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Oktober 2018

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GvA Power Electronics

CONTENT

The Gallery

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electronica Hall B6 Booth 404

The WE-CMBNC is a VDE certified series of common mode chokes with a highly permeable **nanocrystalline core material.** Despite the small size, it delivers outstanding broadband attenuation performance, high rated currents and low DC resistance values. Low profile and high voltage ratings can also be realized by the common mode chokes of the WE-CMB family.

For further information, please visit:
www.we-online.com/we-cmb

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Nanocrystalline WE-CMBNC | MnZn WE-CMB | NiZn WE-CMB NiZn | MnZn/NiZn WE-ExB | Horizontal WE-CMBH | High Voltage WE-CMB HV

Bodo´s Power Systems®

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www.bodospower.com

Back on Track

After a well-deserved summer vacation, we're back at the desk - preparing for the conference season in fall 2018. Publishing a monthly magazine only allows a few days off, but that's better by far than working with few breaks, as Bodo has done for many years. That's hard to imagine in these times when work/life-balance is getting more and more important, and for many good reasons. My destination for this year's summer vacation was the North Africa region.

Lots of interesting impressions filled our days there, and I must admit that those weren't all positive ! Seeing little kids playing on garbage left a lasting impression. A social challenge that endures, I'm afraid. It is pictures like these that dissuade decent people from demonstrating against refugees ! Another challenge…

Regarding conferences, in September we had among others Innotrans in Berlin, EPE in Riga, and ECCE in Portland, Oregon (a summary by Gary Dolny will be part of an upcoming issue!). Looking at the exhibitor list of Innotrans I can see clearly that railway is an increasing field for our industry. In 1879, Werner Siemens introduced one of the first electrical train's - just in Berlin. Two years later, the world's first electrical tramcar started operating in today's capital of Germany. So, from my perspective there couldn't be a better place for the Innotrans technology fair than Berlin. Today, most busy metropolises would collapse without public transportation systems. Railway will surely play a big role in the future of mobility and contribute an important part to reducing emissions.

We're now counting the last days to the big event of electronica in Munich, co-located with Semicon Europa this year, and filling seventeen halls for the first time. This really makes planning ahead a necessity, as you will hardly be able to visit every booth. Semicon in hall A4 and the halls B4-5 and C3-6 (Semiconductors) are a must for us, but also Test & Measurement, Automotive and Wireless are on our list. I wish comfortable sneakers would be more sociably acceptable …

Mark your calendar for the Wide Band Gap Conference in Munich on December 4th at the Hilton Airport Hotel. Building on last year's success, the program this year will continue, and be strengthened, with the cooperation with ICC Media / AspenCore. Visit www.Power-Conference.com for further information. The speakers program is finalized, and we look forward to interesting presentations and good networking!

My Green Power Tip for October:
Give your local public transportation systems a chance, even when it's only for a few times! There will always be limitations in terms of flexibility and comfort, but the environmental benefits should be worth it!

Best Regards

Holger Moscheik

Events

ESREF 2018
Aalborg, Denmark, October 1-5
www.esref2018conf.org

EDI CON 2018
Santa Clara CA, USA, October 17-19
www.ediconusa.com

Power Electronics 2018
Moscow, Russia, October 23-25
www.powerelectronics.ru

ESARS-ITEC 2018
Nottingham, United Kingdom, November 7-9
www.esars-itec.org

electronica 2018
Munich, Germany, November 13-16
https://electronica.de/

SEMICON Europa 2018
Munich, Germany, November 13-16
www.semiconeuropa.org

SPS/IPC/DRIVES 2018
Nuremberg, Germany, November 27-29
www.mesago.de/de/SPS

SemIsrael 2018
Tel Aviv, Israel, November 27
www.semisrael-expo.com

Power Electronics Conference 2018
Munich, Germany, December 4
www.power-conference.com

EUW 2018
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Renesas to Acquire Integrated Device Technology, IDT

Renesas Electronics Corporation and Integrated Device Technology, Inc. announced they have signed a definitive agreement under which Renesas will acquire IDT for US$49.00 per share in an all-cash transaction representing an equity value of approximately US$6.7 billion (approximately 733.0 billion yen at an exchange rate of 110 yen to the dollar). The acquisition combines two recognized leaders in embedded processors and analog mixed-signal semiconductors, each with unique strengths in delivering products to improve performance and efficiency in high-computing electronic systems. The boards of directors of both companies have unanimously approved the transaction. Closing of the transaction is expected to occur in the first half of 2019, following approvals by IDT shareholders and the relevant regulatory authorities. Since 2016, Renesas has been executing its growth strategy to thrive in the global marketplace and become a global leading embedded solution provider. As part of this initiative, Renesas is working to expand its analog solution lineup and to strengthen its kit solution offerings that combine its microcontrollers (MCUs), system-on-chips (SoCs) and analog products. These efforts will be underpinned by revenue growth in its focus domains: automotive segment, which is expected to see tremendous growth with autonomous driving and EV/HEV; industrial and infrastructure segments, which are expected to advance with Industry 4.0 and 5G (fifth-generation) wireless communications, as well as the fast-growing IoT segment. Renesas views accretive acquisitions as key enablers in achieving this growth strategy to deliver further incremental growth.

www.renesas.com

www.IDT.com

Research and Development Centre in the Czech Republic

Allegro MicroSystems (Allegro) established a new research and development centre in the Czech Republic. This centre is currently staffed with two dozen engineers located in Prague. These talented engineers will accelerate Allegro's development of market leading, innovative ICs for both the automotive and industrial markets. The team will initially focus on developing sensor ICs for electrified vehicles, green energy, and high-efficiency industrial motor applications. "We are very excited to formally open our new R&D centre in Prague. We were fortunate to hire an excellent team of engineers. This high performing team is already accelerating Allegro's leadership position in both the automotive and industrial markets," said Michael Doogue, Vice President of Business Development and Advanced Sensor Technologies at Allegro MicroSystems. "We plan to hire an additional 20 to 30 engineers at the centre over the next few years. The Prague team is an important addition to Allegro's global product development team, and I am certain that they will have a positive impact on Allegro's product development velocity and our customer support levels for many years to come." The availability of highly skilled IC design, systems, and software engineers was a major contributor to Allegro's decision to open this new R&D centre in Prague. The area provides an optimum combination of experienced engineers and recent graduates from local universities.

www.allegromicro.com

Overall Victory at the Formula Student Electric

Vacuumschmelze (VAC) has supported Formula Student Electric since the introduction of the electromobility division in 2010. All top teams have been using VAC's high-performance materials in their electric motors since the very beginning. Thanks to the rotor-stator systems made of VAC's cobalt iron materials, the AMZ racing team of ETH Zurich won the overall first prize at the Formula Student Germany in Hockenheim on August 12 this year and remains in first place in the world rankings. The high-performance cobalt-iron materials such as VACOFLUX® and VACODUR® increase torque by up to 53% compared to conventional materials. In combination with segmented permanent magnet assemblies, the parameters "weight" and "speed" can be adjusted to the optimum and more powerful motors of the same size or significantly lighter motors of the same power can be realized.

Recently, VAC's premium materials were also successfully used by the team of the University of Wisconsin-Madison, which won the first place in the "Electric Vehicle Design" category of the FSAE Lincoln Competition. Max Liben, technical director of the team said: "The high level of performance of these motors is a testament of VAC's production quality and in-depth knowledge – although even more impressive was their ability to quickly adapt and meet the project's incredibly fast timeline to actually bring these motors to life from conception to final product within one year."

www.vacuumschmelze.com

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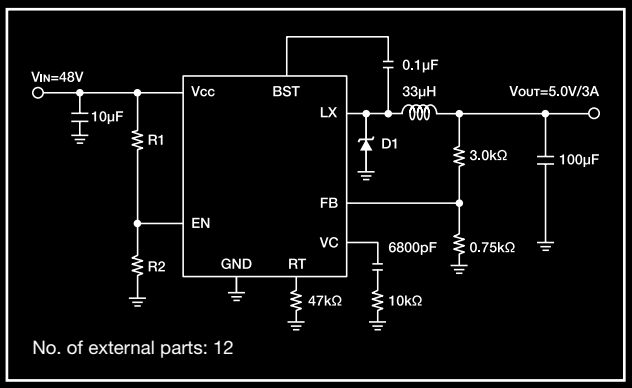
80V BUCK DC/DC CONVERTER IC

With the BD9G341, ROHM offers a high-integration 3A wide input (12-76V) Buck DC/DC Converter IC, variable output voltages and integrated 80V MOSFET.

BENEFITS

- Built in 80V power MOSFET provides sufficient voltage margin in 48V bus lines
- High power conversion efficiency contributes to greater energy efficiency in industrial equipment
- Minimizing mounting area and design load
- Original protection circuit provides greater reliability



No. of external parts: 12

FEATURES

- Input voltage range: 12V to 76V (80V max.)
- Output voltage range: 1.0V to VCC V
- Reference voltage: 1.0V±1.5% (25°C)
  ±2.0% (-40°C to 85°C)
- Operating frequency: 50 to 750kHz (typ.)
- Maximum output current: 3.0A
- EN pin threshold : ±3%
- Soft start function
- Protection Circuit: OCP, UVLO, TSD, OVP
- HTSOP-J8 package (4.9×6.0×1.0mm)

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electronica 2018
HALL C3 / STAND 512

www.rohm.com

Continuing Strong Growth Momentum

Danfoss continued its progress in the first half of 2018. Sales grew by EUR 106m to EUR 3,041m – a growth of 9% in local currency. While continuing the high investment levels, the earnings (EBIT) improved by 21% to EUR 370m and the net profit improved by 27% to EUR 253m. The positive development in earnings was driven by the higher top line and the gain from the divestment of the heat pump business Thermia. "We have maintained strong momentum across our business segments. Our solutions are relevant to several strong global megatrends, such as urbanization and the fight against climate change, which are driving a growing demand for energy efficiency and smarter digital solutions. The transition of the global energy supply to greener energy is driving another trend towards electrification. Here, too, we can see that our customers are looking to Danfoss as a technology partner who matches their future needs for solutions for hybrid or fully electric cars, ships and off-highway vehicles," says Kim Fausing, President and CEO. The half-year results were generated across Danfoss' businesses and markets. In the first six months of the year, China, in particular, stood out with significant growth driven by increasing demand for climate-friendly and energy-efficient solutions, such as large heat pumps and the expansion of district heating systems, driving a growing demand for Danfoss technologies. At the same time, Danfoss is experiencing a continued strong demand on the two largest markets, North America and Europe.

www.danfoss.com

Advanced Power and Energy Management Technologies

ROHM Semiconductor will again be exhibiting at the upcoming electronica 2018, November 13 to 16, 2018 in Munich. At its exhibition booth in hall C3, stand 512, the company presents new solutions for power and energy management in the automotive and industrial sectors as well as its commitment to Formula E. Highlights include demonstrations from updates of new power devices such as 1700V SiC module and other SiC devices, Power Management ICs and sensor technologies for the automotive and industrial market. In addition, ROHM will highlight local support capabilities by presenting Power-Lab Test benches and sensing solutions by Finland Software Design Center. For automotive applications, the company will show the latest generation of SiC-based inverters, human interface solution, car infotainment, PMIC and high reliability discrete components. New solutions for the industry sector will be presented including 99% efficiency SiC inverters, application example of a solar inverter, on-board charger, power supply and EV charging station. Further applications showcase AC/DC and DC/DC converter ICs, motor drivers and sensors together with new IGBTs and high-speed switching MOSFET (Presto MOS Series) devices.

www.rohm.com/electronica

Promoting Freya Petersen to Product Manager

ZESTRON Europe is pleased to announce the promotion of Freya Petersen to Product Manager.
Ms. Petersen has been with ZESTRON Europe since 2011 as Junior Product Manager. In her new position, she is responsible for managing and marketing of the Process Optimization Products such as the ZESTRON® EYE product line. This product segment helps analyze and optimize the cleaning process for electronic boards and components. Furthermore Ms. Petersen is responsible for the product area of maintenance cleaning agents.

www.zestron.com

Extending Market Leadership for Power Semiconductors

For 2017, industry analyst IHS Markit confirms Infineon Technologies AG as the global market leader for power semiconductors. In the overall market, which also includes power ICs, Infineon remained the lead and achieved the biggest organic growth across the industry. In the submarket for discretes and modules, Infineon has been confirmed number one for the fifteenth time in a row, increased its market share and is now more than double the size of the company in second place. In the market for discrete IGBTs, Infineon is now more than three times the size of the next smaller competitor. Infineon made the next big leap in IPMs: The company increased its market share by 1.4 percentage points – more than all the competitors. In addition, at 39.2 percent, Infineon grew almost two times faster than the market (20.1 percent). Power semiconductors help to efficiently generate and convert power from wind turbines and photovoltaic systems. The power is then provided to home appliances, notebooks or data centers among others with minimum losses. That saves resources and ensures a sustainable power supply.

www.infineon.com

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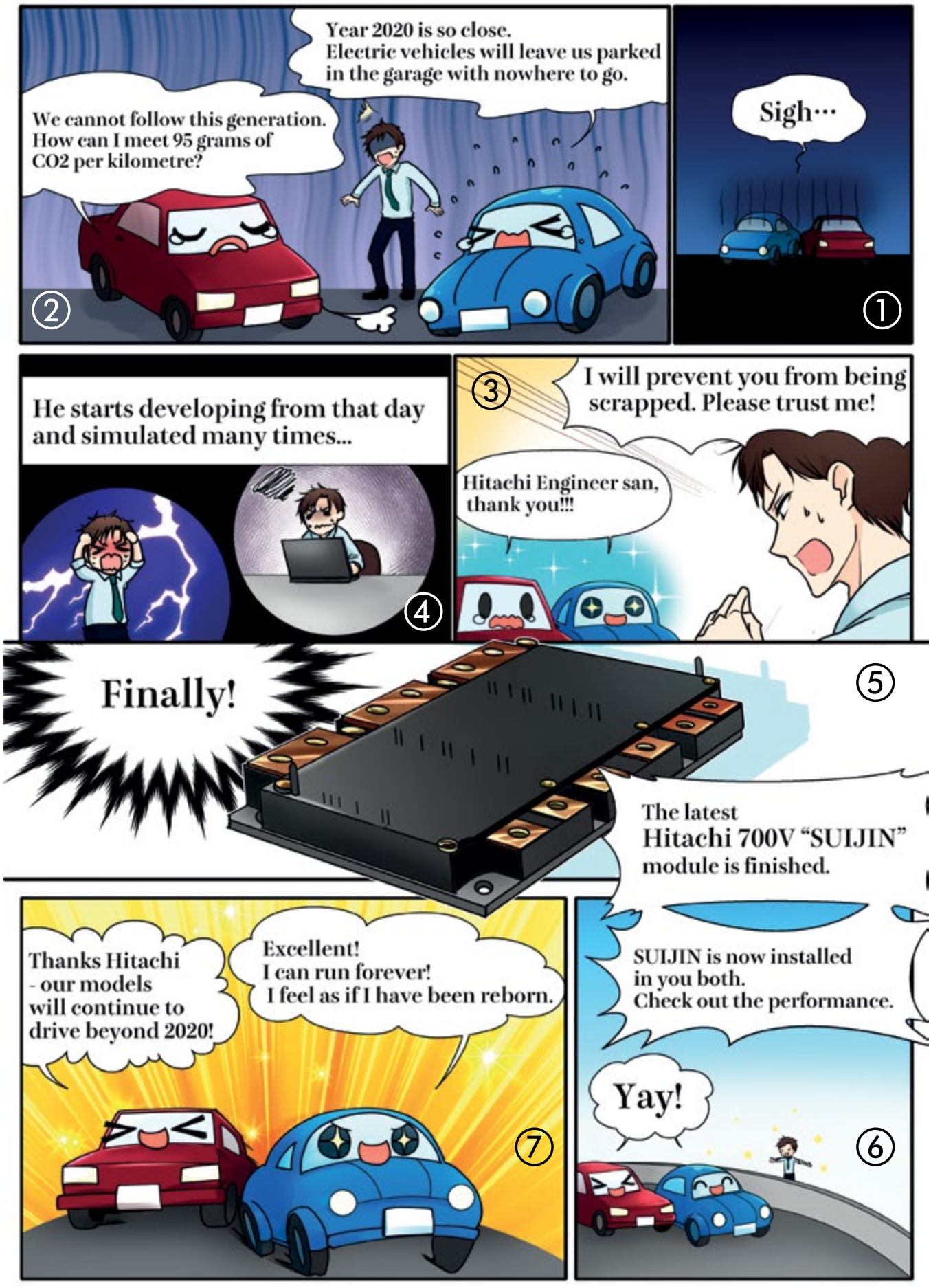

Please read right-to-left, in respect to Akira Toriyama and Manga artists around the world. Just follow the numbers.

650V – 1200V SUIJIN AUTOMOTIVE IGBT MODULES

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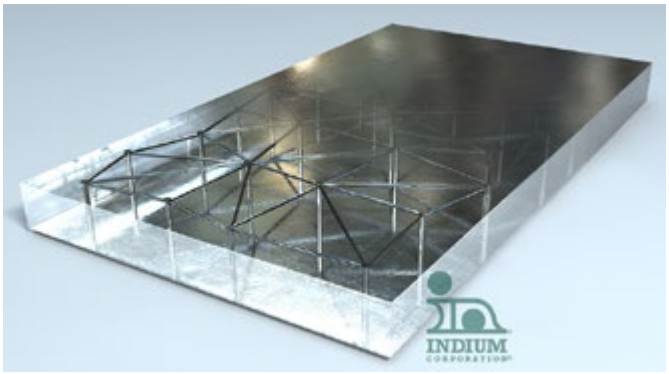
InFORMS® Reinforced Solder Preforms at IMAPS 2018

Indium Corporation will feature its reinforced solder alloy fabrications, InFORMS®, at IMAPS 2018, Oct. 8-11 in Pasadena, California.
Indium Corporation is redefining solder with its InFORMS® solder preforms. InFORMS® are a composite preform consisting of solder with a reinforcing matrix. This results in:

- Improved mechanical and thermal reliability
- Uniform bondline thickness
- Low-voiding performance

InFORMS® do more than just bond two surfaces.
These solder preforms are designed to address some specific challenges to the power electronics industry.
InFORMS® provide engineers with an enhanced material for the development of more reliable and higher performance modules. Due to the planarity improvements and stand-off tolerances, the package design becomes more predictable. In addition, stronger and more dependable joints allow for high power densities.



For more information about InFORMS®,
visit www.indium.com/informs or visit us at booth #722.

www.indium.com

Global Headquarters in Wilmington, MA

Analog Devices, Inc. announced it has officially broken ground on its new global headquarters in Wilmington, MA. The expanded facility will feature state of the art laboratories, design and manufacturing and cross-functional group collaboration space. In addition to 13,700 additional square meters for research and development, the global headquarters will include a 4,700 m² Hub comprising a café, fitness facility and auditorium designed to enable and encourage employees from all departments and functions to gather, connect and engage.

At a ground-breaking ceremony on July 11th, the Company hosted Jay Ash, Secretary of Housing and Economic Development for the Commonwealth of Massachusetts, Senator Bruce Tarr, Jeff Hull, Manager of the Town of Wilmington and other dignitaries from the Commonwealth, Associated Industries of Massachusetts, the Town of Wilmington Board of Selectmen and Finance Committee. Following brief remarks from guests including Analog Devices' Co-Founder and Chairman Ray Stata, executives and speakers participated in a celebratory ground-breaking. A pictorial history of the Wilmington facility was on display alongside renderings of the new facilities and renovations to existing structures that showcased light-filled spaces and greenery in and outside the buildings.

www.Analog.com

Silver Award Winner

TTI, Inc. has recently been honoured by TDK Europe with the Senten Manten Silver Award in the category of international volume distribution in their annual European Distribution Awards.
It is the fifth time these European Distribution Awards have been presented by TDK Europe in the categories of international volume distribution, high-service distribution and local distribution. "I am particularly pleased that in Europe the prizewinners were able to raise the bar from the already high level of the previous year and I want to congratulate the whole team from TTI for their great performance and efforts in promoting our products during the last year," says Dietmar Jaeger, head of TDK's distribution business in Europe and Vice President of Global Sales Distribution.

Comments Felix Corbett, Director Supplier Marketing, TTI, Inc. in Europe: "We are delighted to receive the Senten Manten award again this year. This award is particularly important for TTI as it acknowledges the quality of our service to TDK customers, by measuring the standard of key metrics, such as inventory quality and logistic performance. These measurements form a part of our continuous improvement activities and contribute to strengthening our TDK partnership and our customer service proposition.

www.ttieurope.com

www.tdk.com

UJ3C Series
650V & 1200V

UnitedSiC
Simply More Efficient

Silicon Carbide FETs – Simply More Efficient

The new UnitedSiC UJ3C series elevates SiC FETs to a whole new level of efficiency, performance and ease of use. Our FETs are compatible with commonly used silicon and SiC gate voltages, come in industry-standard power packages, and allow for easy, drop-in replacement.

- Drop-in replacement for IGBTs, Si and other SiC MOSFETs
- Excellent body diode performance (V_f <2V)
- Lowest $Rds_{(on)}$ in TO-220 (27mΩ)

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Find out how easy it is to upgrade your design at **unitedsic.com**

Upcoming ECPE Events

- ECPE Tutorial
  'Function and Design of Multilevel and Multi-cell Converter'
  10 - 11 October 2018, Toulouse, France
  Chaimen: Prof. M. Hiller (KIT), Prof. T. Meynard (Univ. Toulouse)
- ECPE Tutorial **'Power Semiconductor Devices & Technologies'**
  4 - 5 October 2018, Catania, Italy
  Chairmen: Dr. A. Mauder (Infineon), Prof. N. Kaminski (Univ. of Bremen)
- ECPE Tutorial
  'Power Circuits for Clean Switching and Low Losses'
  17 - 18 October 2018, Lyon, France
  Chairman: Dr. R. Bayerer (Infineon)
- ECPE Workshop **'The Future of Modelling and Simulation in Power Electronics Packaging for Thermal and Stress Management'**
  20 - 21 November 2018, Nuremberg, Germany
  Chairmen: Prof. U. Scheuermann (Semikron), Prof. B. Wunderle (TU Chemnitz)

Save the date!
ECPE SiC & GaN User Forum
26 - 27 March 2019, Erding / Munich, Germany; Chairmen: Prof. A. Lindemann (Univ. of Magdeburg), Prof. L. Lorenz (ECPE), Dr. P. Friedrichs (Infineon) in conjunction with the ECPE Annual Event

www.ecpe.org/ecpe-events

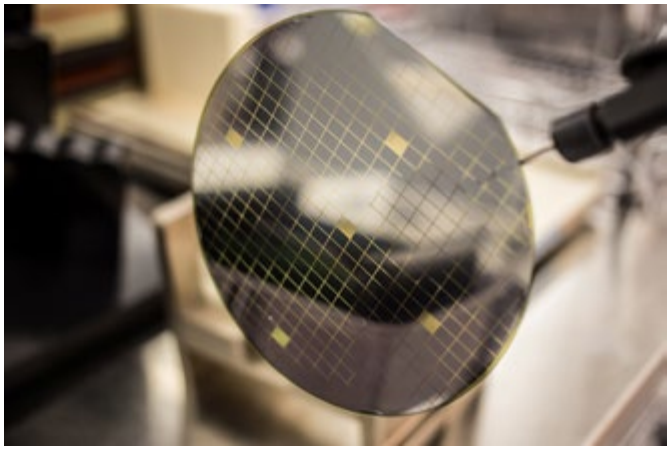
China Office to Support Strong Growth

UnitedSiC has opened an office in Shenzhen, China, and appointed Henry Jiang as Senior Sales Manager for the South China region. Jiang joins the company from STMicroelectronics, where he was the team leader of the power division. UnitedSiC has seen exceptional sales growth for its high-efficiency silicon carbide (SiC) power semiconductors in China, particularly in electric vehicle (EV) charging systems. The CEO of UnitedSiC, Chris Dries, commented on the appointment as one that will support UnitedSiC's rapid growth in the Chinese market, thanks primarily to the strong development of electric vehicle manufacturing sector in the region. "Today, UnitedSiC's products are designed into the majority of electric vehicles being manufactured in China," said Dries. "In both efficiency and reliability, our SiC transistors outperform both silicon and GaN devices. As a result, they enable smaller, faster EV charging systems to be developed, giving our customers competitive advantage. We are committed to supporting Chinese customers and will continue to grow our business in this region with more experienced and talented people like Henry Jiang." UnitedSiC's devices are also widely used in power supplies, variable speed motor drives and solar photovoltaic inverters.
Jiang can be contacted by email at hjiang@unitedsic.com or by telephone on +86 13691860680.

www.unitedsic.com

Doubling 6-Inch SiC Foundry Capacity in Response to Customer Demand

X-FAB Silicon Foundries announced plans to double their 6-inch Silicon Carbide (SiC) process capacity at its fab in Lubbock, Texas in response to increased customer demand for high efficiency power semiconductor devices. In preparation for doubling capacity, X-FAB Texas has purchased a second heated ion implanter for use in manufacturing 6-inch SiC wafers. Delivery of this heated ion implanter is expected by the end of 2018, and production release is planned during the first quarter of 2019 in time to meet projected near-term demand. X-FAB was the first wafer foundry to offer SiC manufacturing on 6-inch wafers. This doubling of X-FAB's SiC process capacity furthers its strategy to remain the premier 6-inch SiC wafer foundry, and demonstrates the Company's commitment to SiC technology and the SiC foundry business model. Advantages of X-FAB's 6-inch SiC process capabilities for power semiconductors include superior high voltage operation, significantly lower transistor On-resistance, significantly lower transmission and switching losses, extended high temperature operation as high as 400°F/204°C, higher thermal conductivity, very high frequency operation, and lower parasitic capacitance. X-FAB's SiC process capabilities allow customers to realize high efficiency power semiconductor devices including high power MOSFETs, JFETs, and Schottky diodes.



www.xfab.com

New Subsidiary in Indonesia

Hioki Singapore, a wholly-owned subsidiary of Hioki E.E. Corporation, has established its own sales subsidiary in Jakarta, Indonesia, as part of Hioki's continuing efforts to widen the sale of our products in the world and strengthen the Hioki brand. Official operations of Pt. Hioki Electric Instrument began in September 2018. Building a global sales network continues to be a top priority for Hioki. To date, Hioki Singapore Pte. Ltd. has served the market in Indonesia through a representative office located on the island of Java. Hioki believes demand for electric measuring instruments will grow in the country, driving additional growth for its businesses there. The new company is expected to more fully realize the potential of the Indonesian market, and will work to spread awareness of the Hioki brand, to build a sales network, and to expand Hioki's customer base.

"Jakarta is well-known for its massive traffic congestions, but it is predicted that the expansion of MRT, LRT and other public transportation facilities will spur further development of this already bustling economy," comments Toshihiko Tsuchiya, President of Hioki Singapore. "Hioki sees increased opportunities to support Indonesia's various industries including maintenance, repair and operations. The representative office we set up prior to this milestone faced many limitations in terms of offering pre-sales support, satisfactory lead times and after service. I am confident that with the establishment of an official sales subsidiary, we will be able to deliver more rapid and precise service, and further narrow the distance to our customers."

www.hioki.com

Projects to Advance Wide Bandgap Technology in U.S.

The PowerAmerica Institute at N.C. State University, a member of Manufacturing USA, recently awarded funding to six new member projects that will enhance wide bandgap technologies in the United States. In addition, PowerAmerica awarded funding for 20 projects to be led by existing members for a total of $20 million in project funding for this cycle. A detailed list of all projects with descriptions is available online. "These projects are instrumental in fulfilling PowerAmerica's mission of accelerating the adoption of wide bandgap technologies into power electronics systems. To date, the institute has funded scores of projects that have contributed to the development of more efficient power electronics, which will benefit a range of applications – from electric vehicles to data centers," said PowerAmerica Deputy Executive Director and CTO Victor Veliadis.

www.poweramericainstitute.org

Next Generation of Precision Power Analyzer

New WT5000 combines exceptional accuracy with stability, noise immunity and flexibility to meet the measurement needs of developers of energy-efficient systems

The Yokogawa WT5000 is the first of a new generation of Precision Power Analyzer that offers exceptional measurement accuracy of ± 0.03% combined with stability, noise immunity and plug-in modular flexibility to meet the measurement needs of today's developers of energy-efficient systems.

In rapidly evolving industry sectors like electric vehicles, renewable energy and energy efficient technologies, the need for reliability in testing to enhance safety, efficiency and performance has never been greater. Changing application needs and evolving international standards call for custom measurements and consistent accuracy, and in the WT5000 Precision Power Analyzer, engineers have a versatile platform that not only delivers reliable measurements today, but is ready for the challenges of tomorrow.

The WT5000 achieves the world's highest measuring accuracy: ±0.03% of total at 50/60 Hz. As a result, it has become possible to evaluate the power consumption, loss, and efficiency of electrical and electronic devices. In particular, its wide dynamic current range is indispensable for tests on energy-saving designs.

One of the essential elements for determining the performance of a power measuring instrument is the A/D converter that performs analogue-to-digital conversion. In order to obtain the world's highest measurement accuracy, the WT5000 uses an 18-bit converter with a sampling frequency of maximum 10 MS/s. As a result, it becomes possible to accurately capture waveforms from the latest high-speed inverter devices. It is very effective for stable measurement results.

While the WT5000 has the same dimensions as existing models in Yokogawa's WT series, it incorporates up to seven input channels, allowing it to support applications that previously could only have been measured by synchronising several separate instruments. As a result, it offers considerable savings in installation space, communications overheads and cost-effectiveness. Further benefits result from the use of plug-in modular input elements, which can be swapped directly by the user.

The 30 A and 5 A elements, for example, can be switched for applications involving electric vehicles or fuel-cell vehicles, where developers are increasingly required to evaluate a number of different motors. Using the WT5000 equipped with the /MTR1 and /MTR2 options, it is possible to evaluate up to four motors simultaneously with one unit. Since these options allow the input of four channels, flexible measurement of the A, B, C and Z phases of each motor can be carried out.

With a 7 elements input capability, multi-system measurement is increased in harmonic measurements on 3-phase systems, for example. The WT5000 can carry out two harmonic measurement functions simultaneously, each at up the 500th order and up to 300kHz fundamental waveform. This makes it possible to measure the carrier frequency component from the rotational speed of the motor in the inverter drive and also to check the influence of the carrier frequency on the motor drive.

An increasing number of applications require the evaluation of larger-current devices, typical examples being electric vehicles and large-scale solar installations. In these cases, external current sensors are often used. An external current sensor input function is fitted as standard in the input element of both the 30 A and 5 A input elements of the WT5000. For much higher currents (up to 2000 A RMS) dedicated high-current sensors are available.

www.tmi.yokogawa.com/eu

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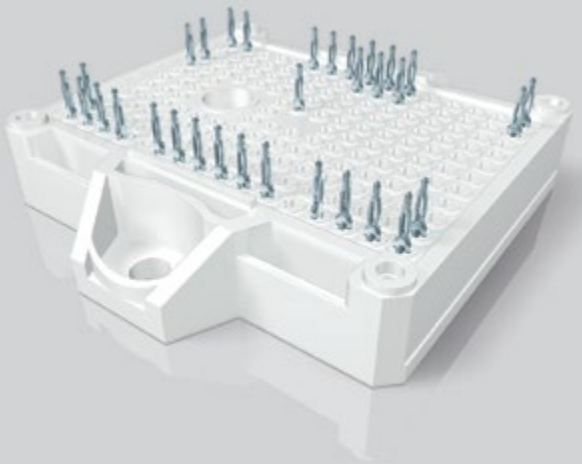

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Precharger Solution for Railway Applications

Powerbox announces the introduction of its ENR1000-PC series precharger unit designed to deliver peak power to high capacitive loads in railway applications. The precharger converts the battery nominal bus voltage of 50VDC up to 137.5VDC to a regulated output voltage of 400VDC or 600VDC to charge high voltage capacitor banks used to switch electric valves actuators such as for unlocking and lifting pantographs. The series delivers a peak power of 1000W, is able to charge a load of 5 to 35mF in two seconds and automatically switches to standby mode when charging is completed.

It is part of PRBX's Enhanced Rail Power Solutions (PRBX-ERPS).

Within operating input voltage range as wide as 50VDC to 137.5VDC, the ENR1000-PC series is covering the 72V, 96V and 110V system voltages according to EN50155.

The series comprises two models:

- The ENR1000D110/400-PC is delivering 400VDC is able to charge a capacitance load of 5 to 35mF. The unit sustains a maximum voltage of 137.5VDC, a 154VDC transient voltage and an external output reverse voltage of a maximum up to 5.8kVDC.
- The ENR1000D110/600-PC is delivering 600VDC to 10 to 12mF capacitive loads. The unit sustains a maximum voltage and transient of 130VDC and an external output reverse voltage of a maximum up to 2.5kVDC.

The ENR1000-PC series includes overvoltage, overload, short-circuit and thermal protection.

Designed for indoor and outdoor applications, the ENR1000-PC series can be operated within a wide range of temperature from -40 to +70 degrees C, EN50155 temperature class TX and up to +85 degrees C in storage conditions.

The precharger unit is designed according to EN50155, EN50124-1 and IEC61287-1. Its secondary to ground, and primary to secondary insulation resistance is up to 8.5kVDC, and its primary to ground is 1.5kVDC for one minute. Clearance and creepage distances are designed in accordance with IEC664, and the overvoltage achieves category II with a pollution degree II rating. The ENR1000-PC series belongs to material group IIIa , CTI 175-400.

Built for demanding railway applications and EMC environments, the ENR1000-PC series is designed in accordance to EN50155 EN50121-3-2 and EN50121-5, ESD to IEC61000-4-2 and IEC62236-3-2, fast transient immunity to IEC61000-4-4 and IEC62236-3-2, surge to EN61000-4-5 and IEC62236-3-2.

The precharger is built in a metal case of 229 x 184 x 86mm. Input connection is via a standard H15 connector, and the output a threaded shafts or high isolated cables on request. The unit weighs a maximum of 2.5 kg.

www.prbx.com/product/enr1000-pc-series

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The High Performance Analog Leader

VIP-Interview with Tony Armstrong, Marketing Director, Power Products at Analog Devices about ADI's position in the current and future market for power electronics.

By Henning Wriedt, US-Correspondent Bodo's Power Systems

Henning Wriedt: Last year ADI took over the Linear Corp. Did that "create a high performance analog leader" as the company claims?

Tony Armstrong: If you recall, back in March of 2017, when ADI officially took over Linear Technology, Vincent Roche said " The combination of Analog Devices and Linear Technology brings together two of the strongest business and technology franchises in the semiconductor industry. Our shared focus on engineering excellence and our highly complementary portfolios of industry-leading products will enable us to solve our customers' biggest and most complex challenges at the intersection of the physical and digital worlds.

We are creating an unparalleled innovation and support partner for our industrial, automotive, and communications infrastructure customers, and I am very excited about what this acquisition means for our customers, our employees, and our industry." Even though it has only been a little over one year since the acquisition, it is our belief that we have created the high performance analog leader.

Henning Wriedt: Regarding power electronics, your product portfolio covers a broad application range from battery management and energy harvesting to power control and µModule Regulators. In which segments do you see major activities right now and in which expect you major growth in the future?

Figure 1: 60V low Iq Buck Controller plus 4-Channel 8A configurable Buck DC/DCs

Tony Armstrong: ADI's Power by LinearTM (PbL) µModule® (micromodule) products are complete System in a Package (SiP) solutions that minimize design time and solve the most common problems of board space, heat dissipation and density issues.

Our µModule products are complete power management solutions with integrated DC/DC controller, power transistors, input and output capacitors, compensation components and inductor within a compact, surface mount BGA or LGA package.

Designing with Linear Technology micromodule products can significantly reduce the amount of time needed to complete the design process by up to 50% depending on the complexity of the design. The µModule regulator family transfers the design burden of component selection, optimization and layout from designer to device, shortening overall design time, system troubleshooting and ultimately improving time to market.

At the same time, switch-mode power supply design expertise is declining around the world, while time-to-market pressures are increasing. Having a "simple and done" solution has many benefits for manufacturers that need a finished power supply that is guaranteed to work right the first time.

PbL's µModule regulator solutions integrate key components commonly used in discrete power, signal chain and isolated designs within a compact, IC-like form factor. Supported by our rigorous testing and high reliability processes, our µModule product portfolio simplifies the design and layout of power conversion designs.

The µModule family of products embraces a wide range of applications including point of load regulators, battery chargers, LED drivers, power system management (PMBus digitally-managed power supplies), isolated converters, battery chargers and LED drivers. As highly integrated solutions with PCB Gerber files available for every device, µModule power products address time and space constraints while delivering a high efficiency, reliable and with select products a low EMI solution compliant with EN55022 class B standards.

As design resources become stretched by increased system complexity and shortened design cycles the focus falls on development of the key intellectual property of the system. This often means the power supply gets put to one side until late in the development cycle. With little time and perhaps limited specialist power design resource, there is pressure to come up with a high efficiency solution with the smallest possible footprint.

This is where the µModule regulator provides an ideal answer; the concept is complex on the inside, simple on the outside – the efficiency

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- Improved silicone gel
- Solder or mini press-fit pins
- High power density

of a switching regulator and the design simplicity of a linear regulator. Careful design, PCB layout and component selection are very important in the design of a switching regulator and many experienced designers have smelt the distinctive aroma of burning circuit board in the earlier days of their career. When time is short or power supply design experience is limited, the readymade µModule regulator saves time and reduces risk to the program. As a result of all the feature and benefits outlined herein, it is easy to see how the µModule regulators are one of our fastest growing product categories.

Henning Wriedt: Are there certain market segments and regions showing a high demand for power electronics?

Tony Armstrong: Right now, virtually all market segments and geographic regions are exhibiting high demand for power electronics. Major driving factors include the LTE 4G infrastructure build out, the electrification of the automobile and the insatiable demand for "data" which drives the need for more data centers to be built with increased through-put capacity.

By way of an example, let's take vehicle electrification. The newly proposed automotive standard, LV148, combines a secondary 48V bus with the existing 12V system. The 48V rail includes an integrated starter generator (ISG) or belt start generator, a 48V Lithium-Ion battery and a bi-directional DC/DC converter for delivery of up to 10kW of available energy from the 48V and 12V batteries combined. This technology is targeted at conventional internal combustion automobiles, as well as hybrid electric and mild hybrid vehicles, as auto manufacturers strive to meet increasingly stringent CO2 emissions targets.

For this new standard, the 12V bus will continue to power the ignition, lighting, infotainment and audio systems. The 48V bus will supply active chassis systems, air conditioning compressors, adjustable suspensions, electric superchargers/turbos and also support regenerative braking.

Figure 2: 72V hybrid step-down DC/DC Controller reduces Solution size by 50%

The decision to use an additional 48V bus, which is expected be available across production model ranges soon, can also support starting the engine, which would make stop-start operation smoother. Moreover, the higher voltage means smaller cable cross-sections are needed which reduces cable size and weight.

Today's high-end vehicles can have more than 4 kilometers of wiring. Vehicles will become more like PCs, creating the potential for a host of plug-and-play devices. On average, commuters spend 9 percent of their day in an automobile. Thus, introducing multimedia and telematics into vehicles can potentially increase productivity as well as providing additional entertainment.

The future for the 48V battery system is very much near-term. According to some auto manufactures, a 48V based electrical system results in a 10%-15% gain in fuel economy for internal combustion engine vehicles, thereby reducing CO2 emissions.

Moreover, future vehicles that use a dual 48V/12V system will allow engineers to integrate electrical booster technology that operates independently of the engine load, thereby helping to improve acceleration performance. Already in its advanced development phase, the compressor is placed between the induction system and intercooler and uses 48V to spin-up the turbos.

Henning Wriedt: How is your position on new technologies, like SiC, GaN, IEGT and wide Bandgap? How do they effect your power electronics products in the near future?

Tony Armstrong: It is clear SiC and GaN technologies have large future potentials for growth as these technologies develop and become more main stream. We cannot go into the specifics of what we are doing in these product areas other than to say that we are closely watching how these technologies and their market growth potentials are developing. Should we see an area where we can bring strong product solutions, we will develop and design high performance solutions for them.

Henning Wriedt: Vincent T. Roche, your CEO, recently mentioned, that " 5G represents an enormous opportunity for ADI." How do your power electronics products participate in that?

Tony Armstrong: 5G performance is hundreds of times faster than 4G. Theoretical download speeds reaching 10 Gbps. Dramatically increased reliability and greatly reduced latency. But the real story is the rise of 5G and how it will impact our lives. Imagine downloading a feature film, in 4K resolution, in seconds. Imagine virtual reality completely indistinguishable from actual reality.

Moreover, imagine an always-on, always-connected world of 50 billion devices – all working to make your commute easier, your home smarter, your body healthier, your entertainment more immersive and our world safer. That is our 5G future. Perhaps the best part is, that future is closer than ever, with 5G being designed and tested right now. Together, National Instruments and Analog Devices are working to develop 5G – with innovations, and a partnership, that are ahead of what's possible.

National Instruments gives engineers and scientists the innovative tools they need today to create groundbreaking solutions that define tomorrow. NI's design and test instruments, which enable the research and development of 5G, are another manifestation of this commitment.

One example is National Instruments' family of second-generation Vector Signal Transceivers (VST). The RF VST combines multiple

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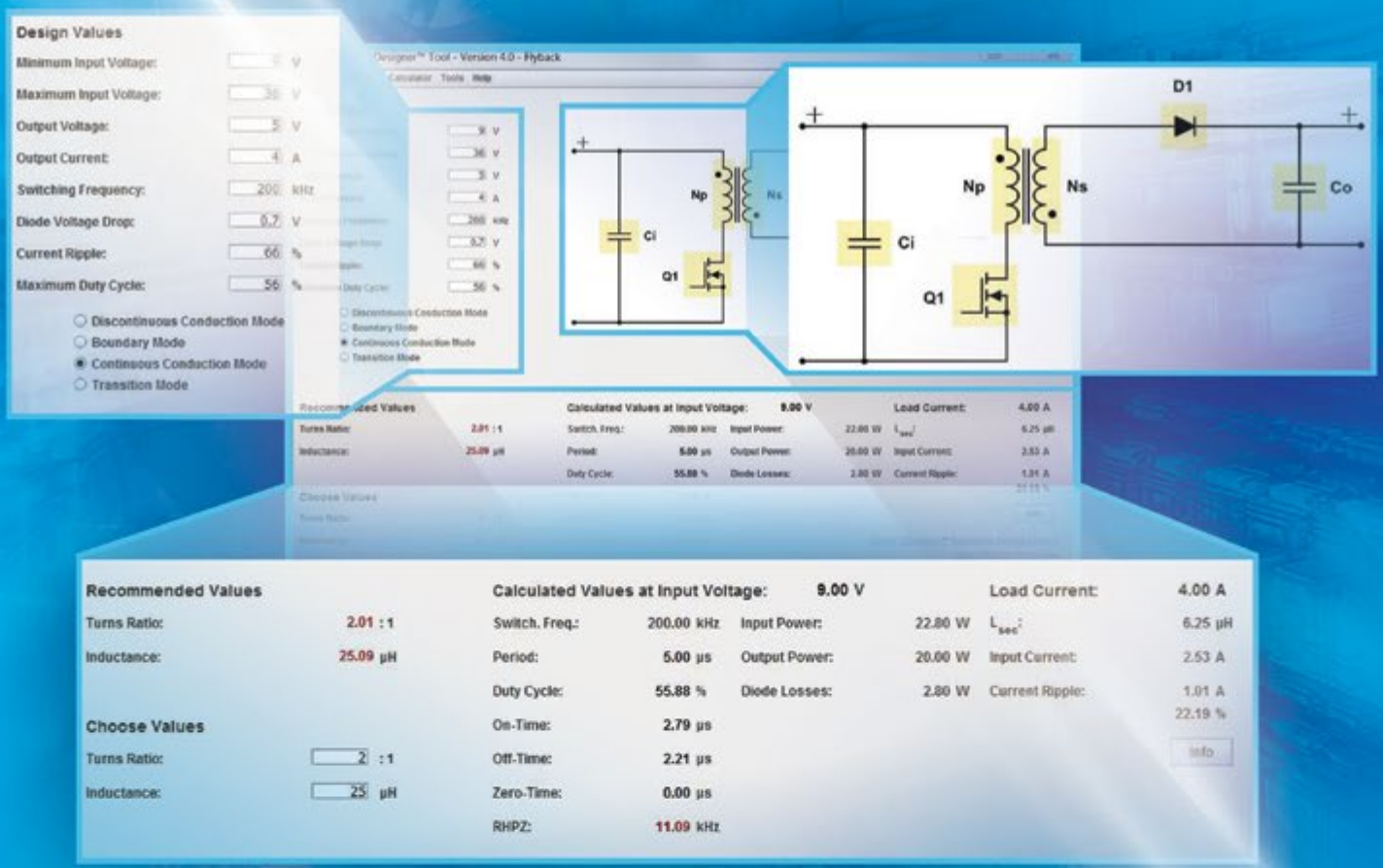

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instruments – including an RF signal generator, RF signal analyzer and user-programmable FPGA – into a single 2-slot PXI module.

Similarly, the baseband VST combines a baseband IQ signal generator, baseband IQ digitizer and user-programmable FPGA into a 2-slot module. The unique design of both instruments allows engineers to lower the price of testing by accelerating measurements and lowering the cost of capital equipment.

This performance and reprogrammability enables engineers to develop test and characterization programs for multiple cellular standards (including 3G, 4G, LTE and 5G, along with WiFi and Bluetooth) with a single, integrated solution. And because the second-generation VST can rapidly adapt to each new standard through software, it can significantly accelerate 5G prototyping and test development.

The resulting efficiencies and performance gains reduce test time and costs and allow for increased speed to market for the most advanced designs. Evidence of this success can already be found in universities and corporate efforts around the world, where National Instruments' reprogrammable instrumentation is currently enabling 5G NR (New Radio) prototyping in massive MIMO, mmWave, channel sounding and waveform development.

And as 5G continues to be developed, the second-generation VST's performance and flexibility enable it to adapt to changing standards, making it an invaluable, future-proof tester for tomorrow's demanding 5G challenges.

There are over 100 Analog Devices components fueling the second-generation VST's vast performance improvement and reduced form factor. But just as important as these 100 optimized solutions is the one deep partnership shared between Analog Devices and National Instruments. It is through this partnership that ADI and NI could discuss how the second-generation VST could work at the performance levels needed by the industry – with ADI providing parts customized to NI's exact specifications. Together, NI and ADI tested and optimized part performance in iterative fashion, giving NI the ideal solutions to integrate into the second-generation VST, and driving mutual insights into the performance needs of 5G.

Henning Wriedt: How are your opportunities in markets like renewable energy sources, power infrastructure, and battery-powered portable devices?

Tony Armstrong: PbL manufactures a comprehensive line of high performance battery charger ICs for any rechargeable battery chemistry, including Lithium-Ion, lead acid, and Nickel-based for many types of battery-powered portable products. These battery charger ICs are offered in linear or switching topologies and are completely autonomous in operation, or can be utilized with a microcontroller.

Charge currents from as little as 10mA, up to 4A are easily attained. Other notable features include battery pre-conditioning, thermal regulation, NTC interface and dual smart battery systems management with SMBus or I2C interface. They make an excellent choice from the care and feeding of batteries used in automobiles should the main battery be disconnected and an Emergency call via a wireless system is necessary.

Another key growth market of interest to us is in the field of green technology. Any products targeted toward energy conservation or energy harvesting will see growth opportunities and be insulated from the current market conditions. Energy costs and environmental concerns, as well as the need to extend battery life for mobile devices, has resulted in a focus on power optimization for a wide range of applications.

Our energy-efficient products enable customers to convert power more efficiently, consume less power and extend battery life. Our LED drivers enable a new generation of low power lighting for a range of applications, from cars and medical instruments to laptops and office lighting. Our efficient analog solutions will play a role in driving innovative cleantech markets such as solar and wind power systems.

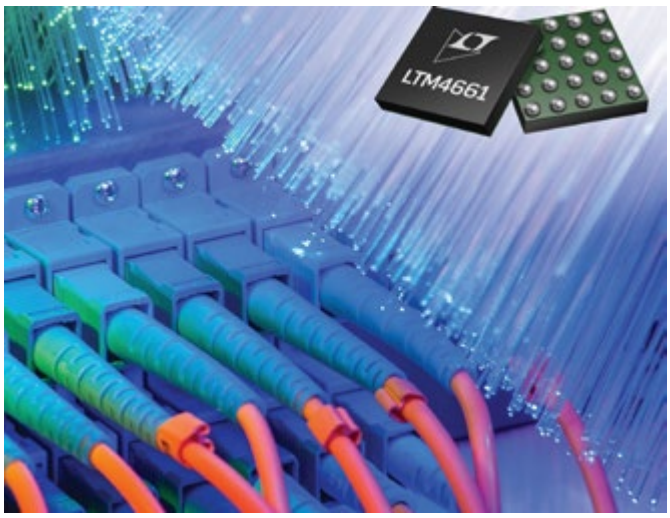

Figure 3:
Tiny µModule Boost Regulator for low voltage optical Systems

Henning Wriedt: What kind of "hand-holding" do you offer design engineers, who are looking for the best solutions in power electronics? What about Analog Devices Wiki?

Tony Armstrong: As our customers' design resources become stretched by increased system complexity and shortened design cycles, their focus falls on the development of the key intellectual property of the system. This often means the power supply gets put to one side until late in the development cycle. With little time and perhaps limited specialist power design resource, there is pressure to come up with a high efficiency solution with the smallest possible footprint.

This is where Analog Devices Inc's PbL support team becomes a valuable aid to customer's power supply needs. Not only do we supply readymade and proven solutions; we have applications engineers available to do the complete power tree for them – if needed. Nevertheless, we have numerous software design tools that are available free-of-charge from our web site. Below are some specifics:

1. LTpowerPlay® is a powerful development environment supporting the Power System Management (PSM) products of Analog Devices, including PMBus Power System Managers and DC/DC Power Converters with PSM. The software supports a variety of different tasks, including an offline mode (with no hardware present) in order to build a multichip configuration file that can be saved and reloaded at a later time.

2. The LTpowerCAD® design tool is a complete power supply design tool program that can significantly ease the tasks of power supply design and provides recommendations for component values

and performance estimates specific to the user's application with the µModule and monolithic DC/DC regulator products of Analog Devices. This guides the user through the entire design process reducing design effort and speeding up design time.

3. ADIsimPE, which is powered by SIMetrix/SIMPLIS, is a circuit simulation suite optimized for the design and development of analog and mixed signal circuits. SIMetrix mode is ideal for the simulation of general non-switching circuits. It provides full Pspice compatibility for use with industry-standard SPICE models. SIMPLIS (SIMulation Piecewise-Linear System) mode simulates the operation of switching circuits with vastly improved robustness, speed, and accuracy compared to standard SPICE. It is particularly useful for switching power supply, PLLs, and ADC/DAC applications.

4) ADIsimPower™ Selector uses your specific application requirements and compares solutions from over 300 power management parts and over 10 different topologies. Each solution takes into consideration the IC, external components, and operating condition to be able to compare expected performance.

Tony Armstrong, Product Marketing Director

Tony Armstrong is currently the Product Marketing Director for Analog Devices' Power by Linear product group. He is responsible for all aspects of the power conversion and management products from their introduction through obsolescence. Prior to joining ADI, Tony held various positions in marketing, sales and operations at Linear Technology, Siliconix Inc., Semtech Corp., Fairchild Semiconductors and Intel. He attained a BS (Honors) in Applied Mathematics from the University of Manchester, England.

Analog Devices (NASDAQ: ADI) is a world leader in the design, manufacture, and marketing of a broad portfolio of high performance analog, mixed-signal, and digital signal processing (DSP) integrated circuits (ICs) used in virtually all types of electronic equipment. Since the inception in 1965, the company is focused on solving the engineering challenges associated with signal processing in electronic equipment.

Used by over 100,000 customers worldwide, the signal processing products play a fundamental role in converting, conditioning, and processing real-world phenomena such as temperature, pressure, sound, light, speed, and motion into electrical signals to be used in a wide array of electronic devices.

We focus on key strategic markets where our signal processing technology is often a critical differentiator in our customers' products, namely the industrial, automotive, communications, and consumer markets.

We currently produce a wide range of innovative products - including data converters, amplifiers and linear products, radio frequency (RF) ICs, power management products, sensors based on microelectromechanical systems (MEMS) technology and other sensors, and processing products, including DSP and other processors - that are designed to meet the needs of our broad base of customers.

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The Successful Launch of the International Energy Harvesting Ecosystem – EnerHarv 2018 Workshop

In July 2017, the Energy Harvesting Committee of the Power Sources Manufacturers Association (PSMA) aspired to capitalize on their growing momentum with higher profile activities that enhance awareness and adoption of energy harvesting (EH) and related micro-power management technologies. The group recognized that the single, biggest barrier to the advancement of these emerging technologies was the siloed nature in which they were being developed.

By Brian Zahnstecher, PowerRox & Mike Hayes, Tyndall National Institute

Given the success and positive response from prior efforts such as Industry Sessions at the 2017 & 2018 Applied Power Electronics Conference (APEC) and numerous industry presentations/webinars/etc. from Committee members, it seemed many players in key industries such as the Internet of Things (IoT), wearables, industrial controls, automotive, and many more were finally starting to gain enough acceptance of the potential for energy harvesting technologies to be a unique enabler to many of their associated, target verticals. The next logical step was to propose a focused event that brought together the best and brightest from the world of EH to not only educate each other, but also allow ample opportunity for networking and collaboration opportunities. For these reasons, a workshop format was chosen and intentionally executed to be fully experienced as a collective. Hence, EnerHarv 2018 was born with the financial support of the PSMA Board of Directors, the technical support of key partners from IEEE Power Electronics Society (PELS), European Center for Power Electronics (ECPE), the CONNECT Science Foundation Ireland Research Centre, China Power Supply Society (CPSS), the venue/hosting support of Tyndall National Institute and media partner How2Power (and support from Bodo's Power Systems). Whilst there was a strong mix of academia and industry contributors, there was a heavier emphasis on industry and real-world application enablement.

Figure 1: Most of the EnerHarv 2018 delegation. It should be noted this picture was captured at the very end of the event, which is a testament to the interest and dedication of the community to absorb absolutely as much as possible to the very last minute. (Picture by Tyndall National Institute)

The international EnerHarv 2018 workshop was held May 29-31, 2018 in Cork, Ireland at Tyndall National Institute. There were 81 attendees representing every major geographical region on the planet (sorry, Antarctica). The program was divided [roughly] evenly between lecture sessions, functional demonstrations, and interactive panel discussions with plenty of time reserved for networking and team-building prospects as well as a poster session as a bonus. In summary, there were 20 lecture presentations (inc. two keynotes and three panel introductions), 16 functional demonstrations, & 19 posters. The program opened with two keynotes, the first from Yogesh Ramadass, Director of Power Management for Texas Instruments' Kilby Labs with an overview of EH technologies and applications from the past to where we are headed in the future. This was followed by Eric Yeatman, Head of the Department of Electrical and Electronic Engineering from Imperial College London, with a focus on wireless sensor networks and outlining how their deployment, enabled by EH, opens the doors to many of the applications receiving much industry focus today from IoT to Unmanned Aerial Vehicles (UAV).

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Then followed a prolific line up of speakers for technical, application and panels sessions from Analog Devices, Carnegie Mellon, ST Micro, Ilika, ARM, UNIST (Korea), Cambridge Display Technologies, Fraunhofer, IMTEK-University of Freiburg, Tyndall, MCCI, NCSU (North Carolina), Boston Scientific, Cap-XX, University of Southampton & United Technologies. The speakers were divided amongst major topic areas of Transducers, Low Power Loads, Storage, Power Management and System Integration. The three panel sessions drew engagement from the full delegation and generated lively conversations around Applications, Energy Optimization and Future Directions.

Many great things came out of this workshop, some expected and some surprises. Given the emphasis put on developing synergies across the siloed contributors of this industry, it was great to see the excitement and willingness of the participants to learn about each other's area of expertise and organically seek collaboration, where appropriate. Towards the end of the workshop, this was best exemplified by Gopi Patel of Wurth Electronics who stated "I now realize what was a competitor is now a collaborator" in the final panel session and open discussion in response to an excellent summary of the week's events and look to the future delivered by Francesco Carobolante, CTO, G2nd Systems. Perhaps more surprising were some of the contributions that the majority of participants (from what one might call the "mainstream EH ecosystem") did not even realize were relevant, let alone important, additions and enablers of the IoT. One example of this was a presentation (the only real software talk in a very hardware-focused program) given by Brandon Lucia, Assistant Professor of Electrical and Computer Engineering at Carnegie Mellon University in which he described the need for software code that has the intelligence to use an "intermittent execution model" that can handle unexpected power interrupts and simply pick up seamlessly from where it was operating when power was lost. Alex Weddell, Academic Staff Member & Co-Investigator for the ARM-ECS Research Centre, an award-winning collaboration between ARM and University of Southampton, gave some eye-opening perspective on the part-to-part variation of photovoltaic cells, even within a common lot, that can drastically change the design calculations required to reliably deliver an integrated IoT device.

Figure 2: Carnegie Mellon's Prof. Brandon Lucia energizes the crowd with the need for software in EH designs.
(Picture by Tyndall National Institute)

One of the most important enablers for perpetuating the EH ecosystem is demonstrating many of these technologies are viable today for real-world applications, particularly for the IoT. This is why the inclusion of functional demonstrations (days 1 and 2) was a mandatory, complementary aspect of the workshop program. Each demo got a 60 second elevator pitch immediately preceding the session. Delegates could freely meander the demos, interact with the presenters and learn about the technology and/or applications being shown. A poster session always creates structure and stimulates discussions and networking and this also went extremely well. All the demo and poster sessions were composed of a nice mix of contributions from both industry and academia.

While this diverse group of contributors and audience provided a wide area of breadth and depth of coverage, there is still so much more to

Figure 3: Analog Device's Jane Cornett discusses the massive potential of chip-scale thermoelectrics.
(Picture by Tyndall National Institute)

Figure 4: Gerd vom Bögel of Fraunhofer IMS demonstrates his industrial application, EH-powered sensor for Alex Weddell of the University of Southampton/ARM collaboration.
(Picture by Tyndall National Institute)

Figure 5: At the closing session, a poll is taken on how the audience felt about meeting the workshop objectives and if there should be more in the future…seems affirmative!
(Picture by Tyndall National Institute)

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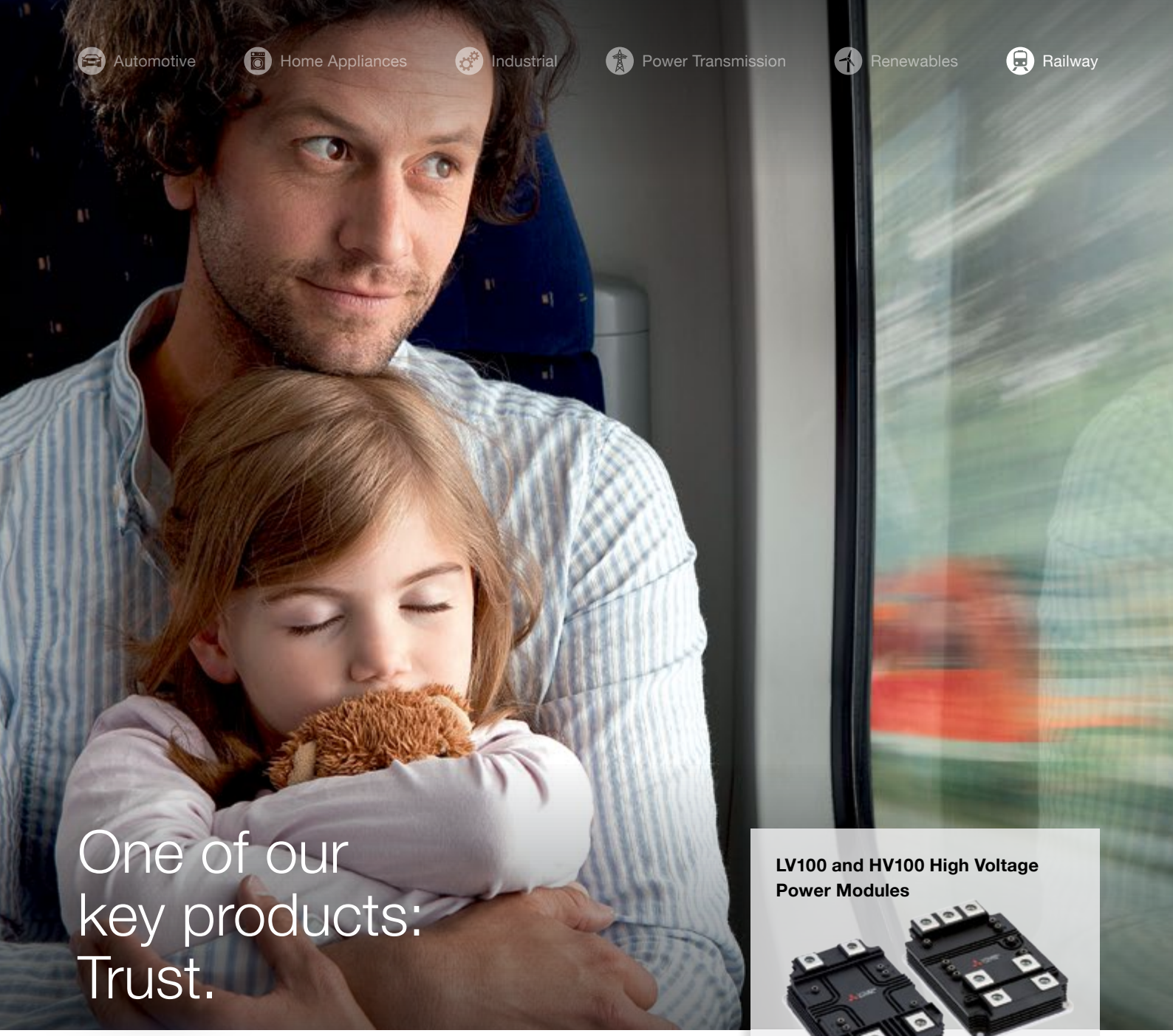

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consider. Even in 2.5 days, EnerHarv 2018 could only fit so much into the program and maintain the high standards of quality and balance demanded by the organizers. Even those working heavily in the EH space continually discover there are always additional, important areas of expertise to incorporate into this community and expand their horizons, while growing the ecosystem. EnerHarv 2018 was no exception to this. If one truly wants to internalize the technological and market requirements for enabling EH-powered applications, then it is important to transcend the typical coverage areas (e.g. – transducers, power management, storage, loads) to consider things like software, test & measurement, user interaction and industrial design. It is also important to recognize that many applications will not have an ambient energy harvesting source but nonetheless the micro-power management technologies being developed offer the opportunity to significantly extend the battery life for IoT devices thereby reducing maintenance costs, improving reliability and functionality.

Post-event surveys were distributed both at the workshop and in electronic form following the event with responses received from over 40% of the attendees. Feedback was quite positive, but this must also be interpreted in the proper context. EnerHarv 2018 was designed primarily for the contributors of the EH ecosystem to develop synergies and learn from one another, but this also means there was a significant deficit of representatives from the user or implementer perspective. This meant an obvious, positive bias to the perceptions of attendees. Some of this bias can even be attributed to the locale since Cork, Ireland was far more amenable to those (particularly in Europe) providing EH materials and components as opposed to those on the application side. For instance, if this event was held in Silicon Valley (San Francisco Bay area, USA), then it would be far more likely to include more contributions from the implementer/application side of the fence and therefore, may have a more apprehensive, cautious and risk-averse approach to implementing EH technologies. This will absolutely be taken into consideration for those of us from the PSMA EH Committee and others that are involved in planning future activities. One of the most frequent feedback comments was not in regard to IF there should be another EnerHarv, but a question of WHEN and that for example a biennial event is not frequent enough to keep up with the pace of this emerging technology space or the demand of the ecosystem for knowledge and insight.

At the end of the day, this effort was an experiment and an effort to build, network and steer a critical mass of people in the 'powering IoT' ecosystem and to this end it was a major success and a solid foundation for future activities. The members of the PSMA EH Committee recognized the growing awareness and acceptance of EH technologies and their critical enablement role in the IoT/IIoT, wearable, industrial automation, autonomous vehicle, and many more industries. Taking advantage of this momentum, it was decided to drive that thrust to the next level and officially recognize this emerging technology area for what it is, a true ecosystem. Most delegates arrived at EnerHarv 2018 with a passion for EH and a motivation to figure out how to identify and work with partners to perpetuate it. Those same people walked away with knowledge, collaborative relationships, and the realization they were witness to and members of a proper, EH ecosystem.

If you are interested in learning more about EnerHarv, the PSMA EH Committee, or anything else referenced in this article, then please feel free to contact Mike Hayes (michael.hayes@tyndall.ie) and/or Brian Zahnstecher (bz@powerrox.com).

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About the Authors:

Brian Zahnstecher is a Sr. Member of the IEEE, Chair of the IEEE SFBAC Power Electronics Society (PELS) awarded 2017 Best Chapter awards at the local/national/worldwide levels concurrently (an unprecedented achievement), sits on the Power Sources Manufacturers Association (PSMA) Board of Directors, and is the Principal of PowerRox, where he focuses on power design, integration, system applications, OEM market penetration, market research/analysis, and private seminars for power electronics. Additionally, he Co-chairs PSMA's Energy Harvesting Committee and the Reliability Committee (which he also co-founded) and is a regular segment owner and contributor to the PSMA Power Technology Roadmap ('15, '17, & '19). He was a Co-founder and Technical Chair for EnerHarv 2018. Brian is a recognized leader in the areas of ultra-low power management and energy harvesting technologies giving many presentations each year at the industry's most prestigious events.

Brian leads Power for the IEEE 5G Roadmap Applications & Services Working Group, authored the Group's position paper, is Co-chair of the 5G Webinar Series, is Co-chair of the 1st 5G Energy Efficiency Tutorial, and has lectured on this topic at major industry conferences. He has successfully handled assignments in system design/architecting, AC/DC front-end power, EMC/EMI design/debug, embedded solutions, processor power, and digital power solutions for a variety of clients. He previously held positions in power electronics with industry leaders Emerson Network Power (now Artesyn), Cisco, and Hewlett-Packard, where he advised on best practices, oversaw product development, managed international teams, created/enhanced optimal workflows and test procedures, and designed and optimized voltage regulators. He has been a regular contributor to the industry as an invited keynote speaker, author, workshop participant, session host, roundtable moderator, and volunteer. He has over 14 years of industry experience and holds Master of Engineering and Bachelor of Science degrees from Worcester Polytechnic Institute.

Mike Hayes (MEngSc, University College Cork) has over 30 years of experience working in Power Electronics industry and ICT/Energy Efficiency research promoting and leading synergy opportunities between domains. He has written a number of publications, participated in EU studies, presenting & chairing conferences and workshops related to this. He is currently work package leader on 3 EU energy/factory efficiency projects and coordinator of a 'Powering the Internet of Things' infrastructure project ('EnABLES') giving industry access (expertise, equipment, models, feasibility studies) to 11 leading research centres and universities in Europe.

Mike is currently president of PSMA board of directors and co-founder of the PSMA energy harvesting committee in 2015, chairing energy harvesting industry sessions at APEC 2017 & 2018 and contributing to the PSMA technology roadmap in 2017. He is also Co-founder of EnerHarv and was General Chair for EnerHarv 2018.

Since 2008 he has been a Program Manager at Tyndall primarily focusing on energy harvesting powered wireless devices and systems retrofitted on or near people, equipment and infrastructure. Prior to this he worked at power electronics multinational Artesyn Technologies covering a wide variety of technical and senior management roles. For Tyndall he has secured over $10M in funding leading to the creation of over 30 jobs & helping industry partners secure $2.6M in VC/research funding. Tyndall is one of Europe's leading research centres and a world leader in PSiP (power supply in package) & PwrSoC (power supply on chip) domains and an epicentre for micro-power energy harvesting research in Europe.

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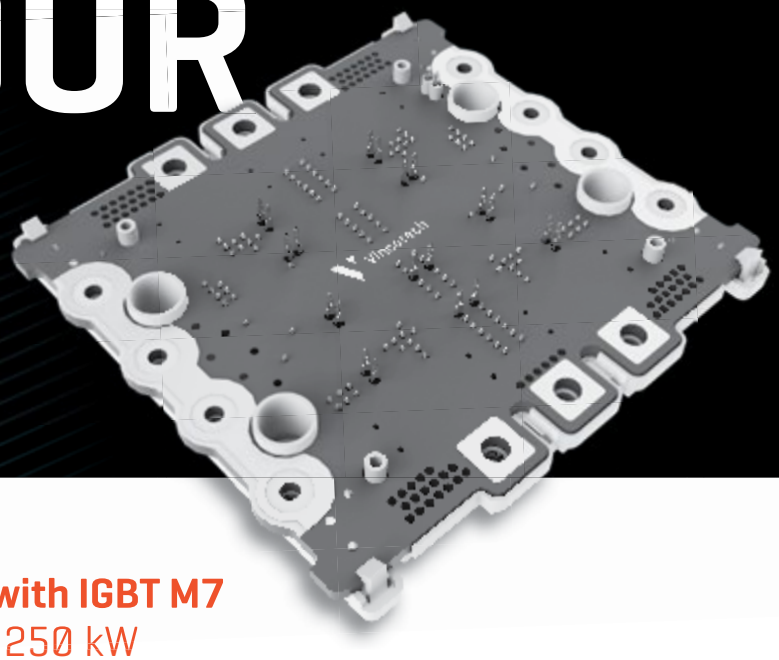

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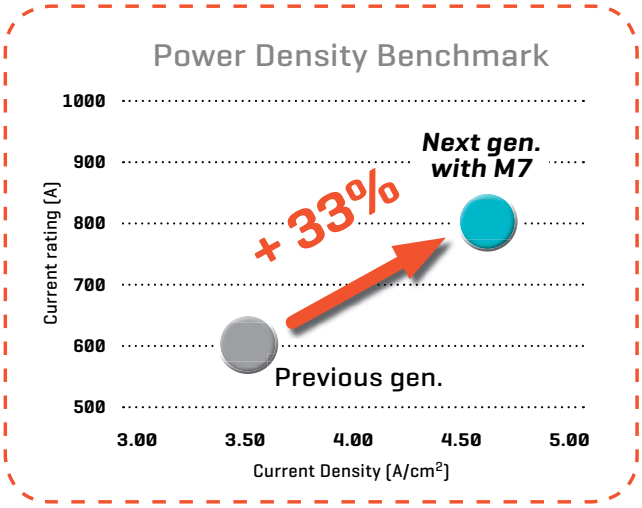


www.vincotech.com/VINcoMNPC-X4

EMPOWERING **YOUR IDEAS**

DCM™ Powers Electric Vehicles

Enabling the Electrification of the Drive Train

Third quarter of 2018 was the quarter where global cumulative passenger electric vehicle sales hit four million. While it took 60 months to reach the first million sold passenger EVs, in late 2015, it took the fourth million just six months. The fifths million EV is estimated to be sold in the first quarter of 2019 [1]. With the current development – mainly driven by China – the share of electric vehicle sales today will only grow and is anticipated to reach 50% of new car sales in 2040 [2].

By Max-Josef Kell, Martin L. Kristensen, Ole Mühlfeld, Omid Shajarati, Robert Roesner, Tim Rettmann;
Danfoss Silicon Power GmbH, Germany

Introduction

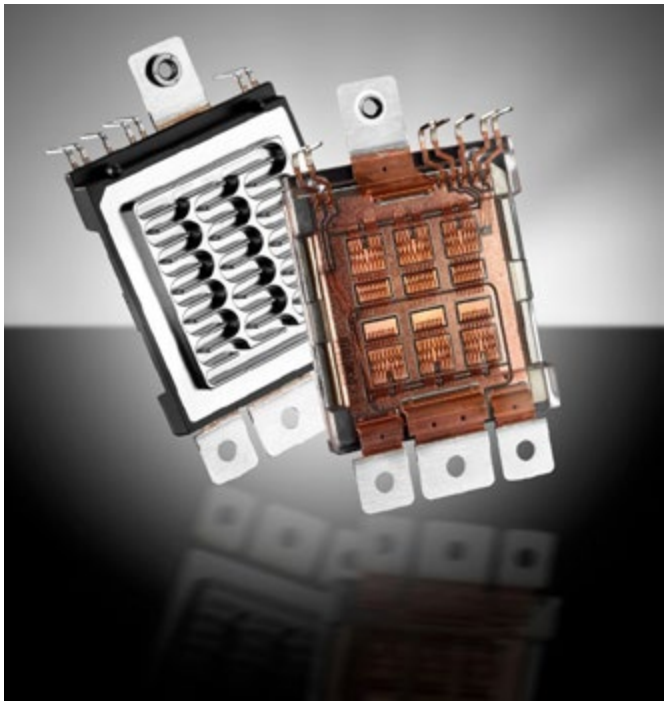
Electrification is a game-changer that will disrupt the transportation sector. With electrification, great opportunities open to enhance the flexibility, efficiency and environmental performance. This would be true for almost any application or system – in particular for electric passenger vehicles, off-highway vehicles and ferries. Today, the transportation sector accounts for 25% of all CO2 emissions in Europe [1], and emissions regulations from transportation potentially requiring reductions of more than 60% below 1990 levels by 2050 [1]. Therefore, electrification of transport is essential for meeting the European Union goals of decarbonization. Danfoss provides solutions for next-generation hybrid- and full-electrification of marine vessels, off-highway as well as passenger and commercial vehicles, taking fuel savings and energy efficiency to the next level.

For decades, Danfoss has enabled the world's leading automotive manufacturers to deliver solutions that are designed to meet stringent efficiency, reliability and cost targets and ultimately lowering the overall cost of the system. For EVs, Danfoss has the technology portfolio to significantly contribute to the development and penetration of electric vehicles. Having announced our new DCM™ power module technology platform [3,4], this article presents results achieved in hardware tests utilizing extreme load profiles.

DCM™ automotive traction module platform

Danfoss has introduced the Direct Cooled Molded (DCM™) module technology platform for traction applications in hybrid electric and battery electric vehicles. DCM™1000 is prepared to accommodate up to 1000 mm² of semiconductor area. The DCM™1000 technology platform is truly flexible in being optimized to utilize Si, SiC or Si/SiC hybrid semiconductor setups. Si or SiC chips from various semiconductor manufacturers may be used. The DCM™1000 is designed to meet the drivetrain power requirements, while being scalable in terms of different voltage classes of up to 900V blocking voltage, and output currents ranging up to 700A.

Furthermore, the DCM™ platform was recently extended with DCM™1000X family, utilizing latest generation of 1200V SiC MOSFET or Si IGBT. Consequently, the 1000X platform is designed for drive trains operating at DC-link voltages up to 950V and current ratings up to 600A.

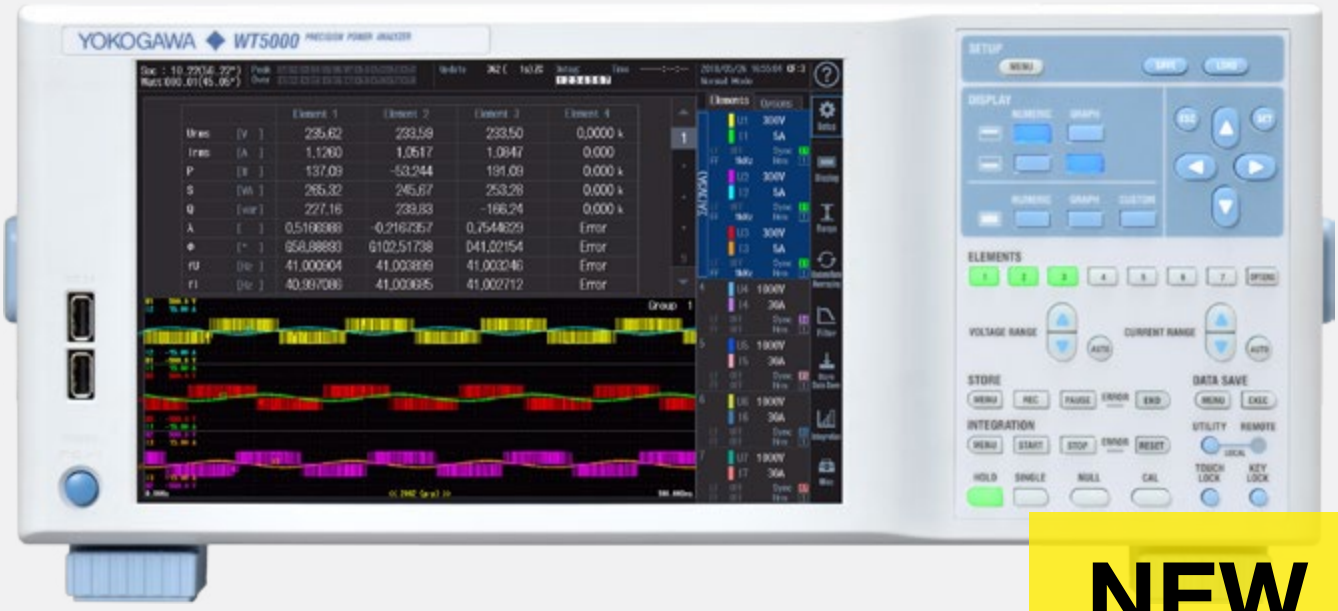


The current ratings are scaled through the amount of semiconductor area and optimized by processes and material selection. The platform is designed to meet commonly applied HV and insulation requirements, e.g. LV123, IEC 60664-1 including safety margins for 950V DC-link voltage.

The DCM™ platform ensures versatility and flexibility allowing the customers to utilize scalable drive train inverter design approaches. Using the same package and footprint for different inverter power classes, opens the possibility to have scaling effects with the supporting hardware for OEM's.

It is essential to have in mind that drivetrain inverters are designed to operate under harsh conditions; high temperature cycles, humidity, mechanical shocks and vibrations, resulting in significant challenges for the power module bonding and joining technology.

The DCM™ utilizes a specific transfer mold package material (Epoxy-Resin) for the power module. In combination with the Danfoss Bond Buffer® (DBB®) technology, the DCM™ platform reaches a superior power cycling performance and lifetime. DBB® consists of a sintered die attach and a sintered copper layer on the chip topside. The topside copper layer allows the use of copper wire bonding with much



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improved current carrying capability and lifetime. DBB® furthermore enables stable operation at elevated junction temperatures. Sintered semiconductors combined with the copper bond buffer and copper wire bonding offers highest power and temperature cycling capabilities, achieving up to 15 times higher lifetime than any other standard bonding and joining technology. All this contributes to satisfy the harshest operation conditions found in electric vehicles.

One of the main differentiators of Danfoss Silicon Power is being chip independent giving Danfoss the ability to select between a wide range of suppliers and offerings of suitable IGBTs, diodes and MOSFETs. This enables Danfoss to provide the best suitable semiconductors while ensuring an optimized cost and supply security for our customer through multiple sources on chip level. Through proven cooperation with several major semiconductor suppliers, Danfoss has ensured supply security and optimized topologies for the customers throughout the past decades.

Hardware under test

Following the module level tests previously presented [3,4], Danfoss performed inverter level tests with DCM™1000 modules using the matching application kit. The kit contains all necessary functions to run as a demonstrator for double pulse and inverter level tests. It encompasses a reference gate driver, a suitable heatsink for direct liquid cooling and a low-inductive DC cap bank in addition to all necessary mounting hardware and gaskets required.

Figure 1: DCM™ 1000 Application kit, fully assembled.

The users provide low-voltage control signals and the desired pulse pattern to the gate driver. For the gate control signals, the gate driver performs interlock protection to prevent unintended triggering of the upper and lower IGBT at the same time. If one of these conditions is met, a specific fault signal is set for higher level control.

There are several built in protection features in the application kit. The integrated gate driver continuously monitors the DC-link voltage for a desaturation state of the device. The substrate temperature can be measured by utilizing different sensors. A Pt1000 is included inside the modules, and for the application kit, the module in middle position on the heatsink is measured and connected to a circuit on the gate driver. The galvanic isolation of the temperature signal is included directly on the gate driver board, which makes it easy for the user to record temperatures during test.

The gate driver board has pre-selected gate resistor values that utilize the low loss and fast switching behavior of today's latest generation of automotive power semiconductors. Verified through testing, a safe turn-off under short-circuit conditions is ensured. The module is protected against short-circuit and limiting of the overvoltage during short-circuit turn-off is done with an active clamping circuit. The gate driver has all basic functions for a quick and simple integration of the application kit into a prototype testing environment. Danfoss provides further documentation regarding the interfaces and functionality of the gate driver together with the application kit.

For cooling, the demonstrator takes advantage of the unique ShowerPower®3D concept of the DCM™ platform. Three channels in the baseplate guide the water directly below the heat sources ensuring a high uniformity of the temperature distribution across the module. Thermal gradients between single chips operating in parallel are practically eliminated. Furthermore, ShowerPower®3D is an integral part of the baseplate and serves also as a supporting structure, leading to a high level of mechanical stiffness of the module. This allows reduction of the baseplate thickness and improves the heat transfer, while still providing extra support for pressure pulses above the nominal system pressure without risk of spillage or unwanted warpage of the module. The module is sealed with a double gasket and all clamping forces are applied directly onto the baseplate via clamping brackets. A redundant and reliable sealing is also included.

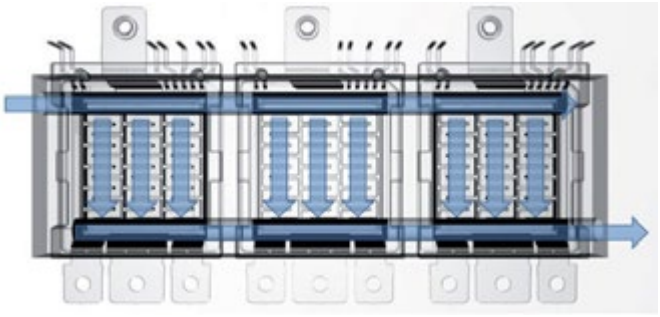

Figure 2: Coolant flow for a three phase B6 configuration as in the application kit.

The fastening of the modules towards the DC capacitor bank is done with screws, for reasons of simplicity and ease of assembly. For series products, the interfaces can be customized, i.e. allowing for a welded interface towards the dc-link or press-fit connections on the sensing pins.

The capacitor bank itself is optimized for low inductance, to allow the user to fully exploit the fast-switching capabilities of the module. The three-terminal structure of the DCM™ platform, where the two outer terminals connect to DC positive, and the inner single terminal connects to DC negative further helps to reduce commutation inductance. The voltage rating of the capacitors of the application kit is up to 500Vdc continuously, which is in line with requirements for most current system voltages and fits well with the 750V IGBTs.

Achieved results

Before investigation of PWM inverter operation, the commutation inductance was investigated. Using a single point of the voltage and current waveform for analysis is more sensitive to errors compared to an integral measurement method. The approach using

$$L_\sigma = \frac{\int_{t_0}^{t_1} \Delta U_{DS}(t) \cdot dt}{I_D(t_1) - I_D(t_0)} \qquad \text{with } \Delta U_{DS} = U_{DC} - U_{DS}$$

as shown in Figure 3 will provide better results.

Danfoss – **powers electric** vehicles

DCM™ - Enabling the electrification of the drive train

Danfoss' new, scalable power module technology platform for traction applications lives up to the stringent automotive requirements. The platform is based on market leading technologies; Danfoss Bond Buffer® that combines sintered die attach and copper wire bonding, transfer molding processes for robust packaging, to liquid cooling technologies namely ShowerPower® and SP3D®.

The DCM™ is designed to operate under the harshest conditions and is versatile in application and yet open enough to be scalable and customized. Additionally, the DCM™ platform allows flexible use of Si and SiC power semiconductors and is designed to meet the customers' specific mission profile.

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From the switching waveform shown, a total commutation loop inductance of 7.85nH (module including dc-busbar and capacitor) was measured in the setup, proving that the DCM™ technology platform is perfectly suitable for fast switching semiconductors with special focus on SiC MOSFETs for future generations of drive train inverters.

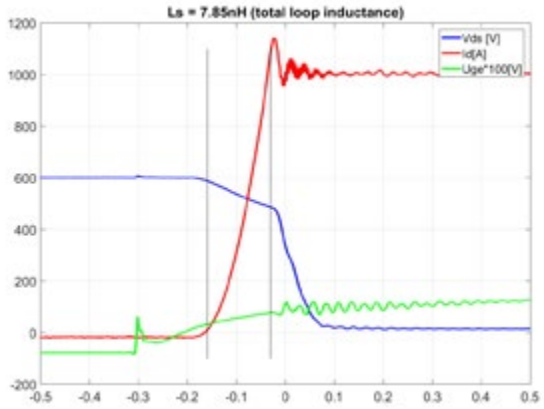


Fig 3: DCM™ 1000X turn-on transient, vertical black lines indicating integration limits. Test setup using a low inductance dc link capacitor rated 1000Vdc.

Following the component level test, the application kit based on DCM™1000 power modules rated for 600A was investigated in a back-to-back test bench. The target was to validate design calculations, to prove output current performance, and to investigate switching and conduction losses. The inverter (DUT) was feeding a three-phase ohmic-inductive load where a second unit, acting as rectifier, forces the energy back into the dc-link. Figure 4 shows the test setup utilized.

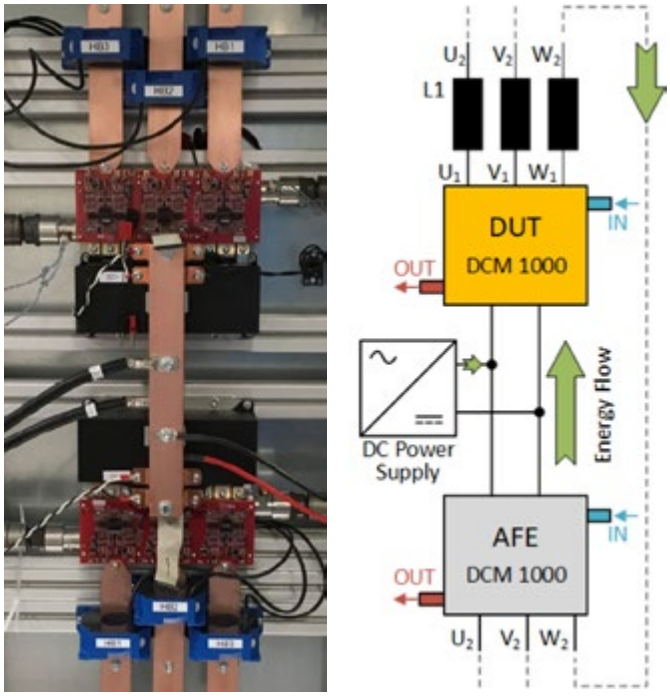
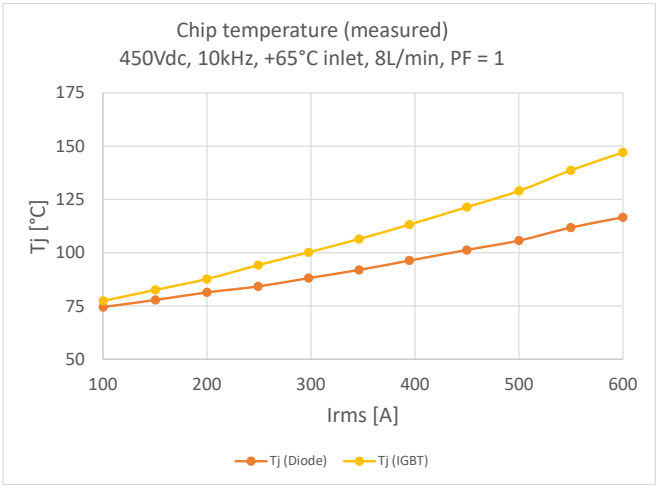


Figure 4: System level test setup.

The modules have been equipped with Pt1000 sensors mounted directly on the chip surface, allowing precise monitoring of IGBT temperature. The following electrical and thermal parameters have been used as boundaries: Vdc = 450V, fsw = 10kHz, PF = 1, m = 1, Tcoolant = 65°C, flow rate= 8 L/min.

Figure 5 shows the measured data (top) compared to simulation results (bottom). Inverter output power exceeded 200kW in this test without reaching critical temperatures in the power module. Up to 600A true RMS, the chip temperature stayed below 150°C and with a SOA limit of 175°C allows some additional margins that can be used for transient overload conditions.



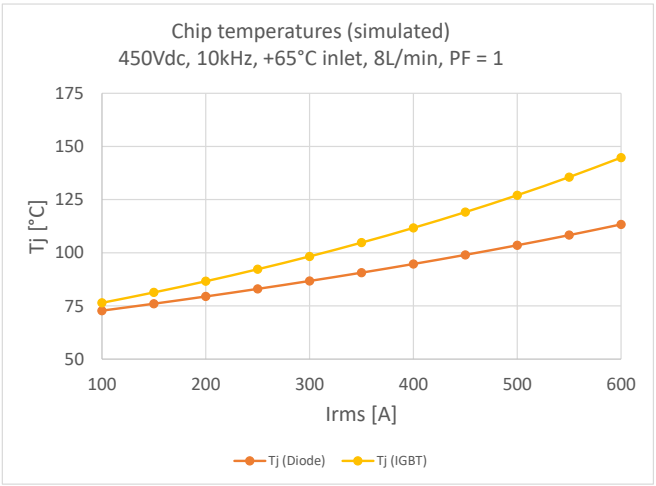


Figure 5 + 6: Chip temperatures for different operation points based on measurement (top) and simulation (bottom).

In addition, accuracy of junction temperature simulation was validated. Maximum deviations found were in the range of 4 Kelvin only, which is equal to around 5% relative error. See figure 7 and 8.

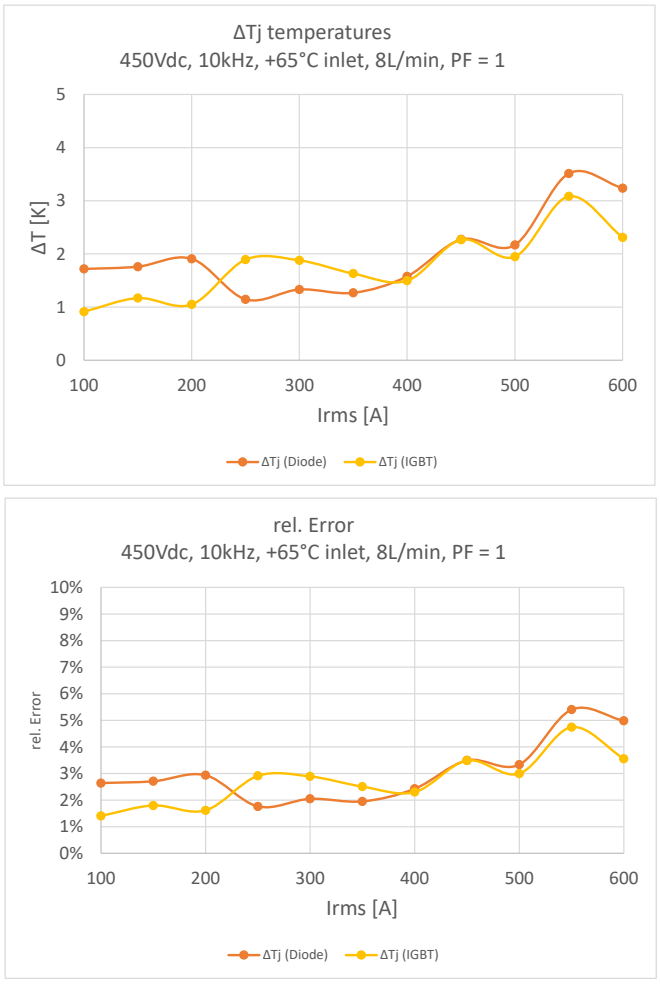


Figure 7 + 8: Comparing deviations between measured and simulated results.

Hardware tests have proven the targeted output performance is achieved, allowing automotive drivetrain applications to fully utilize the power semiconductors without derating. DBB® technology ensures that the power cycling will not be critical to the bonding and joining technology inside the module and that the thermal stack will remain intact over the full lifetime of a vehicle.

The power losses and efficiency of the module were addressed with a power meter and a calorimetric measurement system. Figures 9 and 10 show power and power loss curve as well as the inverter efficiency ranging from 98% to 98,5% depending on operation point.

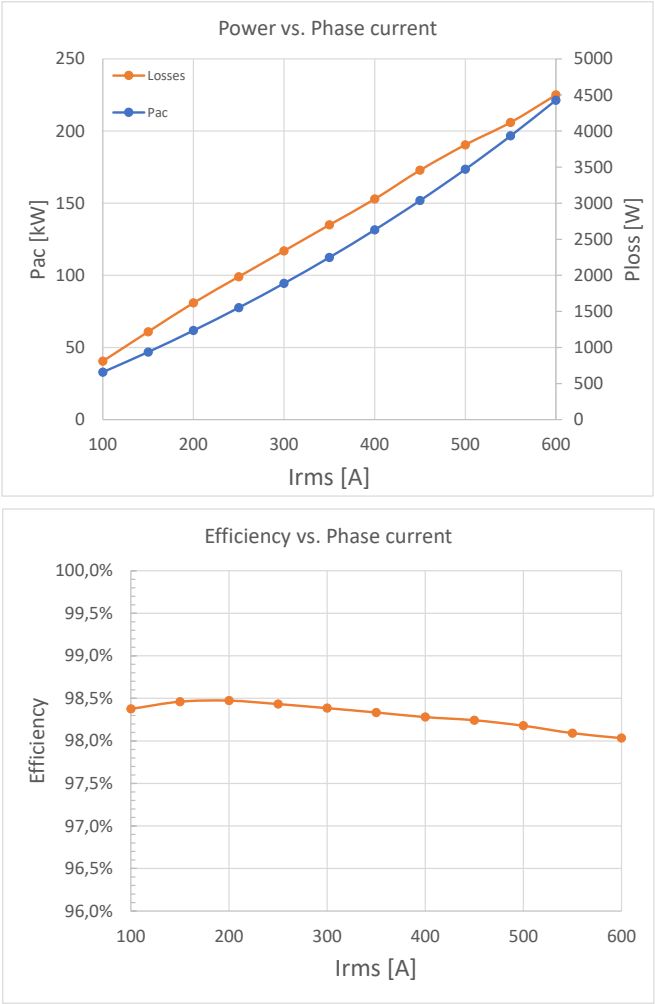


Figure 9 + 10: Measurement of power losses and efficiency.

Conclusion and Outlook

Danfoss' DCM™ is the next generation technology platform for automotive traction inverters. The DCM™ technology platform has been presented, and the performance of the modules mapped through experimental results. The DCM™ power modules, with the unmatched performance, ensure future high-performance traction applications can benefit from using this scalable power module platform, by offering full scale performance and latest Si and SiC semiconductor technology for the best fit to requirements and use.

Danfoss has also introduced an application kit, offering customers an easy path to start testing and verification of drive train designs utilizing the DCM™ technology platform. To ensure and further strengthen Danfoss' product offering and ensuring continues improvements, it is planned to push the technology boundaries of DCM™1000 to the limits for reaching 800Arms and beyond.

For more details send an email to dsp_info@danfoss.com

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Power Analysis: New Levels of Accuracy and Flexibility Meet the Challenges of Evolving Technology and Standards

In rapidly evolving industry sectors like renewable energy, electric vehicles and energy-efficient technologies, the need for reliability in testing to enhance safety, efficiency and performance has never been greater. Changing application needs and evolving industry standards call for custom measurements and consistent accuracy, meaning that engineers need a test and analysis platform that not only delivers reliable measurements today but is also ready for the challenges of tomorrow.

By Anoop Gangadharan, Yokogawa Europe

Automotive demands

In the automotive sector, meeting consumer demands for greater charging capacity, shorter charging times, and greater travelling range requires thorough positive and negative cycle evaluations of battery charge and discharge characteristics. Similarly, the evaluation of inverter signals needs to account for the harmonic superimpositions from switching circuits. Minimising the interference from this switching noise requires isolated inputs, high-speed sample rates, and long-time observation (Figure 1).

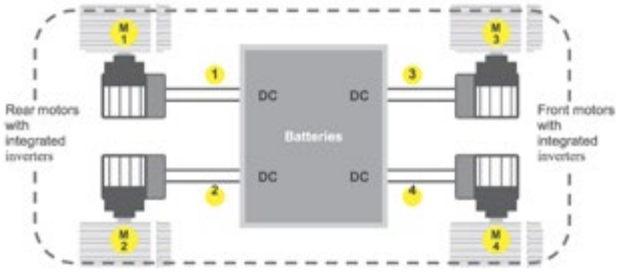

Figure 1: Measuring power-train efficiency in an electric vehicle, showing four DC measurements (1 to 4) with the corresponding mechanical power measurements (M1 to M4).

With the forthcoming advent of contactless charging, such evaluations will need to be done at lower power factors, while motor-drive technologies are using higher switching frequencies. Not every measurement solution in the market has the ability to guarantee high accuracies in such conditions.

Power networks

Similarly, in the area of power transmission and distribution, new developments such as renewable energy stations, energy-positive buildings and infrastructures mean that electricity no longer has a unidirectional flow from the power station to the consumer (Figure 2). With a multitude of renewable and non-renewable power stations feeding the grid, engineers in charge of ensuring a balanced grid need robust testing and accurate measurements to reduce the impact of noise, distortions and harmonics from multiple sources. Power generation stations and large consumers also need to evaluate the effects of their power outputs and usage levels on the grid and on other users.

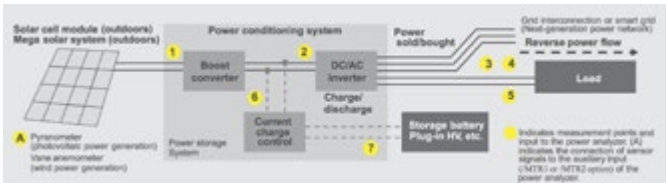

Figure 2: A precision power analyser helps engineers in renewable energy grids to improve conversion efficiency by offering precision insights in charging, discharging, storage and overall efficiency.

Reliability and versatility

These developments require a versatile test platform that not only delivers reliable measurements today but is also ready for the challenges of tomorrow. Hence power measurement solutions now need to achieve accuracies that stay relevant for years to come.

High-accuracy measuring instruments also need to include the ability to carry out high-frequency measurements. With mean voltages increasingly differing greatly from the fundamental voltage waveform, harmonic measurements are needed to establish the values of derived measurements such as active power. Similarly, addressing the challenges of measuring parameters such as energy efficiency, harmonic content and power factor will require both progressively greater accuracy and consistency in measurement over the specified ranges and conditions.

Again, the use of brushless DC motors and PWM (pulse-width-modulated) waveforms demands the simultaneous measurement of normal values with harmonics for overmodulation analysis of PWM waveforms and the high-speed measurement of power fluctuations.

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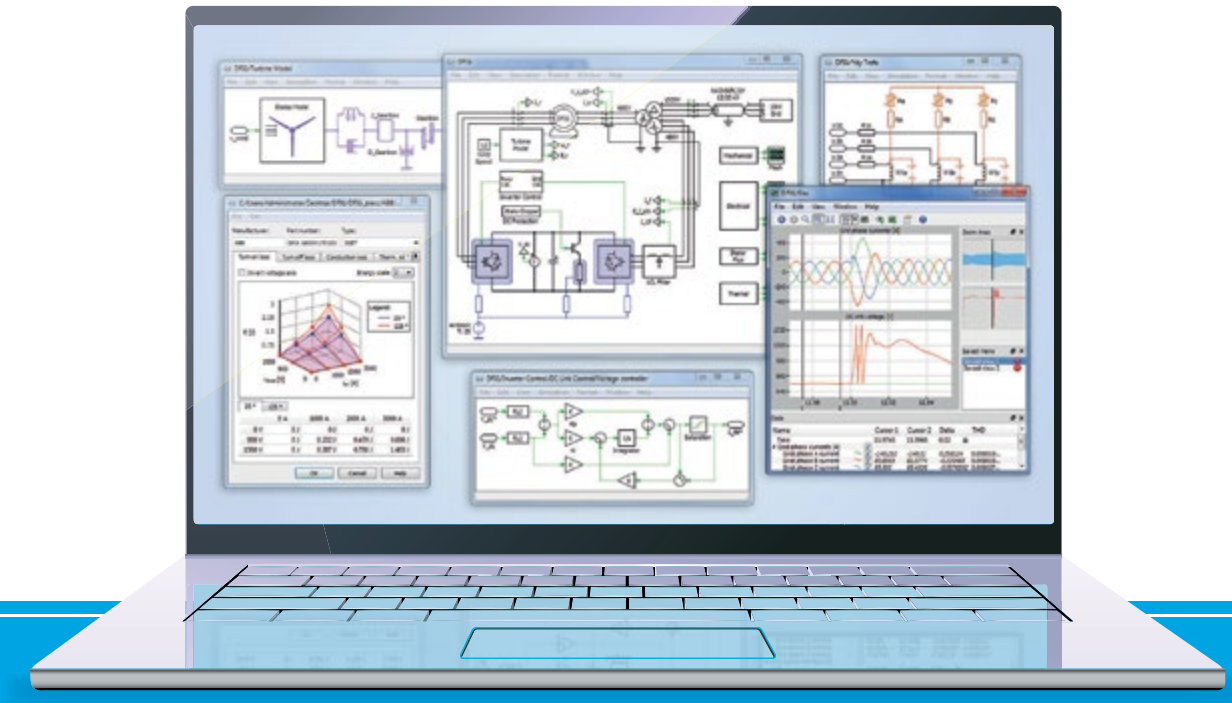

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Addressing the challenges

These challenges are now being addressed in the Yokogawa WT5000 (Figure 3): the first of a new generation of Precision Power Analysers that offers exceptional measurement accuracy of 0.03% combined with stability, noise immunity and plug-in modular flexibility.

Figure 3: The Yokogawa WT5000 combines measurement accuracy of 0.03% with moduar flexibility. Here, a WT5000 is configured for simultaneous synchronised measurements from four torque and rotation sensors to determine the overall efficiency of four motors.

Versatility is provided by seven built-in slots for user-swappable power input modules (Figure 4) and diverse mainframe options that enable users to expand or reconfigure the WT5000 as their applications and their requirements change. In addition to measurements on power parameters, the torque and speed from four separate motors can be measured.

Other key features include the ability to use 5 A or 30 A input modules in conjunction with the split-screen touch display to compare multichannel measurements; and custom measurements for added flexibility, with user-defined triggers and computations as well as functions like dual-motor evaluation. The WT5000 also performs harmonic measurements including comparisons of two simultaneous measurements up to the 500th order.

Simplicity of operation results from the full touchscreen interface, supported by hardware hotkeys and powerful software for remote measurements, interconnection and configuration.

Figure 4: The WT5000 has seven built-in slots for user-swappable power input modules and mainframe options that enable users to expand or reconfigure the WT5000 as their requirements change.

High-speed A/D convertor

The WT5000 achieves the world's highest measuring accuracy: ±0.03% of total at 50/60 Hz - by using an 18-bit analogue/digital converter with a sampling frequency of 10 MS/s. This makes it possible to accurately capture waveforms from the latest high-speed inverter devices.

Very high-speed power devices using semiconductor materials such as silicon carbide and gallium nitride are increasingly being used in the latest power-conversion products such as invertors and drives. As a result, common-mode voltage effects can create noise problems that can affect the performance of measurement systems. The design of the WT5000 minimises the effects of high-frequency common-mode voltage, resulting in an excellent CMRR (common-mode rejection ratio) characteristic.

The WT5000 incorporates internal memory of up to 32 Gbyte (/M1 option) for storing large quantities of measurement data in field applications. This is achieved without the need for any external storage media, while at the same time speeding up the measurement process.

The availability of up to seven input channels allows the instrument to support applications that previously could only have been measured by synchronising several separate instruments. As a result, it offers considerable savings in installation space, communications overheads and cost-effectiveness. Further space-saving benefits result from the use of the plug-in input modules.

The 30 A and 5 A modules, for example, can be switched for applications involving electric vehicles or fuel-cell vehicles, where developers are increasingly required to evaluate a number of different motors. Using the /MTR1 and /MTR2 options, it is possible to evaluate up to four motors simultaneously with one unit.

The dual harmonic measurement function makes it possible to measure the carrier frequency component from the rotational speed of the motor in an inverter drive while checking the influence of the carrier frequency on the motor drive.

High-current measurements

An increasing number of applications require the evaluation of larger-current devices, typical examples being electric vehicles and large-scale solar installations. Since an external current sensor input function is fitted as standard in both the 30 A and 5 A input modules of the WT5000, the instrument can measure up to 30 A or 5 A with direct input. For much higher currents dedicated high-current sensors are available.

Conclusion

With its unmatched 0.03% accuracy and modular architecture, the WT5000 helps engineers to innovate their power testing and analysis with precision, flexibility and confidence. Whether it is for the development of energy-efficient devices and appliances, plug-in hybrid/electric vehicles or renewable energy technologies, the WT5000 helps engineers to solve design challenges, improve productivity and ensure quality through reliable power measurements.

The accuracy and precision of the WT5000 is backed up by calibrations carried out at Yokogawa's European standards laboratory at its European headquarters in The Netherlands. This facility offers ISO17025 accredited power calibration, to national and international standards, at frequencies up to 100 kHz: a requirement for higher harmonic measurements specified in quality standards such as ISO9000.

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Tampering Protected Power Supply for E-Meters

Electricity Meters (E-Meters) use switch mode power supplies (SMPS) because of their high efficiency and good performance levels. And it's a matter of common knowledge that SMPS rely on magnetic devices for their operation. A very popular and cost-effective topology used in modern E-Meters is a flyback, with a transformer essential for transferring energy and providing isolation from the primary to the secondary side.

By Florian Mueller, Texas Instruments

Today's most opportune criminals are tampering with E-meters by using strong external magnetic fields to interrupt the operation of this power supply, illegally lowering their own electric bill. A common practice is to order a strong magnet – available from many online shops – which can be placed next to or on top of the transformer of the E-Meter power supply.

This magnet interrupts the entire operation and in some cases, can even destroy the power supply, rendering the unit inoperative. This happens when a strong external magnetic field causes the transformer core material to turn in similar directions, meaning the material saturates when it reaches its maximum flux density B.

Once saturated, the magnetic field strength is not directly proportional to the current flowing through the primary winding anymore. Therefore, the core loses its magnetic characteristics, the primary inductance drops and the current increases, which can lead to a catastrophic failure. This article presents some methods to make an offline flyback more robust in order to protect against a criminal employing an external magnetic field.

Principle of operation of a valley switching flyback

Gone are the days when flyback controllers used a constant frequency. Typically, modern versions use a valley switching or quasi-resonant modulating technique to improve efficiency. This article will only consider a valley switching controller, where the switching frequency varies so the actual switching event happens on a valley of the switchnode resonant ringing.

This particular controller modulates the switching frequency while simultaneously maintaining the primary peak current constant over most of the operating range. As the output load increases, the switching frequency increases, reaching a maximum switching frequency clamp (typical value = 100kHz-130kHz), which limits the maximum achievable output power.

The role of the primary Inductance

Generally, the primary inductance (and turns ratio) of a flyback transformer will determine if the controller works in transition mode, deep in discontinuous mode, or in continuous conduction mode for full load.

The primary inductance between the primary and the secondary windings defines the operating frequency if a valley switching technique is used. An incorrectly calculated primary inductance can decrease efficiency or even make it impossible to deliver the full output power. The primary inductance, therefore, must be chosen with extreme care.

The challenge for creating a tamper-proof power supply is that the effective primary inductance decreases under the presence of a strong external magnetic field. And what does that mean for the operation point? If the controller is using a voltage mode technique, then a reduction of the effective primary inductance would suddenly lead to a high primary peak current, which forces the transformer deeper into saturation and can destroy the power supply. To combat this, a current mode controller (instead of a voltage mode controller) should be used, because it limits the primary peak current each switching cycle.

Normally, even under an external magnetic field, a current mode controller can keep the maximum primary peak current under control. If an external magnetic field is present, this controller will compensate for the lower primary inductance by increasing the actual switching frequency.

So it's recommended to structure the primary inductance so the switching frequency is way below the maximum switching frequency clamp of the controller. This means it's also recommended to choose a higher primary inductance, which will allow the controller to increase the switching frequency (during an external magnetic field attack), ensuring maximum power delivery.

Another advantage of a higher primary inductance is that if the external magnetic field ends up reducing the effective primary inductance, the 'on-time' will not fall below the minimum on-time of the controller, which could cause stability issues. Figures 1 & 2 below show the switch node with and without the presence of an external magnetic field.

Prevent fast saturation

Equipping the transformer with a high number of primary turns reduces the magnetic flux ϕ. The reason for this is that a core with a higher magnetic reluctance Rm (due to larger air gap) must be used to maintain the same primary inductance. The flux density is, simply, the magnetic flux ϕ divided by the effective core area Ae. Therefore, a high number of primary turns (limiting flux ϕ) combined with a large effective core area Ae, ultimately reduces the flux density in the core. The inevitable tradeoffs, however, are a higher core and winding losses.

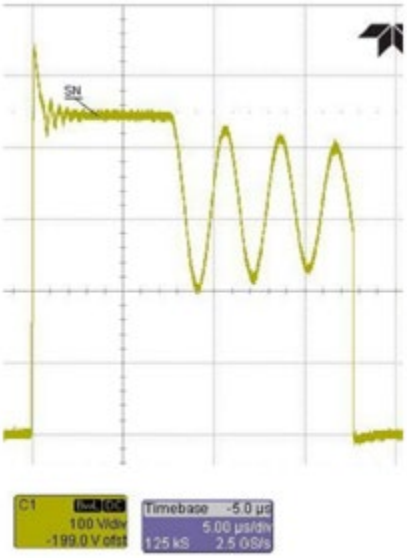
Probably the most effective way to prevent saturation is to use a core with soft saturation characteristics and a high saturation flux density, such as an iron powder core. This material will not saturate as abruptly as ferrit does. There are iron powder flyback cores available

that can withstand a flux density of more than 1.5Tesla, which is a great choice for preventing saturation but, unfortunately, it comes at the expense of poor efficiency due to high core losses.

Orientation of the transformer

Besides the core material, the orientation of the transformer plays a critical role, as the transformer core provides an ideal path for the external magnetic field. The core greatly 'amplifies' the external field, and if the magnetic field lines of the external magnet have the same direction as the transformer flux density, the field inside the core can be very high. For this reason, a horizontal mounted transformer would be preferable to a vertical mounted one.

Figure 1: SN 0mT:

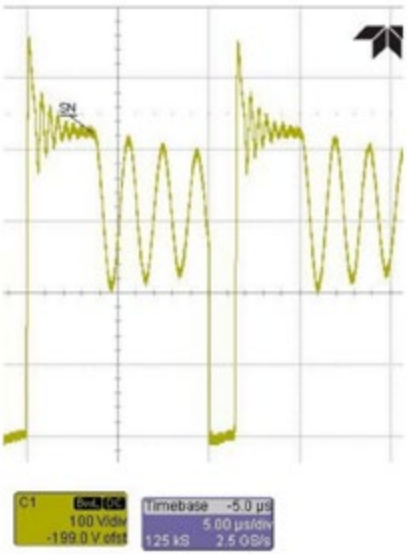


Reference Designs

A few tampering protected designs are available at www.TI.com. For example, the reference design PMP30276 uses an iron powder core that can handle a strong external magnetic field, at the drawback of lower efficiency. The PMP30345 uses a Sendust core, which can also withstand a strong external magnetic field, but isn't as robust as an iron powder core. Using a Sendust core is a good compromise between efficiency and tampering immunity and the PMP30435 uses the UCC28740 valley switching flyback controller from Texas Instruments. The optimized circuit and transformer make the design robust against an external magnetic field up to 200mT.

The test report below shows the measurement results with and without the presence of an external magnetic field. A magnet (Neodym, N35, Br=1.21T, 50mm x 12.5mm x 50mm) was placed on top of the transformer in order to generate a 200mT Field. The distance D between transformer and magnet was 5mm.

Figure 2: SN 200mT:



The figures show the behavior of the power supply when an external magnetic field is present. There are always two measurements, one with and one without a magnet placed on the top of the transformer.

Figure 1 shows the Switchnode Voltage VSW (Drain-Source Voltage of primary MOSFET) without, and Figure 2 with an external 200mT field at full output power.

It's evident the controller is operating with a switching frequency of 55kHz. When the external magnetic field is present, the controller increases the switching frequency to 85kHz. The maximum switching frequency of the UCC28740 controller is 100kHz. As mentioned earlier, the higher the switching frequency, the higher is the output power, which means there's still some margin to deliver the maximum output power.

Figures 3 & 4 show the dynamic load regulation for a loadstep from 40% to 100% of the maximum output current.

Without an external magnetic field, the output voltage derivation is about 110mV. If a 200mT field is applied, the load step gets worse and the voltage derivation increases to about 220mV. This means the magnetic field reduces the bandwidth of the system.

A good sign is that the voltage of both measurements shows a damped ringing, an indicator of an adequate phase margin. This can be verified with the test report of the PMP30435 (available at www.ti.com) because it includes the measurement of the total open loop (small signal analyses). The bandwidth without an external magnetic field is 2kHz and the phase margin is 63°. If the magnet is placed on top of the transformer, the bandwidth reduces to 0.5kHz but with a sufficient phase margin of 70°. This means the system remains stable even under the 200mT external magnetic field.

Figure 3: loadstep 0.4Ato1.0A 0mT:

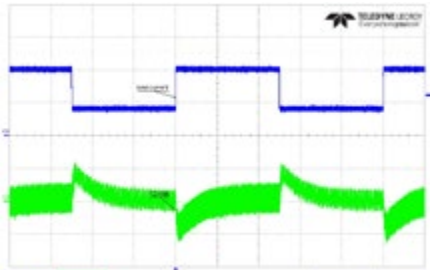
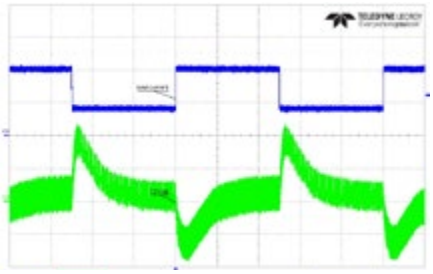


Figure 4: loadstep 0.4Ato1.0A 200mT



Conclusion

If a tampering protected power supply is needed, then a current mode controller and a transformer with a high saturation flux density (e. g. iron powder) is recommended. A high number of primary turns, a core with a large effective core area, and a horizontal mounted transformer will reduce the maximum flux density inside the core. The primary inductance should be specified carefully in order to achieve a stable system, even under the presence of a strong external magnetic field.

About the author

Florian Mueller was born in Rosenheim, Germany, in 1976. He received a degree in electrical engineering from the University of Haag. After working for several years as freelancer in the field of electrical engineering, he joined TI in 2008 and is working in the European Power Design Services Group, based in Freising, Germany. His design activity includes isolated and non-isolated DC/DC and AC/DC converters for all application segments.

www.ti.com

Too Fast to Handle for You? New Generation of Fast 650 V IGBT

Power semiconductors are getting thinner, smaller and faster. And the challenges for manufacturers that employ the latest chip technology in their power modules are getting bigger.

A sure-fire way to decrease losses and increase power density is to improve switching behavior. From the perspective of a device designer seeking to boost a power-converting system's energy efficiency, this is certainly the best choice of parameters. The power module manufacturer will have to incorporate state-of-the-art IGBT technology into the product to afford designers the option of tweaking these parameters.

By Daniel Hofmann, Field Application Engineer, Vincotech GmbH

The IGBT powered by Infineon TRENCHSTOP™5 H5 is designed for a 15-to-80 kHz carrier switching frequency range with a maximum blocking voltage of 650 V. Available in discrete housings such as the TO-247, it is designed for systems with a stray inductance of 30 to 50 nH for the PCB tracks. [1].

Vincotech is a manufacturer that uses these very fast devices, rather than discrete packages, in power modules. The flow family of modules can handle IGBT's performance. The company builds power modules with low internal stray inductance that can accommodate many different types of fast-switching power semiconductors, including this 650 V chip.

Housing

The *flow* family's special housing technology has enabled Vincotech to rise to the challenge of incorporating the latest chip technology in a power module with features that include

- No baseplate
- Low internal stray inductance
- Freely positioned auxiliary pins (solder, press-fit)
- DC capacitors built into the module

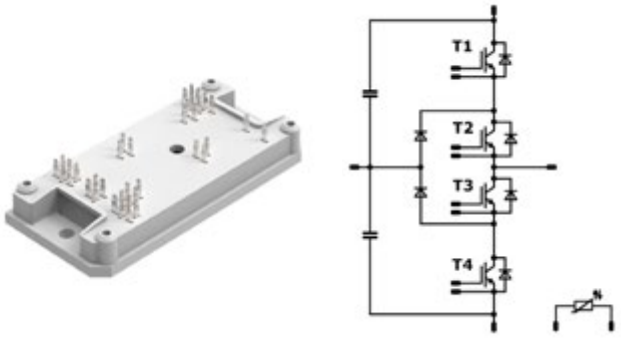


Figure 1: flowNPC 1 with integrated DC capacitors, 650 V very fast IGBT, fast diodes and a temperature sensor [2]

The *flow* 1 housing pictured in figure 1 features very fast dies in a neutral point clamped (NPC) inverter topology. Also known as I-type topology, it is deployed in three-level converters designed mainly for solar and UPS applications. The combination of fast switching IGBTs, fast diodes and integrated DC capacitors ensures highest efficiency and fast switching capability in a compact power module (item code 10-FY07NPA200SM02-L366F08).

Measurements: Impact of DC caps

The nature of an IGBT's design makes it all but impossible for the gate-resistor Rg to control turn-off behavior. The corresponding collector-emitter voltage peak (V_{cep}) during turn-off depends on the turn-off speed of the current and on the stray inductance L between the capacitors and the semiconductor at a given collector-emitter voltage Vce. The equation

describes the voltage overshoot ΔV_{cep} at turn-off, a relationship that is very well known. This equation tells us that decreasing the stray inductance or the turn-off rate will reduce the voltage overshoot across the IGBT.

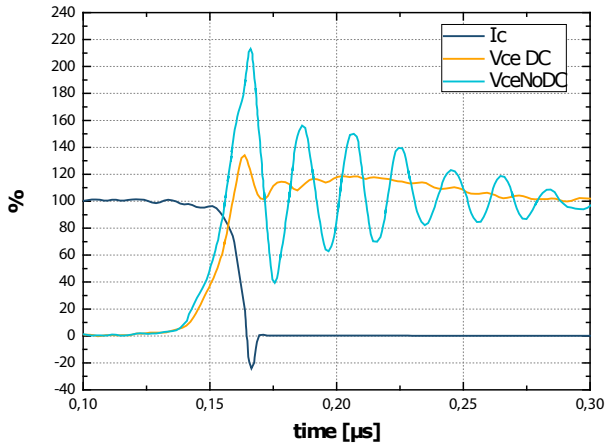


Figure 2: Two power modules' turn-off waveform at the given current Ic with an integrated DC capacitor (orange) and without (blue)

The following Figure 2 shows the integrated DC capacitors' impact on the collector-emitter peak voltage in a power module. The measurements with an integrated DC capacitor (orange) and without it (blue) were taken under the same testing conditions. The chart clearly indicates that without an integrated DC capacitor, the collector-emitter voltage V_{ce} oscillates after a turn-off voltage peak of around 218% of the applied DC link voltage of 350 V from neutral point to DC. The integrated DC capacitor not only reduces the V_{cep} to 137% of the DC link voltage; it also suppresses oscillation.

Placing a DC capacitor as close to the IGBT as possible is definitely the smart move for very fast switching power semiconductors.

Measurements: Characterizing switching behavior

Dynamic characteristics need to be analyzed regardless of the low inductive package's design. The slopes of the collector-emitter voltage Vce and the nominal current Ic during turn-on and turn-off have to be handled, particularly when using a fast IGBT. This is why the measurements focus on these switching slopes, respectively dV/dt and dI/dt of the T3 (figure 1). Slowing down power semiconductor's switching speed decreases the switching slopes, thereby increasing power loss.

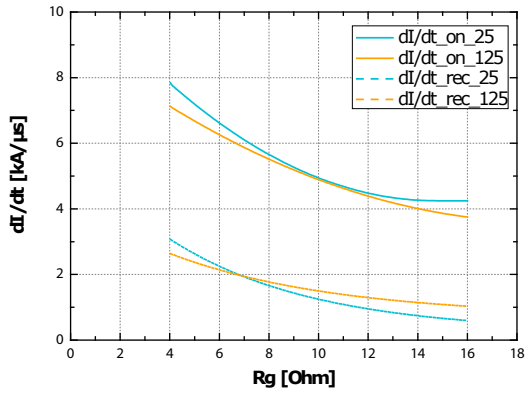


Figure 3: Turn-on dI/dt at 25°C (blue) and 125°C (orange). Reverse recovery dI/dt at 25°C (black) and 125°C (orange)

Figure 3 shows the turn-on current slope dI/dt_on (solid lines) and the reverse recovery dI/dt_rec (dashed lines) behavior in accordance with the gate resistance R_g at room temperature (blue) and 125°C (orange).

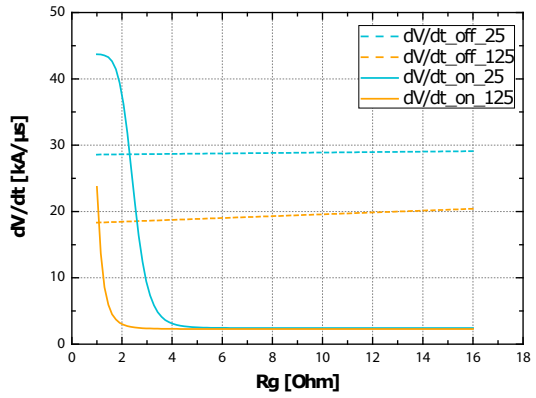


Figure 4: Turn-on (solid lines) and turn-off (dashes) dV/dt at 25°C (blue) and 125°C (orange)

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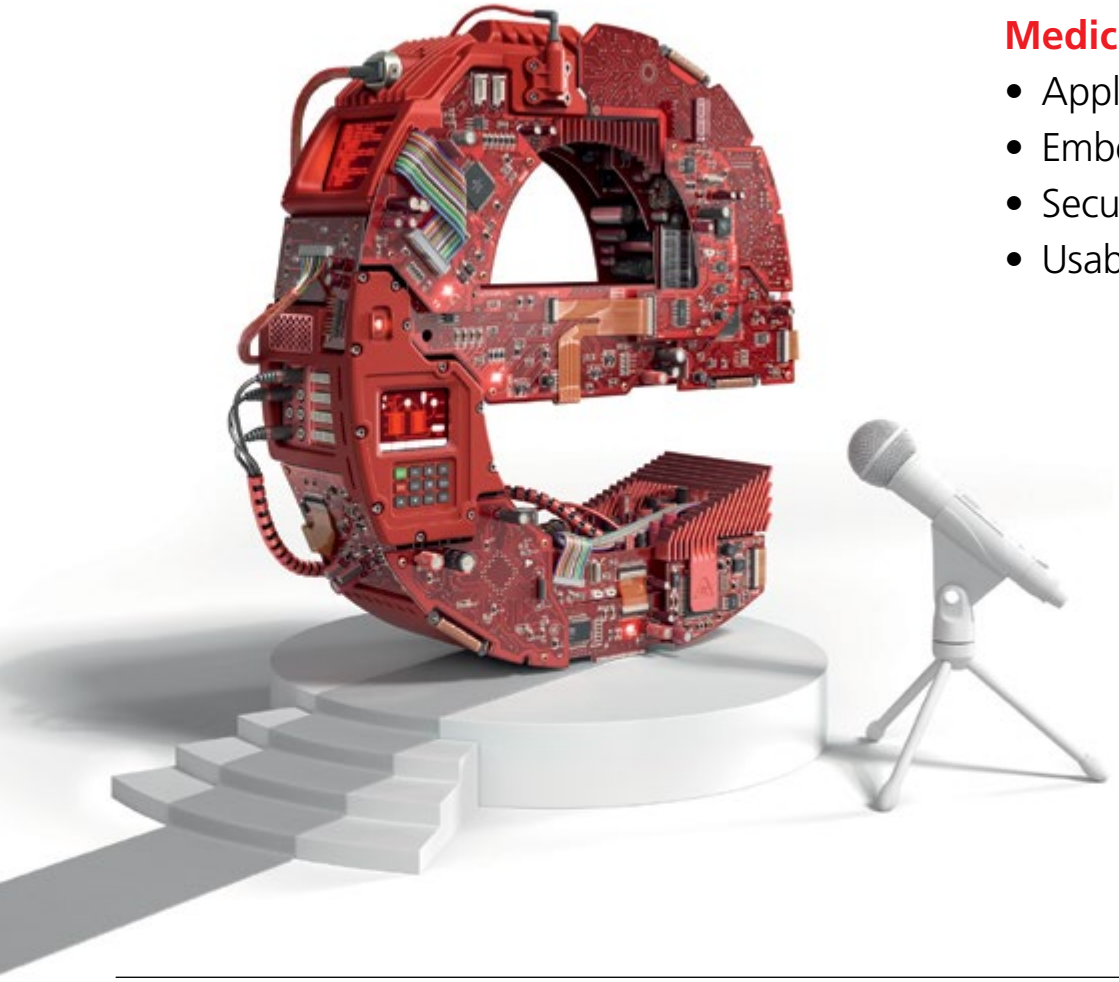

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Values below 4 Ω are not shown because of measurement noise.

The turn-on speed at 25°C drops from 4 Ω onwards down to around 45% of the peak value at 16 Ω. Temperature has a slight but discernible impact on the turn-on current slope, as the dI/dt_on values at 125°C attest: They remain below values measured at 25°C. The turn-on speed's reduction from the peak to the lowest value at 125°C amounts to around 47%.

Figure 3 also shows the reverse recovery current slope dI/dt_rec; that is, the curve's post-peak current trajectory. Temperature has very little impact; the curves are very similar and practically identical at around 7 Ω.

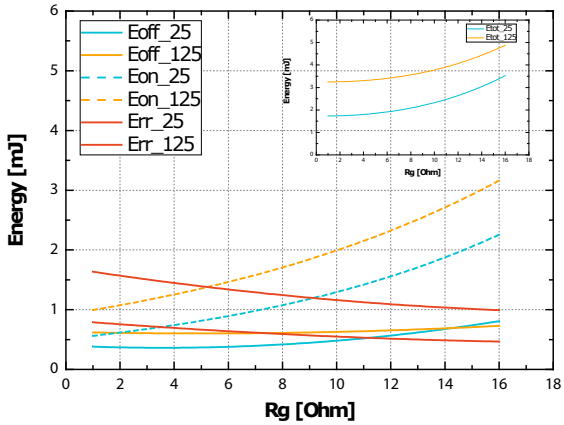


Figure 5: Switching energies of T13 in relation to R_g at 25°C and 125°C. This graph shows E_{off} (solid lines), E_{on} and E_{rr} (dashes lines). The inset graph shows the total energy at 25°C (blue) and 125°C (orange)

Figure 4 shows collector-emitter voltage switching slopes in relation to Rg. The turn-off voltage slope remains fairly constant above 4 Ω, which confirms that the physics of semiconductors are such that turn-off behavior can hardly be controlled by Rg. The turn-off dV/dt is quite stable throughout gate resistance range; the only discernible impact is to be seen at turn-on. At low Rg, dV/dt_on is high. A higher resistance value can bring it down. The turn-on behaviors at 25°C and 125°C (solid lines) are similar. The only difference would appear to be the turn-on dV/dt reduction that subsequently occurs at 25°C.

Figure 5 depicts turn-on and turn-off switching energies. The solid lines represent measurements of turn-off energy E_{off}; the dashes show the data for turn-on and reverse recovery energy (E_{on} and E_{rr}) at room temperature and 125°C. These readings were taken to investigate to what extent E_{on}, E_{off} and E_{rr} depend on R_g. E_{on}, E_{off} and E_{rr} similar tendencies at both temperatures. E_{on} increases with increasing gate resistance because the IGBT slows down and device loss increase. Consequently, reverse recovery energy decreases slightly because of a lower reverse recovery peak, which is in accordance with the dI/dt_rec behavior to be seen in figure 3. In terms of the dI/dt steepness and given the total energy Etot at 25°C (blue) and at 125°C (orange) as shown in figure 5's inset graph, a gate resistor with more than 4 Ω would appear to be a reasonable proposition. However, this would require a tradeoff between the current slopes and total energy losses because of the loss that increase with increasing gate resistance. As we have seen in figure 4, the gate resistance has hardly any impact on the turn-off dV/dt or on E_{off}.

Conclusion

IGBTs are getting faster, which complicates their installation in power modules. Integrated DC capacitors can be very beneficial to this end as they prevent turn-off voltage overshoots. We measured a reduction from 218% to 137%.

Furthermore, designers also have to strike the right balance between switching speed, switching loss and dV/dt-controlled electromagnetic compatibility for the power-converting system. Our measurements tell us that they need to choose the right gate resistor to this end. In this case, a resistance value greater than 4 ohms would appear to be the best choice for a tradeoff between total energy loss and switching slopes. However, every system and application is different and the right R_g value for each has to be determined with the proper measurements.

References

[1] Infineon, Application Note AN2015-15 Rev. 1.0, TRENCHSTOP™5 S5 Infineon's low Vce(sat) high-speed soft-switching IGBT

[2] Datasheet of 10-FY07NPA200SM02-L366F08, www.vincotech.com

Achieving Increased Solder Joint Reliability and Low-Voiding in High Power Applications

Solder joints in higher power applications are being challenged like never before. In addition to providing mechanical and electrical interconnections between components and boards, solder joints must also dissipate significant amounts of heat (Figure 1).

By Tim Jensen, Sunny Neoh, Adam Murling, and Seth Homer, Indium Corporation

At a relatively low-melting point, solder can bond two surfaces that have a much higher melting point, such as copper. In addition, the bond has very high electrical conductivity and thermal conductivity. Relative to thermal conductivity, SAC solder is about 35W/mK. In comparison, thermal greases are often in the 1–5W/mK range. Therefore, the solder is much more capable of dissipating the heat generated by the power device. Contact area is another factor in which solder performs well. The contact area is ideal when forming an intermetallic bond at the interfaces.

$$\frac{Q}{t} = \frac{kA(T_h - T_c)}{d}$$

Q/t = rate of heat flow
k = thermal conductivity
A = contact area
d = bondline distance
T = temperature

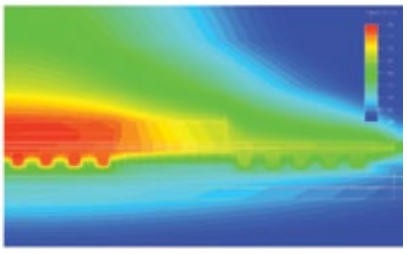


Figure 1: Factors influencing heat flow.

So what is the problem?

The areas that can potentially hinder the thermal performance of a solder joint are bondline distance and voiding within the solder joint itself. Because the soldering process involves the metal becoming molten, the component will float on the molten solder due to the surface tension. Unfortunately, when a component floats on molten metal, the component may not remain parallel upon solidification. This lack of parallelism can result in hot spots. Additionally, this lack of control can mean variability in thermal performance from device to device.

The other area that negatively impacts thermal performance is voiding within the solder joint. Even though the solder itself transfers heat very well, large voids will act as an insulator and significantly slow that thermal transfer.

The Solution

To address the challenges facing solder joints in high power applications, a reinforced solder preform was developed (Figure 2). This technology takes a solder preform and embeds a high-melting point metal standoff into it. The solder can be virtually any alloy currently used in electronics. SAC305 is very common. The standoff is a precise thickness which is based on the final solder joint bondline that is being targeted. These preforms can be flux-coated, if needed for the application.

During reflow, the solder will melt and form the intermetallic bond with the component and board. The component will collapse during reflow. Since the standoff material can be made of a metal that has a much higher melting point than the solder, it does not melt. Therefore, the collapse of the component will be limited to the thickness of that standoff. Because this is manufactured to a precise thickness and is uniform across the entire solder area, the final bondline will be consistent.

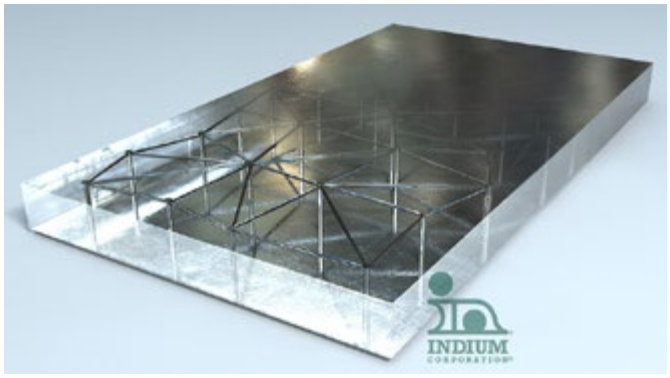


Figure 2: InFORMS® are a reinforced matrix solder preform.

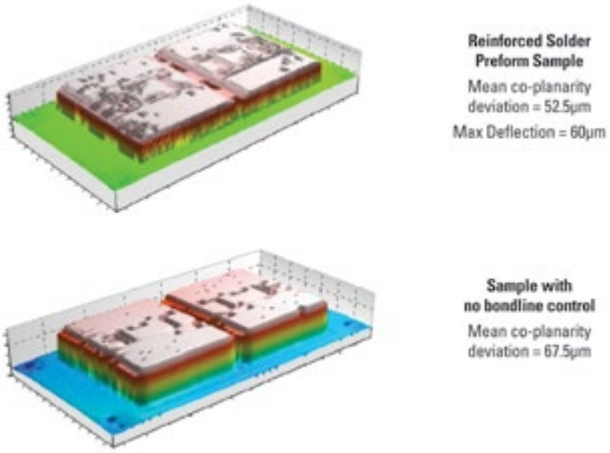
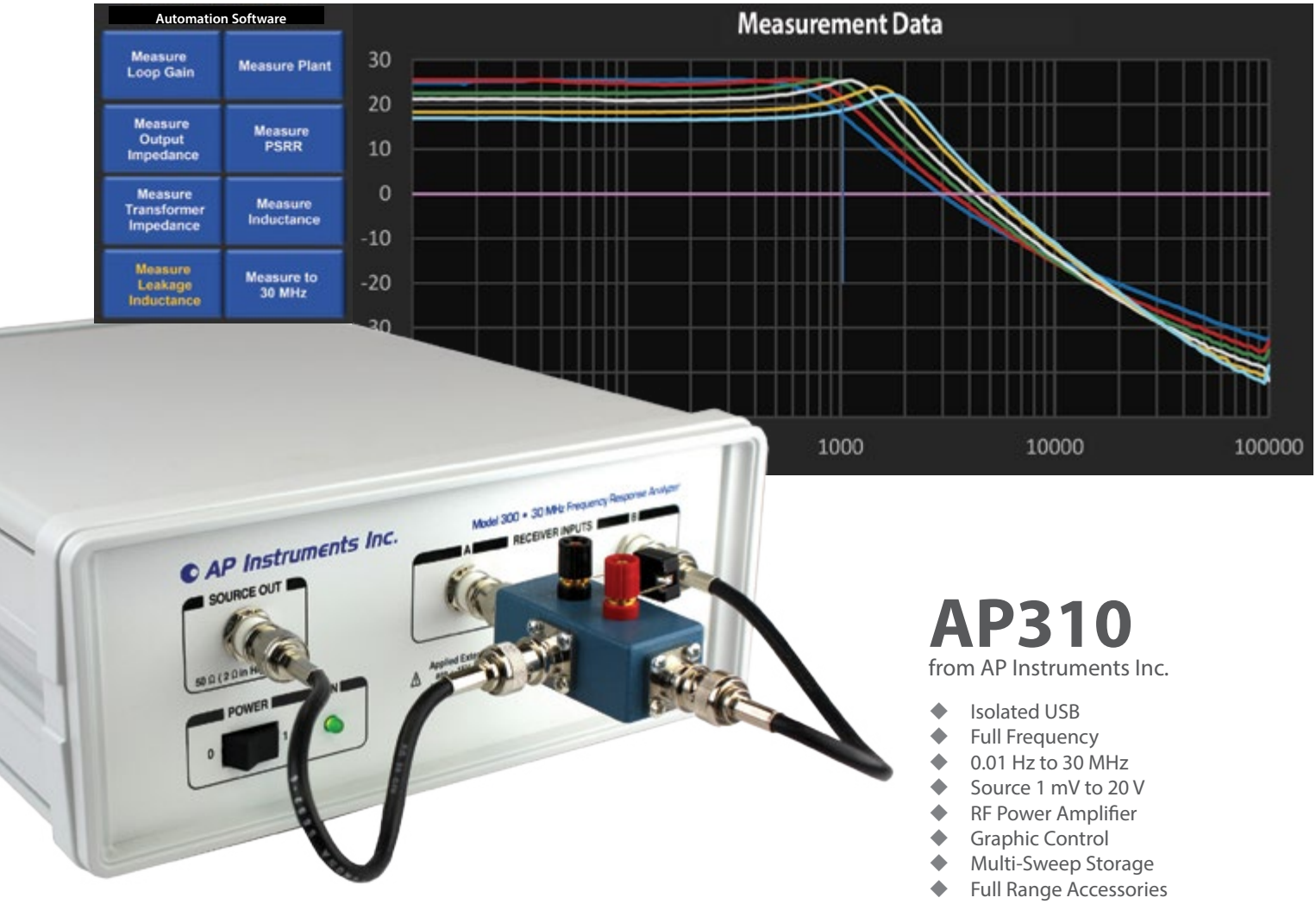


Figure 3: Reinforced solder preform results in solder joints that have a much more consistent bondline.



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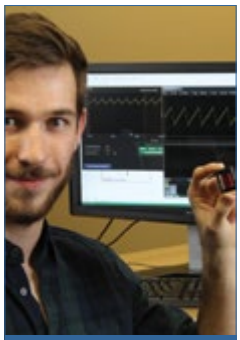
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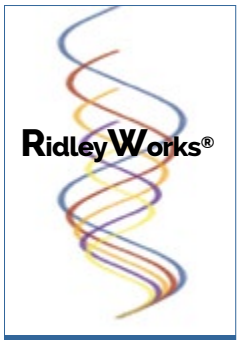

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Proven Bondline Consistency

In work done by Booth, et al. [1], a reinforced solder preform was used in an IGBT assembly to bond the DBC to the baseplate. In this study, a 95Sn/5Sb preform was embedded with a standoff having a thickness of 0.008". The assembly process, like most IGBTs, was done in a fluxless, vacuum reflow process. After reflow, they looked at overall device planarity, as well as thermal cycling reliability.

Figure 3 shows laser profilometers of an IGBT assembled with a reinforced solder preform next to one assembled with just a standard solder preform. When assembled using the preform with the built-in standoff, the overall co-planarity was better with a mean deviation of 52.5 micron versus 67.5 microns with a standard preform. The maximum deflection for the reinforced solder preform was 60 microns, while the standard preform had a maximum deflection of 90 microns.

Clearly the Booth, et al. work shows that the reinforced solder preform results in solder joints that have a much more consistent bondline. Additionally, they ran thermal cycling from -50 to +150°C with one-hour dwells. The C-SAM images shown in Figure 5 compare a standard solder after 600 cycles to a reinforced solder preform after 800 cycles. The standard solder is showing delamination, which is believed to be a result of an inconsistent bondline thickness. Even after 200 additional cycles, the reinforced solder joint shows no delamination. This provides sufficient evidence that the bondline consistency has an impact on overall solder joint reliability.

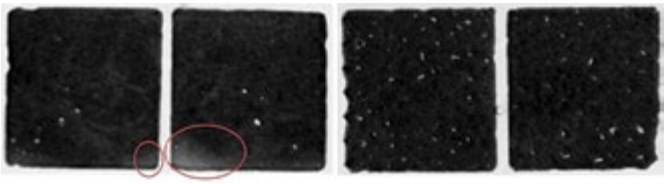

Figure 4: The image on the left is a standard preform showing solder joint delamination after 600 cycles. The image on the right is a solder joint formed with a reinforced solder that shows no delamination after 800 cycles.

New Proof of Low-Voiding

The earlier work done shows that reinforcing the solder preform will result in solder joints with a more consistent and reliable bondline. However, voiding is another important factor when soldering. With so many possible variables when designing reinforced preforms, it was previously unclear how these variables would impact voiding. Therefore, a test coupon and DOE were developed to evaluate these variables.

- The substrates tested were 0.354" x 1.26" and plated with immersion Sn.
- Sandwiched between these substrates was a SAC305 reinforced preform.
- Five grams of pressure were applied to the coupons to force collapse of the solder during reflow.
- The reflow profile was linear at about 1°C/sec with a peak temperature of around 245°C using an air reflow process.
- This experiment looked at 0.010", 0.012", and 0.016" total preform thicknesses.
- Two flux percentages of 1% and 2% were examined.
- For each leg, 25 coupons were reflowed.

When analyzing the voiding data from the DOE, there were some clearly identifiable differences among the reinforced solder preform designs. The summary of the data is shown in Figure 5. For the standoff type, the first two characters (LM or SM) refer to the amount of spacing. The LM is much less densely packed with standoff metal. The SM has about 3x the packing density, which means much more standoff metal was embedded into the preform of equal size.

The second two characters refer to the amount of standoff (04 is 0.004" and 08 is 0.008"). All designs exhibited an average void percentage of less than 10%. Five of the designs did not have any data points over the 10% mark. Further analysis was done to determine the significance of specific attributes. In this statistical analysis if the P value is less than 0.05, the mean of at least one of the factors is statistically different.

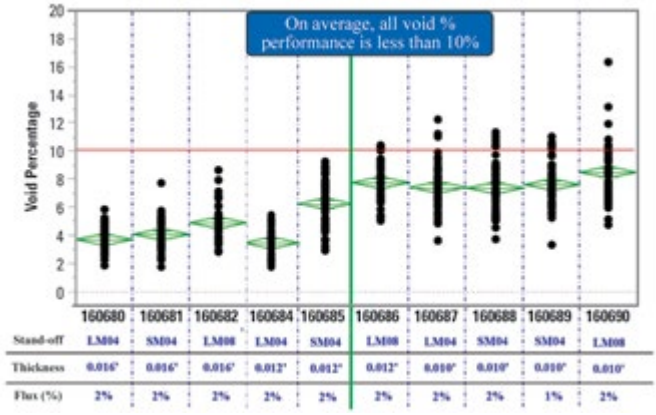

Figure 5: Summary of voiding results.

Preform Thickness

LM04, LM08, and SM04 data sets were analyzed separately for the impact of overall preform thickness. In every case, a higher overall preform thickness resulted in less voiding. Voids escape out of molten solder due to the surface tension by forcing them to the perimeter. Unmelted metal in the molten solder could impede the pathway for these voids to escape. By having more solder available, the voids can possibly escape around the metal matrix prior to complete collapse of the solder joint.

Packing Density

When exploring the packing density of the standoff material, the void differences between SM and LM were examined individually for each overall preform thickness. The results here are not as clear. For the 0.016"- and 0.010"-thick preforms, the packing density did not significantly impact the void performance. For the 0.012" thickness, the SM product was statistically better than LM. Based on these results, it cannot be conclusively stated that packing density does or does not influence voiding. The data suggests that at most this factor would only be a very minor contributor to voiding.

Standoff Thickness

In this case, LM04 was compared to LM08 for each of the preform thicknesses. For every preform thickness, the higher standoff (08) always resulted in statistically significant higher voiding. This also can be explained relative to the solid standoff material impeding the escape of the voids. Because the 08 material is thicker, there would be more overall volume of standoff metal embedded into the preform versus the 04 material. More solid material has the potential to impede the ability of the void to escape the molten solder.

Flux Percentage

Based on the chemistry of oxide removal and volatilization, it is expected that more flux will result in more voiding. Basically, as the product is going through reflow, the flux is removing oxides on the metal surfaces. That oxide removal process creates some vapor.

Additionally, there are non-active ingredients in the flux that will also volatilize at elevated temperatures. Both of these attributes of fluxes could result in vapor getting entrapped in the molten solder. However, the work in this study did not show any significant difference between 1% and 2% flux. It can only be speculated that, perhaps the 1% difference in flux was not enough to impact the voiding. This is an area where further work could be done.

Conclusion

It is known from previous works that reinforced solder preforms can help to improve the reliability of solder joints by providing a consistent solder joint bondline. The new data obtained from the more recent study shows that the final thickness of the preform, the packing density of the standoff material, and the thickness of the standoff all can be adjusted to impact the amount of voiding in the solder joint. Through an optimized design of the reinforced preform, it is clear that this technology can produce high-reliability, low-voiding solder joints without incurring additional process steps such as wire bond stitching to control the collapse of the solder.

References

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This data was first presented at SMTA Pan Pacific Microelectronics Symposium, February 6-9, 2017, Kauai, Hawaii, USA.

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Smart Transformer

The Smart Transformer represents a central control point in the distribution grid: the high controllability that it introduces can defer the grid infrastructure upgrades and at the same time offer ancillary services.

By Prof. Marco Liserre, Dr. Rongwu Zhu, Dr. Giovanni De Carne, Chair of Power Electronics Christian-Albrechts-University of Kiel; Anthony Donoghue, Scottish Power Energy Networks, UK; Ali Kazerooni, WSP, UK

Smart Transformer definition

Distributed generators (DGs) and EV charging stations are steadily increasing their presence in the distribution grid. It has been proven that it can be more efficient to supply DGs such as PV panels, fuel cells and micro-wind turbines, and DC loads, such as EV with DC network hence, this may attract the attention towards hybrid AC/DC distribution grids. However, the conventional distribution grid experiences a series of challenges in terms of voltage limit violations (upper and lower ones) and overload of network assets (e.g., circuits and transformers). In order to alleviate these issues, distribution system operators conventionally reinforce the grid by increasing the ratings of existing components, like larger size cables or larger capacity transformers. However, these upgrades are costly, time consuming and may lead to disruption of customers.

Currently, there is no a comprehensive solution to the grid needs. Due to wide distributed power converters, the research trends in smart grid are towards an decentralized scenario, which leads to many solutions for the system control, as shown in Figure 1(a), such as STACOM, storage, DC distribution converter, inter-area connection converter and DGs injecting reactive power. However, coordinating all these smart solutions can be challenging, with the need of an extensive fast communication infrastructure.

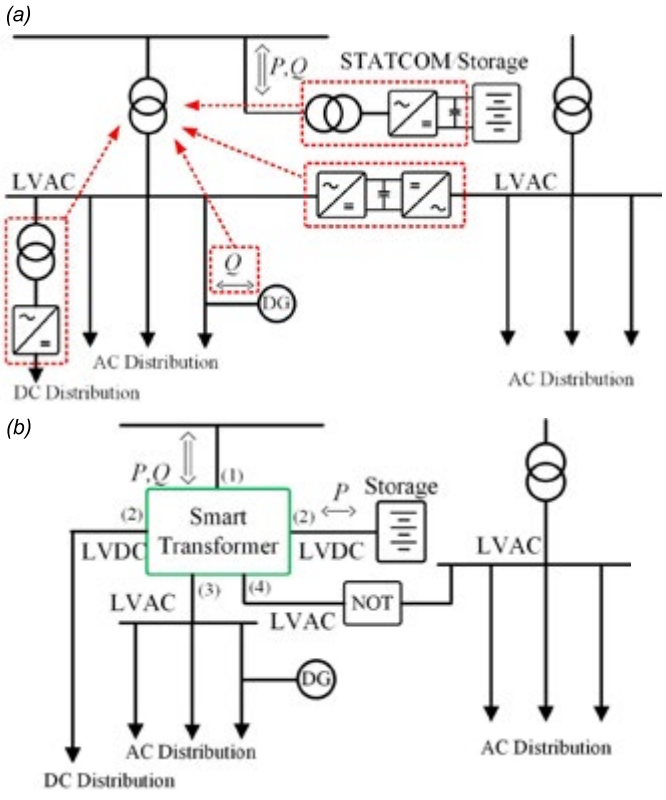

Figure 1: Configuration of (a) current distribution system and (b) ST-based distribution system

On the opposite, the Smart Transformer (ST) solution (Figure 1(b)), a solid-state transformer-based transformer, introduces higher grid controllability and provides DC connectivity to loads and generators and at the same time saves the infrastructure cost avoiding extensive grid upgrades [1]. Compared to the current distribution grid scenario (Figure 1(a)), all the functions, such as DC distribution, STATCOM/ Storage integration making unneeded or minimize the reactive power integrations from integration and enabling inter-area connection, can be integrated inside the ST. Moreover, the ST represents a solution to implement a semi-decentralized control of the electric grid, where the ST receives the information from the downstream grid and acts as unique control point for the main grid. This avoids the drawbacks of an extreme-decentralization, and thus the complexity of managing large data inputs, actors, controls and decision-making options.

Several ST architectures are possible for the MV-front-end stage: low frequency transformer combined with an AC/DC converter (T1); AC/ DC converter combined with an isolated DC/DC converter (T2) and isolated AC/DC converter (T3), which are selected respect to the DC network demands in real electric system, as shown in Figure 2.

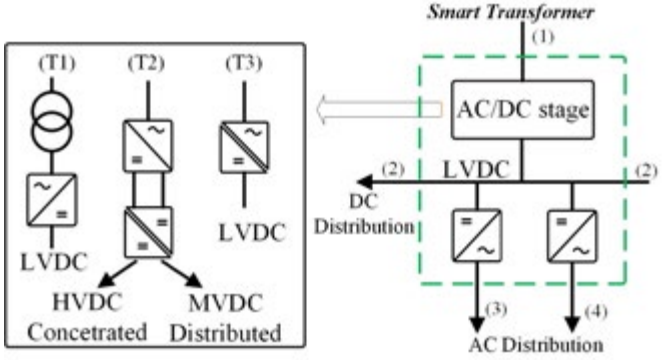

Figure 2: Detail structure of ST: (T1) low frequency transformer and back-to-back solution; (T2) AC/DC converter and DC/DC stage; (T3) isolated AC/DC converter.

Smart Transformer services

The ST acts on three different levels: on MV grid, on LV grid and on DC grids. In this case, a 3-stage topology ST has been considered, in order to show the full extension of services that it can provide [1]. In

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MV grid, the ST controls the AC active current in order to maintain the voltage at the nominal value in the MV DC link. This implies that the ST can regulate the reactive power injection independently from the active power, always respecting the converter ampacity limits. This allows to support the voltage amplitude in the MV grid, and eventually alleviating the overload of the main transformer, reducing the import of reactive current from the HV grid. Furthermore, it can inject higher frequency currents, both active and reactive, working as harmonic compensator for the MV grid.

The DC/DC converter regulates the power flow from the MV to the LV DC link in order to control the voltage in the LV DC link. The presence of DC links can be used as first step for a DC grid infrastructure, where larger DC loads (fast charging electric vehicles stations) and generators (wind farms) can be connected directly in MV DC and small resources, such as household PV, DC street lighting, and slow charging electric vehicle stations, can be connected in the LV DC link.

The LV side converter controls the AC voltage waveform to be sinusoidal and balanced. The ST, in the LV grid, has large possibility to provide services. The possibility to vary the voltage amplitude and frequency enables to shape the fed loads consumption and generators production, allowing fast load control dynamics. As example, it can reduce rapidly the load consumption by means of voltage reduction with the Soft Load Reduction control, offering an alternative to the firm load shedding during large power system perturbations. Alternatively, the ST can operate with the frequency, interacting with the droop characteristics of the local generators, in order to reduce (or increase, if possible) their power production. It has been shown that the reverse power flow from LV to MV grid can be avoided using the frequency control in the LV grid.

The ST can offer also advanced protection features, clearing rapidly a fault (<10ms) and continuing to supply the loads not affected by the fault. As example, in case of single-phase fault, the ST can continue to energize the remaining two phases at nominal voltage, despite one phase is cleared out.

Furthermore, the ST can work as active damper in LV grids. In presence of many small DGs, resonance phenomena may occur. The ST can actively damp these resonances, acting on its own control, without the need of additional hardware in the grid (e.g., active dampers).

A business case for the ST: the LV-Engine project

In the UK, the distribution networks are already experiencing growing connections of electric vehicles, heat pumps and photovoltaics. This has caused existing network assets e.g. distribution transformers reach their thermal ratings or voltage violation from statutory limits are experienced in the LV network. Over-voltage and under-voltage conditions may be experienced at different times of the day depending on different levels of demand/generation. The conventional approach practiced by Distribution Network Operators (DNOs) is to reinforce networks to alleviate network issues and comply with the grid code requirements for quality and continuity of the supply to customers. The traditional reinforcement base case includes the replacement of the transformer with a larger one (e.g., replace a 500kVA with an 800kVA transformer), which is capable of satisfying the additional demand. In addition, the LV cables should be replaced with larger size cables, in order to maintain the voltage within the statutory limits. Whilst these solutions will facilitate the load growth, they are prohibitively expensive, time-consuming and may cause disruptions due extensive costly excavation of public roads and pavements.

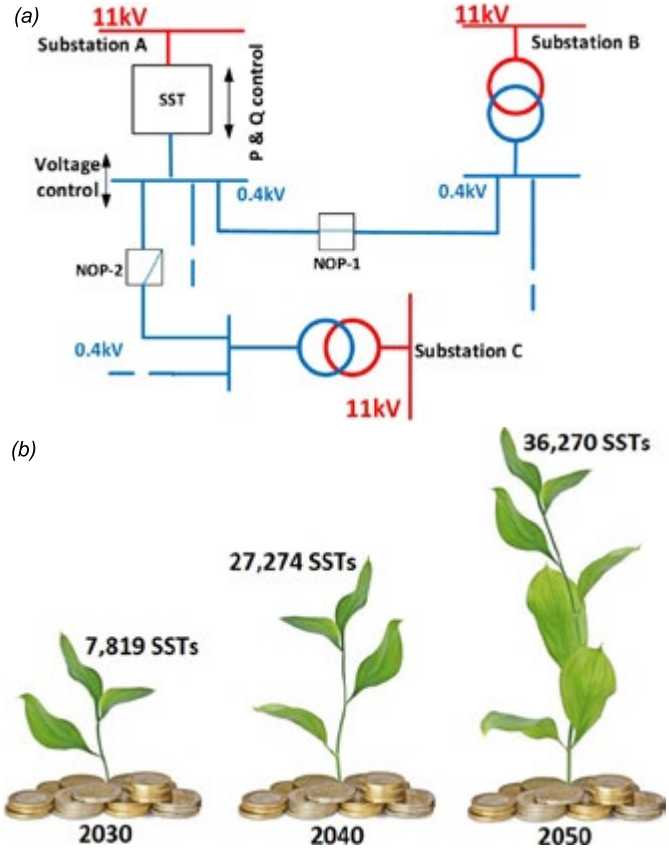

Figure 3: LV-ENGINE project: (a) possible substations interconnection strategy developed in the project; (b) number of foreseen STs in the UK grid.

As an alternative approach, SP Energy Networks, one of the UK DNOs, is planning to trial ST within 11kV/0.4 secondary substations [2]. This project, LV Engine, aims to demonstrate that ST can be used for overcoming the overload and voltage issues within LV networks. The ST, providing higher controllability and more services in the distribution grid, introduces several advantages:

- Reduction in network charging costs: the ST will reduce the network charging costs imposed on customers by avoiding and deferring the costly network reinforcement required in both the LV and MV grids.

- Facilitate access to low cost energy: the ST acts as an enabler of PV connection, due to its voltage regulation feature and availability of DC grid connection.
- Providing scalability to secondary substations: the modular nature of ST allows to increase the substation capacity with limited cost and disruption to customers, by adding additional hardware blocks to meet the demand increase.
- Enabling the transition to DSO: the ST increases the flexibility and adaptability of the LV network. This provides DSO with the tools requires to intelligently and efficiently operate the distribution grid and also delays the point at which the DSO is required to interact with customers to remove local constraints.

The initial estimation showed that there can be considerable deployment opportunity for STs within the UK distribution network, reaching to around deployment within 16% of existing secondary substations by 2050. This estimation has considered other potential smart solutions that may deliver part or full functionalities of ST. The initial cost benefit analysis showed that by deploying STs, there can be total saving of £62m by 2030 and £528m by 2050 at national level.

Our Prototype

A 100kW prototype (Figure 4(a)) has been built in the laboratory of the Chair of Power Electronics at Christian-Albrechts Universität zu Kiel. It consists of a Combined H-Bridge converter at the MV side, connected with quadruple-active-bridge (QAB) module in each phase as shown in Figure 4 (b). The LV DC/AC converter is not currently included in this prototype due to the higher focus on the challenges in the MV and DC/DC stage. Furthermore, the technology for the LV DC/AC converter is already largely available in the market, and thus ready to be integrated in the ST. The voltages of each DC/DC module adopted in this case are 0.8kV for the DC link and 1.5kV in MVAC. In case higher voltages are needed (10kV or higher), they can be reached by simply connecting more QAB modules in series in MV side. In LV side, these modules will be connected, instead, in parallel, in order to satisfy the higher power consumption (and thus higher current) need of the LV grid.

This prototype can be used to test the advanced control strategies, such as: power routing in QAB for system lifetime extension, active thermal control for IGBT reliability improving, power reverse limitation, MVAC voltage support and harmonic compensation [3].

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[1] M. Liserre, G. Buticchi, M. Andresen, G. De Carne, L. Costa, Z. Zou, The Smart Transformer: Impact on the Electric Grid and Technology Challenges, IEEE Industrial Electronics Magazine, Vol. 10, no. 2, pp:46-58, 2016
[2] https://www.spenergynetworks.co.uk/pages/lv_engine.aspx
[3] http://www.pe.tf.uni-kiel.de/en/teachings/industrial-phd-course

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(a)

(b)

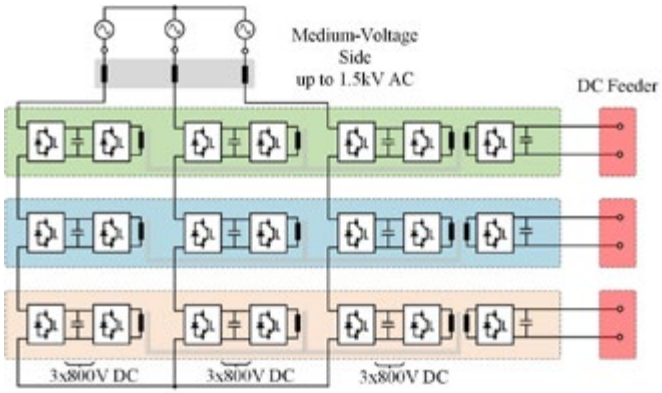

Figure 4: 100kW tested prototype in laboratory (a) photograph and (b) configuration

Power Capacitors Toughen Up for Life with Wide Band Gap Semiconductors

High-efficiency power MOSFETs, rectifier diodes and Insulated Gate Bipolar Transistors (IGBTs) are needed to meet the requirements of power, temperature, and cost placed upon the power conversion industry. As the demand for greater efficiency overtakes other concerns, and the cost of energy continues to increase, technologies such as silicon carbide (SiC) and gallium nitride (GaN) – which have formerly been regarded as exotic and expensive – have become more cost-effective. Moreover, as markets have grown, economies of scale continue to make SiC or GaN transistors and diodes more economically attractive.

By Reggie Phillips, Product Line Manager, KEMET

As these devices become more commonly designed-into power circuits, particularly appliance or EV motor drivers, grid feed-in inverters, and data-centre power supplies, designers need to consider their effects on other parts of the circuit, such as passive components like capacitors, and how these should be designed to help maximise efficiency gains and ensure reliability.

High-Efficiency Power Semiconductors

There are several mechanisms by which power semiconductors such as diodes and MOSFETs deliver significant energy savings. SiC diodes can achieve far shorter reverse-recovery time than conventional silicon alternatives, which allow faster switching. In addition, the reverse recovery charge is much lower leading to lower switching losses. SiC MOSFETs, for their part, do not exhibit the tail current that characterises the turn-off behaviour of conventional silicon IGBTs, and so can reduce turn-off loss by up to 90% while allowing increased switching frequency thereby reducing reliance on external capacitance for smoothing. Also, the wide band gap of SiC allows high-voltage transistors to be designed with an extremely narrow channel, resulting in low RDS(ON) per unit area and so enabling SiC devices in standard power packages to offer lower conduction losses than a comparable silicon device in the same type of package.

The combination of simultaneous low switching and conduction losses, with high breakdown voltage, allows the design of efficient high-voltage circuits that have low distribution currents and associated I2R losses. This is increasingly important in circuits such as data centre power supplies, as servers demand higher power to handle increasing compute loads that come with trends such as greater numbers of subscribers, consumer demand for streaming services, growing reliance on Cloud analytics and storage, and the effect of the burgeoning Internet of Things (IoT).

Design-in Effects on Other Components

Because wide-bandgap devices allow higher operating voltage and higher switching frequencies, lower external capacitance values are needed for filtering and smoothing voltage and current ripple. On the other hand, high operating frequencies demand extra care when laying out the circuit, to minimise unwanted effects such as inductance in PCB traces or cables.

As far as the demands on capacitors are concerned, although the required capacitance values may be lower, high voltage ratings are needed as well as small case sizes because power circuitry is often subject to extreme size constraints: for example, Cloud-server designers want to maximise board real-estate for processors and FPGAs to handle high compute loads, while EV designers demand small inverters to aid with overall packaging of the vehicle.

Designing-in wide-bandgap semiconductors also requires components to withstand higher ambient operating temperatures. SiC or GaN devices can operate at higher temperature that conventional silicon devices, with equivalent reliability. SiC-based semiconductors in the market today can operate at over 200°C with voltages in the range 400V to 3500V. System designers can take advantage of this to simplify thermal management and hence reduce overall cost and size: a smaller, lower-cost heatsink can deliver significant economies for an appliance maker; data-centre operators can benefit from lower server-room air-conditioning costs; or a smaller-capacity EV-inverter cooling system can help reduce vehicle weight and cost.

Because the higher switching frequencies generally employed with wide-bandgap devices demand short conductor lengths to minimise unwanted inductance, components like capacitors tend to be placed closer to the hot power semiconductors. Hence, not only are increased capacitor temperature ratings required, but designers also require greater temperature stability to ensure adequate capacitance at the typical steady-state operating temperature. Capacitor Equivalent Series Inductance (ESL) and Equivalent Series Resistance (ESR) should also be low to minimise unwanted self-heating and high-frequency induced voltages.

Enhancements to Capacitor Design

Demand for capacitors capable of operating up to 200°C has typically

been confined to specialist markets such as defence or down-hole drilling. Various capacitor technologies have been applied, such as tantalum capacitors with liquid sulphuric acid electrolyte. These are not suitable for widespread use in consumer equipment. Although tantalum capacitors with safe solid electrolyte have been developed in surface-mount packages rated for operation up to 200°C, these are typically available with voltage ratings of 10V to 35V and in EIA 7343 case size that make them most suitable as bulk capacitance.

Multi-Layer Ceramic Chip Capacitors (MLCCs) have been developed for down-hole drilling applications, featuring precious metal inner electrodes to allow temperature ratings of 260° or higher. However, from a cost perspective, precious metal technology is not desirable in consumer or high-volume applications.

KEMET has developed MLCCs rated for operation up to 200°C, featuring C0G dielectric and nickel Base-Metal Electrodes (BME), delivering a cost-effective alternative in voltage ratings of 200V as well as 500V and 2000V to meet the needs of the down-hole drilling market. These devices benefit from low leakage current, low dissipation factor, low ESR and ESL, and relatively long lifetimes at temperatures up to 300°C. Moreover, the effective capacitance has been shown to change very little with temperature or applied voltage, thereby assuring designers of stable capacitance and high reliability at sustained high operating temperatures.

Figure 1 shows the results of a comparison between a 33nF, EIA 2824 surface-mount nickel BME C0G capacitor, and a 10nF radial-leaded 500VDC X7R precious-metal electrode capacitor, over temperature, with a continuous 500V DC bias applied. When voltage is applied, the capacitance of the X7R capacitor falls by 25% of its rating. At 200°C, the capacitance is more than 50% lower than the specified nominal value. In contrast, the BME MLCC C0G capacitor displays minimal capacitance change across the entire temperature range.

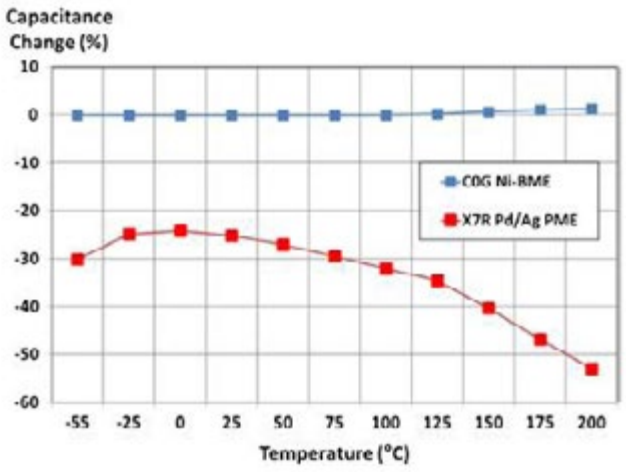

Figure 1: C0G BME MLCC displays superior capacitance stability over temperature at 500V DC bias.

In addition to high-temperature capability and stable capacitance, BME MLCCs can also be designed to minimise capacitance loss and device failure due to cracking of the MLCC layers as the board substrate flexes. For applications where there is a high mismatch in the coefficient of thermal expansion (CTE) between the capacitor and PCB substrate, leaded or stacked capacitor packages can tolerate greater flexing or mechanical stresses.

Transient Liquid-Phase Sintering

In the TLPS process, an alloy that has low melting point reacts with an alloy that has a higher melting point to form a metallurgical bond between two surfaces. KEMET utilises two TLPS processes for assembling high-temperature capacitor packages for its KONNEKT technology. One of the TLPS processes is based on copper-tin (CuSn) alloys, reaches a maximum sintering temperature of 300°C for 30 seconds, and has been used to bond the leads of radial and axial conformal-coated MLCCs. When compared with capacitors assembled using conventional soldered or welded leads, the SnCu TLPS interconnects have maintained high shear strength at the over-molding process temperature of 275°C, whereas the soldered and welded joints have displayed minimal shear strength. An alternative process based on indium-silver (InAg) alloys has also been developed, which increases immunity to embrittlement in larger components such as stacked MLCCs.

KEMET's KONNEKT technology enables high power density by combining multiple components into a single surface mount package and serves the growing number of applications where high-power density in a small form factor is required.

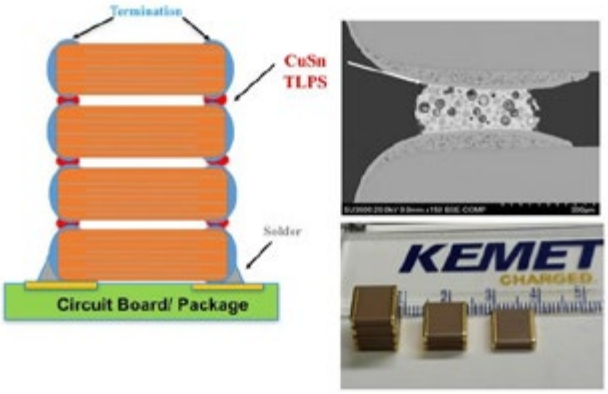

Figure 2: KEMET's Leadless Stack using KONNEKT technology.

Conclusion

Wide-bandgap power transistors and diodes will become increasingly used to help raise power-conversion efficiency, reduce circuit size and simplify thermal management. Designing with these devices requires reassessment of associated, external components such as capacitors. These must be suited to higher switching frequencies, operating voltages, and ambient temperatures. New families of MLCCs meet designers' demands, leveraging newly-developed transient liquid-phase sintering to enable leaded packages to withstand high over-molding temperatures and continuous circuit operation at up to 200°C.

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Easy Monitoring of Multiple Voltages

Supervisory ICs are small monitoring modules that, with their own voltage references, can monitor voltage supplies in electronic systems. If the monitored voltage is higher or lower than a set value, an alarm is emitted and the system can behave according to a defined pattern. These modules have been used successfully for many years now.

By Frederik Dostal, Analog Devices, Inc.

Today's electronics frequently require many different voltages—some for analog and others for digital circuits. Several supervisory ICs are necessary for reliable monitoring. With a multiplicity of different voltages, the question as to whether or not sequencing—that is, ordered rise and fall of the individual voltages—should be implemented arises. A corresponding monitoring system is extremely complex and difficult to implement.

To simplify the monitoring of voltages, there are comprehensive digital solutions that can be easily operated via a simple graphical user interface (GUI). LTpowerPlay® is an example of one.

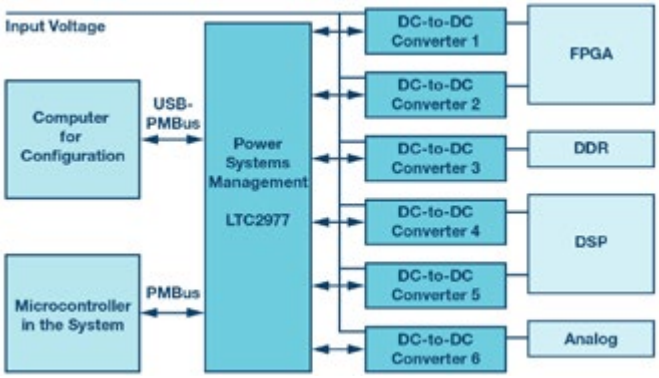

Figure 1: Block diagram of a digitally controlled voltage supply system.

Figure 1 shows a system configuration illustrating how an arbitrary number of analog dc-to-dc converters can be connected to the digital control system. Monitoring modules, such as the LTC2977, can be controlled and programmed via a PMBus™ connection. This is done on a computer via a USB interface or in the field with a microcontroller (if present). An LTC2977 monitoring module also functions autonomously without any digital connection after it has been set.

Figure 2: Simple monitoring with graphical dashboard under LTpowerPlay.

Possible functions of this module are the controlled power-up and power-down of a dc-to-dc converter to enable adherence to a specific control sequence. The set output voltages of the dc-to-dc converters can be changed dynamically. This can also be used for more precise adjustment of the respectively generated voltage. For this, the respective output voltage is measured and then a current is impressed via a connection on the respective feedback pin to change the voltage generated by the dc-to-dc converter. If necessary, an additional shunt can be used to enable current measurement.

Figure 2 shows the free LTpowerPlay software and the measured parameters on its user-friendly dashboard. It is installed on a computer and, via a USB interface, can communicate directly with the digital PMBus port on the LTC2977 or with another one of the many power system management (PSM) modules. There are a plethora of dc-to-dc converters with built-in PMBus ports available. They can be directly connected to the PMBus and then also simultaneously controlled via the LTpowerPlay software.

If numerous different voltages have to be monitored, things can quickly get complicated. That's why it is important for setting and monitoring software to maintain a clear overview. If there is a fault in a generated voltage, the last monitored values are saved in an EEPROM to enable subsequent analysis for determining where the problems occurred. This can be very helpful for fault localization in the case of field returns. Device families can also be improved by means of this information.

Digital control and monitoring of a voltage supply system is useful for different applications and opens up a multitude of possibilities that could only be generated with great difficulty with pure analog signals.

About the Author
Frederik Dostal studied microelectronics at the University of Erlangen- Nuremberg, Germany. Starting work in the power management business in 2001, he has been active in various applications positions, including four years in Phoenix, Arizona, working on switch mode power supplies. He joined Analog Devices in 2009 and works as a power management technical expert for Europe. He can be reached at frederik.dostal@analog.com.

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Wide Band Gap semiconductors have become mature during the last decade. We are facing a change of semiconductor power switches away from Silicon to SiC and GaN. It is important that systems design engineers get involved in the advanced design work using wide band gap devices for their next project. The experts from the semiconductor manufactures and the early users are important to teach the field their experience and take the barrier down using new technology.

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Modern Electric Motor Technology & Applications

The benefits of Brushless Motors have been marketed in recent years, reference vacuum cleaners and portable drills for example. Motors with/without integrated permanent magnets are finding their way into a plethora of new generation products including appliances and electric vehicles. Hence electric motor technology is firmly back in the media with a consequential increase in public awareness. This article reviews where these motors and their hybrids originate, some pros/cons and the associated control complexity. Understanding this plus the trade-offs and algorithms can assist with optimizing a complete motor control system design.

By Martin Hill CEng, MPH Technical Consultancy Ltd

As companies seek to differentiate their products they are paying attention to efficiency. The latter word has many context related meanings:
For example, a product which reduces the amount of time required to complete a task like vacuum cleaning your house would be deemed to be efficient by the end user. Here we also have robot technology available to let humans do less manual work and have more time to play!
Similarly so, if a product is lighter in weight, maneuverable and easier to use by a human operator.
In fact, there are many scenarios for illustrating the efficiency point and so far, designers could address this without necessarily focusing on the motor design in detail.

However, today's product standards are increasingly focused on reducing power consumption and labeling products for public awareness accordingly. This has spawned from the appliance market and is trending in others. It also impacts motors sold on the open market for Industrial applications by way of example. So, there is a move toward product refinement involving each of its sub systems. However, the cost constraint also makes the time to move to improved technology a moving target.

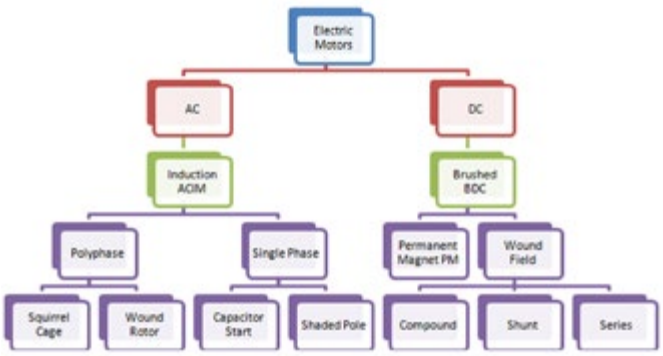


Figure 1: Motor Technology - Historical Perspective & Predominant Types

Motor technology continues to be refined but the supply and demand of key raw materials can dramatically influence product competitiveness. For example, there was notable impact when permanent magnet temperature stabilizing elements availability was restricted in China. When this happens, the phone tends to ring from concerned OEMs seeking alternatives. Some would say this is business as usual!

So, let's look back at history and where and why some specific motors types are being deployed in new generation products.

Motor conception goes back several hundred years and thereafter fundamental types evolved to leverage AC & DC power availability. Control via electrical engineering methods and components was limited in contrast to today. In the 20th century the ACIM (AC Induction Motor) tended to be used with fixed speed applications (predominantly fans and pumps) and for variable speed the DC motor was deployed especially in process control applications and railway traction. The ACIM became the industrial workhorse with lower maintenance requirements. Both types scaled to MW power machines and Industry was the major user of electric motors.

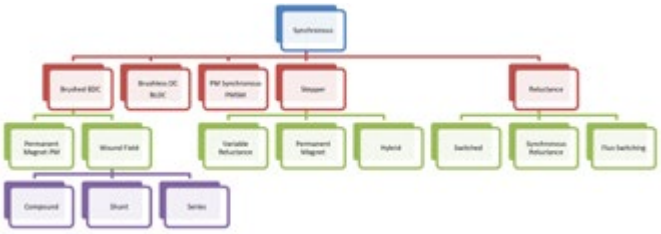


Figure 2: Motor Technology - Era of Electronic Control & More S ynchronous Types

With electronic component availability starting in the 1950s and 60s improved motor control was enabled and further motor types were developed or refined. Thus, the dependence on either AC or DC supply was removed through electronic conversion. Therefore, the overall main motor types categorization could be changed to Asynchronous and Synchronous from AC/DC. The number of smaller motor applications increased with deployment in the home and car. Especially for the automotive application the brushed and brushless DC motor (synchronous) have been dominant and similarly the ACIM (asynchronous) for appliances in the home.

Hybrid Motors

Hybrid infers evolution and for an electric motor we can think of this as a combining of torque producing mechanisms. The physics behind this leads to three fundamental principles/forces:

- Reluctance Force – the tendency for a ferrous object to align itself in a magnetic field
- Induction principle – the rotor magnetic field & current is induced by motion of the rotor through the stator magnetic field (which is also rotating)
- Permanent Magnet Force – Magnet(s) being used to replace coil(s) which would produce an equivalent MMF (Magneto Motive Force)

to the MTPA (Maximum Torque per Ampere) being extracted from the motor, which is a refinement that can yield a few percentage points efficiency gain if the reluctance torque contribution is small.

Figure 3 shows the classic design topologies. As the names suggest the IPMSM has magnets placed inside or embedded in the rotor whereas the SPMSM has them placed on the surface. The key thing is the SPMSM rotor magnets can be made into an effective contiguous magnetic assembly whereas the IPMSM has defined boundaries and gaps between. These give a path for the reluctance force to come into effect and hence there is a torque contribution which can be leveraged

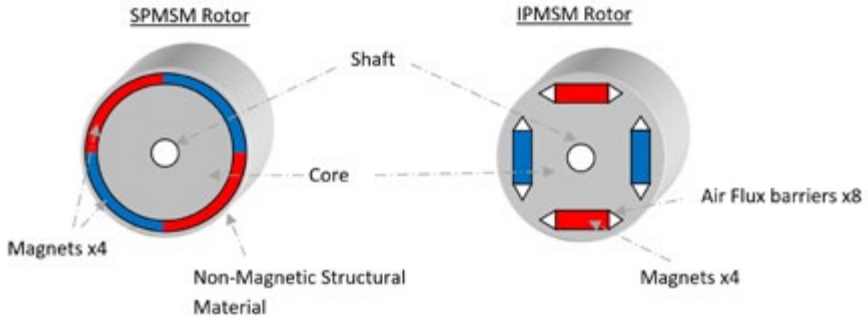


Figure 3:
IPMSM & SPMSM (Surface Permanent Magnet Synchronous Motor) Rotor Constructions

Designing in a combination of these leads to a Hybrid motor. This affords versatility in machine design with multiple modes of operation possible.

The IPMSM (Interior Permanent Magnet Synchronous Motor) is an example hybrid design which leverages permanent magnets but also reluctance force. The contribution of each can be tailored by the machine designer and accounted for using an advanced control algorithm. Embedding the fundamental motor equations or model inside the firmware breaks out the two torque producing components and a commutation angle compensation is calculated. This leads in addition to say the main torque coming from the magnets.

Additional advantages of the IPMSM over SPMSM include:

- Field weakening capability
- Under-excited operation for most load conditions
- Permanent magnet demagnetization mitigation
- Robust mechanical design

The IPMSM has been applied in Modern HEV (Hybrid Electric Vehicles) and other applications seek some of the benefits, HVAC and Appliances for example.

Motor Type	Pros	Cons
ACIM (Squirrel Cage)	Repairable, Technology Familiarity, Robust, Speed range	Rotor Losses, Power density,
BDC	Controllability, Low speed performance	Maintenance, noise
SPMSM	Efficiency, Power density	Temperature Dependence, Constant power range, Cost
Switched Reluctance	Simple Construction, Low cost, Reliability	Power density, noise

Table 1: Motor Types - General Pros and Cons

There is not an all round winner but hybrid designs pave the way

Control Complexity

Particularly in hybrid motor system design attention to detail and additional control complexity is required to extract the best performance for a given application. A one size fits all approach is not applicable. However, there are some fundamental algorithm building blocks and customizable/application centric ones which can be leveraged. On top of that additional application centric refinements and modes are designed in for an effective expert form of control. The complexity is affected by a range of design requirements, one of the key things is if the application will use a rotor position sensor or not. The other is getting the interactions between all the control sub systems to work seamlessly across the speed range and operating conditions.

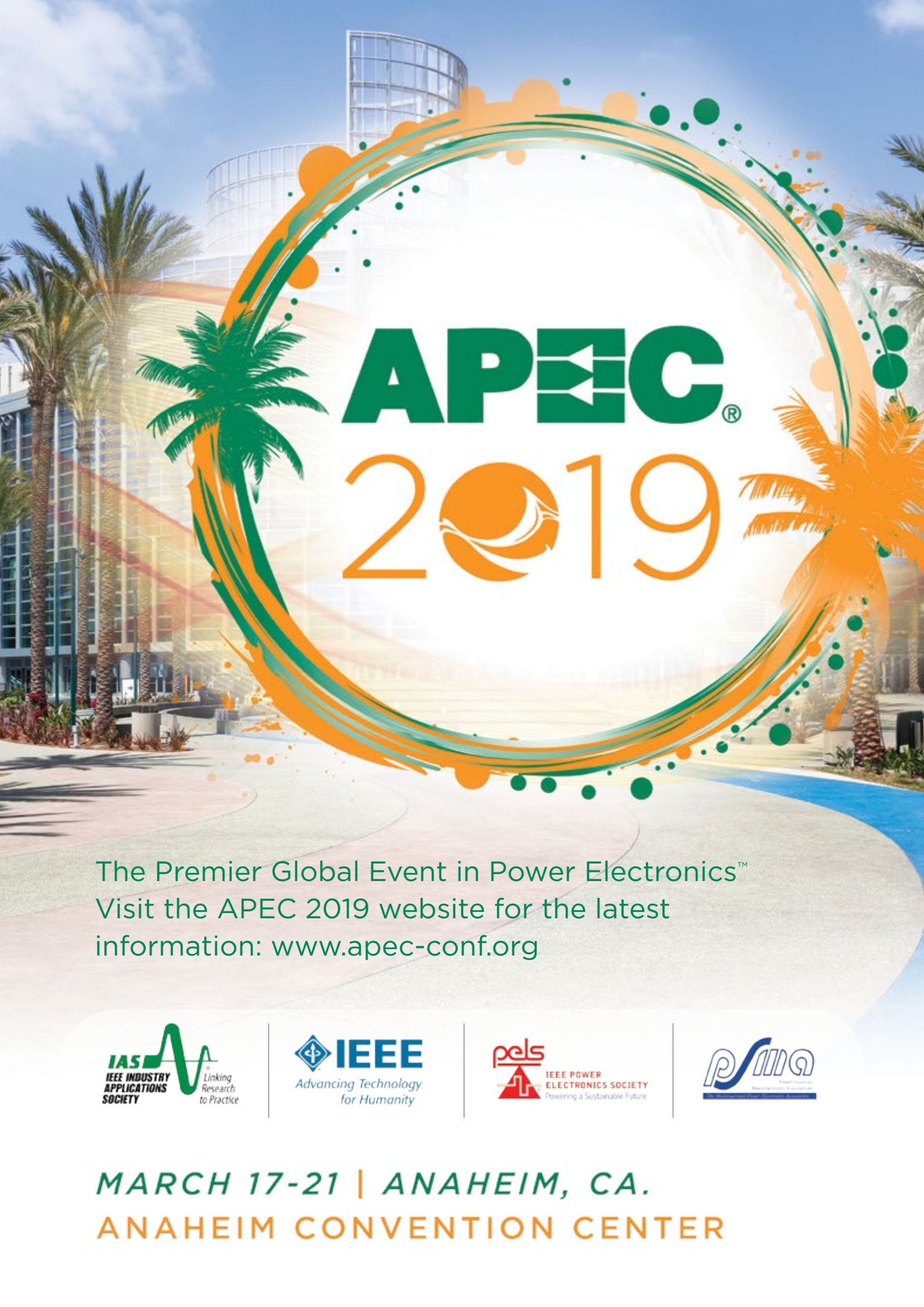
The digital control element needs to have enough resources and especially bandwidth to serve all this complexity and application refinements. The trend is most definitely to optimize the motor control system, focus on safety, problem reporting and even add functions such as predictive maintenance scheduling. The latter could be a distributed scheme using cloud based servers. Hence the software tasks need to be scheduled to cope with the hard-real time performance demands alongside everything else. Here the designer has options to create a modular or single chip implementation and in support there are evolved devices available to consolidate the solution. This invariably comes down to the target market and volume but the baseline is shifting, meaning the lower cost products are becoming more complex.

Conclusions

Advanced motor control used to be name tagged to Field Oriented or Vector Control and associated with DSPs (Digital Signal Processors). However, the new era heralds further attention to detail because evolution, legislation and remaining competitive demands it. Systems are therefore more complex and resources scale up accordingly. To make expert systems is for sure an engineering challenge and extracting small percentage efficiency gains helps enable the way to the optimized/green world we are striving to make. Refinement and development of motor designs and their control algorithms is key.

About the Author:
Martin Hill spent that the last 14 years working for Microchip, largely on motor control and spanning most market areas/applications. He was World Wide Motor Control Function Group Leader before starting his own technical consultancy business.
Contact details @ http://www.mphelectronics.co.uk/

www.mphelectronics.co.uk



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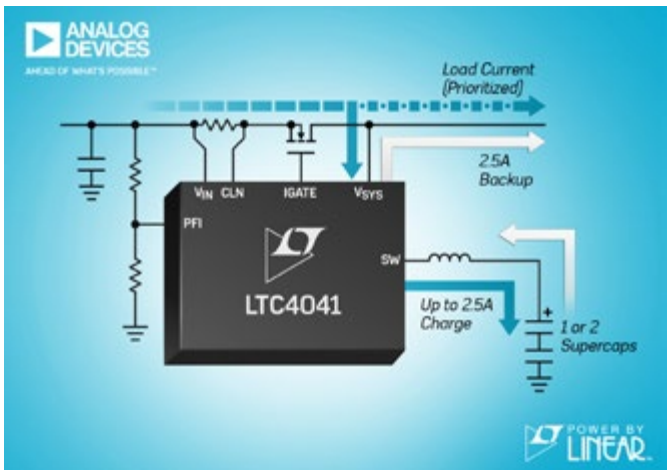
Integrated 2.5A Backup Power Manager

Analog Devices announces the Power by Linear™ LTC4041, a complete supercapacitor backup power management system for 2.9V to 5.5V supply rails that must be kept active during a main power failure. Supercapacitors have higher power density than batteries, making them ideal for systems requiring high peak power backup for short periods of time. The LTC4041 uses an on-chip bidirectional synchronous converter to provide high efficiency step-down supercapacitor charging, as well as high current, high efficiency boost backup power. When external power is available, the device operates as a step-down battery charger for one or two supercapacitor cells while giving preference to the system load. When the input supply drops below the adjustable power-fail input (PFI) threshold, it switches to step-up regulator operation, capable of delivering up to 2.5A to the system load from the supercapacitor. During a power fail event, the device's PowerPath™ control provides reverse blocking and a seamless switchover from input power to backup power. Typical applications for the device are include ride-through "dying gasp" supplies, high current ride-through 3V-5V uninterruptible power supplies (UPSs), power meters, industrial alarms, servers and solid-state drives.

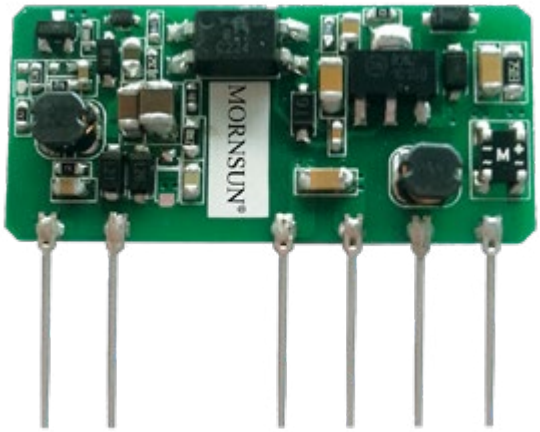


It includes an optional overvoltage protection (OVP) function using an external FET which can protect the IC from input voltages greater than 60V. An internal supercapacitor balancing circuit maintains equal voltages across each supercapacitor and limits the maximum voltage of each supercapacitor to a predetermined value.

www.analog.com/LTC4041

Ultra-wide Input Voltage AC/DC Converters

Mornsun recently introduced 5W ultra-wide input voltage SIP AC/DC Converters LS05-26BxxSS (-F) series after the launch of the 3W LS03-16BxxSS series (SIP) and LD03-16Bxx series (DIP). This series have a wide input voltage range of 90-528VAC, and meet the power requirement of supporting any two-wire connection in nominal voltage 380/220VAC of three-phase four-wire. The design meets the UL62368/ EN62368 (pending)/IEC62368 standards, and input to output isolation voltage is as high as 4000 VAC. They provide output short-circuit protection and over-current protection, featuring higher reliability than discrete power supply solutions. In addition, small board space and high integration levels are required for extremely space-constrained systems. The unique SIP package design is particularly suitable for these small-size applications, and customers can use different peripheral circuit to meet different requirements.



www.mornsun-power.com

650 V TRENCHSTOP™ IGBT6 for Small Motor Drives up to 1 kW

Infineon Technologies introduced the next generation TRENCHSTOP™ IGBT6 technology. With a 650 V blocking voltage the discrete device is optimized for specific applications demanding long lifetime, high reliability and efficiency. These are especially major home appliances and small home appliances, industrial sewing machines and general purpose drives which can be found in e.g. fans, pumps and other BLDC motors. The trench and field-stop technology co-packed with a soft, fast recovery anti-parallel Rapid 1 diode translates into reduced losses. The building block for motor drives up to 1 kW is marked by a good thermal performance, especially at higher switching frequencies improving reliability and design margin. Key features of the 650 V TRENCHSTOP IGBT6 are very low V CE(sat) and V f as well as a short-circuit protection capability of 3 µsec. It is optimized for switching frequencies ranging between 5 kHz and 30 kHz and suitable for applications that need to control the EMI noise efficiently.

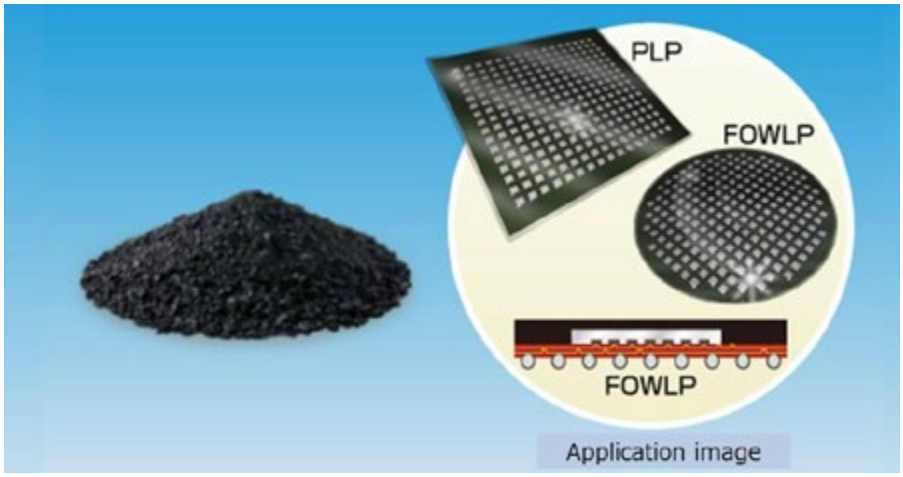
Availability

These are the first devices in the new 650 V technology family. Other package types will be introduced 2019. Commercial samples of the 650 V TRENCHSTOP IGBT6 can be ordered now.

www.infineon.com/igbt6

Granular Epoxy Mold Compound (EMC) Semiconductor Encapsulation Materials

Panasonic Corporation announced that it has commercialized a granular semiconductor encapsulation material designed specifically for fan-out wafer-level package (FOWLP(*1)) and panel level packaging (PLP(*2)). Sample production is scheduled to start in September 2018. These new products will increase the productivity of these leading-edge semiconductor packages for wearable and mobile devices and reduce their manufacturing costs. Electronic designers and manufacturers are increasingly incorporating more functionality into smaller form-factor products. This trend has driven the development and adoption of semiconductor packaging technologies that deliver lower profile, reduced footprint packages using cost-effective and scalable processes. PLP offers the promise of significantly reduced costs because of the large number of semiconductors that can be packaged in each molded panel. Encapsulation materials of these semiconductor packages need to uniformly encapsulate large-area formats like wafers and panels without warpage while exhibiting excellent adhesion to the other structures within the package. The newly commercialized granular epoxy mold compounds meet these requirements. Panasonic has developed a portfolio of semiconductor encapsulation materials for FOWLP and PLP. In addition to the newly commercialized granular epoxy mold compounds, Panasonic also offers sheet-format encapsulants (suitable for encapsulation thicknesses of 200 µm or less), as well as liquid encapsulation products.



www.panasonic.com

Multi-Channel Mini LED Driver for Digital Signage

MagnaChip Semiconductor announced it now offers a multi-channel Mini LED Driver for the rapidly growing digital signage market, leveraging the company's more than 10 years of experience with BLU LED drivers in the television set market. As digital signage and media façades are installed outdoors, the display size can range up to several hundred inches, which requires a much higher level of technology and reliability than found in television sets. For LED panels used in digital signage, about 1,000 LEDs per square meter are used. This results in a situation where the capability of the LED driver must be doubled or even tripled for the most cost-effective scenario. For example, compared with existing LED drivers in the market capable of controlling 12-channel or 16-channel LEDs, MagnaChip's new Mini LED Driver for digital signage is able to drive 36-channel LEDs concurrently, featuring high density, reduced energy consumption and more efficient product designs.
The Mini LED Driver uses 12 Bit Grayscale PWM (Pulse Width Modulation) to enable the 4,000-step PWM control and a sophisticated LED current control. It also provides 64-step output current control, which enables not only detailed graphic representation, but also accurate depictions of a variety of pictures and images according to the brightness of the contents.

www.magnachip.com

Plug-and-Play Wireless-Charging Kit for Wearables and IoT Devices

The STMicroelectronics plug-and-play wireless battery-charger development kit (STEVAL-ISB045V1) lets users quickly build ultra-compact chargers up to 2.5W with a space-saving 20mm-diameter coil, for charging small IoT devices and wearables such as smart watches, sports gear, or healthcare equipment. Built around the STWBC-WA wireless charging-transmitter controller, the kit comprises a charging base unit containing a transmitter board with the 20mm coil already connected and ready to use. Getting started is easy, using the PC-based STSW-STWBCGUI software to configure the STWBC-WA and monitor runtime information such as power delivered, bridge frequency, demodulation quality, and protocol status. The kit includes a dongle for running the GUI. The supporting ecosystem includes certified reference boards, software, and detailed documentation to help developers quickly deliver the smallest and best-performing chargers into fast-growing new markets for smart objects and wearables. The STWBC-WA controller chip contains integrated drivers and natively supports full-bridge or half-bridge topologies for powering the antenna. The half-bridge option allows charging up to 1W with a smaller-diameter coil for an even more compact form factor. The chip supports all standard wireless-charging features, including Foreign Object Detection (FOD) and active presence detection for safe charging, and uses digital feedback to adapt the transmitted power for optimum efficiency at all load conditions.

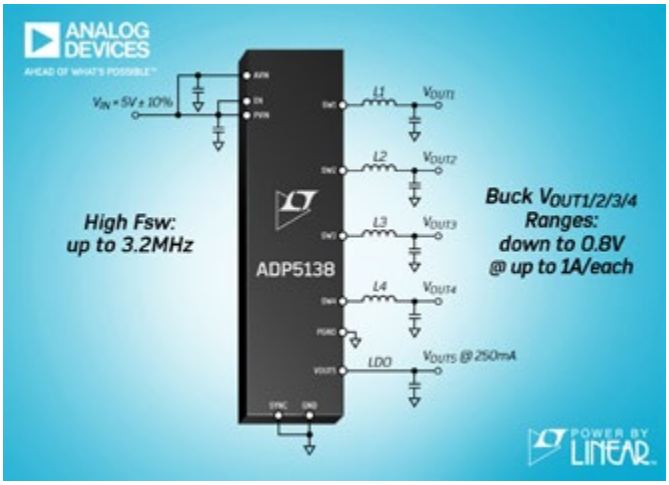
www.st.com/wbc

3.2MHz, Automotive Quad 1A Step-Down Regulators + LDO Reduces Footprint & EMI

Analog Devices announced the Power by Linear™ ADP5138, automotive qualified, high efficiency, 3.2MHz synchronous quad output buck regulators, incorporating a unique fixed frequency, peak current mode, PWM control architecture that reduces conducted and radiated emissions. The device's high efficiency buck regulators improve thermal management, operate down to 0.8V outputs and deliver up to 1A of continuous output current from each channel. Also integrated is a 250mA low output noise (20µVRMS from 10Hz to 100kHz), high PSRR (61dB at 1kHz) low dropout linear regulator (LDO) for powering noise-sensitive devices. This high level of integration and combination of features, in addition to the compact 4mm x 4mm LFCSP package, make it ideal for automotive, industrial and instrumentation systems, as well as DC to DC point-of-load applications where space is at a premium.

View the ADP5138 product page, download the data sheet, order samples and evaluation boards:

www.analog.com/ADP5138



Surface Mount Inductors (SMD) for Lighting

Signal Transformer, a Bel group company, announce their SCIH1040HC and expanded SCIHP1367, SCIHP1350, SCIHP1338, SCIHP0718 and SCIHP0724 Series of Surface Mount Inductors (SMD) for Lighting Applications. These new series of SMD Inductors for Lighting complement existing Signal Series SMD SCRH5D28, SCRH129 and SCMS7D43AY. Emergence of LEDs as the most efficient lighting is driving electronic technology of SMD inductors to ensure that LEDs are powered sufficiently to achieve the highest level of performance and luminescence. Increased importance is also placed on cost savings and quick delivery times by design engineers and OEM manufacturers who specify and build products which include LED lighting, including consumer, commercial, industrial, vehicle and emergency transportation, fire and security, gaming, medical and automation markets. Utilizing an enhanced manufacturing process, Signal has implemented composite molded construction technology, which provides a uniform, seamless powder iron core platform, encapsulating the entire coil structure and exposing only the surface mount terminal elements. This ensures our SMD Inductors for Lighting are footprint compatible and easily substitutable to other manufacturers, as well as highly efficient, with high energy storage, high noise filtering, high saturation current, high moisture protection and low magnetic radiation.

www.belfuse.com/signal

5 Watt AC/DC Modules for Industry 4.0, IoT and Smart Home

RECOM expands its low power AC/DC portfolio with encapsulated 5W power supplies, which operate up to an impressive +90°C. They accept input voltage lines of up to 305VAC and offer peak power capability up to 6W. These modules are ideal for Industry 4.0, IoT and smart household applications requiring features that go beyond the industry standard.

With its RAC05-K/277 series, RECOM introduces 5 Watt AC/DC converters that support peak power needs and are specially designed for extended input lines and reliable operation at extreme temperatures from -40°C up to an impressive +90°C. The series are built to operate from extended input lines with mains voltages from 85VAC up to 305VAC, are EMC compliant to EN55022 class "B" with a minimum 6dB margin on both radiated and conducted readings without the need for external components. At a 1" x 1.25" footprint, these new PCB-mount or wired modules feature fully protected outputs and international safety certifications for industrial, household and ITE for worldwide use. The RAC05-K/277 series is an addition to RECOM's ultra-compact RAC05-K converters with a 1"x1" footprint, as well as the recently released RAC05-K/480, an AC/DC module dedicated for phase-to-phase operation up to 528VAC and exclusive only to RECOM. Wired versions of the RAC05-K/277 series are due to be released in October of 2018. Samples of the pin-versions and OEM pricing are available from all authorized distributors or directly from RECOM.

www.recom-power.com

SimSurfing Design Support Software

Murata has added extra functionality to their popular on-line 'SimSurfing' tool for simulation of the company's capacitor, inductor and filter components. The previous version of the tool allowed visualisation of individual component performance characteristics for impedance, transmission and reflection variation, with frequency and other operating conditions. The new tool features simulation of the application circuits, particularly DC-DC converters, where selection of components is critical for efficient and minimal size/cost designs. SimSurfing is now able to simulate DC-DC converter behaviour at high speed with user-specified variables such as input/output voltages, switching frequency and starting values for filter inductance and capacitance. A particular feature is the ability of the software to predict inductor power loss. This is normally a difficult value to calculate from published data, leaving designers no choice but to measure prototype performance with a selection of components, slowly iterating to an optimum solution. SimSurfing, however, is pre-programmed with a wealth of database information and know-how, accumulated by Murata over decades of evaluation of their products. This enables designers to rapidly come to a final design using real components from the Murata range with their latest performance data. Further enhancements to the DC-DC simulation feature are planned such as inclusion of load transient response, vital for confirmation of converter stability and large signal performance.

www.murata.com/en-eu/tool

MIL-STD-810G Option Available for MagnaDC Programmable Power Supplies

Magna-Power Electronics announced the immediate availability of a new military-standard (MIL-STD) rated ruggedized option for its popular SL Series and XR Series programmable DC power supplies. Tested to MIL-STD-810G functional shock and vibration specifications, the new Ruggedized Option (+RUG) is now available on 235 models spanning power levels 1.5 kW to 10 kW, voltage levels from 5 Vdc to 10,000 Vdc and current levels from 0.2 Adc to 600 Adc.

The Ruggedized Option, specified at time of order with option code +RUG, allows Magna-Power's commercial programmable DC power supplies to be integrated in applications that have high levels of shock and vibration. "Magna-Power products are designed for a broad range of applications An assortment of build options are configured at time of order that tailor a product's performance and functionality to best satisfy customer requirements" said Grant Pitel, Magna-Power's Vice President of Engineering. "The new ruggedization option continues Magna-Power's design trend, in this case, by allowing the company's economical commercial off-the-shelf (COTS) power supplies to be applied in high shock and vibration applications that have historically required specialized solutions."

With the new Ruggedized Option, the 1U SL Series spanning 1.5 kW to 8 kW and the 2U XR Series, spanning 2 kW to 10 kW are rated to comply the following standards:

MIL-STD-810G CHG1 Method 516.7 Functional Shock, Procedure I; which subjects the product to 40G, 11 ms terminal saw tooth pulse; three shocks in each direction along three mutually perpendicular axes, and MIL-STD-810G CHG1 Method 514.7 Vibration; which subjects the product to two hours per axis along three mutually perpendicular axes.

www.magna-power.com

LMG1020 Low-Side GaN Driver, Ideal for High-Speed LiDAR and TOF Applications

Mouser Electronics, Inc. is now stocking the LMG1020 gallium nitride (GaN) driver from Texas Instruments. The single, low-side driver enables efficient, high-performance designs in speed-critical applications such as LiDAR, time-of-flight laser drivers, facial recognition, augmented reality, and class E wireless chargers. The Texas Instruments LMG1020 low-side GAN driver, available from Mouser Electronics, drives GaN FETs and logic-level MOFSETs, enabling propagation delays of just 2.5 nanoseconds and minimum pulse width of 1 nanosecond. The device's drive strength is independently adjustable for pull-up and pull-down edges by connecting external resistors between the gate and OUTH and OUTL, respectively. The robust LMG1020 driver features over-temperature protection and under-voltage lockout to guard against overload and fault conditions, plus common-mode transient immunity of more than 300V/ns, delivering industry-leading system-noise immunity. The LMG1020 is housed in a 0.8 mm × 1.2 mm WCSP package, which minimizes gate loop inductance and maximizes power density in high-frequency applications. The miniscule size allows designers to reduce component count and decrease power supply size by up to 80 percent. The LMG1020 driver features an adjustable dead-time control feature to provide improved efficiency for applications such as DC-DC converters, Class D audio amplifiers, and motor drives.

www.mouser.com/ti-lmg1020-gan-driver

Battery Fuel-Gauge ICs Deliver Lowest Operating Current to Maximize Run-Time

Designers of lithium-ion (Li-ion) battery-powered mobile and portable devices such as wearables, electric bicycles, power tools and internet of things (IoT) products can improve the end-user experience by extending run-time and delivering the most accurate battery state-of-charge (SOC) data in the industry with the MAX17262 single-cell and MAX17263 single-/multi-cell fuel-gauge ICs from Maxim Integrated Products, Inc. (NASDAQ: MXIM). The MAX17262 features just 5.2µA quiescent current, the lowest level in its class, along with integrated current sensing. The MAX17263 features just 8.2µA quiescent current and drives 3-to-12 LEDs to indicate battery or system status, useful in rugged applications that do not feature a display.

Designers of electronic products powered by small Li-ion batteries struggle to extend device run-times to meet user expectations. Factors such as cycling, aging and temperature can degrade Li-ion battery performance over time. Inaccurate SOC data from an unreliable fuel gauge forces the designer to increase the battery size or compromise the run-time by prematurely shutting the system down, even if there is usable energy available. Such inaccuracies can contribute to a poor user experience due to abrupt shutdown or an increase in device charging frequency. Designers also strive to get their products to market quickly due to competitive demands. Maxim's two new fuel-gauge ICs help designers meet end-user performance expectations and time-to-market challenges.

The MAX17262 and MAX17263 combine traditional coulomb counting with the novel ModelGauge™ m5 EZ algorithm for high-accuracy battery SOC without requiring battery characterization. With their low quiescent current, both fuel-gauge ICs minimize current consumption during long periods of device standby time, extending battery life in the process.

www.maximintegrated.com

Microcontrollers and Development Kits for IoT and Touch-Control Applications

RS Components (RS) has announced availability of the SAM L10 and SAM L11 family of 32-bit microcontrollers (MCUs) from Microchip, along with supporting development kits that enable users to experience the high performance levels and integrated hardware-based security delivered by these new ArmR CortexR-powered MCUs. This latest family of Microchip MCUs targets a broad spectrum of potential applications including the IoT and security-in-home automation or smart agriculture, and ultra-low-power applications such as energy harvesting and other low-power industrial use. The devices are also suitable for capacitive touch control applications such as remote controls, automotive door handles or industrial keypads. The low-power SAM L10 and SAM L11 family comprises the industry's first Arm Cortex-M23-based MCUs in a small footprint, delivering enhanced performance and smaller code size compared to Arm Cortex M0+-based devices. The family has achieved an EEMBC ULPMark certified benchmark score of 405, which is more than 200% higher than the nearest competitor devices.

www.rs-online.com/designspark

www.microchip.com

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BGA Package Option for 48V Cool-Power ZVS Buck Regulators

The PI354x-00-BGIZ is the latest addition to the 48V Cool-Power ZVS Buck Regulator portfolio, offering a new BGA package option to the existing PI354x-00-LGIZ LGA series. PI354x Cool-Power ZVS Buck Regulator's

high performance ZVS topology enables 48V direct to PoL without sacrificing performance. With step-down regulation from a higher voltage source, engineers can deploy more efficient power distribution architectures, reduce I2R losses, and eliminate costly and inefficient intermediate conversion stages. Operating from 36VIN to 60VIN, the PI354x regulates an output voltage ranging from 2.2V to 14V and delivers an output current delivery up to 10A. Power delivery can be further increased by using single wire current sharing without any additional components.

The PI354x series is designed for a wide range of applications leveraging higher voltage distribution, including: telecom, network infrastructure, data centers, industrial, battery, and lighting applications.

When used in conjunction with the Vicor front-end products and factorized power products, the PI354x series enables a complete power chain from AC or HVDC (200V+) source to PoL. The PI354x series expands and enhances the Vicor Power Component Design Methodology.

www.vicorpower.com/new-products/cool-power-zvs-buck-regulator

Expands Rail R3 DC/DC converters up to 40W in 2*1 package

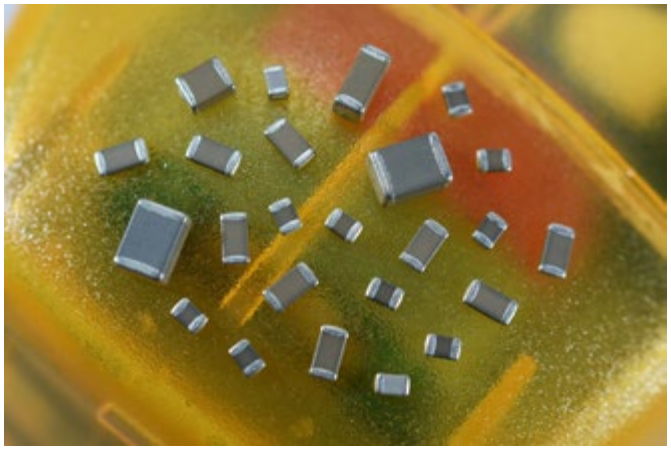
MORNSUN recently launched Rail R3 DC/DC converters URF1D_LD-40WR3, as an extension of the 6-20W rail R3 DC/DC converters.

This series URF1D_LD-40WR3 provides a wide input voltage range of 40-160VDC required by input voltages of 72V, 96V, 110V in railway industry. Outputs and isolation voltage up to 3000VDC/1500VAC ensure them to meet the railway locomotive EN50155 standard requirements and EN62368 standard requirements. The converters also offer a wide operating temperature range of -40° to +85°. Protections for input UVP, OSC, OCP, OVP and OTP are also included. Housed in 2*1 inch DIP package, this URF1D_LD-40WR3 series is available for packages with optional heat sink in PCB mount, chassis mount and DIN rail mount, which offers flexibility to the designer of the end-product and makes this series ideal for applications in railway monitoring, lighting equipment, information display and other railway vehicle-related equipment.

www.mornsun-power.com

Increasing AEC-Q200 Product Offering

Under the Syfer brand, the AEC-Q200 series of MLCC capacitors has had a range extension increasing the available working voltage from 2kV up to a maximum of 4kV. Designed for EV applications where ever higher voltages are needed, but where a margin for derating has to be accommodated for - ideal for power train use, like battery management and invertors. Available in X7R dielectric, and with capacitance up to 22nF, this extension joins an already comprehensive offering of Syfer AEC-Q200 qualified MLCC capacitors and complements the extensive AEC-Q200 qualified components KPD offer. Available as standard with KPD's lead-free, RoHS and REACH compliant, FlexiCap termination for crack prevention and high number thermal cycle withstand.



For those automotive applications that require High Q, low loss MLCC's the Syfer branded 'X8G HighQ series now also has AEC-Q200 qualification. These low ESR HighQ parts are manufactured with a Copper electrode for optimum performance at high frequencies and are rated to work over the temperature range -55ºC to +150ºC. The capacitance range of 0.3pF to 100pF is covered, with rated voltages up to 500V. They will also find a home in many other applications such as networking & wi-fi, as well as use in safety systems such as radar. Again, lead-free RoHS and REACH compliant termination options.

www.knowlescapacitors.com

Fully Integrated, Monolithic Power Monitoring IC with Reinforced Isolation

Allegro MicroSystems has released a fully integrated, small form factor, power monitoring IC with reinforced voltage isolation. Allegro's ACS724 and ACS711 Current Sensor ICs are commonly used in internet connected power outlets and other IOT devices. The ACS71020 improves upon these popular ICs by including power sensing functions and by eliminating power and isolation components that would otherwise increase the cost and the size of customer systems.

The ACS71020 IC builds upon Allegro's innovative Hall-effect current sensor IC technology by adding line voltage sensing (to voltage levels > 500 VRMS) and a dedicated metrology engine that digitally calculates detected power levels. This enables the first power monitor IC that can be powered from the same voltage supply as the system microprocessor, without needing digital isolators or multiple power supplies.

Allegro's power monitor IC simplifies common power measurements by offering digital computation of parameters including active, reactive and apparent power. These power values can be read out through I²C or SPI. The IC also includes dedicated pins for voltage zero crossing (suitable for light-dimming applications) and fast overcurrent fault detection (for sensing short-circuits). The ACS71020 eliminates the need for opto-couplers, dual output isolated power supplies and a current sense-resistor in single phase power monitoring applications.

www.allegromicro.com

Space Fuses Successfully Recertified

SCHURTER and the European Space Agency (ESA) have a long and intensive cooperation in research and development. The MGA-S is an SMD fuse, which is manufactured in thin-film Technology, hermetically sealed and extremely robustly designed with a ceramic housing. Similarly, the HCSF (High Current Space Fuse) fuse was developed for applications with higher rated currents.

Following an intensive evaluation and qualification process, SCHURTER also received the certification of the HCSF fuse in January 2016. Eight years after the successful qualification of the MGA-S, SCHURTER is still the only Swiss company and also the only European supplier of fuses with this qualification.

Both fuses meet the extraordinarily demanding requirements of the space industry, such as consistent properties in high vacuum operation or accelerations up to 1600 g. Since 2008 SCHURTER has been producing MGA-S fuses according to the agreed product requirements. The evaluation phase for the development of the requirements and solutions took four years. Each individual space fuse is subjected to a screening test. All measured values are recorded and handed over to the customer together with the delivery in a batch documentation. In requalification processes recurring every two years, ESA checks compliance with all technical production measures on the basis of defined qualification criteria. Currently, space fuses are used to protect redundant systems in satellites against short circuits or to switch them off specifically so that a replacement system can take over the function. Communication systems are also specifically switched on and off, for example to send data packets at a specific time. These switching characteristics cause high pulse loads when switching on, which must be absorbed by the fuses without tripping and without influencing their long-term switching off behaviour.

www.schurter.com

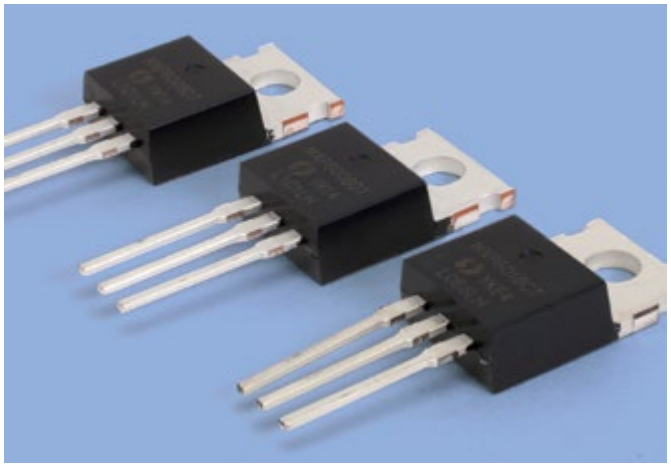
Ultra-Compact Automotive Grade Buck DC/DC Converters

ROHM has recently announced the availability of the BD9S series (BD9S400MUF-C, BD9S300MUF-C, BD9S200MUF-C, BD9S100NUX-C, BD9S000NUX-C). This series of automotive synchronous secondary buck DC/DC converters have a high reliability and low power consumption in a compact form factor with a temperature range of -40 to +125 degree. The products are offered in a leadless package with wettable flanks. This makes them very suitable for using them in applications like radars, cameras and sensors which can be used for assisted driving.

The BD9S series is comprised of a very compact, highly efficiency automotive-grade power supply ICs that include an enable function to adjust the startup time and a PGOOD output indication to improve system functional safety.
This broad lineup of products supports output currents from 0.6 to 4.0A. It is offered in the industry-leading* 2 and 3mm2 space-saving packages that deliver high efficient operation, resulting in a best-in-class power conversion efficiency of 90% (at 3.6V input/1.8V output). Additionally, the current mode control ensures fast response to load transients and combined with a fixed 2.2MHz switching frequency, it prevents interference in the AM Band. This higher frequency allows use of smaller external components, which contributes to a higher degree of miniaturization and power savings.

www.rohm.com

Discrete N/P Channel and Depletion-Mode MOSFETS



Finepower has entered into a sales partnership with the innovative semiconductor manufacturer MaxPower Semiconductor. This cooperation ensures a perfect and targeted response to customer wishes and requirements of individual projects and to supply components, for example with adapted gate threshold voltages.
The product range includes discrete semiconductors such as low and high voltage MOSFETS and IGBTs. According to FinePower, adjustments to existing products or new developments are possible at any time in collaboration with Maxpower. Internationally recognized development experts paired with decades of experience in the field of power semiconductors thus guarantee flexible, easily adaptable processes and technologies in order to quickly react to customer-specific requirements.

www.Finepower.com

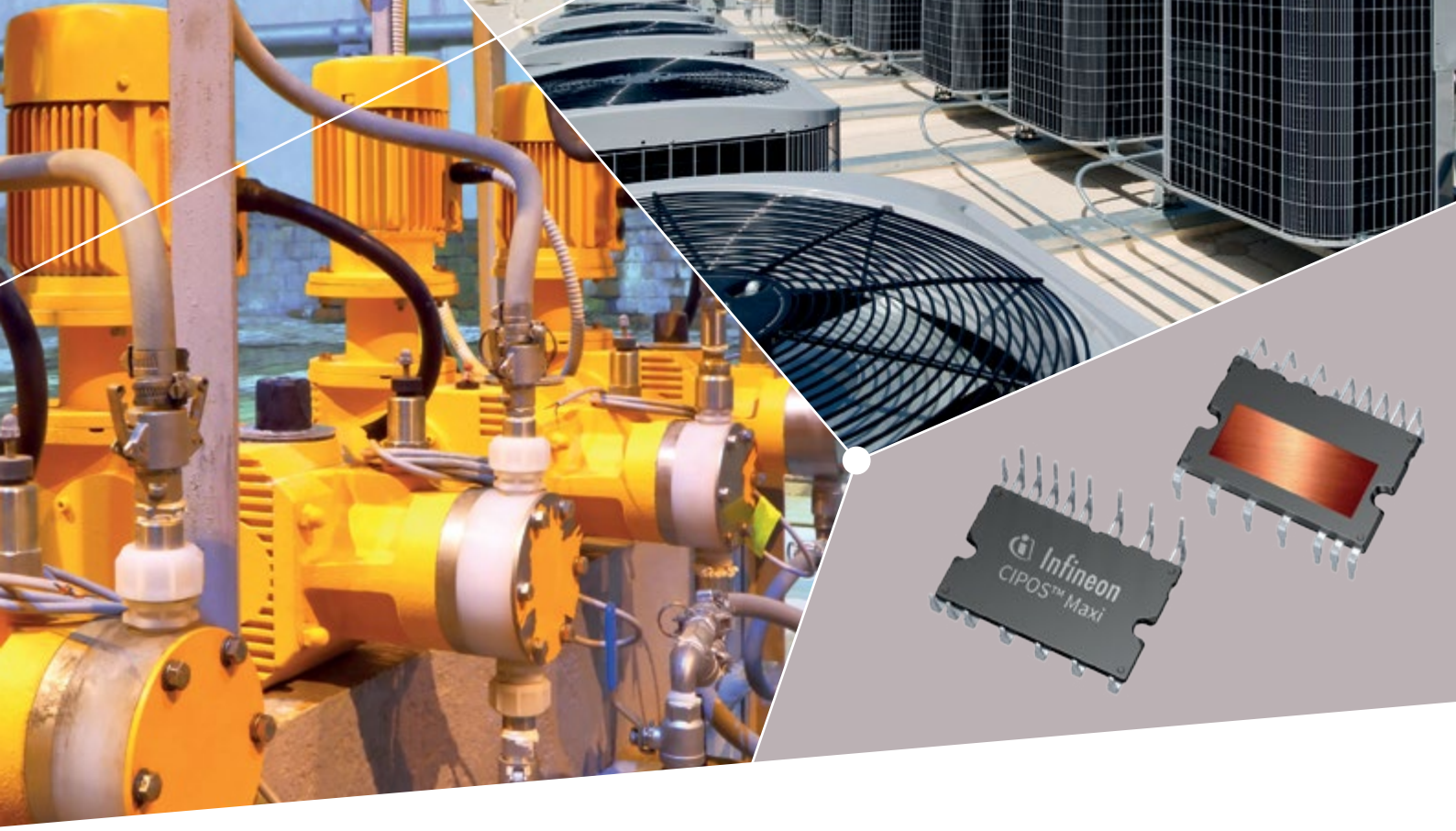
Advertising Index

62Pak

High-quality products for industrial applications.

ABB is a world's leading suppliers of high-power semiconductors, setting standards for quality and performance. Our unique knowledge in the field now expands to industry standard medium-power IGBT. The 62Pak phase leg IGBT modules, featuring 1700 V are designed for low-loss, high performance and the best in class operating temperature capability of up to 175 °C for the most demanding medium-power applications.

abb.com/semiconductors



New high-performance Intelligent Power Modules

CIPOS™ Maxi IM818-series 1200 V/5-10 A three-phase inverter

Infineon's high-performance CIPOS™ Maxi Intelligent Power Modules (IPMs) integrate various power and control components to increase reliability, optimize PCB size and system costs. They are designed to control three-phase AC motors and permanent magnet motors in variable speed drives applications such as low-power motor drives, pumps, fan drives and active filters for heating, ventilation, and air conditioning.

Features

- Totally isolated dual-in-line molded module with DCB
- Equipped with well established 1200 V TRENCHSTOP™ IGBT 4
- Rugged 1200 V SOI gate driver technology with protection against transients
- Integrated bootstrap functionality
- Overcurrent shutdown
- Undervoltage lockout at all channels
- All of six switches turn off during protection
- Cross-conduction prevention
- Multi-function pin

Benefits

- System cost and space saving
- Fast time to market
- Highest power density
- High efficiency
- Broad application range from pump, blowers, fan motors, active filter and low-power general purpose drives

Learn more about Infineon's IPM portfolio.
www.infineon.com/ipm