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Bodo´s Power Systems®

Electronics in Motion and Conversion

February 2014

OPTIMIZED RENEWABLE INVERTER SYSTEMS

o-f.de

COMPARISONS

are always interesting!

MODIS – the modular inverter system

Thanks to its modular and flexible design, MODIS offers compelling benefits. The desired power can be easily achieved via parallel connection of the modules. You are also free to choose your preferred cooling type. And the use of standard components makes MODIS both cost-efficient and sustainable. Talk to the House of Competence, because MODIS fears no comparison. Even with your current inverter systems, right?

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engineered by

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Read online and search for key subjects from all articles in Bodo's Power Systems by going to Powerguru: www.powerguru.org

powerguru.org

The Gallery

Vincotech
The Power to Move Ahead

Speed and Flexibility

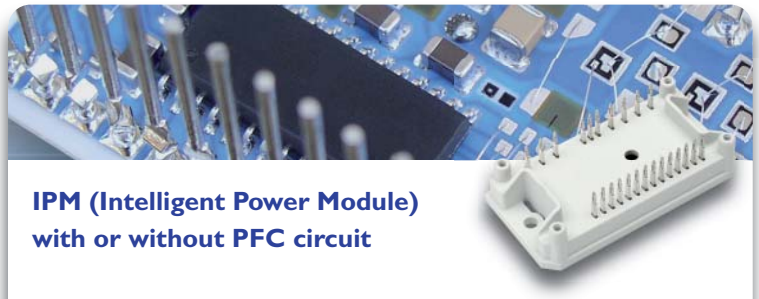
Vincotech, a 100% independent company within **Mitsubishi Electric Corporation**, is a market leader in power modules. With over 40 years of experience Vincotech develops and manufactures high-quality electronic power components for Motion Control, Renewable Energy, and Power Supply applications.

What Vincotech offers:

- Power module topologies ranging from 4 A to 800 A and from 600 V to 2400 V
- All topologies with low stray inductance (Rectifier, Sixpack, PIM (CIB), IPM, Boost, NPC, H-Bridge, Half-Bridge, PFC, etc.)
- 21 various standard housings

The Vincotech difference:

- A large variety of standard products for qualified, reliable solutions
- Building blocks to design your product – flexible designs to meet your specific requirements
- Ultra-low inductance designs
- Phase-change material – no more thermal grease



IPM (Intelligent Power Module) with or without PFC circuit

***flow*IPM 1B**

- Output power at 230 V input: up to 2 kW
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- Integrated gate drivers with complete bootstrap circuit
- Ultra low inductive design with integrated DC-capacitor

www.vincotech.com/flowIPM_1B

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Events

Cips 2014,
Nuremberg, Germany, February 25-27
www.cips-conference.de

Embedded World 2014,
Nuremberg, Germany, February 25-27
www.embedded-world.de

EMC 2014,
Duesseldorf, Germany, March 11-13
www.mesago.de/en/EMV/home.htm

APEC 2014,
Fort Worth, Texas, March 16-20
www.apec-conf.org/

APEX 2014,
Las Vegas, Nevada, March 25-27
www.ipcapexexpo.org/html/main/default.htm

battery university,
Aschaffenburg, Germany, March 25-27
www.batteryuniversity.eu

Looking Forward to APEC in Texas

Meeting friends in warm places is nice: chatting about the year ahead, developments in our industry, and the power semiconductor evolution. The Advanced Power Electronics Conference (APEC) follows the popular Consumer Electronics Show in Las Vegas – but APEC is focused on power electronics, our bread and butter, and the heart and soul of all those amazing electronic gadgets.

Digital power has been discussed a lot at APEC, but now digital power control has found its way into a broad range of applications. Similarly, wide band-gap semiconductors have been around for quite a while. But now production in volume is beginning. Wafer size and defect density in SiC are both on the right track for lower cost devices and all the resulting system benefits. While SiC most easily adapts to line-voltages and higher, new developments in GaN show line- voltage capability. Avalanche breakdown capability (UIS), common to silicon MOSFETs, is being compensated for by extra enough margins in the breakdown voltage of GaN devices.

Advances in packaging design for higher temperatures are at this point still in a formative stage. SiC and GaN open the possibility for higher temperature operation, but require a reliable packaging solution. Reduced switching losses provide a basis for increased frequency and smaller passive components. Taken all together, systems are more compact for the same function and power output.

The most critical applications for weight and efficiency are in aviation and space, followed by transportation in general. Cars continue to be the favorite choice for individual mobility – so developments in this area will have a large impact. The electrification of automobiles is challenged by battery distance capability. Liquid fuels still offer much better energy density. Charging batteries at dedicated stations is still an inconvenience on many travel routes. Pure electric vehicles need some careful planning for the distance of a planned journey - running out of energy would not be fun. Urban areas can provide sufficient infrastructure through utility companies, but charging the battery in the outback may be a problem. To learn more about the capability of batteries, mark your calendar for

the Battery University Forum in Aschaffenburg, Germany at the end of March.

Renewable energy sources can best help in supporting utility power, as long as there is a system for energy storage. The New Energy Conference at Husum, Germany, also in March, presents solutions for “green” power generation. At Husum, small wind power and other green solutions are a theme.

So, we’re off to a good start this year with compelling shows and conferences around the world.

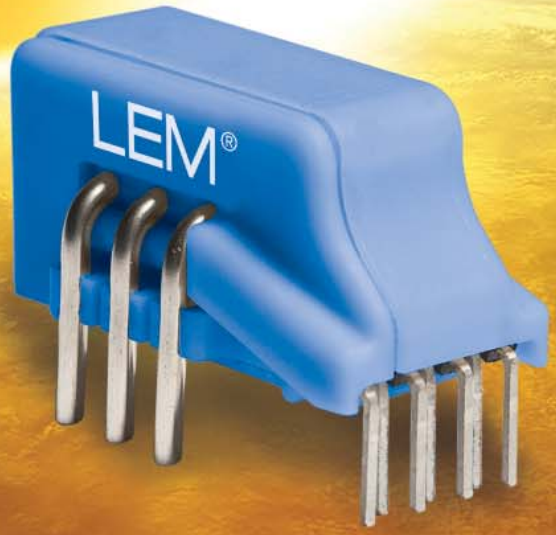
Communication is the only way to progress. We delivered twelve issues last year, each month, on time, every time. With this February issue we’ve published 21 technical articles amongst 104 pages so far this year. As a media partner, Bodo’s Power Systems serves readers across the globe. If you speak the language, or just want to have a look, don’t miss our Chinese version: www.bodospowerchina.com.

My Green Power Tip for February:
Clean out the trunk of your car - extra weight costs you extra fuel, reducing the load saves. Little by little, and all together, we can save a lot.

See you soon at APEC in Texas, and around the world.

Best Regards

Dawn of a new intelligence for current measurement



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Industry Leaders and Public Authorities Celebrate EPIC 10th Anniversary

The EPIC anniversary was celebrated through a rich combination of activities; bringing together the focus on public policy as well as the European photonics community cohesion. Meetings with the European Commission, an EU Funding session, the presentation of the EPIC Phoenix Award, and the two panel discussions on technology and business made-up the core of the event. The occasion concluded with a festive and entertaining dinner which provided an additional networking opportunity in a convivial environment. 160 delegates from 26 countries attended the occasion, including executives from industry and representatives from public authorities. EPIC was also recognized by OSA for its sustained effort in promoting the photonics industry in Europe for a decade.

The keynote presentation by imec gave participants the opportunity to peak into the exciting possibilities in the field of Medical and Life Science fuelled with electronics and photonics technologies in the short-term, which triggered great interest and discussion

in the subsequent panel discussions.

The Photovoltaic technology also put forward several comments related to pricing, manufacturing, and regulation but Eicke Weber from Fraunhofer ISE reminded all of the importance of access to capital for large scale manufacturing capability and also clarified misconceptions about the cost of PV and how in some regions it is already competitive. The discussion was very down to earth addressing issues such as access to skilled labour and increasing the involvement of women, public procurement as a tool to promote the uptake of new technologies for instance in LED street lighting, optimization of funding possibilities including the use of regional development funds. Martin De Prycker, ex-CEO of start-up Caliopa, said that public funding can be a golden cage and encouraged innovators to go out and start-up on their own. At the moment however, industry is still heavily reliant on support from public authorities (even though the accessibility and priorities need to be reviewed) hence a possible call for follow-up action may be coordinated by EPIC on behalf of its members.

www.epic-assoc.com

Electronic Companies in Cambridge to Attract Students to Industry

Cambridge is to host a launch event for a nationwide scheme designed to attract young talent to the economically-vital electronics industry.

The UK electronic systems industry is worth £78 billion ($130bn) and employs 850,000 people in well-paid, skilled jobs. It is predicted to grow by 55% by 2020 and has a hub in Cambridge, with world leading firms including ARM, CSR, and Plastic Logic based in the area.

But, a decreased awareness of the industry among British school students is putting this growth at risk, with applications for higher education courses in electronic engineering down 29% since 2002.

To counter this, the UK Electronics Skills Foundation has teamed up with leading education charity the Engineering Development Trust (EDT) on its Go4SET programme and with some of the region's top firms to create an east-of-England competition for school students aged 12-14. These challenges aim to stimulate interest in and raise awareness of electronic engineering as an exciting subject and rewarding career path.

www.ukesf.org

www.etrust.org.uk

United Silicon Carbide Inc. meets President Obama.

United Silicon Carbide Inc. (USCi), as part of the new Clean Energy Manufacturing Innovation Institute, attended a Presidential address at North Carolina State University on Wednesday 15th January 2014.

The Next Generation Power Electronics Institute will provide the innovation infrastructure needed to support new product and process technologies, education, and training to become a global center of excellence for the development of wide bandgap semiconductor devices and industry-relevant processes. This new institute, led by North Carolina State University, brings together a consortium of US based companies that include the world's leading wide band gap semiconductor manufacturers, leading materials providers, and critical end-users with universities on the cutting edge of technology development and research. The institute will enable the next generation of energy-efficient, high-power electronic chips and devices by making wide bandgap semiconductor technologies cost-competitive with current silicon-based power electronics in the next five years. These improvements will make power electronic devices like motors, consumer electronics, and devices that support our power grid faster, smaller, and more efficient.

"We are very proud to be part of the Institute and look forward to working with other industry leading companies to enable the widespread adoption of wide band gap semiconductors. The world need this technology and American innovation will now be at the forefront of the development and implementation" Stated Guy Moxey, VP of product marketing at USCi.

The Department of Energy is awarding $70 million over five years, matched by at least $70 million in non-federal commitments by the winning team of businesses and universities, along with the state of North Carolina.

www.unitedsic.com

http://www.whitehouse.gov/the-press-office/2014/01/15/president-obama-announces-new-public-private-manufacturing-innovation-in

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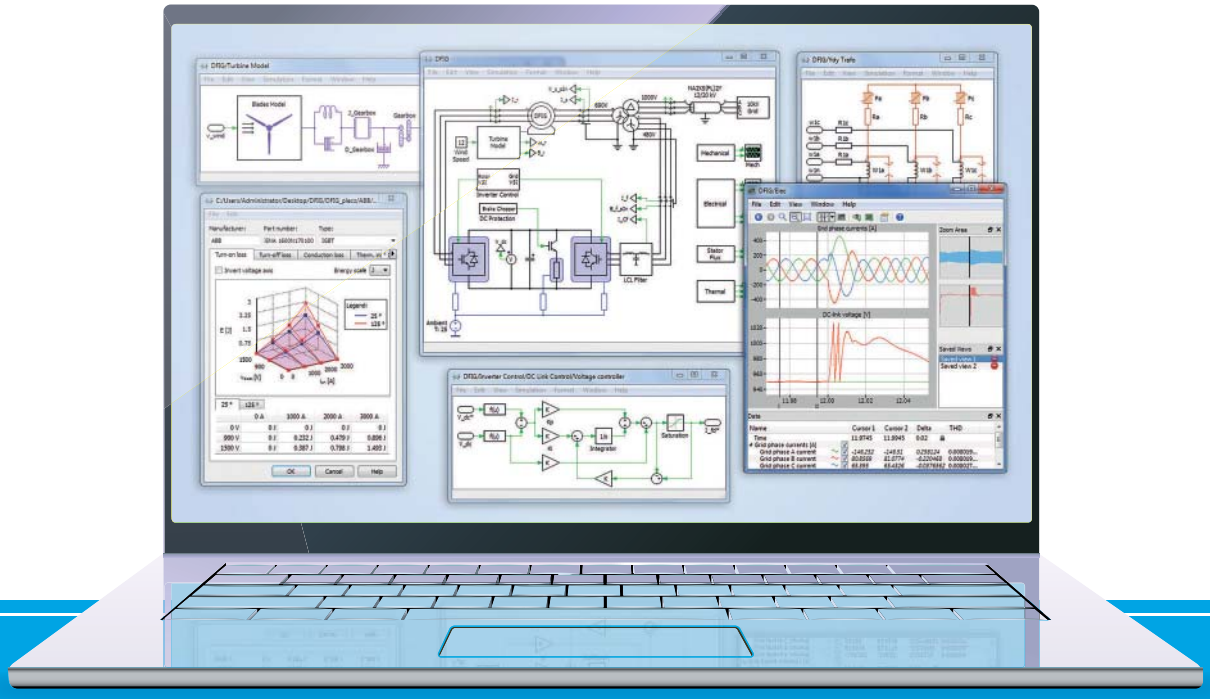

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Extended Range of Wireless Power Transfer

Duke University researchers have demonstrated the feasibility of wireless power transfer using low-frequency magnetic fields over distances much larger than the size of the transmitter and receiver.
The advance comes from a team of researchers in Duke's Pratt School of Engineering, who used metamaterials to create a "superlens" that focuses magnetic fields. The superlens translates the magnetic field emanating from one power coil onto its twin nearly a foot away, inducing an electric current in the receiving coil.
The experiment was the first time such a scheme has successfully sent power through the air with an efficiency many times greater than what could be achieved with the same setup minus the superlens.
The results, an outcome of a partnership with the Toyota Research Institute of North America, appear online in Scientific Reports on Jan. 10.

http://duke.edu/

Power Electronics and Electrical Challenges for Engineering Energy-Efficient Buildings:

Seventy percent of global energy production is consumed in commercial and residential buildings. Power electronics applications can reduce this substantially. The IEEE PELS Emerging Technologies Technical Committee and PSMA, with leadership from the PSMA Alternative Energy Committee, will sponsor this special one-day workshop in conjunction with the Applied Power Electronics Conference.
Participants are invited to this pre-APEC workshop that is designed to gather a group of experts in power electronics and advanced energy-efficient buildings. Much of the past work on low-energy buildings has emphasized HVAC and envelope design, but the essential actuators and devices employ power electronics. The workshop objectives are to establish key subject matter, identify gaps and technology challenges, discuss market opportunities, and develop a power electronics and electrical systems community for global initiatives in energy-efficient buildings.
Saturday, March 15, 2014; Omni Hotel, 1300 Houston Street, Fort Worth, Texas 76102
http://www.psma.com/technical-forums/alternative-energy/workshop

www.psma.com

Pete Klessel as VP of Worldwide Sales

Akros Silicon Inc., a premier supplier of leading-edge intelligent energy management ICs, announces the appointment of Pete Klessel as the company's Vice President of Worldwide Sales. Pete Klessel joins Akros to expand the company's reach into high growth consumer and communications markets where manufacturers face stringent requirements for improved power and energy management in their systems.
"Pete's ideal combination of deep technical knowledge and outstanding customer advocacy has led to a successful track record selling into large strategic accounts," said Elie Antoun, President & CEO of Akros. "He has extensive experience with power management products and brings a system-level sales approach that has helped him build high-quality customer and channel relationships that are an excellent fit to Akros' power-system-on-chip (PSoC) solutions."

www.akrossilicon.com

Expanding Horizons: Europe in 2014

Change and challenges in the semiconductor and related industries will continue in 2014. The good news: with US$ 40 billion, the global equipment market in 2014 will grow — with more than stunning 30 percent year-over-year growth. Materials will reach US$ 47 billion, a 4 percent increase year-over-year. And European fabs will spend US$ 3billion in 2014 compared to US$ 2 billion in 2013 according to the latest SEMI forecast.
In 2014, consolidation of our industry is expected is to go on and technological advancements such as EUV, 450mm transition, and 3D-TSV will continue, supported by an aggressive growth strategy (Key Enabling Technology and 10/100/20 initiative) of the European Commission. SEMI Europe provides services and support to address the full potential for your company or organization and we have aligned our events and services to the opportunities and challenges that the industry will face in the years to come.
For the first time, SEMICON Europe will be located in Grenoble and will showcase a broader array of technologies, products, solutions and opportunities spanning the most exciting developments in European microelectronics.

www.semi.org/eu

Neil Whittington EMEA Director of Sales

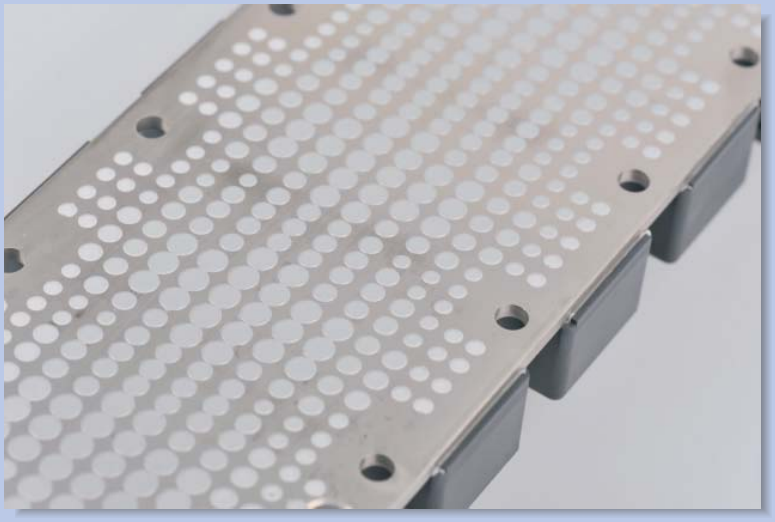
CUI Inc has announced the addition of Neil Whittington as EMEA director of sales. The appointment is part of CUI's drive to increase its European presence and further improves support for its European customers.
Neil will be based in the UK and brings a deep understanding of the European server, storage & networking, industrial/transportation & telecommunications markets and a technical background in power electronics. He joins from Power-One, where he served three years as director of EMEA sales and 10 years as a senior global account manager.
Neil will be tasked with expanding CUI's customer base and channel partners in Europe and the Middle East for the company's broad portfolio of power and board-level components.
"I am incredibly excited to be joining CUI at such a pivotal stage in their history as they make a push to expand their brand and technologies globally," commented Whittington. "I look forward to utilising my experience and background to help build long-term partnerships with current and future CUI customers in this region."
"We are very pleased to welcome Neil as part of the CUI team," stated Matt McKenzie, president of CUI. "We see the EU, EFTA and Israel as vital to our long-term success. With his extensive knowledge of the power industry and unwavering commitment to customer satisfaction, Neil will serve as a great asset to our customers in Europe."

www.cui.com

Fuji Electric

Innovating Energy Technology

Pre-applied Thermal Interface Material (TIM)



The ongoing increase of power densities within the thermal interface between power module and heat sink requires an optimized thermal distribution.

Fuji Electric has developed the pre-applied Thermal Interface Material (TIM) which achieves a stable quality and reproducible thermal performance.

Pre-applied TIM not only provides a significant low thermal resistance, it also fulfills the highest quality standards to achieve the longest lifetime and highest system reliability.

▸ Features

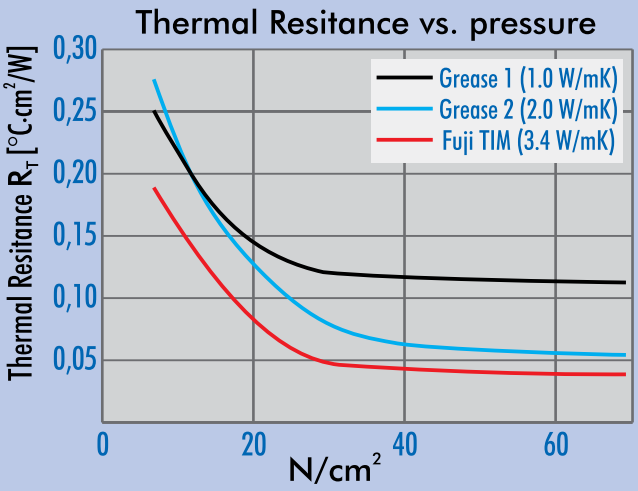
+ Optimized for Fuji Modules
+ Increased lifetime of IGBT
+ Advanced IGBT power density

▸ Process - Benefits

+ Outsourcing a dirty process
+ Stable quality level
+ Increased system reliability

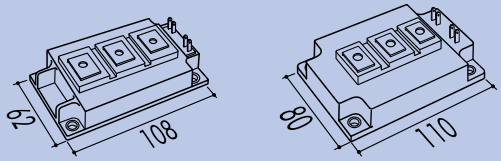
▸ Thermal - Benefits

+ Higher thermal conductivity
+ Decrease R_{th}-value significantly



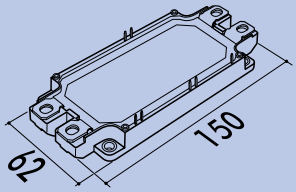
Available IGBT-packages with pre-applied TIM

1 in 1 & 2 in 1

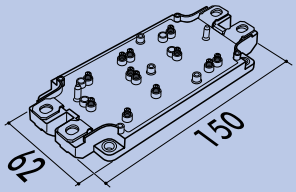


2 in 1

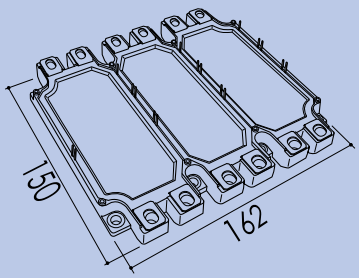
With solder pins



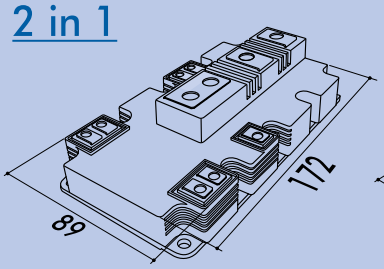
With spring contacts

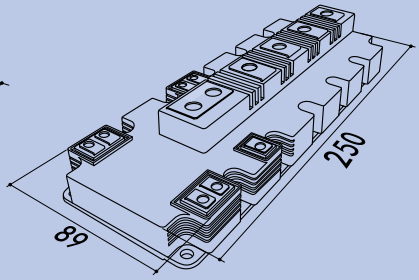


6 in 1



2 in 1





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Products Overview ▸ www.fujielectric-europe.de/overview.pdf

Gallium Nitride Transistors included in Multisim 13.0 SPICE Software

Efficient Power Conversion Corporation, (www.epc-co.com) the leader in enhancement mode gallium nitride FET technology, announced that its enhancement mode gallium nitride transistors (eGaN® FETs) SPICE models have been included in the latest version of National Instruments' Multisim circuit simulation and design software. The Multisim toolkit enables engineers to easily calculate, change and sweep critical component parameters in advanced power conversion system applications.

"The EPC component models in Multisim 13.0 are now leveraged by thousands of engineers to improve power system efficiency, reduce final product size, reduce development cost, or a combination of all three. Multisim is also a leading circuit design tool in both academia and with companies that are excited about basing their power electronics designs on cutting edge components. We are delighted to have EPC's industry-leading gallium nitride transistors included in Multisim and are looking forward to the future releases of eGaN FETs and their continued integration within Multisim," said Mahmoud Wahby, product manager at National Instruments.

According to Alex Lidow, EPC's co-founder and CEO, "In order to make eGaN FETs easy to use, we developed these devices to behave very much like silicon power MOSFETs, but with greatly enhanced high frequency capability. With the inclusion of our products in Multisim SPICE models, National Instruments provides user-friendly tools that make a significant impact in how easy it is to design with our eGaN devices. These device models will enable rapid time-to-market of power conversion systems taking full advantage of our high performance gallium nitride power transistors."

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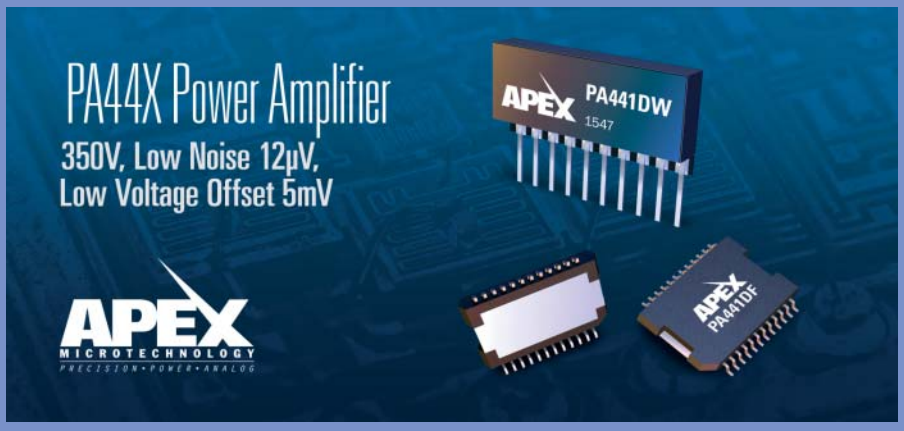
Texas Instruments

Fourth Generation High Voltage Amplifier IC Continues to Deliver Industry Innovation in Three New Single Channel and Dual Channel Designs

Reduces Signal Noise by 96% and Improves Offset Voltage by 2X

Back in 1991, Apex Microtechnology introduced the industry's first high voltage, 350V power amplifier IC – the PA41. Apex continues to drive industry innovation by designing next generation performance inside the fourth product iteration of this popular device, the monolithic PA44X series.



Featuring a single channel and dual channel option, this monolithic design provides a 96 percent reduction in noise and a 2X improvement in offset voltage. The PA441DF, PA441DW and PA443DF have a low noise rating of 12µV RMS at 20kHz to enhance their selection as high voltage drivers in piezo positioning applications. In terms of offset voltage, all three ICs exhibit a low 5mV at a typical 25°C operating temperature, and just 20mV max. across the full -40°C to +125°C operating range.

"The popularity of this high voltage IC product family has driven our continued efforts to shrink its footprint and cost while incorporating performance innovation for next generation applications," explained Jens Eltze, Strategic Marketing Manager. "Signal quality is probably the most crucial component of the targeted high voltage applications for the PA44X series, so driving down the voltage noise is going to maintain design-win status for these ICs as well as land new sockets."

The single-channel PA441DF is housed in a non-hermetic plastic, surface mount 24-pin PSOP, and the PA441DW is in an electrically-isolated, 10-pin ceramic SIP. The PA443DF is the dual channel version and also is available in the PSOP. All three ICs operate on a wide ±10V to ±175V supply. Output current is continuous at 60mA, with PEAK output of up to 120mA. The dual-channel device doubles the output current performance and the quiescent current is a very low 2.2mA per channel. All three devices are pin compatible, drop-in replacements to their predecessor devices -- the PA341DF, PA341DW and PA343DF.

In addition to being a popular choice as a voltage driver for the fine movement positioning of piezo-electric applications, the PA441DF/PA441DW/PA443DF are targeted at other applications requiring the accurate delivery of high voltage, including electrostatic transducer and deflection circuits, deformable mirror focusing, biochemistry stimulators and computer to vacuum interface designs.

Pricing, Availability and Evaluation Tools

The PA441DF is currently available in sample quantities for evaluation and prototyping, as well as volume production. Per unit pricing for the PA441DF is $7.98 USD in 1,000 quantities. Both the PA441DW and PA443DF will be available for evaluation in Q1 2014. The EK13 is the development kit for both the PA441DF and PA443DF and includes a PCB and heat sink. The EK42 can be used with the PA441DW. Complete product information is online at www.apexanalog.com. For technical support, contact Apex applications engineering at 800-546-2739, or apex.support@apexanalog.com.

Apex Microtechnology is an industry leader in high power analog components, designed to meet the performance and cost design targets of our customers' precision control applications. Apex Microtechnology is headquartered in Tucson, AZ, USA. More information about Apex Microtechnology is available at:

www.apexanalog.com

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Compact Converter Series

Summary
The Austrian manufacturer of electronic components EGSTON provides a new compact Converter series (EGSTON COMPISO) with high bandwidth output signals. The modular series is optimally suited for building up DC-DC, DC-AC as well as AC-AC converter systems in the power range of 120kW up to 1 MW.

Introduction
EGSTON has developed a new series of compact converters (VIN up to 1.000V) with minimum ripple (VRIPPLE_OUT_peak < 0.15 % VIN; THD < 0.12%) and high bandwidth output signals (10 kHz – 3 dB). Due to the high signal quality and high dynamics, test-benches are the most attractive application field. During the development of power electronics for the manifold areas like electric drives, energy storage, utility interfaces, it is essential to support the test process with Hardware-in-the Loop systems based on electronic emulators. Batteries are emulated by a dc-source/sink, the grid by a three-phase inverter with sinusoidal output voltage (artificial mains) and electric motors are replaced by inverters which are reacting according to the selected motor model. For these and other demanding applications like harmonic compensation in the grid or inverters for high speed motors (e.g. for turbines), EGSTON is offering galvanically isolated high-speed interfaces allowing dynamic control with minimum latency.

Applications
The converter series is based on a modular concept, where power balancing and dynamic voltage controllers are integrated in the system as a standard. The customer is free to add superimposed process-specific controllers via the high speed communication link. This will be supported by providing simulation models for the converter system, which allows simulating the applications in advance.

DC-Power Source/Sink
Typical applications for DC-power supplies are battery test systems and battery emulators as well as DC-motor testers and emulators. For applications with a high demand of dc-power several converters can be connected in parallel. The DC-output signal can be superimposed by harmonics up to a bandwidth of 10 kHz to emulate noise an artefacts generated by DC Sources / Sinks operating at low PWM frequencies. The system is designed with extremely low time constants, which means that a transient voltage output response is faster than 1.000 V / 100 µs.

Synchronization and power balancing guarantees the full dynamic performance independently of the number of parallel devices.

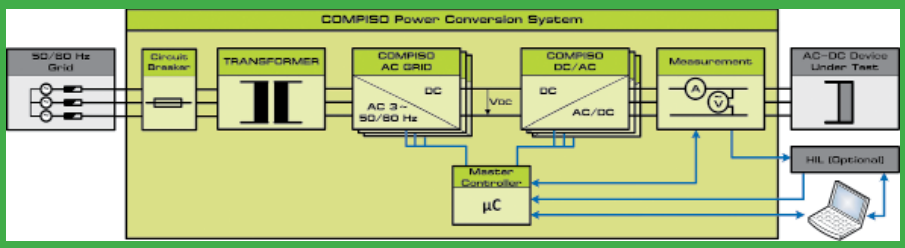

Figure 1: Compact Converter series COMPISO

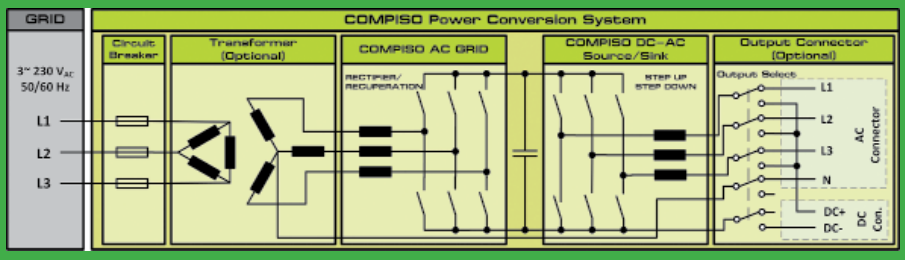

Figure 2: Compact Converter COMPISO as AC source / sink or DC source / sink optionally

Three-Phase (N-phase) DC-AC Converter
The three-phase converter can be applied as pure actuator for generating three phase output voltages, which can also be composed by single harmonics. One converter can be operated as AC source / sink or DC source / sink just by switching over the output connectors (see Fig 2).
With optionally available software packages it can also be operated as a grid-tie inverter (VOC) or as a motor control inverter (FOC).

Converter combinations
EGSTON converters are available as single components (DC-DC Converter, DC-AC Converter) or as Power Conversion Systems by combining different converter systems like 4 quadrants drives or complete hardware-in the loop test benches including e.g. battery emulators and motor emulators can be built up. Such systems will be characterized by high dynamics as well as high efficiency due to the cycling energy.

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The EconoPACK™ 4 is an optimized module for 3-level applications such as

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- High Speed Drives

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Further information is available on request.

The degree of efficiency for the two 3-level topologies, NPC1 and NPC2, has to be evaluated depending on the switching frequency.

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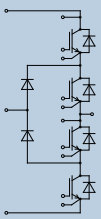
- EconoPACK™ 4 NPC1 topology for high switching frequencies (approx. $f_{sw} \geq 12$ kHz)

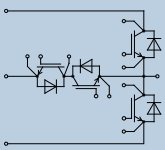
NPC1 topology

- 650V IGBT4
- Optimized for $f_{sw} \geq 12$ kHz
- Portfolio
  - F3L200R07PE4
  - F3L300R07PE4



NPC2 topology

- 650V/650V IGBT4
- 650V/1200V IGBT4
- Optimized for $f_{sw} < 12$ kHz
- Portfolio
  - F3L400R07PE4_B26
  - F3L300R12PT4_B26
  - F3L400R12PT4_B26



www.infineon.com/highpower

On the Immanent Adoption of 600 V Rated GaN-on-Si Based Power Devices

By Michael A Briere, ACOO Enterprises LLC, under contract to International Rectifier

The immanent adoption of commercially viable 600 V rated GaN-on-Si based power devices marks a milestone in the power electronics industry. Though there has been much talk of this transition over the past 5 years, its realization is now here. Several prominent players in the power semiconductor field including Panasonic and International Rectifier have announced sampling of these revolutionary devices in 2013. The delay between first customer samples and volume production shipments is due, in large part, to the time required to accumulate the substantial long term reliability data required to satisfy both the supplier and customer's comfort level that the devices are ready for commercial use.

In fact, due to the markedly different materials and device structure involved, entirely new test criteria needed to be developed, beyond the previous silicon based standards, in order to provide estimated product lifetimes in common applications (i.e. qualification). Even so, the available reliability and quality data, based on the production and testing of some 10's millions of devices over several years is clearly only sufficient to support consumer and commercial level applications at this time. It is expected to require the production of billions of devices over an additional 3-7 years in order to satisfy the database required to support the < 10 ppm quality requirements of the heavy industrial, automotive and aerospace markets. It is for this reason that it is so important that the initial technology platforms for these devices be cost competitive with the silicon incumbents. It is only through the commercial introduction of such a technology that the necessary history can be developed in an economically sustainable manner.

While it is true that GaN based HEMTs have been used commercially for several years,

these devices have mostly been developed for much lower voltage applications, 20 to 48 V, such as RF amplifiers and low voltage dc-dc point of load power supplies with 100 V rated GaN-on-Si based HEMTs more recently being released commercially in class-D audio amplification for home use. Though there are demonstrable advantages of GaN HEMTs in such applications, especially due to the near absence of reverse recovery charge, the overall power electronics market has not yet recognized these as broadly essential. This is expected to be different with the advent of commercially viable 600 V rated GaN-on-Si based power HEMTs.

Though the basic value proposition in power conversion of density*efficiency/cost remains true across the targeted voltage application range of 20-1200 V, the fundamental relative advantage of the GaN based power devices over the silicon alternatives is substantially greater as the device voltage rating is increased. For 600 V rated devices the present realized advantage in terms conduction loss*switching loss is more than a factor of 4 compared to state of the art silicon based IGBTs or superjunction FETs. This provides for compelling advantages in a variety of power electronic applications such as motor drives, where a factor of more than 10 in density/power loss has already been demonstrated. The ability to produce low Qrr switches (unlike superjunction FETs) enables the use of synchronously rectified power factor correction (PFC) circuits, providing highly efficient, low noise filters without the added expense of SiC based devices. Higher frequency operation (to several MHz) will produce much more dense, efficient ac-dc power supplies. As impressive as these advantages are, the truly revolutionary promise of GaN based power device will be realized when the potential additional order of magnitude advantage over silicon alternatives is achieved over the coming 10-20 years.

Beyond the obvious advantages in performance, it is expected that the cost of producing a given resistance switch (e.g. 100 mohm) in this new GaN based technology will be less than state of the art silicon alternatives within the next 5 years. With such compelling advantages in terms of both performance and cost, GaN-on-Si based power devices will be well positioned for widespread adoption across a variety of applications.

Finally, the inherent integratability of GaN based HEMTs is expected to provide for an entirely new level of revolution in power electronics, akin to that of the 1960's in data processing. Exciting!

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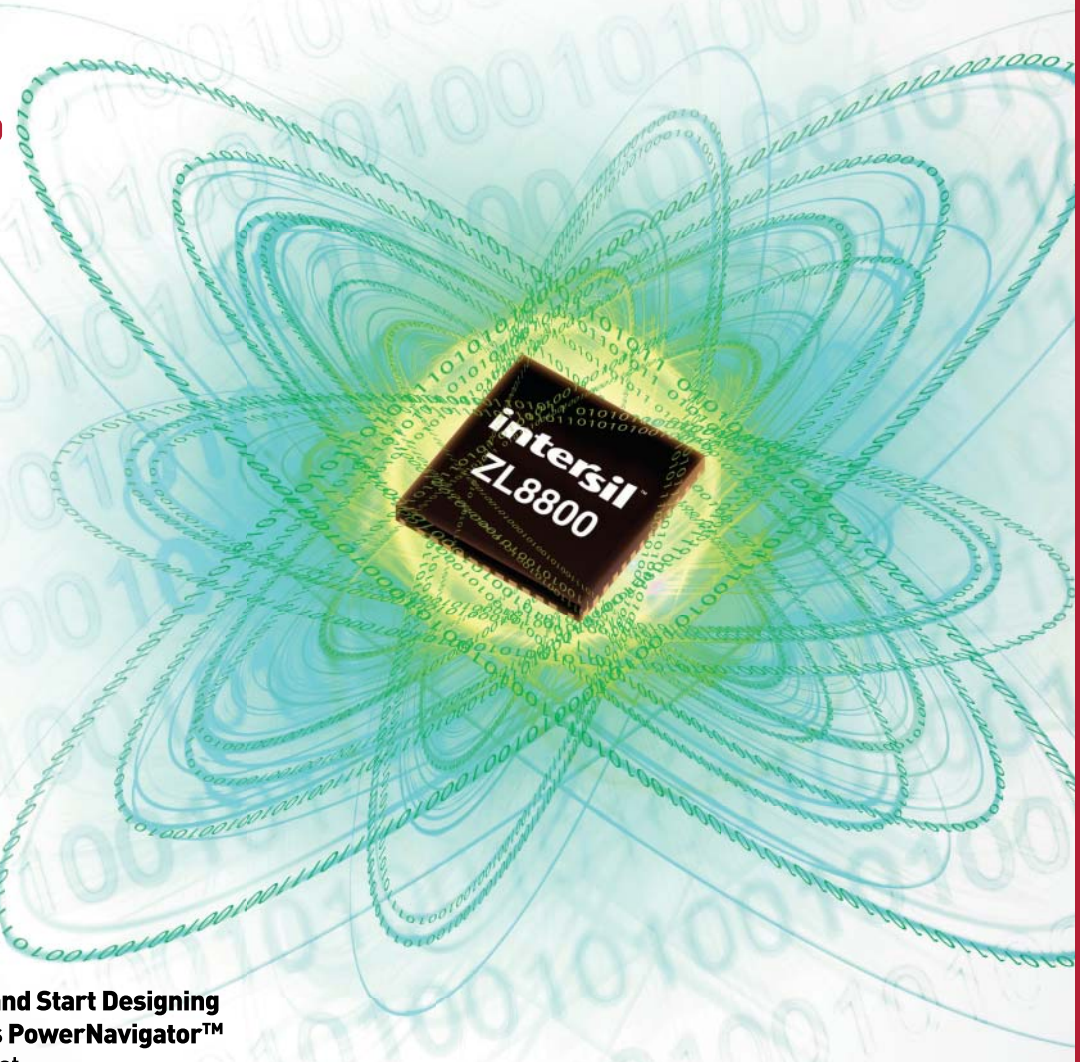

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Electronics Industry Digest

By Aubrey Dunford, Europartners

Total worldwide production value of electronic systems is projected to increase 4 percent in 2013 to $ 1.41 trillion and climb to about $1.74 trillion in 2017, which represents a compound annual growth rate (CAGR) of 5.0 percent, so IC Insights. Cellphones will overtake standard personal computers (desktop and notebook PCs) as the largest electronic systems market for the first time in 2013.

SEMICONDUCTORS

The world semiconductor market in 2013 will be $ 304 billion, up 4.4 percent from 2012, so the WSTS. The market is expected to recover throughout 2013, driven mainly by double digit growth of Memory product category. By region, all regions except Japan will grow from 2012. In particular, the European semiconductor market in 2013 will be $ 34.6 billion, up 4.3 percent from 2012. Worldwide semiconductor market is forecasted to be up 4.1 percent to $ 317 billion in 2014 surpassing historical high of $ 300 billion registered in 2011. For 2015, the market is forecasted to be $ 328 billion, up 3.4 percent. All product categories and regions are forecasted to grow positively in each year, with the assumption of macro economy recovery throughout the forecast period.

Avago Technologies and LSI have entered into a definitive agreement under which Avago will acquire LSI for $ 11.15 per share in an all-cash transaction valued at $ 6.6 billion. The acquisition creates a highly diversified semiconductor supplier with approximately $ 5 billion in annual revenues by adding enterprise storage to Avago's existing wired infrastructure, wireless and industrial businesses. The combined company will be positioned to capitalize on the opportunities created by the rapid increases in data centre IP and mobile data traffic. Avago is a supplier of a broad range of analog semiconductor devices with a focus on III-V based products. LSI designs semiconductors and software that ccelerate storage and networking in datacentres, mobile networks and client computing.

Fujitsu, Fujitsu Semiconductor and Transphorm, a supplier in GaN power devices for power supplies, have reached an agreement whereby Fujitsu Semiconductor and Transphorm will integrate their gallium-nitride (GaN) power devices for power supplies businesses. The three companies have also agreed that both Fujitsu and Fujitsu Semiconductor will take a minority equity position in Transphorm. Fujitsu and Fujitsu Semiconductor will establish a new company in Japan for the GaN power device business, and will transfer to the new company their combined design and development assets as well as intellectual property rights in GaN power devices. The new company will become a wholly owned subsidiary of Transphorm.

SEMI projects that worldwide sales of new semiconductor manufacturing equipment will contract 13.3 percent to $ 32 billion in 2013. In 2013, Europe will reach equipment sales of $ 3.01 billion, compared to $ 2.5 billion in 2012. In 2014, all regions except "rest of world" are expected to have strong positive growth, resulting in a global increase of 23.2 percent in sales. Wafer processing equipment, the largest product segment by dollar value, is anticipated to decrease 10.7 percent in 2013 to total $ 25.1 billion. The forecast predicts that the market for assembly and packaging equipment will decline by 22.1 percent to $ 2.4 billion in 2013. The market for semiconductor test equipment is forecasted to decline by 20.7 percent, reaching $ 2.8 billion this year.

A single layer of tin atoms could be the world's first material to conduct electricity with 100 percent efficiency at the temperatures that computer chips operate, according to a team of researchers from the U.S. Department of Energy's SLAC National Accelerator Laboratory and Stanford University. Researchers call the new material "stanene," combining the Latin name for tin (stannum) with the suffix used in graphene, another single-layer material whose novel electrical properties hold promise for a wide range of applications. Stanene wiring should significantly reduce the power consumption and heat production of microprocessors. "Eventually, we can imagine stanene being used for many more circuit structures, including replacing silicon in the hearts of transistors," the researchers said.

Harting's investment during its financial year focused on the construction of the "Harting Quality and Technology Centre (HQT)". An estimated € 10 M is being invested in the new building which is set to officially open in summer 2014 in Espelkamp, Germany. Research will be conducted into new technologies for future products and solutions at the technology centre in Espelkamp which has a 60-strong workforce. Harting posted revenues of € 484 M (previous year: € 479 M) for the 2012/2013 financial year (October 1, 2012 to September 30, 2013), marking the highest revenue achieved in the company's history. The supplier of connectors has generated 64 percent of its revenues outside of Germany.

OTHER COMPONENTS

Maxwell Technologies, a supplier of ultracapacitor-based energy storage products, has signed a Memorandum of Understanding with SK Innovation, a subsidiary of SK Holdings and Korea's leading energy provider, to develop next generation energy storage solutions leveraging the complementary characteristics of SK's lithium ion batteries and Maxwell's ultracapacitors. The two companies will explore and identify global commercial opportunities for products that enable enhanced functionality and improve energy efficiency in industrial and transportation markets.

LTX-Credence, a global provider of ATE solutions, has completed the acquisition of the Multitest and Everett Charles Technologies (ECT) businesses of Dover, for a purchase price of $ 93.5 M.

This is the comprehensive power related extract from the «Electronics Industry Digest», the successor of The Lennox Report. For a full subscription of the report contact:
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Controversy over DC Power Distribution: How Fast will it Grow?

By Jeff Shepard, President, Darnell Group

One of today's 'great controversies' in power electronics has been the use of ac-powering versus dc-powering for data centers, campus-sized micro grids, and other applications of varying sizes. This year will see the seeming controversy resolved and dc-powering will be increasingly seen as a viable and valuable solution. The commercial development of dc power distribution and dc micro grids will be one of the major topics in September at the Second Annual "Darnell Energy Summit" (DES) Mark your calendar and join us in Boston for DES 2014.

DC power is only one of the leading-edge areas of power electronics technology that will be delved into during DES 2014. DES will look broadly into power electronics including advanced semiconductor devices, digital power, energy harvesting, wireless power transfer/charging, instrumentation and monitoring, smart loads and demand-side management, electric and hybrid vehicles, large-scale energy storage, intelligent power monitoring sensors, and more. You can find details at: http://energysummit.darnell.com/

Three examples serve to illustrate the evolving situation for dc powering and the benefits that will be derived from the use of dc-powering technologies, the European Union's DCC+G (DC Components + Grid) Project, the directive from the California Public Utilities Commission to incorporate extensive energy storage resources into the electricity grid, and the U.S.-based EMerge Alliance. Numerous similar efforts are underway in various forms in Japan, Korea, China and other countries.

The DCC+G project is being driven forward by the European Commission's target of 2021 for 'nearly net-zero energy buildings' in new construction. According to the EC: The ac main utility grid does not completely match to today's electronic (dc) loads and dc distribution offers simpler control of multiple sources, easier integration of renewable power, and higher efficiency end to end for dc loads. The initial test beds are aiming for at least a 5% overall efficiency improvement compared with today's ac-based architectures.

With a total budget of €18M, the DCC+G project is running on a 3-year timeline that started in April 2012. It includes 13 world-class partners from 5 countries (including 5 industry partners, 5 SME partners, and 3 research institutes). The major industry partners include Emerson Climate Technologies, Emerson Network Power, Infineon Technologies, Philips and Siemens.

Lower-power loads connected to a single 380Vdc bus while larger loads connect to the +/- 380Vdc bus. Grounding will be typical IEC TN-S system. Example of commercial buildings being targeted include; Supermarkets, large office buildings, and airports. The key objective of the project is to design and validate an energy-efficient building, with an integrated 380-Vdc energy distribution system including innovative and highly-efficient semiconductor power technologies.

Two primary goals of the project include; Infrastructure component design (sensors, switches, IGBTs, and so on) and Subsystem design for 380-Vdc grid in test bed installations. Many new technologies are expected to be developed to advance the application of 380-Vdc applied in commercial buildings. The DCC+G project expects to have two test beds operational starting August, 2014, with a final report available in 2015.

In October, 2013, the California Public Utilities Commission (CPUC) established an energy storage target of 1,325 megawatts for Pacific Gas and Electric Company, Southern California Edison, and San Diego Gas & Electric by 2020, with installations required no later than the end of 2024. The guiding principles of today's decision are 1) the optimization of the grid, including peak reduction, contribution to reliability needs, or deferment of transmission and distribution upgrade investments; 2) the integration of renewable energy; and, 3) the reduction of greenhouse gas emissions to 80 percent below 1990 levels by 2050, per California's goals. Energy storage systems can be deployed in three "grid domains" — transmission-interconnected, distribution-interconnected and behind-the-meter-interconnected.

This decision directs the utilities to file separate procurement applications containing a proposal for their first energy storage procurement period by March 1, 2014. The decision further establishes a target for Community Choice Aggregators and electric service providers to procure energy storage equal to 1 percent of their annual 2020 peak load by 2020 with installation no later than 2024, consistent with the requirements for the utilities.

According to the decision, the state's investor-owned utilities must begin buying a combined 200 MW of energy storage technology by 2014 and reach 1.3 GW (1,325 MW) by the end of 2020. This is expected to increase California's installed capacity six-fold from its current 35 MW. "This decision represents an important first step in encouraging the storage market and supporting grid reliability," said Commissioner Carla J. Peterman, the lead Commissioner for this proceeding.

In anticipation of the growing market for utility-scale energy storage systems, EnerSys entered the market with its new OptiGrid Stored Energy Solutions, a new turnkey megawatt-hour scale energy management system for utilities and large industrial applications. According to the company, power grid stabilization is a prime concern among today's utilities, as they balance supply and demand and cope with issues such as voltage regulation, frequency regulation, peak management and renewable power integration. In addition, power disturbances are a major cost and concern today for both utilities and industry. It is estimated that the U.S. economy is losing between $119 billion and $188 billion annually from power outages and power quality issues.

Last November, the EMerge Alliance announced the launch of a new residential dc power standards initiative to advance the use of dc power in homes and small businesses. The Alliance is the only application standards development group working on advancing the use of dc power in residential and commercial buildings. The Alliance is forming a technical committee to identify needs and opportunities for residential dc power standards. EMerge Alliance members will collaborate with organizations like IEEE on the standards-development process.

Also in November, EMerge announced expansion of the EMerge Alliance Registered™ product program to include the first products supporting the EMerge Alliance Data/Telecom Center Standard. The EMerge Alliance Registered product program is the industry's only program designed to simplify the use and adoption of dc power products that deliver numerous benefits enabling net-zero energy buildings.

The EMerge Alliance Data/Telecom Center Standard creates an integrated, open platform for power, infrastructure, peripheral device and control applications to facilitate the hybrid use of ac and dc power within data centers and telecommunications central offices.

The residential dc power standard initiative is an expansion of the Alliance's long-term strategic plan of creating standards for the use of dc power throughout buildings. Since its inception in 2008, the Alliance has focused its work on developing dc power standards to increase the sustainability, flexibility and efficiency of commercial buildings. It also pioneered a data/telecom center standard designed to improve the efficiency and reliability of equipment, while decreasing the total operating costs of these centers.

According to EMerge Alliance Chairman Brian Patterson, the increasing percentage of home electronics running on dc power, combined with the rapid expansion of the residential solar market in the U.S., makes dc power distribution a clear opportunity for homes to achieve energy savings and grid independence.

"We have seen the sustainability, flexibility and reliability advantages that DC power provides to commercial building spaces, and it's time to extend these benefits to homes and small businesses," Patterson said. "DC power distribution would not only maximize the efficiency and ROI of rooftop solar panels by enabling them to directly power consumer electronics, appliances, LEDs and electric vehicles (EVs) without conversion losses, it could also give homeowners a choice to either store excess DC power or continue selling it back to power companies."

Like all EMerge Alliance standards, this new residential initiative will include the hybrid use of ac and dc power by defining interfaces with existing ac power systems at various upstream and downstream levels, with the goal of providing plug-and-play convenience for homes and small businesses, including faster EV charging and direct support of the expanding use of USB, wireless charging and other low-voltage dc power distribution means that simplify the convenient and efficient use of personal electronics and home automation equipment.

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SCALE™-2 IGBT Gate Drivers Ease the Design of Optimized Renewable Inverter Systems

The 2SP0325 IGBT gate driver – a member of the SCALE™-2 plug-and-play gate drivers from CONCEPT – allows New Mega Power Dual IGBT modules from Mitsubishi to be driven efficiently in solar and wind power applications. The driver facilitates compact and reliable power converter design thanks to its high level of integration and robustness to EMI, resulting in a flexible and ready-to-use solution.

By Dominik Frauenfelder and Olivier Garcia, CT-Concept Technologie GmbH, Switzerland

The growing market for renewable energy requires powerful IGBT modules for use in solar and wind mill inverters. Ideally, the number of IGBT modules required must be kept to a minimum to reduce system costs and complexity while keeping the reliability at a high level. In response, Mitsubishi has released its New Mega Power Dual, an IGBT module family which uses half-bridge topology for three-phase converters in the MW range without requiring parallel connection of IGBT modules. Two types are available: a 1200V/2500A designed especially for solar inverters (CM2500DY-24S), and a 1700V/1800A module for wind mill inverters (CM1800DY-34S). The IGBT modules have been optimized using CSTBT™ (Carrier Stored Trench Bipolar Transistor) technology combined with a very low inductive internal wiring and a sophisticated aluminum baseplate to optimize module cooling [1].

Figure 1: 2SP0325T screwed onto a New Mega Power Dual IGBT module

This article describes the main functionality of the 2SP0325 SCALE™-2 driver which has been designed to drive the New Mega Power Dual IGBT modules. The driver family comprises two main versions:

- 2SP0325T drivers feature an electrical interface. They are cost-efficient and target cost-sensitive applications.
- 2SP0325V drivers include a fiber-optic interface for applications where this is a requirement.

Both driver versions are safe, compact and reliable solutions that allow short converter design cycles to be achieved.

Design for harsh EMI environments

The gate driver is a key element in achieving a compact and highly-reliable solar or wind power inverter. The driver controls not only the switching characteristics and the associated performance of the converter system, but is also responsible for ensuring that the IGBT switches within safe operating limits, even in the event of an overload or short circuit.

The IGBT module's internal inductance is kept relatively low thanks to a bus bar placed lengthwise along the module, directly under the 2SP0325 driver. Induced electromagnetic interference (EMI) on the driver under normal operation is relatively low, because the current changes in the bus bar happen in both directions, resulting in a small external magnetic field which is typically not a problem for driver electronics placed directly above the IGBT module. However, in the case of an IGBT short-circuit, the magnetic field changes are much higher due to the high currents flowing in the IGBT modules. One crucial task of an IGBT driver is to be able to turn-off reliably within a short time (<10µs) if there is a short circuit. The driver design must, therefore, be optimized to allow operation even at locations with high magnetic fields, specifically to allow for the instance of an IGBT short circuit.

Significant consideration was given to the layout of the 2SP0325 to ensure proper shielding of the driver's electronics with corresponding planes, as well as to optimally cool the components with associated higher power losses, resulting in a lower operating temperature and correspondingly higher reliability. The electrical version (2SP0325T) has been designed for 15V logic to further increase the signal-to-noise ratio of the driver. The choice of the discrete components was carefully made to guarantee a long lifetime and high reliability. As an example, no electrolytic capacitors are used on CONCEPT products.

The highly-integrated SCALE-2 chipset together with the optimizations discussed allow the driver to be operated safely directly on top of an IGBT module without the use of any shielding plates between IGBT module and driver.

Proven SCALE-2 Technology

The SCALE-2 chipset integrates the full functionality of a dual-channel gate driver core in a primary-side chip LDI (Logic to Driver Interface) and a secondary-side chip IGD (Intelligent Gate Driver). Thanks to the high integration level of the chipset, the number of discrete components can be drastically reduced, resulting in cost and reliability advantages.[2]

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The primary-side ASIC LDI fulfils the following main tasks:

- The input signals are converted to transformer pulses (electrical interface).
- The fault signals generated by the driver's secondary side are communicated to the driver's primary interface. If there is a fault, the driver remains blocked during the "blocking time" (the corresponding driver's channel remains in off-state).
- The switching signals for the DC/DC converter are generated.
- The primary-side power supply is monitored. In case of supply-under-voltage, both driver channels are turned off and a fault signal is generated.
- Two operation modes can be selected: In direct mode the user can control both driver channels independently (dead times must be generated externally). In half-bridge mode, the LDI generates the dead time between both channels automatically.

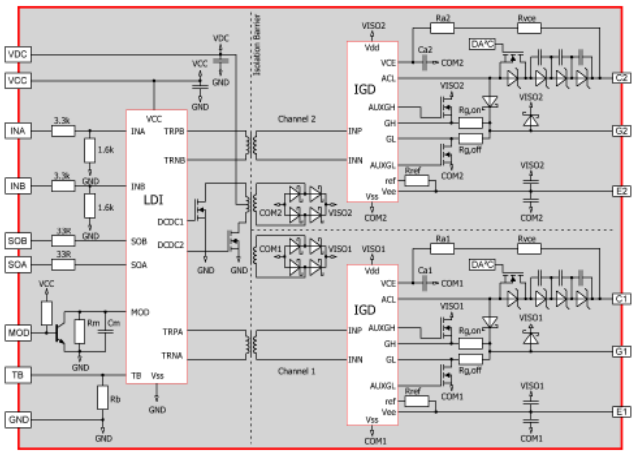

Figure 2: Block diagram of the 2SP0325T SCALE-2 driver

The secondary-side ASIC IGD provides the following functions:

- Transformer signals are converted in +15V/-10V gate-emitter voltages.
- Short-circuit monitoring - during a short circuit, the corresponding IGBT is turned off and a fault is communicated to the primary-side interface.
- Advanced Active Clamping (explained in more detail later in the article) limits the Vce turn-off overvoltage.
- The driver's secondary-side power supply voltages are monitored. The IGBTs are turned off safely in case of supply under-voltages and a fault signal is generated and transmitted back to the driver's primary side (electrical interface).

The DC-DC transformer required to transfer the energy for the gate driver to the secondary sides is also built in to the driver. DC-DC converter and signal transformers both feature safe insulation to EN50178 protection class II between the driver's primary and either secondary side.

Flexible solution

Because the 2SP0325 driver uses the SCALE-2 chipset which includes monitoring and controlling features it is not necessary to assemble any customer specific components like gate resistors: the driver is able to handle a wide range of stray inductances of up to over 35nH. Users only need to supply the driver with 15V non-isolated supply voltage and to provide the corresponding input signals (electrical or fibre-optic connectors) to the gate driver.

Advanced Active Clamping

A key feature of the IGBT driver 2SP0325 is the control of the IGBT turn-off over-voltage. The challenge when designing a ready-to-use driver is to setup the driver's parameters so that they fit a wide range of converter systems without changing gate resistors or other driver parameters.

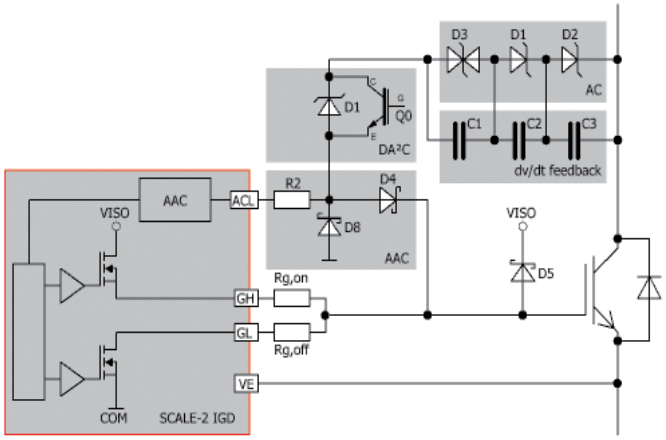

Figure 3: Dynamic Advanced Active Clamping with dv/dt feedback

The well-understood Basic Active Clamping (box AC in Figure 3) limits the collector-emitter voltage of an IGBT during the turn-off event. This clamping topology implements a single feedback path from the IGBT collector through transient voltage suppressors (TVS) to the IGBT gate. The IGBT is partially turned on as soon as its collector-emitter voltage exceeds a predefined threshold. The IGBT is then maintained in linear operation, thus reducing the fall rate of the collector current and therefore the collector-emitter over-voltage.

In SCALE-2 technology, Advanced Active Clamping (AAC) feedback (box AC and AAC in Figure 3) operates on the driver's secondary side ASIC. As soon as the voltage increases due to the active clamping activity, the turn-off MOSFET of the driver connected to GL is progressively switched off. This reduces the charge that flows away from the IGBT gate to COM over the turn-off gate resistor Rg,off. This results in a reduced IGBT turn-off collector-emitter over-voltage as well as reduced power losses in the TVS [3].

dv/dt feedback

A dv/dt feedback function (box dv/dt feedback in Figure 3) is additionally implemented in the 2SP0325 drivers. The purpose is to achieve a very efficient turn-off over-voltage limitation during regular switching operation without thermally overloading the TVS. During the collector-emitter voltage rise, a current, defined by the equation $i=C\cdot dv/dt$, flows in the dv/dt capacitors applied parallel to the TVS. This current further supports the Advanced Active Clamping, as it flows to the same driver's terminal, but is applied sequentially prior to the Advanced Active Clamping feedback. With this additional driving method, the V_{CE} voltage clamping is more effective and the losses generated in the TVS are reduced. The IGBT switching frequency can therefore be increased or it is possible to switch an IGBT module with higher DC-link stray inductances without exceeding the module's Reverse Bias Safe Operating Area (RBSOA). Also, snubber capacitors are not necessary.

Turn-off measurements of CM2500DY-24S IGBT modules with different collector currents and DC-link stray inductances L_σ show the benefits of the SCALE-2 technology. The Advanced Active Clamping and the dv/dt feedback control the turn-off switching to the maximum possible speed without exceeding the RBSOA. This is clearly visible

in the measurements for turn-off peak overvoltage for nominal current in Figure 4 ($V_{ce,peak}$=1086V @ L_σ=15nH, $V_{ce,peak}$=1090V @ L_σ=30nH) and double nominal current in Figure 5 ($V_{ce,peak}$=1097V @ L_σ=15nH, $V_{ce,peak}$=1085V @ L_σ=30nH) which show nearly the same results. The oscillation on the gate-emitter voltage is related to the control feedback of the clamping circuit and is fully normal. At the beginning of the collector-emitter dv/dt phase, the gate-emitter voltage increase related to the dv/dt feedback can clearly be seen. In the second part the gate-emitter voltage increase is related to the high turn-off di/dt of the collector current which activates the Advanced Active Clamping functionality.

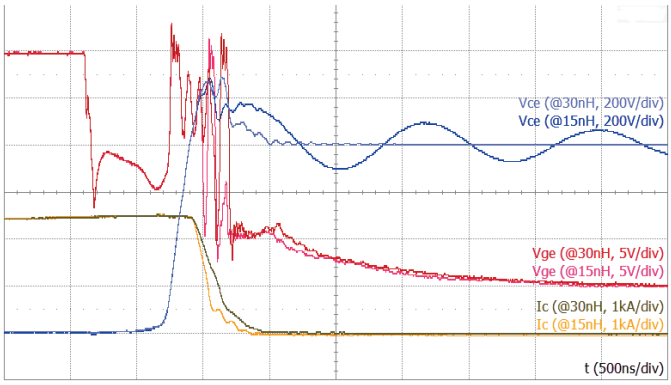

Figure 4: Turn-off comparison of CM2500DY-24S with L_σ=15nH and 30nH (I_C=2500A, V_{DC}=800V, T_A=25°C)

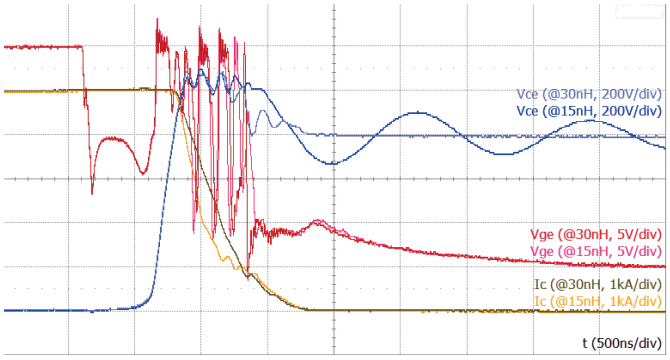

Figure 5: Turn-off comparison of CM2500DY-24S with L_σ=15nH and 30nH (I_C=5000A, V_{DC}=800V, T_A=25°C)

The measurements were performed using double pulse measurement methods in a half-bridge configuration with a CM2500DY-24S driven by 2SP0325T IGBT gate driver. Specific 1µF/1250V snubber capacitors were used to minimize the stray inductance down to 15nH. The results show that the driver can handle currents up to double the nominal current of the IGBT module with full DC-link voltage of V_{DC}=800V.

The measured turn-off overvoltage is lower than the permitted 1200V with sufficient safety margin. The measurements of Figure 4 and Figure 5 were performed at 25°C. The V_{CE} turn-off over-voltages are up to 60V higher at 85°C ambient temperature (maximum allowed ambient temperature of the gate driver), but still clearly remain inside the IGBT module RBSOA.

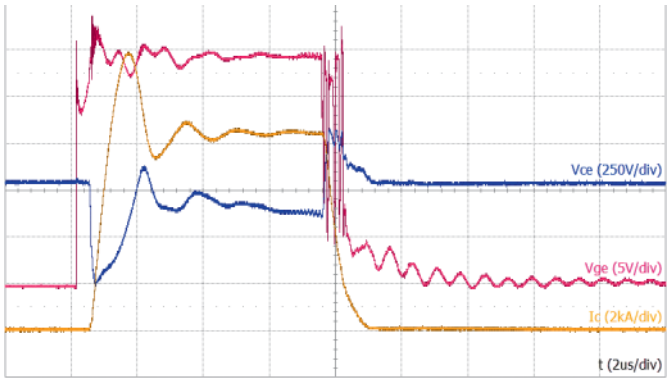

Figure 6: Half-bridge short-circuit with 2SP0325T and CM2500DY-24S

Dynamic Advanced Active Clamping

CONCEPT's Dynamic Advanced Active Clamping (DA²C) is a further development, implemented on 2SP0325 drivers. An additional TVS (box DA²C in Figure 3) is added in series to the TVS used for Advanced Active Clamping. This TVS is short-circuited with an auxiliary IGBT Q0 during the IGBT on-state as well as for about 15-20µs after the IGBT turn-off command to guarantee efficient active clamping (the additional TVS is not active during IGBT turn-off). After this delay, the auxiliary IGBT Q0 is turned-off. The additional TVS is therefore activated and allows the DC-link voltage to be increased to a higher value during the IGBT off-state. This allows, for instance, the possibility to demagnetize the output inductors of the converter system after emergency shut-down, leading to an inevitable short-time DC-link voltage increase.

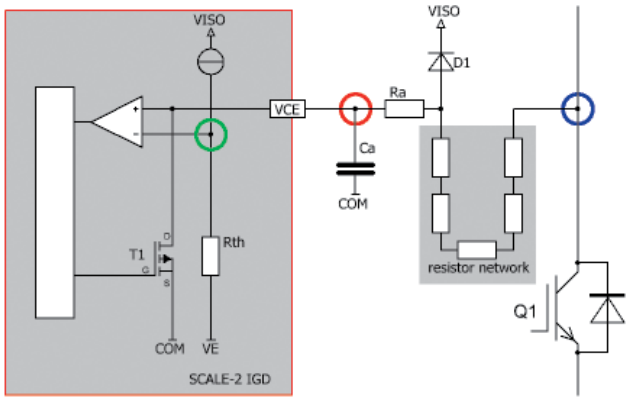

Figure 7: Circuit for short-circuit detection

IGBT Short-Circuit Protection

Short-circuit detection in 2SP0325 drivers is achieved using the same tried-and-tested principle as other SCALE-2 drivers: the saturation voltage of the IGBT during IGBT on-state is monitored with a resistor network. The circuit checks if the collector-emitter voltage has dropped below a pre-defined level in a given time period after the turn-on event. If the collector-emitter voltage does not fall below that level, or later rises above this level during IGBT on-state, a short-circuit condition is detected and the driver will safely turn-off the IGBT within its RBSOA.

During IGBT off-state, the driver's internal MOSFET T1 of Figure 7 connects pin VCE to pin COM. The capacitor Ca is then discharged to the negative supply voltage. At IGBT turn-on and in the on-state, the driver's internal MOSFET T1 is turned off. If the collector-emitter voltage (blue circle) is over the pre-defined level, Ca is charged from the COM potential to the IGBT saturation voltage. If the voltage of Ca (red circle) rises above the level of the reference voltage (green circle), the IGBT is in short-circuit condition and the driver will turn-off the IGBT immediately to protect it against thermal overload.

The desaturation protection function using a resistor network provides further advantages over a standard solution using diodes. Direct V_{CE} sensing is no longer influenced by parasitic capacitances of the high voltage diodes or their pronounced temperature-dependency. Additionally, the filtering time constant during IGBT saturated protection is relatively high – in the range of 50µs. This filtering prevents unnecessary protection regimes being applied in the case of short, abrupt increases of V_{CE} during IGBT on-state.

Moreover, the SCALE-2 drivers provide a tightly regulated V_{CE}+15V gate voltage during IGBT on-state. This feature is particularly advantageous in Type II short-circuit conditions. The high collector-emitter dv/dt values occurring in this failure mode inject considerable amounts of charge into the gate circuit (Miller feedback). This causes the gate voltage to rise, resulting in excessively high levels of short-circuit current. This may lead to a dangerous situation for the IGBT module, especially if the short-circuit time is too long. SCALE-2 drivers use a Schottky diode clamp to limit the gate-emitter voltage to safe values. The stable 15V supply absorbs the Miller feedback charge and safe operation of the IGBT is maintained.

Conclusion

Thanks to the SCALE-2 chipset and high levels of integration, the 2SP0325 CONCEPT gate driver is a cost-effective and reliable solution to drive the New Mega Power Dual IGBT modules from Mitsubishi. The driver has been optimized to cover the requirements of most of the IGBT's applications. The ready-to-use solution allows immediate operation after mounting the driver onto the IGBT module. Short design cycles with low development risks can therefore easily be achieved. With a plug-and-play driver family for the New Mega Power Dual IGBT modules, CONCEPT has again demonstrated the excellent performance of the proven SCALE-2 chipset which enables the optimized operation of the latest generation of IGBT modules in environments with high EMI.

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Up to 15,000V
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■Feature

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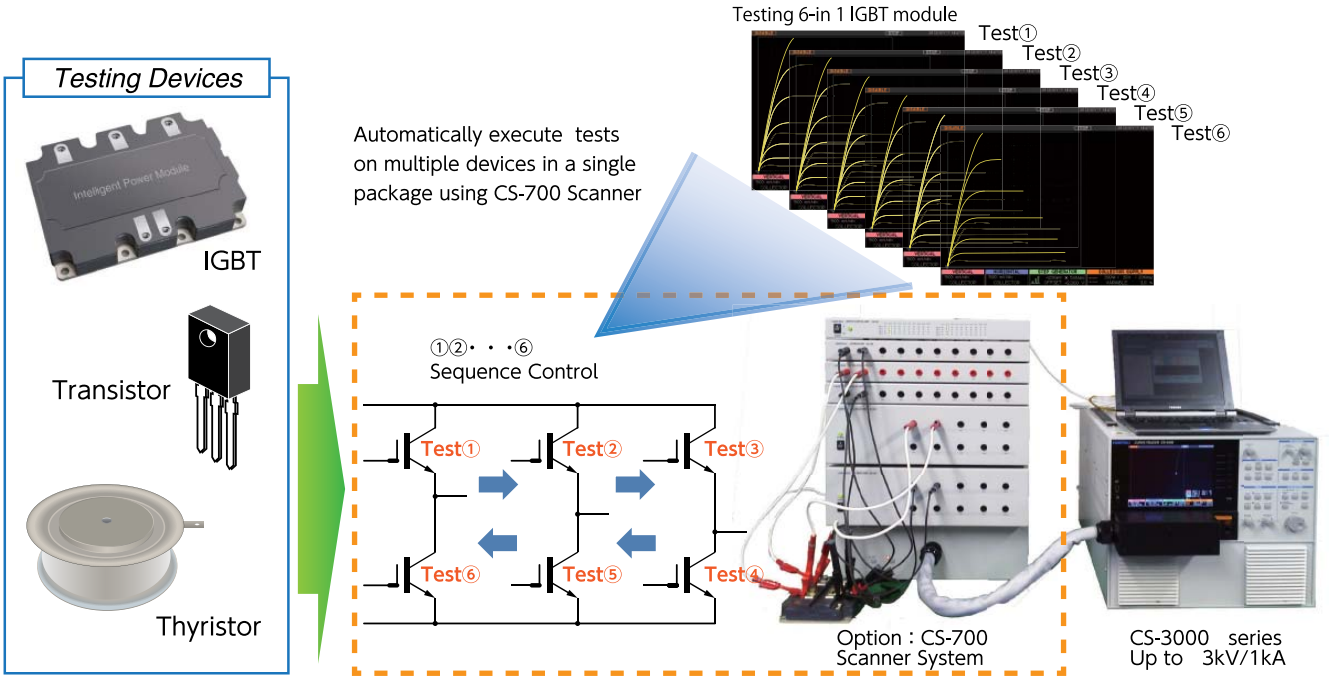

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■Feature

Ideal for measuring magnetic characteristics of soft magnetic materials such as silicon steel plates, ferrites, and amorphous materials for High Efficiency Motors (IE3,IE4,IE5), Switching Power Supplies, High-frequency Transformers, Reactors, etc.
Constant-temperature Chamber scanner system is also available to configure automatic testing system
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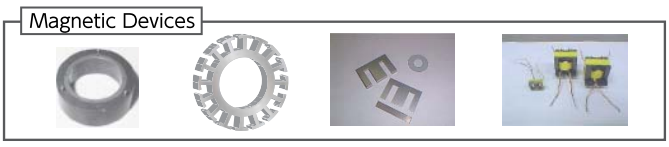

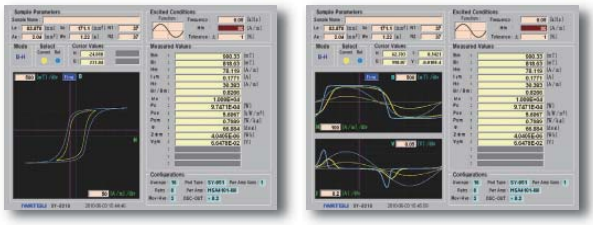

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SiC Devices are Moving towards Standard Products

Material defects are reduced and wafer sizes are growing

Silicon carbide (SiC) has been talked about for a while. Historically, silicon carbide was known for its hardness and used as a grinding material. It's potential for semiconductor's has been known since the middle of the last century, but unfortunately large scale quality substrates have not been available until recently.

By Bodo Arlt, publishing editor Bodo's Power Systems

Rectifier and switch production in SiC started on relatively small wafer sizes, as compared to silicon. Technology has developed over the last decade – now much larger lower defect wafers are reducing cost. And it is not only the device cost that is significant, the whole solution changes with SiC. With higher current density in SiC semiconductors, the chip size can be smaller. Switching losses are mostly eliminated. Passive components can be smaller as frequency can be increased. Smaller capacitors and coil sizes have a significant impact. The device can operate at much higher temperature, so cooling is easier. Critical space and transportation applications benefit from reduced weight.

All areas of application show improved performance from the excellent switching behavior of SiC devices... Modules using SiC diodes paired with silicon switches (for example, IGBT's) show a remarkable improvement in system performance. At the ROHM SiC Forum in December, Dr. Ino presented a comparison of losses at 125°C junction temperature, showing a reduction of about 75% in losses in a module equipped with SiC devices (Figure 1).

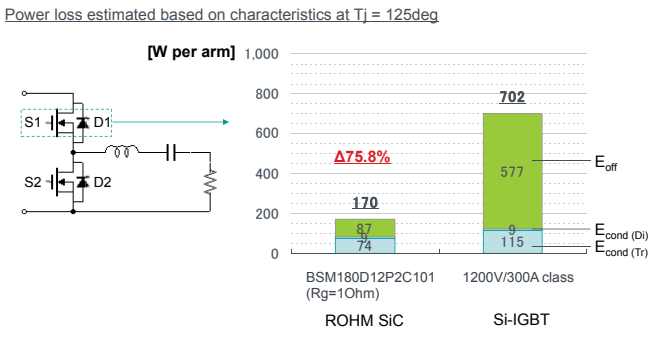

Figure 1: Estimation of Module Power Loss versus Standard IGBT in Silicon (Source ROHM; Dr. Ino)

SiC switches in different variations are now being introduced to the market, and a modular approach makes good sense immediately. To utilize higher switching frequency in most applications creates problems in Electro Magnetic Interference (EMI), so reduced spacing between switching devices is a requirement. Short internal wire length between semiconductor elements is perfectly achieved in well-designed modules.

A challenge remains to get to higher temperature packaging materials to fully utilize the SiC temperature capabilities. Articles in my publication during the last years have addressed the packaging opportunity.

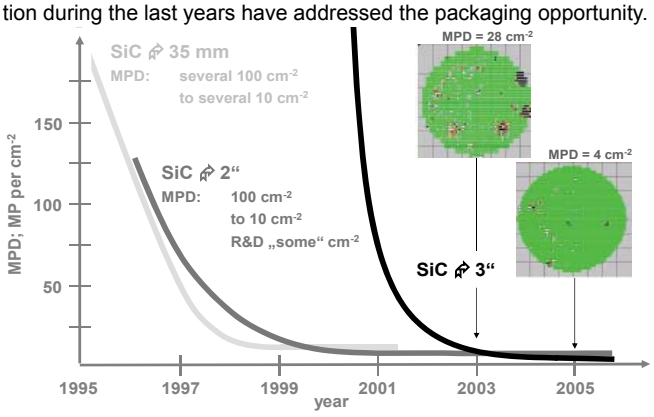

Figure 2: The Micropipe Density of SiC wafers (Source SiCrystal; Dr. Eckstein)

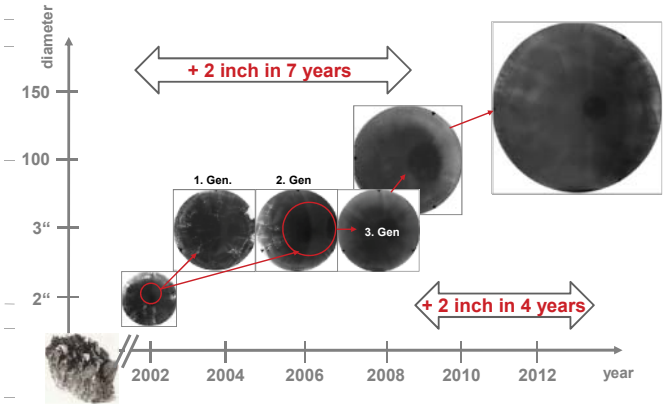

Figure 3: The Timeline Upscaling and Quality improvement (Source SiCrystal, Dr. Eckstein

Also, the practical use of SiC and GaN has been widely covered.

Conventional wisdom of the past has been that wafer cost and size would always dictate against volume applications. At the ROHM SiC Forum, Dr. Robert Eckstein from SiCrystal AG presented a significant update and outlook. Micropipe density (MPD), shown in Figure 2 from SiCrystal, shows remarkable improvement.

In parallel the wafer size for SiC is growing over the years. Processing here is different to what we know from silicon, but as the crystal structure is the basis for the semiconductor elements, it is the basis of product improvement. Figure 3 and 4 draws a clear picture of what has been achieved in the last ten years.

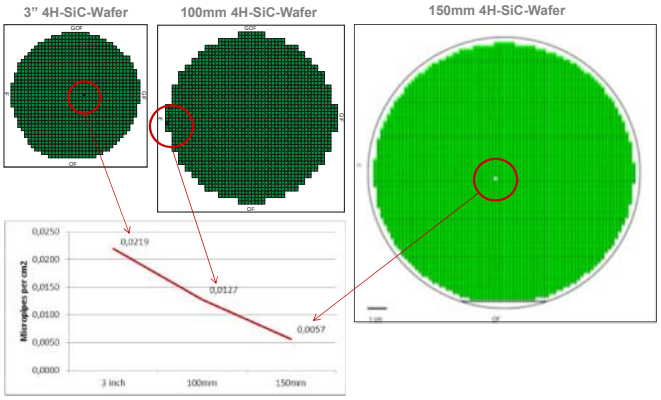

Figure 4: Micropipe Mappings: 3 inch, 100mm & 150mm as of today (Source SiCrystal, Dr. Eckstein)

So we are looking forward to see wide band gap semiconductors moving more and more into volume designs. Not only SiC devices at higher voltages, but GaN devices are now available for line voltage applications. It will be great to see at upcoming power conferences this year, starting with APEC in Fort Worth, what to expect as the norm in semiconductors. Technology has moved from tubes to mercury-arc, to Germanium, then to Silicon bipolar and MOS devices, and now to Silicon Carbide. That all happened within the last 60 Years – a continual improvement in capability.

What will be next?

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Multi-Physical Domain Modeling of a DFIG Wind Turbine System using PLECS® Simulation Software

Power conversion systems comprise several physical domains including electrical, magnetic, thermal, and often mechanical subsystems. To fully understand the behavior of the overall system prior to construction, and therefore increase likelihood of a successful design, the characteristics of the individual domains and their effects on the power converters must be taken into account. PLECS is a simulation tool developed for power electronics engineers that allows for very efficient and robust modeling of such systems with multi-physical domains and associated controls. In this study, a 2MW grid-connected wind power generation system has been designed in detail using PLECS, and the effects of the multi-domain interactions are investigated.

By Min Luo, Plexim GmbH and Kristofer Eberle, Plexim Inc.

Introduction

A cost effective method of wind power generation is to connect the output of the turbine to a doubly-fed induction generator (DFIG), allowing operation at variable speeds while minimizing the losses, cost and size of the power converters. A DFIG wind turbine system has a complex design involving multiple physical domains strongly interacting with each other. The electrical system, for instance, is influenced by the converter's cooling system and mechanical components, including rotor blades, shaft and gearbox. The influence of domains on one another must be considered in order to achieve an optimized overall system performance.

In addition to creating an accurate model of the entire system, it is also important to model the real-world operating and fault conditions. For fast prototyping and performance prediction, computer-based simulation has been widely adopted in the engineering development process. Modeling such complex systems while including switching power electronic converters requires a powerful and robust simulation tool. Furthermore, a rapid solver is critical to allow for developing multiple iterative enhancements based on insight gained through system simulation studies.

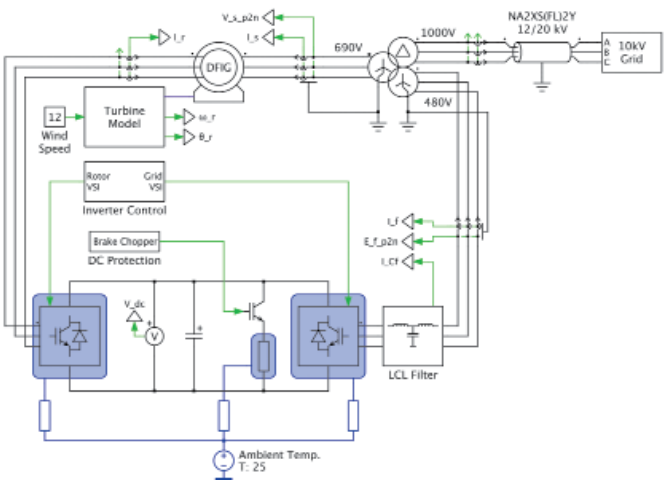

Figure 1: Schematic of the DFIG wind turbine model in PLECS.

System modeling of a wind turbine in PLECS

A 2 MW DFIG wind turbine model has been developed in PLECS and a demonstration is shown in Fig. 1. The components of the system are taken from PLECS' different physical domain libraries, including the electrical, magnetic, and mechanical, as well as signal processing and control systems categories.

Electromagnetic system

The electrical domain is used to accurately model the grid, power converters and electric machine. The machine's stator terminals are directly connected to the medium-voltage grid via a three-winding transformer and transmission line. The rotor is connected to the transformer via two back-to-back AC-DC converters with a common DC-link. A brake resistor is included to discharge the DC-link capacitor in the event of an overvoltage condition. The rotor-side inverter is directly connected to the induction machine's rotor, while the grid-side inverter is connected to the tertiary winding of the transformer through an LCL filter to meet current THD standards for grid connection. Multi-legged coupled magnetic structures, such as the transformer in this application, can be difficult to represent with an electrical equivalent circuit. Magnetic modeling in PLECS[1] offers a powerful method for modeling such components by directly capturing a magnetic circuit using windings and lumped core parts with user-specified geometries. Compared to a co-simulation with a finite element analysis (FEA) tool, which results in significant simulation times, this lumped magnetic circuit method is able to integrate magnetic component models into a system level simulation without causing any substantial increase in the duration. The PLECS magnetic domain is also capable of handling more complex effects including nonlinearities caused by saturation and hysteresis. In addition, the separation of electrical and magnetic domains provides the user a clearer overview when approaching the actual hardware construction.

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A Wye-Wye-Delta connected three-leg iron core transformer with laminated material is designed and each leg is modeled as a magnetic permeance. The complete model is shown in Figure 2, where the linear permeance core components can be replaced by permeances with saturation or permeances with hysteresis to simulate nonlinear effects. In this case, Eddy current power losses are represented by magnetic resistance components, which are series-connected to the permeances. Leakage fields are modeled with leakage permeances connected in parallel to the windings and the winding components serve as the interface between the electrical and magnetic domains.

Cooling system and device thermal modeling

Semiconductor power losses play an important role in the converter design and can be investigated using PLECS' thermal domain[2]. The PLECS ideal switch approach yields fast and robust simulations. Accurate conduction and switching loss calculations are obtained via look-up tables that are easily populated with values from data sheets. The dependence of temperature in determining power losses can be established, and the thermal energy transfer characteristics from the junction to the case can be specified.

The PLECS heat sink component absorbs the power losses produced by the components that it borders. It feeds these losses to the cooling system, which is simply modeled in this case as a thermal resistance and a constant temperature sink (ambient temperature). During the simulation, the junction temperature of the IGBTs can be monitored to ensure the cooling system is properly sized. Major and minor temperature cycles of the semiconductor dies can be used for life and reliability analyses.

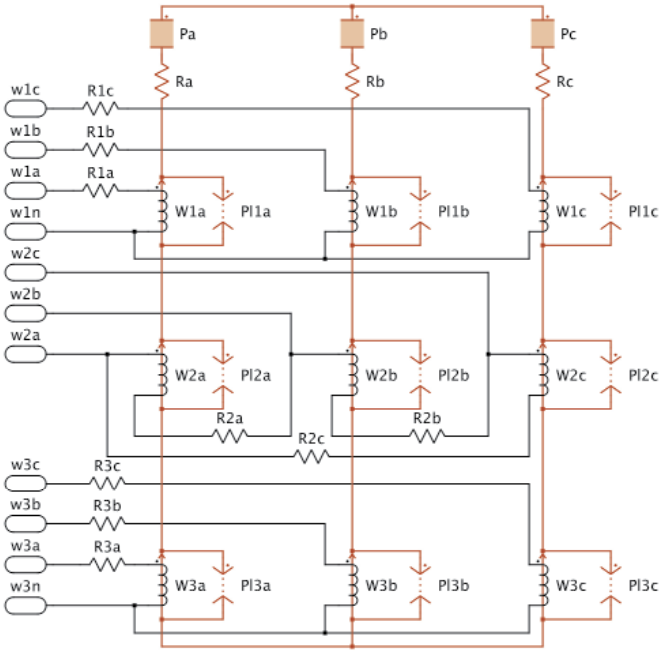

Figure 2: Transformer model in the PLECS magnetic domain.

Mechanical system

Variations of the aerodynamic torque on the blades and, consequently, electrical torque on the induction machine's rotor are propagated to the wind turbine's drivetrain. Rotational speed fluctuations can lead to disturbances in the electrical domain, which depends critically on drivetrain torsional characteristics to damp out oscillations. This model uses a wind source to perturb the mechanical system in order to investigate the effects of such system resonances. A wind torque input depending on wind speed and propeller rotational speed is provided. The three blades transfer the wind torque to the hub shaft, which is connected to a gearbox. Using a specific gear ratio the gearbox increases the rotational speed of the hub shaft onto the induction machine's rotor shaft. The coupling between the components experiences elastic and damping effects due to its material characteristics. Friction also occurs on the bearings, leading to additional power losses. The mechanical portion of this model includes components representing inertias, masses, a gearbox, shaft elasticity and damping, and friction, as shown in Figure 3.

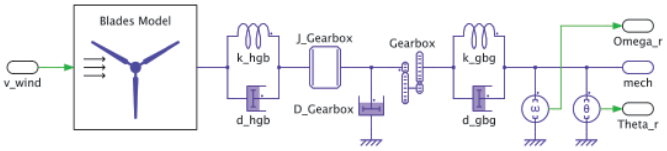

Figure 3: Complete drivetrain modeled in the PLECS mechanical domain.

Control system design

The back-to-back converter comprises separate machine-side and grid-side portions, connected via a DC-link capacitor. The machine-side converter regulates the DFIG torque and thus the rotational speed with a double loop structure, where the outer speed loop generates the reference signal for the inner current loop. In addition, the machine-side converter regulates the DFIG reactive power injection. The grid-side converter transfers the active power from the machine-side converter into the grid through an LCL filter, and maintains the DC-link voltage. The methods of active damping, feedforward, and integrator anti-windup are adopted for the PI controllers, and the converters operate using space vector pulse-width modulation (SVPWM). The current control loop is synchronized with the grid voltage, where the orientation reference is provided by a phase-locked loop (PLL).

In a real wind turbine system, the turbine power controller often uses a maximum power point tracking (MPPT) scheme to provide the reference signal for the speed controller. In this case, an MPPT scheme is not modeled considering the relatively short time range of the simulation and a constant value is instead given as the speed reference.

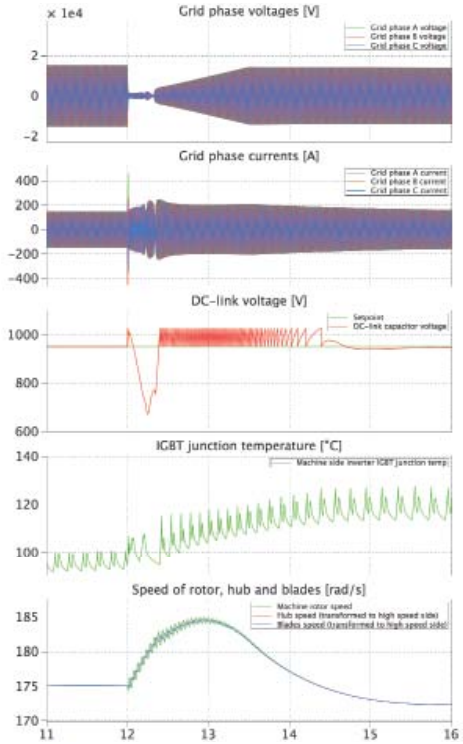

Figure 4: Electrical, thermal and mechanical transient during the grid fault.

Simulation schemes

The following example scenarios can be studied through simulation:

- Initial state: At simulation start, the generator operates at synchronous speed to the grid frequency. Most of the generated active power is injected into the grid via the stator winding of the induction machine, while due to the zero slip condition, virtually no power flows through the rotor except for the resistive losses. The reactive power generation is not activated yet at this stage.
- Acceleration: The rotation speed of the turbine is accelerated via a step jump on the reference input of the speed controller, to achieve maximum power generation under a given wind speed.
- Grid fault: A three-phase short circuit fault (zero voltage sag condition) occurs on the medium-voltage grid and the interaction between the grid, converters, and control systems can be studied immediately after.

Results and discussion

By simulating such scenarios described above, the robustness of the design is observed and improvements can be made, namely with the control techniques. The various parameters in the system are chosen to provide desirable results during the entire operating range of the turbine. At the start of the simulation, a damped oscillation can be observed due to the elastic and lossy coupling between the mechanical parts. After a period of acceleration, the electrical torque of the induction machine and the wind torque enter a balanced state and the rotational speed remains constant.

A grid-side fault known as "low voltage ride through" (LVRT) behavior is investigated by reducing the grid voltage. The electrical transient during the grid fault is shown in Figure 4. The AC current exhibits a large peak immediately after the fault occurs, and then is maintained below a certain range because of the saturated input of the current controller. Due to the voltage drop at the transformer tertiary winding, the grid-side inverter is also no longer able to transfer power, so the DC-link voltage is nearly uncontrolled in the first seconds after the fault. The DC-link capacitor is then charged or discharged purely by the machine-side inverter. The voltage is clamped to a safe level due to the activation of the chopper circuit. The capacitor is discharged as the grid voltage recovers and the grid-side inverter is again able to transfer enough power.

Conclusion

The modeling and simulation of a complete DFIG wind turbine model has been presented in this article. The same model is packaged as a PLECS demo model and can be further explored using the Demo Mode of PLECS Standalone. To obtain this free download, visit Plexim's website (www.plexim.com). With the help of PLECS, the transient effects from multiple physical domains can be evaluated in a single system model without requiring excessive simulation times, thereby providing an effective and accurate means for investigating and addressing issues related to inter-physical domain interactions. Such fully integrated models provide power electronic designers with more insight into the system before hardware is built, leading to time and cost savings.

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PTC Thermistors for Inrush Current Limiting

Always on the safe side

At high temperatures and currents PTC thermistors offer reliable protection as inrush current limiters (ICLs) in power supplies - even in case of short circuits. NTC thermistors are not always the solution of choice as inrush current limiters (ICLs) in power supplies. In certain cases with especially demanding temperature and power conditions, PTC thermistors are able to offer more reliable protection. An added benefit: EPCOS PTC ICLs also provide protection in case of short circuits.

By Dr. Stefan Benkhof, Product Marketing Manager PTC Thermistors, EPCOS/TDK

High currents are encountered whenever electrical equipment such as drive systems, inverters or power supplies are turned on. Because excessive inrush currents can damage or destroy the sensitive components such as the rectifier in a power supply or blow the fuse, for example, protection measures are needed (Figure 1). Two basic approaches to inrush current limitation are available: the simple insertion of a protection device as inrush current limiter (ICL) in the power circuit and the use of an active bypass circuit that is activated after the inrush current peak decays. These are also referred to respectively as passive and active ICL circuits. The choice of inrush current suppression technique that is suitable for a particular application depends on many variables. Most important are the power rating, the frequency at which the equipment is likely to be exposed to inrush currents, the operating temperature range, and system cost requirements.

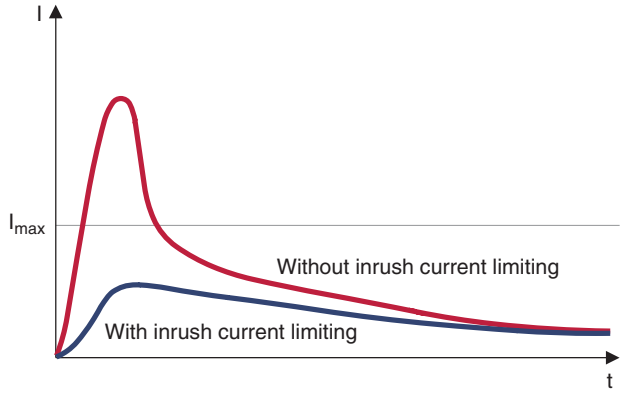


Figure 1: Inrush current with and without ICL
Inrush current limitation is needed to prevent the current from exceeding the critical level and either blowing fuses or destroying the rectifier.

Passive inrush current limitation

For very small power supplies with power ratings of up to a few W, the easiest and most practical solution for inrush current limitation is simply to add an ohmic resistor in series with the load. In power supplies with higher power ratings, however, the power loss of a fixed resistance would significantly impair the overall efficiency. In these cases, NTC thermistors are the established standard ICL solution for passive current limitation (Figure 2).

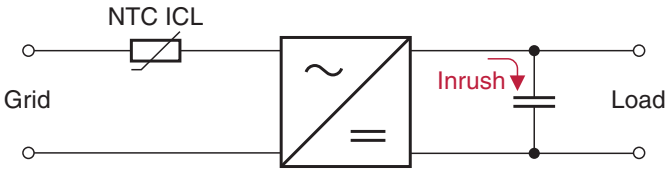


Figure 2: Passive inrush current limitation with an NTC ICL
The fact that an NTC thermistor's initially high resistance drops to negligible levels once it becomes warm makes NTC ICLs the standard ICL solution for power supplies with power ratings of up to approximately 500 W.

NTC thermistors are high ohmic when cold and low ohmic when hot. In the cold state, the high initial resistance of the NTC ICL effectively absorbs the peak inrush currents. As a result of the current load and the subsequent self-heating, the resistance of the ICL then drops to a few percent of its value at room temperature. This special feature reduces the power consumption of the inrush current limiter in continuous operation and is, therefore, the reason why NTC ICLs can be left in the circuit even after the capacitor is fully charged. Finally, their cost is low and the solution is simple to realize.

Focus on low-loss solutions for higher power levels

Increasingly, the design of power supplies focuses on eliminating power losses wherever possible. Once the power rating exceeds a level of around 500 W, the drawbacks of the passive circuit solution become evident. If the ICL is always in series with the load, the power losses it causes become too high. The higher the power rating of the device and the longer its typical run time, the more significant the parasitic power losses become. For example, assuming that an NTC ICL generates a power loss of 1 percent of the total power of the device and the power supply has a 92 percent efficiency rating, about 12.5 percent of the overall losses are due to the NTC.

Active inrush current limitation

At the higher power levels, it is, therefore, standard practice to bypass the ICL once the inrush current peak has decayed using relays or triacs. Depending on the application requirements, this active inrush current limitation circuit can employ a power resistor, an NTC thermistor or a PTC thermistor (Figure 3) as the ICL component. PTC thermistors, for example, are commonly used in on-board chargers (OBC)

of plug-in hybrids or of electric vehicles, where the power rating is typically a few kW. While the benefits of active inrush current limitation are most evident for power ratings higher than 500 W, the approach may be necessary to achieve improved performance even for applications at lower power levels. Although the system cost for active inrush current limitation itself is somewhat higher, this approach reduces power losses and enables the use of less costly switches and semiconductors with a lower rating.

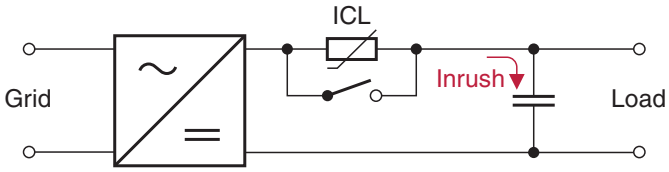


Figure 3: Active inrush current limitation
In active inrush current limitation an ohmic resistor, an NTC thermistor, or a PTC thermistor can be used as an ICL component.

When to use PTC thermistors as ICLs

In certain applications, PTC thermistors offer superior performance as ICLs. The resistance of an NTC ICL when the power is switched on depends on the ambient temperature. At very low ambient temperatures the NTC thermistor's resistance is higher, leading to lower charging currents and resulting in longer charging times. High ambient temperatures, on the other hand, can limit the ability of the NTC ICL to suppress inrush currents because the NTC is already in a low ohmic state. This temperature dependency can pose a problem especially for applications with a wide operating temperature range. For example, a power supply used outdoors in a northern winter may never warm up enough for the NTC resistance to drop enough.

Conversely, a circulator pump for hot water can already be very warm during startup, causing the NTC thermistor to fail to limit the inrush current. An NTC thermistor's cool-down time varies typically from 30 s to 120 s after the system has been switched off, depending on the particular device, its mounting method and the ambient temperature. Only after it has completely cooled down is the NTC ICL ready to limit the charging current again. In many cases, the cooling period is quick enough; however, effective inrush current limitation is sometimes required before the NTC has cooled down sufficiently. This is the case in applications where a quick active discharge of the DC link capacitor is possible, for example, in inverter-driven home appliances such as modern washing machines and dryers. The necessary cool-down time can also be critical after short power outages. Consequently, active inrush current limitation designs must always take into account all possible situations where an inrush peak can occur while the NTC ICL is still in a low ohmic state. In both of these cases, EPCOS PTC thermistors offer an effective inrush current limiting solution.

Built-in self-protection

Under normal operating conditions, a PTC ICL functions as an ohmic resistor. When the power is switched on and the temperature of the component is the same as the ambient temperature, PTC ICLs have a resistance of between 20 Ω and 500 Ω, depending on the type. This is enough to limit the inrush current peak. Once the DC link capacitors are sufficiently charged, the PTC ICL is bypassed.

If there is a malfunction in the charging circuit, the specific property of the PTC thermistor serves to protect the circuit. When current flows through the component, it heats up and its resistance increases significantly. Thus, thanks to their self-protecting properties, PTC thermistors have a built-in advantage under the following failure modes:

- Short circuit of capacitor
- Current limiting element not bypassed after the DC link capacitor is charged (failure of switching element)

All these failure modes have one thing in common: thermal stress to the current limiting device. There are two ways to effectively ensure that the ICL component is not destroyed by such events: the use a power resistor with a sufficient power rating or the use of a PTC thermistor. EPCOS PTC ICLs are designed to survive being directly connected to the supply voltage even at their maximum rated voltage. No additional current limitation is required because these PTC ICLs are self-protecting. In case of excessive currents such as short circuits, the temperature of the PTC increases, which in turn leads to a significant rise in the device's resistance. Consequently, the PTC thermistor itself limits the current to uncritical levels (Figure 4).

Thus, EPCOS PTC thermistors offer key benefits when used as ICL components for active inrush current limitation in certain applications:

Ordering code	V_{max} [V AC]	V_{link}, max. [V DC]	R_R [Ω]	C_{th} [J/K]	In sample kit
In phenolic resin plastic case					
B59105J0130A020	260	360	22	2.3	X
B59107J0130A020	440	620	56	2.3	X
B59109J0130A020	560	800	100	2.3	X
B59750B0120A070	260	360	25	1.0	X
Leaded disks, uncoated					
B59751B0120A070	260	360	50	1.4	X
B59752B0120A070	260	360	80	1.4	X
B59753B0120A070	440	620	120	1.4	X
B59754B0120A070	440	620	150	1.4	X
B59755B0120A070	560	800	500	1.4	X
B59770B0120A070	260	360	70	0.4	
B59771B0120A070	260	360	120	0.6	
B59772B0120A070	260	360	150	0.6	
B59773B0120A070	440	620	500	0.6	
Leaded disks, coated					
B59412C1130B070	440	620	120	2.1	X
B59451C1130B070	440	620	56	2.1	X
B59750C0120A070	260	360	25	1.0	
B59751C0120A070	260	360	50	1.4	
B59755C0115A070	560	800	500	1.4	

Table 1: Key data for EPCOS PTC ICLs

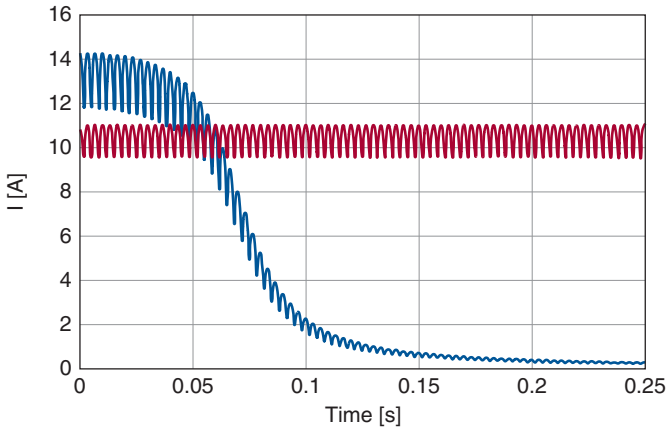


Figure 4: Current curve with shorted capacitor
With a shorted capacitor, the current flowing through the PTC ceramic drops very quickly to non-critical values (blue). With the ohmic resistor, however, the current flow remains constant at high values (red).

- Their ICL functionality is not affected by extreme operating temperatures.
- Effective inrush current limiting as soon as load is turned off, cooling already takes place during normal operation.
- They are self-protecting against current overloads caused by circuit malfunctions.

Thanks to the broad portfolio of EPCOS PTC ICLs power supplies can be reliably protected from high inrush currents and short circuits under demanding temperature conditions. The Table 1 shows a representative selection of PTC ICLs which are included in the sample kit, Inrush Current Limiters – Self-Protecting Power Resistors (ordering code B59003Z0999A099).

Figure 5: EPCOS PTC inrush current limiter in a robust plastic case

www.epcos.com/ptc_icl

www.epcos.com/samplekit

Bringing Value Back to the Power Equation

Over the past decade, the power industry has continually been driven by demands for cheaper power supplies. The notion that "power is a necessary evil" is still the underlying sentiment, even in a world that demands greater performance and efficiency from its devices.

By Mark Adams, CUI

And, while it's true that power is not what makes the internet work; it is the sophisticated processing infrastructure of switches, routers, servers, etc that drives the web, it is quickly being realized that the power system can no longer be an afterthought when performance and efficiency is a priority.

Times are Changing

At the start of a typical design project, the marketing requirements document is given to the engineering team and it can usually be summed up in a very simple sentence - "For this project we need 2X+ the processing power in the same PCB space and at the same bill of material cost."

Semiconductor companies have been able to stay ahead of these market demands thanks to advances in manufacturing that have allowed for greater densities of processing power. But, that comes at the cost of needing more power for that chip. 75A+ board level power rails used to be limited to Intel and AMD processors, which (unlike the majority of their customers) both had the extensive power design teams to handle this task. Now, however, the companies utilizing these new generations of chips typically have design teams that rely on non-power centric engineers, making it harder to get the power system right.

Unfortunately, the power industry has not been able to stay on par with the rapid rise in processing performance. To complicate matters for power supply companies, while demand for faster access to larger amounts of data via a reliable and secure infrastructure accelerates, the expectation is that board mount power supplies will keep up with new levels of performance at the commoditized price levels of the past. Some of the chips used in networking equipment can cost upwards of $1000, yet the focus on the modules powering these devices is still on cost. That is akin to buying a Ferrari, but then installing the engine of a compact car to save cost. It will look nice on the outside, but won't perform to the expectations of a Ferrari. The reality is that it is very difficult to get (for the lack of a better term) "good and cheap."

Alliances

Previous to the newest generations of semiconductors, the industry as a whole had set an expectation and a roadmap methodology that they would design better products, cheaper—and that power should be considered a commodity with multiple sources available. Now that performance requirements for a range of advanced ICs have skyrocketed, this expectation is no longer reasonable.

One of the significant drivers of pin compatible power supplies in the board mount dc-dc area has been the Distributed-power Open Standards Alliance (DOSA), as well as the Point of Load Alliance (POLA). These alliances were formed to drive power supply compatibility across numerous isolated and non-isolated form factors. POLA was the first to announce this initiative in 2003 and DOSA announced in 2004. The intent of each of these alliances was to provide the customer base with a pin compatible second source for their board mount dc-dc power supplies.

Each of them came about it in a different manner. POLA was a smaller group of companies and the intent was that each POLA power supply utilized the same schematic. DOSA focused on the mechanical aspects, dimensions, pin-out, and functions. At that time an alliance of power supply companies seemed logical and was a need driven by the customer. The industry had come out of an internet bust and the customer base had been burned by companies that were sole sourced and didn't survive the downturn. They were forced to redesign many projects in order to eliminate sole sourced products that could no longer be purchased. This by no means was limited to the power segment, but nonetheless it drove the industry overall to require multisource products.

Today, DOSA continues to define standards and in 2010 added the first standard that included a digital bus. POLA on the other hand seems to have lost focus and has not released a digital bus converter or other standard release part for several years.

An alliance like DOSA has value to the customer in some applications, but it does have limitations. An alliance by nature is focused on serving the masses or the widest market segment in order for everyone to participate. However, that only covers 90% of the market…it is the other 10% that is the problem. When a power supply company designs to a specific mechanical, the opportunity to innovate becomes limited.

Today's Need
The power architecture design process had typically looked to reuse as much as possible from the previous design. This is a logical process when the priority is to reduce development costs and streamline the AVL, but the problem is that POL power supplies have not been keeping up with the requirements of the next generation chips. The opportunity to reuse previous power designs is no longer a viable solution for many new applications.

In today's complicated designs, the initiatives of old cannot satisfy some of the most challenging power needs. Innovation in power supply design is critical to meet requirements that are pushing 75A+ per rail. A design of this nature is not trivial, and requires companies to embrace the idea of bringing value back to the power supply. Commoditized power supplies simply cannot meet many of these expectations.

Innovation is associated with the dirtiest of four letter words, "cost". If you spend money on innovation, it will cost more. In reality it is exactly the opposite. The value, or total cost of the solution, should actually be lower when a complete analysis is done.

A simple example of this is CUI's Solus® Power Topology. Our first POL development based on this patented SEPIC-fed buck topology has significant advantages in transient response. This is a problem that many designs solve by laying out a dump truck worth of capacitors on the output of the POL module. This new topology will allow for a 50% reduction in expensive, bulky output capacitors, compared to competing digital POL products on the market. This is in addition to the significant increase in density and efficiency that our new topology provides. In this scenario you cannot compare module cost alone. The total cost of the solution, including the cost of required external components, board area, and complexity of design must be factored into the equation.

Innovation doesn't always need to be limited to technology or topology. Innovation can also apply to mechanical design improvements. The mantra, "We want more in the same space" usually refers to the X & Y axis of the board. However, in many designs the Z axis of the design has room that is not being utilized. In our POL design utilizing Solus Topology, CUI has taken a unique approach and will offer the same exact module in a vertical and a horizontal orientation. This will allow the engineer the opportunity to leverage technology and packaging to find the optimal balance to achieve the requirements of their design.

A Different Approach
Not all designs need ground-breaking performance from their power modules. Simple power conversion via commodity-type power supplies can fill numerous needs. However, power supply companies need to push outside the historic path in order to satisfy the requirements of the growing number of advanced ICs introduced to the market. As systems become more sophisticated, there will be an increasing number of sockets in each design that push the limits of existing power supplies and cannot be supported with commodity modules.

Through our Novum® Advanced Power group, we've made it our mission to properly understand the power requirements of tomorrow's networking designs. Engineers are looking for power supply partners that will work to provide a balanced portfolio of products able to address the more "standard" power needs as well as those that push the limits of traditional power designs. CUI was the first to release an auto-compensated POL module and the first 50A digital POL product, and is pushing to densities and performance to satisfy the new higher density/performance requirements. CUI continues to invest in innovation that will support those difficult power requirements, and we also have growing portfolio of standardized products that can support a wide range of needs. In addition, through cooperative agreements with companies like Ericsson Power Modules, CUI offers leading products and footprint alliances with companies that are also driven to meet the needs of today's sophisticated/complex systems.

Be sure to visit our booth (1233) at the Applied Power Electronics Conference (APEC) in Fort Worth, TX from March 16-20 to learn more about our solutions to the power challenges of next-generation networking applications, including the latest high density modules based on CUI's Solus Power Topology.

www.cui.com

5 Watt Chipset for Fast Wireles Charging

Toshiba Electronics Europe (TEE) has announced enhancements to its TB6865FG power transmitter and TC7763WBG receiver chipset enabling faster wireless charging of mobile devices. The wireless power chipset now supports 5 Watt power transfer and is compatible with the Qi Standard[1] Low Power Specifications version 1.1. Features include a rigorous Foreign Object Detection (FOD) function and an integrated digital logic controller that reduces component count and minimizes design complexity.

The chipset is designed to meet the growing demand for fast and efficient wireless charging of smartphones, game controllers and portable devices. One emerging application for wireless charging is for waterproof mobile gadgets where a device is fully enclosed in its housing with no exposed connections.

Built with Toshiba's mixed-signal process with optimized MOSFET design, the chipset achieves high-efficiency wireless charging performance. The TB6865FG integrates an MCU that can drive 4 external MOSFET H Bridges of 4 coils for a free positioning architecture supporting two mobile devices.

www.toshiba-components.com

Low-Power Sensor Hub Makes Sensor Fusion Easy

Microchip announces the SSC7102, a low-power, flexible and turnkey sensor hub that makes implementing sensor fusion easy and provides an extremely large selection of supported sensors. Microchip has partnered directly with multiple industry-leading sensor manufacturers and sensor-fusion specialists to create this solution, enabling faster time to market without the need for sensor-fusion expertise. The SSC7102 is also extremely efficient. It consumes ~4 mA while running complex sensor-fusion algorithms, resulting in longer battery life for Windows® 8.1 tablets, laptops, ultrabooks and smart phones.

Sensors can now be added to virtually anything, due to their small cost and size. IHS iSuppli predicts that more than 6 billion motion sensors are expected to ship in mobile handsets and tablets by 2016. As sensors continue to surround us, system requirements are moving from simple monitoring to providing complex information about our environment and activities. Data from multiple sensors, which sense motion via accelerometers, magnetometers and gyroscopes, as well as environmental factors such as light, temperature, humidity and pressure, needs to be incorporated or "fused" in the system. Microchip's low-power SSC7102 sensor hub runs these complex sensor-fusion algorithms, while providing maximum flexibility in an easy-to-implement solution.

www.microchip.comget/9821

Unipolar Hall-Effect Switch Offers Unique Self-Diagnostic Capability

The A1160 from Allegro MicroSystems Europe is a unipolar Hall-effect switch with built-in diagnostic capabilities that provide a unique solution to the monitoring of device performance and the self-diagnosis of incorrect device operation.

The device is the only Hall sensor IC capable of verifying proper electrical performance and magnetic sensing: a critical feature for safety applications that must adhere to Automotive Safety Integrity Level standards or for those applications requiring two sensors for redundancy.

The key to the self-diagnostic capability of the A1160 is an integrated coil surrounding the Hall sensing element. During normal operation, the A1160 functions as a typical unipolar switch (with the output turning on in the presence of a south-pole magnetic field and turning off when the field is removed), but when the diagnostics pin is pulled high it enters the diagnostics mode.

This patented feature allows current to pass through the integrated coils, generating magnetic field. The proximity of the coils to the Hall sensing element allows the element to sense the field generated by the coil, while ignoring external fields. In diagnostics mode the device will output a PWM (pulse-width modulated) signal of 50% duty cycle when the device is properly sensing the internally generated magnetic field.

The diagnostics mode exercises the entire electrical signal path of the integrated circuit, and ensures proper sensing of the magnetic signal to provide accurate device functionality.

www.allegromicro.com

650V XPT™ IGBTs Improved Switching Performance

IXYS Corporation announced an expansion of its 650V XPT™ IGBT product portfolio.

With current ratings ranging from 16A to 200A, these new devices are designed to achieve an optimal balance between the turn-off energy loss and on-state voltage, especially in hard-switching applications. Able to support switching frequencies up to 60 kHz, they allow designers to use smaller and lighter components in their systems. Devices co-packed with anti-parallel fast diodes are also available.

Built with the proprietary Extreme-light Punch-Through (XPT™) technology, and the state-of-the-art 3rd generation (GenX3™) IGBT process, these devices exhibit such qualities as reduced thermal resistance, low tail current, low energy loss, and high-speed switching capability. They are avalanche rated and able to withstand short-circuit conditions. They also have square Reverse Bias Safe Operating Areas (RBSOAs) up to the breakdown voltage of 650V. All of these attributes make them exceptionally rugged and particularly useful for snubberless hard-switching designs.

Other advantages include low gate charge and a positive temperature coefficient of the on-state voltage, translating into lower gate drive requirements and multiple-device paralleling capability, respectively.

www.ixys.com

Connectors with 80 and 90 Position Offerings

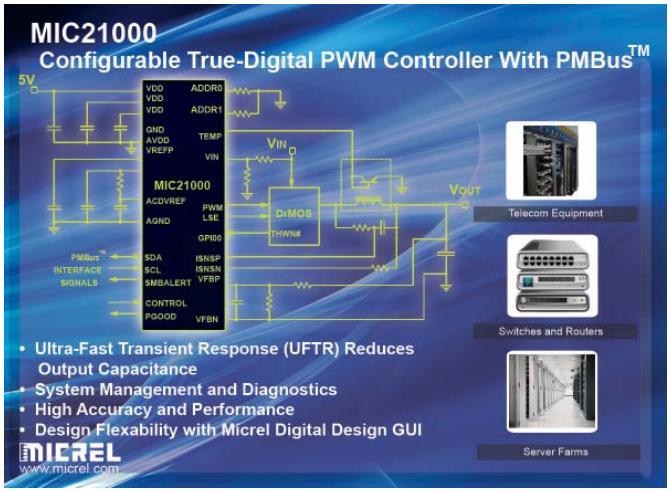
FCI, a leading supplier of connectors and interconnect systems announced that it has strengthened the portfolio of its MezzoStak® Mezzanine connectors with the addition of 80 and 90 position offerings. These variations' stub-less contact interface supports PCIeGen2 compatibility and facilitates high speed performance of up to 5Gb. These characteristics enable the connectors to support communications and networking applications with higher signal transmission while allowing engineers to still tap on this category's core value propositions – cost-savings, easy mating and space optimization.

The MezzoStak® Mezzanine connectors features an innovative hermaphroditic "mate-to-itself" design that reduces product mix and simplifies connector selection, documentation and component maintenance. This allows engineers to significantly reduce cost and time spent in the design and maintenance phase.

www.fci.com

Digital PWM Controller for High Current, Non-Isolated DC-DC Power Supplies

Micrel, Inc. introduced the MIC21000, true-digital PWM controller for high-current, non-isolated DC-DC power supplies in computing and telecom applications. Designed to work with an external industry standard DrMOS as well as Micrel's proprietary IntelliMOS® solution, the MIC21000 can be used as a flexible building block for +12V or +5V step-down, high current point-of-load power supplies.



The MIC21000 meets designers' challenges by integrating a digital control loop, optimized for maximum flexibility and stability, as well as for load transient and steady state performance. The MIC21000's ultra-fast transient response reduces the output capacitance. The non-linear control feature improves transient response by a factor of two versus competing analog solutions. Highly-reliable fuse-based, on-board nonvolatile memory (OTP NVM) and I2CTM/PMBUSTM interface enable user configuration and communication with a supervisory controller for monitoring and fault management. This allows for rapid power subsystem development and debugging which, in turn, accelerates time to market.

www.micrel.com

Power Modules Integrated into one Housing Size for 90° PCB Mounting

Vincotech, a supplier of module-based solutions for power electronics, has unveiled the new power module flow90PACK 0, which integrates several power modules into one housing size for 90° PCB mounting. Featuring three half-bridges up to 1200 V / 35 A with open emitters, this is the module of choice for multiple-axis servo drives where space is at a premium.

Another step up the evolutionary ladder from Vincotech's popular flow90 1 housing, the flow90 0 housing is a space-saving unit that does not require costly L-shaped heat-sinks. flow90PACK 0 not only works with standard heat-sink formats, it is also phenomenally easy to mount. The module simply clips into the PCB.

Both the new flow90 0 housing and standard modules feature the same DCB dimensions (33 x 66 mm) and power and chip options. Consequently, flow90PACK 0 is well suited for much the same range of products – the selection of layouts and topologies being limited only by the special pinning concept. With the benefit of its remarkably slim housing, this module is the perfect choice for bookshelf sized systems with multiple modules.

www.vincotech.com/products/by-topologies.html

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Single-Chip 5V Wireless Power Transmitter Solution

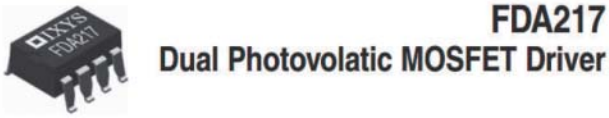
Integrated Device Technology, Inc. announced the industry's first Qi-compliant single-chip wireless power transmitter solution supporting a 5V input. The highly-integrated solution enables the development of USB-powered wireless charging bases with 75% fewer ICs than competing solutions. IDT's transmitter solution is ideal for use in wireless charging systems that seek to take advantage of a universal power port while minimizing system complexity and physical size.

The IDTP9038 is a single-chip wireless power transmitter IC compatible with the Wireless Power Consortium (WPC) 1.1 "Qi" standard for A5 and A11 coil configurations, enabling OEMs to develop charging bases that are fully compatible with any Qi-compliant portable device. The device operates with a 5V input, allowing it to be powered by any standard USB port, USB wall adapter, or traditional 5V adapter. Such ports and adapters are ubiquitous and already included with many popular portable electronics, streamlining the user experience and reducing solution cost. In addition, IDT's device is designed as a single high-efficiency IC, whereas existing solutions require four or more ICs. This enables system designers to minimize system complexity, ease PCB routing constraints, and simplify the bill-of-materials.

www.idt.com

Dual Photovoltaic MOSFET Driver

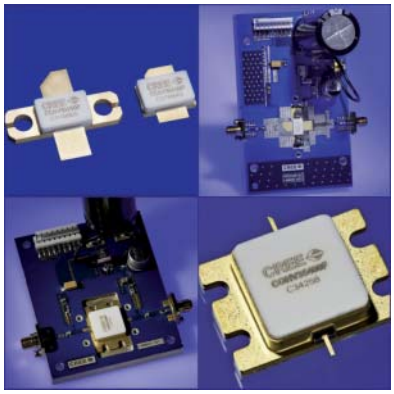
IXYS Integrated Circuits Division (ICD), Inc., a wholly owned subsidiary of IXYS Corporation (NASDAQ: IXYS), announced the availability of the FDA217, an optically isolated, dual photovoltaic MOSFET driver. Each independent driver consists of an LED that is optically coupled to a monolithic PV array. Each array is capable of generating an open circuit voltage of 12.2V and short circuit current of 9.1uA with a forward LED current of 10mA.



The FDA217 driver output is controlled by means of an efficient infrared LED at the input. The PV array is capable of generating a floating power source with voltage and current sufficient to drive high-power MOSFET transistors. The device can achieve a 27uA short circuit current with a higher input LED current of 30mA. The independent outputs can be connected in parallel to deliver a short circuit current of 18.2uA with a forward LED current of 10mA. Alternatively, the outputs can be stacked in series to deliver an open circuit voltage greater then 24.4V. Each PV array contains an integrated turn-off circuit that discharges the external MOSFET gate when LED current is removed. This eliminates the need to use external components to facilitate the discharge. The optically coupled technology provides 3750Vrms of input to output isolation.

www.ixysic.com

S-Band GaN HEMTs



Cree introduced two gallium nitride (GaN) high electron mobility transistors (HEMTs) ideal for use in 2.9–3.5GHz S-Band radar amplifier systems, including: weather, air traffic control, marine, port surveillance, and search and rescue radar applications. Based on Cree's high power density 50V, 0.4µm GaN on silicon carbide (SiC) foundry process and performance rated at 85°C case, both the 150W CGHV35150 and 400W CGHV35400F exhibit high efficiency, high power gain, wide bandwidth capabilities, and uniform performance at high temperatures. The CGHV35150 features 150W typical output power, 13.5dB power gain, and 50% typical drain efficiency. The CGHV35400F features 400W typical output power, 10.5dB power gain, and 60% typical drain efficiency. Both the 150W and 400W S-Band GaN HEMTs are specified at 85°C case and feature <0.3dB pulsed amplitude droop.

Additionally, both transistors also feature considerably smaller footprints than competing gallium arsenide (GaAs) or silicon (Si) RF technology, enabling enhanced design flexibility. The 400W S-Band GaN HEMTs are supplied in a ceramic/metal flange package and the 150W devices can be supplied in ceramic/metal flange or pill packages.

www.cree.com/RF/Products

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Vertical Dual-Hall Sensor for Rotation Direction and Speed Detection

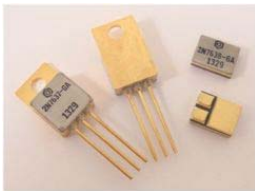
Infineon Technologies AG takes the next step in sensor product innovation and announced the TLE4966V, a vertical dual-Hall sensor for detecting rotation direction and speed. The TLE4966V is the first dual-Hall device with its integrated Hall plates oriented vertically and not horizontally on the chip surface, thus making it sensitive to magnetic fields with in-plane direction. This 90-degree orientation change provides flexibility to fit designs into space-constrained areas.

The design flexibility and the 4mA to 7mA current consumption of the TLE4966V make it well-suited for energy-sensitive electronic automotive systems such as trunk lifts, power window lifts, sun roofs and seat adjustment. In non-automotive applications, the sensor is also an excellent solution for escalators, motorized window blinds and shades.

www.infineon.com/vertical-hall

High Temperature (250oC) SiC Junction Transistors Offered in Hermetic Packages

The promise of high temperature in SiC Transistors realized through compatible industry-standard packages will critically enhance downhole and aerospace actuators and power supplies



GeneSiC Semiconductor, a pioneer and global supplier of a broad range of Silicon Carbide (SiC) power semiconductors announced the availability through its distributors and directly a family high temperature packaged 600 V SiC Junction Transistors (SJT) in the 3-50 Amperes current ratings in JEDEC industry-standard through hole and surface mount packages. Incorporating these high temperature, low on-resistance, high frequency SiC Transistors in hermetic packages, high temperature solders and encapsulation will increase conversion efficiency and reduce the size/weight/volume of high temperature power conversion applications.

Contemporary high temperature power supply, motor control and actuator circuits used in oil/gas/downhole and aerospace applications suffer from lack of availability of a viable high temperature Silicon Carbide solution. Hermetically packaged SiC transistors offer unique characteristics that promise to revolutionize the capability of downhole and aerospace applications. GeneSiC's 650 V/3-50 A SiC Junction Transistors feature near zero switching times that does not change with temperature. The 250oC junction temperature-rated devices offer relatively large temperature margins for applications that are operating under extreme environments.

www.genesicsemi.com/index.php/hit-sic/sjt

1 Watt DC/DC Converters and R-78 Switching Regulators

RECOM has expanded its product portfolio with seven new cost-effective DC/DC converters called the E-series, which are lower cost versions of the most popular converters in our industrial products portfolio. It has been possible to keep the quality on the same high level but to halve the price by optimizing the design, streamlining the manufacturing process and by production in high volumes on RECOM's own efficient SMT-production lines.

The E family includes seven converters: the R1SE-0505 (1 W unregulated in SMD case), the REE-0505S & RBE-0505S (1 W unregulated in SIP7 case with different pin-outs), the ROE-0505S (1 W unregulated in SIP4 case), the RKE-0505S/H (1 W unregulated in SIP7 case with 3.75kVDC isolation), the R-78E5.0 (500mA switching regulator in SIP3 case) and the ROF-78E5.0 (500mA switching regulator, open frame SMD construction). The 1W isolated converters features 5V input/output and operate with efficiencies up to 75% at ambient temperatures from -40°C to +85°C. Such converters are often used for isolation of interfaces or bus systems and RECOM offers five different case and pin-out styles for drop-in compatibility. Despite the low price of the E-series 1W converters, they are fully UL60950 certified to reduce the costs and certification time for the end-application.

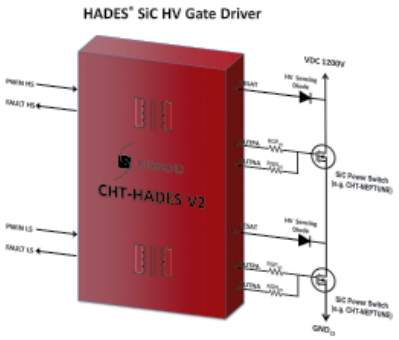
www.recom-electronic.com

Highly Integrated 225°C Isolated Gate Driver for SiC and Si Power Switches

CISSOID unveils its 2nd generation of HADES®, the high-reliability, high voltage isolated gate driver chipset. HADES® drives both high efficiency Silicon Carbide (SiC) and traditional silicon power switches.

HADES® Gen2 is aiming at four key objectives:

- Maximizing the benefits of the newest Silicon Carbide (SiC) power switches: Increased switching frequencies translate into dramatic reduction of the size & weight of the passive & magnetic components;
- High temperature capability of HADES® allows to locate the driver next to the power switches;
- Addressing the distinct needs of very high-temperature applications (e.g. 225°C normal operation), as well as of lower temperatures (100~175°C);
- Bringing the highest integration level for miniaturization of the gate driver function.



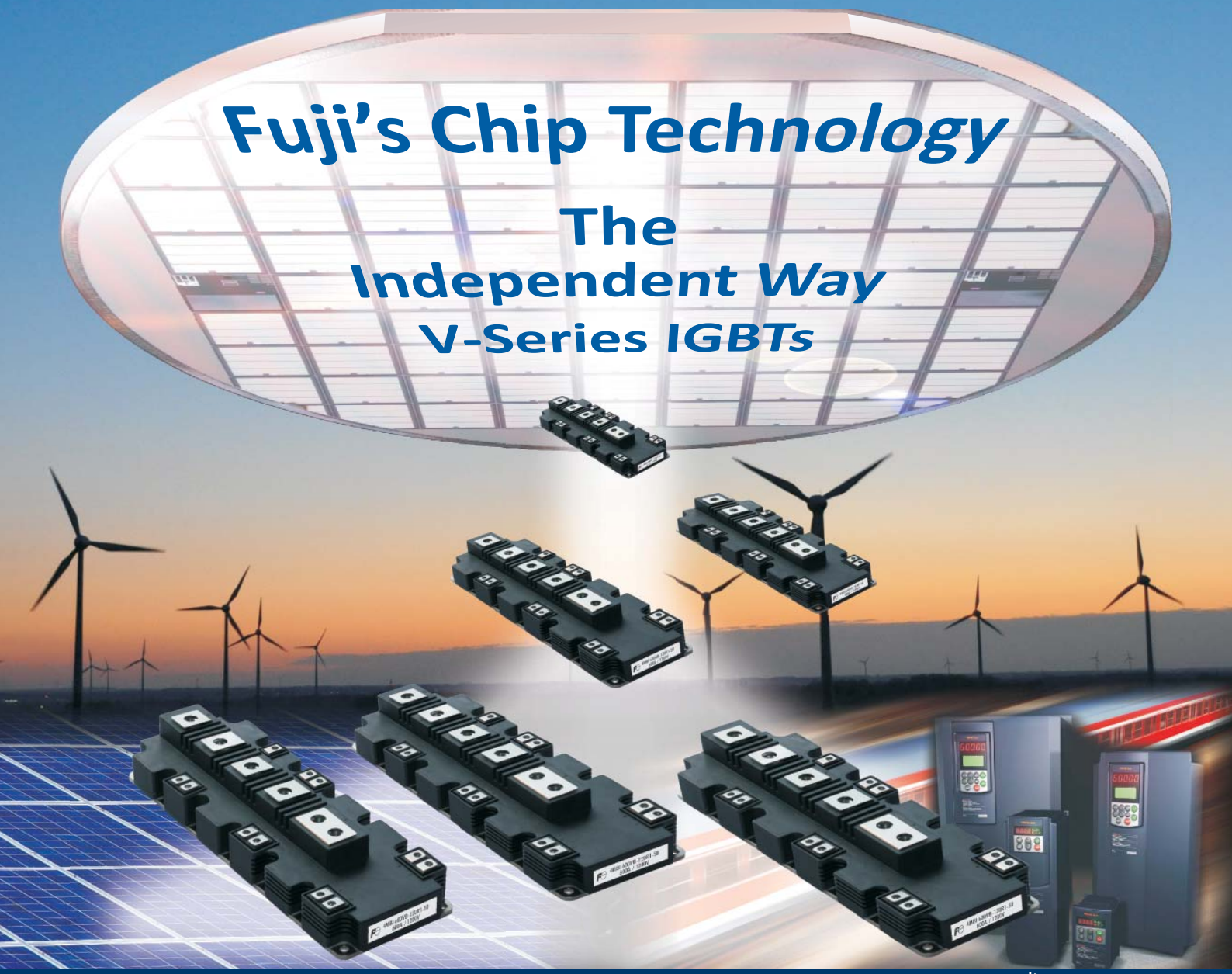
www.cissoid.com

Advertising Index

Fuji's Chip Technology

The Independent Way

V-Series IGBTs

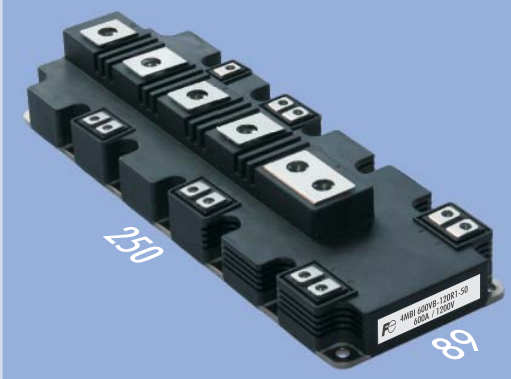


- Trench-FS IGBT
- High thermal cycling capability
- Low spike voltage & oscillation free
- Excellent turn-on dIc/dt control by R_G

IGBT modules for 3-Level inverters

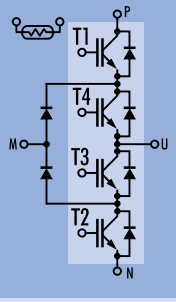
- All in one package
- Market standard footprint
- Low internal leakage inductances
- High performance T-type with RB-IGBT

1 phase IGBT modules

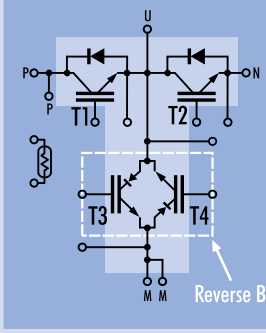


I-Type

I_C	T1 , T2 , T3 , T4
600A	1200V



T-Type
with Reverse-Blocking IGBT



I_C	T1 & T2	T3 & T4
450A	1200V	900V
650A		
900A		
450A	1700V	1200V
600A		

Fuji Electric
Innovating Energy Technology

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Products Overview ▸www.fujielectric-europe.de/overview.pdf

1947: IR opens for business, launching selenium rectifiers

1954: Commercializes germanium rectifiers

1959: A pioneer in silicon controlled rectifier (SCR)

1962: Introduces new epitaxial process for producing industry's most stable high voltage SCRs

1979: Patents first commercially viable Power MOSFET (HEXFET®)

1980: Introduces high reliability power semiconductor devices for space programs

1983: Launches first commercially viable high voltage power ICs

1996: Introduces MOSFET and Schottky in a single package

1950 **1960** **1970** **1980** **1990**

2000

Introduces wafer level package (FlipFET™)

2001: Invents integrated building blocks for DC-DC converters (*iPOWIR*™)

2002: Invents first dual-sided surface mount package (DirectFET®)

2003: Introduces *iMOTION*™ Integrated Design Platform

Invents scalable multi-phase architecture (xPHASE®)

2006: Introduces AC-DC Smart Rectifier™ IC

2007: Introduces Sup*IR*Buck® Integrated Voltage Regulators

2008: Introduces GaN-based Power Device Technology Platform

2011: Introduces PowIRstage™ integrated devices

2012

2012: Introduces *µIPM*™ power modules

First in Power Management
First in Innovation

Six Decades of Technology Leadership

EXPECT MORE

INNOVATIVE power semi technology

INNOVATIVE application-specific chip sets

INNOVATIVE packaging designs

INNOVATIVE power systems architectures

A rare blend of benchmark silicon, advanced circuit design, control architecture, packaging and applications know-how.

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