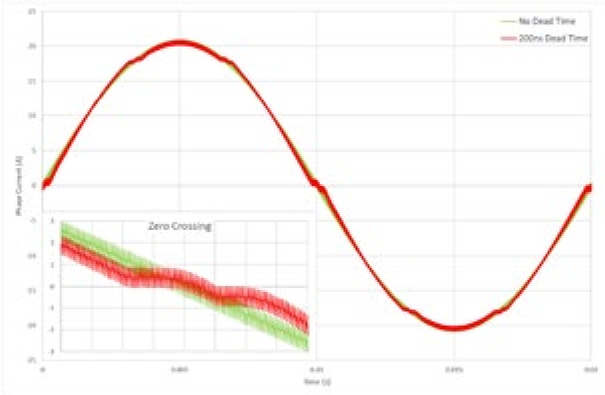
Whilst it is common to use the power factor as a figure of merit, IEC Standard 61000-3-2 actually dictates maximum limits of harmonic distortion in the current waveform when determining EMC compliance. Although compliance can only truly be assessed by looking at the current harmonics individually, a rough guide is that THDi should be less than 10% (the sum total of all of the stated harmonic limits). For reference, this would equate to a power factor of 0.995 on a system where the voltage and current are perfectly in phase.

THDi was seen to reduce with an increase in switching frequency. Running the AFE at a switching frequency of 50 kHz presents a THDi of just 3.2% and the THDi was observed to be less than 5% across the range of switching frequencies tested, though there was a slight drop off in performance above 80kHz.

The Impact of Dead-Time

The drop off in efficiency and harmonic performance at high frequency are likely both attributable to the increasing impact of dead time. As demonstrated in [2], the error in the duty cycle when a sine wave is generated by an inverter power stage is directly proportional to the dead time divided by the switching period. This causes deformation of the waveform, which gets exaggerated at higher switching frequencies. This distortion causes the waveform to contain more low order odd harmonics, causing THDi to increase. This can be seen from the simulation results shown in Figure 5.

The less immediately obvious impact is how this affects the losses. During the dead time period, circulating current will be forced to flow through the diodes rather than the MOSFETs. The MOSFET in this package has a very low RDS(on) of 25 mΩ whereas the diode is less optimised and has a typical forward voltage of 1.5 V. By forcing the current to spend more time flowing through the comparatively lossy diodes instead of the MOSFETs it is inevitable that the power loss of the system will go up.



Dead Time (ns)	0	200
Irms MOSFET (A)	6.32	6.23
Irms Diode (A)	4.69	5.02
Iph THD (%)	1.10	2.60

Figure 5: Simulating the Effect of Dead Time on AFE Currents

Conclusions

One of the key benefits of operating at high frequencies is the ability to reduce the size of magnetics. The impact of the inductance value on both the operation and control of the AFE has been demonstrated, highlighting the complications that arise when increasing switching frequency in an attempt to minimise the inductance value.

It has also been shown that dead time directly impacts both the generated waveform shape and the distribution of losses throughout the power devices so should be considered when determining the operating frequency and even when assessing semiconductors. Although dead-time is important for safe operation of the converter, the loss incurred in the diodes during the dead-time period could become a factor when targeting ultra-high efficiencies (>99%).

Using the Hardware Stack to investigate the operation of an AFE over a wide range of frequencies gave 50 kHz as the optimum switching frequency for this converter, resulting in an efficiency of 98.6 % and a THDi of 3.2% at full load. This was achieved without optimisation of magnetics, implementation of specialised modulation patterns or the use of proprietary control algorithms. The fact that there are demonstrable, explainable upper limits to the switching frequency at which the efficiency and power factor both start to decrease should not dissuade us from pushing the limits of high frequency operation but be used alongside other considerations to make an informed decision on the operating window of the converter design.

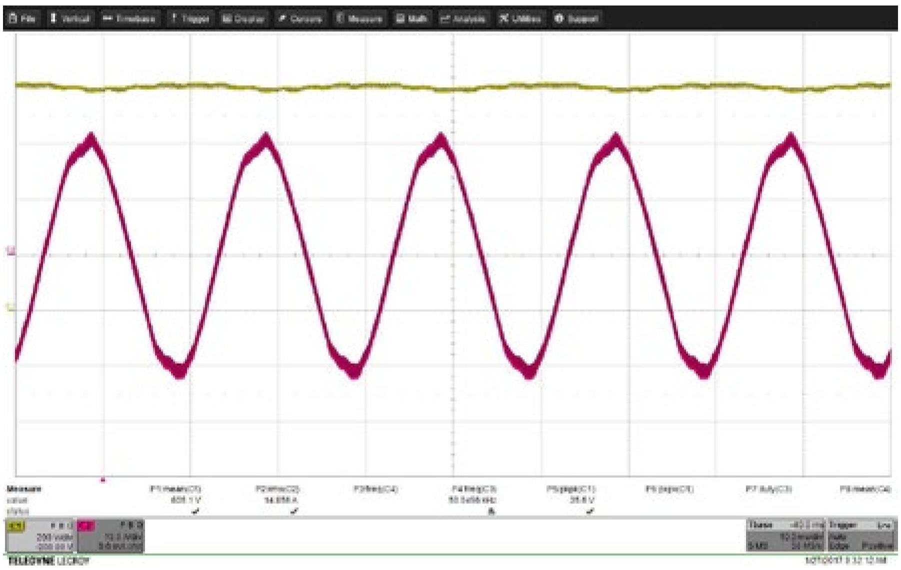


Figure 4: Vout and Iph at Fs = 50 kHz, Pout = 10 kW, Dead Time = 200 ns. Efficiency = 98.6%, THDi = 3.2%

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- S. L. Sanjuan, “Voltage Oriented Control of Three-Phase Boost PWM Converters,” 2010. [Online]. Available: http://webfiles.portal.chalmers.se/et/MSc/SylvainLECHAT-SANJUANMSc.pdf. [Accessed 1 February 2017].
- I.D.Mosely, P.H.Mellor and C.M.Bingham, “Effect of Dead Time on Harmonic Distortion in Class-D Audio Power Amplifiers,” Electronics Letters, vol. Vol. 35, no. No. 12, 1999.

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Essential Overvoltage Protection

Smart building and smart home applications such as intelligent thermostats, access controls and burglar alarms are becoming more widely established as a standard in building management. Of these applications, fire alarm systems are especially important, because people's lives and property depend on them. TDK offers a series of EPCOS components that are crucial to the reliability of fire alarm systems. Particular importance is attached to solutions for overvoltage protection.

By Bettina Renz, Dipl.-Ing. (FH), Product Marketing Manager, Piezo and Protection Devices, Multilayer Components, TDK

Office blocks, hotels, airports, shopping malls: buildings designed for large numbers of people must be equipped with automatic fire alarm systems. These are complex systems consisting of sensors, actuators, power supplies and data transmission units. The individual fire detectors are generally linked over a network to a controller. Depending on the building structure and layout, both ring and star network topologies are used. The controller has two tasks: to scan the installed devices at regular intervals and then, if a detector is actuated, it must trigger the necessary actions – including the audible and visual alarms in the building, the closing of fire doors and the notification of the fire service over the LAN or mobile communications network.

Fire alarm systems are powered, for example, by means of 24-volt power supplies. As the systems must continue to function even if the power fails, this supply is combined with a UPS that guarantees a voltage supply even during extended power outages. Apart from fire detectors, motion detectors and glass breakage sensors must also be integrated into the system. Figure 1 illustrates the basic structure of a fire alarm system.

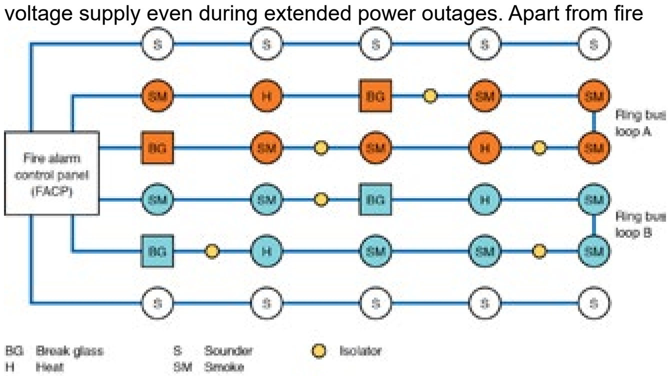


Figure 1: Structure of a fire alarm system whose network for the fire detectors is based on a double ring topology. The audible alarms (sounders), on the other hand, operate in a star network topology

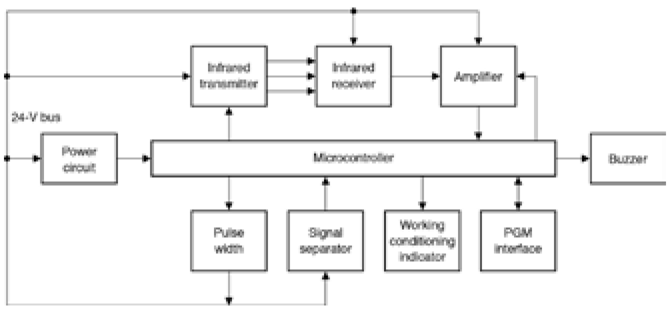


Figure 2: Internally, the voltages for the microcontroller (3.3 V) and for the infrared transmitter and receiver (10 V) are generated from the voltage of the supply bus (24 V)

The fire detectors operate with different sensor technologies, depending on requirements:

- optical sensors for detecting smoke
- temperature sensors for detecting rises in temperature
- gas sensors for detecting CO and CO2

Figure 2 shows the block diagram of a fire detector with optical sensors.

Tough demands regarding overvoltage protection

Due to their complexity, fire alarm systems can be exposed to all kinds of overvoltages. These can occur on both data and power supply cables. The problem is exacerbated by the considerable length of the cables in the system, as this produces a number of possible coupling scenarios. Figure 3 provides an overview of the possible types of overvoltage.

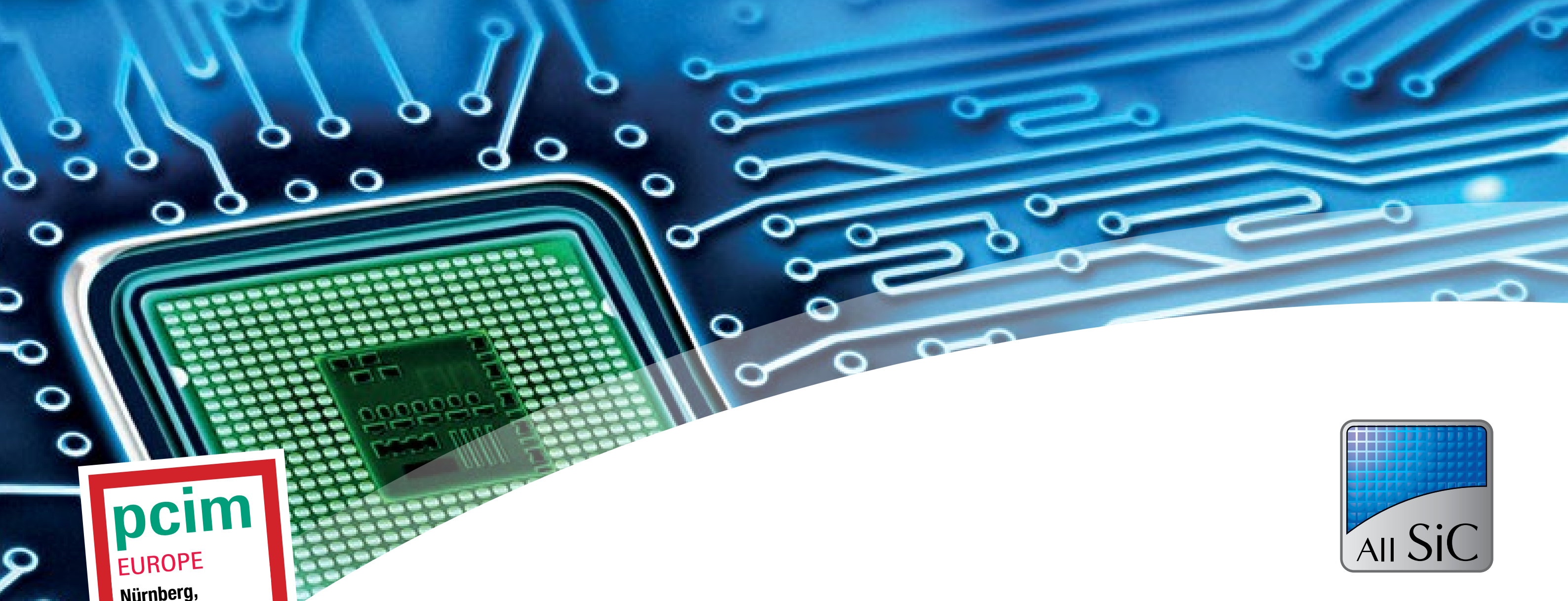
Figure 3: Overvoltages differ according to level of voltage, duration and cause. The wave forms and standards by which these are measured are correspondingly diverse.

TDK markets suitable EPCOS varistors for all kinds of overvoltage. A distinction is made here, however, between monolithic and multilayer types.

ESD	IEC 61000 4-2
Surge, lightning	IEC 61000 4-5
Burst, EFT (electrical fast transient)	IEC 61000 4-4
Switching of inductive loads	ISO 7637-2
TOV (temporary overvoltage)	no standard

Table 1: Information for Figure 3

Monolithic varistors are designed for high voltages and currents and are therefore used for the mains inputs of power supplies. In addition to conventional disk varistors, the T14 and T20 series of EPCOS ThermoFuse™ varistors are particularly suitable for safety-related



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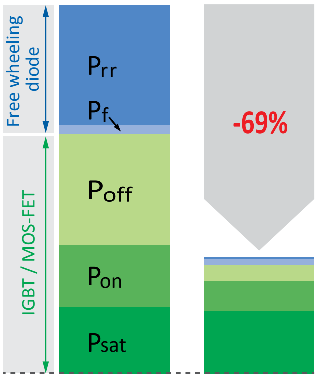
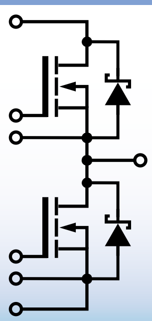
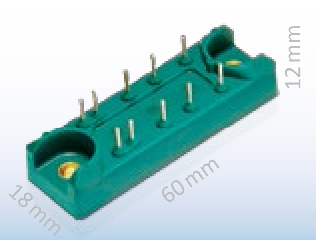
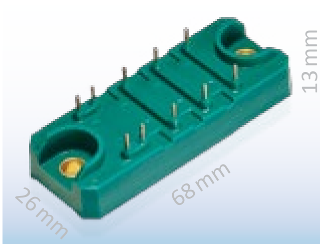
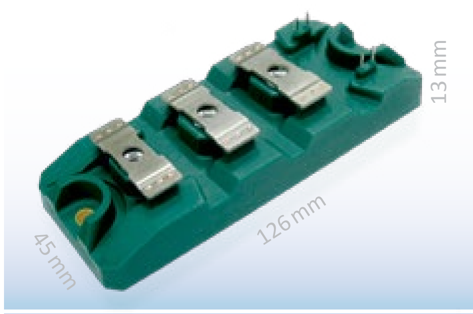


Optimum performance:

Combining the AllSiC technology with the new package concept

- **Thick copper block with isolation substrate**
  - Low thermal impedance & effective heat spreading
- **Interconnection by copper pins instead of wire bonding**
  - Downsizing, Low inductance, Very high reliability
- **High temperature epoxy resin, no silicone gel**
  - High temperature strength (Tg > 200° C)

Line-up plan of Fuji Electric Green Package, 2 in 1

	Type 1	Type 2	Type 3L
	 18 mm, 60 mm, 12 mm	 26 mm, 68 mm, 13 mm	 45 mm, 126 mm, 13 mm
1200V 1st gen. TrenchMOS	25 A, 50 A	75 A, 100 A	200 A, 300 A, 400 A

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www.fujielectric-europe.com

applications. They are designed for voltages between 130 VRMS and 1000 VRMS and their surge current capability is up to 10,000 A (8/20 µs).

If the varistor of a ThermoFuse should overheat, the integral fuse isolates the varistor from the network and prevents any fire on the printed circuit board or damage to components located near the varistor. Fuse and varistor are housed in a plastic casing that, like the coating of the varistor, is made from flame-retardant material.

The components have three connections: Two for the power cable and one acting as a monitoring output, by means of which the status of the component can be displayed with an LED, for example. To simplify replacement, these varistors can be installed using a printed circuit board terminal.

Figure 4: Varistors of the ThermoFuse series protect themselves against overheating. Moreover, the status of the component can be continuously monitored by means of a monitor output

For the power supply bus of fire alarm systems as well as the fire detectors themselves, the multilayer varistors of the CTVS surge protection series are suitable for protecting against surges in accordance with IEC 61000 4-5. Thanks to their multilayer technology, these components can be manufactured for different rated voltages according to requirements. The surface-mount components in case sizes 0805 through 2220 are designed for surge currents of up to 6000 A at 4 kV in the pulse shape 8/20 µs or 2 kV at 10/700 µs and can withstand forces of up to 15 J. These components are even suitable for ESD protection according to IEC 61000 4-2 Level 4 and offer reliable protection up to 30 kV.

In contrast to other protection component technologies, such as TVS diodes, EPCOS CTVS varistors exhibit no derating up to a temperature of 150°C.
As required for certain components by manufacturers of safety systems, the relevant types of the CTVS series are approved to UL 1449 (file ID E481997).

Key data of the EPCOS CTVS surge protection series

V_{RMS} [V]:	30 - 115
VDC [V]:	38 – 150
Isurge (8/20 µs) [A]:	80 – 6000
Wmax [J]:	0.3 - 15
Size (EIA):	0805 - 2220

Table 2: The key data of the CTVS surge protection series

One varistor for every voltage level
Fire detectors that operate with optical sensors require additional internal voltage levels: 10 V for the infrared transmitter and receiver and 3.3 V for the microcontroller. Figure 5 shows a possible circuit diagram for generating the different voltages in a fire detector.

The input, which is supplied by the 24-volt DC bus, must always be protected with a varistor (CTSV1), in order to prevent injection of overvoltages. A CT2220K30G EPCOS SMD multilayer varistor from the CTVS surge protection series can be used for this purpose. It has a maximum DC voltage of 30 V and is designed for a surge current of 1200 A (8/20 µs). It should be placed as near as possible to the connecting terminals. The parallel-switched C1 capacitor – for example, a TDK MLCC – is used for suppressing high-frequency interference. Depending on the bus voltages or surge voltage requirements, there are a large number of other multilayer varistors from the TDK portfolio which can be used at the input.

would paralyze the entire line section. To prevent this, every fire detector must be equipped with a fuse. PTC thermistors are particularly well-suited to this task, as they act as self-resetting fuses. Functional principle: as long as the thermistor is cold (room temperature), it has a low resistance. If, as in the case of a short circuit, a current occurs that is significantly above the specified maximum, the PTC thermistor heats up and switches suddenly to a high-impedance state. This restricts the current flow to a non-critical level. As soon as the cause of the short circuit

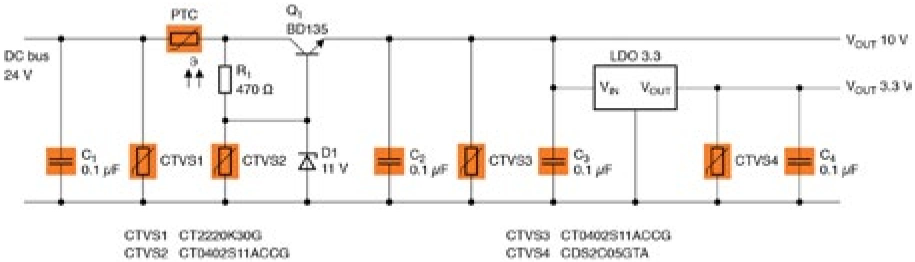

Figure 5: Generation of different voltage levels in a fire detector by means of a discrete solution for 10 V and an LDO (low-dropout controller) for 3.3 V. Four varistors are used here for the protection against over voltages

The circuit comprising Q1, R1 and D1 forms the voltage controller for the 10-volt output. To increase safety, a CT0402S11ACCG EPCOS varistor is switched in parallel with the Zener diode (D1) in order to prevent an excessive voltage rise at the base of Q1 should the diode fail. The stabilized 10-volt output is protected with a further varistor (CTVS3). The ceramic capacitors C2 and C3 are used for stabilizing and noise suppression. The voltage for the microcontroller that is generated via the LDO controller is protected by means of a CDS2C05GTA varistor (CTSV4).

Apart from the power supply lines, it is also necessary to protect the data cables, because ESD events can damage interfaces in particular. For this purpose, TDK offers excellent protection in the form of the EPCOS CeraDiode® high-speed series. Thanks to the low self-capacitances, which are as small as 0.6 pF depending on the type, the integrity of the signal is not affected. Apart from the conventional single-chip types, arrays are also available, for example, for as many as four data cables. A further striking technical feature of the product is the extremely short response time of the CeraDiodes at no more than 0.5 ns.

Short-circuit-proof thanks to PTC thermistors

As all fire detectors lie parallel to the supply bus, a short circuit in just a single device has been rectified, the PTC thermistor cools down and returns to its low-impedance state. The B59873C0120A570 EPCOS PTC, which is designed for a maximum load current of 90 mA at 25°C, is ideally suitable for use in fire detectors.

Broad range of components for fire alarm systems

Apart from the solutions for overvoltage protection, a whole series of other EPCOS and TDK components are suitable for use in fire alarm systems. These include inductances as well as ceramic, film and aluminum-electrolyte capacitors, as well as NTC thermistors. The latter can be used, among other things, to make fire detectors that operate on the thermal principle.

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Product Marketing Manager
Piezo and Protection Devices • Multilayer Components, TDK

www.epcos.com/varistors_thermofuse

www.epcos.com/ctvs

www.epcos.com/ptc

IPM Solution for Low Rated Power Application

µIPM-DIP & CIPOS Tiny without Heat-sink

"Energy saving" is applied on all power electrical systems and low rated power application is no exception to this. It can be realized to move forward from no-inverter design to inverter design. In addition, the light weight and compact size are always a concern for the product design. No heat-sink approach is in the trend. In this article, no heat-sink IPM solution with µIPM-DIP is introduced.

By Simon Kim & Pengwei Sun, Infineon Technologies, Korea & USA

Home appliance market needs

To further reducing the energy consumption, consumer market requests to speed up the inverterization. It is no exception to home appliances. Especially, home appliances with low rated power are also falling in the range gradually. Home appliance makers try to make product smaller and lighter. With these considerations, no heat-sink approach can be in the trend. Therefore, no heat-sink IPM solution is introduced with some application specifications.

Low rated power application

The definition of low rated power can be different for each application field. In this document, rated power application under 150W is reviewed with some application in home appliance. Here, fan and fridge compressor under 150W can be considered with the following specifications (refer to Table1).

App.	Power [W]	P.F	Vin [V]	Vdc [V]	Vout [V]	Iout [A]	Fs/w [kHz]	Ta [°C]
Fan	130	0.85	220	311	190	0.46	15	45
Fridge	80	0.55	220	311	190	0.44	8	50

Table1: Target specification for fan & fridge compressor

For these targeted specifications, IPM solution is considered as fast and easy solution.

Under 150W application, 600V 3A IPM can be considered. However, for both no heatsink approach and higher frequency applications (around 15[kHz]), 3A cannot be a proper solution. Hence, 600V 4A ~ 6A can be good candidates. Infineon µIPM-DIP 4A module's plastic body dimension is "29 x 12 x 2.9[mm]" and 3 package types can be supplied to customers: SOP23, DIP23 & DIP23A.

Figure 1 (bottom) shows sensor-less motor drive circuit example with Micom, IRMCF171. µIPM-DIP is composed with gate driver, IGBT and NTC. By adding bootstrap capacitor, IGBT can be operated from controller due to embedded bootstrap diode simply. Also, this IPM has open emitter type in each leg and it makes easier for developer choose between one- shunt and three-shunt solutions. 3.3V controller is compatible with this IPM. By using embedded NTC in µIPM-DIP, this module can be protected by thermal comparator. In the example circuit, external thermal comparing with 3V reference voltage allows controller to be aware of the NTC temperature inside of IPM around 115[°C]. In no heat-sink condition and steady status, this NTC value matches estimated junction temperate, 135[°C] (refer to [1]). If developer wants to set lower thermal protection level, reference level can be set in another value. In addition, NTC terminal from IPM inside is connected to controller and its value is monitored by controller directly.

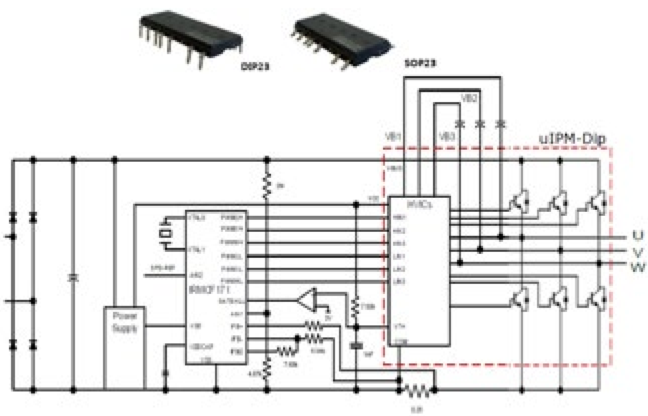


Figure 1: µIPM-DIP 600A 4A IPM package (top) & its application example circuit (bottom)

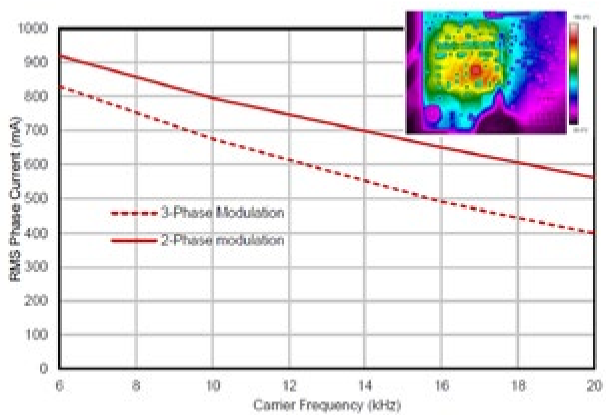
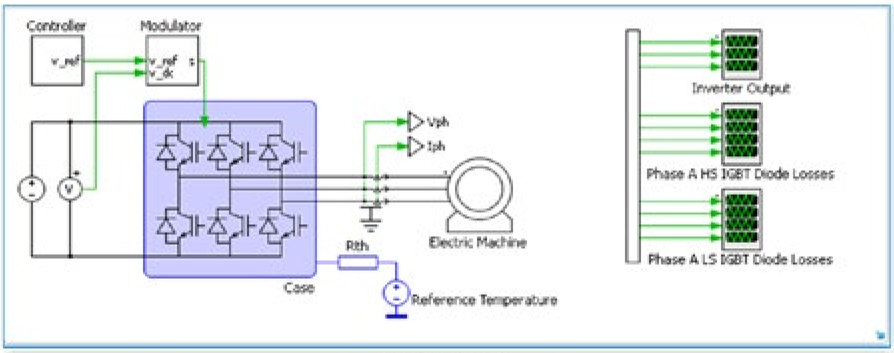


Figure 2.Max phase current vs carrier frequency, no heat-sink. Space Vector Modulation, V+=320V, Ta=28°C, Tj=128°C

Fan application in air conditioning system
Thermal result for estimated 130W fan application can be expected from the followed Figure 2. This shows "carrier frequency vs RMS phase current" with fixed junction tempature. This graph was made and based on thermal tests. Test was done with two different control modulations: 3-phase & 2-phase modulations. Junction temperature was monitored by IR camera. Junction tempature was controlled around Tj=128°C. Estimated 130W fan is operated in fs/w = 15[kHz] & Iout = 460[mA] in Table 1. Figure 2 shows that 530[mA] is achieveable in 15[kHz] around Tj=128[°C]. So, in operation for estimated 130W fan, this IPM's junction temperature can be lower than Tj=128[°C].



Inverter Losses				
	Part Name	Total	Efficiency	
IGBTs	IRSM506-076	2.260 W		
Diodes	IRSM506-076	0.4639 W		
Inverter	IRSM506-076	2.724 W	97.88 %	
Phase A High Side Device Losses and Maximum Junction Temperatures				
	Part Name	Switching	Conduction	Device maximum junction temperature
IGBT	IRSM506-076	0.3165 W	0.1563 W	132.6 °C
Diode	IRSM506-076	0.02211 W	0.01243 W	129.8 °C
Phase A Low Side Device Losses				
	Part Name	Switching	Conduction	
IGBT	IRSM506-076	0.08846 W	0.1923 W	
Diode	IRSM506-076	0.07752 W	0.04255 W	

Figure 3: Expected simulation result for 130W fan with 15[kHz]

To estimate junction temperature with targeted customer operation conditions, Infineon IPM simulation tool can be supported as online simulation [2]. Especially, no heatsink simulation is possible. First, user should select "No heatsink needed". Put Ta=28°C in Reference temperature and 0.53[A] in "Motor driver phase current RMS". Then, put the value in "thermal resistance (case to reference)" and adjust this value till simulation result in Tj=128°C. In this case, this value would be around 30.5[k/w]. This value is high due to no heat-sink condition and highly depends on customers' PCB design. With "thermal resistance (case to reference)" value, the maximum junction temperature for 130W fan without heatsink operation can be calculated in Ta = 45[°C] and the value would be around 132[°C] (Refer to Figure 3.). It is in the thermal safe area.

Fridge Compressor applications
In addition, 80W Fridge compressor application can be reviewed with Figure 4.

Estimated thermal result for 80W fridge can be calculated by Infineon simulation tool. In Ta = 50 [°C], the estimated max junction temperature is around 113[°C] It is in the thermal safe area as well.

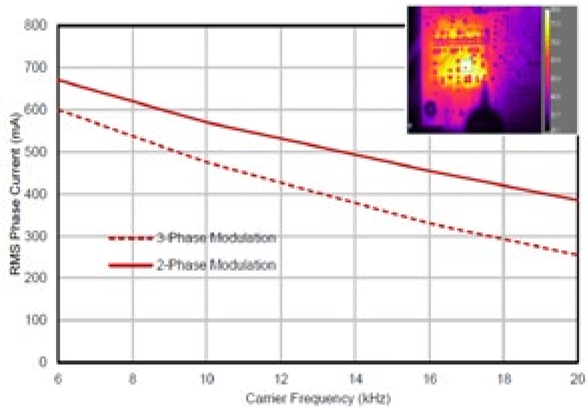


Figure 4.Max phase current vs carrier frequency, no heat- sink. Space Vector Modulation, V+=320V, Ta=28°C, Tj=98°C

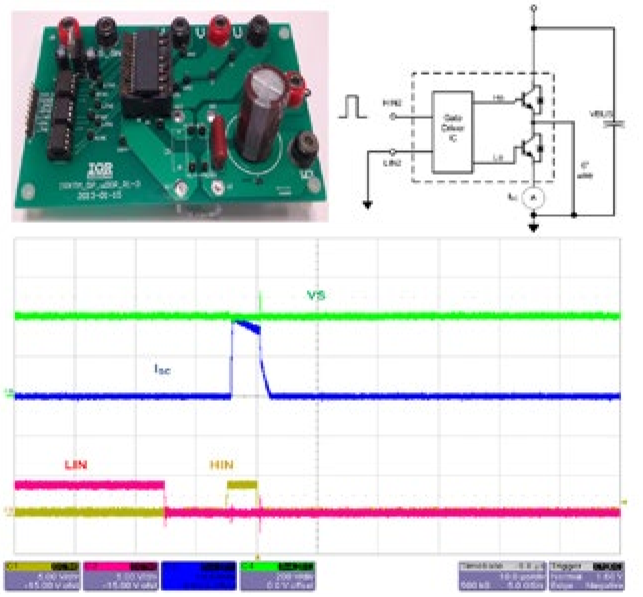


Figure 5: Test board & Test circuit with u-IPM-Dip(Top) and Test graph for short circuit test in Vdc = 400[V] & Isc = 20[A] peak(bottom)

For system safety, short circuit capability must be reviewed and tested. In this test, AC line and (-) terminal was in common by wire and then one pulse was applied on Top IGBT in Infineon µIPM-DIP 4A module. Test condition was with Vdc = 400[V] and Isc = 20[A] for 5[µs]. The IPM was passed without any failure (Refer to Figure 5).

For short circuit or over current protection, controller does monitoring the voltage on shunt in software protection. Or, for hardware protection, external comparator can be applied with some voltage reference level (current trip level) additionally.

Additional solutions

If customer wants to use IPM with error feed-back to controller, Infineon suggests CIPOS Tiny (Refer to Figure 6).

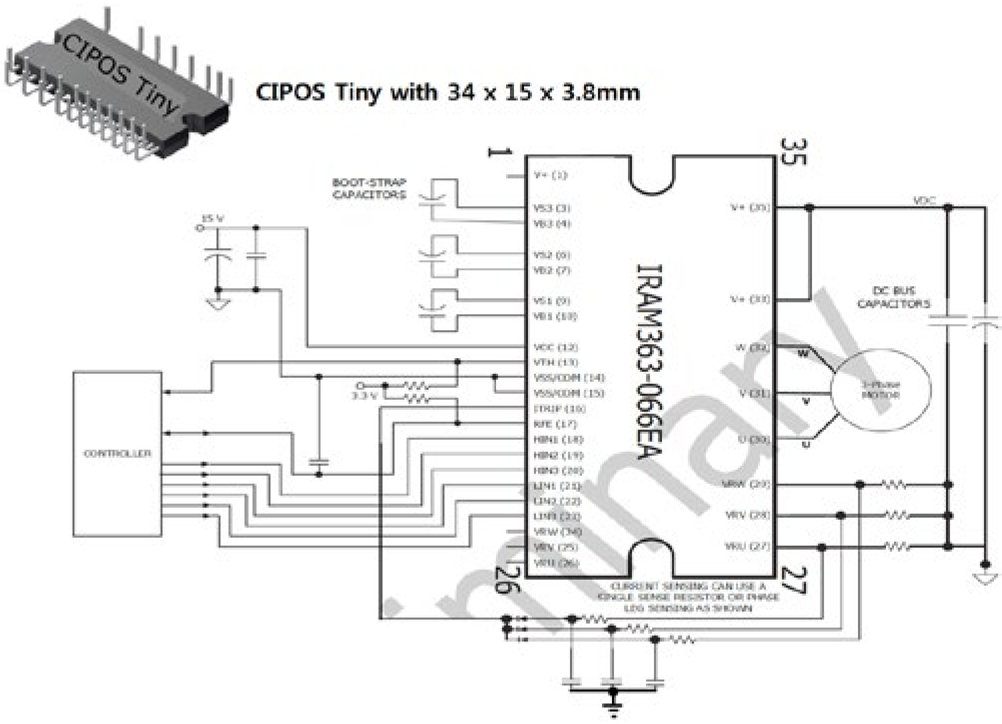


Figure 6: CIPOS tiny's body dimension(top) and it circuit example with Error feedback

Conclusion

In this article, for low rated power applications under 150W without heat-sink approach, 600V 4A µIPM-DIP was proposed. It showed good short circuit capability and thermal margin with both applications: 130W Fan and 80W Fridge compressor applications. For Error Feedback from IPM to controller, CIPOS Tiny can be a solution.

Reference

[1] IRSM506-076, uIPM-DIP (600V 4A IPM) data sheet
[2] Web Infineon IPM Motor Drive Simulator: https://plex.infineon.com/plexim/ipmmotor.html
[3] IRAM363-066EA, CIPOS Tiny (600V 6A IPM) data sheet

www.infineon.com/power

Configurable Mixed-signal ICs and Asynchronous State Machines Can Optimize Embedded Designs

Lower Power, More Secure & Easier to Implement Alternatives to MCUs

By Mike Noonen, John McDonald and Nathan John, Silego Technology Inc.

Introduction
SoC and MCUs require external circuitry for power management, human interface or connecting to sensors. As a result, there are almost always comparators, op amps, level shifters, various logic and discrete transistors scattered across a design. These SoCs are almost never truly Systems on a Chip.

In some cases, the support logic needed can be swept up into a low-end FPGA. But usually this is not a cost saving over discrete components. It is also an inadequate solution since an FPGA cannot address analog or discrete components. For an embedded device, this challenge will be even more pronounced as an MCU or SoC cannot address all the possible sensor, power, and connectivity options.

Configurable Mixed-signal ICs
Configurable Mixed-Signal ICs (CMICs) offer a clever solution to these challenges. CMICs are a matrix of analog and digital circuit functions that are configurable through One-Time-Programmable (OTP) Non-Volatile Memory. The pioneer and leader of this new category of devices is Silego Technology. Since introducing CMICs in 2009, Silego has completed over 1,300 customer designs and shipped over 2 billion CMIC devices. Silego's CMICs offer an Asynchronous State Machine (ASM) and a variety of analog and digital resources that a designer can configure into mixed-signal circuits. Designers can drag and drop these resources and "wire up" their design in a schematic capture tool, or they can emulate the design with the Silego Hardware Development Kit (see Figure 1). When they are satisfied with the design, they can program the CMIC device with the on-board OTP memory.CMICs can be used for a variety of essential mixed-signal functions including motor control, system reset, power sequencing, etc.

Figure1: Green PAK Universal Development Kit

CMIC Advantages
CMICs offer embedded designers and manufacturers multiple advantages over traditional discretes and analog:

1. **Embedded Designs Need Optimized Board Space**
   A dozen or more components can take up precious space which could be better used for a larger battery or a slimmer form factor. A CMIC can integrate several components into one tiny product as small as 1.0 x 1.2 mm. 88 percent board reduction is possible.
2. **Embedded Designs Need a More Convenient, Faster Way to Innovate & Prototype**
   Traditional circuit prototyping requires days if not weeks to design a PCB, order components, fabricate the board, assemble, debug and repeat. CMIC Design, Emulation and Prototyping can be done in just one day.
3. **Embedded Designs Need Lower-Cost Bill of Materials**
   CMICs have been designed to reduce the bill of materials cost over discrete and analog components. A recent design profiled on embedded.com highlighted that 1 CMIC part replaced $1.50 of level shift and comparator circuitry with a single $0.35 CMIC.
4. **Embedded Developers Want a Confidential Design That Is Hard to Copy**
   The custom circuitry inside a CMIC is as secure as a full custom IC and only the designer or its designated ODM and supply chain partners can procure it.

No static power & no code ASM vs. Low Power MCU for embedded applications
Portable systems often use low power microcontrollers to address their challenges with size and battery life. Silego's CMICs with ASM offer an alternative solution. The following comparisons illustrate design tradeoffs between microcontrollers and CMIC's ASM.

Handling MCU code
1. The ASM in Silego's 5th generation GreenPAK CMIC contains 8 states and 24 possible decisions. The ASM represents an MCU program with up to 24 IF...THEN statements. When the 8 State ASM capabilities are considered together with hardware input and output circuits, the CMIC may be represented as being roughly equivalent to about 100 lines of standard C code written for common 8 and 16 bit MCUs.A CMIC ASM is event driven and does not operate with a clock. As such, when there are no events, the

ASM stays in one state and consumes no static power. Thus, applications with limited input cycles can operate at leakage current power consumption well in to the single digit nanoamps of average current consumption at room temperature.

2. **Handing embedded control problems**
   Silego has modernized the ASM, mitigating the well-known hazard and race conditions, the programming/configuration headaches, while retaining all the inherent low-power, low-latency benefits for simple (up to 8 states) embedded control problems that would require less than 100 lines of code.
3. **Over kill microcontrollers vs. CMIC ASM value**
   Microcontrollers are often inefficient in size and power. It is quite common to find MCUs designed into applications where less than 1% of the MCU horsepower will ever be used. CMIC's ASM is well suited to simple embedded control applications, especially ultra-lower power applications (see Figure 2).

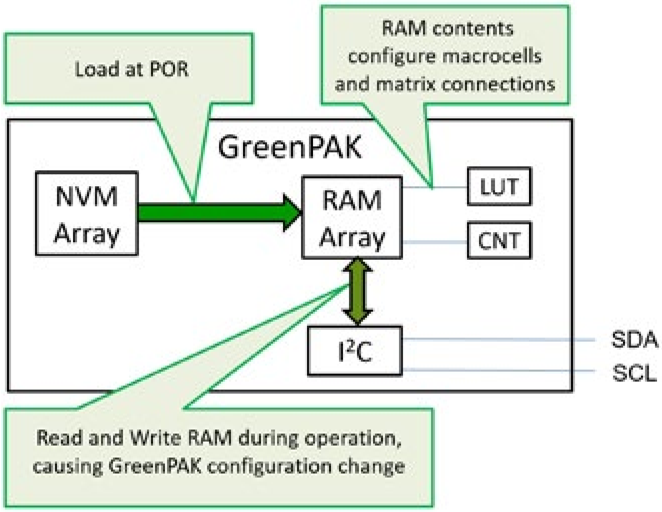


Figure 2: GreenPAK Block Diagram with I2C

4. **Interrupt latency (ns vs. us)**
   An important benchmark for microcontrollers is how short is the time from an external interrupt signal until the core is executing the first instruction of the interrupt service routine (ISR), the so-called interrupt latency. MCU interrupt latency is usually measured at around 5 to 10us.
   An ASM equivalent of interrupt latency is measured in nanoseconds. If the CMIC is operating at 5V power supply, the latency is a maximum of only 50ns..
5. **VDD variation**
   A CMIC ASM works over a wide voltage range. A properly designed ASM is guaranteed hazard and race condition free because each ASM signal path is guaranteed by signal length and gate count. Thus, as the VDD changes, so does the propagation delay. However, the propagation delays are all matched and thus performance is guaranteed.
   Microcontrollers, on the other hand, are clocked with signals that are not correlated well with VDD. As the VDD changes, the MCU propagation delays change and since the timing doesn't change, the timing margins are soon compromised.
6. **Crash vs. no crash**
   Design and system flaws that can cause a microcontroller to crash include: poorly written software, timing issues, miscalculations of interrupt latency, running out of stack memory, memory leakages, and accidental writes in program memory. Silego's ASM is configured in hardware with NVM bits, has no timing issues, latency measured in ns, no stack memory, no ability for memory leakage, and no ability to unintentionally over write program memory, and is therefore inherently more robust with VDD noise and brownouts.
7. **No Code GUI based tools vs. typical MCU tools**
   A CMIC ASM is configured using the GreenPAK Designer development environment. The software is an easy to use schematic capture editor that can reduce the typical MCU tool learning curve from months to Silego's GPAK learning curve of a few days (see Figures 3).

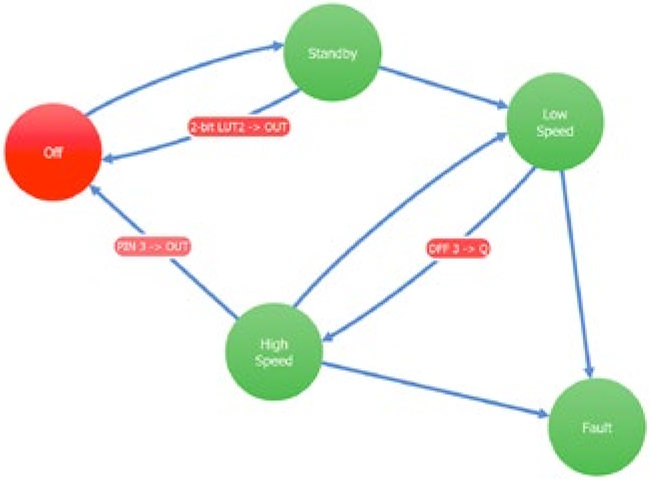


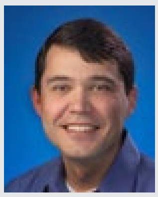
Figure 3: CMIC Asyncronous State Machine Software

8. **CMIC size vs. low-power MCUs**
   Without all the complexity of the MCU architecture the CMIC is usually smaller. If a CMIC product can perform the control function, then it is also usually the smallest programmable option on the market.

CMICs Make Embedded Design Easier and Products Better
In summary, the tiny CMIC with the 8 state ASM can take on a variety of embedded control applications that would formerly have been the exclusive domain of microcontrollers. The easily configured ASM brings key advantages of ultra-fast state transitions, leakage level static current consumption, robust design, and supply voltage tolerance important for IoT, portable, and embedded applications. In addition, CMICs offer many benefits that will allow embedded designers' to make products more profitable.

www.silego.com/products/greenpak.html

Mike Noonen,
VP Sales and Business Development



John McDonald,
VP of Marketing

Nathan John,
Director of Marketing

Double Sided Cooling to 60V Power MOSFETs for Motor Control and Power Supplies

Toshiba Electronics Europe has extended its range of high-efficiency U-MOS IX-H MOSFETs with an N-channel device in a 'DSOP Advance' SMD package that offers double sided cooling.
The 60V TPW1R306PL has an ultra-low typical on resistance (@ VGS = 10V) of just 0.95mΩ and is offered in a very small form factor of 5 x 6mm. Maximum drain current and power dissipation are 260A and 170W respectively. The enhanced thermal dissipation provided by the double-sided cooling will help to reduce device count and save space in high-component-density applications. The thermal resistance rating (Rth (ch-c) of 0.88k/W) to the top side of the package is significantly lower than that of competitor packages.
Target applications for this latest MOSFET include DC-DC converters, secondary-side circuits of AC-DC power supplies and motor drives in cordless home appliances and power tools.

www.toshiba.semicon-storage.com/eu/company/news.html

Smallest Isolated RS-485 Transceiver

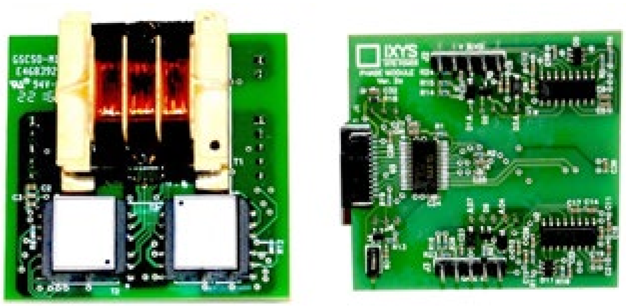
Intersil Corporation announced the industry's smallest isolated RS-485 differential bus transceiver designed to provide 4Mbps bidirectional data transmission for Industrial Internet of Things (IIoT) networks. The high-speed ISL32704E delivers industry-leading electromagnetic interference (EMI) and common-mode transient immunity (CMTI) in a small 4mm x 5mm QSOP package that is 70% smaller than competitive devices. It also provides 600VRMS of working voltage, which is approximately 50% higher than the closest competitor.
The ISL32704E RS-485 transceiver leverages giant magnetoresistance (GMR) technology to provide galvanic isolation that keeps the communication bus free from common-mode noise generated in electrically noisy factory and building automation environments.
The ISL32704E is ideally suited for the equipment-to-bus interface in IIoT networks that connect programmable logic controllers (PLCs) to instruments, robots, motor drives, data acquisition and digital I/O modules. The advantage of Intersil's ISL32704E GMR isolation over other isolation technologies is its low radiated emission and low EMI susceptibility. In addition, its GMR isolation does not require the elaborate encoding schemes found in capacitive and transformer-

based isolators that use RF carriers or pulse-width modulation (PWM) to transfer DC and low frequency signals across the barrier.

www.intersil.com

10A/4000V, Dual Channel, Isolated Gate-Driver

IXYS Corporation announced a 10A/4000V, dual channel, isolated gate-driver: IXIDM1401_1505_O.
Built using the IX6610 and IX6611 gate-driver chipset, it allows a 3.3 V microcontroller (MCU) through a 4 kV isolation barrier, to control IGBTs and MOSFETs in the half-bridge configuration. The PWM signals can be as short as 500 ns, and there is no lower limit on the switching frequency. It is capable of driving high-power IGBT and MOSFET modules rated up to 1700V.
The IXIDM1401_1505_O gate-driver core can support switching frequencies up to 250 kHz. The two output channels are electrically isolated from each other and from the primary side. An internal power supply can provide up to 2W per channel of isolated power to drive both upper and lower IGBTs (or MOSFETs), effectively isolating the MCU from the high power circuitry. Operating from a single polarity 15V power source, it provides +15 V/-5V and 10A peak current to the IGBT gates as well as +3.3V (at 50mA) to the corresponding controlling MCU.
The IXIDM1401_1505_O provides a complete dual-channel, gate-driver solution, best in class, outperforming existing solutions.



This product is designed with all the necessary features such as short-circuit protection, under and over-voltage lockout protection, advanced active clamping, and supply voltage monitoring. It is well suited for digital power control, where a typical MCU, like the Zilog line of MCUs, can be used to provide the brains for controlling power modules.

www.ixys.com

12-V, 10-A DC/DC Step-Down Power Solution

Texas Instruments introduced a pair of 12-V, 10-A, 4-MHz step-down power modules that provide a power management solution that is 20 percent smaller than any other 10-A power module-based solution available today. The easy-to-use SWIFT TPSM84A21 and TPSM84A22 DC/DC modules integrate power MOSFETs, shielded inductors, input and output capacitors, and passives into a tiny, low profile footprint. In addition, it provides industry-leading performance, with as little as 1 percent overshoot in transient conditions without special magnetics or additional capacitors. For more information, samples and an evaluation module, see http://www.ti.com/tpsm84a21-pr-eu. By using the step-down power module together with TI's WEBENCH® Power Designer, engineers can get their space-constrained point-of-load (POL) telecom, networking, and test and measurement power-supply designs to market faster. TI will demonstrate the TPSM84A22 module in its booth (No. 701) at the Applied Power Electronics Conference (APEC), March 27-29 in Tampa, Florida.

www.ti.com

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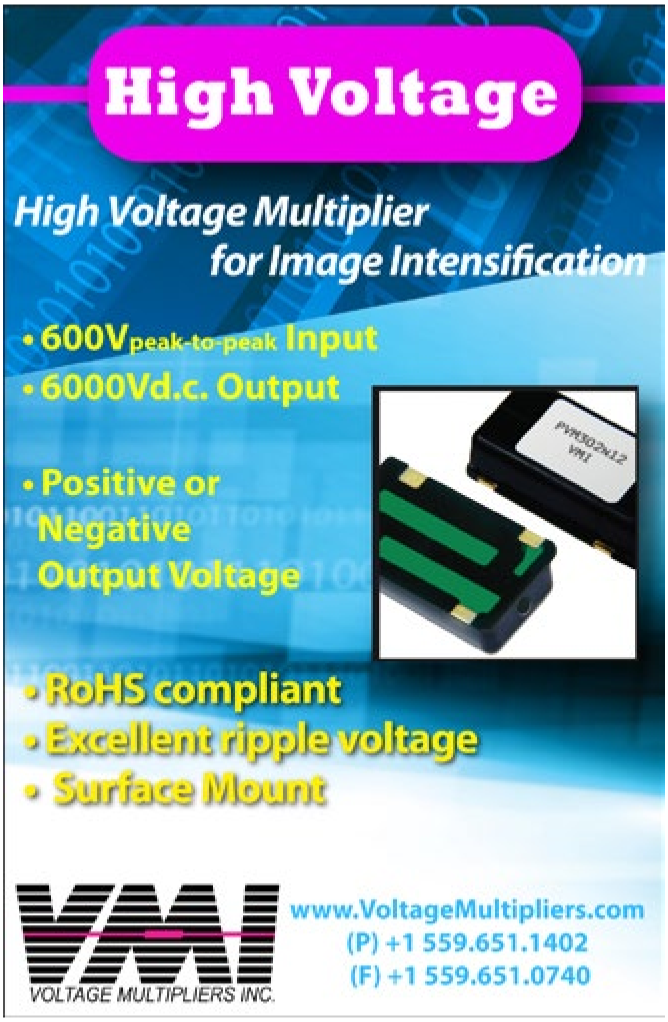
Diodes for Industrial Welding Equipment

Proton-Electrotex, the Russian manufacturer of power semiconductors and power stacks, recently released new series of welding diodes – one in ceramic housing and two housingless diodes. All welding diodes can be used in industrial welding equipment and perfectly suit welding robots. The company offers diodes with enhanced average forward current ratings comparing to available on the market alternatives. On top of that, all diodes completely correspond to industrial standards and requirements including low on-state and switching losses, low thermal resistance, and high load cycle capability. Application note, data sheets, and additional information can be found on the company website.

This March Proton-Electrotex will participate in APEC 2017 conference, which will take place in Tampa, FL, USA. Everyone interested can appoint a meeting with company representatives to have all their questions about welding diodes as well as IGBTs, power thyristors and diodes to be answered. An appointment can be made through a form available at company website.

www.proton-electrotex.com



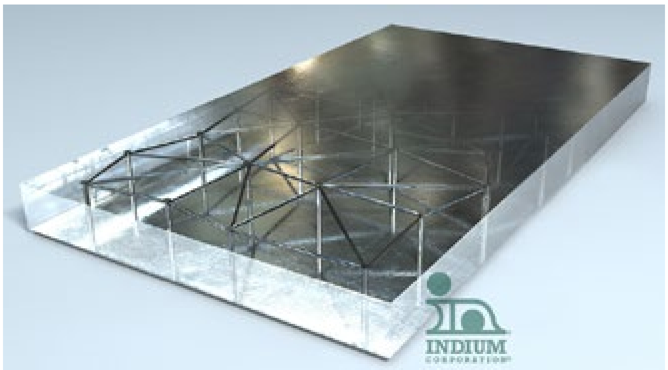
Reliable 3 to 6W DC/DC Converters with Integrated EMC Filter

RECOM´s DC/DC converters REC3A, REC5A and REC6A have a built-in EMI filter to meet EN55022, class A. Class B can be achieved easily with a small capacitor.
The compact DIP24 modules (31.8 x 20.3 x10.2 mm) with 2:1 input (4.5-9VDC; 18-36VDC) provide a regulated 5VDC output and can be operated 0% minimum load. They are short-circuit and overload protected and are available with an optional integrated under voltage lockout. The converters can be operated in a wide temperature range of -40 to +100°C (with derating) due to their excellent efficiency up to +81%. These modules are designed for industrial applications and can drive high capacitive loads.
The series are IEC/EN/UL60950-1 and IEC/UL/EN62368-1 certified. They come with RECOM's standard 3 year warranty.

www.recom-power.com

Featuring InFORMS® Reinforced Solder Preforms at PCIM Europe 2017

Indium Corporation is redefining solder with its InFORMS solder preforms. InFORMS are a composite preform consisting of solder and a reinforcing matrix that, together, increase lateral strength and bondline co-planarity while improving thermal cycling reliability.



When InFORMS were used to solder a DBC to the baseplate of an IGBT, one study showed:
4x improved thermal cycling reliability compared to a solder preform-only approach
2x improved thermal cycling reliability compared to a solder preform + Al wirebond stitch approach
Reduced voiding (<1%)
Lower cost of ownership – as a drop-in replacement for a standard preform or solder paste, InFORMS require no additional process steps or equipment
Indium Corporation will feature its reinforced solder alloy fabrications, InFORMS®, at PCIM Europe 2017 booth 7-315, May 16-18, in Nuremberg, Germany.

www.indium.com

High Accuracy Power Analysis in a Portable Device

Hioki has enhanced the legacy 3390 Power Analyzer with the new PW3390 Series Power Analyzer, a 4-channel device with a built-in

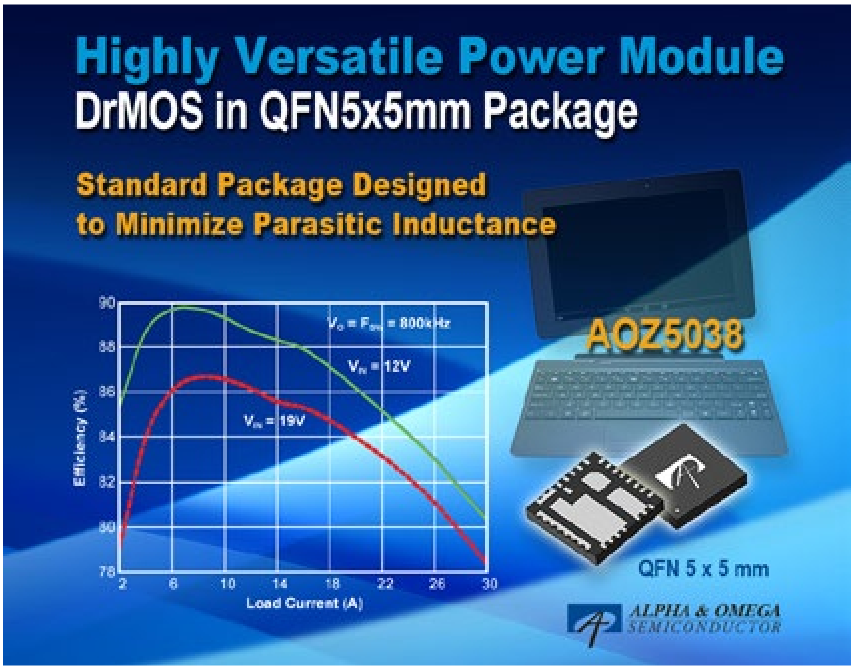
motor analysis option, to deliver a high accuracy power analysis regardless of the measurement situation. The PW3390 series offers a power accuracy of ±0.04% rdg. and a DC to 200kHz measurement bandwidth, which covers the range necessary to correctly measure the input and output power of inverter devices as well as the efficiency level of high-efficiency equipment. In addition, a built-in current sensor phase shift function based on a new virtual oversampling technology enables the phase characteristic compensation of current sensors at 0.01° resolution, resulting in the accurate measurement of even high frequency power with low power factors. 17 Hioki current sensors rated 20 A to 6000 A are available to pair with the PW3390 to meet applications ranging from automotive power to infrastructure equipment testing, resulting in a flexible lineup of power analysis devices to accommodate any measurement situation. Learn more at

www.hioki.com

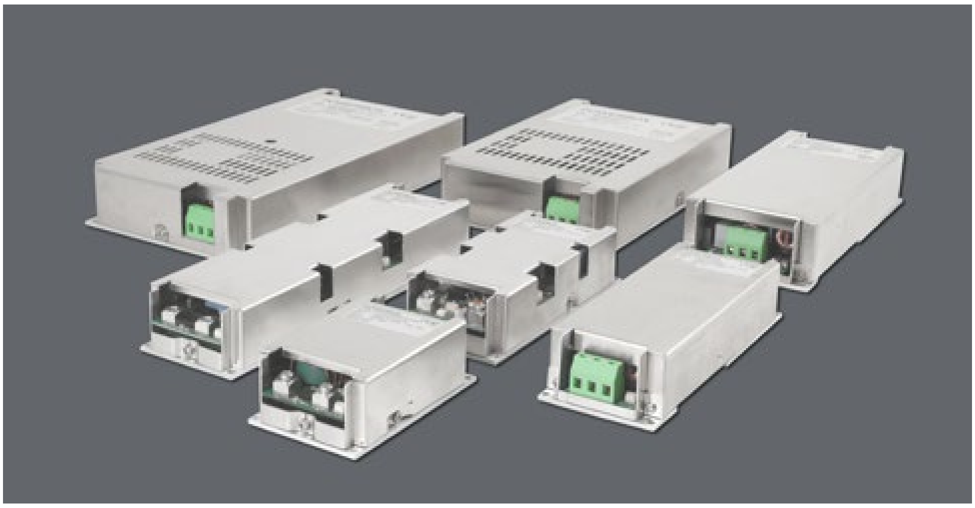
Highly Versatile DrMOS Power Module

Alpha and Omega Semiconductor introduced AOZ5038QI, the highly versatile latest generation of power modules. The AOZ5038QI integrates a dual gate driver and two optimized MOSFETs in a 31-pin 5mm x 5mm QFN package to produce a high-power and high-efficiency power stage for synchronous step-down applications. The new AOZ5038QI enables high power density-voltage regulator solutions ideal for CPU and GPU power regulation in notebook PCs, servers, and graphic cards. The standard 5mm x 5mm QFN package is optimally designed to provide maximum power density and minimize parasitic inductance for minimal EMI signature. "Complement to our small form factor, QFN3.5x5 power stage series, the AOZ5038QI is a new addition to our QFN5x5 standard package footprint series with higher power density for today's high-end computing and graphic applications," said Peter Cheng, Sr. Director of Power IC Product Line at Alpha and Omega Semiconductor.

www.aosmd.com



Power Supplies Make Highly Demanding Applications a Reality



Powerbox has announced the release of its Defense Line of ruggedized power solutions for highly demanding environments. The launch includes seven series of new power supplies, comprising three DC/DC (DAA-DAB-DAC), four AC/DC (DBA-DBB-DBC-DBD) and embracing a power range from 50W up to 1,200W. In metal chassis format with a baseplate for conduction cooling, the DAx and DBx series can be used with a baseplate operating temperature range of -40 up to +100 degrees C. For extremely demanding applications they can be configured with a conformal coating and mechanically ruggedized as well as electrically ruggedizing to withstand harsh transients and demanding EMC performance requirements as required with most common defense, marine, avionics, rugged industrial and railway standards. Designed for high availability, short time-to-market and to meet commercial and military off-the-shelf (COTS/MOTS) business models, the modular build style of the DAx and DBx series allows up to six outputs which can be connected in serial, parallel or used as a standalone output – very versatile products.

Ready to use, Defense Line DC/DC DAA/DAB/DAC power supplies include a very efficient input filter, reverse voltage protection internal diode, input transient protection and an internal fuse to protect against damage in the event of failure. Each output is protected against accidental and permanent short-circuit situations. An internal over-temperature circuit (OTP) protects the units in the case of over-heating, with automatic recovery.

www.prbx.com

Foil Resistors Offers Industry-Exclusive Reliability and Long-Term Stability

The VPG Foil Resistors product group of Vishay Precision Group (NYSE: VPG) (www.vpgfoilresistors.com), manufacturers of the industry's most precise and stable Bulk Metal® Foil resistors, today announced the global market launch of the Powertron PCS Series, a high-reliability power current sensor family, offering exceptional long-term stability, reliability and performance.

Design of the Powertron PCS Series incorporates VPG's own proprietary Bulk Metal Foil technology, combining high-precision resistors with both high power and a low temperature coefficient of resistance (TCR). The result is a power current sensor which offers truly industry-exclusive, high-precision measurements, without the need for compensation for external temperature effects. Units are offered in 73 unique standard packages, with resistance ranges from 1 mOhm to 10 Ohms, a TCR down to 3 ppm, and load stability and resistance tolerances to ±0.01%. They are lead free and RoHS compliant. To meet 30 Watt power requirements, the PCS Series may be further mounted to an external heat sink. This allows them to provide three times more rated power than any other comparable industry model.

www.powertron.de

Single-Chip Rad Hard 32-Channel Driver with Integrated Decoder

Intersil Corporation introduced a radiation hardened 32-channel driver with integrated decoder that reduces the size, weight and power (SWaP) of satellite command and telemetry systems. The ISL72813SEH is the industry's first high current driver to integrate the decoder, level shifter and driver array in a single monolithic IC, allowing satellite manufacturers to significantly increase system capacity and reduce solution size by up to 50%. The device offers a 4x higher density channel count compared to the nearest competitor, and the integrated level shifter eliminates several peripheral components.

The ISL72813SEH driver leverages Intersil's proprietary silicon on insulator process, which provides single-event latch-up (SEL) robustness in heavy ion environments. The driver's integrated decoder interfaces directly to the general purpose I/Os of FPGAs and CPUs in the satellite's flight computer, dramatically reducing pin count compared to competitive 1-input to 1-output driver arrays. Each of the device's 32-channels of common-emitter open-collector driver outputs can generate pulses of up to 42V and 600mA. The ISL72813SEH addresses latching relay and solenoid commanding for most satellite control functions, including redundancy management, mechanism drive enables, propulsion component relays and enables, battery management, and payload switch control. The ISL72813SEH's low VCE saturation levels eliminate a major customer concern by reducing the overhead voltage required to drive the load. The driver's power efficiency and high integration reduces the amount of circuitry required on the bus, allowing customers to add more spacecraft functionality and processing power.

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Third-Generation SiC MOSFET Platform expanded to 1200V

Wolfspeed, a Cree Company and a leader in silicon carbide (SiC) power products, has expanded its innovative C3M™ platform through the introduction of a 1200V, 75mΩ MOSFET in its recently released low-inductance discrete packaging. The new device simplifies designs and enables an increase in frequency while maintaining efficiency, lowering system cost, reducing circuit EMI, and enabling 99% efficiency levels in three-phase power factor correction circuits.

These features enable designers of applications such as telecom power supplies, elevators, grid-tied storage, on and offboard EV charging, as well as factory automation to increase switching frequency while maintaining efficiency, decreasing system size and bill of materials. This device achieves the industry's lowest figure-of-merit for any SiC MOSFET at 1200V. Wolfspeed has released this device in a 4L TO-247 package and plans to release it in a 7L D2PAK in the coming weeks.

"SiC MOSFETs have proven to be beneficial for many high-power applications connected to a battery simply due to the improved efficiency." explains John Palmour, Wolfspeed's CTO. "In the case where power is bidirectional, such as grid-connected AC-DC, the potential cost savings are significantly increased due to the reduction in the size of the input filter."

www.wolfspeed.com/C3M0075120K

T-Series IGBT Modules Line-up Expansion to 1700V

Mitsubishi Electric Corporation will continue the expansion of its successfully launched T-series power semiconductor modules by introduction and commercialization of its 1.7kV rating line-up. The new modules realize improved power density, reliability and cost efficiency for general-purpose and servo inverters, uninterruptible power supplies (UPS), photovoltaic (PV), wind power-generation systems and other industrial equipment.

The most remarkable feature of the novel 7th generation CSTBTTM and diode chip set is the significant reduction of switching losses. As result even at relatively low carrier frequencies below 1 kHz, the new 1700V modules offer an improved total loss behavior when compared to previous 1700V IGBT-generations. This benefit is getting even more evident with increasing PWM switching frequencies typical for industrial inverter applications, for example at 2 or 3 kHz.
The 1700V line-up consists of various rated currents between 75A and 600A and supports both half-bridge and 6in1 topologies. Mitsubishi Electric is housing the new chips with the latest package technology providing a Standard-package type as well as an NX-package type.

The 1700V NX modules offer the newly developed SLC (SoLid Cover)-technology, the same feature as supported on 650V and 1200V versions of this package type. The SLC-technology combines a solder-free resin insulated metal baseplate (IMB) and a specially controlled epoxy resin potting material. Due to the matched thermal expansion coefficients of the constituent materials, thermally induced mechanical stress within the module is significantly reduced and the

pump-out effect on the thermal grease due to baseplate warpage during heat cycling is also minimized. This feature makes the NX-module type ideal for inverters operating under challenging conditions with heavy and intermittent load cycles. Also, the use of hard mold potting instead of silicone gel provides a higher resistance against aggressive gases or harsh environmental conditions and offers – due to its property of being silicone free – attractive possibilities in certain applications.

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Cool-Power ZVS Buck-Boost Regulator

Vicor Corporation announced a addition to its growing PI37xx family of Cool-Power ZVS Buck-Boost Regulators. Delivering up to 140 Watts of power, and up to 8 Amps of output current, at up to 96% efficiency, the new PI3740 Cool-Power regulator features an input operating voltage range of 8 – 60 VDC and a regulated output voltage range of 10 – 50 VDC. Incorporating Vicor's proprietary high frequency zero-voltage switching (ZVS) technology, and featuring a best-in-class combination of conversion efficiency, power density and performance, the PI3740 is an ideal choice for demanding, automotive, industrial, test automation, LED lighting, and battery charging.

Like all members of the PI37xx family, the PI3740 meets its performance specifications "out of the box" across the full breadth of its operating voltage ranges without the need for special circuit customizations. Wide operating voltage ranges can enable a reduction in both the number of regulators and the number of power supply designs that must be designed, configured, manufactured, inventoried and maintained. The PI3740 converter, for example, can be used in a range of applications that would otherwise require the use of several different alternative regulators having narrower operating voltage ranges.

www.vicorpower.com

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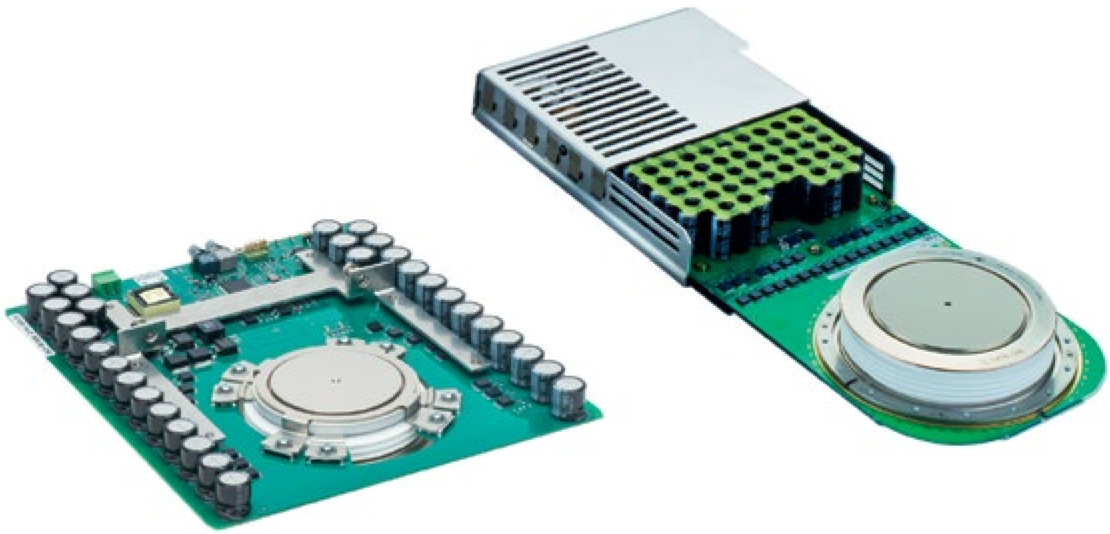

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